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Department of Health and Rehabilitation Sciences

Division of Physiotherapy

MSc (Physiotherapy) by Dissertation

The design of an intervention programme to address the prevalence of obesity and physical fitness of adolescents attending high school

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PLAGIARISM DECLARATION

I, Shane Naidoo (NDXSHA092), hereby declare that the work on which this dissertation is based is my original work (except where acknowledgements indicate otherwise) and have used the Harvard UCT system of referencing. I declare that neither the whole work nor any part of it has been, is being, or is to be submitted for another degree in this or any other university.

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Date : 12 March 2021

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Abstract

Background: South Africa has the highest prevalence rate (8.3%) of childhood obesity in sub-Saharan Africa. Obesity is a complex condition to control as it has environmental, as well as genetic factors that influence its prevalence. Childhood obesity, a rising problem world-wide and within South Africa, has been negatively linked with both physical fitness and physical activity. PA and school-based nutrition intervention programmes have been shown to have positive effects on diet and PA behaviours in children. However, there is minimal literature reporting on the effectiveness of school-based interventions in a South African setting. The aim of this study was to determine the prevalence of obesity, levels of physical fitness and physical activity in adolescents attending school in an urban setting. Together with the literature, an intervention programme was designed addressing key outcome measures identified from the sample.

Methodology: The study was conducted in two phases. Ten schools were randomly selected from the school education district in KwaZulu-Natal Department of Education (KZNDoE) for phase one. A total of 400 eligible students were identified by the respective school teachers and parental consent was obtained, with assent obtained from the participants. A sample of 278 (girls *n* = 150, boys *n* = 128) participants with a mean age of 15yrs 1 month (CI 95% 12,1 – 17.1 and SD 1.14), was measured for height, weight, hip circumference, waist circumference and physical fitness (standing broad jump, sit-ups in 30s, hand grip strength, sit-and-reach and 20m shuttle run). BMI and WHR were calculated using anthropometric measurements. Physical activity (PA) was self-reported using the Physical Activity Questionnaire for Adolescents (PAQ-A) and the International Study of Childhood Obesity, Lifestyle and the Environment (ISCOLE) demographic form were completed by the participants' guardians/parents. Phase two involved the design of a PA intervention programme using evidence-based outcome measures from previous studies and problem areas identified in this study.

Results: The mean BMI z-score was 0.30 (CI 95% 0.12 to 0.49) with boys displaying a mean of 0.19 (CI 95% -0.89 to 0.46) and girls 0.39 (CI 95% 0.15 to 0.65). There was a 16.2% prevalence of overweight (1 < BMI-z score ≤ 2), 13.3% prevalence of obesity (2 < BMI-z score ≤ 3) and 2.9% prevalence of morbid obesity (3 < BMI-z score ≤ 4). Mean WHR for the sample was 0.82 (CI 95% 0.81 – 0.83). Low levels of PA were reported by 45% (girls *n* = 83,

boys $n = 42$) of the sample and 53.6% (girls $n = 66$, boys $n = 83$) reported moderate levels of PA. Girls in the sample had a higher mean sit-and-reach (t = 4.68, $\boldsymbol{p < 0.05}$) and hand grip strength (t = 5.49, $\boldsymbol{p < 0.05}$) than the normative values. Boys in the sample had higher mean (t = 13.2, $\boldsymbol{p < 0.05}$) sit-and-reach than normative values. Multiple regression models were applied and BMI was found to be an inverse predictor for sit-ups ß = -0.07 ($\boldsymbol{p < 0.05}$, CI 95% -1.0 to -0.03) and broad jump ß = -0.01 ($\boldsymbol{p < 0.05}$, CI 95% -0.01 to -0.005). BMI was also a direct predictor for hand grip strength ß = -0.07 ($\boldsymbol{p < 0.05}$, CI 95% 0.05 to 0.09).

Discussion: The 16.2% prevalence of obesity was higher than the reported 8.5% in another South African study on adolescent scholars and the national reported level of 5.5%. The waist-hip ratio (WHR) was lower than the national reference level of 0.84 and higher compared to values obtained from adolescents in Europe (comparisons were made to age and gender specific normative values obtained in Europe, as there are no national reference physical fitness values for adolescents). Girls displayed lower values in three of the five physical tests (standing broad jump, sit-ups and 20m shuttle run), while boys displayed lower values for four (standing broad jump, hand grip strength, sit-ups and 20m shuttle run) of the five physical fitness tests. PA is indirectly correlated with BMI, and with BMI being a predictor for physical fitness, the promotion of PA amongst adolescents is imperative and urgent to curb the growing prevalence of obesity. Using evidence from previous research an intervention programme was designed to address the problems areas identified. These were high prevalence of obesity and overweight, low PA levels, poor cardiovascular function , low muscular power and poor muscular endurance across the sample. Boys also exhibited low levels of muscular strength than the normal population mean. PA programmes must be 60 minutes of duration implemented at least three times per week over 12 weeks minimum in order to have a reduction in BMI. Programmes should incorporate aerobic and anaerobic training as concurrent training has shown best results for decreasing BMI. The aerobic component of the programme must include a high intensity interval training (HIIT) as this has positive benefits on cardiovascular markers. The anaerobic component must include free weights as this showed better improvements than using resisted exercise devices in body composition, increases in upper and lower limb muscle strength in boys and improved lower limb muscle power especially in girls. Programmes should be implemented in schools with trained instructors and incorporate the family as a combination of these showed favourable compliance and overall better outcome measures. PA programmes that have a circuit formation and that incorporate a fun element has also shown to have better outcome measures and compliance.

Conclusion: Physical activity levels are on the decline and obesity prevalence is on a rapid upward trajectory amongst South African adolescents. These trends could be ominous for the next workforce generation as these have been linked to numerous non-communicable diseases where the already constrained health system is placed under added pressure. PA programmes should be incorporated into schools' curricula as this may be a viable way to implement successful interventions to address obesity, physical fitness and physical activity.

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Abbreviations

BMI	Body Mass Index
cm	centimetres
CG	Control Group
CI	Confidence Interval
EG	Experimental Group
HREC	Human Research Ethics Committee
HAZ	Height-for-age z-scores
HIIT	High Intensity Interval Training
HIV/AIDS	Human immunodeficiency virus / acquired immunodeficiency syndrome
ISCOLE	International Study of Childhood Obesity, Lifestyle and the Environment
KZNDE	KwaZulu Natal Department of Education
kg	kilograms
NCD	Non-Communicable Diseases
NSNP	National School Nutrition Programme
PA	Physical activity
PAQ-A	Physical activity questionnaire – adolescents
PF	Physical Fitness
PE	Physical Education
PAQ-A	Physical Activity Questionnaire – Adolescents
QoL	Quality of life
RSA	Republic of South Africa
SES	Socioeconomic Status
SANDH	The South African Health and Nutrition Examination Survey
STATSSA	National Statistical Service of South Africa
SANYRB	South African National Youth Risk Behaviour Survey
UCT	University of Cape Town
UMIC	Upper Middle-Income Country
VO_2 Max	Maximal oxygen uptake
WHO	World Health Organisation
WHR	Waist-to-hip ratio

1. Chapter 1 Introduction

South Africa is facing a mammoth task in the Healthcare sector by boasting the unenviable statistic of having the largest number of people living with HIV/AIDS (UNAIDS, 2014). This pandemic has seen the increase in the number of people seeking medical treatment. Added to the burden of the fragile health care system, the World Health Organisation (WHO) reports an increase in the prevalence of non-communicable diseases (NCD) (WHO, 2011). NCD, which include cardiovascular diseases, diabetes, cancer and chronic respiratory conditions (CDC, 2010), are responsible for 63% of all deaths worldwide, (WHO, 2016e) and 43% of all deaths in South Africa (WHO, 2016c). There is substantial evidence, presented by the WHO, that shows obesity to be directly correlated to the prevalence of NCD and indirectly correlated to physical activity (WHO, 2016b). Obesity has been identified with major risk factors associated with NCD. These risk factors include tobacco use, alcohol abuse, physical inactivity and incorrect diet (Boutayeb and Boutayeb, 2005). Section 1.3 outlines the definition of obesity.

South Africa has the highest prevalence rate of obesity in sub-Saharan Africa (Micklesfield et al., 2013). Obesity is a complex condition to control as it has environmental, as well as genetic factors that influence its prevalence (Barness et al., 2007). Overweight and obesity are caused when the caloric intake of a person exceeds the calories expended (WHO, 2016f). There has been a phenomenal increase in the prevalence of adolescent obesity, in males and females in South Africa (Reddy et al., 2012b). Evidence has shown that obesity increases significantly in females from childhood to adolescence, compared to males. This difference is due to males gaining skeletal and muscle mass during puberty while females tend to gain more fat cells during puberty (Lundeen et al., 2016). Research has identified that adolescents, especially females, are the most appropriate group to implement interventions that would help decrease obesity in South Africa. Adolescents have been identified as a critical age group as most trends learnt during adolescence are carried out to adulthood (Craig et al., 2016). Urbanization and social trends tend to promote the decrease of physical activity with various advancements in transportation and sedentary behaviour entertainment (Micklesfield et al., 2013). Adding fuel to the fire is the increase in the consumption of unhealthy fast food, sweetened beverages and processed food which have high caloric intake (SANDH, 2013). High prevalence of poverty in South Africa is a reality (Charlton and Rose, 2002), and there is a general misconception that obesity is prevalent amongst the rich. Poverty increases the risk of obesity as cheaper food generally has a higher energy content with a low nutritional value (Temple and Steyn, 2011). The combination of these components places the South African child and adolescent in a high-risk category of becoming obese. In South Africa, obesity accounted for 31,3% of the risk factors associated with NCD (WHO, 2016c). There is a combined overweight and obesity prevalence of 13.5% for South African children (SANDH, 2015). This number is significantly higher than the global prevalence of 10% for children in the similar age group (SANDH, 2013). Childhood obesity is a condition that usually transcends into adulthood (Carson et al., 2016) which is linked to a premature mortality rate (Singh et al., 2008).

In 2014, 22,4% of all deaths recorded in South Africa occurred amongst young adults (18 to 30 years-old) age group (STATSSA, 2014), and this age group forms the bulk of the workforce. A study done in KwaZulu Natal showed that in lower socioeconomic households, mortality of the breadwinners/families of the home resulted in most homes struggling to function in society (Hosegood et al., 2004). It is also important to note that young adulthood follows adolescence so changes in adolescence today will affect the workforce tomorrow. Non-communicable diseases accounted for the majority of deaths in young adults (STATSSA, 2014). According to a joint report by the WHO and World Economic Forum, four percent of a country’s economic output would be reduced due to high mortality and prevalence of NCD in the adult workforce. It was estimated that in excess of US$7 trillion would be lost between 2011 and 2025 in middle and lower income countries due to the prevalence of NCD (WHO, 2011). These numbers can be decreased with effective control and education around the risk factors associated with NCD (Kontis et al., 2014). The WHO in 2016 reported that if the major risk factors for NCDs were eliminated, approximately three-quarters of heart disease, stroke, type two diabetes and 40% of cancer would be prevented (WHO, 2016e).

The World Health Organization identified the four main risk factors of NCD as tobacco usage, unhealthy diets, physical inactivity and harmful use of alcohol (Phaswana-Mafuya et al., 2013). In the Strategy for the Prevention and Control of Obesity (SANDH, 2015), the concerns of the South African Government were that:

1. South Africa is experiencing a quadruple burden of disease with non-communicable diseases being one of the leading public health concerns.

2. The prevalence of obesity has escalated at an alarming rate and is not limited to the adult population but is emerging in young children.
3. There is no multi-sectorial approach to halting the scourge of obesity in the country.
4. Obesity imposes a significant economic burden on an already strained health system and inflicts great costs to the country.
5. Most South Africans consume diets low in fruits and vegetables and high in fat-and sugar-containing foods.
6. Individuals lead sedentary lifestyles and do not engage in physical activity.

There are 1,2 billion adolescents in the world, (WHO, 2016a) so one in every six individuals on this planet are between the ages of 10 and 19 years. In South Africa there is an estimated 10,1 million adolescents, which equates to 17,9 percent of the total population being between the ages of 10 and 19 years-old (STATSSA, 2016). Adolescence is defined as the transition phase from childhood into adulthood (Costello et al., 2011). In 2016 1,2 million adolescents died globally, mostly from preventable and treatable causes (WHO, 2016d). One of the reasons highlighted for the high death rate was the low levels of exercise and nutrition, where one in four adolescents met the daily recommended guidelines for physical activity. The WHO recommends 60 minutes of moderate to vigorous daily activity for adolescents (WHO, 2016a).

This study aims to address the rapidly growing epidemic of adolescent obesity. The prevalence of obesity and level of physical fitness would be determined in phase one of the study of adolescents attending middle school in South Africa. A literature review of interventions that have been implemented to address obesity and physical fitness in adolescents was conducted. Together with the results of the literature review and the findings of phase one, a comprehensive programme was designed.

1.1 Justification/Rationale for study

There has been intensive research and publications on the positive outcomes of decreasing obesity in children (Kelishadi and Azizi-Soleiman, 2014). However, there has been sparse literature on how specific interventions affect obesity and physical fitness in schools. Hence, programmes that have been designed and implemented may not have been appropriate in the

South African setting. A literature review of contextual findings to analyse the effectiveness of specific interventions that affect obesity and physical fitness in adolescents, is imperative to design an accurate programme for adolescents in the South African setting. The effectiveness of interventions that have relevant outcomes for BMI in adolescents are discussed in detail in section 2.5. Public schools will be selected, based on the following reasons:

1. Physical activity and sport is promoted more in private schools than public schools (Ribeiro et al., 2012).
2. Children that attend private schools generally come from homes in the upper socioeconomic spectrum of society and have the accessibility to better quality of nutrition which places them at a lower risk than students in public schools (Temple et al., 2006).

Determining the prevalence of obesity in public schools could help facilitate a physical activity and lifestyle programme that may be implemented in all public schools based in South Africa. With obesity being a large contributor to the prevalence of NCD, an accurate programme designed and targeted at adolescents could change physical activity levels and lifestyle trends which will transcend into adulthood and help to improve the quality of life and decrease the mortality rate.

Positive outcomes would help aid a strained healthcare system by reducing the treatment of the various NCD. It will also help boost the economy by reducing the mortality rate in the workforce and increase productivity with a reduction in sick leave due to NCD.

1.2 Aims of Study

This study was conducted in two phases. The aims of the study were:

1.2.1 Phase 1

The determination of the prevalence of overweight, obesity, physical activity and physical fitness amongst adolescents attending public high school.

1.2.2 Phase 2

Design of a programme based on key problem areas identified from the results obtained in Phase one. An intervention programme was designed using evidence from the literature that addresses areas of concern identified in Phase one.

1.3 Definitions and Terms

The following terms with their respective definitions were used extensively in this:

1.3.1 Obesity

Obesity is defined as the accumulation of excess body fat that may pose health risks (WHO, 2016f). It usually occurs when the calorie intake exceeds the amount of energy expended over a period of time. The WHO classifies an adult who has a BMI of greater than or equal to 30 kg/m^2 as obese (WHO, 2016f) and defines obesity as a BMI greater to or equal to the 95^{th} percentile for children of the similar age and sex (WHO, 2016b).

1.3.2 Physical Activity

The WHO defines physical activity (PA) as any bodily movement produced by the skeletal muscles that requires energy expenditure. Physical activity should not be confused with exercise which is a repetitive form of planned movement which improves or maintains certain aspects of physical fitness.

1.3.3 Physical Fitness

The American College of Sports Medicine defines health related physical fitness as a set of attributes that people have or achieve that relates to the ability to perform physical activity (Wilder et al., 2006). Physical fitness has many components some of which are health related (cardiorespiratory endurance, strength, muscular endurance, flexibility, and power) and some are skill related (balance, co-ordination, speed, reaction time and agility). Skill related components can assist in sports and play activities in the younger populations (Mancha-Triguero et al., 2019) however these skills are also important in older people as well when it involves balance and co-ordination in dynamic gait (Meusel, 1984).

1.3.4 Body Mass Index

Body Mass Index (BMI) is calculated by dividing the anthropometric measure of an individual's weight in kilograms (kg) and the square of their height in meters (m^2) BMI = kg/m^2 (WHO, 2007b). The value calculated is used to classify respective categories of underweight, normal, overweight or obese (refer section 2.2.1 of literature review).

