RELATIONSHIP BETWEEN PHYSICAL ACTIVITY WITH DIETARY INTAKE AND NUTRITIONAL STATUS OF ADOLESCENT GIRLS ATTENDING A PRIVATE SCHOOL IN DURBAN

By

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Submitted as final Assignment

for the qualification of

Masters of Applied Science in Food and Nutrition

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August 2017

Declaration

This work has not previously been accepted in substance for any degree, and is not being concurrently submitted in candidature for any other degree.

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Date: 20 - 8 - 2017

This submission is the result of my own independent work/ investigation except where otherwise stated. Other sources are acknowledged giving explicit references. A bibliography is appended.

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I hereby give consent for my work to be made available for photocopying and for inter library loan, and for the title and summary to be made available to outside organisations and future students.

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Acknowledgements

I would like to extend my utmost gratitude and appreciation to Professor Carin Napier for her endless assistance in the compiling of this Dissertation; without her patience, guidance and support none of this would be possible. I would also like to acknowledge Durban University of Technology's various departments that were utilised during the process of approving and compiling this study as well as the library facility and assistants who make research and technical issues a lesser burden. I would also to thank the editor Michael Vermeer for his patience and willingness to help me get through the various editing stages.

I would like to acknowledge and thank the high school involved for their time, patience and hospitality and to all the school girls and caregivers/ parents who participated without hesitation or complaint. I would like to also acknowledge all the field workers who spent so many hours of their personal time collecting data and making sure all was perfectly in order.

I also need to thank my family and friends for assisting me with basic proof reading and technical help, sometimes at the most inconvenient of times and for bearing with me through the process by rescheduling their personal lives to assist me in the completion of this Dissertation. I cannot express my appreciation enough.

Dedication

I would like to dedicate this research report to my Mother for always being a pillar of strength throughout my life, for the many arguments that we had to get me to go to school and to complete my studies and for always reminding me of the importance of giving my absolute best at all times.

To my Mother, who motivated me and picked me up during the very low times, who rearranged her personal life to assist me at any time without hesitation, and who has always been my number one fan. Without your love and patience none of this would have been possible! I hope I have made you proud.

Abstract

Aim

The purpose of this study was to investigate the nutritional status of adolescent girls attending a private high school in Durban and included an investigation of what food the girls consumed on a daily basis and an account of physical activity they participated in within a one-week period to determine a relationship between the variables.

Methods

Adolescent girls were selected as part of a convenience study at a private high school. A total of 225 adolescent girls aged 13-18 years were surveyed for nutritional status and dietary intake as well as physical activity levels. The parent/ caregiver of each girl who participated was interviewed to ascertain socio-demographic indicators. Data was collected by interviewing the adolescent girls and the parents/ caregivers using pre-designed and pre-tested questionnaires. Weight and height were measured, physical activity levels were identified through the use of a physical activity questionnaire and socio-demographic data was collected by means of a questionnaire. Dietary intake data was gathered over two week days and one weekend day by using a 24-hour recall questionnaire and a food frequency questionnaire (FFQ).

Results

The majority of the participants were from well-off, financially stable families with good living conditions and well-educated and employed parents/ caregivers who provided a more than adequate variety of food and regular meals every day. The girls were of normal BMI (72.2%) and collectively had a mean BMI of 21.9, lower than the South African national average found for adolescent girls. There was a surprising number of underweight individuals (12.6%) as compared to overweight girls (10.3%). Furthermore, 99.6 percent of the girls were of normal height-for-age (≥-2 <+3SD) but were consuming far less energy than is required for the allocated age category. Energy came from the normal recommended macronutrient range with fat being on the borderline higher end of the normal range and carbohydrates coming from the lower end of the normal range; protein sources were adequately consumed. Fruit and vegetable

consumption was reported to be very low subsequently leading to the poor dietary fibre intake identified across the sample group. Supplementation is taken by nearly a third (32.7%) of the girls which may contribute to their overall nutritional wellbeing. Among the top twenty foods consumed, milk, sugar, bread, tea and lettuce were the top five foods in the order stated. Although a wide variety of foods was consumed across all nine food groups over a week period, a mean daily DDS was lower but still adequate with 5.5 and the quantity of foods consumed were not of a substantial enough amount leading to poor total energy consumed and some micronutrient levels such as calcium, magnesium and folate not being met.

All the participants were seen to be fairly physically active, performing a wide variety of sporting activities during school time and after school hours. The girls completed on average 199.64 minutes (SD±134.97) of physical activity per week, which is less than half of the WHO recommended physical activity minutes per week for adolescents. Significant correlations were seen between BMI and physical activity done on the weekend (p=0.041) and BMI and the amount of money spent on food per month (p=0.016) as well as extremely significant correlations between BMI and the number of minutes spent performing physical activities per week (p=0.002), as well as BMI and the amount of sport done over a one week period (p=0.005).

Conclusion

The results confirm that a relationship does exist between the physical activity levels and nutritional status of the adolescent girls surveyed. The majority of the population had low physical activity levels as well as low energy intake, which was supported by an inadequate quantity of food items consumed; however, anthropometric measurements showed to be majority within normal parameters with cases of underweight girls being more prominent than overweight which may suggest that over- and/ or under-reporting may have occurred. A high dietary diversity indicated a higher nutrient intake suggesting the importance of a diversified diet.

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Glossary of terms

%	Percentage
µg	Microgram
ADD	Attention Deficit Disorder
AI	Adequate Intake
AIDS	Acquired Immune Deficiency Syndrome
AMDR	Acceptable Macronutrient Distribution Range
AOA	American Obese Association
App	Applications
BMI	Body Mass Index
Ca	Calcium
CCPHA	California Centre for Public Health Advocacy
CDL	Chronic Diseases of Lifestyle
CHO	Carbohydrates
CSG	Child Support Grants
CVD	Cardiovascular Disease
DBSA	Development Bank of South Africa
DD	Dietary Diversity
DoE	Department of Education
DoH	Department of Health
DoSD	Department of Social Development
DRI	Dietary Reference Intake
DUT	Durban University of Technology
EAR	Estimated Average Requirement
EER	Estimated Energy Requirement
FAO	Food and Agricultural Organization
FBDG	Food Based Dietary Guidelines
FDA	Food and Drug Administration
Fe	Iron
FFQ	Food Frequency Questionnaire
FGDS	Food Group Diversity Score
FRC	Faculty of Applied Sciences Research Committee
g	gram

GAIN	Global Alliance for Improved Nutrition
GNP	Gross National Profit
HDL	High-density lipoprotein
HIV	Human Immunodeficiency Virus
Hr	Hour
IASO	International Association for the study of Obesity
IBS	Irritable Bowel Syndrome
IDA	Iron deficiency anaemia
IDD	Iodine Deficiency Disorder
INP	Integrated Nutrition Programme
IoM	Institute of Medicine
IREC	Institutional Research Ethics Committee
Kcal	Kilocalories
Kg	Kilograms
KJ	Kilojoules
KZN	KwaZulu-Natal
LDL	Low Density Lipoproteins
LSM	Living Standards Measure
M	Metre
Mcg	Micrograms
MDG	Millennium Development Goals
MET	Metabolic Equivalent
Mg	Milligrams
Mm	Millimetre
MRC	Medical Research Council
MTech	Masters in Technology
MUFA	Monounsaturated Fatty Acids
NARs	Nutrient Adequacy Ratios
NBD	National Burden of Disease
NCD	Non-Communicable Diseases
NDP	National Development Plan
NFCS	National Food Consumption Survey
NGO	Non-Governmental Organization
NHANES	National Health and Nutrition Examination Survey

NHS	National Health System
NICUS	Nutritional Information Centre of the University of Stellenbosch
NIRU	Nutritional Intervention Research Unit
NPC	National Planning Commission
NSNP	National School Nutrition Programme
NSP	Nutrition Supplementation Programme
NSSA	Nutrition Society of South Africa
P/M	Per Month
PAL	Physical Activity Level
PAP	Poverty Alleviation Programme
PE	Physical Education
PEM	Protein Energy Malnutrition
PPS	Portable Physician Scale
Prof	Professor
PSNP	Primary School Nutrition Programme
PUFA	Polyunsaturated Fatty Acid
RDA	Recommended Dietary Allowance
RDI	Recommended Dietary Intake
SA	South Africa
SAARF	South African Audience Research Foundation
SADHS	South African Demographic and Health Survey
SAFBDG	South African Food Based Dietary Guidelines
SAMRC	South African Medical Research Council
SANFFP	South African National Food Fortification Programme
SANHANES	South African National Health and Nutrition Examination Survey
SASSA	South African Social Security Agency
SAVACG	South African Vitamin A Consultative Group
SCN	Standing Committee on Nutrition
SD	Standard Deviation
S-DQ	Socio-Demographic Questionnaire
SFP	School Feeding Programme
SFVS	School Fruit and Vegetable Scheme
SGB	School Governing Body
SPSS	Statistical Package for Social Sciences

StatsSA	Statistics South Africa
TB	Tuberculosis
UCLA	University of California, Los Angeles
UL	Tolerable Upper Intake Level
UN	United Nations
UNDP	United Nations Development Programme
UNICEF	United Nations International Children's Fund
UNIDO	United Nations Industrial Development Organization
USA	United States of America
USDA	United States Department of Agriculture
VAT	Value Added Tax
WFP	World Food Programme
WHO	World Health Organization
WHZ	Weight for Height z-Score
Zn	Zinc

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CHAPTER ONE

THE PROBLEM AND ITS SETTING

1.1 Introduction

Malnutrition has been a key topic of discussion in world affairs since the early 1950s (World Health Organisation (WHO) 1998). When malnutrition is discussed, global challenges such as hunger, food insecurity, starvation and childhood mortality, amongst others, come to mind. Third world countries are evidently plagued by nutrition related diseases due to a lack of food, inadequate facilities and unemployment (WHO 2011a). For many years these problems have dominated research and there has been a global focus on them; however recent years have brought about a new set of challenges. According to Khadilkar and Khadilkar (2012) micronutrient deficiencies among adolescents within modernized first world countries who are food secure, have adequate facilities and dwellings in financially stable environments, may be attributed to the increase of and over indulgence in the convenience fast food industry. Cetteanu and Jones (2014: 68) add that a combination of sedentary behaviour, physical inactivity and poor dietary choices all attribute to a greater risk of disease among children and adolescents.

Both high income countries and developing third world countries have to deal with malnutrition-related problems, albeit in different ways. Media, convenience foods and technology have evolved over time and are consequently starting to negatively affect what were once thought of as non-vulnerable groups (Food and Agricultural Organisation (FAO) 2010, and Buijzen, Reijmersdal and Owen 2010: 1050). Worldwide, approximately 31 percent of people do not meet the minimum weekly physical activity level standards, which contributes towards the downward spiral into overnutrition, more commonly known as being overweight or obese (WHO 2008a). Adolescent children have been identified as being even worse off with only one in four meeting minimum physical activity requirements of sixty minutes of moderate to vigorous activity daily (WHO 2014a). African countries reported less than 50 percent of adolescents aged 13−15 were physically active for 60 minutes three times per week (Peltzer 2009: 176). Similarly it was estimated that 43−49% of South African children aged 15 years or older were also falling short of the daily recommendation of 60 minutes of moderate to

vigorous physical activity (Joubert, Norman, Lambert, Groenewald, Schneider and Bradshaw 2007: 725).

Physical activity can be described as the expenditure of energy through many bodily movements via the expansion and contraction of skeletal muscles (WHO 2014a). Moderate physical activity includes everyday actions such as walking, riding a bicycle or participating in a sport. One should not confuse physical activity with exercise, which is a planned, repetitive routine that aims to achieve physical fitness goals (WHO 2015a). World studies have indicated that the higher the income of a household, the more inactive individuals become across both genders (Hallal, Anderson, Bull, Guthold and Ekelund 2012: 250). In contrast Merchant, Dehghan, Behnke-Cook and Anand (2007: 3) found that Canadian children and adolescents coming from low income neighbourhoods with low socio-economic status have high levels of inactivity and were found to be more overweight with reports of poorer dietary intake compared to adolescents dwelling in affluent neighbourhoods with a higher socio-economic status.

Associated contributing factors such as convenience foods and heavily processed foods which are substituted for home-grown foods due to the world's evolved fast-pace lifestyle exacerbate the incidence of overweight and obesity (He, Tucker, Gilliland, Irwin, Larsen and Hess 2012: 1458). The most important commodity in the modern era is time, with people trying to cram as many daily activities as possible into the time available. In the pursuit of necessary or preferred activities, fresh, nutrient-dense foods that have longer preparation and cooking times are often sacrificed (Popkin and Doak 1998: 106 and Popkin 2006: 289). In 2012 reports indicated that worldwide, children aged 13–15 years spend approximately two hours a day sitting in front of a television (Hallal *et al* 2012: 247). What does this mean for the generation of adolescents and children who have grown up in this era of reduced physical activity and increased consumption of foods with poor nutrient value?

1.2 Background to the problem

1.2.1 Global perspective

Obesity is an abundantly prevalent lifestyle disease worldwide that was declared an epidemic in developed countries in the last quarter of the twentieth century. Five percent of global mortality is due to individuals who succumb to the consequences of being overweight or obese (WHO 2010a). Obesity, in conjunction with inactivity, greatly increases one's chances of

developing non-communicable diseases (NCDs) such as cardiovascular disease, cancer and type-2 diabetes, all of which can lead to early mortality during adulthood (WHO 2015a and Cetteanu and Jones (2014: 68). It is a disease that has previously been linked to wealthy and middle-class income individuals in developed countries but has now infiltrated into developing countries (Popkin and Doak 1998: 106-114, Merchant *et al* (2007: 3), and WHO 2010a). Obesity has direct links to excessive poor nutritional dietary intake as well as decreased physical activity. When energy inputs exceed energy outputs it leads to excess storage of fat cells in the body over a period of time; dependent on metabolic rate, this leads to overweight and to a worsening extent, an obese or morbidly obese condition (Wright and Aronne 2012). Studies show that 43 percent of the Americas and eastern Mediterranean as well as 17 percent of South-east Asia did not meet the daily physical activity needs within the adolescent and adult age categories (WHO 2011b).

According to the WHO (2010b), global studies revealed that inactivity was ranked the fourth highest risk factor contributing to global mortality. This statistic can be related to approximately six percent of global deaths. The World Health Organization's global health observatory data repository report indicates that the minimum globally acceptable physical activity amount per day for adolescents (13–17 years) is a collective amount of 60 minutes of moderate to vigorous physical activity. Adults (18–64 years) should complete 150 minutes of moderate to intense physical activity a week. The latest global statistics show that only one in four adults is meeting the minimum weekly physical activity requirements. Story and French (2004: 1) note that habits formed around eating and physical activity established during childhood and adolescence are highly likely to be tracked into adulthood.

However, of far greater concern is the youth (5–17 years) of the world, with more than 80 percent of the total global youth population not meeting the daily physical activity requirements. It has also been pointed out that adolescent girls were less active than adolescent boys, with 84 percent vs. 78 percent not meeting WHO recommendations (WHO 2015a). It is well known that the less physical activity one does, in conjunction with poor eating habits, the more prone one is to gaining weight. In 2012 it was estimated that globally 170 million children aged 18 years and below were overweight (WHO 2012). Children and adolescents are exposed to a number of factors that contribute towards poor dietary choices and reduced activity levels. The social-ecological model seen below in Figure 1.1 illustrates the relationship between adolescents and various segments of society that influence making healthy lifestyle choices;

these segments include individual factors such as knowledge and skills; environmental settings like the home school or work environment; sectors of influence such as governments media or health care systems; and include social and cultural norms and values regarding religion, lifestyle and belief systems (Institute of Medicine (IoM) 2005).

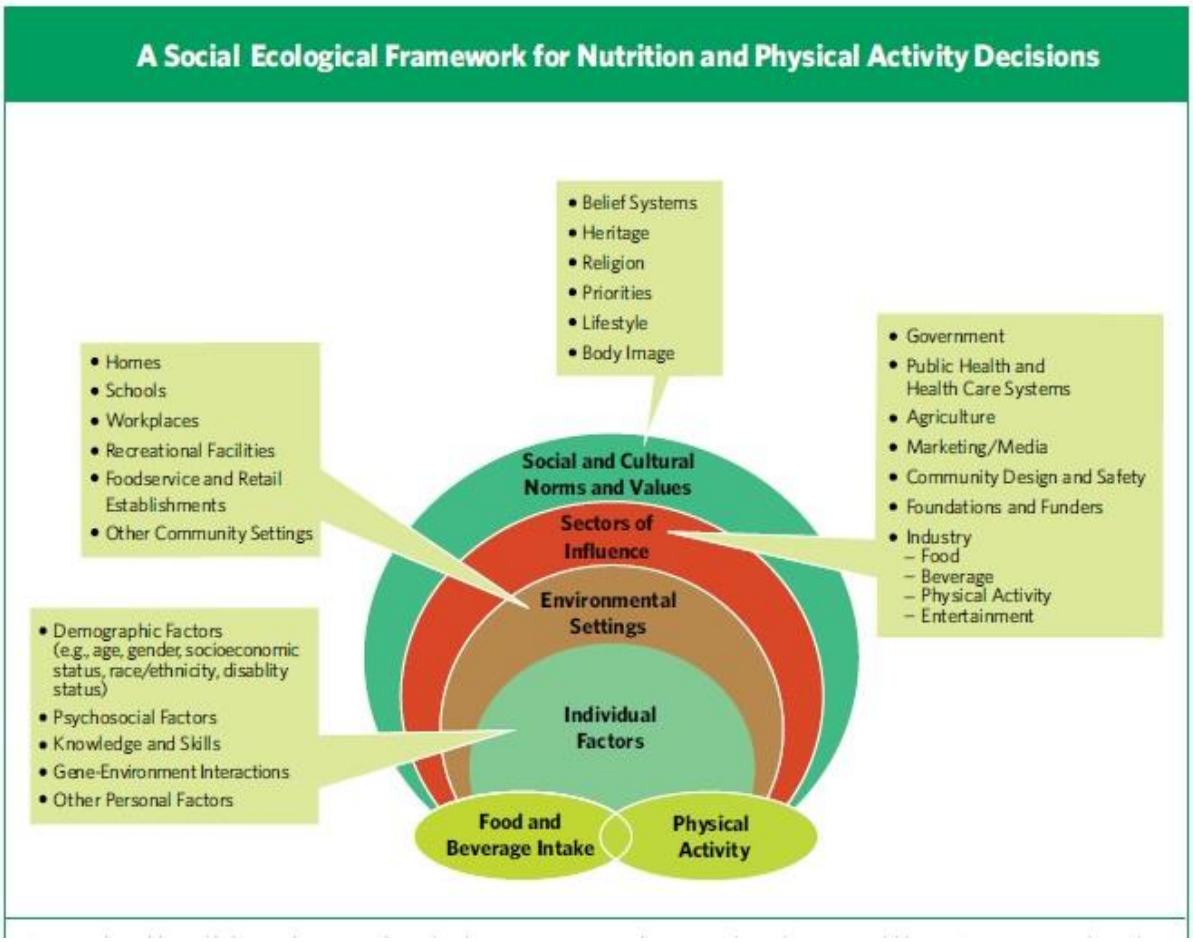

Figure 1.1: Elements of society combining to have an influence on an individual's physical activity and food choices (IoM 2005).

The national health and nutrition examination survey (NHANES) conducted in the United States of America (USA) produced results that showed that between the years 2007 and 2008 approximately 16 percent of children and adolescents (2–18 years) were classified as obese (American Obesity Association (AOA) 2011). The Health Survey for England (National Health System (NHS) 2013) conducted in 2012 showed that 28 percent of English children aged between two and 15 years were regarded as being either overweight or obese. A compilation by the International Association for the Study of Obesity (IASO) (2009) seen in Table 1.1 compares many first world countries experiencing similar high percentages of overweight and

obesity amongst children and adolescents. Greece, USA, Italy, Spain, Mexico and Ireland are counties that have the highest cases of overweight and obesity among girls.

Table 1.1: BMI based percentages of overweight and obese children from selected countries around the world using IASO height and weight cut-offs (IASO 2009).

Country	Year	Age (years)	Overweight (including obese)		
			Boys	Girls	
Australia	2007	2-16	22.0	24.0	
Belgium	2010	10-12	16.9	13.5	Updated
Canada	2004	6-17	28.9	26.1	
Czech Republic	2005	6-17	24.6	16.8	
Denmark	1996/7	5-16	14.1	15.3	
England	2009	5-17	21.8	26.1	
France	2006-07	3-17	13.1	14.9	
Germany	2008	4-16	22.6	17.7	
Greece	2010	10-12	44.4	37.7	Updated
Hungary	2010	10-12	27.7	22.6	Updated
Iceland	1998	9	22.0	25.5	
India	2007-8	2-17	20.6	18.3	
Ireland (Republic)	2003-4	5-12	19.4	28.9	
Italy	2008	7	37.2	34.7	Updated
Japan	1996-2000	6-14	16.2	14.3	
Mexico	2006	6-17	28.1	29.0	
Netherlands	2010	10-12	16.8	15.4	Updated
New Zealand	2007	5-14	28.2	28.8	
Norway	2010	10-12	15.1	13.8	Updated
Poland	2000	7-17	16.3	12.4	
Portugal	2008	6-8	30.0	26.1	Updated
Slovakia	2001	7-17	17.5	16.2	
Slovenia	2010	10-12	31.7	22.5	
Spain	2012	8-17	32.3	29.5	Updated
Sweden	2000	10	17.0	19.5	
Switzerland	2007	6-13	16.7	13.1	
Turkey	2001	12-17	11.3	10.3	
United States[1]	2003-04	6-17	35.0	35.9	

Note. All rates use IOTF reference to define overweight and obese

As seen in Figure 1.2 the incidence of obesity in children has been evident in a variety of countries globally over the last quarter of the century across all definitive categories such as race, age and sex. This lifestyle disease can affect any individual in any country if a healthy lifestyle is not maintained (Public Health England 2012). The South African National Health and Nutrition Examination Survey (SANHANES-1) reported that in 2013 children aged 6-14 years indicated a higher prevalence of overweight and obesity cases than in earlier studies in 2006, especially among black African children and coloured girls (Shisana, Labadarios, Rehle, Simbayi, Zuma, Dhansay, Reddy, Parker, Hoosain, Naidoo, Hongoro, Mchiza, Steyn, Dwane,

Makoae, Maluleke, Ramlagan, Zungu, Evans, Jacobs, Faber, and the SANHANES-1 team 2014: 210).

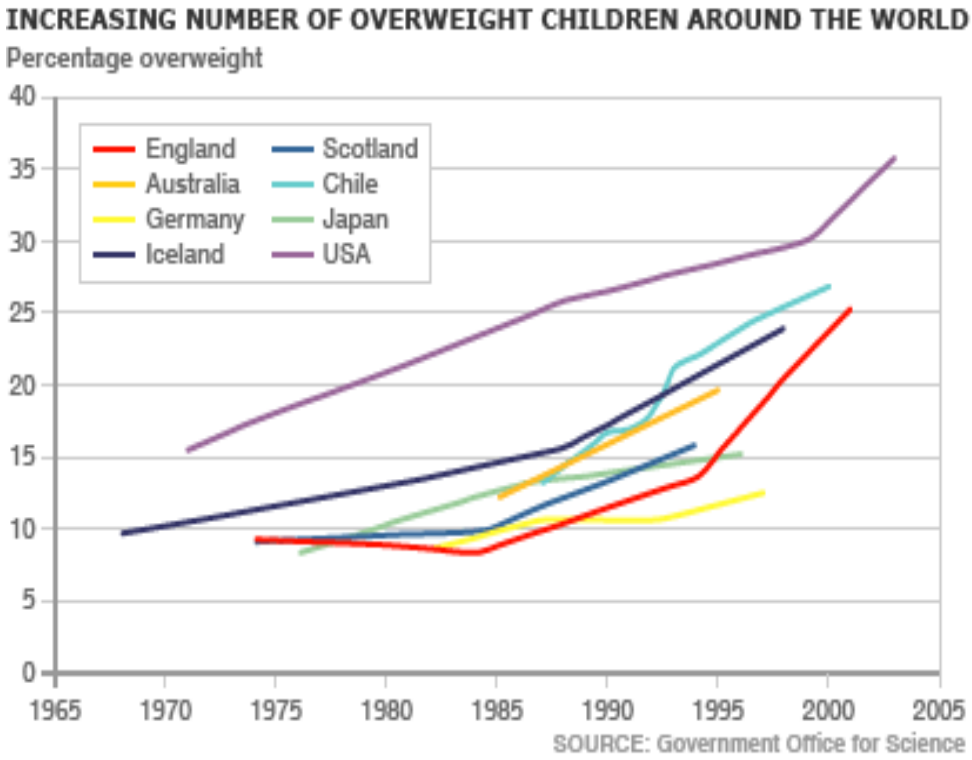

Figure 1.2: The depiction of selected countries' increase in overweight children ranging from the years 1965–2005 (UK National Health System (NHS) 2012).

The USA has been revealed to be one of the countries most heavily burdened by obesity. Shocking statistics show that the proportional growth in the morbidly obese category (Body Mass Index (BMI)>40kg/m²) has increased more than in the obese category (BMI >30kg/m²) hence the ever-growing concern about this epidemic (Flegal, Carroll, and Ogden 2010: 236). However, countries that are experiencing an economic change from undeveloped to developed, such as South Africa, China and Brazil, have seen an overall increase in their populations' overweight and obesity rate (Popkin 1994: 285–95).

1.2.2 An African perspective

Sub-Saharan Africa, as well as many other poor African countries, has mostly been associated with undernutrition and linked diseases such as kwashiorkor and marasmus due to inadequate food intake in younger children. This remains a very real and relevant problem that causes early

mortality in many young rural children and adults (Steyn, Labadarios, Maunder, Nel, and Lombard 2005: 4). In extreme contrast, the more developed of the developing countries in Africa, such as South Africa, Nigeria and Namibia, are now more concerned about overnutrition and the NCDs, type 2 diabetes and hypertension. Type 2 diabetes was previously thought to be a wealthy urban individual's disease but is rapidly infiltrating into rural communities (Kruger, Puoane, Senekal, and van der Merwe 2005: 491-500). Healthy eating during the crucial growing years and the developing years of adolescence is not only important for physical and mental well-being, but also for attendance and performance at school (Dapi, Omoloko, Janlert, Dahlgret and Haglin, 2007) and the prevention of chronic disease (Chandler 2006: 111).

Unfortunately, long-term comparative data on physical activity in Africa is scarce, with only a few isolated studies being done. However, due to related studies outlining the growing concerns of NCDs, more data is needed to assess possible causes related to the issue at hand. It is widely known that physical inactivity in combination with unhealthy eating habits can cause one to carry extra body fat leading to a multitude of secondary NCD problems (Guthold, Louazani, Riley, Conwan, Bovet, Damasceno, Sambo, Tesfaye, and Armstrong 2011: 52). It is believed that unhealthy eating habits developed in Sub-Saharan Africa when a trend towards urbanization was evident from 1975. Westernization introduced and popularized processed convenience foods and soft drinks which are high in energy, saturated fat, sodium and sugar as well as being low in fibre. Within urban areas, Western food items became a desirable status symbol hence the shift from traditional wholesome, home-grown food items which are high in complex carbohydrates and fibre and low in sugar and fat (United Nations Industrial Development Organization (UNIDO) 2013 and Rakodi 1997). Available data from smaller studies indicates that approximately 25–57 percent of Nigerians have been identified as being physically inactive and 80.8 percent were concluded to be obese; however, it is also noted that the data was poorly reported and not easily comparable, so further studies still need to be undertaken (Abubakari and Bhopal 2008: 173).

The WHO conducted a physical activity baseline study from 2003–2009 capturing data in 22 African countries in order to formulate policies and plans to combat NCDs. Figure 1.3 shows the results of this study, where one can see that, generally, African countries surveyed were relatively physically active. Studies also indicated that most activity was done through physical labour during work and commuting to and from a place of work, whereas leisure time physical

activity was less than five percent for all African countries combined, indicating that lack of technological advancement has shielded this third world continent from first world issues associated with much less physical labour. It is also key to point out that, overall, men were close to ten percent more active than woman (Guthold *et al* 2011:52-60).

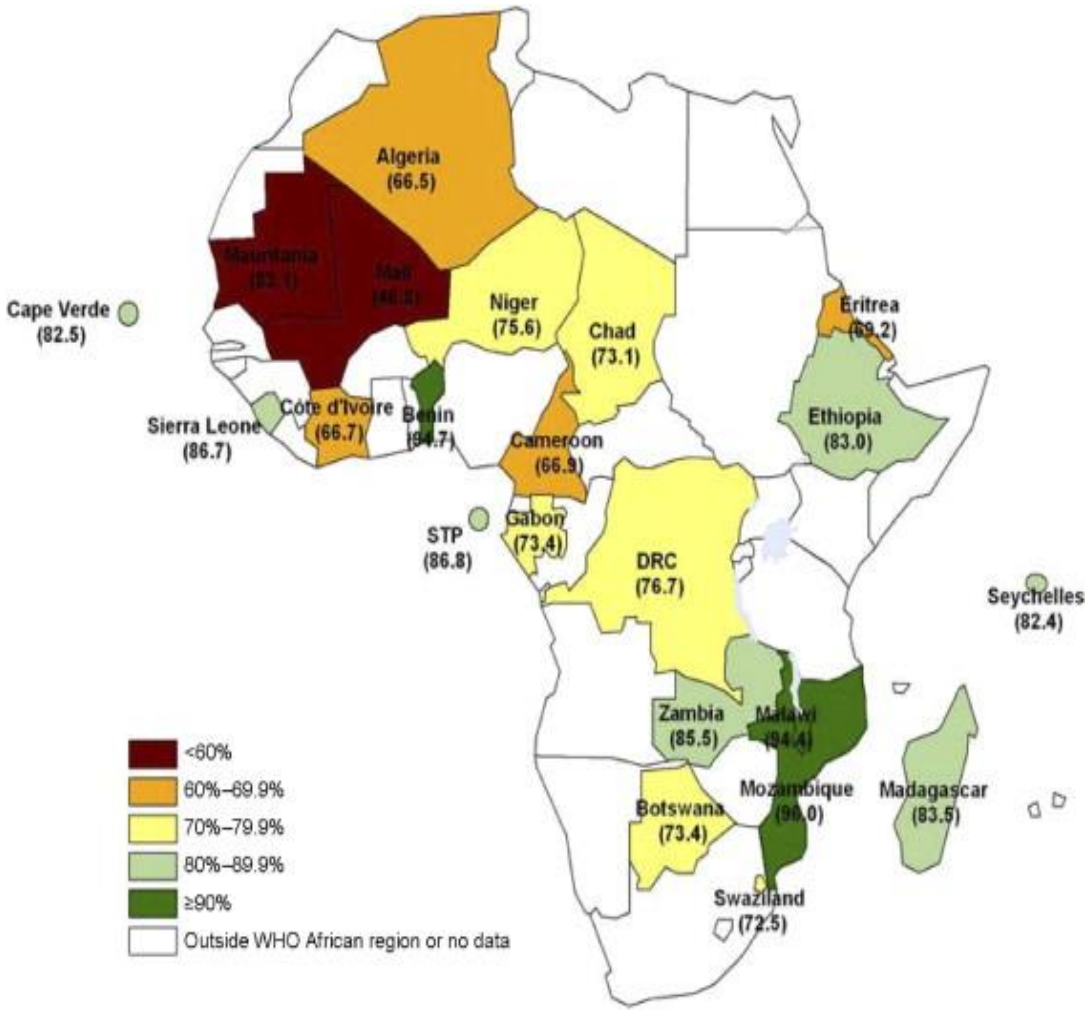

Figure 1.3: Results of the WHO African continents' physical activity study, indicating how physically active particular countries were nationally using a standardized gender and age, STEPS survey from 2003–2009 (Guthold *et al* 2011: 52-60).

In Africa, obesity among woman aged 15-49 years increased by five percent between the years 1999 and 2011. This study also indicates that wealthy, urbanized African woman, who represent 20 percent of the African population, are more likely to experience obesity than 20 percent of the poorest urbanized woman (WHO 2011a). Similar results can be seen in surveys done on the Malawian population that show the noticeable gap between men and women who experience being overweight, with 28 percent of women and only 16 percent of men being

overweight (Msyamboza *et al* 2011). African women are particularly at risk of becoming overweight or obese due to strong cultural beliefs that the larger and more voluptuous a woman's body is, the more desirable one becomes to men and the report also indicates that personal wealth is related to body size (WHO 2003a: 18 and Kruger *et al* 2005: 493).

Unfortunately, due to rapid urbanization, cheaper, non-nutritive energy-dense foods are far more regularly available to those individuals who are still attached to cultural beliefs that restrict them to living out a healthy lifestyle (Popkin 2006: 290). It is estimated that the African continent has an urbanization rate increase of 4.5 percent every year. According to Basu, Mckee, Galea, and Stuckler (2013: 2071), linear regressive studies to estimate the association of diabetes, overweight and obesity with the consumption of sugar-sweetened soft drinks in Sub- Saharan Africa and 75 other African and international countries indicated that every additional one percent of sugar-sweetened soft drinks consumed was associated with an additional 4.8 overweight adults per 100, 2.3 obese adults per 100, and 0.3 adult with diabetes per 100. These results are more evident within low-and middle-income countries. Studies on adolescent African children from Ghana and West Africa, showed that children from affluent backgrounds are more likely to frequently eat breakfast than adolescents who are less affluent. The report also indicated that adolescents in general rarely eat fruits and vegetables with 56 percent of the population captured indicating this. It also shows that adolescent girls were less likely to participate in physical activity than adolescent boys (Doku, Koivusilta, Raisamo, and Rimpela 2011).

It is becoming easier for women from all Living Standard Measures (LSM) to accumulate extra weight and consequently suffer from the major effects of obesity which are commonly referred to as NCDs although mostly being diagnosed as cardiovascular diseases and type 2 diabetes mellitus. According to the WHO (2003b), a predicted figure for 2020 shows that at least 50 percent of African women's mortality will be due to NCDs. It must also be noted that, generally speaking, with reference to children under the age of five years on the African continent, the incidence of overweight has increased from four percent being overweight in 1990 to eight-point five percent in 2010 (WHO 2010a).

NCDs have burdened the African continent for several years and are steadily increasing with time. An African-based study report on NCDs shows that the biggest increases were in hypertension and type 2 diabetes mellitus (Steyn and Mchiza 2014: 89). Between the years

1998–2004, type 2 diabetes mellitus was observed to have increased by 40 percent and hypertension increased by 16 percent (Mufunda Chatora, Ndambkuwa, Nyarang, Kosia, Chifamba, Filipe, Usman, and Sparks 2006: 522). It was also shown that the prevalence of both diseases increased with a rise in social economic status (UNIDO 2013). Hypertension was identified as being closely related to the presence of obesity in the studied African population but it was also noted that some lean subjects also experienced hypertension (Mufunda 2006: 522). Diabetes mellitus was found to be less common in rural communities compared to urban developments and women showed more prevalence to the disease than men (UNIDO 2013 and Mufunda *et al* 2006: 522). The results in a global burden of disease study identified African adolescents aged between 10–24 years in lower income countries as 2.5 times more likely to develop an NCD than those in higher income countries (Gore, Bloem, Patton, Ferguson, Joesph, Coffey, Sawyer, and Mathers 2011: 2094).

1.2.3 The South African perspective

In 2008 a prevalence of obesity study was conducted by the WHO on a population aged 20 years and above from various countries around the world. South Africa was identified with 33.5 percent of the population being classified as obese while the USA came in with 31.8 percent. South Africa is still classified as a middle-income country but has surpassed the first world country that was thought to be one of the worst in the world regarding obesity. In terms of being overweight, 68 percent of South Africans fall into this category, only marginally tailing the USA population with 69.4 percent being overweight. The average BMI status is 26.8 kg/m^2, which causes the South African population to be considered overweight in general. Overweight South African women appear to be almost double that of the male population, with 41 percent being obese compared to 21 percent of men (WHO 2008a).

The first South African nation youth risk behaviour survey conducted in 2002 on adolescents aged 13–19 showed that 17 percent of the children surveyed were overweight and four percent were obese (Reddy *et al* 2002). In 2008 a second study was conducted that showed an increase in percentage nationally with the overweight category increasing to 19.7 percent and the obese category to five point three percent. Both studies showed that women make up a large proportion of the percentage ─ 27.8 percent of girls were overweight whereas only 11.2 percent of boys were overweight. This trend is also reflected in the obese segment with seven-point two percent being females yet only three point three percent were males (Reddy *et al* 2008:

38). According to a study by Feeley *et al* (2012) among adolescent school-going children, the top five food items bought included crisps, cold drinks, fried chips and white bread which made up for 62 percent of total purchases, and female adolescents opted for more sweet and sugar based food items than males.

In terms of overweight school children, KZN has proved to be the most affected province with a substantial 25 percent, whereas Gauteng has a lower but still significant rate of obesity among school-going children with nine point three percent of boys and girls being affected. In contrast, the province of Limpopo scored the lowest rates of both overweight and obesity amongst learners (Reddy *et al* 2008: 38). A study conducted in the Western Cape has shown the province to be slightly stronger in terms of attaining adequate physical activity but it also revealed that 35 percent of those who were inactive had already shown at least one risk factor that could contribute to the development of a chronic lifestyle disease or NCD (Frantz 2006: 74).

SANHANES-1 reports that children between the ages of 10-14 years had a prevalence of 7.5 percent being overweight and 2.7 percent being obese (Shisana *et al* 2014: 205. Contributing statistics from SANHANES-1 state that 71.1 percent of South African children (10-14 years) scored particularly low in general nutrition education testing. The lack of nutrition education may be a contributing factor for overweight and obesity being carried through to adolescence with 19.3 percent of girls aged 15-17 years being overweight and 8.0 percent being obese (Shisana *et al* 2014: 139). When looking at dietary intake, Soweto based studies indicated the top favourite foods bought and consumed by urban black African adolescents are 'magwinya' (deep fried cake dough), kotas (a quarter loaf of white bread filled with deep-fried chips topped with processed cheese and processed meats) or street-roasted chicken, which are all heavily comprised of saturated fats and processed carbohydrates. Within the school environment, adolescents opted for pies if money was limited (Sedibe, Feeley, Voorend, Griffiths, Doak and Norris 2014: 116). Middle to high income adolescents in Cape Town preferred eating an array of full fat items such as milk, cheese, cheese spread and butter daily as well as fried chicken, red meat, mayonnaise, doughnuts, creamy salad dressing, cold cuts (for example, ham) and potato crisps three to four times a week (Steyn 2010: 62).

In general, South African school-going adolescents can be described as being more overweight than obese (Reddy *et al* 2008: 38). This may be due to the fact that, nationally, approximately 26 percent of school-going adolescents did not want to participate in any physical activity and

would avoid it if allowed to. Alarmingly, close to 42 percent of South African high school learners were not at all participating in physical activity or were completing inadequate amounts to make a positive impact on health. The Medical Research Council (MRC) (Reddy *et al* 2008) study also indicated that across South Africa adolescent girls made up the majority of students who did not meet physical activity recommendations. Sowetan based results showed that common exercise done by urban adolescent girls includes running, cycling and walking but it was also noted that community safety played a part in whether the child would participate in exercise (Sedibe *et al* 2014). KZN statistics show that more than 50 percent of female adolescents complete insufficient or no physical activity during a week. Studies also indicated that one in three South African learners watch television for more than three hours per day (Reddy *et al* 2008: 117 and Joubert, Norman, Lambert, Groenevalt, Schneider, Bull, and Bradshaw 2007: 730).

Non-communicable disease studies in South Africa indicate that they are predominantly found in poor urban communities (Mayosi, Flisher, Lalloo, Sitas, Tollman, and Bradshaw 2009: 934). Studies done in the year 2000 in the Mpumalanga and Limpopo provinces indicated a high prevalence of hypertension and diabetes mellitus which may be a result of the extremely high overweight and obesity rate that affected more than 50 percent of the adults surveyed (Alberts, Urdal, Steyn, Stensvold, Nel and Steyn 2005: 347-354). National statistics conducted in South Africa in 2012 identified the top ten causes of premature death among South African women as seen in Figure 1.4 (Msemburi, Pillay-van Wyk, Dorrington, Neethling, Nannan, Groenewald, Laubscher, Joubert, Matzopoulos, Nicol, Nojilana, Prinsloo, Sithole, Somdyala, and Bradshaw 2016: 13). Second only to HIV and AIDS to which 39.5 percent of premature deaths are attributed, collectively NCDs such as cerebrovascular disease (5.9%), diabetes mellitus (3.3%), and hypertensive heart disease (2.8%) contribute to a substantial number of early deaths (Msemburi *et al* 2016: 13).