1.3.5 Waist-Hip Ratio

The waist hip ratio (WHR) is a measure of the circumference of the waist (cm) divided by the circumference around the hip (cm) WHR = Waist (cm) / Hip (cm) (WHO, 2008). This measure is as a good comparative when testing for obesity as BMI measurements may overlook abdominal adiposity (WHO, 2008) The WHR is also a good indicator to predict the risk of metabolic complications for values ≥ 0.90 cm in boys and ≥ 0.85 cm for girls (Bacopoulou et al., 2015).

1.4 Outline of Dissertation

This dissertation is outlined and presented in the following chapters:

1. Chapter two outlines the literature review and presents information pertinent to adolescent obesity globally and in South Africa, with focus on intervention studies.
2. Chapter three describes the method in which the research was conducted.
3. Chapter four presents the results obtained.
4. Chapter five is a discussion of the results obtained and identifies key areas of the study findings as related to the literature.
5. Chapter six describes the design of an intervention programme based on the results obtained and the evidence in the literature.
6. Chapter seven presents the conclusion with limitations and recommendations.

2. Chapter 2 Literature Review

2.1 Introduction

Obesity, once labelled an epidemic that affected first world countries, has transgressed into a global pandemic (Kumanyika et al., 2009). Obesity is defined as the accumulation of excess body fat that may pose health risks (WHO, 2016f). Obesity is directly correlated to the prevalence of non-communicable diseases (NCD), which would include cardio-vascular diseases, diabetes, cancer, and chronic respiratory diseases (CDC, 2010). NCD accounts for 63% of deaths globally (WHO, 2015). Recent research has shown that there are 795 million people classified as being obese globally, of which 50 million were girls and 74 million were boys between the ages of 5-19 years-old (Abarca-Gómez et al., 2017).

The alarming numbers of obesity in children globally show that there is an immediate need to address the growing prevalence. Adolescents have been identified as a critical age group to implement an intervention in children (Alberga et al., 2012). There is an abundance of evidence as evidenced in systematic reviews that shows that interventions targeted to decrease the prevalence of obesity in adolescents have merit (Militello et al., 2018b, Staniford et al., 2012). However, based on the current prevalence of obesity globally, it brings to fore the probability that we may be losing the battle to this "silent" pandemic. Most interventions that have been implemented have focused on three components, namely diet, physical activity and lifestyle/behavioural or psychological Interventions.

These interventions have been used solely or in different combinations to achieve primary outcome measures to decrease and prevent obesity (Psaltopoulou et al., 2019). The authors showed in a systematic review of multi-focused interventions, that appropriate physical activity combined with proper nutrition showed the most promising results in reducing obesity in children. However, physical activity interventions in most research have been poorly described (Zolotarjova et al., 2018). Most differed in duration, combinations and type and this could have attributed to varying results (Psaltopoulou et al., 2019). Physical activity programmes designed and implemented in first world countries may not produce the desired outcome effect in a South African environment due to contextual differences. This chapter aims to explore the topic of obesity, physical activity and physical fitness and the interventions that have been implemented in various settings. Insight gained from this review will be used to construct a physical activity programme. No study has examined various models of physical activity and constructed a physical activity intervention using previous data, especially in the South African setting.

2.2 Obesity

2.2.1 Measure of Obesity

Body mass index (BMI) is a measure that is globally used to measure and give an indication of weight status. In adults it is a calculation of a person's weight in kilograms divided by their height squared in meters (kg/m^2) (WHO, 2016f). The calculation of BMI in children from 0 to 19 years differs from adults as the former does not account for growth spurts and weight fluctuations that may occur during puberty. The WHO have compiled age and gender specific thresholds for children zero to five years old (WHO, 2007a) and five to nineteen years old (WHO, 2007b) to classify obesity, overweight and monitor child growth. This allows for the BMI of a child to be measured against age and gender specific population means and the difference of the BMI can be calculated. BMI thresholds are represented as a z-score, on the child growth reference. Following the calculation of the BMI z-score, this number may be matched with the WHO defined thresholds (Table 1) for child growth reference (Andersen et al., 2015).

Table 1: BMI cut-off z-scores for weight status in children and adolescents (WHO, 2007b)

	Children 0-5yrs BMI z-scores	Children 5-19yrs BMI z-scores
Morbid Obesity	> 3 SD	> 3
Obese	> 3 SD	> 2
Overweight	> 2 SD	> 1
Normal	between -1 and 2	between -1 and 1
Thinness	>-1	> -1
Severe Thinness	>-2	> -2

A BMI z-score indicates the number of units the BMI is above or below the average BMI value for their age and gender. To further illustrate this, a child with a BMI z-score of 1.3 indicates that the child is 1.3 units (standard deviations) above the age specific mean. A child with a BMI z-score of 0 is on par with the age specific population mean, and a BMI z-score of -1.3 indicates that the child is 1.3 units (standard deviations) below the age specific population mean (Nixon et al., 2012).

Growth patterns in children are also monitored using height-for-age z-scores (HAZ). A child's height is compared to population means of similar age and gender (Appendix 24). The calculated value indicates the number of standard deviations from the mean of the population. Table 2 outlines cut off values for HAZ.

Table 2: Height for age z-score classification (WHO, 2007b)

z-Scores	**<-3**	**<-2**	**>-2 < + 3**	**> + 3**
Height-for-age	Severe Stunting	Stunting	Normal	Tallness

The anthropometric measure of waist-hip ratio (WHR) is a reliable tool as a measure of obesity (Neovius et al., 2005). It has been touted as a reliable predictor for cardiovascular disease as abdominal adiposity is strongly correlated to metabolic disorders like glucose intolerance (WHO, 2008). It is calculated by the measurement of waist circumference (measured in cm) divided by the measurement of hip circumference (measured in cm). The ratio is measured against a chart that is gender and age specific (Appendix 24). Skinfold thickness measurements (using a skinfold calliper and measured in cm) were also determined as a valid measurement for distribution of adiposity (Yeung and Hui, 2010). Body Impedance methods have also been used to calculate obesity. However this method is used less frequently and shown to have irregularities (Deurenberg, 1996).

2.2.2 Prevalence of Obesity

There is evidence of 27.5% global increase in prevalence of obesity and overweight in adults between 1980 and 2013 (Ng and Popkin, 2012). The authors reported that this was shadowed by an increase of 47.1% in children during the same timeframe. The prevalence of obesity and overweight increased in developed countries, from 16.9% to 23.8% in boys and from 16.2% to 22.6% in girls. In developing countries, the prevalence of obesity increased from 8.1% to 12.1% in boys and 8.4 % to 13.4% in girls between 1980 and 2013. South Africa has the highest prevalence of obesity in Africa and the highest in all ages in Sub-Saharan Africa (Reddy et al., 2012a), with the prevalence being higher in women (Ng et al., 2014).

Table 3: Prevalence of Obesity (Ng et al., 2014)

	Boys <19 (%)	Girls <19 (%)	Men >19 (%)	Women >19 (%)
USA	12.4	13.4	31.7	33.9
Sub-Saharan Africa	5.6	7.4	11.7	37.0
South Africa	7.0	9.6	13.5	42.0

Prevalence of obesity in the USA increased from 4.8% to 11.3% in boys and 5.3% to 9.7% in girls in a timeframe of 13 years. A similar increase took six years in South Africa (Ng et al., 2014). Although this indicates a lower prevalence of adolescent obesity than the USA, the growth in SA is far larger. This exponential growth was also shown in a 400% increase of BMI in Southern Africa from 1975 to 2016 as compared to a 30% to 50% increase in first world countries (North America, Central Europe) in the same time (Abarca-Gómez et al., 2017).

2.2.3 Risk factors for overweight and obesity

Research has shown that obesity is fuelled by the continuous increase in the positive energy balance of an individual (Malik et al., 2013). This generally results from the change in one or a combination of factors, with some of the external factors being diet, physical activity and lifestyle (Psaltopoulou et al., 2019). The prevalence of obesity in high income and developed countries is inversely proportional to socio-economic status (SES) (Abarca-Gómez et al., 2017). The authors report that a rise in SES affords people in developed countries to have access to expensive healthy food, better recreational facilities and improved healthcare. These factors facilitate better lifestyles and lower their risk profile of becoming obese. South Africa falls into the classification of a upper middle-income country (UMIC), according to the World Bank (WorldBank, 2020). However, South Africa is still labelled as a developing country and differs from most developing countries as it is a developed country with good infrastructure, but also a country with huge social and economic inequalities. In South Africa, like many other developing countries, increases in socio-economic status increases the risk of obesity (Seydel et al., 2017). With a rapidly increasing middle class in South Africa, this poses increased risk for obesity and NCDs.

2.2.3.1 Cultural Influences and Attitudes

South Africa has the largest economical and food security inequalities in Africa (Monyeki et al., 2015), where we are faced with a double burden of over-nutrition and under-nutrition.

Table 4: Prevalence of Overweight and Underweight in South African Children (Monyeki et al., 2015)

	National	Rural	Urban
Overweight	12.1%	11.6%	13.9%
Underweight	19%	12.8%	7.7%

In a country where poverty and malnutrition are rife, an overweight child is often seen as a healthy individual and can signify a measure of wealth (Monyeki et al., 2015). This perception has seen delayed responses to the growing prevalence of obesity from media and government, as compared to health and media responses in first world countries. The South African government has been focused more on the issues surrounding underweight and have launched various programmes like the National Nutrition-Specific Intervention (Montgomery, 2012). The National Nutrition-Specific Intervention is run in conjunction with the National School Nutrition Programme (NSNP) which feeds nine million school children daily. The Nutrition-Specific guides the NSNP on the type of food that is needed based on the prevalence of underweight, malnutrition or stunting in that area. The focus on under-nutrition has left little to no attention, or budget, to address the growing prevalence of obesity. Cultures across the world have a significant influence on the socially acceptable physiques of individuals and inadvertently their eating patterns (Miller and Pumariega, 2001). South African society also has a tendency to stigmatise people who are thin or underweight, perceiving them as individuals who are positive for HIV. This perception has left obese and overweight people to be viewed as healthy individuals, further deferring the urgency to curb the increase in the growing prevalence of obesity (Prentice, 2006). In a society where weight loss is associated with illness, overweight females are viewed as having increased fertility, compounding the preference for South African women to be overweight (Vincent, 2016).

2.2.3.2 Globalization and Urbanization

Globalisation has seen the spread of economic activity from high income countries to developing countries (Kaplinsky, 2004). However, along with the transfer of economic power comes the transfer or spread of the burdens that generally plague first world countries (Malik et al., 2013). Obesity is one of these burdens that started in USA over 40 years ago and has rapidly spread across the globe. The authors support the positive effects that globalisation and urbanization have had on improving levels of poverty and food security, especially in developing countries (Malik et al., 2013). However, this shift has also contributed to people in this transition to indulge in lifestyles that place them at a high risk of becoming obese.

2.2.3.2.1 Diet

The rural-urban drift following the economic rise of the democratic government in South Africa has seen a rise in the urban middle-class population (Victor, 2018). The increase in spending power has changed the types of food that are accessible and available to this population. Globalisation has promoted the growth of many large chain stores in developing countries. These stores have merit in ensuring good supply and distribution of food (Reardon et al., 2003), however these stores also promote bulk buying and people who from part of the rural-urban drift now have access and resources to consume a wider variety of higher caloric food, animal fat food and sugar-laced beverages and confectionaries (Malik et al., 2013). This behaviour places this population at a higher risk of obesity. Globalisation has seen a rapid increase in foreign investment in the nutrition industry of developing countries. However most of these investments have been in the production of highly processed and energy dense food (Hawkes, 2005). Diets that comprise of high quantities of processed food have been shown to have a strong correlation with obesity in South Africans (Holmes et al., 2018). The authors confirm that healthy food in South Africa is generally expensive, and which is affordable and purchased by a small part of the population that are at the higher end of the socio-economic bracket. However not all people from a high SES choose to follow a healthy diet, some indulge in unhealthy eating habits increasing the prevalence of obesity amongst this group (Goyal et al., 2010). The majority of people that have moved into urban areas from rural areas do not have the finances to purchase healthy food. The cheaper food that they purchase are generally high in caloric content, and low in nutritional value (Temple and Steyn, 2011). Globalisation has also resulted in many fast food companies open vast number of outlets in developing countries. Fast foods have been shown to have a high carbohydrate, sugar and animal fatty content which leads to abnormal increases in caloric ingestion increasing the risk of obesity (Pereira et al., 2005). These dietary changes have placed the growing urban population at a high risk of obesity. Media has also played a role with the promotion of fast foods that appeal to the social status for the younger public therefore increasing the appeal and consumption (Spruijt-Metz, 2011).

2.2.3.2.2 Physical Activity

It is well documented that increases in physical activity (PA) have been associated with positive benefits in reducing levels of obesity (Kriska et al., 1993). Physical activity promotes the expenditure of energy or calories. Increases in physical activity can decrease or prevent obesity on condition that there is a neutral or negative energy balance. A neutral or negative energy balance occurs when the amount of calories expended is equal to or less than the quantity of calories ingested respectively (Spiegelman and Flier, 2001). Physical activity has been shown to decrease body fat and assist in decreasing abdominal obesity (Hu, 2008). The shift of people from rural to urban areas has negatively impacted their living spaces (Booth et al., 2005). The authors reported that urban areas have few open areas to engage in recreational activities and these facilities are limited. Booth (2005) and colleagues showed that decreased living spaces inevitably lead to decreased levels of physical activity. People who reside in urban areas are confined to their homes and leisure activities are centred around electronic devices that promote sedentary behaviour (Kruger et al., 2002). One of the reasons that people are confined to their homes are the high levels of crime in developing countries. People are apprehensive about engaging in physical activity outside the home environment as they fear of becoming victims of crime (Mistry, 2004). The International Crimes Victims Survey reported that on average people in South Africa felt the most unsafe in walking in their neighbourhood as compared to people in other developing countries (Mistry, 2004). Globalisation has also changed the amount of physical activity in relation to the occupation or work in which people are engage. Prior to globalisation, people that lived in rural areas engaged in farming and work that involved high levels of physical activity. Globalisation and the inevitable rural-urban drift have seen a change in the type of occupation people are engaged in. People are now employed in offices and factories where the job is less labour intensive, decreasing physical activity (Monyeki et al., 2015). Globalisation has ushered in a technological and motorized era to the developing countries (Ng and Popkin, 2012). These technological advancements have changed the working environment. Motorised equipment has reduced the amount of physical activity required in the modern manufacturing industry and increased sedentary behaviour. Technology has also replaced manual labour in the farming industry, thereby decreasing physical activity even in many rural areas. However, technology does come at a price and air pollution is one of the major drawbacks to the motorised and industrial developments. Air pollution has shown to have a negative correlation to physical activity (Roberts et al., 2014). Prior to the rural-urban drift people who lived in rural areas generally walked to places, maintaining good levels of physical activity.

Technological and automotive advances have seen the availability of various modes of motorized transport in urban areas, hence decreasing the necessity to walk. Technology has also contributed to the decline in physical activity around the home as people now have appliances like washing machines and vacuum cleaners, to carry out certain chores that they once did manually (Malik et al., 2013).

2.2.3.2.3 Behaviour Changes

The move from rural to urban areas has enabled the acquisition of different jobs that place individuals at higher stress levels (Cui et al., 2012). It is well documented that stress affects eating habits in an individual (Groesz et al., 2012) and promotes unhealthy eating patterns which adds to risk of obesity (Heraclides et al., 2012). The economic rise has forced individuals to work longer hours to increase productivity. Longer working hours reduce the amount of time that individuals have for recreational activity and to engage in physical activity. Longer working hours have also shown to have a strong correlation with high levels of stress and burnout (Hu et al., 2016). The demand and stress in the work environment has seen many people resort to sedentary activities, like television watching after work. This not only has an inverse relation to physical activity and obesity, it also impacts negatively on eating behavioural patterns. People who spend more time watching television generally have a greater calorie intake as they are exposed to more advertisements of food and beverages and engage in unhealthy eating habits (Hu et al., 2003). It is also important to note that people that move into urban areas generally come from a village with good social and support structure. The transition decreases the social support structures and this can compound stress levels in these individuals (He and Ye, 2014). Decreased social integration can also lead to loneliness which has shown to have an indirect correlation to physical activity (Pels and Kleinert, 2016). Urban areas are also high in noise pollution as compared to rural areas (de Paiva Vianna et al., 2015). The increase in noises can affect sleeping patterns. Decreased sleep has been linked to the increase in the risk of obesity (Beccuti and Pannain, 2011).