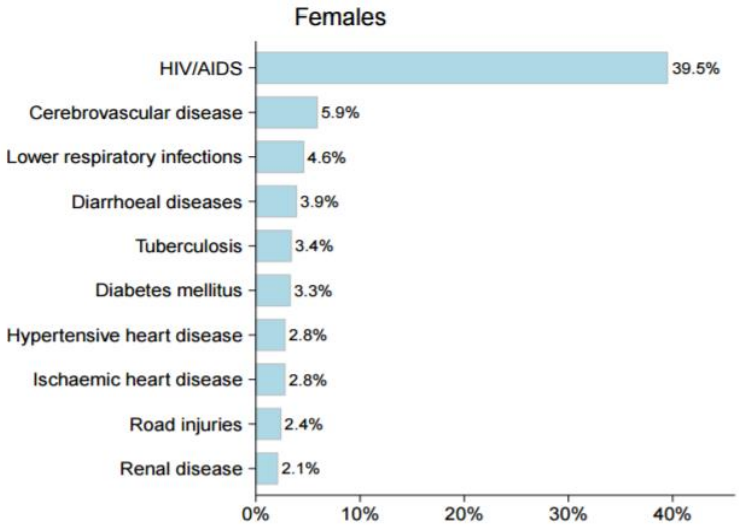

Figure 1.4: The top ten causes of premature death among female South Africans in 2012, n=4,687,000 (Msemburi *et al* 2016: 13).

Statistics on black South Africans, who make up three quarters of the population, have shown that within the last 50 years, the total fat intake has increased considerably, from 16.4 percent to 26.2 percent of total energy, which translates into a 59.7 percent increase (Mayosi *et al* 2009: 934). Racially, Black women were the most affected in both the overweight and obese categories (MRC 2008: 38 and Mayosi *et al* 2009:934–947). There have been several studies done in South Africa showing the links between physical inactivity and nutrition status, some of which have been listed in Table 1.2.

Table 1.2: Physical activity and nutritional status studies on adolescents conducted in South Africa between 2002–2014.

Author and Reference	Study Population	Measuring Instruments	Summarized Results
Reddy, S. P., James, S., Sewpaul, R., Koopman, F,. Funani, N, I., Sifunda, S., Josie, J., Masuka, P., Kambaran, N.S. and Omardien, R. G. 2010.	251 schools 10 270 learners in Grades 8-11 Adolescent boys and girls	The South African Youth Risk Behaviour survey Anthropometric instruments	Forty one percent of the sample group did not complete sufficient physical activity to gain health benefits. Forty three percent, which translates into almost one in two

Umthente Uhlaba Usamila – The South African Youth Risk Behaviour Survey 2008. Cape Town: South African Medical Research Council.			learners, partake in sufficient levels of vigorous activity; 29.3% of learners completed moderate activity.
Joubert, J., Norman, R., Lambert, E., Groenevalt, P., Schneider, M., Bull, F. and Bradshaw, D. 2007. Estimating the burden of disease attributable to physical inactivity in South Africa in 2000. *SAMJ*. 97(8): 725-731.	Persons 15 years and older	The World Health Organization's (WHO) Comparative Risk Assessment (CRA)	South Africa proved to be high in comparison to other global regions with the prevalence of physical inactivity. It also indicates a large amount of deaths due to non-communicable diseases (NCD).
Frantz, J. M. 2006. Physical inactivity as one of the chronic disease risk factors among high school learners in public schools in a local community in South Africa. *South African Journal for Research in sport, physical education and recreation*, 28(2): 73-80.	951 learners in Grades 8-12 in the Western Cape	KUOPIO Ischaemic Heart Disease 24-hour physical activity record over a seven-day period. Anthropometrical and blood pressure measurements. Health Risk Behavioural questionnaires.	Thirty two percent of the learners surveyed were classified as physically inactive. Thirty five percent of the learners showed at least one risk factor for developing a chronic lifestyle disease in the near future or immediately.

Kruger, H., Venter, C., Voster, H. and Margetts, B. 2002. Physical inactivity is the major determinant of obesity in black women in the North-West province, South Africa: the THUSA study. *Science direct*, 18(5): 422-427.	1 040 women	Anthropometric measurements: Body Mass Index (BMI), waist circumference, waist-to-hip ratio, triceps and sub-scapular skin folds, and socio-economic, dietary intakes, and physical activity questionnaires.	Twenty-eight point six percent of the sample size was obese. There appeared to be a correlation between high income households and obesity. Data shows that those who performed vigorous physical activity were less likely to become obese. Inadequate, or a lack of, physical activity levels show a strong link to overweight and obesity.
McVeigh, J., Norris, S. and de Wet, T. 2007. The relationship between socio-economic status and physical activity patterns in South African children. *Acta paediatrica*. 93(7): 982-988.	381 South African children	Interviewed with validated questionnaires pertaining to physical activity and socio-economic status.	Children from high income homes with well-educated mothers did more physical activity, watched less television and weighed more but had more lean tissue. Children from lower income homes showed that there was more inactivity. Homes where both parents were present showed high physical activity levels compared to single parent homes. Racially, white children were more physically active, watched less television and were more willing to take part in

			school physical education lessons than black children.
Sedibe, H., Feeley, A. and Voorend, C. 2014. Narratives of urban female adolescents in South Africa: dietary and physical activity practices in an obesogenic environment. *SAJCN*, 27(3): 114-118.	58 Grade 12 adolescent females	Anthropometric measurements such as Body Mass Index (BMI). Eating practices questionnaire. Exercise participation questionnaire.	Eating locally produced convenience fatty fast foods instead of home-cooked meals is a prominent feature. Food choices were made based on convenience, affordability and disinterest in making healthy meals in the home environment. Physical activity levels were low and included street dancing and walking in local malls.
Kruger, H., Venter, C., Voster, H. and THUSA Study. 2003. Physical inactivity as a risk factor for cardiovascular disease in communities undergoing rural to urban transition: the THUSA study, Cardiovascular journal of South Africa, 14(1): 16-23.	946 adults	Demographic data, anthropometric measurements, physical activity data were collected. Blood pressure was measured and blood was drawn.	Women were less physically active than men. Rural dwellers were shown to be more inactive than urbanized individuals. Both men and woman who were overweight and physically inactive had higher blood pressure and total serum cholesterol contributing to the risk of cardiovascular disease.
Shisana, O., Labadarios, D., Rehle, T., Simbayi, L., Zuma, K., Dhansay, A.,	25 532 individuals	Administering questionnaires (conducting interviews) and	Among woman, 42 percent were considered physically fit. The overall population statistic was one in every

Reddy, P., Parker, W., Hoosain, E., Naidoo, P., Hongoro, C., Mchiza, Z., Steyn, N. P., Dwane, N., Makoae, M., Maluleke, T., Ramlagan, S., Zungu, N., Evans, M. G., Jacobs, L., Faber, M. and the SANHANES-1 team. 2014. *South African National Health and Nutrition Examination Survey (SANHANES-1)*. Cape Town: HSRC Press.		performing clinical examinations. Three questionnaires were used according to participant's profile: visiting point questionnaire to collect demographic data, an adult-aimed questionnaire (15 years and above in age) and a child-aimed questionnaire (0-14 years).	two females were unfit. Adolescent girls aged 10-17 were found to be overweight; 36 percent were overweight and 13 percent were obese.

1.3 Motivation for this study

There is concrete evidence that physical activity levels and poor dietary intake can have direct consequences on personal health status (Kruger, Venter, Voster, Margett, and THUSA study 2003: 17). Physical inactivity is not only a local but also a worldwide endemic that is causing more people to fall into the overweight and obese segments (WHO 2010b and Reddy *et al* 2008). Inactivity and poor diet, in conjunction with obesity, leads to NCDs, which are causing people to develop chronic lifetime diseases which are expensive and, to a greater extent, lead to early mortality (Wright *et al* 2012 and Shisana *et al* 2014: 170). The most prominent NCDs associated with physical inactivity, poor diet and obesity in South Africa are cardiovascular diseases such as high blood pressure and high cholesterol levels (Kruger *et al* 2003: 18).

Several interlinked factors come into play when distinguishing the causes of burden of disease in adolescents. A study conducted in south and eastern Mediterranean countries concluded that energy intakes were far too high especially among female adolescents. This can also be seen

in South Africa; SANHANES-1 identified that the adolescent age group (15-18 years) consumed the highest percentage of energy through fat and sugar intake compared to any other age group. Almost 25 percent of adolescents fell within the high fat intake group and 27 percent fell within the high sugar intake group (Shisana *et al* 2014: 171). Popkin (2002) states that a high-energy intake compared to the recommended requirements is one of the main risk factors for obesity in children, adolescents and adults; and in turn they could run a higher risk of developing NCDs. Figure 1.5 is a conclusive summary of results showing the interdependent relationships and flow between factors that surround adolescents.

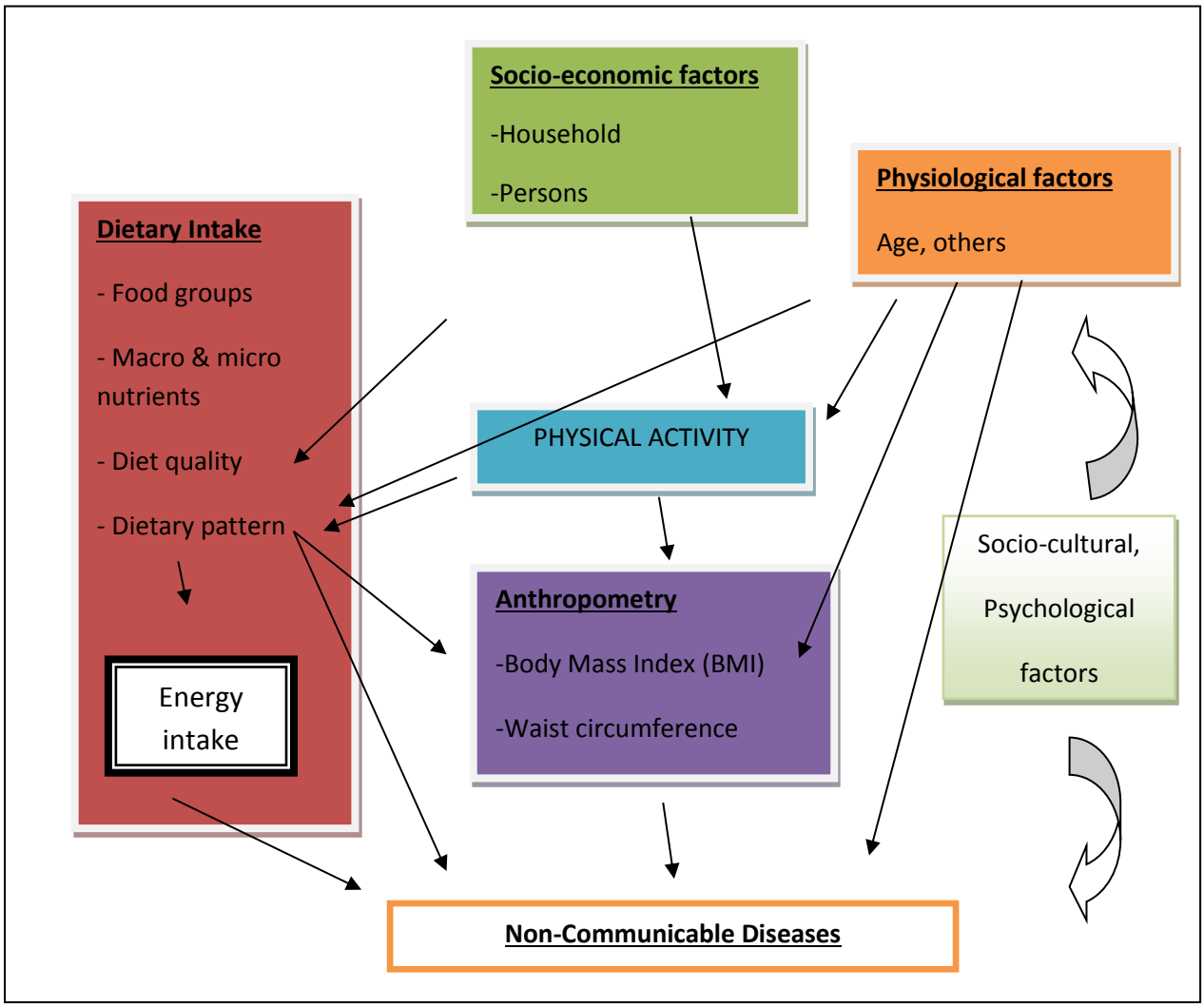

Figure 1.5: A conceptual framework indicating the association between dietary patterns and health outcomes.

The Childhood Obesity Foundation (2014) in Canada has identified and outlined the numerous health problems that are linked to inactivity and obesity in children and adolescents inclusive of respiratory problems, asthma, type 2 diabetes, fatigue, sleeping disorders, liver diseases,

high blood pressure, bone and joint problems and even the development of eating disorders such as anorexia or bulimia nervosa. Figure 1.6 illustrates the many strains a child's body and mind may be subjected to when dealing with NCDs due to inactivity-related obesity (National Health System information centre 2012). The WHO (2010a) regards childhood obesity as being one of the most serious global health challenges of the twenty first century due to the severe adverse and long-term problems associated with the disease.

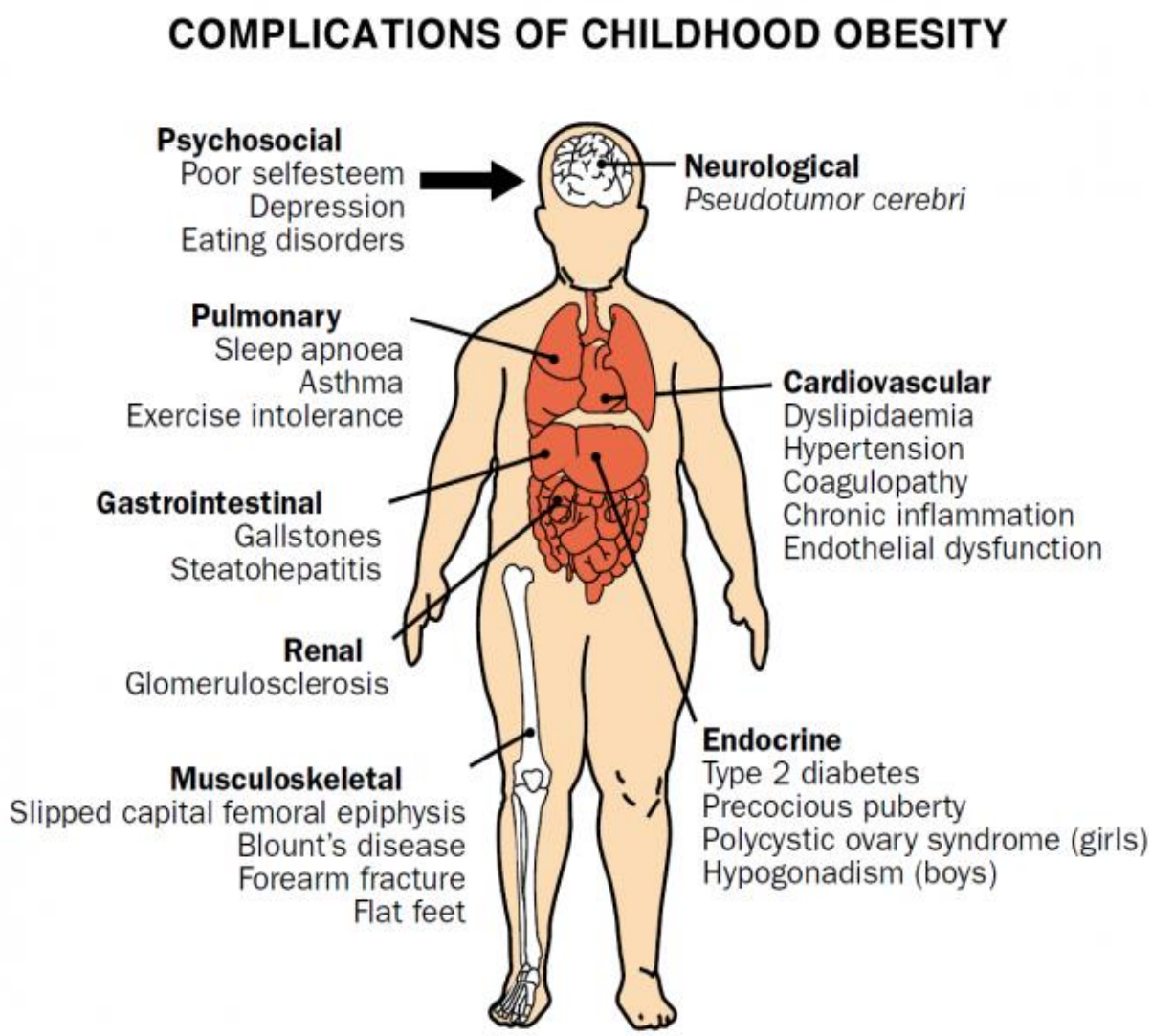

Figure 1.6: Physical and psychological effects of overweight or obesity that a child may experience, also referred to as non-communicable diseases (NCDs) (Ebbeling, Pawlak, and Ludwig 2002).

Modernisation and technological advancements are thought to be linked to the increase in physical inactivity thus resulting in the steady increase of obesity and other health related risks spreading into the younger generation (Popkin and Doak 1998: 110). South African adolescent

learners spend too much time using cell phones or computers and watching television instead of getting involved in more strenuous activities (McVeigh *et al* 2007: 985). This disinterest in physical activity may be the reason why 25 percent of the youth is either overweight or obese (Reddy *et al* 2008). Across all ages, girls and women are the most inactive and consequently are more prone to being overweight and obese as well as increasing the likelihood of experiencing related diseases (Kruger *et al* 2003:18).

Globally, individuals earning a higher income are twice less likely to do physical activity than individuals earning a lower income. The correlation shows a decrease in physical activity where income increased (WHO 2014a). Women are less physically active than men in both lower and higher income households. The main causes of less physical activity were identified as urbanization and the automation of technologies, making the need to physically conduct tasks far less prevalent, which in turn then increases the occurrence of overweight and obesity (WHO 2014a). In contrast, some South African based studies dealing with adolescents state that higher income households produce more active children (McVeigh *et al* 2007). South Africa's second largest causes of death behind Acquired Immune Deficiency Syndrome (AIDS) are, collectively, heart disease, stroke and type 2 diabetes mellitus – all NCDs that are strongly related to inactivity and overweight and obesity (Mayosi *et al* 2009: 941).

1.4 Aim of the study

The aim of this study was to determine the relationships between physical activity and dietary intake and physical activity and the nutritional status of adolescent girls attending a private school in Durban.

1.4.1 Specific study objectives

The purpose of this study was to analyse the nutritional status of adolescent girls who were currently attending a selected high school classified as a 'higher income high school' as well as to determine how physically active the girls were. Thereafter, the information can be comparably analysed and a correlation between the two aspects can possibly be identified. Conclusive outcomes can lead to the compilation of recommendations for the improvement of the health of adolescent girls. The specific objectives for this study were:

- To determine the socio-demographic profile of the household.
- To determine the anthropometric status of the girls with the use of Body Mass Index (BMI) BMI-for-age, height-for-age and weight-for-height in order to determine wasting, stunting, underweight, overweight and obesity.
- To determine the physical activities and the physical activity levels of the girls.
- To determine any relationships between the socio-demographic indicators, physical activity, food intake and nutritional status of the girls.

1.4.2 Null hypothesis

- There is no relationship between physical activity and dietary intake of adolescent girls.
- There is no relationship between physical activity and nutritional status of adolescent girls.

1.5 Structure of the dissertation

A structural overview of the study, which can be seen below in Figure 1.7, indicates a specific breakdown formulated by the researcher under the supervision of Prof. C. Napier.

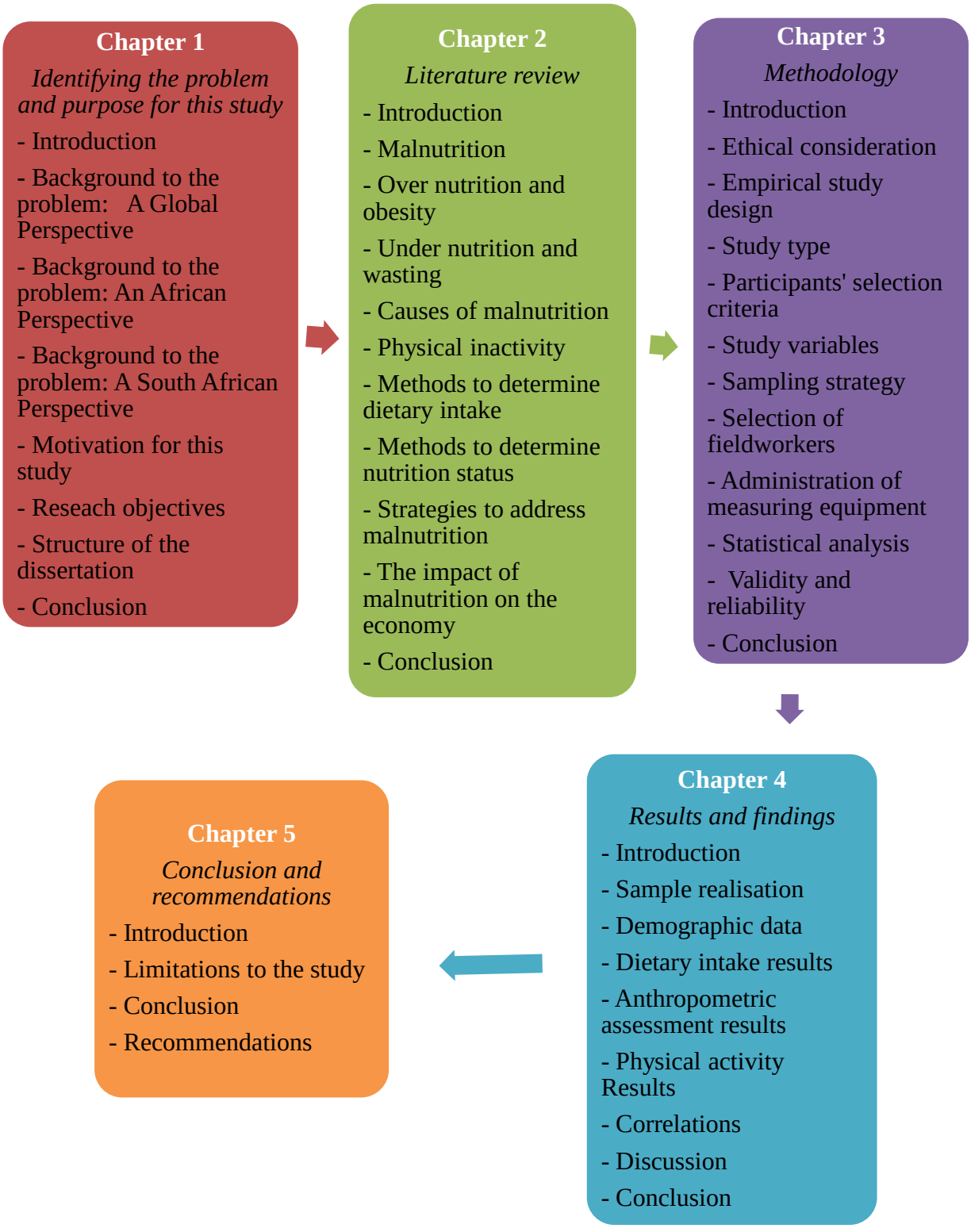

Figure 1.7: Structural overview of the study

1.6 Conclusion

It has been identified that inactivity and poor diet is an ongoing problem not only in South Africa but around the world. It has been linked to malnutrition and, more specifically, to overweight and obesity, which is consequently leading to severe health problems. Women have been shown to be the most affected, and there is a growing concern for the youth and the potential current and future health problems that may affect them if action is not taken. This thesis was formulated to establish local issues that young girls may be experiencing in terms of the relationship between physical activity and nutrition status, and, ultimately, to recommend solutions to prevent further issues arising.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

The purpose of this chapter is to complete and analyse an overview on literature pertaining to the nutritional status, dietary intake and physical activity levels of affluent adolescent girls attending a private high school in Durban. Topics highlighting the importance of child nutrition and the nutritional situation of adolescent girls will be discussed and a situational analysis on the overall nutrition status and physical activity levels of South African adolescents will be presented. The level of income and money spent on food will also be looked at to distinguish whether more affluent adolescent girls are affected differently to middle to lower income adolescent girls with regard to nutrition. Literature on the relationship between physical activity levels and nutrition status will also be discussed.

Several nutrition related studies have investigated the nutritional status of younger children in the country but they are almost always from the lower income LSM groups. There is a notable paucity of information regarding the health and nutritional status of adolescents who come from affluent households. Survey results of the 1999 NFCS and the 2005 NFCS-FB both conclude that various nutrition related disorders continue to plague the children of South Africa. This is supported by the latest results found in the South African National Health and Nutrition Examination Survey (SANHANES-1) conducted in 2012 indicating that South Africa is still very much burdened by disease (Shisana *et al* 2014: 42). However, South Africa is not alone; many researchers from around the world have provided similar results, making it a global challenge for developing countries and one which needs urgent attention.

2.2 What is malnutrition?

Malnutrition is best described by Shih (2007: 4) as the overall term encompassing both undernutrition and overnutrition, which is either a shortage, excess or imbalance of body-building and energy-giving nutrients. When these nutrients are not consumed sufficiently, the body's ability to function is compromised and the immune system is left weakened, resulting

in vulnerability to disease that may lead to premature death (Chesire, Orago, Oteba, and Echoka 2008: 472). Malnutrition is a reversible disorder caused by the inappropriate intake of adequate essential nutrients necessary for bodily systems to optimally perform and function. Malnutrition does not necessarily mean that there is simply a limitation of food. The quality and quantity of food being consumed plays a much larger role in this epidemic as well as situational factors such as poor sanitation, exposure to infectious diseases and even the lack of exclusive breast feeding during infancy (Lesiapeto, Smuts, Hanekom, Du Plessis, and Faber 2010: 202).

According to the World Health Organization (WHO 2014b), malnutrition can be divided into two main root causes, protein energy malnutrition (PEM) and micronutrient deficiencies. Both of these can negatively impact quality of life in various areas such as limiting mental capacity and hindering future productivity, leading to poor economic growth on both a personal and country based level Reddy *et al* 2008: 4). South Africa has been deemed a lower middle-income country (United Nations Development programme (UNDP) 2010: 3) with stunting and underweight being the most common nutritional disorders affecting children. Stunted children can become obese as adolescents (Labadarios, Steyn, Maunder, MacIntryre, Gericke, Swart, Huskisson, Dannhauser, Vorster, Nesmvuni, and Nel 2005). Although malnutrition is present in both poor and rich countries, those with economical disadvantages are more likely to suffer due to a country's poor circumstances and the unavailability of quality help (Kruger *et al* 2005: 490).

Children are the main focus of malnutrition as childhood is the foundation phase leading into adolescence and adulthood. Adolescence is equally important as it is the maturing stage when critical changes to the body and mind are made during this growth period with respect to physical, cognitive and social development (Ani, Uvere and Ene-Obong 2014: 8). Long-term exposure to malnutrition as an infant, child and adolescent can have permanent and life-altering changes once adulthood is reached in terms of bodily structure and mental capacity such as attention deficit and lowered IQ (Waber, Eaglesfeild, Fitzmaurice, Bryce, Harrison, and Galler 2011: 6 and Shih 2007). Malnutrition developed within the later years of adolescence and adulthood have different yet just as serious life threatening complications, linking more to lifestyle diseases which are reversible (Wright *et al* 2012). Contributing factors that have been identified to worsen and perpetuate malnutrition in adolescents are ignorance, illiteracy and attitudes (David, Kimiywe, Waudo, and Orodho 2008: 131).

2.2.1 Overnutrition

Having a well-balanced healthy diet is important to maintain optimal health throughout one's lifetime. Overnutrition occurs as a result of the continuous consumption of a high number of kilojoules (KJ). Obesity is a worsened state of the continuous consumption of high KJ in conjunction with a lack of physical activity. This gives way to lifestyle diseases, or non-communicable diseases (NCDs), such as cardiovascular disease, diabetes, hypertension, cancer and chronic respiratory disease (WHO 2010c and Kruger *et al* 2005: 491). The South African Demographic and Health Survey (SADHS) states that overnutrition is a prevalent and ongoing problem experienced not only by South African children but by children in many countries around the world. Overnutrition and obesity seen in children at a younger age can be carried through to adolescence if not addressed, and may continue and worsen with age (Faber and Wenhold 2007: 394). This view is supported by UNICEF, WHO, and the World Bank Group (2016: 3), where collaborated global statistics show that obesity in children under the age of five has increased from 5.1 percent in 2000 to 6.2 percent in 2015, which equates to 11 million children over the past 15 years. In South Africa 14.6 percent of all children under the age of five years are overweight.

The eating habits and practices learnt during childhood years causing an over-nourished state can be carried through to adolescent years (Shisana *et al* 2014: 246). This can be seen in current information regarding South African adolescent girls. The gradual increase of overnutrition with age can be seen in the SANHANES-1 study where 16.7 percent of young female adolescents aged 10-14 years were identified as being overweight. The older spectrum of adolescence sees the incidence of girls (aged 15-17 years) being overweight increasing to 19.3 percent (Shisana *et al* 2014: 139). The most current information by SADHS 2016, indicates that 16.1 percent of adolescent girls aged 15-19 are overweight (Stats SA 2017: 45). The provincial mean BMI for women in KZN is 29.9 and KZN is reported to have the highest mean BMI reading of all the provinces in South Africa (Stats SA 2017: 45).

2.2.2 Obesity

Within recent years there has been a considerable increase in this metabolic disorder throughout the world and it is proving to be a significant health challenge (Alfaradhi and Ozanna 2011: 1). Studies conducted in 2010 based in the USA identified 68 percent of the adult population as

being overweight and 35 percent were shown to be obese (Flegal *et al* 2010: 234). This, too, can be seen overseas where similar statistics plague the UK. It is predicted, with current figures and growth patterns, that 60 percent of the UK population will be obese by 2050 (Musingarimi 2009). An increase of food intake and reduced energy expenditure by an individual leads to the storage of excess energy in the form of adipose tissue or fat. However, obesity is not limited to developed countries as over five percent of South African adolescents aged 10-14 years are considered obese. The older spectrum of adolescents aged 15-17 years shows an increase to eight percent being obese (Shisana *et al* 2014: 206). The SADHS 2016 indicated this category to be growing among adolescent females (15-19 years) with a new national mean of 10.9 percent being obese in this age category (Stats SA 2017: 45). The SDAHS further reports that women from the highest wealth quintile in South Africa also have the highest mean BMI of 30.7 which is considered obese (Stats SA 2017: 45).

Adolescent studies conducted in Nigeria show that out of the 500 individuals surveyed, 7.5 percent were overweight and 2.1 percent were obese with all the cases of obesity occurring in urban establishments whereas none were found in rural communities. Obesity among girls was much higher than among boys (Ani *et al* 2014: 2). This pattern can be seen in South African adolescent girls, where obesity in urban areas (9.3%) is higher than in rural (4.4%) communities (Shisana *et al* 2014: 206). Some people are more prone to the disorder of obesity than others with an individual's genetic make-up and predisposition to the metabolic disease having significant importance. Becoming obese within early adolescence makes it twice as difficult to overcome the disorder in later years (Frayling 2007: 657).

The time in which overweight evolves into a worsened state plays an equally important role in obesity in later life. Juvenile-onset obesity develops from infancy to childhood where many adipose cells can develop as a result of still being in the growth period of life, each with the potential to increase in size. Whereas adult-onset obesity shows to have fewer adipose cells, they contain excessive amounts of fat (Ani *et al* 2014: 2 and Raj 2012: 13). It is much more difficult to decrease excess body fat if obesity has been experienced from a young age as opposed to an individual who becomes obese in later years. Obesity at a young age is a serious health threat and statistics show that 40 percent of children and 80 percent of adolescents become obese when adults (Starc and Strel 2011).

2.2.2.1 Diseases of lifestyle

The increase in adolescent obesity can be directly linked to serious health problems in adolescence and later adulthood, the increase of lifestyle diseases or NCDs, such as type 1 and 2 diabetes mellitus, cardiovascular complications, high blood pressure and morbidity which can all lead to impaired social integration and even premature death (Alfaradhi and Ozanne 2011: 2 and WHO 2014b). This is supported by current statistics identified in SADHS 2016, showing a high obesity rate among high income-earning women and adolescent girls. This then also explains the SADHS 2016 report that 17 percent of adolescent girls and young female adults (15-24) suffer from hypertension (Stats SA 2017: 48). These statistics are supported by correlating results in a Nigerian study, indicating that a calorie rich diet increases the occurrence of overweight and obesity, placing the individual at a greater risk of chronic disease (Ani *et al* 2014: 4). This is especially seen in affluent societies around the world where collective poor eating habits, physical inactivity, poor diet and an overall sedentary lifestyle have been identified as the main contributors of lifestyle diseases developed in adolescent growth periods and have subsequently worsened in later life (Van Niekerk, Grimmer, and Louw 2014: 18).

Non-communicable disease, worsened by the prolonged presence of an overweight or obese bodily state, can be detrimental to the extent of death. Cape Town based high school studies revealed that adolescent girls had double the frequency of being overweight than adolescent boys (7.7% girls to 3.5% boys) (Van Niekerk *et al* 2014: 22). In South Africa, the second national burden of disease study (NBD) indicated that 22 percent of females died of cardiovascular disease and almost five percent from diabetes in 2012. In later life, NCDs accounted for 64.9 percent of deaths in persons over the age of 45 years in South Africa (Msemburi 2012: 5). This can also be seen in the 2012 SANHANES-1 which named diet-related NCD as a widespread problem in South Africa (Shisana *et al* 2014: 139). Collectively, NCDs lead to more deaths each year than any other disease, yet it is one of the most easily avoidable, with a possible root cure being minor lifestyle changes and small adaptations of one's personal habits, all leading towards a healthy lifestyle (Keller and Lang 2007: 867).

Forecasts for the future as suggested by Hossain, Kawar, and Nahas (2007: 214) are that by the year 2025, it is expected that 1.56 billion people may suffer from hypertension, one of the many NCDs that will be on the increase. According to Bradshaw (2012: 10), hypertensive heart

disease contributed to 4.8 percent of deaths among woman and it is the fourth highest cause of death among South African females. A provincial comparison shows that KZN has the highest number of cases of death due to NCDs than any other South African province (Msemburi 2012: 10). This can be avoided, however, since European based studies have shown a positive correlation between one hour of daily physical activity and the possible prevention of clustering cardiovascular heart disease risk factors in young adolescent children (9-15 years) (Anderson, Harro, Sardinha, Froberg, Ekelund, Brage, and Anderssen 2006).

American studies on adolescents showed that participants who took part in relatively high levels of physical activity have less adiposity than less active youth. Less adiposity around the body lessens the chances of becoming overweight or having an increased BMI (Lazzer, Boirie, Bitar, Montaurier, Vernet, Meyer *et al* 2003). However, generally weaker relationships were identified between lipoproteins and triglyceride levels and physical activity levels (Craig, Bandini, Lichtenstein, Schaefer, and Dietz 1996). With regard to blood pressure, studies show that at least 30 minutes of physical activity three times per week with adequate aerobic intensity (approximately 80% of maximal heart rate) can reduce blood pressure in adolescents with mild essential hypertension. However, strength training did not have the same effect on reducing blood pressure in hypertensive adolescents, only aerobic fitness showed positive change. It is also noted that continued physical activity is the key to a positive outcome (Hagberg *et al* 1984 and Laird *et al* 1979). Unfortunately, habits are difficult to break once formed and according to Brown and Ogden (2004: 261) there is a strong connection between eating habits which are formed in adolescent years and are carried through to adulthood. Hence the importance of parental or guardian guidance throughout the critical learning years, ingraining healthy preferences of dietary habits and the importance of ample physical activity as a basis to grow from adolescence into adulthood (Etelson, Brand, Patrick, and Shirali 2003: 1362).

2.2.3 Undernutrition

Undernutrition may not seem appropriate for adolescents from high-income living situations; however, the reality of self-inflicted undernutrition associated with mental disorders such as anorexia nervosa and bulimia nervosa is a reality at the sensitive age of adolescents. Food may be available to adolescent girls but whether or not it is actually consumed and, more importantly, absorbed into the body is what makes undernutrition a possibility worth mentioning. The global disease study showed that among adolescent females aged 15-19 years

in high-income countries, death related to undernutrition due to mental eating disorders (anorexia nervosa and bulimia nervosa) contributes to 2.2 percent of global deaths and is ranked twelfth in the leading causes of death in adolescent females (Whiteford, Degenhardt, Rehm, Baxter, Ferrari, and Erskine 2013). According to the standing committee on nutrition (SCN 2004: 14 and UNICEF 2010) not only does malnutrition provide the basis for many diseases to thrive; undernutrition contributes significantly to poor mental and physical development in children, such as learning disabilities and stunting.

Stunted children and younger adolescents are identifiable by having a much lower height, or being short for their age, this being one of the main physical symptoms of being chronically undernourished (Barasi 2007: 252). Currently, 28.4 percent of children under the age of five living in South Africa are stunted. Stunted children within South Africa were found to be more likely to be overweight and obese through adolescence and adulthood, increasing the risk of susceptibility to NCDs (Symington, Gericke, Nel, and Labadarious 2016).

Within South Africa, SADHA 2016 reported 6.7 percent of adolescent girls being under weight (Stats SA 2017: 45). Studies on adolescents in Nigeria indicated that even more so than obesity, the prevalence of thinness is a new growing and emerging threat to the youth with 13.9 percent of adolescents studied showing to be underweight (Ani *et al* 2014: 2). This, too, can be seen in Cape Town, South Africa, where urban high school studies indicated that underweight was more common than overweight among adolescent girls (9.9% to 7.7%) (Van Niekerk *et al* 2014: 22). Concerns raised among young African adolescent girls has been noted in SANHANES-1 where 13.8 percent of girls under the age of 14 years were unhappy with their current body weight and 16.7 percent were already attempting to diet and lose weight (Shisana *et al* 2014: 247). Extensive research pertaining to undernutrition identifies that one's diet plays a major contributing factor to the prevention of this chronic disease.

2.2.4 Micronutrient deficiencies

Micronutrients are essential to maintaining good bodily functions. It is important for everyone to maintain good levels of all micronutrients at any age; however, some groups are more vulnerable than others. Children, adolescents with eating disorders and the elderly are more at risk of developing deficiencies as growth and degeneration respectively take place during these periods, as well as women needing extra nutrients during child-bearing stages (Bogden and

Louria 2015: 531). In particular, micronutrients are vital for cognitive development in children and young adults and a lack of micronutrients over a prolonged period could lead to permanent brain damage and may effect learning abilities during adolescence. Children that are deprived during the vital growing years may have compromised immune systems and, in severe prolonged cases, irreversible damage to the brain, chronic disabilities and even mortality (Prado and Deway 2014: 272). With the rise in obesity and the persistent presence of micronutrient deficiencies, it can be said that people are eating food but not nutrients. Empty calorie (nutrient poor) foods which have emerged in modern society through convenience food outlets lack greatly in micronutrients but are mainly comprised of processed macronutrients (Voster 2013: 64).

South African children have been noted in the DBSA (2008: 22) and SANHANES-1 studies of 2012 for consuming under the recommended daily allowance of micronutrients, which may have negative implications for future generations in terms of physical growth, mental capacity and general health (Shisana *et al* 2014: 213). Micronutrient deficiencies as mentioned by Bresnahan and Tanumihardjo (2014: 703) occur when an individual has inadequate access to essential micronutrients or when the body is unable to absorb or retain micronutrients due to infection, disease or external influence (purging). Noted by Tulchinsky (2010: 244), is that micronutrient deficiency has always been thought to exclusively affect the body by weakening the immune system and general health of an individual; however, it forms part of a larger collective issue of hindering economic growth and societal progression, especially among adolescents and young adults.