2.3. Physical Activity

2.3.1 Prevalence

The WHO defines physical activity as any bodily movement produced by the skeletal muscles that requires energy expenditure (WHO, 2018a).

Table 5: Physical Activity Recommendations (WHO, 2018a)

Children/Adolescents 5-17yrs	**Adults 18-64yrs**	**Adults 65yrs+**
- 60 minutes daily of moderate to vigorous intensity - Activities that strengthen muscle and bone min 3 times per week	- 150 moderate or 75min vigorous intensity per week - 300min moderate intensity for health benefits per week - Muscle strength 2 or more days per week	-150 moderate or 75 min vigorous intensity per week -300 min moderate intensity for add health benefits weekly - Muscle strength 2 days/week - Balance exercise 3 days/week

Physical inactivity has rapidly become a global problem with 27% of women and 20% of men being physically inactive (Mielke et al., 2018). These numbers are shadowed by 84% and 78% of adolescent girls and boys respectively, that did not meet the WHO recommendations of physical activity (WHO, 2018a). Higher income countries had higher rates of adult inactivity than adults in lower income countries in 2010. However, studies done in 2013 have shown that with globalisation and urbanization physical inactivity was highest in developing countries (Ferreira de Moraes et al., 2013). In USA at least 24.8% of adolescents engaged in physical activity (Fakhouri et al., 2014) that are at least 60 minutes of moderate to vigorous activity, while in South Africa 40% of adolescents are engaged in physical activity (Wushe et al., 2014). The WHO has recognised the growing prevalence of physical inactivity and has initiated a global plan to reduce physical inactivity by 10% by 2025 and 15% by 2030 (WHO, 2018b).

Physical inactivity has been largely related to increases in non-communicable diseases (Wagner and Brath, 2012). Increased physical activity has been linked to the positive health benefits of physical fitness, changes in fat percentage, waist circumference and decreases the risk of cardiovascular disease in obese and overweight adolescents (Vasconcellos et al., 2014). Currently adolescents comprise the highest percentage of the population that are inactive (WHO, 2018a) and promoting physical activity could have positive health benefits on the future of this generation.

2.3.2 Factors impacting Reduced Physical Activity

Globalisation and urbanization have accounted for a large decrease in physical activity as discussed previously in this chapter. The pressure to perform academically has also been a large contributor to decreases in physical activity as many adolescents spend more time on academic activities after school than engaging in physical activities (Tudor-Locke et al., 2003). In a study by Rosselli et al (2020) on adolescents in Italy, lack of energy and lack of willpower were the main deterrents of physical activity. It is interesting to note that in this study, girls reported lower levels of physical activity compared to boys, citing the lack of energy and willpower as the main deterrents. In a study conducted in the United Kingdom, the authors reported that girls were hesitant to engage in physical activity, as they believed it decreased societies perceptions of them being feminine (Cockburn and Clarke, 2002). Alsubaie et al (2015) pointed out three main deterrents to physical activity of adolescents living in a Saudi Arabian city, namely, the lack of sport facilities, lack of support from other adolescents and the lack of public sports clubs (Alsubaie and Omer, 2015). Parents and guardians have also contributed to decreased levels of physical activity as they have trepidations concerning injuries, hence some parents may discourage children from engaging in physical activity (Boufous et al., 2004). High levels of crime that is prevalent in most urban suburbs in South Africa (Breetzke, 2018), have also discouraged parents from allowing children to engage in outdoor activities as they safety concerns (Draper et al., 2014). The technological era has seen vast changes in media and content available on television. Media promoting sports on television and video games that promote sedentary behaviour has also decreased levels of physical inactivity in adolescents (Gordon-Larsen et al., 2000). The internet has opened the "doorway" to the world of information and entertainment and has enticed people to spend more time on smartphones and computers (Ryan and Lewis, 2017). Internet use is fundamental in most industries and has facilitated working from home in many occupations (Gottlieb et al., 2020). These activities promote sedentary behaviour. Adolescents in South Africa living in urban areas also have less responsibilities around the house and this increases their sedentary behaviour (Micklesfield et al., 2013).

2.3.3 Measurements of Physical Activity

There are different types of approaches in recording physical activity (PA), namely, self-reporting assessments, observational assessments and objective measurements (Trost et al., 2002). Self-reporting assessments are used most commonly due to the low costs incurred to implement this. They have been proven to be a valid tool, such as the PAQ-A (Helmerhorst et al., 2012). Observational assessments are also tools for recording physical activity, however training of recording keepers and risk of bias are high (Welk, 2002). Objective measurements (such as accelerometers, pedometers) are the most reliable tools to measure physical activity.

However, they are generally expensive, especially if the study has a large number of participants (Sallis, 2010).

2.4 Physical Fitness

2.4.1 Prevalence of Physical Fitness

Physical fitness is a state of an individual to carry out his/her daily activities with no effects of fatigue and with plenty of reserve energy to enjoy leisure activities (Malina and Katzmarzyk, 2006). Physical fitness has five pillars (Truter et al., 2010), namely, cardiovascular endurance, body composition, muscle strength, muscle endurance and flexibility. Physical fitness has shown to have an inverse relationship with the prevalence of obesity (Malina and Katzmarzyk, 2006). It is interesting to note that physical fitness has shown to have greater correlations to improved academic performance as compared to BMI (London and Castrechini, 2009). There has been a steady decline in the fitness levels in the adolescent population in United States of America (Malina, 2007). This trend is also seen in South Africa where although data is limited, physical fitness is also at a very low level (Uys et al., 2016).

2.4.2 Factors for reduced physical fitness

Increase in the prevalence of obesity and decrease of physical activity has negative effects on cardiovascular function. This will have a ripple effect and lead to decreases in physical fitness. Obesity has also been linked to the accumulation of excessive adipose tissue and this will affect joint range of motion and affect flexibility tests for physical fitness negatively (Park et al., 2010). Obesity has also shown to have an inverse relation to muscle strength (Jackson et al., 2010). An increase in physical activity will lead to a decrease in obesity which will inadvertently increase physical fitness. Apathy has also been listed as a factor that leads to decreased physical fitness, as many children and adolescents have inherited behaviour patterns from their parents and may show disinterest in many forms of physical activity (Charlton et al., 2014).

2.4.3 Measurements of physical fitness

Most physical fitness tests comprise of a battery of tests which cover different aspects of physical fitness. These results are then measured against the norms for that test that are age and gender specific. Some physical fitness tests are sports specific (Sleeper et al., 2012). The Eurofit Test battery has proven to be a reliable tool in the assessment of physical fitness (Tsigilis et al., 2002). It consists of nine tests used to assess flexibility (sit-and-reach test), speed, speed-agility (10 x five metre shuttle run), balance (flamingo balance test), muscular strength (hand grip strength), muscular power (standing broad jump), muscular endurance (number of sit-ups in 30 seconds) and cardiorespiratory fitness (20m shuttle run). Ruiz and colleagues (Ruiz et al., 2011) proved the validity of using the Eurofit test components to assess physical fitness especially in situations where there are time constraints (Figure 1).

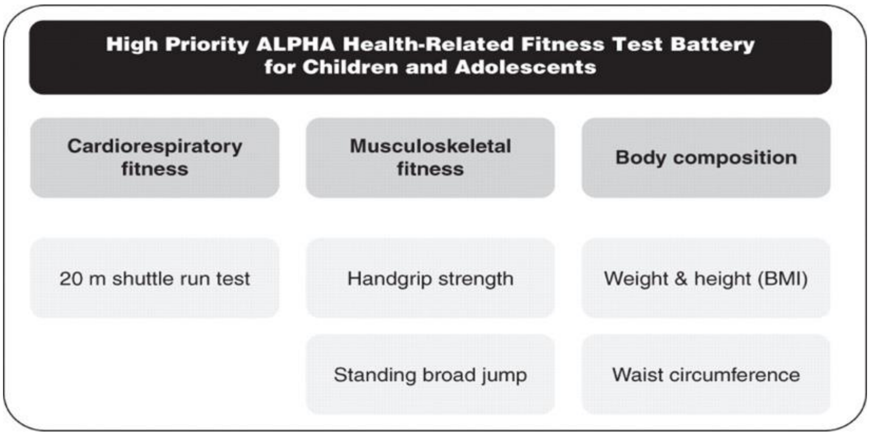

Figure 1: Assessing Levels of Physical Activity (ALPHA) for children and adolescents (Ruiz et al., 2011)

2.5 Interventions

There have been numerous studies that have used various interventions to reduce the prevalence of obesity in adolescents as is evident in systematic reviews (Militello et al., 2018b). Some interventions have involved the use of drugs, however these are not commonly used as many drug trials have been risky in children (Hainer and Hainerová, 2012). Much research has focused on interventions that have focussed primarily on physical activity, diet and lifestyle orientated changes. A systematic review conducted by (Ells et al., 2018) showed that a combination of these interventions has the most beneficial results, compared to interventions addressing individual factors to decrease adiposity and BMI.
Table 7 in section 2.6 makes reference to various intervention studies using different durations of interventions and the outcomes of the respective interventions.

2.5.1 Physical Activity

The type of physical activity (PA) differs between studies and could account for varying results (Staniford et al., 2012). The systematic review conducted by (Staniford et al., 2012) showed that some studies implemented supervised programmes whereas others merely encouraged participants to increase their PA levels. They reported that there was no structured protocol for PA interventions, hence the outcome measurements were different and PA could not be compared. It is known that for physical activity to be beneficial in obesity management, it should be at least 180 minutes per week and preferably three sessions of 60 minutes (Cordero et al., 2014). Alves and colleagues (2019) showed that an exercise frequency of three training sessions per week had more favourable results than twice a week. Alberga and colleagues (2013) proposed ten practical points to consider when choosing a physical activity component after reviewing physical activity interventions in various studies:

2.5.1.1 Setting

Physical activity setting plays an important role in the outcome measures for obesity and the school setting has been proven to be the most beneficial when administering physical activity programmes (Kriemler et al., 2011). This is relevant in the South African setting as most adolescents may not have the space or access to exercise equipment out of school. Adolescents also prefer programmes that are school-based (ALBashtawy, 2015). Barr-Anderson et el (2014) argued that outside school time activities can be beneficial, however this may be questionable with regards to school security after hours, resources for PA participation and supervision, amongst others.

2.5.1.2 Administration of physical activity

The person that administers the physical activity plays an important role and research has shown that the best results were obtained from physical activity programmes that had research assistants with knowledge in kinesiology or exercise therapy (Alberga et al., 2013).

2.5.1.3 PA activity to be varied and fun

Physical activities that have some element of fun like dancing and trampoline activities have been shown to have a greater compliance and therefore attained favourable results (Romero, 2012) (Aalizadeh et al., 2016). The enjoyment factor could have been a key factor in team sports, as an intervention to increase physical activity, having better outcome measures on BMI (Kim et al., 2017).

2.5.1.4 Role of parent/guardian

Supervised physical activity programmes have also been shown to be more beneficial (Ruotsalainen et al., 2015). Parents and guardians or family members play an integral part in the management of obesity (Thomason et al., 2016). Physical activity components that have to be done at home need to involve parents or guardians to ensure compliance and sustainability, and can involve supervision as well.

2.5.1.5 Individual physical and psychological benefits

In the study by Romero et al (2012), the intervention was shown to have increased vigorous PA, as well as decreased psychological barriers with regards to exercise and training.

2.5.1.6 Realistic goals

The study conducted by (Weiss, 2000) revealed that outcome measures were more favourable when achievable physical activity goals and tasks were implemented.

2.5.1.7 Regular Reminders

Regular reminders like text messages to conduct exercises, have shown to be beneficial in assisting in the reduction of BMI (Keating and McCurry, 2015).

2.5.1.8 Multi-disciplinary approach

A systematic review (Psaltopoulou et al., 2019) showed that the multidisciplinary approach to nutrition, behavioural and lifestyle changes, as well as the promotion of physical activity, produced the most favourable results in the management of adolescent obesity.

2.5.1.9 Identify barriers

Robbins et al (2003) demonstrated in their study that identifying barriers to PA could help increase the participation of more children in PA activities and programmes.

2.5.1.10 Deliver the right message

Explanation and communication with the participants demonstrate higher adherence with physical activity programmes, especially in children (Alberga et al., 2013).

2.5.2 Resistance training

Resistance training has been shown to be beneficial in exercise therapy, however, it is important to note that free weight exercises have been shown to have a greater effect on BMI than resistance training using resistance equipment (Lubans et al., 2010). Van de Heijden et el (2010) reported that by using only an aerobic exercise programme of two weekly 30 minute sessions on a treadmill, elliptical or bicycle for 12 weeks had no effect on BMI or weight. The intensity and volume of a study has to be considered. Ardoy et al (2011) showed that by doubling the volume of exercises it had good improvement in flexibility and VO_2 max, and by doubling the volume and increasing the intensity it had very positive results in flexibility, VO_2 max as well as speed and agility (Ardoy et al., 2011). This was also shown in a study where adolescents were tested with moderate and high intensity exercise programmes and the adolescents in the high intensity group showed significant improvements in aerobic capacity, flexibility and agility (Buchan et al., 2011). Resistance training combined with aerobic sessions had greater effects than only using aerobic sessions (Dâmaso et al., 2014). There was significant difference in that the combination of resistance and aerobic training improved lean body mass and decreased adiposity. However Monterio et al (2015) showed that concurrent training (resistance and aerobic) versus aerobic only, produced similar changes in body fat percentages. Similar study done by Sigal et al (2014) showed that combined resistance and aerobic training produced greater changes in body fat, BMI and waist circumference.

Resistance and aerobic activity have merits in decreasing BMI, however a combination of these activities showed greatest change (Sigal et al., 2014). There has been much media hype on the benefits of high intensity interval training (HIIT), however research has shown that this method had no effect on obesity parameters (Eddolls et al., 2017), (Camacho-Cardenosa et al., 2016). It is important to note however that HIIT had good outcomes on cardiovascular markers and prevented the negative effects of a fast food diet (Duval et al., 2017). Eccentric training has shown to have a greater effect on decreasing BMI than concentric training in obese adolescents (Thivel et al., 2020), hence adding this as part of the physical activity will further enhance outcome measures.

2.5.3 Diet Intervention

Obesity management using diet interventions in adolescents showed that diet has a significant influence on the outcome measures of BMI (Militello et al., 2018a). Healthy balanced diet has proven not only to affect physical attributes, it also contributes to executive and cognitive functioning (Xie et al., 2017). An intervention using diet and physical activity was only marginally more effective in reducing BMI than physical activity on its own and not statistically relevant (Aires et al., 2006). However, a controlled trial that focused on results from diet versus diet and exercise versus exercise only showed that the exercise only intervention had the best outcomes (Vissers et al., 2016). It has been discussed that the school environment is the ideal setting for interventions targeting children and adolescents, and it was reported in the White House Paper 2010 (Holzman, 2010) that food programmes in schools had the most favourable results in controlling weight. The South African government have started a National Food Programme, but these programmes have targeted under-nutrition and the growing prevalence of obesity has been over-looked.

2.5.4 Lifestyle Changes

Family involvement has been shown to have the most desirable results in obesity multicomponent interventions in children and adolescents (Spruijt-Metz, 2011).

Table 6: Results from Behaviour Intervention Study (Filgueiras and Sawaya, 2018)

	Base Mean (SD)	6 Months Mean (SD)	13 Months Mean (SD)
Body Fat Percentage	42 (33.3 to 52.2)	42 (29.2 to 52.9)	38 (26.3 to 52.3)
Lean Body Mass %	58 (47.8 to 68.8)	58 (47.1 to 70.8)	61 (47.7 to 76.7)
BMI z-score	2.70 (12 to 4.07)	2.55 (1.72 to 3.89)	2.30 (0.71 to 3.75)
WC (cm)	103 (85.3 to 136.0)	102 (88.0 to 135.2)	99 (76.7 to 12.3)

A study using a behaviour and lifestyle-orientated approach to decrease BMI in adolescents showed good improvement (Table 6) in outcome measures (Filgueiras and Sawaya, 2018). The results obtained from the study was conducted in low-income area in Brazil, and hence results could be pertinent in a South African setting.

Parental involvement and psychology focused interventions in studies have shown favourable results in adolescent's quality of life as compared to weight loss improving quality of life (Murray et al., 2018), (A. Hamid and Sazlina, 2019). It was rather interesting to note that Murray et al (2018) mentioned that adolescents that are overweight or obese reported similar quality of life as adolescents that have cancer. Results from the study showed improvement in quality of life (QoL) (mean difference 0.20 [CI 0.11, 0.29]; $p < 0.01$) and weight (mean difference 0.30 [CI 0.12, 0.47]; $p < 0.01$) following intervention. There were no correlations between weight loss and QoL in the study (Murray et al., 2018). In order for a behaviour and lifestyle component to have significant changes in an intervention, treatment time needs to be a minimum of 26 hours in total and should involve the parents or guardians (O'Connor et al., 2017).

Community and family involvement are fundamental in behavioural changes and achieved positive results in fitness measures (Howie et al., 2016). Sanachez-Olivia and colleagues (2018) studied the outcomes of adolescents who adopted different lifestyles over two years. The study showed that adolescents that adopted a healthy lifestyle of low screen times, low levels of sedentary behaviour and average moderate to vigorous activity, had lower body fat percentages after two years than the other groups (Kuntzleman and Reiff, 1992). These results indicate for any intervention to be successful, there is a need for change in an individual's lifestyle. These changes will include dietary changes, behaviour changes as well as appropriate level of physical activity.

2.5.5 Summary of interventions

The design of a physical activity intervention should take into account key outcome measures from physical activity interventions that have been implemented in research to control obesity and overweight. Table 7 summarises the evidence of key intervention programmes in the last 10 years.

It is evident that for a PA intervention to be successful it has to be a multi-component approach. The necessary components of a PA intervention should include :

1. HIIT to help improve cardiovascular function.
2. Concurrent training (aerobic and anaerobic) as this helps reduce BMI and overall body fat percentage.
3. Use of free weights as, this supports building better muscle strength.
4. Family involvement as this has been shown to increase levels of PA and increases compliance with interventions.
5. PA interventions must be centred around a school environment as this has shown favourable results in the reduction of BMI.
6. The PA intervention must have a fun aspect, preferably with a circuit format as this has shown to increase participation and compliance.

Table 7 Summary of Outcome Measures of Physical Activity Interventions

Year	Authors	Country	Setting	Intervention	No. of participants	Outcome	Comments
2010	Lubans DR, Sheaman C, Callister R.	Australia	School	8 week exercise programme **Group 1** free weights **Group 2** resistance bands and tubing Control group normal activities	n = 108	Body Fat Percentage **Girls** Group 1 pre-test 17.3 % post-test 15.0% Group 2 pre-test 13.6% post-test 12.4% Control group pre-test 14.4% post-test 16.7% **Boys** Group 1 pre-test 27.9% post-test 26.0% Group 2 pre-test 24.0% post-test 23.1% Control group pre-test 23.7% post-test 25.1%	free weights improved lower body strength in girls and upper and lower body strength in boys. Physical activity was not monitored during the testing phase.
2011	Ardoy et al	Spain	School	16 week PA programme **Experimental Group 1 (EG1)** 4 standard sessions PE per week **Experimental Group 2 (EG2)** 4 high intensity sessions PE per week **Control Group (CG)** 2 standard sessions PE per week	n = 67	**VO_2 Max ml/kg/min** **CG** pre-test 39.8 post-test 40.3 **EG1** pre-test 39.5 post-test 42.6 **EG2** pre-test 42.2 post-test 47.1 **Speed-agility (seconds)** **CG** pre-test 12.7 post-test 12.4 **EG1** pre-test 13.1 post-test 12.4 **EG2** pre-test 12.8 post-test 12.0 **Flexibility (cm)** **CG** pre-test 19.8 post-test 18.9 **EG1** pre-test 15.9 post-test 18.1 **EG2** pre-test 16.0 post-test 19.2	Doubling sessions improved aerobic fitness and flexibility and increasing the intensity improved speed-agility. sample size was very small and could have sample bias as sample drawn from one school.
2012	Romero AJ.	USA	School	7 week dance programme to increase PA and self-efficacy	n = 73	PA Activity over 7 days **Girls** Pre-test mean 2.19 Post-test mean 2.72 **Boys** Pre-test mean 2.33 Post-test mean 2.54 **Paired t Tests** $t(54) = -3.87$ $p < 0.001$	Increased vigorous PA and self-efficacy Sample size was small
2014	Sigal et al	Canada	Community Based Facility	22 week programme 4 times a week **Experimental Group 1 (EG1)** aerobic only **Experimental Group 2 (EG2)** resistance **Experimental Group 3 (EG3)** aerobic combined with resistance **Control Group (CG)** non-exercising	n = 304	**Body Fat %** **CG** −0.3 (95%CI,−0.9to0.3) **EG1** -1.1(95%CI -1.7 to -0.5) **EG2** −1.6 (95% CI, −2.2 to −1.0) **EG3** −1.4 (95% CI, −2.0 to −0.8) **Waist Circumference (cm)** **CG** −0.2 (95% CI, −1.7 to 1.2) **EG1** −3.0 (95% CI, −4.4 to −1.6) **EG2** −2.2 (95% CI −3.7 to −0.8) **EG3** −4.1 (95% CI, −5.5 to −2.7) **BMI kg/m^2 diff** **CG** 0.0 (−0.5 to 0.6) **EG1** −0.6 (−1.1 to 0) **EG2** −0.5 (−1.1 to 0) **EG3** −0.9 (−1.4 to −0.4)	Combination training showed best results for decreases in body fat percentage, BMI and WC Inconsistent readings of PA as many participants did not use pedometers as directed. Some results were biased as participants received financial rewards so intervention had better adherence.
2015	Albashtawy M.	Jordan	School	Cross Sectional Study – students to suggest 1. PA Programmes at **School** 2. PA programmes involving **family** 3. PA programs at **leisure**	n = 1126	**School** n = 962 (85.4%) **Family** n = 951 (84.5%) **Leisure** n = 919 (81.6%)	Self-reported so large chance of bias
2016	Camacho-Cardenosa et al	Spain	School	8 week exercise programme 3 sessions per week **Control Group (CG)** 4 to 6 sets of aerobic work at 65-75% maximum heart rate **Experimental Group (EG)** 4 to 6 sets of 20seconds high intensity running	n = 35	**Total Fat Percentage** **Pre**: 21.58 ± 3.93 **Post**: 22.34 ± 3.70; p = 0.05)	Very small sample size Intervention period was too short
2019	Venâncio TI, Honório SAA, Manuel J, Martins, C.	Portugal	School	10 week PA programme Experimental **Group 1 (EG1)** 2 sessions per week Experimental **Group 2 (EG2)** 3 sessions per week **Control Group (GC)** General school exercise programme	n = 40	**BMI (kg/m^2)** **EG1** Pre-test 26.84 ± 3.56 Post 25.49 ± 3.26 **EG2** Pre-test 26.07 ± 1.74 Post 24.87 ± 2.03 **CG** Pre-test 26.06 ± 1.45 Post 26.01 ± 1.45	Programme was very short and sample size was small
2020	Thivel et al	France	Medical Centre	**Phase 1** all participants received 12 week multidisciplinary intervention **Phase 2** **Group 1** 12 week concentric cycling 3 sessions per week **Group 2** 12 week eccentric cycling 3 times per week	n = 24	**BMI kg/m^2** **Group 1** Base 31.8 Post Phase 2 27.6 diff -4.2 **Group 2** Base 34.8 Post Phase 2 29.0 diff -5.8	Small sample size

3. *Chapter 3 Methodology*

This chapter describes the research design, methodology and procedures to gather data as well as the statistical tests used for analysis.

3.1 Research setting

The research was based at urban, public schools in the KwaZulu-Natal Department of Education (KZNDE) within the eThekwini Municipality. Schools were selected from the KZNDE listing of public urban schools.

3.2 Research Design

This study was a descriptive, cross- sectional study.

3.3 Participants

Participants were adolescent students from the eThekwini Municipality schools aged 13 to16 years in grades eight to ten in the middle phase of high schools. Section 4.6 describes in detail the socio-economic of the research setting and the participants. This age group was chosen for the following reasons:

1. Adolescence is a stage between the beginning of puberty and adulthood. During this phase individuals not only undergo physical changes, from the increased production of oestrogen in girls and testosterone in boys, but also emotional, psychological and social changes (Costello et al., 2011).
2. Puberty is defined as the sexual maturation of children (Burt Solorzano and McCartney, 2010).
3. Increased adiposity in childhood will delay puberty in adolescent boys and advance puberty in girls. This will mean that obese or overweight children will go through growth spurts earlier in girls and later in boys. This is due to the increase of growth hormone and insulin-like growth factor during puberty (Burt Solorzano and McCartney, 2010).
4. Adolescents going through puberty have a surge in hormonal levels that does not match the cognitive control system development. This gap in development makes

adolescents more prone to risk taking, e.g. Alcohol consumption, unprotected sexual behaviour, tobacco and narcotic usage (Steinberg, 2004).

5. Adolescents have developed a higher cognitive ability as compared to children,(van den Bosch et al., 2014) and therefore have the ability to comprehend complex topics and terminology in research (Carlisle, 2000).
6. Levels of PA decreases during puberty especially amongst girls and this can account for an increase in the prevalence of overweight (Bacil et al., 2015).
7. Lifestyle trends learnt during adolescence continues into adulthood (Singh et al., 2008).
8. School students were chosen as schools have been identified as providing the most conducive environment for promoting the public health of youth through physical activity (Sallis et al., 2012).

3.3.1 Sampling Frame

The eThekwini Municipality has the largest number of school students attending school than any other Metropolitan in the country (Municipality, 2006). There are 962 public and 89 private schools in the eThekwini Metropolitan (SADE, 2015). There are ten Educational Districts in the KZNDE, of which three fall under the eThekwini Municipality (KZNDE, 2014). The districts that fall under the eThekwini Region have seven circuits. Public schools in the Karanja circuit were chosen using sampling of convenience. Letters of intent were sent to 30 randomly selected schools in the Chatsworth, KZN district and the first ten public schools to respond favourably were selected to be included in the first phase of the study.

3.3.2 Eligibility criteria

3.3.2.1 Inclusion Criteria:

Students meeting the following inclusion criteria were included as participants in the study:

1. 13 to 16 years-old students attending secondary school
2. Enrolled in grades eight to ten
3. Attending an urban school in the Karanja circuit, eThekwini Municipality.

3.3.2.2 Exclusion criteria:

Students not meeting the following exclusion criteria were excluded from participation in the study:

1. A student with a medical condition such as cardiac condition, physical injury/impairment or
2. An acute illness that was confirmed by the parent, child and/or teacher that may endanger/inhibit involvement or influence test results.
3. Any student currently involved in another investigation project or testing.

3.3.3 Sample size determination

The first phase of the study was a cross-sectional study to determine the prevalence of overweight and obesity and levels of physical fitness in adolescent students attending secondary schools in the eThekwini Municipality. A study done on South African adolescents in secondary schools, showed a 25,7% prevalence of obesity and overweight (Reddy et al., 2012b). Epi Info™ Version 3 (Control and Prevention, 2000) was used to calculate the sample size (Table 8).

Table 8: Sample Size Calculation

Population Size (finite population correction) *N*	**1 000 000**
Hypothesized % frequency outcome factor in the population (*p*)	**25% ± 5**
Confidence limits as % of 100(absolute +/- %) (*d*)	**5%**
Design effect (for cluster surveys-*DEFF*):	**1**
Sample Size (n) Various Confidence Levels 95%	**289**
90%	**203**
80%	**124**
Equation	**Sample size** $n = [DEFF*Np(1-p)]/ [(d^2/Z^2_{1-\alpha/2}*(N-1)+p*(1-p)]$

Sample size n = **[DEFF*Np(1-p)]/ [(d²/Z²₁₋α/₂*(N-1)+p*(1-p)]**

$n = 278$

3.3.4 Recruitment

The KwaZulu Natal Department of Education (KZNDE) was approached to seek approval to conduct the research in the eThekwini Municipality. The school principals of the ten randomly selected schools in the eThekwini Municipality circuits were approached to participate in the study. Once approval was obtained from the respective school principal, students who met the inclusion criteria were supplied with an information letter and consent forms for signed consent from their guardians or parents. Students whose parents had completed and signed the consent forms and students who had signed assent forms, following an information session on the nature of the research, were included as participants in the research. Students that refused participation, or had unfinished consent forms, were requested to continue to work with their educators in their relative teaching areas.

The researcher and research assistants involved with the data collection, ensured encouragement of the participants in order that there was no harassment or any discrimination of the participants. Furthermore, all readings documented were done in an predetermined area of privacy with individual participants being assessed and tested behind a screen. This ensured privacy and non-comparison with their colleagues. The 20m shuttle run test was the only test performed in groups of participants. The size of the groups were determined by the availability of space to ensure minimum risk of injury and overcrowding. This is the nature of the test, however, the researcher ensured that adequate explanation was given to all participants before the onset of testing, to eliminate the possibility of competition in the measurements obtained for the tests, but an assurance to the participants that they give the tests their best effort. The researcher was present at all times during the testing, in order that the participants were not discriminated against by their colleagues, and to support all the participants throughout all the testing procedures and measurements.

3.4 Instrumentation

3.4.1 Digital Weight Scale

A digital weight scale (Omron BF214 digital weight scale, HiTech Therapy), was used to calculate weight in kilograms (kg). This was calibrated daily at each data collection setting to ensure reliability and validity using a one kg weight and checking accuracy to 2 decimal points. The digital weight scale has been shown to be a reliable and easy method of recording body weight to 2 decimal points (Kumar et al., 2014).

3.4.2 Height Rod

A stadiometer (Seca 213 Portable stadiometer) was used to measure height in centimetres (cm). The stadiometer has been shown to be a reliable, portable tool to measure body height (Baharudin et al., 2017). Details on the procedures and recording of measurements are outlined in Appendix 21.

3.4.3 WHO Anthroplus Software

The WHO AnthroPlus (WHO, 2009b) was used to calculate BMI z-scores and height for age z-scores (WHO, 2009a). WHO AnthroPlus is a software tool developed by the WHO and is used to monitor growth in children between the ages of five to 19 years-old. The programme uses the anthropometric values of the child's height, weight and age to produce BMI z-scores and HAZ. The details on the application and calculations are in Appendix 23.

3.4.4 Tape measure

An inelastic tape measure read in centimetres (cm) was used to measure waist and hip circumference. This apparatus was also used to measure flexibility and explosive muscle power in the physical fitness tests and is proven to be a reliable and valid measure (Beattie et al., 1990). This was checked for consistency on a daily basis using a meter stick. Details on the procedures and recording of measurements are outlined in Appendix 21.

3.4.5 Digital Dynamometer

A digital hand-held dynamometer (CAMRY Digital Hand Dynamometer Grip Strength Measurement Meter) was used to measure hand grip strength in kilograms (kg). In a study by Espana-Romero et al on measuring hand grip strength in different elbow positions, the hand held dynamometer was found to be valid and reliable to measure of hand grip strength (Espana-Romero et al., 2010). It is easier to hold, and accurate readings are attainable even if the participant is weak. It has also been proven to be more suitable than conventional dynamometers, in situations that require high precision and accuracy (Hogrel, 2015). It was calibrated using a hanging weight force before all testing. Details on the procedures and recording of measurements are outlined in Appendix 18.

3.4.6 Physical Activity Questionnaire – Adolescents

The Physical Activity Questionnaire - Adolescents (PAQ-A) was used to assess the participants' general physical activity patterns. The PAQ-A is a valid self-report activity survey that is easy to administer and takes 10 to 15 minutes to complete (Kowalski et al., 1997), (Kowalski et al., 2004). It comprises of nine questions that assesses general PA over the last seven days. Each question is scored on a five-point score. The ninth question does not add up to the overall score but provides an insight into the general activity patterns and shows unusual physical activity. Physical activity is rated on a scale of one to five, Table 9 outlines the scoring for physical activity. It is a valid and reliable measure that has been tested in South African children (McIza et al., 2007).