If malnutrition is addressed with proper treatment during vulnerable growing periods, permanent damage can be avoided. (Muller and Krawinkle 2005: 280). As explained by Bogden and Louria (2015: 531), the lack of even one of the several different micronutrients leads to health issues experienced worldwide (Welch and Bouis 2009). It is estimated that around two billion people lack important micronutrients especially in the cases of iron, iodine, zinc and vitamin A along with, but to a lesser degree, vitamin C, vitamin B3 (Niacin), and vitamin B1 (Thiamine), which are also lacking in lower to middle income communities like South Africa (UNICEF, WHO, and WFP 2007). UNICEF (2007a) categorises micronutrients according to the deficiency effects on the body. Type I nutrients do not effect growth; however, they do compromise the metabolism and immunity functions before symptoms appear. These

include vitamins A, B1, B2, B3, B6, B12, C, D, iron, calcium, copper, iodine, folic acid and selenium. Type II nutrient deficiencies have a profound effect on the overall growth of a child.

2.3 Nutritional needs of adolescent girls (14-18 years of age)

Nutrition is the leading component that is required for human health and wellbeing. Adolescence is an age where change happens within the body; there are stages of rapid growth, physical and hormonal changes and maturation into adulthood (Moon *et al* 2014: 2673). These changes demand increased amounts of good quality macro- and micronutrients that the body can use to progress efficiently and effectively. An inadequate foundation formed during gestation, infancy and young childhood can make the adolescence period (10–19 years) more challenging physically, mentally and socially. Continuation of an inadequate diet and unfavourable living conditions all contribute to poor development that can have permanent negative effects according to Saxena and Saxena (2011: 3). The National Health and Nutrition Examination Survey (NHANES 2003-2006) conducted in the United States of America (USA) stated that adolescent girls suffer from the greatest inadequacy of micronutrients (Berner, Keast, Bailey, and Dwyer 2014: 1011).

2.4 Macro-nutrient requirements for adolescent girls (14-18 years)

Macro-nutrients such as protein, carbohydrates and fats are ingested to produce energy and are bulk nutrients used as ‘building blocks’ to sustain and support life as compared to the tiny quantities of micro-nutrients needed to facilitate the functions of macro-nutrients. Nutrition deficiencies have detrimental consequences, especially in the case of adolescent girls (Story and Stang 2005: 27). According to King, Burgess, Quinn, and Osei (2015: 8) nutrients and energy are essential for the metabolism, the chemical reactions that take place within the body such as digestion of food, formation of new cells and production of energy. According to a comparative study by Steyn *et al* (2016) of the dietary intake of South African school-going children (6-15 years), mean energy was identified as being low across all discussed studies.

Adolescents have been identified as a particularly vulnerable group and are often overlooked as the group is not young enough to be classified with children but are not yet adults (Anyika, Uwaegbute, Olojede, and Nwamarah 2009: 1596). The rapid growth spurts, physical activity and the basal metabolic rate demand extra nutrient intake to provide adequate energy for

cellular functions, primarily coming from the carbohydrate and fat groups (Saxena and Saxena 2011).

The acceptable macronutrient distribution range (AMDR) is a range of intake for a particular energy source that is associated with reduced risk of chronic disease while providing adequate intake of essential nutrients. The role of AMDR is to ensure the sufficient intake of essential nutrients. It indicates a high and low range of nutrients; if consumption decreases below or exceeds the range it has the potential to increase risk of chronic disease. Chronic disease has adverse long-term effects on health and can inhibit the absorption of essential micro-nutrients (NICUS 2003: 13 and 2007). The AMDR for adolescent girls for specific macronutrients broken down as a percentage of total nutrients are: carbohydrate: 45-65 percent; protein: 10-30 percent; fat: 25-35 percent; and sugar <10 percent (IoM, Food and Nutrition 2003).

2.4.1 Carbohydrates

Carbohydrates are inclusive of sugars, starches and dietary fibres which act as a fuel source for the body. They are the main sources of energy; however, fats and proteins also contribute to total energy. How much energy is required is dependent on age, weight, height, gender and level of physical activity, assuming the presence of consistent good health (King *et al* 2015: 11). The Estimated Energy Requirement (EER) for the average healthy and active adolescent girl is 2368kcal (9946kJ); however, each girl is unique and this amount may increase or decrease accordingly (NICUS 2003: 18). As previously stated, overall, South African school-going children (6-15 years) fall below the EER (Steyn *et al* 2016). This may be due to decreasing carbohydrate consumption, which was identified by Sedibe *et al* (2014: 117) as a dietary practice used to lose weight by South African adolescent girls. Extra energy is required during the adolescent period to support rapid growth, skeletal development, sexual maturity, energy expenditure doing physical activities and cognitive use during schooling (Story and Stang 2005: 30).

Carbohydrates are found in a vast variety of food items. Those most carbohydrate rich are almost always from plant based foods such as grains, cereals, vegetables, fruits and legumes (Duyff 2012: 55). The EER further defines that about 100g/day is a sufficient carbohydrate quantity for adolescent girls (NICUS 2003: 24). However, the more physically active one is, the more energy is required to be consumed to maintain body mass. Adolescents within

developed countries are known to take part not only in school related sports but recreational types of physical activity which then require an increase of kJ/day (Floyd, Bocarro, Smith, Baran, Moore, Cosco, Edwards, Suau, and Fang 2011: 259).

It has become easier to over indulge in simple (overly refined, high calorie, high sugar and low nutrient) carbohydrates with the introduction of fast and convenience foods. These foods include doughnuts, biscuits, cakes, syrup, chocolates and sweets which are easily accessible, cheap and tasty and have been known to have addictive qualities – all aspects that teenage children thrive on in the modern world (Steyn, Burger, Monyeki, Alberts, and Nthangeni 2001: 143 and Dyff 2011: 60). This can be seen in South Africa where Sedibe et *al* (2014: 116) revealed that the top two foods consumed by urban African adolescents are 'magwinya' (deep fried cake dough) and kotas (a quarter loaf of white bread filled with deep fried chips topped with processed cheese and processed meats). In Cape Town, middle to high income adolescents were reported to eat potato crisps and doughnuts three to four times per week (Steyn 2010: 62). Sugar, which forms part of the carbohydrate group, is recommended to be consumed sparingly and should constitute only 10 percent or less of total energy intake (WHO 2010a). It is exceptionally important to base meals on complex carbohydrates which are nutrient dense, low in sugar and high in fibre. These include whole grain brown rice, barley, oats and vegetables (Dyff 2012: 65).

2.4.2 Protein

Protein is paramount for lean muscle development and is the product of amino acid strains. There are 20 amino acids that make up a full protein, nine of which are considered essential proteins. Essential proteins are crucially important for muscle synthesis and if they are not present in adequate amounts, muscle and tissue development is limited. The body is unable to store or reproduce essential amino acids, which means a daily intake is required. If the body does not receive adequate intake it results in muscle wasting, even in caloric surplus (Duyff 2012: 89). There are two classifications of protein: complete (animal proteins) and incomplete (plant based) proteins. Complete proteins have all the amino acids present and can be simply ingested; however, incomplete plant proteins have missing amino acids. These sources have to be consumed with additional foods that will complete the protein chain which only then can be used to develop muscle (Barasi 2007).

Steyn *et al* (2016) identified that, overall, among school-going children and young adolescents in South Africa, mean protein intake was above EAR and has accredited the larger intake, based on typical dietary patterns of South Africans, to the extra consumption of legumes (plant based proteins) (Labadarios *et al* 2005: 533). The AMDR suggests 10–30% of total energy to come from protein sources. When there is a lack of carbohydrates in the diet and a low calorie intake, the body will turn lean muscle and protein into an energy source. This is seen in severe cases in developing countries due to lack of food and in developed countries due to mental disorders like anorexia nervosa (self-inflicted starvation) and is referred to as wasting. According to IoM (2003: 38), adolescent girls have a DRI of 46g/day of protein or 0.85g/kg/day. Insufficient protein in adolescent girls is associated with the development of iron deficiency anaemia (IDA) (Camaschella 2015: 1832).

2.4.3 Fats

The major role of fat within the body is to insulate the layer underneath the skin to keep the body warm, it accumulates around internal organs to protect and cushion them from injury, it is a vehicle for fat soluble vitamins, it is a highly-concentrated source of energy (9kcal/g, or37kJ/g) and has an important role in the palatability and general flavouring of foods (Duyff 2012: 92). In recent years, adolescents have been in the spotlight for increased consumption of high fat and high sugar foods, in conjunction with sedentary behaviour, which has led to increased cases of overweight and obesity worldwide (He *et al* 2012: 1458). Convenience/ fast foods are notoriously high in trans fats (Low Density Lipo Proteins [LDL] bad cholesterol) which are known to cause cardiovascular disease (King *et al* 2015: 17). A Cape Town based study of middle to high income adolescents indicated the top foods eaten daily included numerous high fat food items such as butter/margarine, full cream cheese or cheese spreads and milk (Steyn 2010: 62).

The institute of medicine (2003) recommends that 25–35 percent of the total daily energy from fat should come from unsaturated fat sources and less than 10 percent of energy should come from saturated fat sources. Unsaturated fats include Monounsaturated Fatty Acid (MUFA) and Polyunsaturated Fatty Acid (PUFA), which are considered healthy fats and have positive effects on the body such as increasing high density lipo protein (HDL) (good cholesterol) levels and are recommended to be included in the diet to prevent the development of cardiovascular

disease. It was estimated that in 2001, American children were obtaining more than 50 percent of total daily calories from fats and sugar (Story and French 2004: 1).

PUFA is an essential fatty acid that the body cannot synthesise therefore it has to be ingested through rich sources such as oily fish (salmon and mackerel), nuts and seeds and vegetable oils (sunflower oil, soybean, nut oils) (King *et al* 2015: 14). Dietary fat is important during adolescence as it is an additional source of energy and plays a significant role in cell structure, both of which are required during the rapid growing years (Gibson 2005: 115). It is also essential in the absorption of fat soluble vitamins such as vitamin A, which has been identified as a common micro-deficiency in adolescent girls (Labadorios *et al* 2005 and Shisana *et al* 2014: 214). Other sources of good fats that should be included in the diet are avocado, coconut oil, ground nuts and peanuts.

2.4.4 Dietary fibre

Total fibre is a dietary carbohydrate that is resistant to the digestion process; it is rather passed through the small intestinal tract acting as a pulley system for digested food particles. Once it has entered into the large intestine, it can go through partial or total fermentation (IoM 2006: 341). It has been noted that South African young adolescents have a low fruit and vegetable intake leading to lowered dietary fibre intake and low fibre intake can contribute to developing NCDs (Shisana *et al* 2014: 213). Mchiza *et al* (2015) also notes that fruit and vegetable consumption is deficient in older adolescents and young adult South Africans. When dietary fibre is ingested in adequate amounts, it has been known to lower blood glucose and ensure proper bowel movements, which may be attributed to the prevention of developing an NCD such as cancer of the bowel and diabetes (Anderson, Baird, Davis, Ferreri, Knudtson, Waters, and Williams 2009: 188). NICUS (2003: 25) concurs and adds that adequate intake of fibre has been set based on the prevention of the NCD coronary heart disease. Dietary fibre is described by its physical behaviour in water; there are two types:

Table 2.1: A comparative look at the two types of dietary fibre (NICUS 2003: 25).

Type	Example
Insoluble fibre	Hemicelluloses, lignin and cellulose: found in wholegrain cereals, brown rice and skins of fruit and vegetables.
Soluble fibre	Mucilages and pectins: found in legumes, flesh of fresh fruit and vegetables, nuts and beta-glucans present in barley, oats and some yeasts.

A dietary fibre content of 26g per 1000kcal (4184KJ) ingested daily is considered an adequate intake (AI) for girls aged 14–18 years (NICUS 2003: 28). It is equally important to have enough but to not exceed dietary fibre requirements. Adolescent girls in India have shown to be micronutrient deficient not only because of inadequate food intake, but the large number of vegetarians within the population results in them consuming high volumes of phytate and dietary fibre from plant-based foods (Khadilkar and Khadilkar 2012). High fibre diets have been documented to bind with vitamins and minerals, moving quickly through the digestive tract and leaving minimal time to be absorbed by the body (Carlson, Eisenmann, Norman, Ortiz, and Young 2011: 1690 and NICUS 2003: 27). Excessive high fibre diets have also been known to cause gastrointestinal stress particular in the case of individuals with irritable bowel syndrome (IBS) (Eswarn, Muir, and Chey 2013: 718 and NICUS 2003: 27). Valtin (2002: 994) notes that fruit and vegetables are also a good source of fluid and electrolytes, which are important for physical exercise.

2.5 Micronutrient requirements for adolescent girls (14-18 years)

Micronutrients are required in much smaller amounts than its counterpart macronutrients (NICUS 2003). Yet the small amounts required contribute to a large role within the body to maintain optimal functioning of every biological system and cellular structure. Micronutrient deficiencies developed within infancy and young childhood have the potential to be carried on through adolescence and adulthood (Swaminthan, Edward, and Kurpad 2013: 468). Deficiencies of micronutrients have been described by Bresnahan and Tanumihardjo (2014: 703) to not only burden people with health implications, but they also delay the social and economic development of a country. Micronutrients that are important for adolescent girls and

their daily requirement (DRI) are: vitamin A (485.00µg EAR), B6 (1.0mg EAR), B12 (2.0µg EAR), vitamin C (56mg EAR), vitamin D (5µg AI), vitamin E (12mg EAR), vitamin K (75µg AI), calcium (1300mg AI), iron (7.9mg EAR), magnesium (300mg EAR), phosphorus (1055mg EAR), zinc (7.5mg EAR), selenium (45µg EAR), iodine (95µg EAR), thiamine (0.9mg EAR), riboflavin (0.9mg EAR), niacin (11mg EAR), folate (330µg EAR), pantothenic (5mg AI), biotin (25µg AI) (NICUS 2003).

2.5.1 Vitamin A (retinol)

In the USA reduced fat products such as milk and yoghurt have been fortified with vitamin A to meet the equivalent content of whole fat options. This change has been directly caused by more individuals, especially in the case of adolescent girls and young women within developed countries, changing traditional diets to diets high in reduced fat or fat free ones (Berner *et al* 2014: 1014). Adolescent girls have been identified as being most likely to experiment with dietary changes hence the need to fortify vitamins and minerals into staple foods (Bonjour *et al* 2013: 250). Within South Africa, the NFCS (2008: 261) identified girls of a reproductive age to be prone to micronutrient deficiencies and this is reflected in 27.2 percent of girls identified to have vitamin A levels lower than WHO recommended levels in 2005. However, through fortification of staple foods and supplementation, this number has decreased to 11.6 percent of female adolescents (16-25years) participating in SANHANES-1 2012 having mild vitamin A deficiency (Shisana *et al* 2014: 157). It is also noted that the NFCS uses a <67% RDA cut-off which was said to increase the number of deficiencies identified. When looking at other current studies relating to school children (6-15 years) in South Africa, the mean vitamin A intake was found to above EAR (Steyn *et al* 2016).

2.5.2 B vitamins

According to Steyn *et al* (2016) in a comparative study of children and young adolescents in South Africa, the NFCS identified B vitamins falling below mean EAR as niacin, folate and vitamin B6 but not thiamine and riboflavin. Urban studies on adolescent children in India conducted by Swaminthan *et al* (2013: 469) link the lack of B vitamins in conjunction with an iron deficiency to negative implications for cognitive and physical performance. A deficiency may occur due to insufficient intake or malabsorption. Dror and Allan (2012) note that adolescents may be more prone to B12 deficiency due to a pre-existing deficiency of iron

causing IDA. Adequate intake of iron is required for proper absorption of B vitamins, folate and vitamin A. This correlates with Nojilana *et al* (2007: 741) and WHO (2007a) stating that iron deficiency is the most common and widespread micronutrient disorder. This is supported by (Camaschella 2015: 1832), identifying adolescent girls and women of menstrual age to be at high risk of iron and vitamin B12 deficiency.

The most common and rich dietary sources of vitamin B12 are animal products (Dror and Allan 2012). Obersby *et al* (2015: 785) indicates that diets which omit animal products are much more likely to become B12 deficient. With adolescents being of an age where diet becomes experimental, individuals choosing a vegetarian or more extreme vegan diet are destined to develop a vitamin B12 deficiency without proper precautions and micronutrient food knowledge. Results identified by Pawlak, Parrott, Raj, Cullum-Dugan, and Lucus (2013: 115) indicate that 21–41 percent of adolescents that are vegetarian suffer from B12 deficiency. It is recommended that this vulnerable group supplement daily to maintain adequate levels.

2.5.3 Vitamin C (ascorbic acid)

Vitamin C deficiency is commonly associated with poor immune function but is also linked to the increase of cardiovascular disease (Dror and Allan 2012). It was reported that 50 percent of females within rural KZN, South Africa did not meet vitamin C requirements (Kolahdooz, Spearing, and Sharma 2013). The EAR for vitamin C is 56mg/day. Scurvy, a common symptom of a vitamin C deficiency, can be avoided with as little as 10mg/day (Lykkesfeld and Poulsen 2009: 1). The vitamin C content of fruit and vegetables is dependent on the season of the year and growing conditions from which the produce came (Dror and Allan 2012).

2.5.4 Iron (Fe)

According to SANHANES-1, in 2012, 10.5 percent of older adolescents and young adult women (16-25 years) were found to have iron deficiency anaemia (IDA) (Shisana *et al* 2014: 220). Current studies by SADHS 2016 state that 33 percent of adolescent girls and young adults (15-19 years) suffer from anaemia (Stats SA 2017: 51). However, the Global Burden of Disease study in 2013 indicated that South Africa has a higher percentage of 25.5 percent of children and adolescents with IDA. South Africa is also noted to have a lowered rate of IDA children as compared to the rest of Africa (Shisana *et al* 2014: 220). This can also be seen in places like

rural India, where iron is the top micronutrient that is crucially lacking in adolescents (Swaminthan *et al* 2013: 467). Ahmed, Khan, Banu, Qazi, and Akhtaruzzaman (2007: 369) reported that adolescent girls (14–18 years) within the Bangladesh based high school study indicated that 28 percent of the girls had extremely low iron stores with only 12 µg per/l. There were also reports of low vitamin B12 and vitamin A which is associated with inadequate iron levels (Dror and Allan 2012). A strong relationship between the frequency of meat consumed and low iron levels was concluded even with adequate consumption of total energy (Ahmed *et al* 2007: 372).

Currently, 48 percent of women aged 15–35 in South Africa suffer from anaemia (Shisana *et al* 2014: 166). Anaemia is a problem because about 90 percent of iron absorbed is incorporated into haemoglobin and is responsible for keeping red blood oxygenated and transported throughout the body to replenish organs and tissues (Prasad 2013b: 98). A high level of iron is needed to compensate for menstrual losses, development of the foetus during pregnancy and if blood is donated frequently especially in the case of adolescent girls. Supplementation has shown to decrease cases of IDA as seen in SANHANES-1 (2015). Like in South Africa, many developing countries such as Zimbabwe, India and South Asia choose to supplement iron to pregnant women to combat iron deficiency and facilitate better circumstances for the children's future (Yakoob and Bhutta 2011, WHO 2007b and Shisana *et al* 2014: 166). However, overdosing on iron, usually through incorrect supplementation, can be toxic. Amounts taken in excess of 45mg/day can lead to liver damage (NICUS 2003: 49 and Prasad 2013b: 114).

2.5.5 Calcium (Ca)

Girls in particular need more calcium during the adolescent phase where bone formation and growth is most critical. The skeletal density created in adolescence is carried throughout adulthood and the elderly years (Bonjour *et al* 2013: 252). Marta, Seiquer, and Navarro (2011: 199) reiterate this, stating that adolescence is an important age to reach optimum peak bone mass to prevent osteoporosis in adulthood. Approximately 45 percent of peak bone mass formulation occurs during the growth spurt of adolescence (Story and Stang 2005: 29). Beto (2015: 7) confirms that in later life women have been identified as being most vulnerable to bone demineralisation during hormonal changes due to poor levels of calcium absorbed during adolescence in association with continuous low calcium intake.

Older South African adolescents and young adults were identified to commonly have a deficient intake of dairy as reported by Mchiza *et al* (2015); this causes a reduction in overall calcium intake. Adolescence is a stage where eating becomes a personal choice as opposed to being fed by a parental figure. Balanced diets, inclusive of correct calcium levels, may not always be a main concern for teenage girls. Instead, an increase of the use of fad diets, restrictive diets such as veganism or the exclusion of certain foods and food groups increases the chances of calcium deficiency, especially apparent in western society (Marta *et al* 2011: 199 and Bonjour *et al* 2013: 250).

2.5.6 Zinc (Zn)

South African school children including young adolescents were reported across several studies to have below EAR for zinc, although it is also noted that there is a paucity in zinc status information for children and adolescents (Steyn *et al* 2016). This is similarly seen worldwide with an estimated 1.2 billion adolescents, which equates to one in every five adolescents, having a zinc deficiency (UNICEF 2011). It is difficult to test zinc levels within developing countries due to limited access to laboratories that can conduct chemical testing (NICUS 2003: 51.) Individuals often go without diagnosis and do not receive the necessary attention which contributes to a high mortality rate. This may be why zinc deficiency can be referred to as one of the most detrimental nutrients of 'hidden hunger', a name given to describe micronutrient deficiency (Swaminathan 2012: 1009). Adolescent girls aged 14–18 years have an EAR of 7.5mg daily (NICUS 2003: 53). Vegetarian and vegans require as much as 50 percent more than the daily recommendation due to the high phytate content of the plant based diet (Kawade 2012). Zinc is important for several bodily functions including fertility, taste perception, cell reproduction, regulation of vitamin A from the liver, cognitive functioning and anti-inflammatory responses (Khadilkar and Khadilkar 2012).

2.6 Causes of malnutrition

Long-term exposure to malnutrition as an infant, child or adolescent can have permanent and life altering changes once adulthood is reached. Craigie, Lake, Kelly, Anderson, and Mathers (2011: 266) note that an unhealthy diet, sedentary behaviour and physical inactivity are known to track from childhood into adolescence and become difficult to change in later life. Adolescents were once considered a low-risk group; however, the rapid rate of urbanization,

increased production of processed foods and ever-changing lifestyles have shifted eating patterns and have made malnutrition more common than not (WHO 2015a).

Physical abnormalities can be challenging as an individual; however, the possible mental implications and lowered IQ are not only challenging for the individual (Waber *et al* 2011: 6 and Shih 2007) but may result in a reduction of contribution to societal responsibilities. Inability to work and be self-sufficient after adolescence can attribute to a lowered economic state which then exposes individuals, and possibly the immediate family, to the detrimental factors of the poverty cycle (Kruger *et al* 2005: 490). In addition, there are many other factors that may initiate or promote malnutrition throughout a lifetime such as level of education, limited food consumption, social and economic status, healthcare facilities, physical inactivity and the home environment (Lesiapeto *et al* 2010: 202 and WHO 2015a).

2.6.1 Inadequate dietary intake

Dietary intake as described by Kolahdooz *et al* (2013) suggests that food quality, which is determined by the micronutrient content, is a far stronger determinant of nutritional status than the quantity of food being eaten. Inadequate dietary intake is effected by and associated with socio-economic status, family income, education level and limited access to food. More specifically, dealing with adolescent girls, it may have additional contributing factors such as religion or belief restrictions, sickness or loss of appetite during adolescent hormonal changes, obsession with self-image and peer pressure.

In Addition, Khadilkar and Khadilkar (2012) state that micronutrient deficiencies among adolescents within the modernized world may be attributed to the increasing of and over indulgence in the convenience/ fast food industry. UNICEF, WHO and the World Bank Group (2016; 7) identified a 25 percent increase of obesity among children and adolescents dwelling in upper middle and high-income areas between the years 2000-2015. However, overweight and obesity among children and adolescents is not limited to developed, first world countries where food is readily available and poverty is less prominent. Studies have shown a link between overnutrition and low-cost non-nutritive convenience/ fast foods (Cetteanu and Jones 2014: 74).

A consistent pattern around the world of overweight and obese children and adolescents coming from deprived low socio-economic areas can be seen in studies based in the USA (Singh, Siahpush, and Kogan 2010: 503), Europe (Knai, Lobstein, Darmon, Rutter, and McKee 2012: 1472), the United Kingdom (UK) (Conrad and Capewell 2012; Macdonald, Cummins, and Macintyre 2007: 251; Cummins, Mckay, and Maclintyre 2005; and Kinra, Nelder, and Lewendon 2000: 457), New Zealand (Pearce, Blakely, Witten, and Bartie 2007: 376) and Canada (Janssen, Boyce, Pickett, and Simpson 2006: 139). UNICEF, WHO and the World Bank Group (2016: 7) confirm this with recent statistics pertaining to obesity among children, where a 60 percent rise can be seen within low-middle income communities and a 4.2 percent increase in very low income communities. Increased volumes of heavily saturated, processed macronutrient foods that have little micronutrient density contribute to inadequate dietary intake, leading to micronutrient deficiencies and increased risk of disease (Cetteanu and Jones 2014: 7). The suggested intake of fruit and vegetables per day, recommended by WHO (2003b), is at least 400g (5 portions) daily yet more often than not, fruit and vegetable intake decreases dramatically during the adolescence period (Jøgensen, Aarestrup, Jøgensen, Due, and Krølner 2016: 112). A connection has been drawn between parents with low socio-economic positions and poor dietary intake of children and adolescents. These diets are often associated with high fat and sugar intake and low fruit and vegetable consumption. Socio-economic status is just one of many factors contributing to the growing rate of adolescent obesity, according to Van der Horst, Oenema, Ferrira, Wendel-Vos, Giskes, van Lenthe, and Brug (2007: 203).

2.6.2 Sickness / illness

A combination of poor food choices, poor eating habits and inadequate exercise during adolescence has been described by Khadilkar and Khadilkar (2012) to impair growth and these are ultimately the root causes of developing illness in the future. Cuenca-Garcia, Ortega, Ruiz, González-Gross, Labayen, Jago, Martinez-Gómez, Dallongeville, Bel-Serrat, Marcos, Manios, Breidenassel, Widhalm, Gottrand, Ferrari, Kafatos, Molnár, Moreno, De Henauw, Castillo, and Sjöström (2014) confirm this, stating that it is the combination of diet quality and physical activity levels that determine whether adolescents may develop cardiovascular disease at earlier stages within adulthood. Over-and undernutrition play equally devastating roles in developing children and adolescents. Children generally are prone to suffer more from malnutrition due to the higher requirement of all nutrients during the growing years especially in low income areas (Lesiapeto *et al* 2010: 202). The adolescence period is an equally vulnerable stage for the

effects of illness caused by malnutrition. This is when critical changes take place in the body and mind with respect to physical, cognitive and social development (Ani *et al* 2014: 2).

Adolescents have been shown to have severe deficiencies pertaining to calcium, iron, vitamin A and several other vitamins and minerals on a smaller scale (WHO 2003b). These deficiencies give way to illness such as anaemia and retinol (eye) disease. Within South Africa as a whole, SANHANS-1 indicated 13.3 percent of girls of reproductive age are currently suffering from vitamin A deficiency (VAD) and 23.1 percent have anaemia. It is also reported that KZN has the highest (33.1%) prevalence of anaemia and black girls of a reproductive age are twice as likely to be iron deficient compared to coloured women of the same age (Shisana *et al* 2014: 12). Poor nutritional status can lead to a high risk of NCDs developing in later life (Kruger *et al* 2005: 491 and Ani *et al* 2014: 8). Within South Africa, the presence of HIV and AIDS as well as tuberculosis has had exacerbating effects on chronic diseases of lifestyle (CDL) and increased vulnerability to malnutrition. The immune system is compromised with the presence of HIV and provides a way for NCDs (cancer, cardiovascular and respiratory diseases) to manifest. At this point, the body requires even more micronutrients than usual, yet often infected people already suffer from malnutrition (Bhutta, Makrides, and Prentice 2015: 2). It has also been identified that education on health and nutrition, with reference to the adolescent's surroundings, is the primary prevention method used to combat obesity and development of NCDs (Bay and Vickers 2016: 502).

2.6.3 Education and ignorance

There are many studies internationally that link the level of education one is exposed to with the level of general health knowledge. Berner *et al* (2014: 1010) states from food intake studies conducted in the USA, that adequate education, especially on nutrient intake, is vital to put dietary advice and knowledge into a practical context. Theoretically, the more educated one is increases the chances of having better health knowledge and thus being able to make healthier choices and practice hygienic cooking methods (Conti, Heckman, and Urzua 2010: 235). This is supported by the SANHANES-1 studies of 2012, indicating that, as a whole, the South African population has inadequate nutritional knowledge and as a result tested poorly in healthy food knowledge categories. Conti *et al* (2010) further describes that nutritional knowledge alone is insufficient and behavioural change towards healthy eating needs to be in conjunction with practical guidelines. Steyn's (2010: 62) research in South Africa on middle to high income

adolescents showed that 52 percent have poor nutritional knowledge of dietary fat, with students who were interested in nutrition being those who scored highest. Interestingly, an average to good score indicated that nutrition education had been incorporated into school subjects. This shows that dietary knowledge can be imparted at school level and has a beneficial effect on nutrition behaviour.

It has always been thought that the income of a family has a huge influence on the health and wellbeing of an individual. It is assumed that the wealthy have better knowledge of nutrition due to better education and access to healthy foods whereas those who may have a lower income are less likely to have access to health information to make better food choices thus falling into the poverty cycle, which often spirals into worsened conditions. However, according to the SANHANES-1 studies of 2012, this is not always the case. South Africa as a whole has poor nutrition knowledge across all financial sectors, regardless of education levels (Shisana *et al* 2014: 213). This indicates that even individuals with the best education can still be ignorant about general nutrition education, which may mean relooking basic nutrition education at school level and carried forward into the tertiary schooling and working environments.

2.6.4 Lack of nutrition education at school level

Contenro (2011: 14) describes how nutrition education has evolved beyond directing traditional education methods towards learners. It has become a combination of educational strategies that have environments that support the voluntary adaptation to better food choices and other nutritional related behaviours. Conti *et al* (2010: 236) adds that evidence suggests that education in general improves health knowledge, which reflects in healthier choices and behaviours. Children spend many hours of the day within a schooling environment. Classroom based health education provides an optimal environment to learn about healthy food choices. Children can then associate the importance of the subject alongside traditional learning subjects such as mathematics (Hassan 2015: 3). South African children (aged 10-14 years) score particularly low in the general nutrition education testing done by SANHANES-1 with 71.7 percent scoring lower than average (Shisana *et al* 2014: 247). This is supported by a study by Sedibe *et al* (2014: 118) where adolescent girls in Soweto, South Africa, reported a weak association between nutrition knowledge provided at a school level and dietary behaviour.

In Canadian studies, adolescents who came from areas where there was a low percentage of residents (parents and other influential adults) and who had a high school education showed to have increased unhealthy eating habits highlighting the importance of nutrition education at a foundation school level in order to be brought forward into adulthood (Janssen *et al* 2006: 140). Adolescents can be equipped with nutrition knowledge at school level to understand the consequences of certain food choices and encouraged to practise self-control; however, modern society has made the daily environments (homes, schools, malls) adolescents are exposed to tempting and they can encourage bad eating habits. A localised study within the Eastern Cape reported that 58.7 percent of the adolescents studied could not identify correct food portions/ serving sizes (Oldewage-Theron, Egal, and Moroka 2014: 138).

2.7 Other factors contributing to malnutrition

2.7.1 Lack of safety and exercise

Safety plays a big role in contributing to factors of malnutrition. Crime in neighbourhoods decreases the desire to walk to school, shops and playgrounds for fear of becoming a victim of crime. Walking behaviours have been linked to a neighbourhood walkability status (Koohsari, Owen, Cerin, Giles-Corti, and Sugiyama 2016: 121) which can be seen in (Merchant *et al* 2007: 3) Canadian studies reporting that neighbourhoods that are identified as less walkable due to decreased safety (crime) have fewer children and adolescents walking to school or walking around in general hence a decrease in physical activity. This was also identified in the South African study by Sedibe *et al* (2014: 118) on adolescent girls who identified community safety as well as limited resources (youth recreational and sporting facilities) as factors that limited participation in physical activity by the young women.

It is reported that children under the age of 18 years dwelling in middle to high income neighbourhoods that were deemed ‘safe’ engaged in more unsupervised sports and used recreational facilities such as parks and playgrounds more, thus increasing overall physical activity levels compared to those who lived in ‘unsafe’ neighbourhoods (Veugelers, Sithole, Zhang, and Muhajarine 2008: 154). In contrast, Burdette and Whitaker (2004: 59) found no relationship between low income children who were overweight and the proximity to a playground or fast food outlet, nor were crime levels significant.

2.7.2 Physical inactivity

Physical activity is defined by WHO (2014a) as any bodily movement produced by skeletal muscles that requires energy expenditure. Physical inactivity has been identified globally as the fourth leading risk factor for mortality causing an estimated 3.2 million deaths annually. Regular moderate intensity physical activity such as walking, cycling or participating in sports has significant benefits for health. For instance, it can reduce the risk of cardiovascular disease, diabetes, colon and breast cancer and depression developing in later life. Moreover, adequate levels of physical activity help with weight control (WHO 2014a). In South Africa, steps have been taken to promote physical activity through the improvement of road safety for cyclists and pedestrians with the introduction of cycle lanes and beach promenades (Western Cape Government 2007).

Physical activity is the behaviour that results in energy expenditure involving bodily movements (Ainsworth, Cahalin, Buman, and Ross 2015; 387). Globally only one in four adolescents meet the minimum physical activity requirement of 60 minutes of moderate to vigorous activity daily (WHO 2014a). This equates to more than 80 percent of the total global youth (5–17 years) population not meeting the daily physical activity requirement. Adolescent girls were less active than adolescent boys, with 84 percent vs. 78 percent not meeting WHO recommendations (WHO 2015a). In contrast, Gaspar, Amaral, Bruno, and Borges (2011: 563) identified adolescent girls who were dissatisfied with their body image as displaying higher levels of physical activity. In South Africa, approximately 26 percent of school-going adolescents did not want to participate in any physical activity and would avoid it if allowed to (Shisana *et al* 2014). Alarmingly, close to 42 percent of South African high school learners were not participating in physical activity at all or were completing inadequate amounts to make a positive impact on their health. According to Reddy *et al* (2008) adolescent girls made up the majority of students who did not meet physical activity recommendations across South Africa.

KZN statistics show that more than 50 percent of female adolescents complete insufficient activity or do no physical activity during the week. Studies also indicated that one in three South African learners watch television for more than three hours per day (Reddy *et al* 2008: 117 and Joubert, Norman, Lambert, Groenevalt, Schneider, Bull, and Bradshaw 2007: 730). The most prominent NCDs associated with physical inactivity, poor diet and obesity in South Africa are cardiovascular diseases such as high blood pressure and a high cholesterol level

(Kruger *et al* 2003: 18 and Mayosi *et al* 2009: 941). A study conducted in the Western Cape has shown the province to be slightly stronger in terms of attaining adequate physical activity but it also revealed that 35 percent of those who were inactive had already shown at least one risk factor that could contribute to the development of a chronic lifestyle disease or NCD (Frantz 2006: 74).

A possible reason for the lack of exercise among adolescents may be due to the uncomfortable side effects that are associated with exercise such as headaches from dehydration or muscle cramping from inadequate magnesium intake. Poor nutritional knowledge can lead to insufficient dietary intake needed to support the extra body functions used during physical activity. This includes additional electrolytes and water which support optimum bodily functioning. Kemptom, Ettinger, Foster. Williams, Calvert, Hampshire, Zelaya, O'Gorman, McMorris, Owen, and Smith (2010: 78) observed the effects of dehydration and report that it results in shrinkage of brain tissue. Within adolescent based studies, it was reported that after mild dehydration due to thermal regulated exercise, an inefficient use of brain metabolic activity was recorded. It was concluded that the executive functioning of the brain used for planning and processing was adversely impacted from dehydration. This correlates with the findings of Armstrong, Ganio, Casa, Lee, McDermott, Klau, Jimenez, Le Bellego, Chevillotte, and Lieberman (2012: 388) that included increased perception of task difficulties, low concentration, headaches and a degraded mood in healthy young girls who had exposure to mild dehydration from exercise.

In 2012 reports indicated that worldwide, children aged 13–15 years spend approximately two hours a day sitting in front of a television (Hallal *et al* 2012: 247). According to Janssen *et al* (2006:140) adolescents who have decreasing perceptions of material and family wealth are more likely to be physically inactive. This concurs with Merchant *et al* (2007: 3) who found that children and adolescents coming from urban deprived, low socio-economic circumstances have high levels of inactivity and are reported to sit in front of the television and computers more, as well as reports of poorer dietary intake as compared to adolescents attending affluent schools. However, it is also noted that there was no significant weight gain due to this sedentary behaviour.

Cuenca-Garcia *et al* (2012: 553) reports that active adolescents who took part in cardiovascular fitness activities had healthier blood pressure compared to their peers who were inactive with

or without a healthy diet. This shows that even if a healthy eating lifestyle cannot always be maintained, incorporating physical activity increases heart health. It is also noted that the healthiest cardiovascular risk score came from a combination of an active lifestyle and healthy eating. Activity levels also play a part with micronutrients. Middle Eastern studies on children and adolescents correlate inactivity with decreased vitamin D scores. With the same exposure to sunlight, it was identified that those who were moderately to highly physically active had higher vitamin D levels as opposed to individuals who were inactive (Al-Othman *et al* 2012: 6). In contrast, NICUS (2003: 76) states that over exercising has shown an increase in the demand for thiamine (vitamin B1) and can cause a deficiency if this is not monitored.

South African school-going girls could not identify the minimum requirement of physical activity that is required to maintain a healthy lifestyle (Shisana *et al* 2014: 213). Although South Africa has a multitude of traditional beliefs and cultural diversities, the westernised way of living has urbanised most of the country which promotes less traditional foods, less walking, less manual labour and less playing outside and advocates more convenience foods, use of motorised vehicles, technologies and sedentary luxury items (Steyn *et al* 2001: 143). Veugelers *et al* (2008: 154) report that children and adolescents who had access to parks, playgrounds and recreational facilities had increased physical activity levels and were less likely to gain weight or develop the onset of childhood obesity. Cross-sectional studies within China showed children and adolescents were more likely to participate in leisure-time sports and exercise if the parents participated in the same or similar activities (Dong, Howard, Herring, Thompson, Adair, Popkin, Aiello, Zhang, and Gordon-Larsen 2016: 118).

A South African based study on middle income adolescent girls reported that watching movies, listening to music, street dancing and going to the local mall are their preferred daily activities and no formal exercise was done. These results were found to be similar to a study by Pearsons *et al* (2009: 34) on adolescent girls aged 12-16 in the UK (a high income county) where physical activity was also found to be low. It was also apparent that most of the girls were aware of the importance of physical activity but only a few participated in any way thus not reaping the benefits of it (Sedibe *et al* 2014: 118). Westernised countries have access to an array of technologies and adolescents have grown up in a media saturated world, which heavily influences behaviours (Story and French 2004). Interventions to combat inactivity and promote healthy diets are now more in the form of applications (apps) on smartphones and other mobile devices for urban and developing countries. The efficacy of this has been tested by Schoeppe,

Alley, Lippevelde, Bray, Williams, Duncan, and Vandelanotte (2016: 127). Out the 21 different studies on health apps and the effects on physical activity levels, 14 studies showed significant health improvements and some studies have linked increased health app usage to improved health related outcomes.