Table 9: Scoring for PAQ-A

PAQ-A Total Score	Physical Activity Level
between 1 and 1.9	Low level of PA
between 2 to 3.9	Moderate level of PA
> **4**	High level of PA

3.4.7 ISCOLE Demographic and Family Health Questionnaire- South Africa

A questionnaire was used to obtain valuable information pertaining to the participants family background. The Demographic and Family Health Questionnaire (Appendix 5) collected information on demographics, self-identified ethnicity, family health and socio-economic status, with questions derived from other validated sources (Katzmarzyk et al., 2013). This questionnaire was completed by the parent/s or primary caregiver and legal guardian of the study participant and returned with the informed consent form.

3.5 Measurement Outcomes

3.5.1 Body Mass Index z-scores (BMI z-scores)

BMI z-scores is a measure used to determine obesity and overweight in children and adolescents. It is calculated using the WHO AnthroPlus software (WHO, 2009a) using measures of height, weight, sex and date of birth. The details on the procedure for recording can be found in Appendix 21. The BMI z-score is a value indicating the number of standard deviations from the median as set out by the age and gender specific growth charts (WHO, 2007b).

3.5.2 Waist-Hip Ratio

Research has shown that anthropometric measurement for determining overweight and obesity requires at least two measures, e.g. BMI and Waist-hip ratio (WHR) (WHO, 2008). The WHO acknowledged that the accumulation of abdominal fat was a measurement that could be overlooked in BMI measurement for obesity. WHR is used as a valid measure in combination with BMI to determine obesity. WHR is calculated using the formula

WHR = Waist Circumference (cm)/Hip Circumference(cm)

The details on the procedure to record the measures used to calculate WHR is outlined in Appendix 21. WHO norms for gender and age (Appendix 24) will be used for comparison of findings in this study (WHO, 2008).

3.5.3 Physical Fitness

Physical fitness is comprised of nine important pillars. For this study, the following tests were chosen as they have comparable norms for adolescents (Tomkinson et al., 2018). They were quick to administer as all tests were under five minutes except the 20m shuttle run which was done in a group and took an average of 10 minutes. They required minimal equipment and have a low injury rate (Tomkinson et al., 2018). These measurements include :

1. cardiovascular and respiratory fitness (20m shuttle run)

3 muscular strength (Hand grip test)

4 muscular power (standing broad jump)

5 flexibility (sit-and-reach)

6 muscular endurance (number of sit-ups in 30 seconds)

7 body composition (measures for BMI and WHR)

3.5.3.1 20m Shuttle Run Test

The 20m shuttle run is commonly used as a maximal running aerobic fitness test. This test was used to measure cardio-respiratory endurance. It has been proven to provide a valid and reliable result for measurement of an individual's aerobic capacity (Mayorga-Vega et al., 2015) Appendix 15 details the procedure and scoring for this test.

3.5.3.2 Sit-ups in 30s

It is one of the most conventional tests to measure core trunk strength and endurance. It has been proven to be a valid and reliable indicator of core muscle strength and stability (Armstrong et al., 2011). Appendix 16 details the procedure and scoring for this test.

3.5.3.3 Sit-and-Reach

This test is used to measure flexibility in the hamstrings and lumbar areas. It has been proven to be a valid and reliable measure for flexibility in South African children (Armstrong et al., 2011). Appendix 19 details the procedure and scoring for this test.

3.5.3.4 Broad Jump

The Broad Jump, also called the Standing long jump, is a common and uncomplicated to administer test of explosive lower limb power. It is one of the most commonly used physical fitness test and is used globally. Its validity and reliability has been tested in a South African environment as a measure of physical fitness (Armstrong et al., 2011). Appendix 17 details the procedure and scoring for this test.

3.5.3.5 Hand Grip Strength

This is a straightforward test to administer, however, accurate measurement can provide an objective index of upper body strength (Armstrong et al., 2011). Appendix 18 details the procedure and scoring for this test.

3.6 Research Personnel

Research assistants were post-graduate students in Sports Science from the (University of KwaZulu Natal. Following training with the research supervisor, the researcher commenced extensive training of the research assistants on all testing procedures prior to testing the participants. The researcher ensured training in all testing measures and recording of data to reduce recording errors and bias. Research assistants were also educated on safety measures and the significance of confidentiality. To ensure standardisation and precision, all test procedures were conducted by the researcher and trained assistants, with techniques repeated in the same manner and by the same research assistants for all participants to ensure inter-tester reliability. An anthropometric data recording page was used (Appendix 11). Quality control was ensured by the researcher ensuring completion and accurate recording of all test measures, once all measurements were recorded at the end of the data collection at each of the respective schools.

3.7 Procedure

3.7.1 Ethics Approval

Application for ethical approval was obtained from the University of Cape Town (UCT), Human Research Ethics Committee (HREC 850/2016) before the study commenced (Appendix 8).

The study was conducted in two phases:

3.7.2 Phase 1

3.7.2.1 KZN Department of Education

A letter to the KZNDE was submitted to request their support to conduct the study at the listed eThekwini Municipality schools within the KZNDE (Appendix 1).

3.7.2.2 School Principals

A letter was sent, followed by a telephone call to the principals of the relevant schools to request a meeting informing them of the study. An information letter was given to the school principals (Appendix 2) and signed consent (Appendix 3) was collected by the researcher.

3.7.2.3 Parents

An information letter (Appendix 4), ISCOLE demographic and family health questionnaire (Appendix 10) and consent form (Appendix 5) was sent to the parents of students. Signed consent forms, returned to their teacher, were collected by the researcher before the study commenced.

3.7.2.4 Students

An information sheet (Appendix 6) about the study and procedures that the students could understand, were given to the students. A verbal explanation was given, and the students were provided opportunity to ask questions. This was followed by obtaining assent from the students (Appendix 7).

3.7.2.5 Preparation for Testing

Contact with relevant school representatives was made to identify the pertinent students with signed consent and confirm eligibility for the study. Further communication with the school followed to set up an appropriate date and area for testing. Class lists were obtained from the respective teachers, and those students with signed consent and who met the eligibility criteria were identified on the class lists. Testing was done during the lunch/interval breaks, so that the academic programme was not interrupted.

3.7.2.6 Testing Procedures

3.7.2.6.1 BMI and WHR measurements

Students that formed the sample group were taken to an area of privacy (this was prearranged with the collaboration of the principal and designated teachers at the school). This area was screened and anthropometric measurements for BMI and WHR were calculated. The BMI calculation was then used and compared to the BMI percentiles in Appendix 13 for boys and girls. Appendix 21 describes the detailed procedure for these measures. The digital scale was calibrated daily using a one kilogram weight to check for accuracy. The non-elastic tape measure was measured with a meter stick before all tests to ensure consistency.

Table 10: Measurement Procedures for BMI and WHR

<table>
<tr><th>Measurement</th><th colspan="2">Procedure</th></tr>
<tr><td>Hip</td><td>A non-elastic tape measure was used to measure the hip measurement. The hip measurement was the circumference around the widest part of the hips and was measured at the level of the greater trochanter.</td><td rowspan="4">All measures were taken twice, and a third measure was done if there was a difference of more than 0.5cm between the first two readings.</td></tr>
<tr><td>Waist</td><td>A non-elastic tape measure was used to measure the waist measurement. The waist circumference was taken at the midline between the last palpable rib and the top of the iliac crest.</td></tr>
<tr><td>Height</td><td>Height was measured with the participant standing upright without shoes/socks and with their back against the height rod.</td></tr>
<tr><td>Weight</td><td>Weight was measured using a digital scale read to one decimal place.</td></tr>
</table>

3.7.2.6.2 Testing of Physical Fitness

There was a circuit formation of four testing stations with the researcher overseeing and facilitating the participants and the research assistants at each of the stations. Hand grip strength, broad jump, sit-ups and sit-and-reach was tested at each station. The 20m shuttle run was evaluated in a well-ventilated open area free of obstacles (this was pre-determined with the assistance of principal and educators in the school). To ensure that there was minimal student fatigue during the other physical tests, this was evaluated last by the whole research team. Appendices 15 to 19 outline the details of the tests.

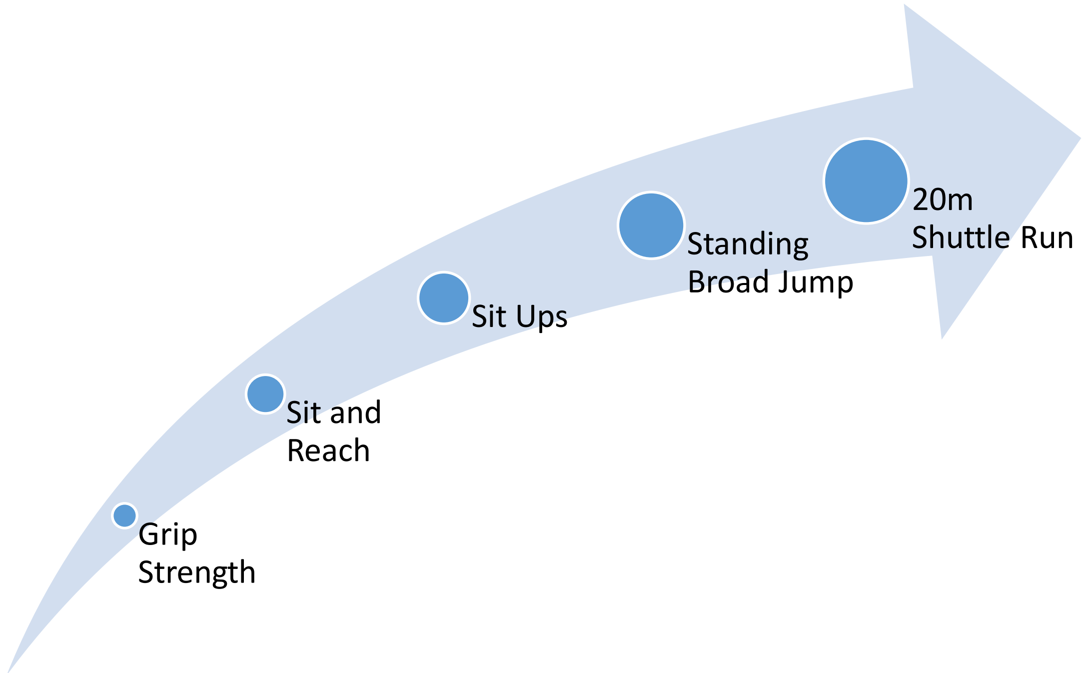

Figure 2: Physical Fitness Tests

3.7.2.6.3 Procedure for Physical Assessment Questionnaire

The Physical Assessment Questionnaires for Adolescents (PAQ-A) were completed in the classroom setting during the first interval, while the tests for BMI and WHR were being conducted. Questionnaires were handed out and collected by the researcher, who ensured that they were correctly and fully completed. The researcher was present at all testing to answer any questions from the participants. A version of the questionnaire in isiZulu was also made available to any student who preferred to answer the questionnaire in isiZulu. A score of one indicates low physical activity, whereas a score of five indicates high physical activity (Kowalski et al., 2004). Appendix 12 describes the scoring procedure for the PAQ-A.

3.7.2.7 *Data Management*

All participants received an identification number on the day of testing, and this was used for the duration of the study. This warranted that demographic information remained confidential and that anonymity was maintained. Data recorded and collected was entered in a Microsoft Excel spreadsheet which was password protected, with access limited to the researcher and the supervisor. The data was stored in a locked room for safety and security.

3.7.2.8 *Statistical Analysis*

The sample was analysed using descriptive data and statistical analysis using STATISTICA (version 13.5.0) and STATA (Version 15). STATISTICA was used for ease of computation (t-tests, Shapiro-Wilk test, Q-Q plots, Mann-Whitney U test, correlation tests, mean, median and confidence interval) by the researcher and assistance was sought from a statistician for multigrade regression analysis who used STATA to analysis the data. Descriptive data showed results with means and confidence intervals (CI). CI shows the probability of the data falling within a certain range. BMI, WHR and measures of physical fitness yield continuous quantitative data. Tests for distribution and normality were undertaken with Q-Q plotted graphs and the Shapiro-Wilk test respectively. Outliers identified in the Q-Q plots were analysed using Grubbs test if they were significant to be included in the data analysis. Independent t-tests were used for normally distributed data and data not normally distributed, was analysed using the non-parametric Mann-Whitney U test. T-tests test (parametric data) and the Mann-Whitney U test (non-parametric data) were used to test if there were significant differences between the means of the sample and the population. Statistical significant was deduced on calculation of $p < 0.05$ as it indicated a significant difference between the population and sample. Correlation tests were conducted to determine the relationship between variables. The statistical calculation of the correlation coefficient (*r)* determined the relationship between the variables. The (*r)* value describes the relationship between the variables, and holds a value between -1 and +1. Values (*r*) between -1 and 0 indicates an inverse relationship with values < -0.7 showing a stronger inverse correlation. Values (r) between 0 and +1 indicates a direct correlation with values > 0.7 showing a stronger direct correlation between variables.

3.8 Ethical Considerations

Information letters and informed consent/assent forms noting the UCT-No-fault Insurance policy was given to the principals, parents and students participating in the study (Appendix one to eight). All participants and parents received a fact sheet on obesity, overweight and physical activity as set out by the WHO (Appendix 22). Principals and students who do not wish to partake in the study were not coerced into taking part, thus participation was voluntary. Participants also had the right to withdraw at any time during the study with no penalties incurred. The researcher and research assistants who were involved with the data collection, ensured support of the participants in order that there was no bullying or any discrimination of the participant. Further, the measurements to be taken was done in the privacy of an allocated space, with individual participants being measured and tested behind a screen where the participant was away and not in view of other participants. This facilitated privacy and non-comparison with their peers. The only test that would was done in groups was the Bleep test. This is the nature of the test, however, the researcher ensured that an explanation was given to all participants before testing, that there was no competition in the measurements obtained for the participants, but an assurance from the participants that they give the tests their best attempt. The researcher was on-hand at all times during the testing, in order that the participants were not discriminated against by their peers and to support all the participants throughout all the testing procedures.

The participants were not at any risk of harm or exploitation during the study. The tests were performed at the participant's own pace. The research team supervised all activities and were vigilant to any signs of fatigue or injury. Participants were also encouraged to report to the research team if he/she felt uncomfortable or dizzy during any of the testing procedures. It was stressed to the participants that the tests were not a competition so that they do not push themselves beyond their physical capabilities and increase the possibility of injury.

All participants received an identification number on the testing day, and this was used for the rest of the study. This ensured that demographic information remained confidential and that anonymity was maintained. Data collected was entered in an Excel spreadsheet which was password protected, with access limited to the researcher and the supervisor. The data was stored in a locked room for safety and security.

The study was conducted during school intervals and did not affect the school academic programme. The participants did not receive any payment and the school, parents and participants did not have to pay anything to participate in the study. Participants that were involved in the study received a healthy snack and beverage after the testing phase.

The principals and parents were given a summary of the completed study and positive outcomes that can be used to improve physical fitness and lower the prevalence of obesity and overweight.

4 Chapter 4: Results

This chapter reports on the results of the prevalence and correlates of obesity in adolescents regarding physical activity, physical fitness and related individual and contextual factors. The characteristics of the participants are first described; this is followed by examining the relationship between PA, PF, family structures and socio-economic indicators, BMI and the prevalence of obesity. The key sampling strategy was based in schools, with data collection therefore being conducted during the school year.

4.1 Sample

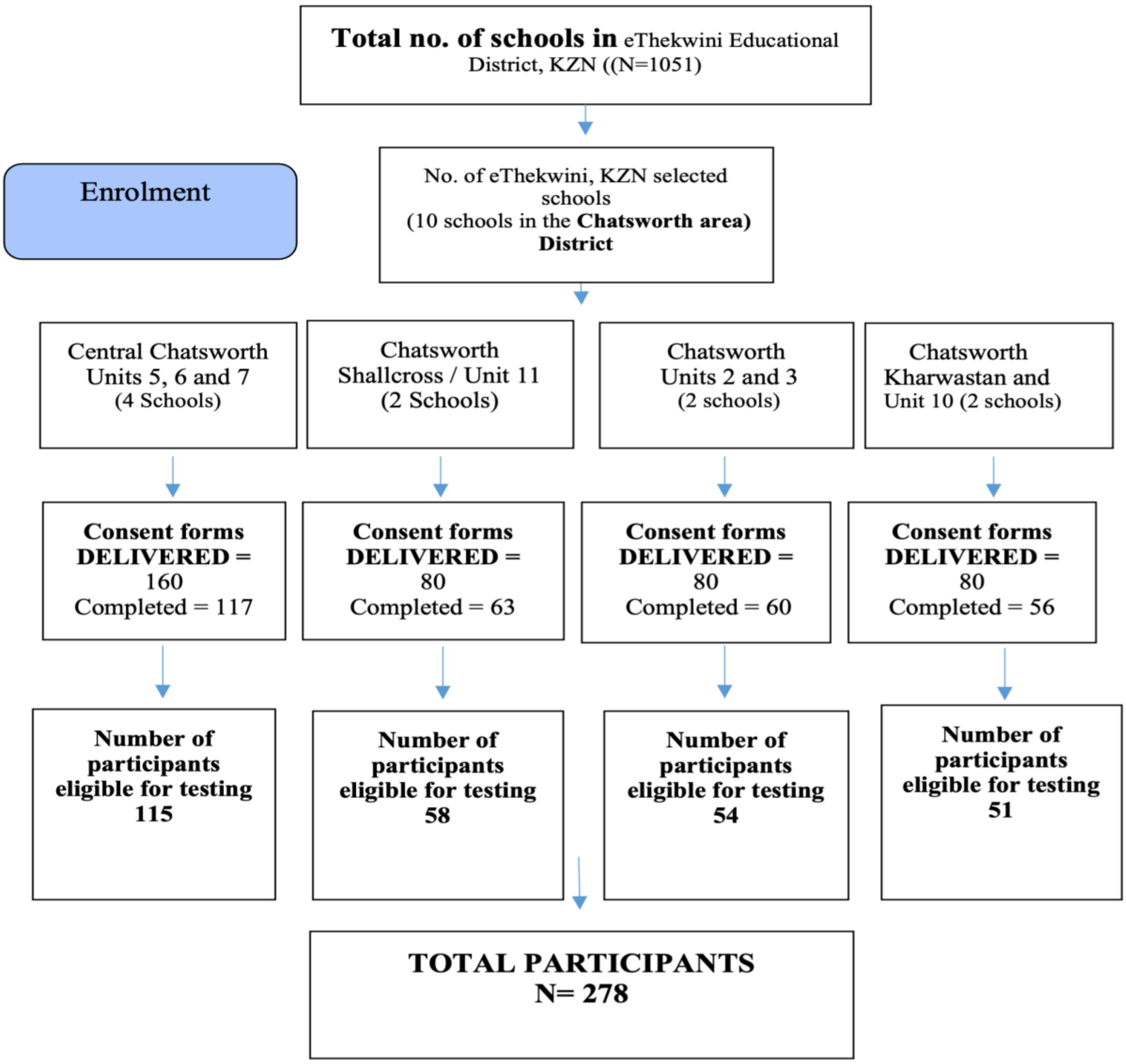

Figure 3 Flowchart showing selection of participants

Figure 3 indicates the recruitment and enrolment of participants and the final sample of 278 participants. The schools selected were all public schools in the suburb of Chatsworth, within the eThekwini Municipality, KwaZulu Natal (KZN). A total of 400 students who met the selection criteria were provided with consent forms for completion by their parents. There was a total return rate of 83.5% (n=334) of forms. There were 88.6% (n=296) completed forms and 11.4% (n= 38) incomplete forms. On analysis of the returned completed forms, four students did not meet the inclusion criteria and was excluded from the study. A further 14 students were absent on the day of testing, and a final sample of 278 students were included in the study (participation rate of 69.5% of the total number of consent forms delivered).

4.1.1 Gender Representation

There were 128 boys (n =128, 46%) and 150 girls (n = 150; 54%) in the final sample. Table 11 reflects the gender representation at the different schools in the sample.

Table 11: Gender Representation in sample

School District	School	Number of boys	Number of girls	Total per school district in sample	Ratio Boys: Girls
Chatsworth Central	1	21	18		
	2	17	20		
	3	20	19		
	Total	**58**	**57**	**115**	**58:57**
Chatsworth Shallcross/Unit 11	4	16	10		
	5	11	21		
	Total	**27**	**31**	**58**	**27:31**
Chatsworth Unit 2,3	6	12	19		
	7	12	11		
	Total	**24**	**30**	**54**	**23:40**
Chatsworth Unit 10, Kharwastan	8	12	6		
	9	7	26		
	Total	**19**	**32**	**51**	**25:15**
TOTAL		**128**	**150**		**128:150**
TOTAL	**278**				

4.1.2 Age distribution

The participants ages ranged from 12 to 17 years-old (Figure 4) with a mean of 15 years 1 month (CI 95% 12,1 – 17.1 and SD 1.14). t-tests showed no significant differences between the ages of boys and girls in the sample (*p* = 0.57).

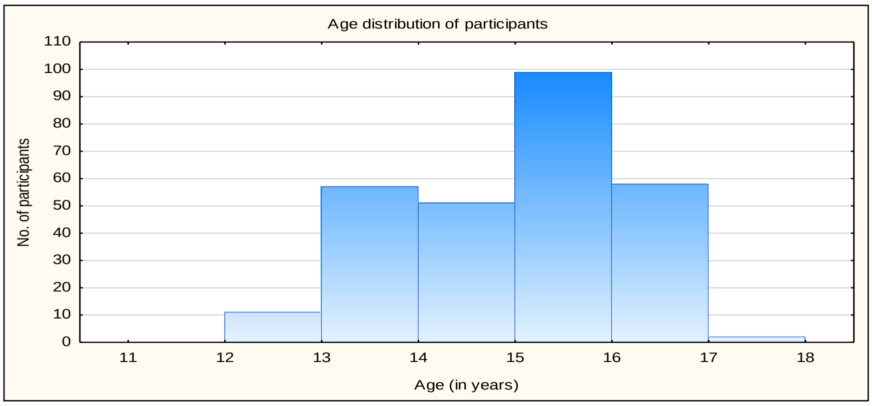

Figure 4: Age distribution of all participants

4.2 Growth and Weight Status

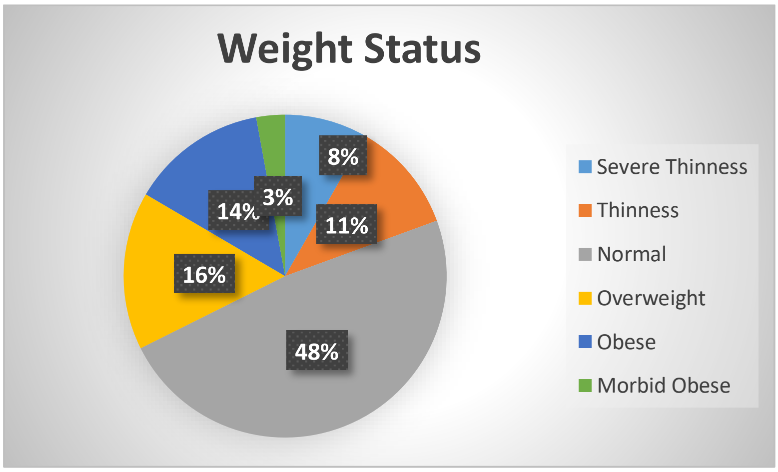

Figure 5: Categories of weight status as presented in this study

There were 134 participants that were classified as having normal weight (girls *n* = 73; boys *n* = 61), 54 were underweight (girls *n* = 27; boys *n* = 27) and 90 were overweight/obese (girls *n* = 50; boys *n* = 40) (Figure 5).

4.2.2 BMI z-score

The mean BMI z-scores of all the participants was 0.30 (CI 95% 0.12 to 0.49) (Table 12).

Table 12: Mean BMI z-scores

	Mean	Minimum	Maximum	SD
BMI z-score	0.30	-4.02	3.44	1.55

***n* = 278**

Table 13 shows the cumulative BMI z-scores as represented by the different weight categories.

Table 13: Frequency table for BMI-for-age z-score

BMI z-score	Count	Cumulative	Percent	Cumulative %	Classification
-5,00 <x< =-4,00	1	1	0,4	0,4	Severe Thinness
-4,00 <x< =-3,00	1	2	0,4	0,7	
-3,00 <x< =-2,00	21	**23**	7,6	8,3	
-2,00 <x< =-1,00	33	**56**	11,9	20,1	Thinness
-1,00 <x< =0	66	122	23,7	43,9	Normal
0 <x< =1,00	66	**188**	23,7	67,6	
1,00 <x< =2,00	45	**233**	16,2	83,8	Overweight
2,00 <x< =3,00	37	**270**	13,3	97,1	Obese
3,00 <x< =4,00	8	**278**	2,9	100	Morbidly Obese

Table 14: Mean BMI z-scores of Boys and Girls

	BMI z-score of sample	BMI z-score population norms (WHO, 2007c)
Boys	0.19 (CI 95% -0.89 to 0.46)	-1.77 to 0.12
Girls	0.39 (CI 95% 0.15 to 0.65)	-1.40 to 0.14

n = 278

The BMI z-scores for boys and girls were above that of the population norms.

4.2.3 Height-for-Age

The mean Height-for-Age (HAZ) of the sample was -0.44 (CI 95% -0.57 to -0.32). HAZ scores showed that five percent of the participants had stunted growth (n = 14) and one percent had severe stunting (n = 3) (Table 15). Girls had a mean HAZ of -0.36 (CI 95% ± 0.16) and boys -0.54 (CI 95% ± 0.19)

Table 15: Height for age z-scores

	Mean	Minimum	Maximum	Standard Deviation
HAZ	-0.44	-3.66	2.40	1.04

4.3 Waist-hip Ratio

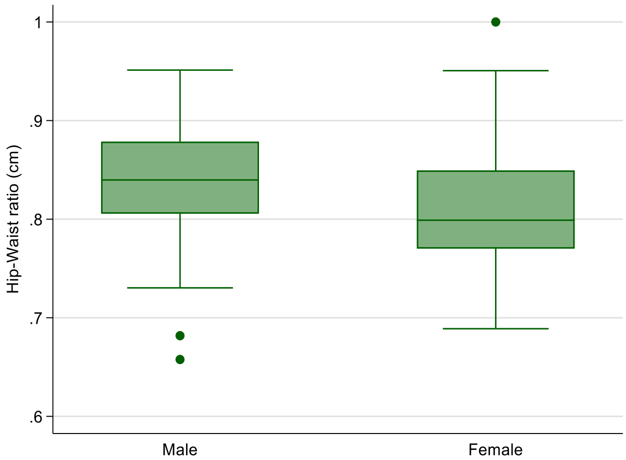

Figure 6: Gender representation of WHR

The mean waist-hip ratio (WHR) for the sample was 0.82 (CI 95% 0.81 – 0.83). Table 16 outlines WHR results for boys and girls in this study.

Table 16: WHR for boys and girls with WHR normative values (Fredriks et al., 2005)

	Mean	Min	Max	*n*	Norms	*n > Norms*
Boys	0.84	0.65	0.95	128	0.82	72
Girls	0.81	0.68	1	150	0.77	101
Total	0.82	0.65	1	278	0.79	173

4.4 Physical Fitness

On examination of the individual physical fitness test scores, sit-and-reach scores were greater than the population mean norms for both boys and girls; with boys at 27.37cm (CI 95% 26.72 – 28.52) and girls at a higher mean of 27.46cm (CI 95% 26.17 – 28.75). Girls in our study also had a higher mean for hand grip strength of 25.72kg (CI 95% 24.67 – 26.78).

Table 17 outlines the differences between the sample and the population means in the five physical fitness tests.

Table 17: Mean of participants and Population (Tomkinson et al., 2018) Physical Fitness Tests

	Boys ***n =278***	**Boys Population Norm mean**	**Girls** ***n* = 150**	**Girls Population Norm mean**
Sit-and-Reach (cm)	27.37	19.15	27.46	24.40
Hand Grip (kg)	30.55	35.50	25.72	22.80
Broad Jump (cm)	147.99	185.2	118.79	119
Sit-Ups (No. in 30s)	14.98	23.33	11.12	19.50
20m Shuttle (Laps)	37.73	55.83	23.93	32

t-tests were done to check for differences between the sample and the population are shown in Table 18. Girls in the sample had a higher mean for sit-and-reach (t = 4.68, ***p* < 0.05**) and hand grip (t = 5.49, ***p* < 0.**05) than the normative values obtained by Tomkinson et al (2018). However, girls in our sample did have lower mean values for broad jump, sit-ups and 20m shuttle run than the population.

Table 18: t-tests for physical fitness in girls

	Mean	**SD**	**t-value**	***p***	**Critical *t* value**
Sit-and-Reach	27.46	7.99	4.68	< **0.05**	±1.976
Hand Grip	25.72	6.53	5.49	< **0.05**	± 1.976
Broad Jump	118.79	28.74	-14.36	< **0.05**	± 1.976
Sit-Ups	11.12	5.11	-20.08	< **0.05**	± 1.976
20m Shuttle Run	23.93	9.34	-10.58	< **0.05**	± 1.976

***n* = 150**

Boys in the sample (Table 19) had higher mean (t = 13.2, ***p* < *0.05***) for sit-and-reach than normative mean values obtained in the study by Tomkinson et al (2018). The four other physical fitness tests (hand grip, broad jump, sit-ups and 20m shuttle run had lower means than the mean values from the study by Tomkinson et al (2018).

Table 19: Physical fitness in boys

	Mean	SD	*t*-value	*p*	Critical *t* value
Sit-and-Reach	27.37	7.08	13.12	< ***0.05***	± 1.97
Hand Grip	30.55	8.27	-6.77	< ***0.05***	± 1.97
Broad Jump	147.98	31.34	-13.44	< ***0.05***	± 1.97
Sit-Ups	14.98	5.35	-17.65	< ***0.05***	± 1.97
20m Shuttle Run	37.73	19.30	-10.61	< ***0.05***	± 1.97

n = 128

Correlation tests were done to examine the relationship between physical fitness and BMI z-scores (Table 20) Table 20 outlines these correlations.

Table 20: Correlation between BMI z-scores and physical fitness

	Total		Boys		Girls	
BMI for age z-score versus	**Correlation coefficient**	***p***	**Correlation coefficient**	***p***	**Correlation coefficient**	***p***
Sit-&-reach (cm)	0.042	0.47	0.02	0.81	0.06	0.43
Hand grip (kg)	0.1663	***0.005***	0.20	***0.02***	0.20	***0.01***
Sit-up (No. in 30 secs)	-0.26	***0.0000***	-0.33	***0.0001***	-0.19	***0.01***
Broad jump (cm)	-0.23	***0.0001***	-0.26	***0.002***	-0.20	***0.01***
20m Shuttle laps	-0.22	***0.0001***	-0.29	***0.0006***	-0.10	0.19

Hand grip strength had a weak positive correlation for the total sample (r = 0.16, p < 0.05). This weak correlation was also demonstrated in boys (r = 0.20, p < 0.05) and girls (r = 0.20, p < 0.05). Boys had a weak negative correlation between sit-ups and BMI z-scores (r = -0.33, p < 0.05). Boys (r = -0.26, p < 0.05) and girls (r = -0.20, p < 0.05) had very weak correlations between broad jump and BMI z-scores. Very weak negative correlation was also observed between 20m shuttle runs and BMI z-scores in boys (r = -2.9, $p < 0.05$) and the total sample (r = -0.22, $p < 0.05$).

4.5 Physical Activity

Physical activity was self-reported using the PAQ-A questionnaire (Appendix12). Table 21 shows the overall physical activity levels of the participants.

Table 21: PAQ-A summary of activity levels

	Low PA Levels (%)	**Moderate PA Levels**	**High PA Levels**
Boys	42	83	3
Girls	83	66	1
Total	***125 (45%)***	***149 (53.6%)***	***4 (1.4%)***

N =278

Almost all the participants had between low (45%) and moderate (53.6%) PA levels. Table 22 shows the frequency of PA reported in a calendar week.

Table 22: Frequency of PA reported over 7 days

Weekly Frequency of PA	**Boys %**	**Girls %**	**Total %**
None	15.48	23.9	39.38
Little Bit	10.84	15.21	26.05
Medium	11.56	6.73	18.29
Often	4.57	5.60	10.17
Very Often	3.65	2.46	6.11

N = 278

Data extracted from the PAQ-A showed that 65.43 % of the sample engaged in little to no PA in a week. Table 23 outlines the mean PA values for boys and girls in the sample.