2.7.3 Tuck shops and snacking

Many schools in South Africa have tuck shops (food shops) where energy-dense (high sugar and fat) and micronutrient poor food items are sold to learners (Steyn *et al* 2016: 509). This is supported by Prasad (2013: 100) who also reported that low cost, high calorie foods are often found in tuck shops in primary schools, high schools and universities. The snacking culture gained momentum in the early 2000s and causes concern because snacks chosen by school children and adolescents are often high energy-dense foods with little nutrient value (empty calories) usually filled with sugar, fats and salt such as chips, cakes, vetkoek, sweets, chocolates, sodas, pies and samosas. An increase of passive over-consumption on snack foods is thought to be a main factor linked to childhood obesity and carried into adolescence and adulthood in the modern world. It is reported that the prevalence of snacking among children has increased from 78 percent in 1998 to 94 percent in 2006 (Wang, Zhai, Zhang, and Popkin 2012: 253).

According to Story and French (2004) commercial food advertisements or convenience/ fast foods readily available in the environment to which children and adolescents are continuously exposed can attribute to a higher intake of empty calorie foods. This is confirmed by Buijzen *et al* (2010: 428) who point out that children and adolescents are easily influenced by media persuasion. With the ever-evolving media saturated environment, children and adolescents are more exposed to aggressive forms of food marketing. It was estimated that in 2004, adolescents spent $140 billion a year on purchasing food and are thought to have significant buying power hence the media's heavy marketing directed towards the youth (Story and French 2004).

In South Africa adolescent high school girls indicated that healthy foods were not provided at school tuck shops and the girls were more inclined to buy fast food items as they were affordable and accessible unlike fruit and vegetables which were not readily available at school and in the home environment (Sedibe *et al* 2014: 118). This can also be seen in America where Hess and Slavin's (2014: 4750) results indicate 97 percent of children and adolescents ate

snacks and were shown to have diets that were very low in dietary fibre, vitamin D, calcium and potassium yet showed excessive consumption of refined carbohydrates and added sugars. It was added that snacks were contributing about 18 teaspoons of sugar per day to the diet. This exceeds the WHO (2015b) recommendation that less than 10 percent of total energy should attribute to sugar intake.

According to Kerr, Rennie, McCaffrey, Wallace, Hannon-fletcher, and Livingston (2009: 122) snacking patterns among adolescents in Britain and Ireland showed a significant increase in snack portion size and energy density from 1997–2005 and the number one snack still remains high-sugar carbonated soft drinks. According to Larson, Story, Eisenberg, and Neumark-Sztainer (2016: 240) latest studies have shown that snacking was found to decrease on school days and holidays away as compared to home life except in the case of adolescents who prepared snacks at home and carried snacks on hand. Snacking in itself is not considered a bad habit; however, what is being snacked on is usually the problem. Healthy micronutrient dense alternatives such as fruit, carrots, hummus, lean biltong (dried meat) and yoghurt, in appropriate portion sizes, can have positive effects on the diet.

2.7.4 Parents' influence on children's food intake

Ruopeng's (2016: 57) study on adults' dietary patterns indicates that there is an increase of total energy (KJ) intake on weekend days (Saturday and Sunday) as compared to week days. Also noted is the decrease in diet quality with high fat, high sugar foods and a low fibre intake being favoured. Adults that expose children to these types of eating patterns may be promoting an unhealthy relationship with food. Story and French (2004: 1) explain this, mentioning that the eating habits established during childhood are often tracked into adolescence and adulthood and this may have long-lasting health implications and increased risk of chronic disease if bad habits are formed. Frongillo and Bernal (2014: 2840) add that mental stress has been linked to over-eating. It could be possible that a child mimics the eating practices of the mother figure and may associate over-eating as a coping mechanism, leading to an increase of overweight and obesity at a young age.

According to Barry, Jarlenski, Grob, Schlesinger, and Gollust (2011: 132) high- and middle-income societies have a very different outlook on weight gain and food opinions compared to low-income communities. Mothers (and fathers) who are uneducated in respect of proper

nutritional knowledge may have concerns about a child's weight as a result of alarmist media reports and without professional advice, have been known to restrict foods that the mother believes are not healthy as an experimental task to get the child to lose weight; for example, cutting out carbohydrates from the diet (perhaps a fad diet popular at the time) (May, Donohue, Scanlon, Sherry, Dalenius, and Faulkner 2007: 1167). This practice has been associated with children having increased 'food seeking' behaviours, emotional attachments to food and over eating when not required to adhere to a restrictive diet. Usually these foods are limited to foods such as sweets or chocolates, and can be called palatable food restrictions (Webb, Butler-Ajibade, and Robinson 2014: 426). Ultimately overweight and obesity does occur in children and adolescents who experience restrictive feeding (Etelson *et al* 2003; May *et al* 2007: 1168 and Webb *et al* 2014: 427).

Dong *et al* (2016: 118) has drawn associations between the parent's/ caregiver's physical activity levels and dietary intake and those of the children within the same household. The same cross-sectional study within modernised China has also linked dietary intake and physical activity as key factors that influence obesity and cardiovascular diseases among children, thus making it essential to address these factors at an early age, with positive habits being formed and practised within the home environment during the vital learning years of childhood and adolescence. Studies of two vastly different cultures – American (Beydoun and Wang 2009: 137) and Chinese (Dong *et al* 2016: 118) ─ with different dietary habits and views on physical activity have similarly concluded that parents do have an influence over children and adolescents regarding food intake and activity levels.

Contributing to this, Danish studies show that women have the most involvement and influence in what children and adolescents eat within the parental unit. It is also noted that adolescents learn dietary habits and cooking methods through observation within the home environment, which indicates parental influence (Jøgensen *et al* 2016: 112). This is why having the correct nutritional knowledge on food preparation and dietary intake is important as children are always watching and absorbing information. A consistent connection was also drawn between parents' education level on nutrition and adolescents' (13–18 years) intake of fruits and vegetables and both siblings and parents had an influence on the total energy and fat intake of adolescents within the same household. This shows that the family home environment plays an important part in influencing what adolescents choose to eat (Van der Horst *et al* 2007: 203).

2.7.5 Food eaten away from home

The California centre for public health advocacy (CCPHA) and the University of California, Los Angeles (UCLA) (2008) note that the physical environments that adolescents are exposed to (at home and at school) have both an encouraging and a discouraging impact on food choices. This is supported through studies by He *et al* (2012) as well as Powell and Bao (2009: 65) who state that when unhealthy convenience/ fast food outlets are near (within one kilometre) to the home or school environment, there has been a negative impact on food choices by adolescents. Furthermore, both Powell *et al* (2009) and Sturm and Datar (2005: 1060) found a relationship between increased BMI gain in children and adolescents and areas densely populated with fast food outlets (per capita). The same relationship was found in British studies on adolescent studies that noted an even stronger association between unhealthy food being sold to children and the high levels of overweight and obesity (Cetteanu and Jones 2014: 7). South African studies on adolescent girls' dietary intake and physical activity levels showed that teenagers who chose to eat chips, fast foods and sugared beverages were also identified as opting not to cook at home and being less likely to participate in exercise (Sedibe *et al* 2014: 117).

Eating away from home and snacking have been identified as urbanization-related behaviours (Dong *et al* 2016: 118). Larson, Neumark-Sztainer, Laska, and Story (2011: 1696) explain that during adolescence, eating away from home becomes more frequent through the socialising process, for example, meeting friends at cafés and canteens or frequenting restaurants at the local mall and this all exposes them to foods that would not usually be eaten. The temptation to over-indulge in processed treats grows with the enormous presence of the fast food industry within urbanised areas. Studies show that adolescents that choose to frequently eat at restaurants and take-away stalls that primarily serve pizzas, burgers and french fries were associated with a higher intake of total energy and fat and an increased consumption of sugar-filled carbonated drinks and had a higher risk of overweight and obesity (Larson *et al* 2011 and Wang *et al* 2012). In comparison, Chinese studies have stated that snacking has increased rapidly and have attributed it to a major shift in food marketing especially regarding 'on the go' convenience/ fast foods (Wang *et al* 2012: 253). Studies on purchasing behaviour show that 65 percent of adolescents purchase from fast food outlets or convenience stores. This percentage increased further if the food outlet was less than one kilometre away from home and has been noted to have a dramatic effect on macronutrient levels (He *et al* 2012).

In Canada statistically one out of every three youths (children and adolescents) are either overweight or obese (Tjepkema and Shields 2005). Similar results can be seen in the USA where over the last thirty years, adolescent (12-19 years) obesity has increased from five percent to 18.4 percent (Fryar, Carroll and Ogden 2012: 1). Both findings have been linked to poor food choices of cheap 'junk' foods and convenience/ fast food items consumed on a daily basis (Nelson, Gordon-Larsen, and Adair 2006: 702 and He *et al* 2012: 1458). In contrast, Burdette and Whitaker (2004: 58) found no statistical relationship between the proximity of a fast/ convenience food outlet and weight gain in children. Veugelers *et al* (2008: 153) in a Canadian based study, concluded that children from areas that had more 'moderately priced fresh produce' made healthier food choices and overall had healthier diets and were thus less likely to become overweight or obese.

2.7.6 Eating disorders

The modern world is run by the media. Social media which flood the minds of impressionable young people aggressively present content on television, the internet and women's magazines indicating what women should look like, promoting acceptable model body weight and measurements, perceived images of perfection and unrealistic expectations of beauty (Steiner-Adair and Vorenberg 2013: 105) all leading to dissatisfaction with personal body composition and then the adoption of an unhealthy mental disorder (anorexia nervosa) to achieve 'thinness' (low BMI) (Webb *et al* 2014: 426). Some South African adolescent girls (19%) between the ages of 15 and 18 years have been reported to have abnormal eating habits and concerns about body image, regardless of ethnicity (Caradas, Lambert and Charlton 2001: 111).

Anorexia nervosa is the extreme restricting of food characterized by an exaggerated drive for thinness, refusal to maintain a body weight above the standard minimum (> 85% of expected weight), intense fear of becoming fat with self-worth based on shape or weight and possible evidence of an endocrine disorder (Ozier and Henry 2011). Girls that have greater exposure to social media have a stronger desire for thinness (López-Guimera, Levine, Sanchez-Carracedo, and Fauquet 2010: 389). A range of symptoms may indicate the development of a poor self-image which is the beginning of an eating disorder, restrictive calorie intake, continuous dieting (use of fad diets and diet pills), over exercising, never feeling thin enough, reduced socialising (fear of having to eat in public) and strict and structured eating habits. This can spiral further into a worsened state where laxatives and diuretics are used, eating possibly ceases altogether

(fasting), and binge eating (bingeing) and purging becomes routine practice, all to control weight.

Bulimia nervosa is the practice of binge eating and the subsequent purging of food often characterized by overwhelming urges to over eat, and inappropriate compensatory behaviours (for example, purging) following a binge episode, excessive amounts of exercising, vomiting stomach content, abuse of laxatives and diuretics, alternating with periods of starvation and drug abuse. As with anorexia nervosa, individuals have an intense fear of weight gain or being overweight (Ozier and Henry 2011). Studies have well established that adolescent girls are the most vulnerable group prone to eating disorders although within recent years, eating disorders among adolescent males have steadily increased (Latzer, Spivak-Lavi and Katz 2014: 375).

A reduction of food intake has been shown to have a detrimental effect on the brain. The risk of developing a mental disorder is at its highest during adolescence and is usually carried through into adulthood (Bhutta *et al* 2015: 3). Girls pass through the stages of puberty much earlier on than boys and experience hormonal changes and imbalances at a much younger age (Belachew *et al* 2013: 55). The development of an eating disorder at a young age is not uncommon; unfortunately, girls have now been overly associated with this type of behaviour about body dissatisfaction that often the disorder is overlooked by family members (Latzer *et al* 2014: 376 and Webb *et al* 2014: 427). Depression and anxiety are commonly associated with eating disorders and hormonal changes in the body during the sensitive time of adolescence (Herpertz-Dahlmann, Dempfle, and Konrad 2015: 675). Girls who perceive a greater difference between idealised body image and what they have are shown to have increased feelings of frustration, lowered self-esteem and destructive thoughts (Tylka and Sabik 2010: 20).

Eating disorders were always associated with Western culture; however, Hoek (2016) has found an increasing number of cases within Asian, Arabian and African countries in conjunction with urbanisation. This can be seen in South Africa, where, of the overall population, 87.9 percent perceived current body weight as being fat. Furthermore, 18.1 percent of the females within the population indicated they were unhappy with their body weight and 14.6 percent were actively trying to lose weight. Due to globalization, the Western world's perceived ideal thin body shape has filtered through into developing countries. Concerns raised among young African adolescent girls has been noted in SANHANES-1, where 13.8 percent

of girls under the age of 14 years were unhappy with their current body weight and 16.7 percent were already attempting to diet and lose weight (Shisana *et al* 2014: 247).

This is supported by Sedibe *et al* (2014: 118) where adolescent girls in Soweto were observed to often skip meals as a dietary practice to lose weight, opting to snack on potato crisps bought at school rather than eating a full meal. Other noted practices designed to lose weight by the school girls were drinking only lemon water, only eating snacks, missing dinner on purpose and not eating carbohydrates. Considerably reducing portion sizes was identified as the most common method the adolescent girls used to manage weight. It was also reported that they still did not participate in exercise even as a means to lose weight (Sedibe *et al* 2014: 117). Eating disorders can come in the form of anorexia nervosa, bulimia nervosa and binge eating disorder (bingeing). In Europe statics indicated that 1-4 percent of the total population are thought to suffer from anorexia nervosa, 1-2 percent are bulimic and 1-4 percent have a binge eating disorder (Hoek 2016). Malnutrition as a result of an eating disorder can be so severe that the cardiovascular system fails due to low potassium levels, anaemia is almost always present and loss of a menstrual cycle is another consequence of an eating disorder (Herpertz-Dahlmann *et al* 2015: 676).

2.7.6.1 Fad and restrictive diets

Adolescent girls are of child bearing age yet often do not understand the implications of poor nutrition on foetal development during expected and unexpected pregnancy. A Very Low-Calorie Diet (VLCD) and Intermittent Fasting (abstaining from food for around 16-20 hours) are popular among adolescent girls for a number of reasons, one being the result of negative self-image and pressures of social media. According to Almond and Mazumder (2011: 58) exposure to fasting during pregnancy can increase the possibility among adolescents and adults of physical, and to a greater extent, mental and learning disabilities by 20 percent as seen in studies in the Iraqi and Ugandan Muslim population during the daytime fasting period of Ramadan. Similar results can also be seen in the historic Dutch famine of 1944 where, during war time, food supplies were cut and food became a scarcity resulting in a VLCD with a total daily intake estimated to be only 500kcal. This had major negative implications with regard to fertility, weight gain during pregnancy and adequate nutrient intake. This resulted in a generation with decreased cognitive performance and a notable increase of schizophrenia (Stein, Mervyn, Saenger, and Marolla 1975: 1944).

Another practice which has been gaining popularity is the trend to follow plant based diets (such as vegetarianism and veganism). With climate change being a massive global issue, land is becoming less available and with extreme weather patterns, it is more difficult to support the growth of livestock to be slaughtered to feed the ever-growing world population. Livestock also contribute more methane into the atmosphere than all transportation systems combined. Methane has been identified as one of the major contributors to ozone depletion resulting in the increase of global warming related issues. It has become a vicious cycle that requires immediate attention hence the public outcry to decrease animal meat consumption and to encourage more sustainable plant based dietary habits. This, however, comes with additional issues such as the well documented vitamin B12 deficiency that results from following vegetarian and vegan diets. Plant based diets have also been known to decrease the intake of all B vitamins which are vital for proper nerve and brain functioning (Oberdby *et al* 2013: 785 and Oyedemi *et al* 2013: 38).

2.7.7 Cultural beliefs, traditions and religion

Food, cultural and religious practices are core aspects that link societies in different ways to economic and daily choices. These aspects have also been known to be the demise of diet related intervention due to strict beliefs and traditional habits. Culture and religion can dictate an individual's eating habits by ruling on when one can eat, how much can be eaten and which foods are acceptable for consumption (Fieldhouse 2013: 1). In rural Indian households, it is customary that boys and men are fed first, with girls consequently receiving less food and often food that is of an inferior quality. This food allocation discrimination may have contributed to the severe case of undernutrition in adolescent girls. Associated studies indicate that at the age of 17 years, 35 percent of rural Indian adolescent girls are severely underweight with a body mass of 38kg or less and 23 percent are stunted with a height of 145cm or less (Saxena and Saxena 2011: 3).

2.8 Strategies to address malnutrition

Insufficient dietary intake has been identified among children and adolescents due to a multitude of factors. Nutrient levels are not being met, leading to deficiencies and a decreased health status (UNICEF, WHO, the World Bank Group 2016: 6). Strategies are developed in the hope of eradicating suffering among children. Programmes are developed targeting various

factors that may contribute to the cause of malnutrition and they then try to make changes at the source of the problem. Healthy children are vital in the progression of a country's economic growth (Harris and Drimie 2012: 5).

2.8.1 South African Food Based Dietary Guidelines

South African food-based dietary guidelines (FBDG) are short, clear nutritional messages that are appropriate for all cultural, ethnic and LSM groups (Voster *et al* 2001: S3). They were implemented to encourage better eating practices for all South Africans and address identified public health problems. As a nation, high saturated fat foods which are nutrient empty are popular among the youth and adults whereas vegetables and fruits are known to be less likely to be consumed (Shisana *et al* 2014: 213). Globalization has contributed to the change of eating patterns towards unhealthy habits of convenience foods and the global burden of diet-related diseases (Dong *et al* 2016: 118). Urbanisation has decreased the consumption of traditional foods and indigenous vegetables (Voster *et al* 2013: S5). The FBDGs were introduced in 1997 as part of the promotion of nutrition and well-being. It is important to consume adequate amounts of good quality food to absorb enough nutrients for proper bodily functioning (Cetteanu and Jones 2014: 7). The guidelines seen in Table 2.2 are general food-based recommendations and are not specific to micronutrients and are recommended for children over the age of seven years. This allows for a wider variety of use regarding children of any weight category (Labadarios *et al* 2005 and Voster *et al* 2013: S7).

Table 2.2: Revised food-based dietary guidelines (FBDG) (Voster *et al* 2013: S7).

For the use of children over seven years and adults
Enjoy a variety of foods.
Be active.
Make starchy foods the basis of most meals.
Eat dry beans, peas, lentils and soy regularly.
Chicken, fish, meat or eggs can be eaten regularly.
Drink lots of clean, safe water.
Eat plenty of vegetables and fruit every day.
Eat fats sparingly.
Use salt sparingly.
If you drink alcohol, drink sensibly.

Use foods and drinks containing sugar sparingly and not between meals.

2.8.2 Food fortification

Fortification is the addition of nutrients such as vitamin A, B vitamins (B1, B2, B6, B12), niacin, riboflavin, folic acid, iron, iodine and zinc to food sources (Berner *et al* 2014: 1010). The NHANES (2003-2006) conducted in the USA on children and adolescents aged 2-18 years indicated that the introduction of fortified foods decreased some micronutrient deficiencies, and in terms of the population as a whole, increased the percentage of individuals to meet EARs without adding significantly to percentage growth of UL intake. The foods that have the best response from adolescents for fortification are ready-to-eat cereals; other foods include breakfast bars (granola), juice-based drinks and milk (Berner *et al* 2014: 1010). The B vitamin group (thiamine) is often fortified in bread and cereals as these are considered staple items that are able to reach a vast variety of people regardless of their financial situation (Osiezagha *et al* 2013: 26). Faber, Kvalsvig, Lombard, and Spinnler Benadé (2005: 1032) state that the introduction of fortified foods into the diet is the most affordable and accessible method of obtaining nutrients if the normal diet does not provide adequate intake.

In 1999 the first NFCS identified a large proportion of children suffering from micronutrient deficiencies (iron, zinc, selenium, vitamin A, vitamin D, vitamin C, vitamin E, riboflavin, folic acid, niacin, vitamin B6 and calcium) and who did not meet standard energy consumption requirements (Labadrios *et al* 2008). This sparked major concerns for the health of South African children and the implementation of food fortification was initiated. It is the most effective and efficient way of supplying a wide variety of micronutrients daily (Berner *et al* 2014: 1010). The most successful fortified food that has actively decreased deficiency is iodised salt. There are far fewer cases of iodine deficiency and related diseases since its introduction. Iodised salt has also been used to improve the iodine content of breads in developed countries (Jooste and Zimmerman 2008: 8). Eight out of ten South Africans are recorded to use fortified salt and this has seen the decrease of iodine deficiency due to this food fortification intervention (Labadrios *et al* 2008: 260).

Studies by Steyn, Wolmarans, Nel, and Bourne (2007) testing the effectiveness of fortified foods on micronutrient intake levels in South Africans concluded that increased levels were seen in B6, thiamine, riboflavin, niacin, folate and iron. However, in the case of young adult

women, iron and calcium levels were still found to be low despite fortification of maize meal and wheat flower. According to Steyn's *et al* (2016) comparative study of children and young adolescents in South Africa, thiamine and riboflavin were consistently seen to be above mean EARs pre-fortification and post-fortification, hence indicating it may not have been necessary to fortify these specific B vitamins.

2.8.2.1 Maize meal and wheat flour fortification

South Africa has implemented an intervention where wheat flour and maize meal are fortified with folic acid, zinc, iron, thiamine (B1), Riboflavin (B2), Pyridoxine (B6), niacin and vitamin A. Addressing malnutrition through fortification is seen as so crucial to the good health of South Africans that legislation was passed requiring manufacturers, importers and sellers of brown bread and maize meal to fortify these commodities; failure to comply is punishable by fine (DoH and UNICEF South Africa 2007: 4). Although wheat flour is naturally nutrient dense, the milling process has been found to destroy micronutrients and massively reduces the content as compared to the raw product (Jaarsveld, Faber, and van Stuijvenberg 2015). Bowley (2010: 2) suggests that the consumption of fortified flour could decrease mortalities and cases of morbidity especially in populations with low folic acid levels. Much like India, the USA and several other countries have raised concerns of upper limit (UL) being exceeded due to over-dependency on staple fortified cereals and other commercially fortified foods (Swaminthan *et al* 2013). The fortifying of staple foods can also be seen in high income countries such as the USA, where through the US Food and Drug Administration (FDA) it is now compulsory to add thiamine, niacin, riboflavin, folic acid and iron to refined grains such as flour (Berner *et al* 2014: 1010). Steyn *et al* (2016) report that within the comparative study of four nutrient intake reports on school children in South Africa (Oldewage-Theron and Egal 2010; Samual *et al* 2010; Oosthuizen *et al* 2011, and Oldewage-Theron, Napier and Egal 2011) one is still unable to confidently state that food fortification of maize and bread has improved micronutrient intake.

2.8.3 Nutrition and physical activity education

Nutrition education interventions are described by the United States Department of Agriculture (USDA 2016) as 'behaviourally focused activities and/or actions to promote healthy eating and physical activity in the hope of preventing obesity and chronic disease'. Adolescence is a phase

of life where schooling and education should be a core activity. Adolescent education has been described as the 'circuit breaker' of the poor health and disease cycle (Bay and Vickers 2016: 501). Overweight and obesity among learners is an increasing endemic and several studies have linked the issue to over-consumption of unhealthy foods and a lack of adequate nutrition knowledge specifically in respect of healthy eating habits and lifestyle choices. A Cape Town, South Africa study on middle- to high- income adolescents indicated that a significant correlation was found between high nutrition knowledge scores and healthy dietary practices, emphasising the importance of knowledge having a positive impact at school level (Steyn 2010: 62). In contrast, a KZN based study on the high school government curriculum programme revealed that only limited nutrition education was being integrated into the grades 10, 11 and 12 learning programmes aimed at adolescents (Naidoo 2015: 88). High school-going adolescents have fewer long-term school-based nutrition interventions than primary school children and a paucity of information is evident especially in South Africa. Some successful international studies that have shown some significant changes in knowledge and behaviour in adolescents were the PATH and VYRONAS school-based interventions.

PATH was aimed at improving the nutrition knowledge of adolescents in grade nine and ten over an 11 week period. This programme resulted in improving nutrition based knowledge significantly with regard to dietary intake and dietary knowledge where decreased levels of saturated fats and cholesterol were reported post-study. Girls especially were noted to be impacted by this nutrition education intervention making the most positive change (Fardy, White, Haltiwanger-Schmitz, Magel, McDermott, Clark and Hurster 1996: 247). Girls were also reported to be significantly more perceptive of healthy eating being reinforced than boys in the long-term education CATCH programme for children and young adolescents (Edmundson, Parcel, Feldman, Elder, Perry, Johnson, Williston, Stone, Yang, Lytle and Webber 1996: 442). The VYRONAS 12-week school-based long-term intervention on diet, nutritional intake and BMI for urban adolescents showed a significant decrease of the mean BMI of participating adolescents and a decrease in the total energy and fat consumed after 12 months of intervention. This intervention also saw the reduction of red meat consumption and take-out meals (non-homemade) eaten by the students as well as an increase in the frequency of fruit consumed (Mihas, Mariolis, Manios, Naska, Arapaki, Mariolis-Sapsakos and Tountas 2010: 712). However, not all long-term nutrition education programmes have shown positive results with some showing less significantly improved behaviour and little overall

improvement in adolescents' dietary intake and behaviours (Bere, Veierod, Bjelland and Klepp 2006: 258).

There is a paucity of interventions to improve physical activity levels among high- to middle-income adolescents. Recent studies by Sedibe *et al* (2014: 118) on middle income adolescent girls in Soweto identified low physical activity levels but, more importantly, it was noted that the girls had learnt about the importance of being physically active on a daily basis through already existing school-based education within the prescribed curriculum yet few girls took part in any extra activity. This indicated that South Africa could improve by implementing physical activity interventions alongside nutrition education as these two factors coincide to address weight and obesity. A successful physical activity intervention can be seen in the USA through the one-year long LEAP school-based intervention programme for adolescent girls where direct improvements as a result of the intervention were found with increased physical activity levels, goal-setting abilities and self-efficacy (Dishman, Motl, Saunders, Felton, Ward, Dowda, and Pate 2004).

Adolescent girls have a critical role to play in the future when it comes to a family's dynamics and health and nutrition status. According to Alam, Roy, Ahmed, and Shamsir-Ahmed (2010: 87) the future generation's outcome and well-being is dependent on the current nutrition education levels adolescent girls are receiving. The point of nutrition education is to increase knowledge and awareness of what is happening within the body and to learn about nutrient intake during different phases and create long-lasting practices. Even short-term nutrition education has been shown to reduce the number of low-weight births and improve pregnancy outcomes within urban Bangladesh women (Jahan, Roy, Mihrshahi, Sultana, Khatoon, Roy, Datta, Roy, Jahan, Khatun, Nahar, and Steele 2014). Parents who are educated in nutrition are likely to make better food choices for their children. Furthermore, eating patterns are often learnt from a parental figure within the household. It is important to learn and establish good nutritional eating habits at a young age to track into later life (Frongillo and Bernal 2014: 2840).

2.8.4 Other strategies relating to adolescents in South Africa

Although not directly aimed at middle to high income households, other strategies are in place within South Africa to address malnutrition among children and adolescents. The Integrated Nutrition Programme (INP) was formulated in 1994 as a response to poor nutritional status

among the South African population; it facilitates inter-sectional solving of nutritional problems and provides appropriate nutrition education (DBSA 2008). The Nutrition Supplementation Programme (NSP) was established to assist in the alleviation of micro-nutrient deficiencies present among vulnerable groups in South Africa. The main aim of the NSP was to provide nutrition supplements according to age-specific criteria, as well as nutrition education, and to introduce long-term solutions to nutritional problems, specifically the provision of foods such as formula milk, fortified infant porridge, maize meal porridge and energy drinks (Anderson, Wandel, Eide, Herselman, and Iversen 2009: 91).

The National School Nutrition Programme (NSNP) aimed at integrating meals into the school day not only promotes the attendance of learners but has been shown to alleviate hunger, increase nutritional status, improve cognitive development and retain enrolment levels within schools (Jomaa *et al* 2011: 83). An evaluation on the South African school feeding scheme conducted by Nhlapo, Lues, Kativu, and Groenewald (2015: 3) tested the nutrient content of the school lunches provided to primary and secondary schools. Within adolescent (11-18 years) meals, only 30 percent met iron standards and less than 10 percent met the minimum standards for calcium and zinc. The meal provided at schools was, in some cases, the only meal eaten by the children per day hence the importance of nutrient rich meals. The introduction of the vitamin A supplementation (VAS) programme was to address the levels of deficiency within the country. The SANHANES-1 has shown that girls of reproductive age are likely to suffer from chronic VAS due to lifestyle habits and the stress of the growth period on an adolescent female's body. Supplementation of vitamin A in South Africa has seen a decrease in vitamin A deficiency (VAD) by 50 percent from 2005-2012 (Shisana *et al* 2014: 155).

2.9 Conclusion

NCDs are responsible for 68 percent (38 million) of the world's total deaths. Lifestyle aspects including behaviours of diet, physical activity levels and sedentary lifestyle patterns are all modifiable aspects attributing to these diseases. Financial and healthcare burdens can be reduced simply by improving key behaviours during growing years (Schoeppe *et al* 2016 and WHO 2014b). Having macro- or micronutrient deficiencies during childhood and adolescence exacerbates associated health problems in later life. This highlights the importance of preventing health risks throughout one's lifetime, from infancy to adulthood (Story and French 2004: 1 and WHO 2014b). Low-middle income homes are noted as having the worst increase

in obesity among children and adolescents within the last 15 years due to rapid urbanization. However, according to UNICEF, WHO, and the World Bank Group (2016: 7) high income homes have shown to be just as vulnerable, coming in with the second largest increase of obesity among children and adolescents across the world.

CHAPTER THREE

METHODOLOGY

3.1 Introduction

The purpose of this chapter is to explain the procedures for data collection used to determine the socio-economic, dietary intake, and the nutritional and physical activity status of adolescent girls attending a high-income high school in Durban. Various types of measuring equipment and techniques were used such as a socio-demographic questionnaire (S-DQ), a food frequency questionnaire (FFQ), a group diversity questionnaire, a 24-hour recall interview and a physical activity questionnaire. Anthropometric measurements, namely weight and height, were measured to determine Body Mass Index (BMI). This study was based on a calculated representative sample of participants to reflect an average total population result in the school.

Studies conducted by Sedibe *et al* (2014) and Frantz (2006), as well as many other localised studies such as this one, may contribute to a further understanding of the overall status of the higher LSM population that currently has a paucity of data with regard to the South African adolescent population and, more specifically, the adolescent population of KZN province belonging to a higher income bracket. By having a better understanding of the dynamics of a specific sample group, such as high-income adolescent girls, problematic areas could be identified and ways formulated to arrest nutrition related issues before they become endemic.

3.2 Study design

This study was for non-therapeutic purposes and it was a quantitative, descriptive, cross-sectional study. It focused on adolescent girls attending a private school in an affluent area relating to the very high LSM group. Only girls in the high school section of the school were directly consulted. Due to the small size of the school community, all the girls who were willing to participate in the study were used and this made for a convenient sample selection. The minimum sample size was calculated using a power calculation indicator showing that 217 participants would represent a reliable sample group with a confidence level of 95 percent (The Survey System 2012). Therefore, 225 girls were interviewed to account for marginal errors.

Quantitative data was collected in the form of questionnaires which included socio-demographic, 24-hour recall, FFQ and physical activity questionnaires which were conducted via interview by one of the trained fieldworkers at a private station. Anthropometric measurements were also conducted at a predetermined point. All administering and collection of data done by the fieldworkers was conducted in the presence of and under the supervision of the researcher.

3.2.1 Study variables

This study was conducted on specific dates that were allocated by the principal to best suit the learners' academic programme. Data collection was implemented during the last two weeks of the second term 17th June 2014–26th June 2014. Friday the 27th June 2014 was only to be used if the sample size minimum was not reached within the specified time. Variables such as time were different from day to day due to the fact that girls in different grades participated in academic and extramural activities at different times and this lead to a wider exposure to all grades. The extra day was needed to collect enough data for a statistically reliable report. Fewer Grade 12 learners were available due to personal study commitments and examination preparation.

3.3 Sample

The inclusion criteria for a learner to participate in this study were firstly, that participation was on a voluntary basis and secondly, that parental consent was given. Any uncompleted consent forms or data gaps in records resulted in the exclusion of the participant.

Inclusion criteria

Only adolescent girls aged 13 to 18 years from the high school section of the private high school were included in this study. This was inclusive of girls from different cultural backgrounds, religious practices and ethnic groups. The girls had to be enrolled at and attending the high school on a daily basis. The participants had to have been living within the Durban area during the academic year. A written consent form was signed and dated by each participant as well as by a parent or supervisory adult.

Exclusion criteria

Girls who were attending the high school but were not living permanently in Durban, KZN for the entire academic year, such as international exchange students, were excluded from the study. No members of the high school staff, including part-time staff or parents were allowed to participate in the study or influence other participants. The school that was chosen for this study had both primary and pre-primary sections on the school grounds; however no girls under the age of 13 were permitted to participate. Girls that were visibly pregnant were also excluded.

Sampling strategy

A convenient sample was used as a sampling framework. The school was selected purposefully and all the girls who wanted to participate were included. A sampling calculation generated by a power calculation indicator estimated that 217 participants out of a base of 500 learners at a high-income girls' high school were required to report statistically significant data. Sample size was calculated as follows:

$$S = \frac{Z^2 * (p) * (1-p)}{C^2}$$

Where:

Z = Z value (for example, 1.96 for 95% confidence level)
p = percentage picking a choice, expressed as a decimal (0.5 used for sample size needed)
C= confidence interval, expressed as a decimal = 0.06
(This relates to 3 units either side of the normal)

A confidence interval is also referred to as a 'margin for error'. It is a figure given that will indicate a plus-minus range for public reporting. For example, if the confidence interval is calculated as 2, then a research percentage figure (for example, 43% boys like smoking) will add this (43 + 2) and subtract (43 - 2) from the research figure to indicate an approximate range for public reporting (41–45% of boys like smoking). This then accounts for marginal errors (The Survey System 2012).

3.4 Selection of fieldworkers

Fieldworkers had to have basic skills such as the ability to read and write in English, which required attainment of an adequate education level with a good understanding of the English language. The selected school was a first language English-speaking school, therefore English-speaking fieldworkers were needed. It was important that the fieldworkers presented themselves well and practised good manners when dealing with the learners and staff on the school property as they were a reflection of Durban University of Technology and in turn, a reflection of the people associated with the study. Fieldworkers also had to have a good basic knowledge of nutrition and food variety.

3.5 Training of fieldworkers and their responsibilities

The objective for training the fieldworkers was that there had to be a basic understanding across all assessment tools used during the data collection namely, socio-demographic questionnaire, 24-hour recall interview, physical activity questionnaire, FFQ and anthropometric measuring. Three fieldworkers were currently master's students from the Consumer Science: Food and Nutrition department at DUT. These students are highly trained in all aspects of data collection and were only briefed on the different components to administer.

The remaining seven fieldworkers were recruited from the school community. These fieldworkers were trained in depth before the data collection process started until there was full understanding of every component and every procedure that needed to be conducted. All the fieldworkers had to have a good understanding of every aspect of the data collection in anticipation of possible absenteeism. The training was conducted in English as this was the medium the study would be administered in and all fieldworkers were first language English speakers.

The fieldworkers learnt about anthropometric measuring during role-play sessions. Due to the personal nature of the assessment, the fieldworkers had to know exactly how to handle specific situations as well as to fully understand what was appropriate to say and what was not. The 24-hour recalls were allocated the most training time, with each fieldworker being trained in depth about portion sizes and food variety. Plastic model replicas of common foods eaten and exact portion sizes were used to assist the fieldworkers in learning beforehand and to help with visual

descriptions during the data collection process. Most importantly, the fieldworkers were trained to be completely neutral in terms of facial expressions, personal comments and physical gestures in order not to influence the participants' answers or make the participants feel uncomfortable at any point.

One fieldworker's sole responsibility was to record anthropometric measurements and to double-check every participant's records within their allocated file for correctness, completeness and the presence of a signed consent form. Each fieldworker was positioned at a predetermined station and waited for a participant to approach the station. All the other assessment measurement questionnaires were then completed by the fieldworker in a secluded private environment. It was vitally important that the fieldworker recorded everything correctly and double-checked that all information was complete. If any questions arose the researcher was available to intervene and answer them. The researcher was present at all times during the data collection process and was the only one allowed access to the encrypted confidentiality list. The researcher was also allocated an interview station during busy times to relieve the pressure on the fieldworkers. The fieldworkers were also responsible for making the participants feel welcome and not intimidated by the process.

3.6 Survey instruments, measurements and procedures at the school

In order to better understand the sample group, various specially designed questionnaires were formulated to capture the many individual variables concerning the research. All the questionnaires have been piloted, are well established and recognised for nutrition research data collection. All the questionnaires were marked with a participant number to conceal the identity of the participant. Socio-demographic questionnaires were completed by the participant's parent/ caregiver and the physical activity questionnaires were completed individually by the girls in the presence of a fieldworker. Dietary questions were administered by the fieldworker and anthropometric measuring was conducted and recorded by a fieldworker. All data collection was conducted in the entrance foyer of the centrally situated school library which was a convenient meeting venue for the girls when free time was available.

3.6.1 Socio-demographic questionnaire

An established and tested socio-demographic questionnaire (S-DQ) was adapted to better suit the LSM of the sample group being captured (high-income households). The original S-DQ (Napier 2006) is aimed at low-income households that experienced poverty and food insecurity whereas the sample group at hand are from high income households. Various figures were adjusted and some unnecessary questions eliminated to better suit the sample group. This was then piloted using 10 girls from the school who were not participating in the main study and their parents/ caregivers to read through the questionnaire and give suggestions on wording and figures presented so that they would be more easily understood by the participants as seen in Annexure E.

The main aim of the questionnaire was to determine the economic profile of the households that the girls came from. This included being asked about level of education, ownership of motor vehicles, income and expenditure approximations and personal demographic data. Personal family data included the number of family members, head of household, and responsibilities and occupations of members of the household. Profiling household income and expenditure on food is very important to distinguish eating patterns and food variety and availability. The questionnaire also identifies who is mostly responsible for the purchasing and preparation of food. In total, 220 S-DQs were completed by the parents/ caregivers of the girls who volunteered to be part of the study and 225 were viable.

3.6.2 Dietary assessment

To achieve one of the main purposes of this study, which was to establish the nutritional status of the adolescent girls, the dietary intake of the girls had to be assessed. Due to the nature of a generally high LSM group, the exposure to different varieties of food is far more likely than in lower income LSM groups. Therefore, appropriate adaptations were made. To avoid any form of discrimination girls from different cultures and ethnicities and religions were allowed to participate in the study. Food consumption patterns and food variety were assessed via a 24-hour recall and FFQ because these measurement tools have been found to be the most effective indicators of dietary intake though non-invasive methods (Gibson 2005: 34).

3.6.2.1 24-hour recall

A structured 24-hour recall template was used (Annexure F). Food patterns and composition can be assessed by means of a 24-hour recall which requires a participant to describe in detail what foods were consumed in a 24-hour period, the approximate portion sizes, the timeframe and where the food was eaten (Margetts and Nelson 2006: 138). This type of interview determines overall eating patterns, habits and food quality and quantity (Gills, Baker, and Auld 2016). The girls were asked to recall everything consumed, inclusive of beverages, snacks and restaurant foods, over two week days and one weekend day in order to get a full spectrum of their eating patterns (Brown 2008). Weekend dietary intakes may be different to week day dietary intakes and therefore this has to be accounted for and differences noted.

According to Yunsheng Olendzki, Pagoto, Hurley, Mangner, Ockene, Schneider, Merriam, and Hébert (2009: 553) it is recommended that more than one day's worth of recall be collected; three or more days have been identified as having good validation of eating patterns. Ruopeng (2016: 57) concurs and adds that the inclusion of one weekend day is recommended as dietary intake my change over the weekend period. USA studies show an increase of total energy intake over the weekend and a decrease in diet quality. Once a dietary pattern is identified, recommendations to improve the situation according to study goals can be executed, such as improving the health and wellbeing of adolescents through healthy dietary changes (Brown 2008).

During the interviewing process, all fieldworkers had easy access to physical examples (models) of popular foods with a portion size indicated. This helped participants to recall more accurately the portion size consumed. Everyday utensils such as spoons, cups, plates and bowls were also provided to assist the participants to accurately describe portion sizes. It was also important that methods of preparation (grilling, frying, roasting) were accurately described and a good description of the food composition (brown sugar, fat free yoghurt, sweetener) was given. Twenty-four hour recalls were completed in an interview situation.

3.6.2.2 Food frequency questionnaire (FFQ)

A food frequency questionnaire (FFQ) is a listed overview of all food groups where the intake frequency and measures of food types can be recorded (Annexure G) (Gibson 2005: 34). Food

items are split between nine food groups which lie within the same nutrient content categories (Labadarios *et al* 2011). The FFQ determines the variety of foods and the dietary diversity of foods consumed within a seven-day period (Jain and McLaughlin 2000: 355). This data provides an overview of what foods have been consumed but it does not indicate meal patterns. This FFQ template was provided by Durban University of Technology and was adapted to better suit the sample group (Oldewage-Theron *et al* 2008). More up-market and high-cost foods were added to the list which was then piloted with a group of ten girls from the chosen high school who were not participating in the main study. The girls adjusted the assessment method and a final high LSM FFQ was created. Numerous changes have been made to this assessment method to increase its validity since it first appeared in the 1990s (Thompson and Subar 2013).

Fieldworkers administered the questionnaire in an interview situation in the private predetermined location. Participants were asked to recall all foods eaten during the past seven days. It is recommended, especially when dealing with protein and energy nutrition, to use other validating food measurements such as a 24-hour recall supporting the FFQ to provide details of food consumption, and to make statistical adjustments to the FFQ based on valid data (Freedman, Schatzkin, Midthune, and Kipnis 2011: 1086). In collaboration with the information gathered in the 24-hour recall, the most popular foods amongst affluent adolescent girls could be determined as well as the nutrient adequacy ratio as compared to the DRIs.

3.6.3 Anthropometric measurements

Anthropometric measurements are collected to calculate an individual's Body Mass Index (BMI). Various indicators such as height and weight can be measured and age recorded which can then formulate an idea of an adolescent girl's nutritional status (WHO 1995: 270 and WHO 2007b). BMI determines the degree of fatty deposits around the body according to the relationship of height and weight, while also considering general body structure (Shisana *et al* 2014). With the assistance of the researcher, the fieldworker was responsible for measuring, double-checking and recording the results on a data sheet (Annexure H). All measuring was done twice by the fieldworker to eliminate possible initial errors and the average of the two scores was recorded. All measurements were recorded using the South African regulated metric system (KG, g, M, mm).

3.6.3.1 Weight measurements

A portable weight scale was used to measure mass in kilograms (kg) to the nearest 0.5kg. All participants were weighed on the same pre-calibrated scale (Scales 2000, Portable Physician Scale [PPS]) that was placed on a hard, flat uncarpeted surface. The scale was calibrated every day before use, using a standard 1kg metal weight (WHO 1995: 329 and WHO 2008b). The following method was used when recording the weight of each participating girl: the scale was placed on a hard, flat, uncarpeted surface (the floor) in the work room at the school. Each day the scale was calibrated by the researcher using a standard 1kg metal weight before the girls entered the work room. Each participant was asked to remove her shoes, socks and any other additional clothing such as jersey, blazer/jacket, coat, scarf and gloves. Participants were also asked to remove any bulky items from clothing that remained on the body such as cell phones, watches, stationery and food items in order not to distort the weight measurement. These items were placed in a container that could be seen by the participant at all times to ensure the safety of personal items. The scale was turned on and the fieldworker waited for the 0.0kg figure to display after which the participant was asked to stand in the middle of the scale with body weight equally distributed on both feet and with arms held straight down at the sides of the body.

The fieldworker asked the participant to stand flat-footed with feet slightly apart. The body was to be held in a relaxed position and the participant was asked to look straight ahead. The participant was asked to stand still until the number (weight) was displayed and captured. The participant was then asked to step off the scale and stand to the side. The scale was zeroed again and the participant was asked to step back onto the scale and the process was repeated so as to record the second reading. The scale display flashed a figure twice to indicate a final reading. All weight was recorded with two decimal places on the weight recording sheet of the participant's file. The two weights recorded were averaged to assist in the BMI calculation.

3.6.3.2 Height measurements

Each girl who participated in the study had her height recorded using a portable stadiometer (Scales 2000) with a sliding headpiece. All height recordings were measured to two decimal places and the process was performed twice to obtain an average recording (WHO 1995: 330). The procedure for measuring height is as follows: each participant was asked to remove shoes,

socks and any hair accessories from the top of the head as well as any high pony tail or bun hairstyle on the top of the head. The participant was asked to stand on the stadiometer under the headpiece facing outwards and looking straight ahead without lifting the chin or overstretching the spine to appear taller as seen in Figure 3.1. The participant's heels were to be placed together, arms held at the sides, legs straight and shoulders relaxed. The shoulder blades, buttocks and heels of the participant must be positioned so as to touch the measuring rod. The sliding headpiece was lowered by the fieldworker onto the highest point of the participant's head with slight pressure being used to flatten hair. The sliding headpiece was held in place and the participant's height was recorded in metres to two decimal points. The participant was asked to step out from under the stadiometer headpiece and then the process was repeated so that a second reading could be recorded. An average figure was then calculated from the two recordings and was recorded in the participant's private file (WHO 2008b and De Onis, Onyango, Borghi, Garza, and Yang 2006).

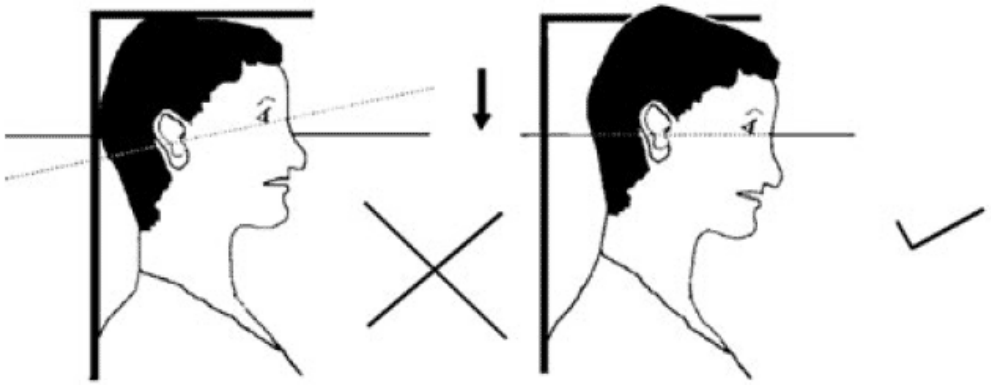

Figure 3.1: Stadiometer head positioning protocol (Scottish government, 2009).

3.6.3.3 Body Mass Index (BMI)

Once height and weight averages have been established, a BMI number can be formulated. BMI is a commonly used indicator to approximate an individual's overall health by identifying where one lies within the spectrum of categories ranging from wasting to morbidly obese. This figure was established according to the relationship between the average height and weight recorded from which a body composition can be drawn and nutritional health risks identified (Nambiar, Truby, Abbott, Davies, 2008: 148). It was also used to identify whether one is at risk of developing cardiovascular diseases (Bianchini de Quadros, Gordia, Rosendo da Silva, and Rodrigues Silva 2015: 455). Shisana *et al* and SANHANES-1 Team (2013) similarly

describe BMI, saying it can determine the degree of fatty deposits around the body according to the relationship of height and weight, while also considering general body structure. This well-established process is used in international statistic collection studies much like the USA and Canadian collection of adolescent profiles (Tjepkema and Shields 2005).

However, BMI alone cannot accurately describe an individual's overall health status and must always be considered in conjunction with complementary nutritional assessment tools such as the FFQ and 24-hour recall. BMI is expressed as a ratio of weight (kg) to height in square metres. Standardized BMI cut-off indicators are supplied by the WHO (2008b) and will be discussed later.

3.6.4 Physical activities questionnaire

The type of physical activity assessment used is referred to as a 'short-term recall', where seven to twenty tailored questions are formulated according to the sample population. It is used to determine frequency, duration, intensity and type of activity performed (Ainsworth *et al* 2015: 390). A valid and reliable physical activities questionnaire (Annexure I) developed by the University of Canada (Kowalski 2004) was used in this study. Permission and approval to use the questionnaire was obtained by the researcher via email (Annexure J). The physical activities questionnaire is used to identify what physical activities are done by school-going adolescents and how much time is dedicated to the activities.

By understanding how much energy is exerted by the girls, this data can be included to better understand the overall health status analysis in conjunction with the abovementioned health assessment methods. Physical activity has a strong correlation between physical stature and health risks (Kruger *et al* 2003 and Joubert *et al* 2007). This questionnaire was completed by the participants in the presence of the fieldworker in a predetermined area and they were assisted only when required.

3.7 Statistical analysis and data management

3.7.1 Socio-demographic questionnaire

Once the fieldwork data collection was completed, all S-DQs were placed in numerical order and hand-checked by the researcher for completeness and accuracy before being captured on a computer. The data was encoded and then entered into a Microsoft Excel® spreadsheet which was then interpreted by the researcher with the assistance of a statistician using Statistical Package for Social Sciences (SPSS) for Windows version 21,0 software programs. The data was then presented using standardized tables, percentages and graphs.

3.7.2 Dietary intake: 24-hour recall and FFQ

Once the fieldworkers had completed data collection, all the questionnaires were categorised and filed in numerical order. The researcher once again checked for completeness, accuracy and the information was cleaned. The FFQ data was similarly encoded and captured on a Microsoft Excel® spreadsheet after which it could be analysed by the researcher for descriptive statistics (frequency, means, standard deviation and confidence interval) and compared against reference standards.

The FAO (2013) provides nine nutrient-based food categories, namely: 1 cereals/roots/tubers; 2 legumes; 3 meat/poultry/fish; 4 eggs; 5 dairy; 6 other vegetables; 7 other fruit; 8 vitamin A rich fruit and vegetables; and 9 fats and oils. From these scores, food variety, food group diversity and means was calculated for each group. A low food variety score was indicated when less than 30 foods were consumed within a seven-day period. A medium food variety score was indicated when 30-60 foods per seven-day period were consumed, and a high food variety score was indicated when 60 and more foods were consumed within a seven-day period. A low food group diversity score (FGDS) was recorded when foods from less than three food groups were consumed over a seven-day period, a medium FGDS was recorded when four to six food groups were consumed and a high FGDS was recorded when foods from more than six food groups were consumed (Oldewage-Theron & Kruger 2008: 101).

The 24-hour recall data was captured and analysed for nutrient adequacy of the diet by using the Food Finder version 3 software that was developed for the Medical Research Council of South Africa (MRC) by a food and nutrition specialist. Fortified foods such as maize and bread

were manually uploaded onto the food finder programme and therefore increased micronutrient value intake from fortified foods have been accounted for. Nutrients identified as being consumed were compared to the dietary reference intake (DRI) for teenage girls (Langenhoven, Kruger, Gouws, and Faber 1991). The energy DRI was calculated and compared against NICUS (2003: 18) indicators of an active and healthy individual. These are the physical activity level (PAL) categories that determined energy DRI:

- Sedentary: (PAL ≥ 1.0 - < 1.4)
- Low active: (PAL ≥ 1.4 - < 1.6)
- Active: (PAL ≥ 1.6 - < 1.9)
- Very active: (PAL ≥ 1.9 - < 2.5) (NICUS 2003: 14)

DRIs are qualitative estimates of macro- and micronutrients intended to avoid deficiencies within different stages of the life cycle (NICUS 2003: 7) and were used to assess the nutrient adequacy of the diets of the participants. These estimates are intended to apply to individuals whose health status is adequate and provide guidelines for different scenarios of health conditions (NICUS 2007).

The MRC DRI tables were used to analyse the macro- and micronutrient content of foods identified as being consumed by the affluent adolescent girls participating in the study. Nutrient intake, standard deviation and means were identified and compared to standardised measures provided in the DRIs. Estimates that are looked at during the analysis are Estimated Average Requirement (EAR) which is used when the intake that meets the estimated needs of a nutrient of 50 percent of individuals in a specified gender group at the given life-stage is met and is used for assessing groups of people. If the EAR is unavailable than the Recommended Dietary Allowance (RDA) will be used. RDA is the average nutrient content that meets the needs of almost all (97–98%) individuals within the gender-based group at a given life-stage. In some cases, Adequate Intake (AI) is used when there is not enough scientific evidence to set an EAR. To indicate levels of toxicity a Tolerable Upper Intake Level (UL) will be used (IoM, Food and Nutrition 2003). The Acceptable Macronutrient Distribution Ranges (AMDRs) were calculated to reflect the energy contribution of the macro nutrients and sugar separately. The parameters used were: protein 10-30 percent, fat 25-25 percent, carbohydrates 45-65 percent and sugar <10 percent (IoM, Food and Nutrition 2003).

Dietary diversity score (DDS) is defined as the number of food groups consumed over a period of 24-hours (Steyn, Nel, Nantel, Kennedy and Labadarios 2005: 645) and is calculated from day three of the 24-hour recall data to present the DDS, and was also calculated by counting each of the same nine food groups as used in the FFQ in this study. These were calculated by re-coding the food items from the exported 24-hour recall provided by the Food Finder 3 software to the same nine food groups as used in a study by Labadarios *et al* (2011). A score below four indicated a poor dietary diversity, four to six indicated an average score, above seven indicated a good score while a score of nine presented a very varied diet (Labadarios *et al* 2011: 3). The top 20 food items consumed were identified from the food finder analysis as the foods most frequently consumed and were presented in this order. The nutrient adequacy ratio (NAR) was calculated as a percentage indicating the percentage of DRIs achieved by the group for the day, and the NARs for day three from the 24-hour recall were also correlated to the one day DDS.

3.7.3 Anthropometric data

Averaged recorded weights and heights were captured on a Microsoft Excel® spreadsheet. Anthropometric measurements were then entered into a Anthroplus software to provide *z*-scores (WHO 2010a) and to indicate BMI-for-age to indicate wasting, overweight and obesity, and height-for-age to indicate stunting (WHO 1995: 7).

- *z*-score (standard deviation score): the number of standard deviations (SD) away from the mean, with a normal distribution. It shows how different an individual's score is compared to the median reference population of the same age or height. This is then divided by the standard deviation of the reference population.
- Percent of median: the ratio of measured or observed value in the child to the median value of the reference data of the same gender and height or age.
- Percentile: a rank scale used to position a child on a given reference chart stated in terms of what percentage of the group the child equals or exceeds (Wang and Chen 2012; WHO 2007a and WHO 2007b).

The same method used for calculating BMI in older adolescents and adults is used for children and young adolescents; the value is than compared to a reference age chart. Table 3.1 is a summary of *z*-scores indicating children's and adolescents' nutritional status with the use of

standard deviation (SD) values. Table 3.1 provides a summary of definitions of growth problems in terms of *z*-scores. Measurements shaded in dark green are areas that are considered to be of normal range. If a *z*-score is plotted exactly on the line between two categories, it will be assumed that it is less severe. For example, if a child's height-for-age lands on the line of -3 then it is assumed that the child is stunted and not severely stunted.

Table 3.1: Growth indicators with the use of *z*-scores for children and adolescents aged 5-19 years (WHO 2007a).

***z*-score**	**Growth Indicators**	
	Length/Height-for-age	**BMI-for-age (adolescents)**
Above 3	Very tall, excess of Human Growth Hormone (HGH), possible endocrine disorder. Referral necessary.	Obese
Above 2		Overweight
Above 1		Possible risk of overweight. Plotted point above 1 shows possible risk. A trend towards the -2 *z*-score line shows definite risk.
0 (Median)		
Below -1		
Below -2	Stunted. Possible for a stunted or severely stunted child to be overweight.	Wasted
Below-3	Severely stunted. Possible for a stunted or severely stunted child to be overweight.	Severely wasted

With regard to height-for-age, nutritional status and heavy exercise have been identified as being the two most influential factors on linear growth in young adolescents (Kolsteren and Kusin 1997: 291 and Belachew *et al* 2013: 55). However, stunting occurs in less than 10 percent

of children and young adolescents from upper middle class and high-income countries but is still present (WHO, UNICEF and the World Bank Group 2016: 7). Stunting occurs when a *z*-score is below the median by more than -2SD (De Onis and Blössner 2012). Weight-for-age was not included as the WHO (2009: 2) indicated that in older children (above 10 years) weight-for-age is not a good indicator as it cannot distinguish between height and body mass in an age period where many children are experiencing the pubertal growth spurt and may appear as excess weight; therefore BMI as a single indicator was also calculated and compared to the WHO indicators as seen in Table 3.2. BMI is calculated by dividing the weight in kilograms (kg) by the height squared (²) in metres (m) (Faber and Wenhold 2007, and WHO 1998). The formula used to calculate BMI was as follows:

$$BMI = \frac{\text{Weight (kg)}}{(\text{Height})\ m^2}$$

Scores from the above formulation can be compared to the BMI categories provided by WHO (1995) and are as follows:

Table 3.2: BMI categories as determined by the World Health Organisation (WHO 2010a).

BMI <18.5	**Underweight**
BMI 18.5- 25	Normal weight
BMI 25- 30	Overweight
BMI 30- 34.99	Obese class 1
BMI 35- 39.99	Obese class 2
BMI >40	Obese class 3 (Morbidly Obese)

3.7.4 Physical activity

Once data collection was completed, all S-DQs were placed in numerical order and hand-checked by the researcher for completeness and accuracy before being captured onto a computer. The data was coded and entered into a Microsoft Excel® spreadsheet which was then analysed by the researcher for descriptive statistics using SPSS version 23. The statistical information could then be compared to the World Health Organisation's global

recommendations on physical activity levels for health (2011) which are as follows: 60 minutes of moderate to vigorous physical activity per day for adolescents aged 13–18 years.

3.7.5 Correlations

Information is correlated to identify whether there are any relationships between the different variables assessed. Information was presented to a statistician who conducted the ANOVA statistical test. This test indicated whether there were any statistically significant or justifiable relationships between data resources. A correlation between the BMI of the girls in relation to physical activity levels can be compared to identify if any relationship exists as well as if BMI correlates with dietary intake. This could then identify whether the identified variables had a statistically significant effect on the overall nutritional status of the affluent adolescent school girls.

SPSS version 23 was used to run correlations and the Pearson's 2-tailed test was applied for this function. This test type identifies whether there were any significant relationships amongst the different sample variables presented. The Spearman's Rho correlation coefficient values were used to measure strengths between the values using cut-off points. If the *p*-value is less than 0.05, this indicates that there is a statistical significance between the variables. If the *p*-value is less than 0.01, then there is a strong correlation between the variables (Yue, Pilon, and Cavadias 2002: 261).

In line with objective four of this study correlations were drawn between the following variables:

- BMI and how many meals were eaten per day
- BMI and how many children in the household
- BMI and total income per month
- BMI and amount spent on food per month
- BMI and sport done after school
- BMI and sport done in the evening
- BMI and sport done on the weekend (personal capacity)
- BMI and physical activity (sport) done over a one week period
- BMI and energy intake

- BMI and carbohydrate intake
- BMI and protein intake
- BMI and fat intake
- Total income per month and energy intake
- Energy intake and money spent on food per month
- Meals eaten per day and total income
- Children per household and total income per month
- How physically active in one week and energy intake.

3.8 Validity and reliability of data

Validity is vital for accurate and usable scientific and statistical data. Validity of information is the extent to which an idea, conclusive results or measurements can be related or correspond accurately to real-world situations. Validity of research is important to determine usable tests and to make sure researchers use ethically sound methods that are a true measure of a concept. Many existing methods of testing can be used, which have the advantage of already having been proven valid and reliable such as the measuring tests used in this study (Joubert and Ehrlich 2008: 117).

Reliability can be identified when a degree of similarity is found when practising the same method on several different participants or sample groups. If the act can be repeated successfully in the same method to produce the same results on an individual, the equipment or measuring instruments are considered reliable (Mouton 2001). All equipment used to collect data was calibrated and checked at the start of each data collection day. All data collection was performed under the supervision of the researcher and collected by trained fieldworkers. At the end of each day participant' files were checked to see that all information had been collected and done completely. The data recorded was cleaned and a statistical analysis was used to check the information alongside the researcher to ensure validity and reliability.

3.9 Assumptions

The following assumptions were made while carrying out this study:

- The sample size (n=217) was chosen to represent the study population.

- Responses from participants were made truthfully, therefore data is representative.
- Weekend foods are variable and may not always represent a true reflection of dietary intake.
- The calibrated scale and stadiometer took accurate measurements.

3.10 Ethical consideration

Prior to conducting this study, the research proposal was submitted and approved in 2014 by the Faculty of Applied Sciences Research Committee (FRC) at Durban University of Technology (DUT). Ethical clearance was also approved with the submission of the research proposal to the Institutional Research Ethics Committee (IREC) in May 2014, clearance number IREC 033/14 (Annexure A). Permission to conduct the study at the private school was obtained through various meetings with the principal, which were communicated via email and an informational letter (Annexure B) was presented about the study after which a consent form (Annexure C) was signed as final written permission and approval.

Furthermore, an assembly/ general meeting was held at 10.15am on 23 May 2014 that addressed the entire girls' high school. An informative discussion was conducted with the girls to determine their willingness to take part in the study. A detailed description of what the study would entail, especially concerning the physical body and disclosure of personal information, was provided and questions were answered. It was emphasised that participation in the study was completely voluntary and all data would be kept confidential, and the principal was assured that the academic programme would not be disrupted.

A general consensus indicated that enough girls were willing to participate in the study to make up a suitable sample size. All the girls who volunteered to participate were given an informative consent form to sign. If a girl was under the age of eighteen years, the consent form then had to be signed by a supervisory adult. The girl's parent/ guardian/ supervisory adult was then sent an informative consent letter (Annexure D) that had to be returned to the school to indicate either their approval or refusal for the girl to be allowed to participate in the study.
Once all the participants had been given parental clearance, the participants then also signed the same informative consent letter (Annexure D) reaffirming their agreement to be part of the study. Each girl was allocated a file number to ensure anonymity and confidentiality. All the

individuals who took part in this study signed consent forms. All confidential information will be stored away in a locked filing cabinet in the Department of Food and Nutrition at DUT. The management of electronic data will be password protected. Only the researcher and the supervisory researcher will have access to this confidential information. After five years the information will be shredded.

3.11 Conclusion

This chapter covers a detailed description of the processes used by the researcher to gather all the necessary data in an ethically and methodically correct manner. These processes established the socio-economic status, the physical activity status as well as the macro- and micronutrient status of the adolescent girls attending an affluent high school within KZN. It is an overview of the extensive planning and the various steps taken with regard to the identification of a sample population, acquiring permissions, the handling of fieldworkers as well as capturing and reviewing data through statistical analysis. Results, interpretations and correlations will be discussed in the next chapter.

CHAPTER FOUR

ANALYSIS AND INTERPRETATION OF RESULTS

4.1 Introduction

In this chapter, the analysed data that was captured and interpreted is converted into understandable result tables and graphs. The relationship among variables was also determined and is included as part of this chapter. The results are presented according to the specific objectives of the study. All (n=225) participants took part in relevant data collection methods, which included being interviewed and their anthropometric measurements being recorded. Participants had the option to leave blank questions that they did not feel comfortable answering or to which they did not know the answers. Due to this, there are a few results which were answered by fewer than the total number of participants in the survey; however, all the results below will indicate the number of girls who participated in that specific question. This study aims to determine the relationship between physical activity levels and the nutrition status of affluent adolescent girls attending a private school in an affluent area in the province of KZN.

The South African National Youth Risk Behaviour Survey (Reddy, Resnicow, James, Kambaran, Omardien, and Mbewu 2008: 206) and WHO (1995: 270) firmly expresses the view that anthropometric variables such as weight in relation to height is the most appropriate measure to determine physical status and in turn indicate nutrition status in adolescents. Presented in this chapter are the results of the study covering the dietary intake, nutrition status and physical activity levels according to the collected data. The results are structured as follows:

- Contribution of socio-demographic factors to nutrition status
- Adolescent girls' nutrient intake
- Anthropometric status
- Physical activity levels of the adolescent girls.

4.2 Sample realisation

Since the private school community was relatively small, all the girls who were willing to participate in the study were able to do so thus leading to a more randomly selected sample. In total 225 adolescent girls participated. All the girls who took part in the study underwent an informative introductory interview where the purpose of the study and the various processes that would take place during the study were explained. A complete data set is available for all 225 girls who participated in the study.

Figure 4.1 represents the variety of ages of the girls who participated in the socio-demographic questionnaire. Adolescent girls between the ages of 13–18 years participated, with the largest group being 15 years of age (27.6%; n=62). The 13 year-old age category was the smallest with only 7.6 percent (n=17) of the total sample group participating.

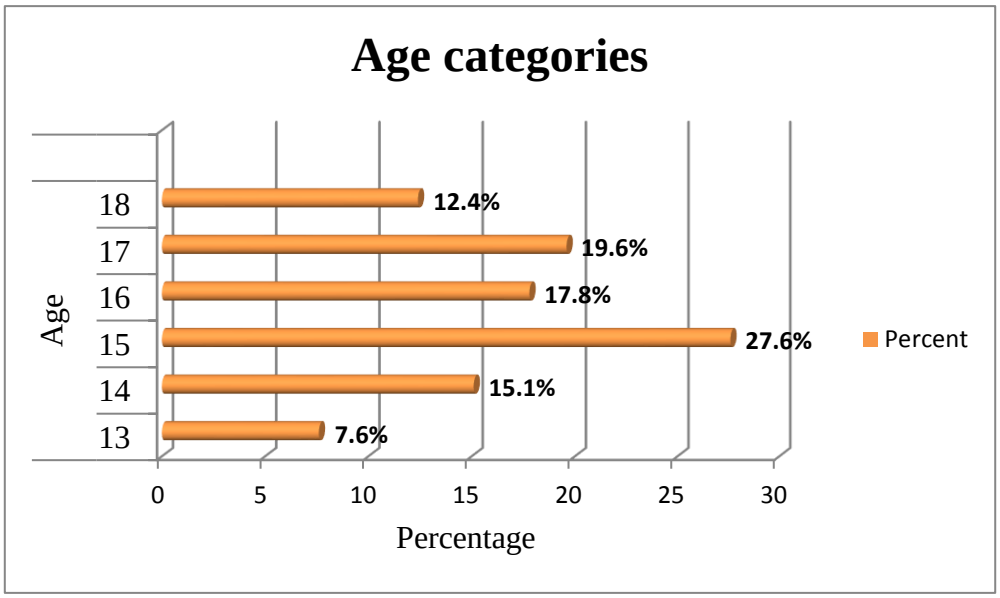

Figure 4.1: Percentage of each age category of the girls (n=225).

The number of meals consumed per day by the majority of the girls (52.4% (n=118)) was three meals per day as seen in Figure 4.2. Thirty-one percent (n=70) of the girls consumed four meals per day and 9.8 percent (n=22) of the girls consumed five meals per day.

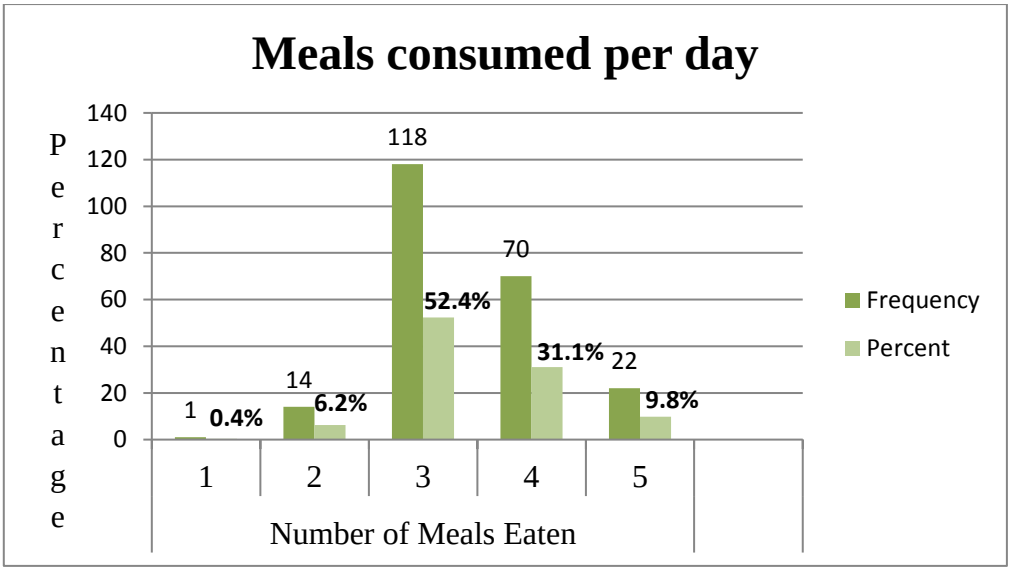

Figure 4.2: Frequency of meals consumed by the girls per day (n=225).

The majority of the girls (56.4% (n=127)) indicated that most meals were eaten at home. The school environment was the place where 41.8 percent (n=94) of the girls consumed their meals. Figure 4.3 clearly shows that only 1.8 percent (n=4) of the girls consumed meals outside the home and school environment.

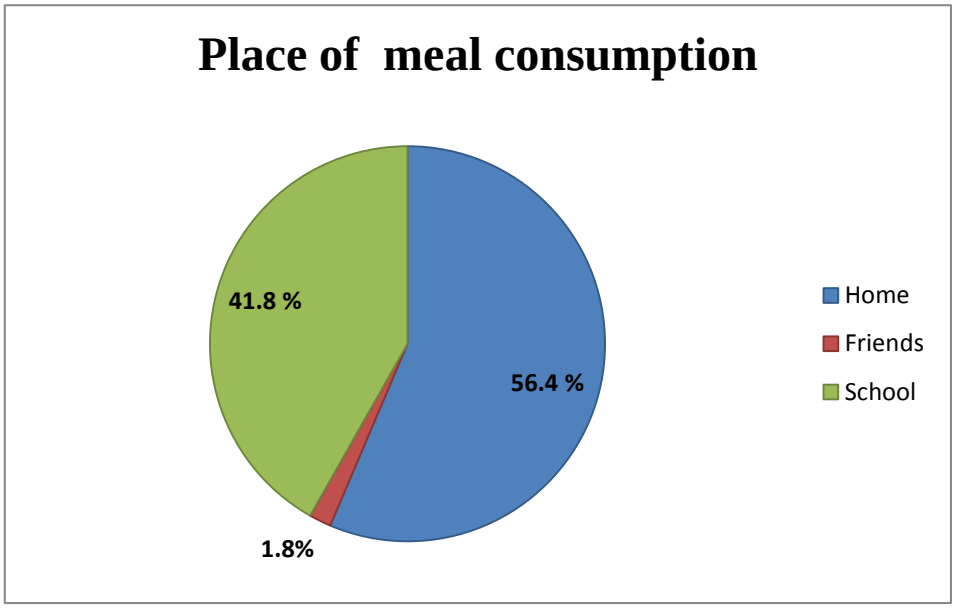

Figure 4.3: Place where meals were frequently eaten (n=225).

Figure 4.4 shows the number of children, including the participants, per household. The most common range of children per household was between one and four children (1 child 15.6%; n=35, 2 children 45.3%; n=101, 3 children 24.9%; n=56 and 4 children 7.1%; n=16). Two

children per household was the most common statistic with 45.3% (n=102) of the participants having only one sibling at home. Three children per household was the second most common statistic at 24.9 percent (n=56). It is important to note that more than four children per household proved less common with an extremely low frequency of the girls indicating that they have several siblings. The 3.1 percent (n=7) of girls that recorded no children in the household were adolescents above 18 years who did not consider themselves to be children.

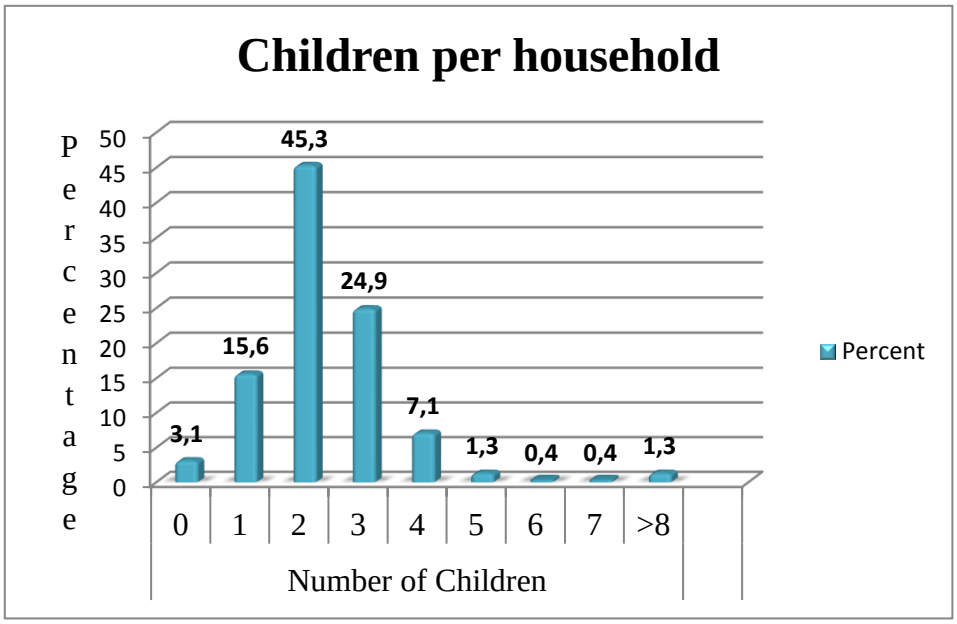

Figure 4.4: Number of children per household (n=224).

4.3.2 Accommodation and family setting

Table 4.1 shows that an overwhelming majority of the participants (92.0%; n=207) lived in an urban town or city type of environment, a small number of girls (3.6%; n=8) lived on a farm, and some girls (3.1%; n=7) lived in the hostel. A very low percentage (1.3%; n=3) of the girls who participated lived in a rural setting or township. A permanent resident is defined as someone who resides in a household for at least four nights per week. Ninety-three point eight percent (n=211) of the participants indicated that people other than the primary caregiver also resided in the same household as they did. Four people per household was the most common in terms of permanent residence at 32.0 percent (n=72). The most common range of permanent residents per household is between four and six people, with fewer occurrences of from seven to above ten people per household.

Table 4.1: Personal data of the girls' accommodation and family composition.

Variable	n=225	%
Place of residence	**Frequency**	**Percentage**
Town/City	207	92.0
Farm	8	3.6
Hostel	7	3.1
Township	3	1.3
	225	100.0
Do other people reside in the same home?	**Frequency**	**Percentage**
Yes	211	93.8
No	14	6.2
	225	100.0
Number of permanent residents	**Frequency**	**Percentage**
1	10	4.4
2	23	10.2
3	47	20.9
4	72	32.0
5	40	17.8
6	14	6.2
7	6	2.7
8	4	1.8
9	1	0.4
10+	5	2.2
Total	222	98.7

4.3.3 Work status and income

As seen in Table 4.2, the vast majority (93.8%; n=214) of the girls' parents/ caregivers were employed; however, it was thought that the 6.2 percent (n=11) of the unemployed parents/ caregivers may in fact choose to stay at home rather than be employed.

Table 4.2: Employment status of parents/ caregivers.

Variable	n=225	%
Main household member employed	**Frequency**	**Percentage**
Yes	214	93.8
No	11	6.2
Total	225	100.0

Figure 4.5 indicates that purchasing food once a week is most common amongst the parents/ caregivers of the girls with 48.4 percent (n=109) of them doing so. Surprisingly, the second most common food purchasing pattern was to buy food every day with 35.1 percent (n=79) of parents/ caregivers choosing this option. Less frequent purchasing patterns, such as once every two weeks and once a month or even less frequently are far less common amongst the participants' parents/ caregivers.

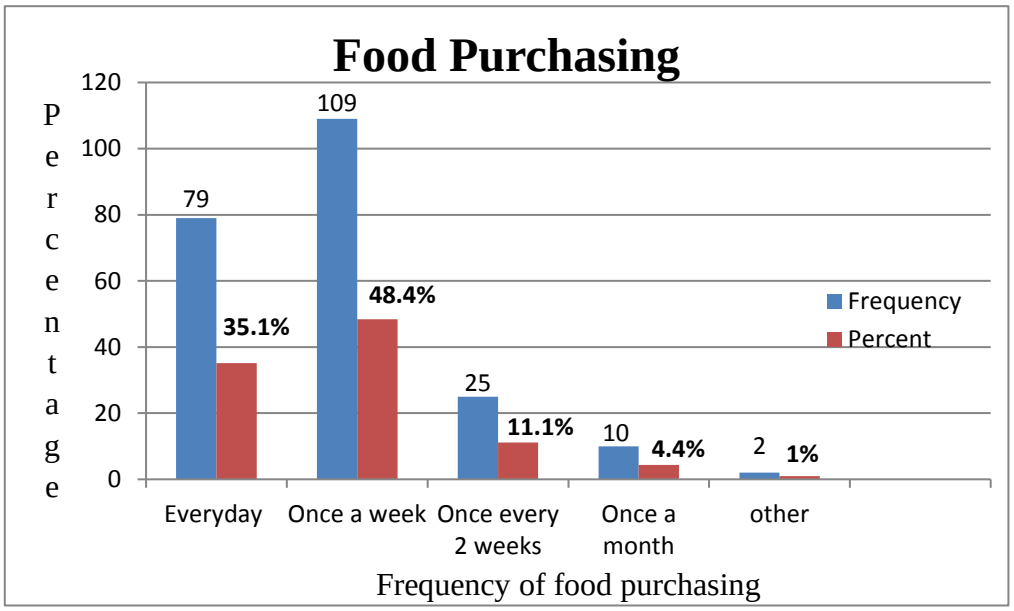

Figure 4.5: How frequently food was being purchased for the household (n=225).

Figure 4.6 indicates that supermarkets, at 80.4 percent (n=181), were the most popular choice of outlet to purchase food from. For a far smaller percentage of 14.7 percent (n=33), convenience stores were chosen to purchase food items. Wholesalers and other food outlets were rarely visited by the participants' parents/ caregivers to purchase food.

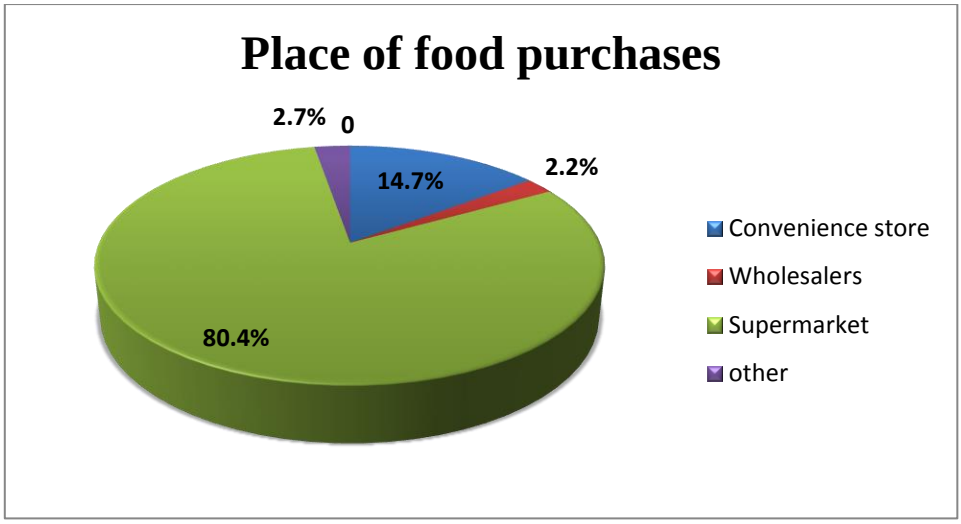

Figure 4.6: Places where food for the household was purchased (n=225).

More than 70 percent (n=163) of the parents/ caregivers indicated that monthly income for the household was greater than R20 000 as seen in Table 4.3 and it can be assumed that this relatively high income is related to the high percentage of money spent on food per month with 29.8 percent (n=64) spending over R5000 per month. A fairly even percentage (10.7%; n= 23) indicated that between R2000–R3000 was spent on food per month but very few participants indicated that less than R1500 (6%; n=13) was spent on food per month as indicated in Table 4.4.

Table 4.3: Approximate total income of household per month (n=224).