Table 23: PAQ-A mean for boys and girls

	Boys				Girls			
PAQ-A	*N*	Mean	SD	*p*	*N*	Mean	SD	*p*
	128	2.47	0,80	<.005	150	2.09	0,70	0,10

N = 278

Figure 7 details the physical activities of choice between the sexes. The majority of the sample participated in the following sports: 67% walking (37% girls and 30% boys), 47% jogging (22% girls and 25% boys), 44% dance (28% girls and 16% boys), 33% soccer (8% girls and 25% boys), 25% skipping (12% girls and 13% boys) and 25% tag (12% girls and 13% boys).

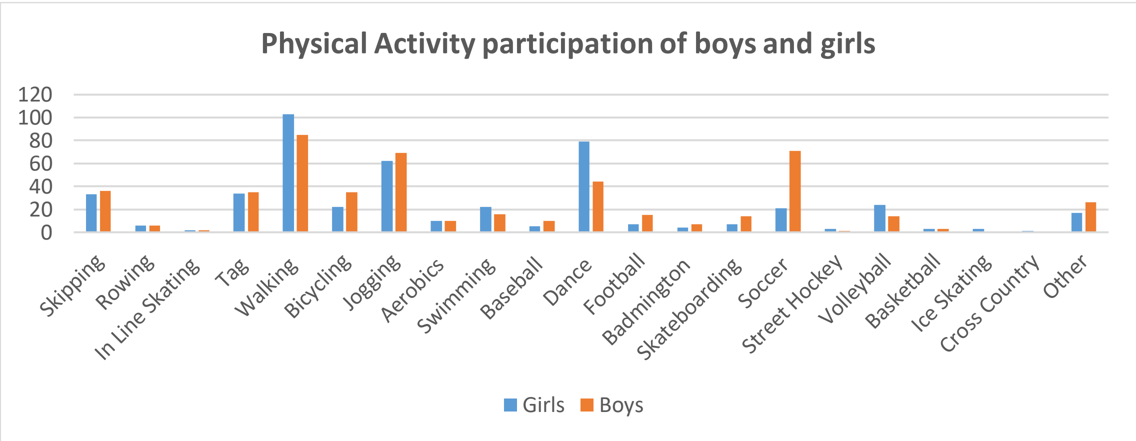

Figure 7: Gender representation of Physical Activity

4.5.1 Physical activity and weight status

Correlation tests were done to determine if there was a relationship between PA and BMI z-scores. No significant differences between BMI z-scores and PA were found in this sample (Table 24).

Table 24: PAQ-A versus BMI z-scores

	Correlation coefficient (r)	p
Total	0.003	0.94
Male	0.05	0.55
Female	-0.01	0.84

4.4 Socioeconomic Status and Demographics

The suburb of Chatsworth is historically an Indian suburb, created by the apartheid regime to enforce the Group Areas Act of 1950. This act compelled people of different races to live in designated areas (Vahed, 2013). People that were forced to live in Chatsworth by the South African apartheid regime, were of low socioeconomic status, however new areas in Chatsworth were developed at later stages that catered for people in the middle and upper socioeconomic status (SES) bracket (Pillay, 2010). The history of Chatsworth was reflective in our sample with 54.5 % (n = 149) of Indian origin, 37% (n=104) of African origin, five percent (n = 15) of mixed origin, three percent (n=9) of Caucasian origin and 0.5% (n=1) of Asian origin.

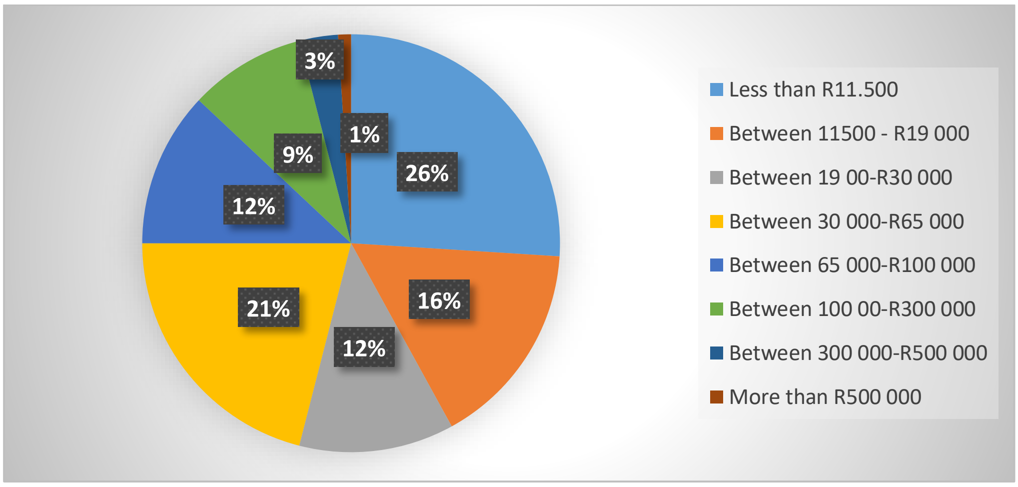

Figure 8: Representation of Gross Annual Family Income

The above Figure 8 represents the family income which is an indicator of SES.

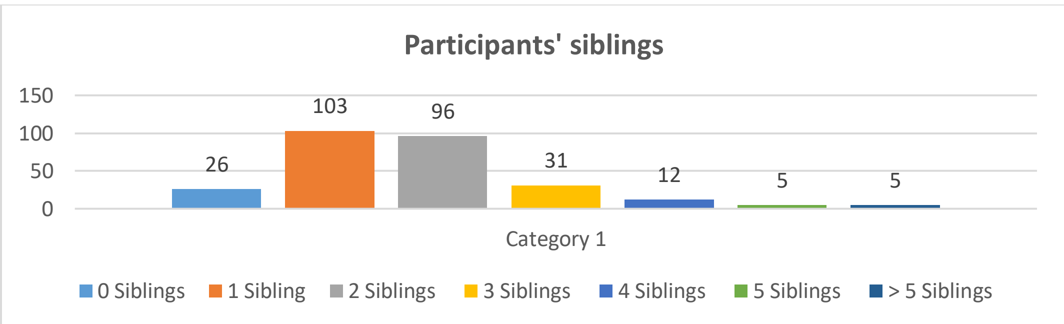

Figure 9: Representation of Participants' Siblings

Figure 9 shows family dynamics and indicates that 103 participants (37.1%) had one sibling and 96 participants (34.5%) had two siblings.

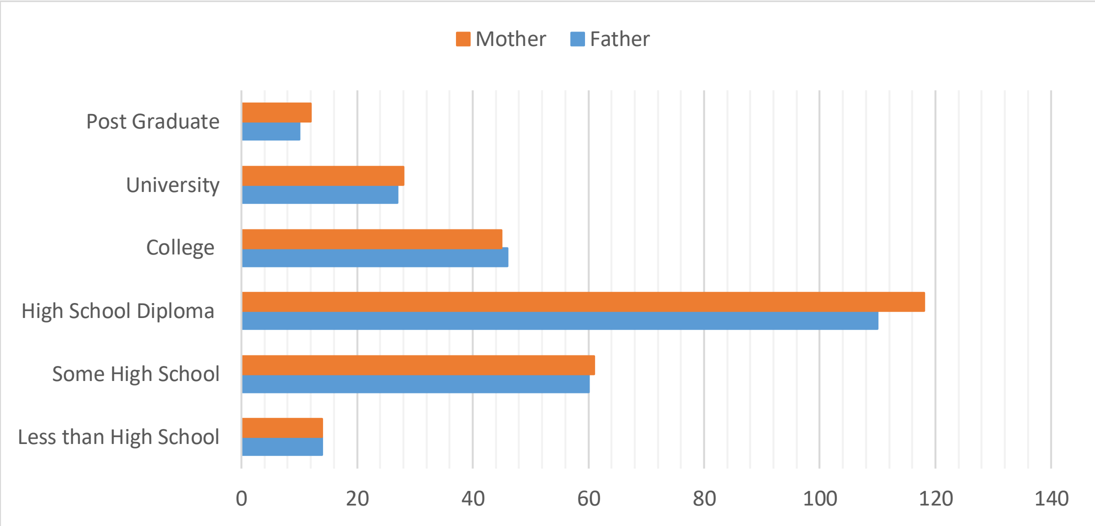

Figure 10: Educational status of participants parents

Figure 10 represents the level of education of the parents. The majority of mothers of the participants had high school diplomas (*n* = 118) than the fathers (*n* = 110). This trend followed into the tertiary environment as more mothers of the participants (*n* = 85) had formal qualifications compared to fathers (*n* = 83). Correlation tests (Table 25) were done to calculate the correlation coefficient (*r*), and establish if there was a relationship between the participants BMI z-scores and the parents BMI. The total sample had a very weak positive correlation ($r = 0.23$, $\boldsymbol{p < 0.05}$), with girls having a stronger positive correlation ($r = 0.30$, $\boldsymbol{p < 0.05}$) between BMI of the parents and the participant's BMI z-scores.

Table 25: Parents BMI versus participants BMI z-scores

	Correlation coefficient (*r*)	***p***
Total	0.23	< ***0.05***
Boys	0.13	*0.14*
Girls	0.30	< ***0.05***

4.6 Predictors of physical fitness and physical activity

Table 26: Predictors for BMI z-scores and WHR

		BMI z-scores			WHR		
		Coefficient (ß)	***p***	**95 % Confidence Interval**	**Coefficient (ß)**	***p***	**95 % Confidence Interval**
Combined Boys & girls	Sit-ups	-0.07	< ***0.05***	- 0.10 - 0.03	-	-	-
	Hand Grip	0.07	< ***0.05***	0.05 - 0.09	0,001	< ***0.05***	0.0002, 0.001
	Broad Jump	-0.01	< ***0.05***	-0.01 - 0.005	-	-	-
	20m Shuttle	-	-	-	0,001	< ***0.05***	0.0007, 0.001
	Sit and Reach	-	-	-	-0,001	< ***0.05***	-0.002, -0.0008
Boys	Sit-ups	-0.10	< ***0.05***	-0.15 - 0.05	-	-	-
	Broad Jump	0.07	< ***0.05***	0.04 - 0.10	-	-	-
	Hand Grip	-0.01	< ***0.05***	-0.02 - 0.006	-	-	-
	High PA	1.20	< ***0.05***	0.15 - 2.33	-	-	-
	20m Shuttle				0,0006	< ***0.05***	0.0001, 0.001
Girls	Broad Jump	-0.01	< ***0.05***	-0.01 - 0.001	-	-	-
	Hand Grip	0.06	< ***0.05***	0.03 - 0.10	-	-	-
	Sit-ups	-0.05	< ***0.05***	-0.10 - 0.002	-	-	-
	20m Shuttle	-	-	-	0,001	< ***0.05***	0.0009, 0.002
	Sit and Reach	-	-	-	-0,002	< ***0.05***	-0.003, -0.0009

Multiple regression models were used to establish if BMI and WHR (Table 26) were predictors for PA and PF. BMI was an inverse predictor for sit-ups (ß = -0.07, $p < 0.05$), broad jump (ß = -0.01, $p < 0.05$) and a positive predictor for handgrip (ß = 0.07, $p < 0.05$) in the combined sample. In boys BMI was a positive predictor with high levels of PA (ß = 1.24, $p < 0.05$). WHR was a positive predictor for 20m shuttle run in the combined sample and in both sexes. WHR was an inverse correlation for sit-and-reach in the combined sample (ß = -0.001, $p < 0.05$) and for girls (ß = 0.002, $p < 0.05$).

Table 27: Physical Fitness predictors for BMI and HAZ

		Combined Sample			Boys			Girls		
		Coefficient ß	***p***	**95% CI**	**Coefficient ß**	***p***	**95% CI**	**Coefficient ß**	***p***	**95% CI**
Hand Grip	BMI z-scores	0,83	< ***0.05***	0.23, 1.42	1.16	< ***0.05***	0.26, 2.06	0.79	< ***0.05***	0.12, 1.46
	HAZ	1,78	< ***0.05***	0.90, 2.66	2.65	< ***0.05***	1.34, 3.96	1.41	< ***0.05***	0.39, 2.43
Broad Jump	BMI z-scores	-5,47	< ***0.05***	-7.98, -2.97	-5.34	< ***0.05***	-8.68, -2.001	-4.19	< ***0.05***	-7,10, -1,27
	HAZ	7,47	< ***0.05***	3.74, 11.19	10.07	< ***0.05***	5.22, 14.93	10.07	< ***0.05***	5.22, 14.93
Sit-ups	BMI z-scores	-0,97	< ***0.05***	-1.38, -0.56	-1.09	< ***0.05***	-1.63, -0.55	-0.64	< ***0.05***	-1.17, -0.101
	HAZ	0,71	< ***0.05***	0.10, 1.32	1.22	< ***0.05***	0.44, 2.01	-	-	-
20m Shuttle	BMI z-scores	-2,45	< ***0.05***	3.71, -1.19	-3.75	< ***0.05***	-5.86, -1.63	-	-	-

Multiple regression models were also done on PF and PA (Table 27) to establish if they were predictors for BMI and HAZ. Hand grip strength was shown to be a positive predictor with BMI and HAZ in the combined sample together with the individual sexes. Broad jump was a positive predictor for HAZ with the combined sample (ß = 7.47, $p < 0.05$) and for the individual sexes. Broad jump had an inverse predictor relationship with BMI in the combined sample (ß = -5.47, $p < 0.05$) as well as in boys and girls.

Sit-ups was a common predictor for BMI across the sample displaying an inverse correlation predictor pattern. Sit-ups was a positive predictor for HAZ in the combined sample (ß = 0.71, $p < 0.05$) and for boys (ß = 1.22, $p < 0.05$), but not for girls. The 20m shuttle run was an inverse predictor for BMI only in boys (ß = -3.75, $p < 0.05$) and the combined sample. The 20m shuttle run was not a predictor for girls BMI nor HAZ in girls.

In summary BMI was a predictor for sit-ups, hand grip strength and broad jump in the sample. WHR was a predictor for 20m shuttle run, sit-and-reach and hand grip strength in the combined sample. Sit-ups, broad jump and hand grip strength were predictors for BMI and HAZ in the total sample and the 20m shuttle run was a predictor for only BMI in the sample.

5. Chapter 5 Discussion

5.1 Introduction

Children in the representative sample of KZNDE eThekwini Municipality did not meet the PA requirements and performed poorly in the physical fitness test components related to agility and speed and relatively well in the items requiring flexibility and strength. WHR was a predictor for speed and agility (20m shuttle run), flexibility (sit-and-reach) and (hand grip) muscle strength in the combined sample. Sit-ups, broad jump and hand grip strength were predictors for BMI and HAZ in the total sample, and the 20m shuttle run was a predictor for BMI only in the sample. The percentage of adolescents who were in the range of overweight, obese and morbidly obese was found to be 32.4%. BMI was a strong predictor for sit-ups, hand grip strength and broad jump in both boys and girls.