Variable	**n=224**	**%**
Total household income p/m	**Frequency**	**Percentage**
>R5000	5	2.2
R5000 - R7 500	4	1.8
R7 500 - R10 000	3	1.3
R 10 000 - R12 500	14	6.3
R12 500 - R15 000	13	5.8
R15 000 - R17 500	6	2.7
R17 500 - R20 000	16	7.1
>R20 000	163	72.8
Total	224	100.0

Table 4.4: Approximate amount of income spent per household on purchasing food items per month (n=215).

Variable	n=215	%
Approximate income spent on food p/m	**Frequency**	**Percentage**
>R1000	2	0.9
R1000 – R1500	11	5.1
R1500 – R2000	13	6.0
R2000 – R2500	23	10.7
R2500 – R3000	23	10.7
R3000 – R3500	28	13.0
R3500 - R4000	31	14.4
R4500 – R5000	20	9.3
>R5000	64	29.8
	215	100.0

Figure 4.7 shows that an extremely high percentage (87.1%; n=196) of the participants stated that there was never a time when they have not had enough money to purchase food and very few participants find themselves not having enough money to buy food or being food insecure.

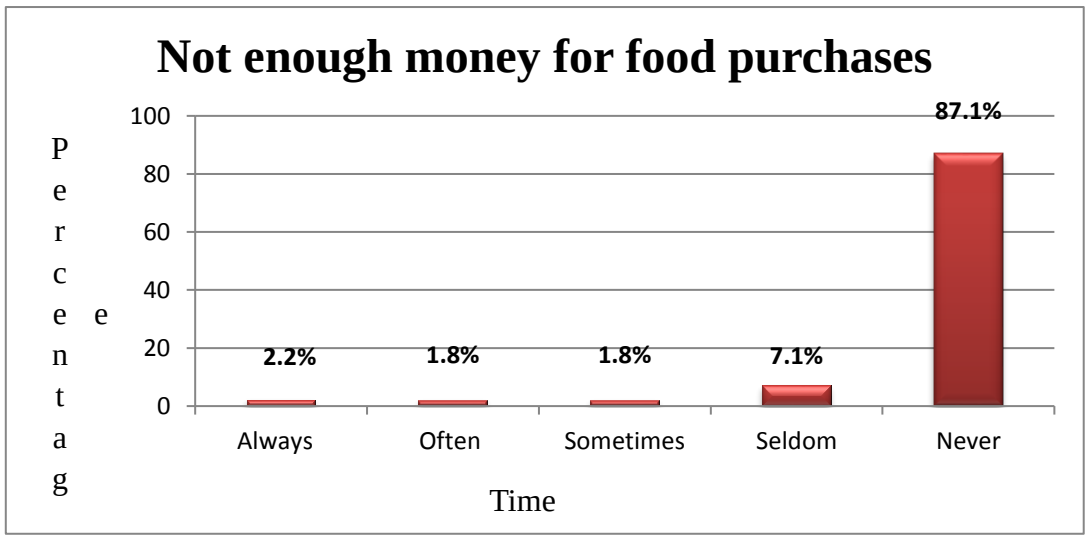

Figure 4.7: How often was there not enough money to purchase food (n=225)?

Figure 4.8 shows that 94.6 percent (n=213), which is the majority of the parents/ caregivers, used personal cars to travel between school/ work and home and to go and purchase food. Less than two percent (n=4) of the parents/ caregivers used taxis or walked and even fewer used motorbikes, bicycles or trains.

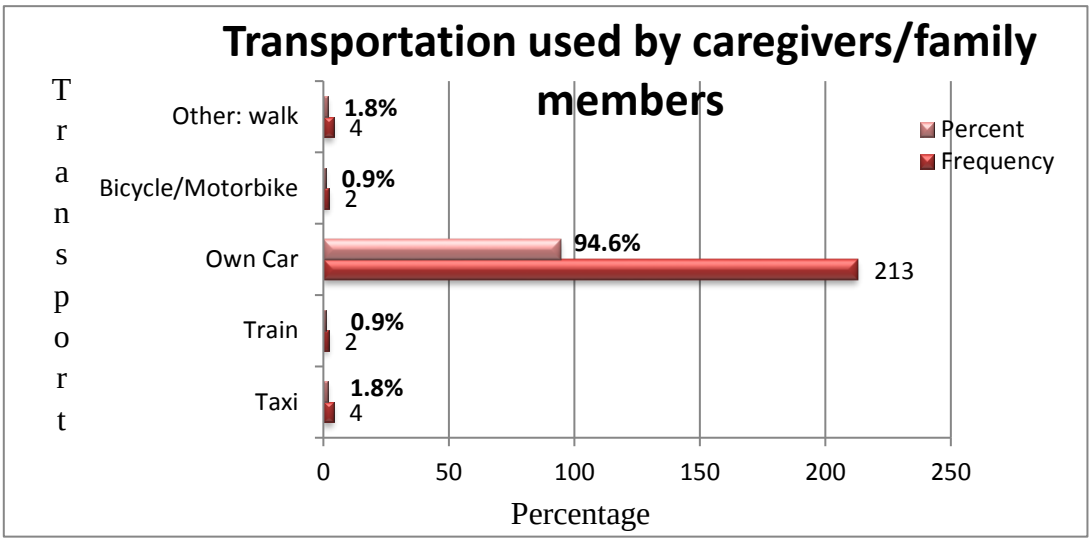

Figure 4.8: Type of transport used to travel by the girls and family members to various destinations such as school, work and home (n=225).

4.3.4 Education and language

In Figure 4.9, information about the parents'/ caregivers' education background indicates that the majority (65.2%; n=141) had attended a tertiary institution including a university. Thirteen percent (n=28) of the parents/ caregivers had up to a grade 12 qualification. The lowest percentage (1.8 %; n= 4) indicated that very few parents/ caregivers were poorly educated and only had a primary school level of education.

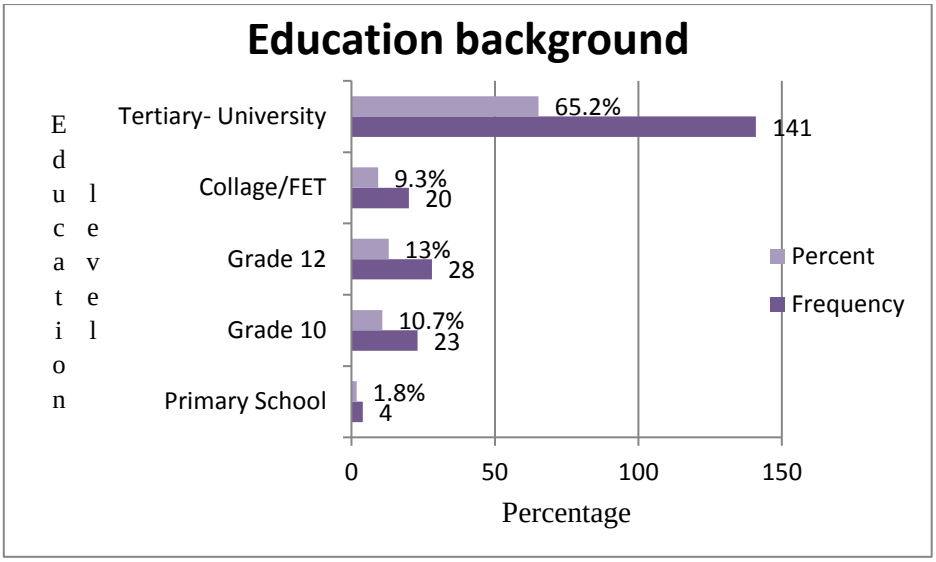

Figure 4.9: Education background of parents/ caregivers (n=216).

The most common language spoken in the home environment was English with 77.8 percent (n=175) of the participants doing so as seen in Figure 4.10. A smaller percentage (11.1%; n=25) spoke isiZulu at home, followed by isiXhosa with 8.4 percent (n=19).

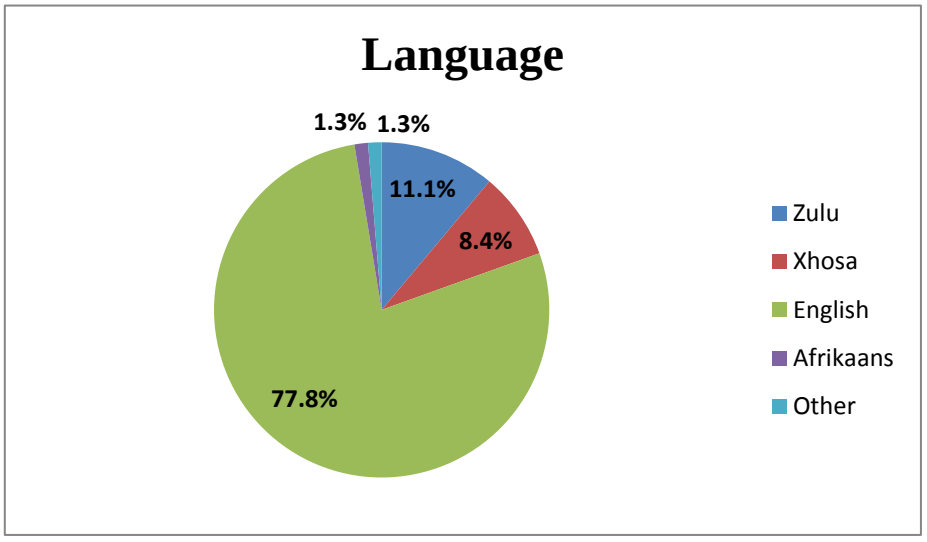

Figure 4.10: Main language spoken in households (n=225).

4.3.5 Food practices in the household

Table 4.5 is a summary of who is involved in decisions about food purchasing and preparation. In more than 75 percent (n=171) of the households, the mother was predominantly responsible for preparing the food. The mother figure was also responsible

for making decisions on what type of food was bought for the household and was the main person responsible for feeding the children (81.3%; (n=183). In contrast, 68 percent (n=153) of the girls regarded the father as the head of the household even though 75.1 percent (n=169) of the girls indicated that the mother figure made the final decision on the amount of money spent on food.

Table 4.5: Food decisions and preparation duties in household (n=225).

Who is mainly responsible for food preparation?	**Frequency**	**Percentage**
Father	14	6.2
Mother	171	76.0
Sibling	2	0.9
Grandmother	7	3.1
Aunt	2	0.9
Friend	1	0.4
Au pair	6	2.7
Other: neighbour, cousin	22	9.8
Who decides on what type of food is bought?	**Frequency**	**Percentage**
Father	13	5.8
Mother	196	87.1
Sibling	1	0.4
Grandmother	5	2.2
Aunt	3	1.3
Other: neighbour, cousin	7	3.1
Who is mainly responsible for feeding/ serving children?	**Frequency**	**Percentage**
Father	17	7.6
Mother	183	81.3
Sibling	1	0.4
Grandmother	3	1.3
Grandfather	1	0.4
Aunt	3	1.3

Cousin	1	0.4
Friend	1	0.4
Au pair	4	1.8
Other: neighbour	11	4.9
Who is the head of the household?	**Frequency**	**Percentage**
Father	153	68.0
Mother	65	28.9
Sibling	1	0.4
Grandmother	3	1.3
Grandfather	1	0.4
Aunt	1	0.4
Other: neighbour, cousin	1	0.4
Who decides how much is spent on food	**Frequency**	**Percentage**
Father	51	22.7
Mother	169	75.1
Sibling	1	0.4
Grandmother	1	0.4
Au pair	1	0.4
Other: neighbour, cousin	2	0.9

4.4 Dietary intake results

4.4.1 Nutrient analysis

The dietary intake of the adolescent girls (n=224) was analysed and discussed. The assessment was done using a FFQ and 24-hour recall questionnaire. Fortified food values were manually uploaded into the analysis program and have been accounted for. The mean of the three 24-hour recalls highlighted in red in Table 4.6 indicates the deficient intake via food consumption of both macro- and micronutrients, including total energy as well as dietary fibre, calcium, magnesium, selenium, folate, vitamin D and vitamin E. The majority of the girls (84.8%; n=190) did not meet the EER for total energy (9 946kJ) with a mean totalling only 7751.7kJ (SD±2082.25) per day calculation based on healthy active

individuals aged 14-18 years. In contrast, carbohydrate and protein intake levels per day were almost double the EAR with 201.6g and 78.5g respectively, much higher than the daily minimum recommendation of 100g of carbohydrate and 46g of protein.

Eighty-seven percent (n=195) of the respondents displayed a lower intake than the AI for dietary fibre intake (26g) with a mean of 18.2g (SD±8.82) per day as can also be seen in Table 4.6. Another prominent deficiency intake can be seen with the calcium intake where 97.3 percent (n=218) of the girls were consuming less than the 1300mg AI per day, totalling a low consumption of 625g (SD±292.06) per day. Iron intake seemed predominantly adequate with an above average mean of 13.4mg (SD±6.48) per day yet 11.1 percent (n=25) of the girls didn't meet the EAR of 7.9mg per day. Magnesium levels indicated an inadequate intake, with 83 percent (n=186) of the girls not meeting the 300mg per day requirement but rather sitting just below it with 239.1mg (SD±81.44) per day as a mean intake.

Table 4.6 continues to show a deficient intake of magnesium, and folate also indicated a predominantly deficient intake with 82.1 percent (n=184) of the respondents failing to meet the requirement with a mean of 248.9µg (SD±127.96) per day opposed to the EAR of 330µg. More than 50 percent of the girls did not meet the EAR for the following nutrients: selenium (65.1%; n=146) with a 40.1µg per day mean (SD±17.83), vitamin D (75.8%; n=34) with a mean of 3.9µg per day (SD±3.29), and vitamin E (63.8; n=143) with an 11.3mg per day mean (SD±6.50). Vitamin K showed a different result with 69.1 percent (n=155) of the girls not meeting the AI requirements; however, the mean for this micronutrient is 77.5µg (SD±97.90) per day which is above the recommended AI of 75µg per day.

Results for micronutrients such as niacin and vitamin B6 showed that almost the entire sample group was meeting adequate intake requirements with only 2.2 percent (n=5) and 2.6% (n=6) of the girls not meeting the EAR respectively. Less than 30 percent of the girls were found to be deficient in the following nutrients: zinc (20.5%; n=46) with a mean of 10mg (SD±3.28), vitamin A (25.8%; n=58) with a mean of 995.9µg (SD±722.60), thiamine (20.9%; n=47) with a mean of 1.4mg (SD±0.59), riboflavin (14.2%; n=32) with a mean of 1.7mg (SD±0.84), vitamin B12 (11.1%; n=25) with a mean of 3.8µg (SD±1.93), pantothenic acid (29%; n=65) with a mean of 3.1mg (SD±3.57), and vitamin C (27.2%; n=61) with a mean of 107.9mg (SD±72.00) per day.

Table 4.6: Dietary intake and nutrient analysis, and percentage of participants not meeting the DRIs measured using the average of three 24-hour food recalls (IoM 2006).

Nutrients p/day	Girls (n=225) Mean ± SD	% Girls <100 of DRI	Dietary reference intakes
Energy (kJ)	7751.7±2082.25	84.8	9946 EER*
Carbohydrate (g)	201.6±62.22	4.9	100 EAR
Total Protein (g)	78.5±23.01	5.8	46 EAR
Total Dietary Fibre (g)	18.2±8.82	87.0	26g AI
Calcium (mg)	625.0±292.06	97.3	1300 AI
Iron (mg)	13.4±6.48	11.1	7.9 EAR
Magnesium (mg)	239.1±81.44	83.0	300 EAR
Phosphorus (mg)	1119.6±349.65	47.7	1055 EAR
Zinc (mg)	10.0±3.28	20.5	7.5 EAR
Selenium (µg)	40.1±17.83	65.1	45.0 EAR
Vitamin A (µg)	995.9±722.60	25.8	485.0 EAR
Thiamine (mg)	1.4±0.59	20.9	0.9 EAR
Riboflavin (mg)	1.7±0.84	14.2	0.9 EAR
Niacin (mg)	25.5±9.17	2.2	11.0 EAR
Vitamin B6 (mg)	2.4±0.85	2.6	1.0 EAR
Folate (µg)	248.9±127.96	82.1	330 EAR

Vitamin B12 (µg)	3.8±1.93	11.1	2.0 EAR
Pantothenic acid (mg)	7.1±3.57	29.0	5.0 AI
Biotin (µg)	31.0±15.62	37.5	25 AI
Vitamin C (mg)	107.9±72.00	27.2	56 EAR
Vitamin D (µg)	3.9±3.29	75.8	5 AI
Vitamin E (mg)	11.3±6.50	63.8	12 EAR
Vitamin K (µg)	77.5±97.90	69.1	75 AI

EER =Estimated Energy Requirements kJ=kilojoules

RDA=Recommended Dietary Allowance g=grams

EAR= Estimated Average Requirement mg=micrograms

AI =Adequate Intake µg=milligrams

* compared to a healthy and active individual

Table 4.7 indicates the top 20 most popular food items and the average daily intake of the sample population who consumed these foods over two week days and one weekend day included in the 24-hour recall. The top five food items frequently consumed over three days are highlighted in Table 4.7. Whole milk proved to be the most popular item of food consumed by the girls with a frequency of 239. However, the per capita intake is only 95.1g and has a mean intake per frequency of the sample population at a nominal 89.2g per day. This is followed by sugar with a mean intake per frequency of 7.6g (frequency 146) and a per capita intake of 5g.

Tea ranked third with a 253.5g mean intake per frequency (frequency 144) with a relatively low per capita of 163g. The first carbohydrate-dense food can be seen coming in at fourth place with a frequency of only 142 with an extremely low mean intake per frequency of 50.95g per day (mean intake per capita 32.4g). Low energy food such as lettuce was the fifth most popular food item consumed with a mean intake per frequency of 17.5g (frequency 82) and a low mean intake per capita of only 6.4g per day. Carbohydrate-dense foods only appear in the form of fruit in the rest of the top twenty foods such as apples in 11th place with a

mean intake per frequency of 136.0g (frequency 60) with a mean intake per capita of 36.7g, bananas in 16th place with a mean intake per frequency of 96.4g (frequency 37) with a mean intake per capita of 15.8g, and naartjies/tangerines in 19th place with a mean intake per frequency of 125.51g (frequency 33) with a mean intake per capita of 18.3g. This was followed by the most carbohydrate-dense vegetable in the top 20: in last position at number 20 was the butternut with a mean intake per frequency of 100.39g (frequency 32) with a mean intake per capita of 14.2g.

A variety of proteins can be seen in the top 20, not only in the number one spot which was whole milk, but also in the form of cheese in ninth place with a mean intake per frequency of 24.8g (frequency 64) and a low mean intake per capita of 7.1g. This was followed by yoghurt in 10th place with a mean intake per frequency of 125.7g (frequency 61) making a very low mean intake per capita of 34.1g; chicken, white meat comes up in the number 15 place with a larger mean intake per frequency of 92.1g (frequency 38) but again with an extremely low mean intake per capita of 15.6g and again, protein is seen in the form of bacon in 18th place with a mean intake per frequency of 42.4g (frequency 33) and another extremely low mean intake per capita of 6.3g.

Fresh vegetables appeared in the top 20 in the form of lettuce at number five; in eighth place was raw tomatoes with a frequency of 67 and with a mean intake per frequency of 38.4g and a mean intake per capita of 11.6g. This was followed by cucumber in 13th place with a frequency of 47 times and a mean intake per frequency of 46.5g (mean intake per capita of 9.8g). Salad with no dressing came in as the 17th ranked food with a mean intake per frequency of 66.4g (frequency 35) and a low mean intake per capita of 10.4g. Lastly, in 20th position, was the previously mentioned butternut. Fruits and vegetables appear eight times in the top 20, protein rich foods appear five times in the top 20, with high carbohydrate dense foods only appearing twice in the form of bread and butternut.

High energy sugar items appear three times in the top twenty with, for example, pure sugar coming in at second place, followed closely by cold drinks and diluted squash coming up in sixth place with a mean intake per frequency of 290.3g (frequency 69) and a mean intake per capita of 89.9g. Lastly, ranking at 12th, carbonated cold drinks come in at a high 331.2g mean intake per frequency (frequency 50) with a mean intake per capita of 73.9g.

Table 4.7: The mean top twenty foods consumed by girls 14-18 years old per day, averaged from three consecutive 24-hour recalls ranked by frequency (n=224).

Rank	Food item	Mean (g) intake	Frequency consumed	Mean intake per frequency (g)	Mean intake per capita (g)
1	**Milk, whole**	21 294.3	239	89.2	95.1
2	**Sugar**	1 110.0	146	7.6	5
3	**Tea**	36 505.0	144	253.5	163
4	**Bread**	7 251.6	142	50.9	32.4
5	**Lettuce**	1 442.6	82	17.5	6.4
6	Cold drinks, squash, diluted	20 130.0	69	290.3	89.9
7	Coffee	16 850.8	68	246.6	75.2
8	Tomato, raw	2 590.6	67	38.4	11.6
9	Cheese	1 584.5	64	24.8	7.1
10	Yoghurt, whole	7 630.8	61	125.7	34.1
11	Apple	8 210.0	60	136.0	36.7
12	Carbonated cold drinks	16 563.3	50	331.2	73.9
13	Cucumber	2 205.0	47	46.5	9.8
14	Mayonnaise	1 125.8	43	26.3	5.0
15	Chicken, white meat	3 502.3	38	92.1	15.6
16	Banana	3 534.5	37	96.4	15.8
17	Salad: no dressing	2 325.0	35	66.4	10.4
18	Bacon	1 401.6	33	42.4	6.3
19	Naartjie/tangerine	4 100.0	33	125.5	18.3
20	Butternut	3 179.1	32	100.3	14.2

Indicated in Table 4.8, are the results of the energy distribution of the macronutrients from the 24-hour recall, according to the institute of medicine, food and nutrition board (NICUS 2003). This suggests that total carbohydrate and fibre intake for girls needs to contribute 45-65 percent of total energy. The sample group of girls showed to be on the lower end of the

range with 48.2 percent of energy coming from carbohydrate sources, but, however, still within the normal range. This low percentage can also be seen in Table 4.7 where there were limited starch based carbohydrates sources present in the top twenty most popularly consumed foods by the girls. Sugar makes up 9.5 percent of total energy which is just below the recommendation of less than 10 percent (WHO 2010a). When referring to Table 4.7, this higher percentage was justified with sugar being the second most popular food item that was consumed.

In contrast, the fat percentage of total energy came in border line on the higher side of the recommended percentages by IoM (2003). It is suggested that energy from fat sources should be between 25-35 percent, and the girls were consuming 34.6 percent of fat as an energy source, coming close to above the recommended maximum percentage. A much more normalised intake can be seen for protein as an energy source. The IoM recommends that an intake of 10-30 percent of protein should contribute to total energy. The girls consumed a moderate amount of 17.2 percent of energy coming from protein. This, too, can be seen in Table 4.8 where many sources of whole fat protein based foods appear within the top 20 foods consumed by the girls.

Table 4.7 indicates that many fruit and vegetable sources are popularly consumed by the girls. According to WHO (2010a), approximately 400g of fruit and vegetables should be eaten every day by girls for them to be considered normal and healthy. However, as seen in Table 4.8, the 24-hour recalls indicated that on average 293.1g of fruit and vegetables is consumed per day by the girls, which is a considerably lower amount than is considered nutritionally sound, indicating that the girls are eating far less in food weight than recommended per fruit and vegetable source. Dietary fibre is also shown to be lower than the recommendation of at least 26g per day by WHO (2010a), with the girls eating only 18.2g per day, which may be the result of the above-mentioned low quantity intake of fruit and vegetables.

Table 4.8: Total energy distribution per macronutrients of the girls as compared to the institute of medicine, food and nutrition board DRIs (NICUS 2003 and WHO 2010a).

Dietary Factor	IoM Goal % of total energy	24-Hour Recall % contribution of total energy Girls n=224
Total fat	25-35%	34.6
Total carbohydrates + fibre	45-65%	48.2
Protein	10-30%	17.2
Sugar	< 10%	9.5
	WHO goal	**g/day**
Fruit and vegetables g/day	≥400	293.1
Dietary fiber g/day	Girls >26	18.2

4.4.2 Food variety score, dietary diversity and nutrient adequacy

Food variety and food group diversity over a period of seven days was assessed to give an extended view of food variety in the diet. The nine nutritious food groups, with a listing of single food items within the various groups, were reported in the food variety score over seven days and are summarised in Table 4.9. The nine food group's individual foods were counted to a maximum total food score of 87 food items from each food group. The food group with the most variety of individual food items was the other fruit (and fruit juices) group with 20 different food items. Thirty-two of the girls consumed seven varieties of fruits within a one-week period, making this the highest and most popular amount of fruit to be consumed. The vegetable group had a high score of 15 different types of varieties eaten. The most popular vegetable variety number is eight different types of vegetables a week with 36 of the girls consuming this number of vegetables. Very few girls consumed a low vegetable variety, with a total of 11 girls eating between 0-3 different types of vegetables per the seven-day period.

A maximum of eight varieties of vitamin A-rich fruit and vegetables was eaten; however, a large number of girls (n=49) only ate four varieties, followed closely by three and five varieties that were both eaten by 48 girls respectively. Over 69 girls ate four different sources of dairy products, followed very closely by 68 girls who ate three varieties of dairy products. The most dairy product varieties eaten were nine. A large number of the girls (n=51) ate at least six different types of cereal, roots and tubers per the seven-day period. A lesser food variety score of only two different legumes and nuts sources was consumed by 66 participants, followed closely by 59 participants eating only one variety.

Animal protein such as meat, poultry and fish had a maximum variety score of twelve yet a large number of the girls (n=52) only ate from six different sources. Oils and fats also had a high variety maximum of seven different sources with 64 girls consuming from five different sources of fats and oils. The majority of the girls consumed eggs (n=178) within the seven-day data collection period.

Table 4.9: Food variety consumed per food group over a period of seven days (n=223).

Cereal, roots and tubers diversity group (n=10)	**Legumes and nuts group (n=5)**	**Flesh foods (meat, poultry, fish) diversity group (n=12)**	**Eggs diversity group (n-1)**	**Dairy products diversity group (n=9)**	**Other vegetables diversity group (n=15)**	**Other fruits (and fruit juices) diversity group (n=20)**	**Vitamin A rich fruit and vegetables diversity group (n=8)**	**Oils and fats diversity group (n=7)**	**Total individual items eaten from all groups (n=87)**
0=2	0=21	0=4	0=45	0=3	0=1	0=1	0=3	0=1	0-20=2
1=1	1=59	1=4	1=178	1=14	1=1	1=3	1=17	1=9	21-30=10
2=7	2=66	2=8		2=31	2=1	2=8	2=26	2=17	31-40=10
3=14	3=34	3=13		3=68	3=8	3=17	3=48	3=45	41-50=10
4=28	4=32	4=38		4=69	4=12	4=13	4=49	4=50	51-60=9
5=48	5=11	5=44		5=25	5=19	5=30	5=48	5=64	61-70=4
6=51		6=52		6=7	6=26	6=32	6=16	6=32	71-87=6

7=40		7=29		7=3	7=23	7=32	7=6	7=5	
8=20		8=17		8=2	8=36	8=22	8=10		
9=7		9=10		9=1	9=21	9=13			
10=5		10=1			10=27	10=18			
		11=2			11=24	11=9			
		12=1			12=9	12=7			
					13=10	13=3			
					14=4	14=4			
					15=1	15=2			
						16=1			
						18=3			
						19=1			
						20=4			

Low food variety – 0-3 groups or < 30 individual foods

Medium food variety – 4-5 groups or 30-60 individual foods

High food variety – 6-9 groups or >60 individual foods (FAO 2013).

A summary of the food variety within the food groups is presented in Table 4.10 and is representative of the total sample group of girls (n=223). The mean total of food variety eaten within a group is 8.6 (mean SD±0.64) when compared to the Food Variety Score (FVS) cut-off points (Matla 2008). The girls' score falls between the 6-9 groups, or greater than 60 individual foods consumed, indicating that a high food variety is eaten by the girls. The score ranges from a low of 14 to a maximum of 83 different food items consumed over a seven-day period.

Table 4.10: A summary of food variety scores within particular food groups consumed over seven days by the girls (n=223).

Food Groups	Mean	SD	Range of Scores
Cereals, roots and tubers	5.7	1.74	1-10
Legumes and nuts	2.4	1.21	1-5
Meat foods	5.6	1.89	0-12
Eggs	1.0	0.00	0-1
Dairy products	3.5	1.35	1-9

Vegetables, other	8.1	2.77	1-15
Fruit, other	7.4	3.72	1-20
Vitamin A rich fruit and vegetables	3.9	1.69	1-8
Oils and fats	4.2	1.38	1-7
Total food items	**8.6**	**0.63**	**14-83**

Low food variety – 0-3 groups or < 30 individual foods

Medium food variety – 4-5 groups or 30-60 individual foods

High food variety – 6-9 groups or >60 individual foods (Matla 2008).

In Table 4.11 the food group diversity is summarised as the majority of the respondents could be classified as having a high food group diversity score (FGDS) as 6-9 food groups were consumed during the seven day period. A predominant majority of the girls, with 70.9 percent (n=158), ate from all nine nutritious food groups during the data collection period.

Table 4.11: A summary of food group diversity over seven days consumed by the girls (n=223).

Number of food groups consumed (n=9)	Frequency	Percentage
1 - 5	0	0
6	3	1.3
7	10	4.5
8	52	23.3
9	158	70.9
Total food items	223	100

4.4.3 Dietary diversity score (DDS)

The DDS was calculated for one day using the three day 24-hour recall data, and this was calculated to present a DD for a one-day period to be correlated to a one-day nutrient intake of the girls. As seen in Table 4.12, 32.3 percent (n=72) of the girls had eaten from six food groups within one day followed by four (22.4; n=50) and five (18.4; n=41) food groups. The lowest (2) and highest (9) number of food groups consumed indicated few girls eating from these groups with both groups at 1.3 percent (n=3). Thus, the dietary diversity score ranges

from 2 to 9 food groups for one day with a mean score of 5.5 (SD±1.36) as seen in Table 4.13. A wide range represents the low score of two food groups being eaten by the girls in one day and progresses to the most optimum score of all nine food groups being eaten in one day. When the mean of total food groups eaten over the seven-day period, which is 8.6 as seen in Table 4.10, is compared to the one day mean (5.5) in Table 4.13; a very different outcome can be seen. The one day DDS is considered an average score whereas the seven-day score of 8.6 which is very close to the optimum score of 9 represents a very varied diet.

Table 4.12: A summary of food group diversity for one day as consumed by the girls (n=223).

Number of food groups consumed (n=9)	Frequency	Percentage
1	0	0.0
2	3	1.3
3	7	3.1
4	50	22.4
5	41	18.4
6	72	32.3
7	34	15.2
8	13	5.8
9	3	1.3
Total Food Items	223	100

Table 4.13: The mean, SD and range of the dietary diversity score (DDS) as calculated for one day.

Mean DDS score	SD	Range
5.5	1.36	2-9

The DDS was calculated and correlated with the nutrient adequacy ratio (NARs) of the diet for one day. Figure 4.11 illustrates the relationship between the NAR (expressed as a %) of energy, protein, carbohydrates, iron, zinc and calcium at different levels of the DDS. The following was found to be statistically significant: DDS and energy at p=0.009, protein at p=0.000, zinc at p=0.000 and calcium at p=0.001. The NARs were calculated by working out the percentage of the average intake in relation to the DRI. For all the nutrients, a

progressive incline is seen with the increase of the NAR as the DDS increases. However, once eight food groups have been reached over all nutrients, NARs steadily decline into the ninth food group.

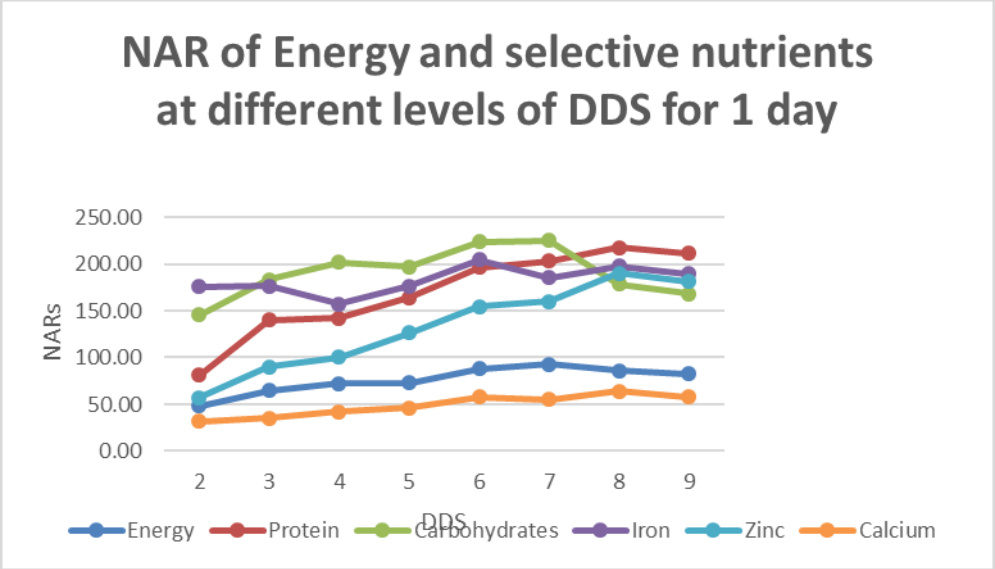

Figure 4.11: Nutrient adequacy ratio (NAR expressed as %) of energy and nutrients at different levels of DDS (n=224).

Figure 4.12 indicates similar patterns in the micronutrient NARs as shown in Figure 4.11 where an overall increase is seen in all nutrients. Vitamin C, Riboflavin and Vitamin B6 start above 100 percent adequacy whereas folate remains below 100 percent of the NAR, but does see a slight increase with an increase in food group consumption specifically between groups seven and eight. Vitamin A starts below the 100 percent adequacy but emerges above the 100 percent NAR and continues to increase until eight groups have been consumed. Statistical significant increases were observed between the DDS and vitamin A at p=0.000, vitamin C at p=0.022 and folate at p=0.005.

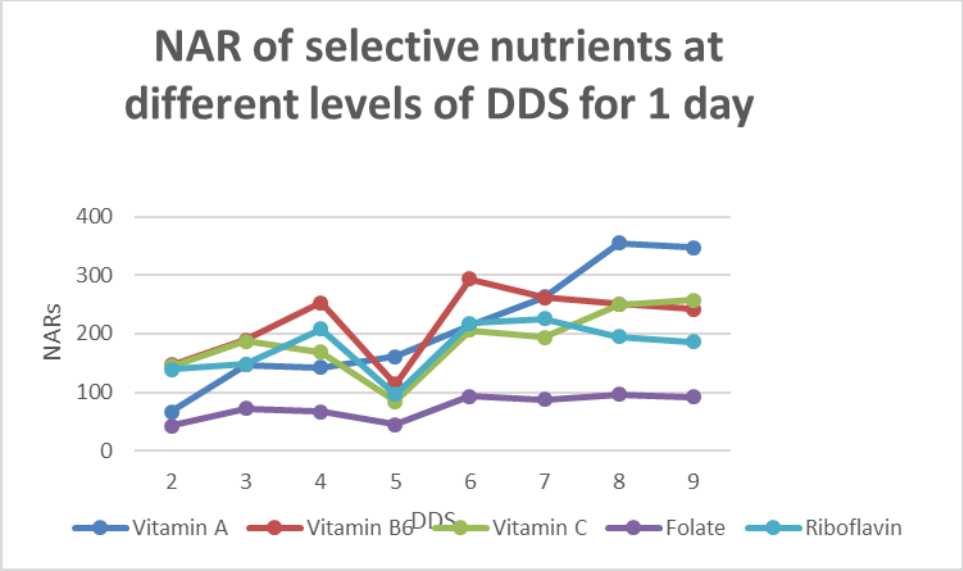

Figure 4.12: Nutrient adequacy ratio (NAR expressed as %) of vitamins and nutrients at different levels of DDS (n=224).

4.4.4 Supplements

A section on supplements was included as part of the girls' nutrition intake data collection. This was to record extra micronutrients that were ingested other than in the form of food items, which may have contributed to the nutrition status of the girls. This was, however, not analysed as part of the daily food intake. The top types of supplements taken by the girls were: a general multivitamin, vitamin C and Omega 3. The most consumed multivitamin brand was Bio-Strath and a nutrition breakdown per tablet can be seen in Table 4.15.

According to Figure 4.13, 32.7 percent (n=73) of the total girls sampled took in some form of supplementation on a daily basis, whereas 67.3 percent (n=150) of the participants relied only on food items for total micronutrient intake.

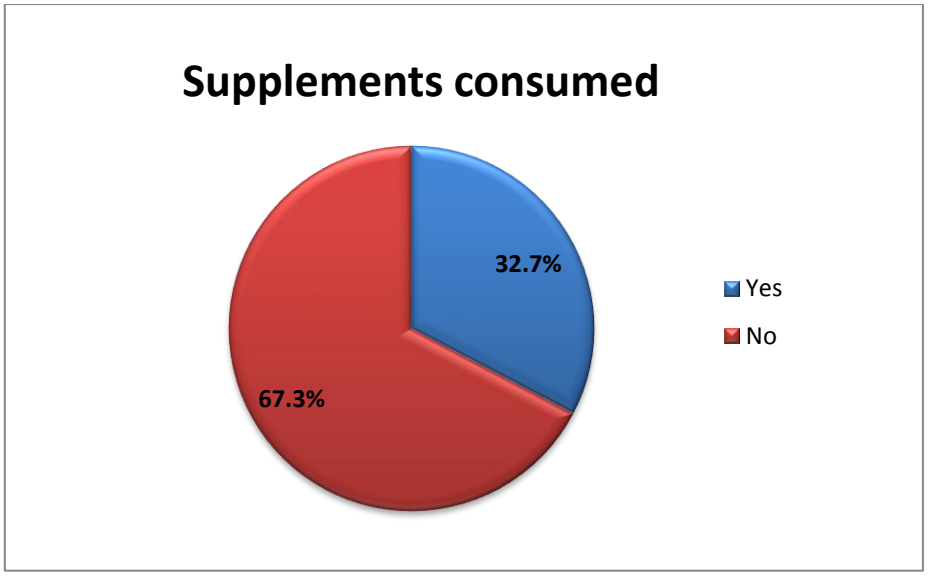

Figure 4.13: Number of girls who consumed supplements (n=223).

Table 4.14 indicates that, out of the total participants sampled, 27.8 percent (n=62) of the girls took multivitamin tablets, with an average of 1.27 tablets per day (SD±0.57). Vitamin C tablets were consumed in a slightly lower amount of 13.0 percent (n=29), with an average of 965.5mg per day (SD± 128.94) and 9.0 percent (n=20) took Omega 3 in a 1000mg tablet form every day.

Table 4.14: Specific supplements taken by the total sample population (n=223).

Supplement	Frequency	Percentage	Mean	±SD
Multivitamin	62	27.8	1.2	±0.57
Vitamin C	29	13.0	965.5	±128.94
Omega 3	20	9.0	1000.0	±0.00

According to Table 4.15, 77.4 percent (n=48) of the 62 girls were taking multivitamins, meaning that the majority of the girls were consuming one multivitamin tablet per day. A smaller percentage of 19.4 percent (n=12) chose to take two tablets per day whereas only one girl consumed three (1.6%; n=1) or four (1.6%; n=1) tablets per day. A per tablet nutrient breakdown of macro and micronutrients can be seen in Table 4.16.

Table 4.15: Quantity of multivitamins taken by the girls per day (n=62).

Multivitamin	Frequency	Percentage
1 Tablet	48	77.4
2 Tablets	12	19.4
3 Tablets	1	1.6
4 Tablets	1	1.6
Total	62	100.0

According to Table 4.16, the nutrient values per individual tablet are very low, contributing little to the overall macronutrient intake levels of the girls. However, some micronutrient EARs are met with the consumption of only one tablet such as thiamine (B1) with 7.8mg per tablet (EAR 0.9) and riboflavin (B2) with 1.7mg per tablet (EAR 0.9mg). Other trace vitamins and minerals may also have contributed to the nutrient intake.

Table 4.16: Bio-Strath multi-vitamin nutritional composition per tablet.

Energy	227.2Kj
Carbohydrates	4.7g
Protein	7.1g
Fats	0.7g
Thiamine (Vitamin B1)	7.8mg
Riboflavin (Vitamin B2)	1.7mg
Niacin Vitamin (B3)	3.0mg
Pantothenate (Vitamin B5)	0.7mg
Folate (Vitamin B9)	9µg
Ascorbic Acid (Vitamin C)	0.4mg
Biotin (Vitamin H)	0.2 µg
Calcium (Ca)	27.3mg
Iron (Fe)	1.4mg
Magnesium (Mg)	16.3mg
Phosphorous (P)	154.5mg

Selenium (Se)	37.7µg
Zinc (Zn)	1.64mg

Vitamin C tablets were mostly consumed in a 1000mg tablet form with 93.1 percent (n=27) of the girls opting to do so. In a lesser percentage of 6.9 percent (n=2) of the girls a 500mg tablet was taken as seen in Table 4.17.

Table 4.17: Quantity of vitamin C consumed by the girls (n=29).

Vitamin C	Frequency	Percentage
500mg	2	6.9
1000mg	27	93.1
Total	29	100

All the girls who supplemented an Omega 3 tablet consumed it in a 1000mg form seen in Table 4.18.

Table 4.18: Quantity of Omega 3 consumed by the girls (n=20).

Omega 3	Frequency	Percentage
1000mg	20	100

4.5 Anthropometric assessment

Anthropometric data is about measuring height and weight to formulate a Body Mass Index (BMI) (weight [kg] ÷ height [m]²) and height-for-age, weight-for-age and BMI-for-age in children. The data obtained is used to indicate stunting, wasting, overweight and obesity and BMI was included for the group.

The results in Table 4.19 indicate that 99.6 percent (n=222) of the girls displayed normal height-for-age (≥-2 < +3SD). Only one girl out of the sample group turned out to be stunted <-2SD. BMI-for-age is used to evaluate the obesity status of the sample group as a risk factor for development of diseases associated with overweight status. The BMI-for-age scores indicated that 77 percent (n=171) of the girls were within a normal category (≥-2SD and <+1SD). However, 17.1 percent (n=38) were at risk of becoming overweight with eleven

girls, amounting to five percent, proving to be within the overweight category (>+2SD) but no girls fell into the obese category. However, two girls were considered to be wasted (<-2SD). Overall a normal BMI-for-age was dominant among the girls.

Table 4.19: Anthropometric data of the girls, indicated by SD indicators for height-for-age and BMI-for-age.

Growth indicators	Classification	Girls %	Girls (n)
	Stunting (height-for-age) (n=223)		
<-3SD	Severely stunted	0.0	0
<-2SD	Stunted	0.4	1
≥-2 <+3SD	Normal (height-for-age)	99.6	222
	Wasting/Thinness (BMI-for-age) (n=222)		
<-3SD	Severely wasted	0.0	0
<-2SD	Wasted	0.9	2
≥-2SD and <+1SD	Normal (BMI-for-age)	77.0	172
>+1SD	Risk of overweight	17.1	38
>+2SD	Overweight	5.0	11
>+3SD	Obese	0.0	0

Figure 4.14 illustrates the BMI-for-age for the girls using the red line. This indicates that the curve is shifted slightly to the right, which suggests that, as a group, the girls lean slightly towards being overweight but are close to the WHO indictor (green line) with a mean *z*-score of 0.24±1.98.

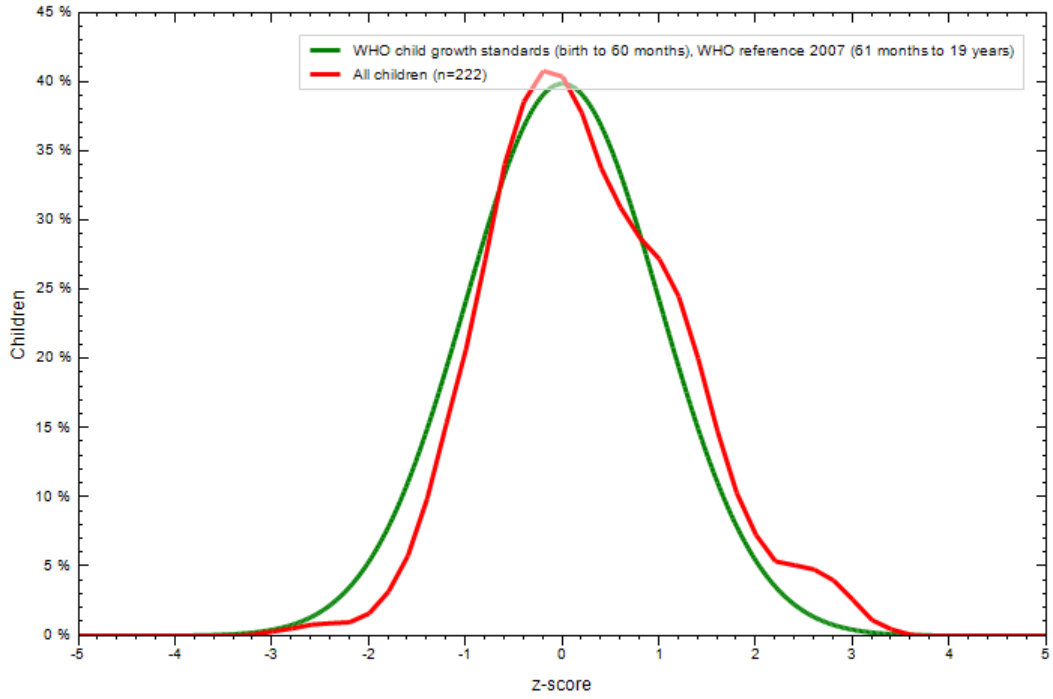

Figure: 4.14: BMI-for-age compared to the WHO child growth standards 13-18 years old girls (n=222).

Figure 4.15 illustrates height-for-age for the girls using the red line which appears to go higher than the WHO's standard indicator represented by the green line. However, it is in close proximity to the guideline suggesting that the girls are slightly taller than normal for age with a mean *z*-score of 0.19±0.93.

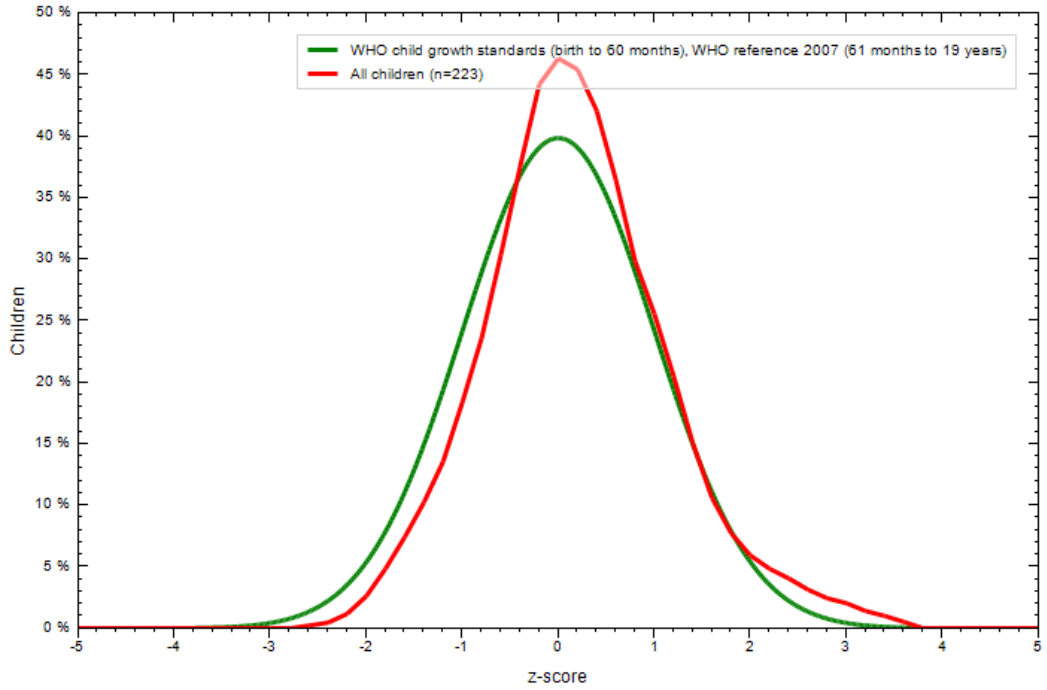

Figure 4.15: Height-for-age compared to the WHO child growth standards 13-18 years old girls (n=222).

Table 4.20 indicates the BMI of the girls. The mean BMI was 21.9 with a SD of 4.11. Overall, the girls were of normal BMI (18.5-24.99) with 72.2 percent (n=161), and the under-weight catagory (<18.5) was the second largest group with 12.6 percent (n=28). Over 10 percent of the girls were overweight (25-29.99) and some girls fell within the obese catagories: class one (30-34.99) being 3.6 percent (n=8), class two (35-39.99) being 0.9 (n=2) and one morbidly obese (obese class three; >40) girl (0.4%). The findings within the BMI catagories of Table 4.19 reflect similarly to the growth chart for BMI-for-age of the girls in Figure 4.14 showing the majority of the girls being normal with a slight leaning towards the various overweight categories.

Table 4.20: BMI categories as determined by the World Health Organisation (n=223) (WHO 2010a).

BMI categories	Classification	Girls %	Girls (n=223)
<18.5	Underweight	12.6	28
18.5- 24.99	Normal	72.2	161
25- 29.99	Overweight	10.3	23
30- 34.99	Obese class 1	3.6	8
35- 39.99	Obese class 2	0.9	2
>40	Obese class 3 (morbidly obese)	0.4	1
Mean	21.9	100	223
SD	4.11	100	223

4.6 Physical activity results

Determining the physical activity levels of the girls provides a more accurate insight into an overall nutrition status conclusion. This physical activity is done over and above the normal daily exertion of energy, such as walking, climbing stairs to get to a destination or lifting items. This physical activity may also be termed as exercise, or additional physical activity, which can be performed through a variety of sports or activities.

Table 4.21 shows the many varieties of sporting activities that the girls participated in. The most popular activity amongst the girls (n=158) is jogging with more than half of the girls taking part in the activity at least one to seven or more times per week. This is closely followed by walking for the purpose of exercise with also more than half of the girls (n=134) participating once to twice a week.

The sports participated in more than seven times a week, in order of popularity, are horse riding with 15.4 percent (n=26) of the girls riding seven or more times a week, followed by dancing of any type with 10.3 percent (n=97) of the girls participating seven or more times a week. The third physical activity most participated in is hockey with 9.8 percent of the 51 girls participating seven or more times a week.

Table 4.21: The percentage of girls performing specific activities at different frequencies within a period of a week (n=224).

Variables	frequency per week (%)			
	1-2	3-4	5-6	7 or more
Skipping (n=63)	82.5	11.1	4.8	1.6
Rowing/ Canoeing (n=29)	86.2	10.3	0.0	3.4
Netball (n=63)	55.6	30.2	6.3	7.9
Walking for exercise (n=134)	56.0	24.6	11.2	8.2
Bicycling (n=37)	78.4	16.2	2.7	2.7
Jogging (n=158)	44.9	36.1	12.7	6.3
Gymnastics/ Aerobics (n=33)	78.8	12.1	0.0	9.1
Swimming/ Water polo (n=32)	50.0	28.1	12.5	9.4
Baseball/ Softball (n=20)	80.0	10.0	10.0	0.0
Dancing (n=97)	60.8	11.3	17.5	10.3
Touch rugby (n=24)	83.3	12.5	4.2	0.0
Squash (n=23)	69.6	21.7	4.3	4.3
Athletics (n=67)	70.1	22.4	7.5	0.0
Soccer (n=35)	80.0	11.4	2.9	5.7
Horse riding (n=26)	46.2	26.9	11.5	15.4
Volley ball (n=17)	70.6	23.5	5.9	0.0
Hockey (n=51)	33.3	41.2	15.7	9.8
Basketball (n=19)	68.4	26.3	5.3	0.0
Ice skating (n=13)	84.6	15.4	0.0	0.0
Cross country (n=27)	77.8	7.4	11.1	3.7
Tennis (n=38)	68.4	18.4	5.3	7.9
Golf (n=13)	00.0	0.0	0.0	0.0
Karate (n=14)	92.9	7.1	0.0	0.0

Figure 4.16 indicates that during a physical education class, more than half of the girls were either always (21.4%; n=48) or quite often (31.7%; n=70) very active. In contrast, 17.4 percent (n=39) of the girls did not take part in physical education classes at all.

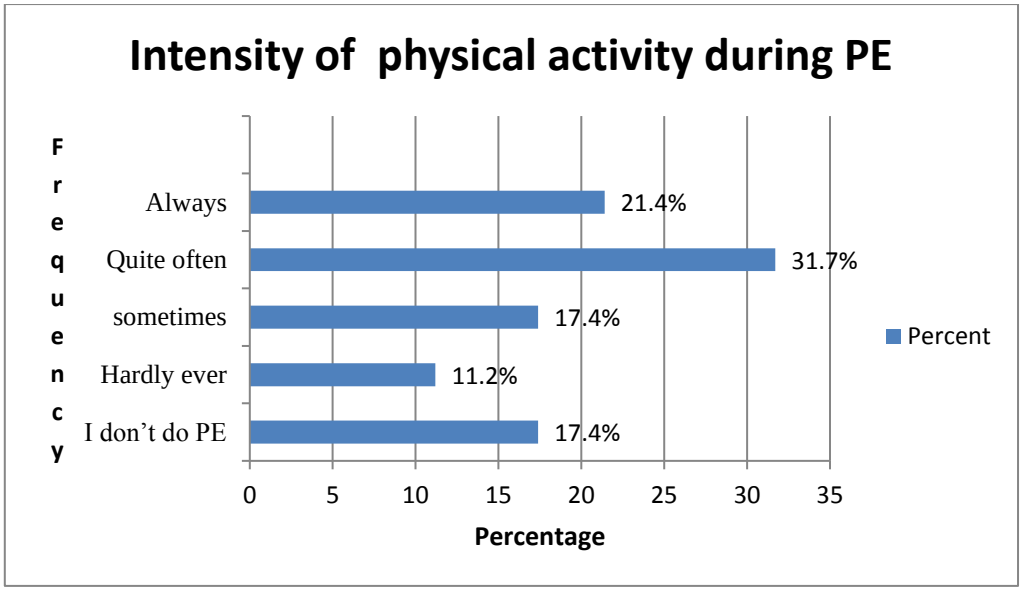

Figure 4.16: During a physical education (PE) class, how intense was the activity the girls are participating in (e.g.: playing hard, running, jumping, throwing) (n=222).

During the lunch breaks the majority (with close to 70%; n=156) of the girls opted to sit and relax during this time, choosing to read or chat with friends as seen in Figure 4.17. A very low percentage of girls (3.1 percent; n=7) participated in physical activity such as running or playing.

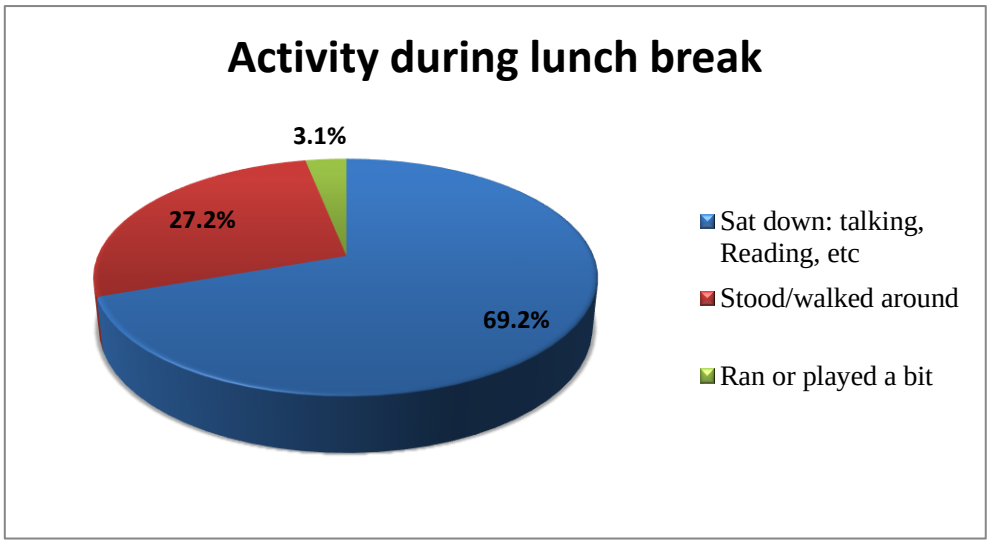

Figure 4.17: Besides eating, what else was done during a normal lunch break (n=223).

The most popular number of times to participate in physical activities after the school day was two to three times per week with 38.8 percent (n=87) of the participants doing so as

seen in Figure 4.18. Collectively, 86.2 percent (n=192) of the girls involved themselves in physical activity such as sports after school, leaving only 13.8 percent (n=31) of the girls who opted not to participate in physical activity.

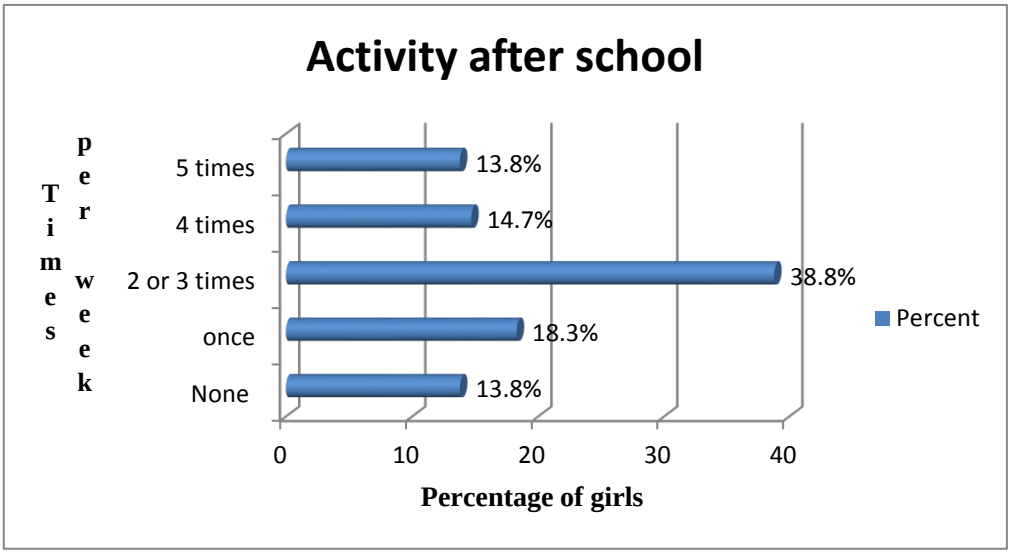

Figure 4.18: Activity levels straight after school has ended per a 1 week period (n=223).

Physical activities performed in the evening, once the participants have left the school premises, proved to be less popular; however, a strong 30.8 percent (n=69) of the girls still participated in additional physical activities in the evenings at least two to three times per week as indicated in Figure 4.19. A combination result of 51.4 percent (n=115), adding up to just over half the girls that participated in the study, were active only once a week or not active at all during the evenings.

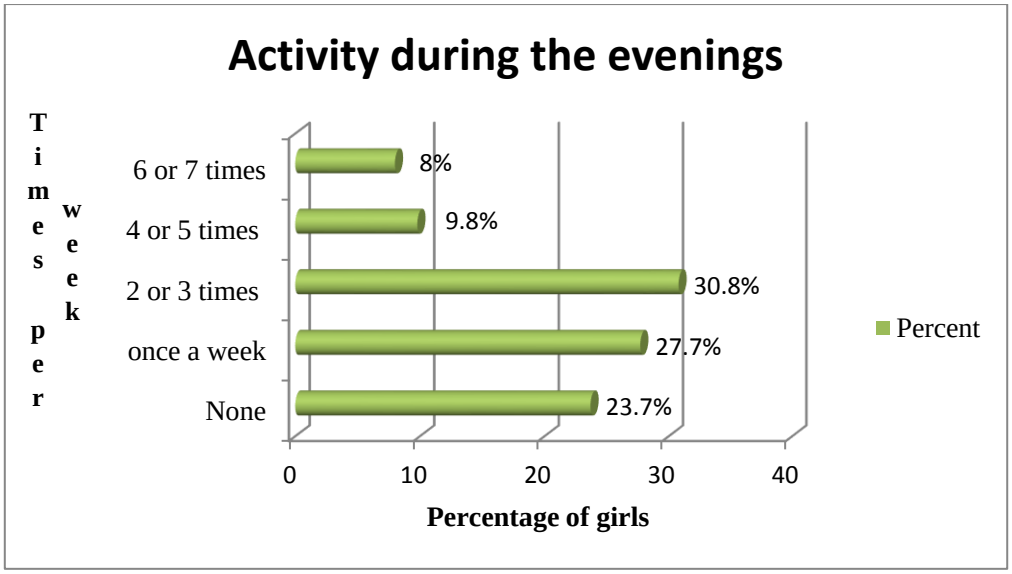

Figure 4.19: How often the girls were active during the evenings (n= 224).

Figure 4.20 shows that the most popular number of times that the girls participate in physical activity on a weekend is two to three times during the Saturday and Sunday period with 33.9 percent (n=76) of the girls choosing this option. Overall, the girls participate in less physical activity during the weekend period with half of the girls (50.9%; n=114) indicating that they are active only once or not at all during the weekend.

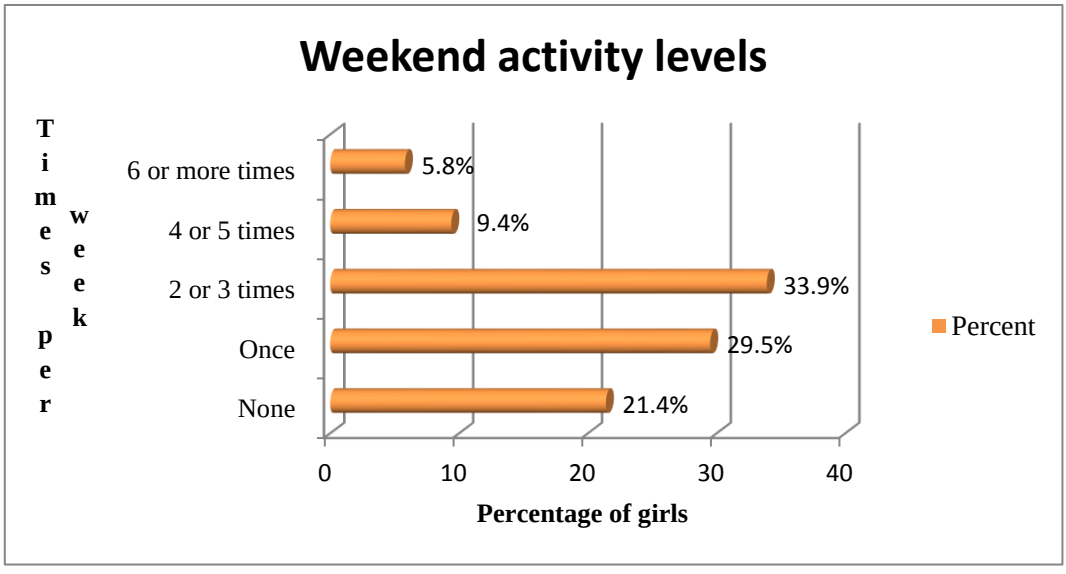

Figure 4.20: How active the girls were on the weekend, for example, doing sport, dance or playing games (n=224).

The girls would describe themselves as 'only sometimes' performing physical activity in their spare time, focusing on one to two activities per week (28.8%; n=64); this is followed very closely by a similar number of girls (26.6%; n=59) indicating that they participate in 'slightly more' activities per week, for example, three or four times during personal free time as indicated in Table 4.22.

Table 4.22: The best description the girls chose to explain a week's worth of activity (n=222).

Description	Percentage of girls
All or most of my free time is spent doing things that involve little physical effort.	15.3
I sometimes (1-2 times per week) do physical activity in my free time.	28.8
I often (3-4 times per week) do physical activity in my free time.	26.6
I quite often (5-6 times per week) do physical activity in my free time.	16.7
I very often (7 or more times) do physical activity in my free time.	12.6

Monday is the most popular day of the week for physical activity to be performed, with 97 percent (n=217) of the girls indicating that they do so as seen in Table 4.23. The girls are also shown to be very active on a Thursday with a 'very often' frequency of 21.7 percent (n=49). The days with the least activity are Friday and Sunday.

Table 4.23: Frequency of exercise done on each week day (n=224).

Week day	Frequency				
	None (0-40 min)	**Seldom (60-120 min)**	**Sometimes (180-240 min)**	**Often (300-360 min)**	**Very often (420 min +)**
Monday (n=216)	30.6	16.2	19.4	17.1	16.7
Tuesday (n=214)	18.2	17.3	20.6	24.3	19.6

Wednesday (n=210)	21.4	13.8	21.0	24.3	19.5
Thursday (n=207)	22.2	15.0	17.9	23.2	21.7
Friday (n=197)	39.1	20.8	11.7	15.7	12.7
Saturday (n=212)	24.5	24.5	18.4	17.9	14.6
Sunday (n=198)	43.9	23.7	14.6	11.1	6.6

Min = Minutes

Table 4.24 indicates that of the girls who participated in less activity than what is considered usual in a normal week, 25.8 percent (n=58) informed that there was a reason for the under-performance of physical activity such as sickness, exam scheduling or personal injury. The remainder of the girls (74.2%) indicated that this was the usual level of physical activity that they would perform.

Table 4.24: Was there a reason for personal goals for physical activity levels not being met (n=224)?

Option	Percentage of girls
Yes	25.8
No	74.2
Reason recorded	Sick, Exams, Injury

According to Table 4.25, the most popular number of minutes spent dedicated to physical activity is 90 minutes per week with 28.8 percent (n=64) doing so. This was followed closely by 210 minutes per week with 26.6 percent (n=59) of the girls spending this amount of time on physical activities. The most physical activity minutes (450) is the amount least participated in with only 12.6 percent (n=28) of the girls choosing this option. The mean average of minutes completed by the girls is 199.64 (SD±134.97).

Table 4.25: Number of minutes of physical activity performed per week (n=222).

Minutes per week	Frequency	Percentage
40	34	15.3
90	64	28.8
210	59	26.6
330	37	16.7

450	28	12.6
Total	222	100.0

4.7 Correlations

According to Table 4.26, the most significant correlation is between BMI and physical activity (sport) done over a one week period with a p=0.002 and r=0.202 and BMI and the number of minutes of physical activity (sport) performed per week with a p=0.005 and r=0.188. A significant correlation is also seen between BMI and sport on the weekend with a p=0.041 and r=0.137 as well as BMI and the amount of money spent on food per month with a p=0.160 and r=0.016. None of the other variables correlated had a significant relationship as seen in Table 4.26.

Table 4.26: Relationship between BMI-for-age, socio-demographic variables and physical activity levels identified through the Spearman's rho correlations.

Variable	Relationship (*r*-value)	Significance (*p*-value)
BMI and how many meals were eaten per day	0.004	0.952
BMI and how many children in the household	0.058	0.389
BMI and total income per month	0.005	0.945
BMI and amount spent on food per month	0.160	0.016*
BMI and sport after school	0.078	0.244
BMI and sport in the evening	0.090	0.178
BMI and sport on the weekend	0.137	0.041*
BMI and physical activity (sport) done over a one week period	0.202	0.002**

BMI and number of minutes of exercise per week	0.188	0.005**
BMI and energy intake	0.035	0.601
BMI and carbohydrate intake	0.005	0.939
BMI and protein intake	0.074	0.267
BMI and fat intake	0.053	0.431
Total income per month and energy intake	0.004	0.949
Energy intake and amount of food spent per month	0.011	0.875
Meals eaten per day and total income	0.088	0.191
Children per household and total income per month	0.024	0.726
How physically active in one week and energy intake	0.021	0.759
Number of minutes of exercise per week and how many meals eaten per day	0.054	0.423
Number of minutes of exercise per week and energy intake	0.002	0.975

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

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

<0.001 = Extremely significant

0.001-0.01 = Very significant

0.01-0.05 = Significant

>0.05 = Not significant

4.8 Discussion

The data collected in this research illustrates the nutritional status, dietary intake and physical activity levels of girls aged 13-18 years attending a private school in Durban. A socio-demographic questionnaire was used to collect general information about the girls' living

conditions. This revealed that the girls came from an adequate, and even above average, socio-economic background, were food secure and predominantly came from suburbs in the upper highway area, namely Kloof, in KZN. Taking into consideration that the KZN province is among the most poverty-stricken areas in South Africa with almost 58.5 percent of the province's population falling victim to poverty (Armstrong, Lekezwa, and Siebrits 2008), this particular school indicates a vast contrast of socio-economic status in KZN. A low number of permanent residents per household, averaging between three to five members, suggests a greater wealth distribution per members of the household. With only two children per household being the most common statistic, supporting the dependants becomes more manageable for the parents/ caregivers with fewer mouths to feed and fewer education fees to pay (Córdova 2008: 5).

The information given by the parents/ caregivers showed that they have a high employment rate (93.8%) and a good income status across the board with a majority income (72.8%) greater than R20 000 per month. This amounts to a much higher figure than the national monthly income average for South Africa, which is recorded to be only R3 897. This indicates the families are in a wealthy income bracket compared to what is considered normal (Writer 2016). The findings also indicated that 94.6 percent of the participants used their own cars to take their children to school or work or go shopping.

Education levels among the parents/ caregivers were of a high standard with 74.5 percent having tertiary education either from a university or college. High education levels among heads of households can also indicate food security with strong correlations seen in an American based study between education levels and a better employment rate in turn resulting in higher income, gaining of personal assets such as cars and generally better living conditions (Córdova 2008: 5 and Armstrong *et al* 2008). As most of the participants within this study lived in an urban environment, it is most likely that their parents had access to higher paying employment opportunities than those living in rural communities, thereby ensuring that the parents/ caregivers were able to effectively sustain their current living conditions (Montgomery 2008: 761).

Sixty-eight percent of the girls indicated that the father was the head of the household. Yet when it came to meal preparation, the amount of money spent on food and the type of food

bought, the mother clearly featured as the one responsible for this. A worldwide study by UNICEF (2007b: 8) reported that when women are involved in food purchasing, a greater influence can be exerted on the family's overall health. Within this study, the parents indicated that the total amount of money spent on food was mostly above R5000 per month, which meant that almost 25 percent of the household's total income was being spent on food per month. This is much more than what is indicated in the income and expenditure survey by Statistics South Africa (SSA 2013), estimating that 12.8 percent of total household income is being spent on food and non-alcoholic beverages per month.

The above average amount of money spent on food and the wide variety of foods consumed by the girls suggests that quality, fresh food items were bought for their meals. According to UNICEF (2009: 38) socio-economic conditions influence the nature of the diet as well as the quality of foods bought. The freshness of the foods can be supported by answers given in the questionnaire stating that the purchasing of food was done predominantly (80.4%) on a weekly basis at supermarkets. Most meals, averaging about three to four meals per day, were consumed in the home environment. This is in contrast to statistics that indicate that one in every two households in South Africa experience hunger and only one in every five households are actually food secure (Labadarios *et al* 2008: 259). This reaffirms the fact that the girls come from a wealthy home environment where food insecurity is almost nonexistent, and this is confirmed by 87.1 percent of the participants saying that there is always enough money to purchase food every month. It can thus be concluded that an adequate amount of well-prepared quality meals was provided for the girls.

This study provided an overview of the girls' daily food intake. In contrast to the anthropometric data collected, which indicated that the majority of the girls were of normal weight and some overweight and even obese, almost 85 percent of the participants did not meet the recommended EER for energy (9 946kJ for healthy active individuals) with a low mean intake of 7751.7kJ per day. This is similar to comparative findings by Steyn *et al* (2016) on school children's (6-15 years) dietary intake across South Africa where a low mean EER was identified, with all studies falling below the recommended EER. The 24-hour recall questionnaires identified that most of this energy was coming from higher sources of fat (34.6%) and moderate sources of proteins (17.2%). Compared to recommended ranges by the IoM, fat was borderline at the higher end of the normal intake range of 25-35 percent

and an average middle range intake was derived from the suggested 10-30 percent of protein. The girls ate within the normal range for carbohydrates, being 45-65 of total energy; however, it is at the lower end of the normal range with 48.2 percent of carbohydrates being consumed (NICUS 2003). When looking at the top 20 foods consumed by the girls, whole milk is the number one consumed food, with other fat and protein sources such as cheese, whole yoghurt, lean chicken and bacon shown as possible contributors to the high fat and protein sources of energy.

According to a South African based study, cheese, bread and fruit are among the most popular foods eaten and appeared in more than 50 percent of urban based adolescents' packed school lunches. A similarity can be seen in the girls' top twenty favourite foods with fruit appearing three times and bread and cheese staying within the top ten most frequently consumed foods (Feeley *et al* 2012). Having said that, the girls' calcium intake was found to be low, at 625mg mean intake (SD±292.06), which is far less than the recommended AI of 1300mg, making 97.3 percent of the girl's calcium deficient. This finding was unexpected considering that several calcium rich foods appear within the top twenty foods recorded, such as milk and yoghurt, which are commonly known high sources of calcium (Fukagawa 2015: 48). This suggests that the girls are consuming inadequate amounts of calcium rich foods as the mean per frequency intake of milk is an extremely low amount of 89.2g. These findings are confirmed in a United States study by Duyff (2012: 89) stating that a low consumption of milk, fruit and vegetables is associated with low calcium, vitamin A and vitamin C intakes.

This, too, can be seen in a South African based study (Mchiza *et al* 2015) where even though milk appeared within the top ten consumed food items among woman, calcium and vitamin D were recorded to be far below the recommended DRIs. Mchiza *et al* (2015) looked at dietary preferences of South African women which identify sugar, tea, maize porridge, oil and bread to be the top 20 food items consumed. When comparing this to the girls within this study, the presence of higher cost food items such as cheese and yoghurt indicated the difference that income can make on food preferences. The absence of low cost items on the girls' top 20 foods such as maize porridge and oil also supports this.

The mean intake of vitamin C was adequate but 27.2 percent of the girls did not meet the recommended EAR (56mg) and 25.8 percent of the girls did not meet the EAR (485µg) for vitamin A even though vitamin A was statistically significant (p=0.000) between the NAR and the DDS for one day's consumption of food recorded. The girls displayed a magnesium deficiency with 83 percent not meeting the EAR (300mg), only averaging a mean of 239.1mg (SD±81.44). Magnesium plays an important role in skeletal strength, nerve functioning, muscle repair and prevention of cramping, which may be a cause of less physical activity being performed per week. Although this is less likely to happen often at the younger age of adolescents, it could still occur in highly active individuals. It is also closely associated with the functioning of calcium in the body, possibly linking the two deficiencies found among the girls (Jahnen-Dechent and Ketteler 2012: 3).

Folate was also found to be deficient with a high 82.1 percent of the girls not meeting the 330µg EAR and falling just under with a mean intake of 248.9µg (SD±127.96). This is also evident at a national level for South Africa, as indicated in the NFCS of 2005 where a folate deficiency was reported. One of the recommended ways of combating folate deficiency is through supplementation (Labadarios *et al* 2008: 263). Thirty-three percent of the girls who participated in the study took supplements daily. A general multivitamin, which did contain a small amount (9µg per tablet) of folate, was most popularly taken by 27.8% (n=62) of the girls; however, this trace amount along with inadequate levels through food intake was still not enough to meet the daily requirement. This study showed that a higher DDS presented a higher nutrient intake, and this shows the importance of a diverse diet and a possible way to increase nutrient intake levels without supplementation. Vitamin C tablets were taken by 13 percent (n=29) of the girls and Omega 3 tablets were taken by nine percent (n=20) of the girls as a daily supplement as well as a multivitamin, which may have contributed to the overall nutritional wellbeing of the girls which enabled them to perform physical activities.

Although the carbohydrate intake was adequately reached by the girls with an average mean intake of 200g, when looking at the top 20 foods eaten by the girls, there was only one true source of carbohydrate, that is, bread, identified within the top five foods. The only other possible source of carbohydrate, although contributing much smaller amounts, may have come from the twentieth top 20 food item being the starch-based vegetable, butternut. However, in terms of the amount consumed per item and the frequency at which each item

was eaten, the foods were found to be consumed in very small and even inadequate amounts, which may have contributed to the overall low energy intake of the girls. Sugar (7.6g mean per frequency consumed; n=146) is the second most frequently eaten food and sugar-based carbonated drinks (331.2g mean per frequency consumed; n=50) are in twelfth place in the top 20 foods consumed, which all contribute to the high sugar intake mean of 9.5 percent of total energy. This high sugar intake is similar to but not as extreme as national statistics on American children who consumed 15 percent of total energy purely from sugar-rich food sources (Munoz, Krebs-Smith, Ballard-Barbash, and Cleverland 1997). This finding reflects the average South African intake as reports conclude that adolescents' sugar consumption is close to 100g of sugar per day, which represents 10 percent of their total energy (Steyn and Temple 2012).

The findings also showed that the girls were eating far less than the recommended daily intake of fruit and vegetables of ≥400g, consuming nearly half the suggested amount and consuming only 293.1g per day. This could also account for the poor intake of dietary fibre (AI 26g) with a lesser amount of 18.2g per day. However, when looking at the food variety score of the girls, a score of greater than 60 different foods from seven to nine different food groups was consumed over a period of seven days. In contrast to the indicated poor intake of fruit and vegetables, the groups with the most variety of foods consumed by the girls is 'other vegetables' (a non-vitamin A rich source of vegetables with a mean of 8.1) followed closely by 'other fruits' (a non-vitamin A rich source of fruits with a mean of 7.4).

Again, as also seen for total energy consumption by the girls, inadequate amounts of fruit and vegetables are being consumed even though a high food variety score was identified. This subsequently leads to a less than recommended total dietary fibre intake, as it is advised that higher volumes of fruit and vegetables should be consumed to meet recommended dietary fibre levels (Liu 2013: 384 and Voster *et al* 2013). The DDS as compared to the NAR for one day's intake of food consumed by the girls revealed statistical significance between the DDS and various important nutrients, vitamin A (p=0.000), vitamin C (p=0.022), folate (p=0.005), energy (p=0.009), protein (p=0.000), zinc (p=0.000) and calcium (p=0.001). This indicated that the more diverse the diet was, the better the chance of increasing nutrient intake levels. When comparing the one day DDS and the seven day FGDS, a very varied diet (8.6) can be seen over seven days but for one day, an average diversity (5.5) is seen.

With reference to the socio-economic status of the girls' parents/ caregivers, the high-income status and money spent on food per month contributes to the high food variety eaten by the girls with 70.9 percent (n=158) of the girls eating from all nine food groups over seven days, which can be described as a healthy diet. When looking at the dietary diversity score (DDS) for one day, the girls scored a mean of 5.5 which is higher than the South African mean of 4.02 and furthermore, higher than the mean of KZN (3.97) (Labadarios *et al* 2011). Canadian and United States (US) based studies have well documented the positive relationship between family income and children's health especially in the case of adolescents (Case, Lubotsky, and Paxson 2002: 1310 and Currie and Stabile 2003: 1813). What is not accounted for in this study, however, is how little of the food in grams is being consumed by the girls, suggesting that even though money is not an issue when it comes to purchasing wide varieties and volumes of food, the girls are personally choosing to consume smaller portions of each food item.

This could be an indication of a possible underlying mental health disorder such as anorexia which is said to be very common among contemporary adolescent girls (Bhutta *et al* 2015: 3). This is also supported by the weight-for-height and BMI results of the girls, which was 12.6 percent (n=28) being underweight and was of a larger percentage than the girls in the overweight category (10.3% (n=8)). French based studies on under-reporting of food intake indicated that the girls surveyed stated that 'they wished to weigh less' (Lioret, Touvier, Balin, Huybrechts, Dubuisson, Dufour, Bertin, Marie, and Lafay 2011: 1672). However, anthropometric data does not correlate with the amounts of food being eaten in terms of macro- and micronutrients. The majority of the girls appeared to be of normal weight with no thinness or stunting thus suggesting either over-reporting with reference to food variety or under-reporting the amount of food that is actually being consumed.

The nutritional status of the girls was determined using two different nutrition indicators such as BMI-for-age and height-for-age with use of the relevant age of the group in conjunction with the WHO growth indicators presented as *z*-scores. The collective result summary of the participants found that a large majority of 99.6 percent of the girls were of normal height-for-age (≥-2 to <+3SD) and only showing one girl to be stunted (<-2SD). BMI-for-age indicating thinness or wasting showed that a positive figure of 77 percent of

the girls were of normal BMI-for-age (≥-2SD and <+1SD) but, however, also highlighting that a high 17.1 percent of the girls were at risk of becoming overweight (>+1SD) as well as a further 5 percent of the girls showing the risk of becoming obese (>+2SD) according to the World Health Organisation's anthropometric classification data for children (WHO 2008b). When compared to WHO's child growth standards for children aged 13-18 years, both the girls' BMI-for-age and height-for-age were almost exactly in line with normal green line readings.

When looking at the BMI categories determined by WHO, the majority of the girls were found to be of normal BMI with 72.2 percent (n=161) but what is surprising is the higher number of underweight (12.6%) girls as opposed to overweight girls (10.3%). When comparing the underweight status of the sample group to the latest SADHS results of adolescent girls (15-19 years), it can be seen in the current study that girls from higher-income households are almost double in number compared to the underweight category (12.6%) than the South African national result of 6.7 percent (Stats SA 2017:45). The mean BMI also indicates a lower average (21.9) than the latest South African statistic on adolescent girls (23.7) (Stats SA 2017:45). For the overweight categories for this study, the results were lower than the results of the South African national health and nutrition examination survey (SANHANES) (Shisana *et al* and SANHANES-1 Team 2013), where 19.3 percent of children aged 15-17 years were classified as being overweight compared to 10.3 percent of the sample group of girls in this study that were overweight. This is also considerably lower than the SADHS results of 27 percent of adolescent girls recorded currently to be overweight in South Africa (Stats SA 2017:45).

The results for obesity are similarly lower with eight percent of South African children classified as obese (Shisana *et al* and SANHANES-1 Team 2013) and SADHS 2016 results showing 10.9 percent of adolescent girls (15-19 years) as being obese whereas only 3.6 percent of the study's sample group were found to be obese. A few girls (0.9% (n=2)) fell within the class 2 obesity and class 3 morbidly obese (0.4 (n=1)). Girls in particular show that they are more prone to overweight and obesity according to the SANHANES study (Shisana *et al* and SANHANES-1 Team 2013). However, when looking at the nutrition intake of the girls as measured by the 24-hour recall, the girls were not meeting energy requirements through food that was indicated to be consumed. This is also reflected in the

surprisingly larger number of underweight participants compared to the number of overweight participants. There was also a significant correlation between BMI and the amount of money spent on food per month.

The results of normal weight, height and BMI being identified despite energy requirements not being met may suggest that under-reporting and/ or over-reporting of food has occurred, resulting in distorted findings. A Slovenian study focusing on under- and over reporting of energy intake in adolescents, showed that 27 percent of the girls under-reported food intake and over-reporting occurred in 11 percent of the adolescent girls. In this same study, very similar results were found in respect of a higher fat and protein intake and a slightly lower carbohydrate intake with under-reporting being linked to the carbohydrate group (Kobe, Krzisnik and Fidler Mis 2012: 574). Studies on French children confirm this with children aged 11-17 years under-reporting by 26 percent with higher contributions of energy from protein reported and much lower contributions from simple carbohydrates (Lioret *et al* 2011:1671).

High sources of fat for energy may account for extra body fat stored, resulting in small cases of higher BMI and indicating some girls to be overweight and obese. In a contrasting study, Okorodudu, Jumean, Montori, Romero-Corral, Somers, Erwin, and Lopez-Jimenez (2010: 791) found that the moderately high protein food intake identified in the 24-hour recall and FFQ, together with the wide variety of physical activities performed by the girls, may result in much higher lean muscle mass which results in the body weighing in at a much heavier weight even though body fat percentage may be normal or even lower than average. The BMI formula, although best used as a nutrition indicator in children, does not take into consideration the composition of the body weight it is recording thus resulting in slightly distorted data with regard to highly physically active individuals. This can be seen in the results of a US obesity and BMI study where BMI was concluded to have a low sensitivity to adiposity resulting in more than half of the participants incorrectly categorized (Okorodudu *et al* 2010: 791 and WHO 2009: 2).

When looking at the physical activity levels of the girls, a wide variety of sports were performed each week. Horse riding and dancing were participated in seven or more times a week, both of which require considerable energy to be exerted. Jogging and walking for

exercise was done by a large majority of the girls at least twice a week showing that a conscious effort is being made to do some exercise for health purposes. On average the girls performed exercise two to three times (45-60 minute sessions) per week either straight after school, in the evenings or on the weekend, adding up to 199.64 minutes per week of purposeful physical activity. This is considerably lower than the WHO's recommended 420 minutes per week, or 60 minutes per day, of moderate to vigorous intense physical activity daily for children aged 5-17 years (WHO 2010b: 17). Similar results can be seen in the South African Youth Risk Behaviour Survey where one in two learners participated in sufficient levels of vigorous physical activity per week (Reddy *et al* 2008: 203).

With regard to inactivity, only 15.3 percent of the girls chose to do very little physical activity and may be classified as inactive. When compared to a Western Cape study of high school-going adolescent girls, a much higher percentage was found to be inactive with 32 percent being classified as inactive (Frantz 2006: 73). The girls, as a whole, may not be meeting WHO physical activity standards yet a variety of different sporting activities are performed weekly. The BMI of the participants mostly appears to be normal and even slightly higher with some girls being considered overweight and this may be due to the significantly strong correlation identified between BMI and the number of sporting activities done in one week (p=0.002) as well as the number of minutes dedicated to physical activities per week (p=0.005). This correlation can be confirmed by studies in the North-West province, which indicated that women who performed physical activity were less likely to be overweight or obese (Kruger *et al* 2002).

The girls spent evenings and weekends dedicating the same amount of time to physical activity as they did during school time or straight after school, suggesting that physical activity is initiated within the girls' personal time and, it can be assumed, for health benefits and/or improving on the skills of the sporting activity in question. Studies also indicate that it is not only the amount of time spent participating in physical activity that is important but rather which activity is being performed such as cardiovascular or strength and flexibility training that makes a substantial difference when building lean body mass as well as contributing to a long-term healthier cardiovascular profile, higher peak bone mass and less occurrence of injury than inactive children and thus increasing overall nutritional well-being (Boreham and Riddoch 2001: 916). A significant correlation can be seen between BMI and

sporting activities performed on the weekend (p=0.041). The extra time spent performing non-school related physical activities within personal time may even have an effect on the girls' nutrition status.

The general findings suggest that the girls' nutrition status is affected by the amount of physical activity performed each week. The majority of girls can be described as being of adequate good health across all nutrition indicators despite a lower than recommended intake of total energy. Most of the energy comes from carbohydrate based foods and adequate protein is eaten with slightly higher consumption of fat rich food items. Fruit and vegetable consumption is reported to be low. Supplementation is taken by a small percentage of the girls which may contribute to their overall nutritional well-being. Among the top twenty foods consumed, milk, sugar, bread, tea and lettuce were the top five respectively. Although a wide variety of foods was consumed across all nine food groups, the quantity of foods consumed was not of a substantial amount, leading to poor total energy consumed and some micronutrient levels not being met such as calcium, magnesium and folate.

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusion

The adolescent girls in the study were from households that enjoy above average living conditions with few family members to support. There was a high education level and employment rate among the parents/ caregivers resulting in a higher monthly income than the national average. This then accounts for the amount of money that was spent on purchasing food every month. The girls were noted to always have access to sufficient food and ate several meals per day. Dietary intake revealed that the girls' diets had a high food variety with anything from 14-83 different food items being eaten within a week. This shows that the girls are consuming a substantial variety of different types of food items which should expose the girls to more diverse sources of macro-and micronutrients. However, the nutrient analysis showed deficiencies in total energy intake. Calcium was identified as the most deficient micronutrient and low levels of dietary fibre, magnesium, selenium, folate, vitamin D and vitamin E were also noted.

This having be said, it was found that three quarters of the girls ate from all nine nutritious food groups every week. In slight contrast, a per day representation of the 24-hour food recall presented a dietary diversity score of 5.5 indicating an average dietary diversity; however, it was still higher than the South African national average of 4.02 (Labadarios *et al* 2011). Increased dietary diversity showed statistical significance with vitamin A, vitamin C, folate, energy, protein, zinc and calcium indicating that from this study, a higher DDS also presented a higher nutrient intake, therefore indicating the importance of a diversified diet. The low total energy intake may suggest that the girls are not eating a sufficient quantity/ volume of food even though a good variety of food items were being eaten daily and this was identified in the top 20 foods consumed. When looking at the distribution of total energy, all macro-nutrients fall within the normal range although fats were border line on the highest point of the normal range.

The girls ate less than half the recommended fruit and vegetable quantities per day, possibly leading to the low dietary fibre count. The top five foods eaten by the girls, in numerical order, included whole milk, sugar, tea, bread and lettuce. Sugar consumption was high and reflected a similar result found in other adolescent girls across South Africa (Steyn and Temple 2012). The top 20 foods eaten by the girls showed evidence of calcium rich foods in the form of whole milk, cheese and yoghurt yet a calcium deficiency was identified, again suggesting that not enough of this food item was eaten. The food items on the top 20 food list contributed mostly to a good protein and carbohydrate consumption with fewer starch based carbohydrates being eaten. An average varied diet was identified on a per day basis; however, over a period of a week, although the girls consumed a varied diet and it was evident that the girls were consuming foods from all the nine nutritious food groups, the amounts recorded to have been eaten were small quantities. The above findings therefore indicted that results may have been subjected to under- or over-reporting by the participants on their dietary intake.

The results illustrated that the majority of the girls were of normal height-for-age (≥-2 < +3SD) and BMI-for-age (≥-2SD and <+1SD). The girls were of normal weight-for-height with 72.2 percent falling within the normal BMI range, which is higher than the national score for adolescent girls (66.3%). The mean BMI was 21.9 which is lower than the national mean BMI of 23.7, which could be the reason why the number of underweight girls was surprisingly large (12.6%), in fact almost double the South African score for adolescent girls (6.7%), and which may be as a result of the lower total energy intake result captured and the small quantities recorded. A significant relationship was identified between BMI and the amount of money spent on food per month.

The girls participated in a wide variety of physical activities with most of the girls choosing to do jogging and walking for the purpose of exercise at least twice a week. A strong relationship was identified between physical activity levels per week and the number of minutes done per week with BMI. On average the girls performed exercise two to three times (45-60 minute sessions) per week totalling 199.64 minutes of purposeful physical activity per week. This is less than half the recommended amount (420 minutes) per week for adolescents, which could explain 10.3 percent of the girls being overweight and 1.3 percent obese. The physical activity levels were found to have a relationship to the nutritional status in terms of the BMI of the girls. Overall, the evidence suggests that girls from high income households have a better

dietary intake and nutritional status than the general South African female adolescent population; however, some nutritional deficiencies were identified.

5.2 Limitations of the study

The data obtained from a private high school represented only one school in the Durban, KZN area and the data is unique to the school involved and the direct surrounding community from which the participants came. The three 24-hour recall interviews were conducted on one day due to time restrictions. The girls had to recall what they had eaten three days previously and this may have led to over- and/or under- reporting. The Food Finder® Version 3.0 software may not include all fortified foods eaten by the girls such as specific meal replacement supplements or imported energy bars.

The results of this study cannot be extrapolated or generalized to apply to the entire Durban area because the sample was limited to adolescent girls attending one private high school. However, an inadequate consumption of certain micronutrients was found in this population. Taking this into consideration, it is possible that nutrient intake inadequacies may also be prevalent among girls in similar circumstances within the general Durban population.

Participants had the option to leave blank questions that they did not feel comfortable answering. Consequently, there are a few missing systems and some questions have different total sample sizes. However, all the questions indicate the number of girls that answered the particular question and all the results are in relation to the correct sample that participated.

5.3 Recommendations

5.3.1 Policy makers/ governmental departments

Nutrition interventions addressing the special nutrition needs of growing adolescent girls could be used as a course of preparation for maturing the girls into well-nourished women. These interventions, such as better food choices being made available at schools or nutrition education classes, should be adapted for higher income households where specific nutrients in foods that are more familiar to the adolescent children in this income bracket can be identified. Specific nutrient breakdowns of macro- and micronutrients that were identified as being deficient, such as calcium, could be communicated, or made known, together with the exact daily quantities

required to be consumed so as to have a beneficial impact on nutrition intake. These interventions should be targeted not only at adolescent girls but also at the mother figure of the households as it was identified that food purchasing and preparation was the responsibility of this family member. Similar interventions can already be seen to be in place for lower income families; however, the language level used in these existing interventions may not be appropriate for higher income, well-educated individuals.

Portion control was identified as being a possible cause of the deficient macro- and micronutrient intake by the girls. It may thus be helpful if the Department of Health distributed handbooks on general nutrition to all schools in lower income communities as well as higher income schools. Nutrition handbooks indicating exact portion sizes and specific food items in ways that can be readily understood by high school-going adolescents of any income level would be beneficial; for example, having a physical representation of the food as well as a recognisable measuring utensil such as a measuring cup or bowl of the correct portion size and including the exact weight of a portion in grams or millilitres would be most helpful. Most high-income households would probably have access to a kitchen scale on which the correct recommended quantities of food can be measured. This handbook could be taken home and shared with the family and the preparer of meals; education would thus effectively be extended into the home environment.

5.3.2 School governing bodies

The inadequate quantities of food being consumed by the girls may be the result of the girls' inability to determine correct portion sizes. It is recommended that the food server within the school should serve correctly predetermined quantities/ portions of food for the girls. This would then ensure that each girl choosing to eat at school gets the correct amount of nutrient rich food on her plate. This assumes that the girls will eat the full recommended portion on their plates.

Extra lesson time should be allocated to addressing adolescent girl-specific insecurities, the importance of food as fuel for both the body and the mind, and the theory behind the importance of incorporating physical activity into an adolescent's lifestyle and the positive impact it would have. For example, the theory behind the importance of increasing muscle targeted physical activity is that it decreases the percentage of extra body fat whilst increasing bone strength and

toning the body. Feeling good about one's physical appearance can encourage one to choose to eat a healthier nutrient dense diet to fuel the muscles. Healthy living education could be integrated into different subjects by educators which may lead to some of the content being remembered and incorporated into the girls' everyday routine.

An eating guide could be developed to cater for the specific needs of the participants in question, for example, one that has inspirational meal ideas, including lunch box meal plans and recommendations for snacks and dinners. It should also be a comprehensive guide to choosing superior nutrient-dense food options and eating foods in correct portion sizes with special emphasis on addressing the importance of consuming a sufficient quantity of wholesome foods such as fruit and vegetables and highlighting how necessary it is to have an adequate intake of dietary fibre intake meeting micronutrient requirements.

Physical activity levels were identified as being insufficient, and were much lower than the recommended weekly amount for adolescent girls. It is recommended that fitness clubs be started in schools as part of the extracurricular programme where girls can be given credit for participating in conventional sports. Non-competitive learners may feel intimidated by conventional sport types and the pressures of participating in a team and may thus not want to participate. Instead, a fitness club could be established to encourage exercising for health, where each girl has personal fitness goals to achieve and this activity could be recognised by the school as an extracurricular activity in which all the girls have to participate. Muscle training rather than just cardiovascular-related activities could also be focused on. If less pressure was placed on individuals who are not interested in sport it may actually encourage their participation in physical activity and, in time, also their level of physical activity.

5.3.3 Future research

This study indicated that supplementation plays a much bigger role in the diet of high income adolescent girls than was anticipated. It is thus recommended that supplements in the form of tablets or in other forms, that could be readily taken by adolescent girls as well as food products that are heavily fortified, such as meal replacements, sports tonics, protein bars etc. be investigated. These supplements were not taken into consideration when conducting the nutrient analysis due to the analysis programme not identifying these specialised food items. It is recommended that the diets of parents/ caregivers as well as their nutrition knowledge be

investigated. The mother figure was identified as the figure mostly dealing with food eaten by the girls hence all decisions are based on the knowledge and eating habits of these parents/ caretakers. Fad diets such as the Banting diet, which many South African see as a healthy alternative way of eating, may in fact provide ideal eating patterns for children and adolescents.

To ensure a more accurate investigation of the nutrient analysis of the girls, biochemical testing such as blood analysis should be considered. This method of testing would interpret the role of supplementation in high income adolescent girls' nutrient intake more accurately. A review of the kind of food served in school canteens and sold at tuck shops will give a better understanding of the food options available to the girls on a daily basis in the school environment. Testing of community support programmes or inter-school based interventions to increase physical activity levels could also be investigated. Further research on the nutrition status of adolescents from high income families should be conducted as there is a paucity of information in South Africa regarding this group. It is recommended that more studies be conducted at other high schools of a similar status around the country in order to establish whether the findings of this study apply to a wider sample of adolescent girls. The reliability of the data collected was entirely dependent on the participants' disclosure.

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Annexure A

22 May 2014

IREC Reference Number: **REC 22/14**

Ms R Watson
P O Box 51419
Westmead
Pinetown

Dear Ms Watson

Relationship between physical activity and nutritional status of adolescent girls attending an elite private school within KZN

I am pleased to inform you that Full Approval has been granted to your proposal REC 22/14.

The Proposal has been allocated the following Ethical Clearance number **IREC 033/14**. Please use this number in all communication with this office.

Approval has been granted for a period of one year, before the expiry of which you are required to apply for safety monitoring and annual recertification. Please use the Safety Monitoring and Annual Recertification Report form which can be found in the Standard Operating Procedures [SOP's] of the IREC. This form must be submitted to the IREC at least 3 months before the ethics approval for the study expires.

Any adverse events [serious or minor] which occur in connection with this study and/or which may alter its ethical consideration must be reported to the IREC according to the IREC SOP's. In addition, you will be responsible to ensure gatekeeper permission.

Please note that any deviations from the approved proposal require the approval of the IREC as outlined in the IREC SOP's.

Yours Sincerely

[redacted]

Prof J K Adam
Chairperson: IREC

Annexure B

PRINCIPLE LETTER OF INFORMATION

Dear Principle Manley

Thank you for your consideration in taking part in my Masters Research study.

The title of my study is as followed:

"The relationship between the physical activity and nutritional status of affluent adolescent girls (13 -18) attending an elite private school within KZN"

Principal investigator / researcher

I, Roxanne Watson, (qualification; B-Tech: Consumer Science Food and Nutrition) will be the main researcher within this study and will be under the supervision of Professor Carin Napier, (qualification; D-Tech Food Service Management).

Studies on the nutritional status of children and adolescents is highly important to contributing towards data collections that is used to improve education systems, developing intervention programs and increase the nutritional well being of communities. South Africa has extensive research on poorer communities and the information uncovered has done wonders in addressing identified problems. However when searching for nutritional status of more affluent communities members; there is a large gap in information.

By taking part in this study, you would be assisting in filling this gap of unknown information and would be contributing to the increase of nutritional knowledge on a national level. This helps in better understanding different communities within South Africa from which specific programs and interventions can be created to address any problems identified. I feel that affluent communities have been slightly neglected in the past and should have an equal chance of being studied and addressed. The World Health Organisation (WHO) indicates that more studies need to be done on adolescent girls to assist in the uplift of a healthy generation of woman for the future.

For this study to be viable, a sample group of 220 girls need to be assessed. It is greatly stressed that all information collected will be private and confidential. Ethical clearance has been granted from Durban University of Technology. The final results of this study will be shared with Durban University of Technology for research purposes only.

What will it involve?

Each girl that participates will be

- Ask to sign a consent form, agreeing that they are willing to take part in the study.
- Asked for their parent/ guardian to sign consent.
- Weighed and height measured to indicate a Body Mass Index (we will not ask to remove any clothing except for shoes and jerseys).

- Will be asked to complete the following:
- Socio-demographic Questionnaire.
- Physical Activity Questionnaire.
- Food Frequency Questionnaire which determines food diversity.
- 24 hour recall (two times week days and one weekend day).

This should take approximately 15-20 minutes of the participants time and will only be done once off. It is important to note that this process will not be disturbing the academic schedule and we are more than willing to negotiate appropriate times and dates that are best suited for the high school, pupils and academic schedule.

Please note the following:

- Participation is voluntary and you can withdraw at any time with no penalty.
- No payment will be given to any participants.
- It won't cost anything to participate in this study.
- No names will be mentioned and only statistical numbering is used.
- This is a non invasive study therefore no injuries to be expected.
- If any nutrition related quarries do arise from a pupil, we will be more than welcome to assist them after the data collection is complete.

Signing this consent form will allow the researcher and the assistant fieldworkers to conduct studies amongst the high school girls on the school premises permitting that the girls are willing to partake and the parents gave informed consent.

For any questions or concerns please feel free to contact my supervisor or our Ethics committee.

Your participation would be greatly appreciated and will contribute considerably in understanding the nutritional well being of the community we live in.

Thank you and warm regards

Roxanne Watson

Persons to Contact in the Event of Any Problems or Queries:
Researcher: Roxanne Watson
Researcher contact: 084 751 7813 roxiwatson81@gmail.com
Supervisor: Prof. Carin Napier
Supervisor contact: 031 373 2326 carinn@dut.ac.za
The Institutional Research Ethics administrator: 031 373 2900.
Complaints can be reported to the DVC: TIP, Prof F. Otieno on 031 373 2382 or dvctip@dut.ac.za.

Annexure C

DUT DURBAN UNIVERSITY OF TECHNOLOGY

INSTITUTIONAL RESEARCH ETHICS COMMITTEE (IREC)
CONSENT

Statement of Agreement to Participate in the Research Study:

- I hereby confirm that I have been informed by the researcher, **Roxanne Watson**, about the nature, conduct, benefits and risks of this study - Research Ethics Clearance Number: 033/14,
- I have also received, read and understood the above written information (Participant Letter of Information) regarding the study.
- I am aware that the results of the study, including personal details regarding my sex, age, date of birth, initials and diagnosis will be anonymously processed into a study report.
- In view of the requirements of research, I agree that the data collected during this study can be processed in a computerised system by the researcher.
- I may, at any stage, without prejudice, withdraw my consent and participation in the study.
- I have had sufficient opportunity to ask questions and (of my own free will) declare myself prepared to participate in the study.
- I understand that significant new findings developed during the course of this research which may relate to my participation will be made available to me.

[redacted]	30 May 2014	9:00	[redacted]
Full Name of Participant	**Date**	**Time**	**Signature**

I, **Roxanne Watson**, herewith confirm that the above participant has been fully informed about the nature, conduct and risks of the above study.

[redacted]	30 May 2014	[redacted]
Full Name of Researcher	**Date**	**Signature**
[redacted]	30 MAY 2014	[redacted]
Full Name of Witness (If applicable)	**Date**	**Signature**

Annexure D

LETTER OF INFORMATION

Dear St Marys Pupil / Parent

Thank you for your consideration in taking part in my Masters Research study.

The title of my study is as followed:

"The relationship between the physical activity and nutritional status of affluent adolescent girls (13 -18) attending an elite private school within KZN"

Principal investigator / researcher

I, Roxanne Watson, (qualification; B-Tech: Consumer Science Food and Nutrition) will be the main researcher within this study and will be under the supervision of Professor Carin Napier, (qualification; D-Tech Food Service Management).

Studies on the nutritional status of children and adolescents is highly important to contributing towards data collections that is used to improve education systems, developing intervention programs and increase the nutritional well being of communities. South Africa has extensive research on poorer communities and the information uncovered has done wonders in addressing identified problems. However when searching for nutritional status of more affluent communities members; there is a large gap in information.

By taking part in this study, you would be assisting in filling this gap of unknown information and would be contributing to the increase of nutritional knowledge on a national level. This helps in better understanding different communities within South Africa from which specific programs and interventions can be created to address any problems identified. I feel that affluent communities have been slightly neglected in the past and should have an equal chance of being studied and addressed. The World Health Organisation (WHO) indicates that more studies need to be done on adolescent girls to assist in the uplift of a healthy generation of woman for the future.

For this study to be viable, a sample group of 220 girls need to be assessed. It is greatly stressed that all information collected will be private and confidential. Ethical clearance has been granted from Durban University of Technology.

What will it involve?

Each girl that participates will be

- Ask to sign a consent form, agreeing that they are willing to take part in the study.
- Asked for their parent/ guardian to sign consent.
- Weighed and height measured to indicate a Body Mass Index (we will not ask to remove any clothing except for shoes and jerseys).
- Will be asked to complete the following:

- Socio-demographic Questionnaire.
- Physical Activity Questionnaire.
- Food Frequency Questionnaire which determines food diversity.
- 24 hour recall (two times week days and one weekend day).

This should take approximately 15-20 minutes of the participants time and will only be done once off. It is important to note that this process will not be disturbing the academic schedule.

You will not feel any discomfort

All measurements will be done in private and results will only be known to the participant at hand. There are no invasive measurements and only shoes and jerseys will be asked to be removed during the weighing process.

The final results of this study will be shared with Durban University of Technology for research purposes only. If there are any personal nutrition questions or concerns we are prepared to come back to you after the data collection to assist you.

Please note the following:

- Participation is voluntary and you can withdraw at any time with no penalty.
- No payment will be given to any participants.
- It won't cost anything to participate in this study.
- No names will be mentioned and only statistical numbering is used.
- This is a non invasive study therefore no injuries to be expected.

For any questions or concerns please feel free to contact my supervisor or our Ethics committee.

Your participation would be greatly appreciated and will contribute considerably in understanding the nutritional well being of the community we live in.

Thank you and warm regards

Roxanne Watson

Persons to Contact in the Event of Any Problems or Queries:
Researcher: Roxanne Watson
Researcher contact: 084 751 7813 roxiwatson81@gmail.com
Supervisor: Prof. Carin Napier
Supervisor contact: 031 373 2326 carinn@dut.ac.za
The Institutional Research Ethics administrator: 031 373 2900.
Complaints can be reported to the DVC: TIP, Prof F. Otieno on 031 373 2382 or dvctip@dut.ac.za.

Annexure E

Food and Nutrition Consumer Sciences

SOCIO-DEMOGRAPHIC QUESTIONNAIRE

This questionnaire covers certain aspects of your life, including work and personal details, health and illness, lifestyle and social life that is relevant to health. The answers to these questions will be kept strictly confidential and the information will not be identifiable on any reports or publications.

1. GENERAL INFORMATION

Participant number:…….. Date: ……

Fieldworker name: ……

Please answer all questions by marking the correct answer with **X,** except where otherwise indicated.

Which area do you live?

……

2. PERSONAL INFORMATION

2.1 When were you born? Year: Month: Day:

2.2 How old are you? _____ years

2.3 Gender:

Male	Female

2.4 How many meals do you eat per day?

0	1	2	3	4	>4

2.5 Where do you eat most of your meals?

Home	Friends	Work	School	Other, specify…….

2.6 How many children in the household

None	1	2	3	4	5	6	7	8	All

3. ACCOMMODATION AND FAMILY COMPOSITION

3.1 Do you live in?

Town/City	Farm	Hostel	Township	Other, specify……..

3.2 Do other people live in the house with you?

Yes	No

3.3 How many people are permanent residents living in the house with you? (Only if these people eat and sleep in this house at least 4 days a week?)

4.

1	2	3	4	5	6	7	8	9	10	10+

4.1. Is the main caregiver currently employed?

Yes	No

If YES, go to Question 4.3.

4.2. If NO, how would you describe your current status (tick one box only)?

Unemployed	Retired	Housewife	Student	Other, specify……

4.3. What is the total income in the household per month?

R5000 or less	R5000-R7500	R7500- R10 000	R10 000 – R12 500
R12 500 – 15 000	R15 000- R17 500	R17 500 – R20 000	>R20 000

4.4. How often does it happen that you do not have enough money to buy food? for you and your family?

Always	Often	Sometimes	Seldom	Never

4.5. How often do you buy food?

Every day	Once a week	Once every 2 weeks	Once a month	Other, specify……

4.6. Where do you buy food?

Convenience store	Wholesalers	Supermarket	Other, specify……

4.7 What type of transport do you use to get around?

Taxi	
Bus	
Train	
Own car	
Bicycle/ Motorbike	
Other Specify	

4.8 How much money is spent on food PER MONTH? (Tick only one box)

<R1000	R1000 – R1500	R1500 – R2000	R2000 – R2500	R2500-R3000	R3000-R3500	R3500-R4000	R4500-R5000	>R5000

5. **EDUCATION AND LANGUAGE **(CAREGIVER INFORMATION)****

6.

5.1. What is their highest education level?

None	Primary School	Grade 10	Grade 12	College/FET	Tertiary - university

5.2 What language is spoken mostly in the house?

Zulu	Xhosa	English	Afrikaans	Other, specify……

Food practices in the household

Tick one block for every question:	Father	Mother	Sibling	Grandma	Grandpa	Aunt	Uncle	Cousin	Friend	Au pair	Other
5.3 Who is mainly responsible for food preparation in the house?											
5.4 Who decides on what type of food is bought for the household?											
5.5 Who is mainly responsible for feeding/serving the children?											
5.6 Who is the head of this household?											
5.7 Who decides how much is spent on food?											

Thank you very much for your co-operation. We appreciate the time.

Annexure F

24 – HOUR RECALL

Subject number: _____ Interviewer: _____

Date: _____ / _____ / 20___

Tick what the day was yesterday:

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday

Would you describe the food that you ate yesterday as typical of your habitual food intake?

Yes	1	No	2

If not, why? _____

I want to find out about everything you ate or drank yesterday, including food you pick from the veld. Please tell me everything you ate from the time you woke up to the time you went to sleep. I will also ask you where you ate the food and how much you ate.

Time (approximately)	Place (Home, school, etc)	Description of food and preparation method.	Amount	Amount in g (office use Only)	Code (office use only)
From waking up to going to work, or starting day's activities					

During the morning at work or at home					

Time (approximately	Place (Home, school, etc)	Description of food and Preparation method.	Amount	Amount in g (office use Only)	Code (office use only)

Middle of the day (Lunch time)					
During the afternoon					

At night (dinner time)					

Time (approximately	Place (Home, school, etc)	Description of food and preparation method.	Amount	Amount in g (office use Only)	Code (office use only)

After dinner, before going to sleep					

* Do you take any vitamins or supplements (tablets or syrup)	Yes	1	No	2
Folate				
Iron				
Other				
Give the brand name and dose of the vitamins/tonic:				

Annexure G

FOOD AND NUTRITION CONSUMER SCIENCES

FFQ LIST OF FOODS AND FOOD GROUPS DIVERSITY

Subject number: _____ Interviewer: _____

Date: _____

PLEASE INDICATE THE FOOD YOU ATE DURING THE PAST SEVEN (7) DAYS BY AN (X)

GROUP 1: Flesh Foods (Meat, Poultry, Fish) Diversity	Y	N
Meat (Chicken)		
Meat (Beef)		
Meat (Mutton)		
Meat (Pork)		
Meat (Goat)		
Meat (Ostrich)		
Dried Meat (Biltong)		
All Mince		
All Tripe/Offals/Runners and Heads		
Fish (fresh / whole) e.g. Salmon (Fresh)		
Tinned Fish (Pilchards/Tuna)		
Processed Meats (Viennas / Polony, Russians, Boerewors Sausage)		
Seafood (Prawns, Mussel's, Calamari, Crab, Shrimp, Crayfish)		
GROUP 2: Eggs Diversity	**Y**	**N**
Eggs (Whole) /Egg white (Only)		
GROUP 3: Dairy Products Diversity	**Y**	**N**
Milk (Full Fat) /Milk (Low Fat/Fat Free)		
Evaporated milk (Unsweetened)		

Condensed milk		
Maas		
Cheese Full Fat (Hard, Soft, Cream Cheese, Cottage Cheese)		
Custard		
Ice Cream		
Yogurt Full Fat (Natural/ Frozen)		
Buttermilk		
GROUP 4: Cereals, Roots and Tubers Diversity	**Y**	**N**
White /Brown Rice		
Maize (Pap, Mealie Rice, Mealie Meal, Samp, Porridge, Corn on the cob, Popcorn, Sweet Corn)		
Macaroni/Pasta/Spaghetti		
Bread (White/ Brown/ Whole Wheat/Rye)		
Dumpling/Steamed Bread/VetKoek		
Scones/Biscuits		
Cous-Cous, Quinoa, Bulgur wheat		
Breakfast Cereals (Corn Flakes, Oats, Weet Bix, Pronutro, Coco-pops)		
All Tubers/Roots (Amadumbe, Sweet Potato)		
Potatoes		
GROUP 5: Legumes and Nuts	**Y**	**N**
Beans including bean sprouts (Fresh, Canned, Dried)		
Peas		
Lentils		
Peanuts and Nuts		
Soya/ Soya products		
GROUP 6: Vitamin A Rich Fruits and Vegetables Diversity	**Y**	**N**
Pumpkin		
Carrots		
Wild Leafy Vegetables (Lettuce, Kale, Rocket) Fresh and Dried – includes fresh herbs		
Spinach		
Butternut		
Apricots (Appelkoos)		
Peach (yellow cling)		
Mango		
GROUP 7: Other Fruits (and juices) Diversity	**Y**	**N**
Deciduous Fruits		
Apple		
Peaches		
Pear		
Grapes (black/green)		

Plum		
Sub – Tropical Fruit	**Y**	**N**
Lemon		
Orange		
Grapefruit		
Naartjie		
Banana		
Pineapple		
Avocado		
Kiwi fruit		
Watermelon, Sweet Melon		
Guava		
Paw- Paw		
Figs		
Blueberries		
Raspberries		
Juices	**Y**	**N**
Juice (100% pure juice e.g. Ceres/Liquifruit) no sugar added, Juice Freshly Squeezed		
GROUP 8: Other Vegetables Diversity	**Y**	**N**
Onions		
Cabbage		
Beetroot		
Tomatoes		
Green beans (fresh)		
Peas (fresh)		
Cauliflower		
Chili (red/green)		
Lettuce		
Green\ Yellow\ Red Pepper		
Frozen Vegetables (Mixed)		
Ginger & Garlic (Fresh)		
Gem squash		
Cucumber		
GROUP 9: Oils and Fats Diversity	**Y**	**N**
Butter		
Sunflower oil		
Olive oil		
Margarine		
Lard (Animal fat)		
Salad dressing/oil - mayonnaise		
Potato Crisps		
Cakes, Sweets, Chocolate		
Coffee Creamer (Cremora, Ellis Brown)		

DURBAN UNIVERSITY of TECHNOLOGY

FOOD AND NUTRITION CONSUMER SCIENCES

Anthropometric Measurements

Section A:

1. Number/Name of the caregiver.....

2. Community:.....

3. Date of birth	Year	Month	Day

4. Gender	Male	Female

Section B:

1. Body weight (kg)	1. Body weight (kg)	2. Height/Length (cm)	2. Height/Length (cm)
kg	kg	cm	cm

3. Waist circumference	3. Waist Circumference	4. Blood pressure	4. Blood pressure
cm	cm	/	/

Annexure I

Physical Activity Questionnaire (High School)

Subject number: _____ Interviewer: _____

Date: _____ / _____ / 20___

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

Remember:

1. There are no right and wrong answers - this is not a test.
2. Please answer all the questions as honestly and accurately as you can - this is very important.
3. Mark the appropriate answer with an **X**

---

1. 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? (Mark only one column per row)

	1-2	3-4	5-6	7 times or more
Skipping				
Rowing/canoeing				
Netball				
Walking for exercise				
Bicycling				
Jogging or running				
Aerobics/Gymnastics				
Swimming/water polo				

Baseball, softball				
Dance				
Touch Rugby				
Squash				
Athletics				
Soccer				
Horse Riding				
Volleyball				
Hockey				
Basketball				
Ice skating				
Cross-country				
Tennis				
Golf				
Karate				
Other				

2. In the last 7 days, during your physical education (PE) classes, how often were you very active (playing hard, running, jumping, throwing)? (Check one only.)

I don't do PE ☐
Hardly ever
Sometimes
Quite often
Always

3. In the last 7 days, what did you normally do *at lunch* (besides eating lunch)? (Check one only.)

Sat down (talking, reading, doing schoolwork) ☐
Stood around or walked around ☐
Ran or played a little bit
Ran around and played quite a bit
Ran and played hard most of the time

4. In the last 7 days, on how many days *right after school*, did you do sports, dance, or play games in which you were very active? (Check one only.)

None ☐
1 time last week
2 or 3 times last week
4 times last week
5 times last week

5. In the last 7 days, on how many *evenings* did you do sports, dance, or play games in which you were very active? (Check one only.)

None
1 time last week
2 or 3 times last week
4 or 5 last week ☐
6 or 7 times last week

6. *On the last weekend*, how many times did you do sports, dance, or play games in which you were very active? (Check one only.)

None
1 time
2 — 3 times
4 — 5 times
6 or more times

7. Which *one* of the following describes you best for the last 7 days? Read *all five* statements before deciding on the *one* answer that describes you.

All or most of my free time was spent doing things that involve little physical effort .....

I sometimes (1 — 2 times last week) did physical things in my free time (e.g. played sports, went running, swimming, bike riding, did aerobics) .....☐

I often (3 — 4 times last week) did physical things in my free time .....☐ I.

I quite often (5 — 6 times last week) did physical things in my free time .....☐

I very often (7 or more times last week) did physical things in my free time .....☐

8. Mark how often you did physical activity (like playing sports, games, doing dance, or any other physical activity) for each day last week.

	None	Little bit	Medium	Often	Very often
Monday					
Tuesday					
Wednesday					
Thursday					
Friday					
Saturday					
Sunday					

9. Were you sick last week, or did anything prevent you from doing your normal physical activities? (Check one.)

Yes .....☐
No .....☐

If Yes, what prevented you? _____

Reference:
Kowalski, K., Crocker, P., & Donen, R. The Physical Activity Questionnaire for Older Children (PAQ-C) and Adolescents (PAQ-A) Manual. College of Kinesiology, University of Saskatchewan.

Reference:

The Physical Activity Questionnaire for Older Children (PAQ-C) and Adolescents (PAQ-A)

Kowalski, K., Crocker, P., & Donen, R. The Physical Activity Questionnaire for Older Children (PAQ-C) and Adolescents (PAQ-A) Manual. College of Kinesiology, University of Saskatchewan.

Kent C. Kowalski, Ph.D.
College of Kinesiology
University of Saskatchewan

Peter R. E. Crocker, Ph.D.
School of Human Kinetics
University of British Columbia

Rachel M. Donen, Bsc. Honours
College of Kinesiology
University of Saskatchewan

Annexure J

From: "Kowalski, Kent" <kent.kowalski@usask.ca>
Date: 7 February, 2014 1:59:05 pm GMT+2
To: Roxanne Watson <roxiwatson81@gmail.com>
Subject: RE: South Africa - Physical activity questionnaire

Hi Roxanne,

The PAQ-C and PAQ-A were developed by us for research purposes, so feel free to use either of them in your research.

Kent

_____
From: Roxanne Watson [roxiwatson81@gmail.com]
Sent: Friday, February 07, 2014 4:30 AM
To: Kowalski, Kent
Subject: South Africa - Physical activity questionnaire

Dear Mr. Kowalski

I am a Masters student from Durban, South Africa.
My Dissertation title is:

The relationship between the physical activity and nutritional status of affluent adolescent girls (13 - 18) attending an elite private school within KZN.
I came across your study and the physical activity questionnaire you used. It would be a perfect tool to use within my own study.
My I please have your permission to use the physical activity questionnaire? It will, of course, be referenced.

Kind Regards
Roxanne Watson

Annexure K

20 June 2017

To whom it may concern

Re: Dissertation by Roxanne Watson

This Declaration serves to confirm that I have recently edited in terms of language use, spelling and grammar and subsequently proofread the Dissertation: **Relationship between physical activity with dietary intake and nutritional status of adolescent girls attending a private school in Durban** written by Roxanne Watson.

In my opinion and to the best of my knowledge it is now free of spelling and grammatical errors and reads well.

I am a qualified editor and proof reader.

Michael Vermeer

082 093 4347

mike.vermeer3@gmail.com