5.2 Sample

The total sample is reflected in the flowchart (Figure 3) and was reflective of research conducted with a larger representation of girls than boys. Girls have been shown to have better organisational skills than boys, and take more initiative especially in completing tasks (Zenger and Folkman, 2019). This could account for more girls returning completed consent forms. Girls tend to have an greater affinity towards body appearance as compared to boys and are more prone to dieting or trying an intervention to change their body image (Neumark-Sztainer and Hannan, 2000) which could account for more participation by girls than boys. Self-esteem is inversely proportional to weight or body image in girls and could be one of the factors that encourage girls to be involved in interventions to alter their body image (Thompson et al., 2006)

5.3 Growth and weight status

5.3.1 Body Mass Index

KwaZulu Natal has the highest prevalence of overweight learners (25.5%), according to the South African National Youth Risk Behaviour Survey 2008 (SANYRB) (Reddy et al., 2012b). There was a 16.2% prevalence of overweight and 16.2% prevalence of obesity in the sample in our study. There was an 8.9 % prevalence of overweight in girls and 7.3% in boys, compared to the national prevalence of 29 % and 11% respectively. Obesity prevalence amongst girls was 9.0% and 7.2% in boys, compared to the national prevalence of 7.5% in adolescent girls and 3.3% in boys (Reddy et al., 2012b). Our sample also displayed higher obesity prevalence than the global adolescent prevalence of 6% in girls. Boys in our study had a lower prevalence than the global obesity prevalence of 8% in boys (WHO, 2016f). Our results were in keeping with another study conducted in South Africa (Jinabhai et al., 2007) where girls displayed higher mean BMI scores than boys. The authors cited boys as being more physically active in sports and outdoor activities, while girls were kept at home to help with chores and often indulged in sedentary activities like television watching, thus increasing the risk of obesity. Maternal BMI is a predictor for girls BMI as demonstrated in this study and a study conducted in China (Chen et al., 2007). As shown in the literature review (Chapter 2, section 2.2.2), South African women have the highest prevalence of obesity in Africa and this could be a contributing factor for the higher overweight and obesity prevalence amongst adolescent girls. The formal education of most parents/guardians observed in our study was of a low level, as most participants (87%) were from areas of low SES. Thomason et al (2016) showed that parents form one of the cornerstones in the weight management of children, and the lack of knowledge surrounding weight management could have been a contributing factor to the high prevalence of obesity in our sample. An inverse correlation between parents education and girls BMI were reported to have been a contributing factor for the higher prevalence of obesity in girls (Ekeland et al., (2005) reported. The suburb of Chatsworth has many informal settlements and most of the children who reside in these informal settlements attend schools in this area (Sewpaul and Pillay, 2011). As discussed in Chapter two, many people who reside in informal settlements form part of the rural-urban drift. This population form part of the lower SES and their diet comprises of cheap and high caloric, yet low nutritional value meals (Temple and Steyn, 2011). This could account for one of the reasons for the higher prevalence of obesity in our sample. Informal urban settlements residents have limited living and recreational spaces which impacts negatively on PA (Booth et al., 2005). Research has shown that PA is inversely correlated with BMI and this could be a factor contributing to the high prevalence of obesity (Vasconcellos et al., 2014, Reichert et al., 2009). Chatsworth also has formal residential areas, with some of these falling into the lower SES and some areas falling into a high SES (Pillay, 2010). (Seydel et al., 2017) reported in a study done on developing countries (South Africa, Brazil, Turkey) that obesity is directly correlated with increases in SES. This is referred to as the “social drift” phenomenon (Steyn, 1995) and contradicts evidence from developed countries where SES is inversely correlated with obesity and could account for the higher prevalence of obesity in our sample. The obesity prevalence in our study was higher than the reported 8.5% prevalence for adolescent scholars in another study conducted in Tshwane (Ngwenya and Ramukumba, 2017). The participants came from different areas of the Tshwane Metropolitan which could have different SES (low, middle and high). As illustrated in the literature review SES are good predictors for obesity and overweight, providing accountability for the higher BMI values in our study, as the participants were from one district with the majority from a low and some from a high SES within the eThekwini Municipality. It was interesting to note that the prevalence of overweight in our sample was lower than the national reported levels, however, the prevalence of obesity was higher in both sexes than the national prevalence. This could point to rapid weight increases of adolescents in KZN.

5.3.2 Height for age z-scores

Boys had a 3.9% prevalence of stunting, which is much lower than reported figures of 21.9% for adolescent boys in a study conducted in South Africa (Jinabhai et al., 2007). Jinabhai et al (2007) also reported a prevalence of 9.4% stunting in adolescent girls, which was still higher than the 1.8% observed in the girls of this study. One of the reasons for these differences could be that the participants from the study done by Jinabhai et al (2007) were of Black decent only as compared to our study that had a mixture of races. Jinabhai et al (2007) reported that food insecurity coupled with poverty placed the black South Africans, especially males, at a disadvantage during the important phase of childhood growth and pubertal maturity and accounts for the high prevalence of stunting and under-nutrition. The authors also reported that the South African male nutritional status was in keeping with other developing countries, however, girls had a higher prevalence of obesity and followed the weight trends displayed in girls and boys in developed countries. A study done in Bloemfontein, South Africa (Meko et al., 2015) reported a 10.3% prevalence of stunting in boys and 4.2% in girls, which is considerably higher than the figures recorded in our study. The authors included participants from all SES in their study and the results could be a fair representation of the South African population, whereas our study had the majority of the participants from one SES and district and could account for the differences observed between our study and that in the setting in Bloemfontein.

5.4 Waist-hip ratio

The mean waist-hip ratio (WHR) of 0.84cm of boys in the sample is in keeping with reference values for WHR obtained in a study done in Egypt by Ahmed et al (2016). Girls in our sample had a WHR of 0.81cm which is lower than the mean reference of 0.84cm of girls in the Egyptian study. As there are no comparative normative values for WHR for South African adolescents, the Egyptian study was used as a reference for our study, as Egypt is an African developing country, much like South Africa. However, when compared to age specific normative values from the Netherlands, a developed country, both boys and girls in our sample displayed higher WHR values (Fredriks et al., 2005). The WHR for boys from our study were in keeping with that observed in boys from a study conducted in North-West province, South Africa (Zeelie et al., 2010). However, girls from our study had higher WHR values than that observed in girls from the study by Zeelie et al (2010). Although the study (Zeelie et al., 2010) had participants from a low SES, it was conducted in another province with the participants of Black ethnicity only. Our study had the majority of the girl participants of Indian ethnicity (46.67 %) and could account for these differences as WHR can differ with ethnicity (WHO, 2008). In adolescents from five regions of the North West Province, boys displayed WHR levels in keeping with the results observed in our study (Schutte et al., 2003). Girls from the study (Schutte et al., 2003) also demonstrated lower WHR values than the girls from our study. WHR (WHR > 0.9 for boys and WHR > 0.85 for girls) is a good indicator as a predictor of metabolic disease (Bacopoulou et al., 2015). The values obtained in this study are albeit lower than the cut-off values to predict for metabolic disease associated with obesity (Bacopoulou et al., 2015), however it could point to early identification and risks for future metabolic complications in girls from this cohort.

5.5 Physical Fitness

Girls in our sample had a higher mean for sit-and-reach (flexibility) and hand grip strength (muscular strength) than the population means obtained in the study by Tomkinson et al (2018). Boys displayed a higher mean for sit-and-reach than the population means, however had lower mean values for the other four physical fitness tests (broad jump, hand grip strength, sit-ups and 20m shuttle). A study conducted in Tlokwe, South Africa reported a mean of 156.6 cm for broad jump and 19.06 repetitions for sit-ups in 30 seconds in boys (Monyeki et al., 2012). Our sample of boys had a lower mean value for both (147.99 cm broad jump, 14.98 reps sit-ups) of the physical fitness tests when compared to the results in the study by Monyeki et al (2012). Adolescent girls from the study done by Monyeki et al (2012) displayed means of 136.39cm for broad jump and 14.08 repetitions for sit-ups in 30 seconds. These values were larger than the mean (118.79 cm broad jump, 11.12 repetitions sit-ups) values for the similar physical fitness tests done in our study. The study by Monyeki et al (2012) had a similar setting as our study however, the overall prevalence of overweight and obesity was lower than that observed in our study (13.7% versus 32.4%). This could account for the differences in physical fitness observed between the studies as Monyeki et al (2012) reported that their normal and underweight participants performed better than overweight/obese participants in physical fitness tests that required participants to carry their body weight (broad jump, 20m shuttle run and sit-ups). The high prevalence of overweight/obesity observed in our study could have affected the PF results negatively as Park et al (2010) showed that excessive adipose tissue and fat accumulation affects joint range of movement and flexibility. Obesity has an inverse relationship with muscle strength, and this could also have contributed to the low PF values observed in our study (Jackson et al., 2010). The removal of PE as a stand-alone subject in schools, could also have contributed to the lower PF values obtained in our study. Physical Education (PE) was grouped with the subject Life Orientation in the curriculum, and is generally taught by educators with poor physical education skills, especially in low SES schools (Burnett, 2020). Burnett (2020) also reported that in high SES schools, sports-specific coaches were employed to enhance physical fitness skills, and children that attend low SES schools have minimal, if any, coaching in sports. Lack of resources and poor family support have also been touted as reasons for decreased levels of physical education in schools located in low SES (Burnett, 2020). A combination of these factors could contribute to the low level of physical fitness observed in our sample.

5.6 Physical activity

The physical activity (PA) levels in boys (PAQ-A 2.46) was higher than girls (PAQ-A 2.09), however, these levels are below the recommended daily PA level for adolescents (WHO, 2017, February). These findings coincide with other studies done in South Africa (Van Biljon et al., 2018); (Micklesfield et al., 2014) where adolescent boys were more physically active than adolescent girls. In the study conducted by Van Bilijon et al (2018) PA levels in children and adolescents from different provinces in South Africa were measured. The authors reported a higher mean PAQ-A value for adolescents than our study (2.61 versus 2.28). The results observed by Van Bilijon et al (2018) is probably a fair reflection of the population as they chose participants from all provinces and of different ethnicity. This could account for the difference observed in our study, as the majority of the participants were from one area of low SES. Chatsworth is traditionally a densely populated area with few areas for recreational activity (Ramoudh, 2002). The author reports that the available facilities are not maintained regularly and are frequented by members that are associated with drugs, gangs, and violence. These factors could contribute to the low levels of physical activity as most children are discouraged from using the few available areas to engage in PA. In addition, parents may be reluctant to permit their children to participate in outdoor PA due to security reasons. Children in the sample that resided in informal settlements have minimal space to engage in PA after school as the dwellings are in close proximity to each other (Booth et al., 2005). Children from a higher SES were reported to engage in more PA with less time engaging in sedentary behavioural activities as compared to their counterparts from with a low SES (McVeigh et al., 2004). These factors could have contributed to the lower levels of PA in our sample. As demonstrated in Figure 10, 29% of the fathers and 31% of the mothers had post-high school qualifications. This is quite significant as a study done in Johannesburg, SA by (McVeigh et al., 2004) showed that children with parents, especially mothers, who had a high educational level were more physically active. A study done in Uganda showed that the mothers level of education and socioeconomic status were better predictors of children's health as compared to the fathers (Wamani et al., 2004). The lower PA values could be attributed to the lower educational status of parents in our study as a contributing factor. Education of the parents and their adolescent children (especially in low SES populations) on the benefits of PA, their involvement with this in the lives of their children, could positively influence change of this situation, and should be considered in intervention programme.

5.7 Summary

The results from this study supported the following points in relation to other studies cited in the discussion:

1. SES is inversely correlated with overweight/obesity except in developing countries.
2. PA is directly correlated with SES.

3. Formal education of parents, especially mothers, had a direct correlation with PA.
4. Overweight/obesity is inversely related to physical fitness.
5. The prevalence of obesity amongst girls is higher than boys of the same age in South African adolescents.
6. KwaZulu Natal has the highest prevalence of adolescent overweight/obesity in South Africa.

6 Chapter 6 Design of Intervention

Interventions programmes form the cornerstone against childhood and adolescent obesity. Key problems areas should first be identified before an intervention is implemented. It is believed that this has been one of the common errors in intervention programmes as many physical activity interventions were implemented. There has generally been minimal consideration of the complex factors that influence weight status, such as specific programmes for specific populations of people based on the risk factors for these specific settings. Table 28 outlines the key problem areas identified in our study.

Table 28: Key problem areas identified

Problem areas	BOYS	GIRLS
High prevalence of obesity/overweight	X	X
Low Levels of PA	X	X
Poor cardiorespiratory function	X	X
Poor muscle strength	X	
Low muscle endurance	X	X
Explosive Muscle Power	X	X
High WHR ratio	X	X

Based on key areas identified in this study (Table 31) and evidence-based research (Chapter 2.5 and additional literature support), the following guidelines are proposed to construct an intervention programme:

1. Intervention programme should be supported in a school setting as this has the most desirable effect with a trained professional conducting the session (Alberga et al., 2013). Additionally, adolescent participants are more likely to attend an intervention at school, they would participate in this PA intervention as part of the school curriculum, during recess or curriculum-allocated time.
2. Intervention programmes need to be a minimum of 12 weeks with three sessions of moderate to vigorous PA activity to have an effect on BMI (Cordero et al., 2014). This would address our study findings where the majority of adolescents had low and moderate PA levels. Maintaining high PA levels for a minimum of 12 weeks is necessary to address BMI.
3. Duration of the PA component of intervention should be 60 minutes split with aerobic (agility training and HIIT) and anaerobic activity (strength and resistance training). Concurrent training has shown best results for decreasing Body Fat and BMI levels (Sigal et al., 2014). This will address the low levels of PA that were displayed by the participants in our study as most of the participants (65.43%) fell below the recommended weekly PA levels (WHO, 2018a).
4. The aerobic component of the PA programme must include a HIIT aspect. This component of the intervention may not improve weight or BMI, but has positive benefits on cardiorespiratory fitness (Duval et al., 2017).
5. The anaerobic session should have free weights as resistance. Free weights have shown to have better effects than many other resistance devices (Lubans et al., 2010). Improvements were observed in body composition, increases in upper and lower limb muscle strength in boys and improved lower limb muscle power in girls (Lubans et al., 2010). This aspect is inexpensive to implement and may be used in interventions in low-resourced schools. They are also less expensive than other resistance equipment and items from the environment and may be adapted, like making weights from sandbags.
6. PA intervention programme should incorporate a circuit type of layout and structure as it gives students a measure and introduces a fun element which will promote activity and participation (Aalizadeh et al., 2016).

7. Mobile phones are a good way to reinforce behaviour and 77% of children between ages of 9-18 years old in South Africa have access to mobile phones (Porter et al., 2016). This tool can be used to remind children to exercise at home and promote healthy behaviour in order to get stronger and fitter and thereby increasing their times in the circuit. This information may be introduced and disseminated to parents as an educational component and as reminders to sustain the exercise intervention. This is also a useful tool to educate parents on key areas surrounding weight management. Those parents and adolescents who do not have access to mobile devices, will be provided with hard copies of reading material (pamphlets, pictures, books) to provide equal opportunity for all to have access to the intervention.
8. Family involvement in PA interventions is critical to the implementation and maintenance of the intervention in order to derive the expected outcomes. Studies have shown that family involvement produced better outcome measures for weight management as compared to studies without family involvement (Spruijt-Metz, 2011, Cordero et al., 2014).

The adage "Knowledge is power" (Bacon, 1597) holds true as this study and others have shown that children who had parents with higher formal education had higher levels of PA compared to their peers. Together with the implementation of the intervention programme, education of the participants and parents on the benefits of PA and information on healthy lifestyle behaviours are essential for successful outcomes. This can be achieved by having all stakeholders (parents, teachers, adolescents, trainers) present at the implementation of the programme to empower them with the necessary knowledge to help achieve the desired outcomes of the intervention. Regular reminders on exercise compliance, healthy eating patterns and hints to decrease sedentary behaviour can be achieved using social media and mobile devices and reminders at school (verbal and other cues). Figure 11 addresses the above points and outlines a programme to set in motion the target areas from key findings of this study. The intervention is designed in a circuit formation to introduce a fun element and can be modified to incorporate a time trial that could become an inter-school competition.

1. Warm-up JOG 5 minutes

65 % maximum Heart Rate

Important to increase core temperature before stretching thus reducing risk of injury

Stretch

2. Upper Limb Strengthening 5min

2 Sets 15 Repetitions Moderate free weights

1 Set 8 Repetitions of Maximum Weight to complete set

Free weights have shown better muscle response and growth and will improve problem areas of muscle strength

Stretch 1 minute

3. JOG 5 minutes

Moderate intensity 65% maximum heart rate

Important to help build endurance.

Rest 1 minute

4. Core strengthening 5 minutes

5 sets 50 seconds core work with 10 seconds rest inbetween

This will assist in improving trunk muscle endurance

5. HIIT 5min

2 X 30 seconds 20m Sprint sessions with 30seconds rest between sessions

This will help address low cardiovascular performance and high WHR observed in the study

6. PUSH-UPS 5min

5 Sets 30sec to failure or maximimum with 30 seconds rest between sets

This will address problems of upper limb strength identified in the study as well as muscular endurance

Rest 1 minute

7. Run 15minutes

Moderate to high intensity 65% to 85% Maximum Heart rate

Field is set with cones and participants do 'figure of 8' running

Will addresses speed and agility as well as cardiovascular endurance

Rest 1 minute

8. SQUATS 5min

2 Sets 15 Repetitions Moderate free Weight

1 Set 8 Reps of Maximum free Weight to complete set

Free weight shown to improve muscle power in lower limbs, a problem area identified in this study

Rest 1 minute

9. SIT-UPS 5min

5 Sets 30sec to failure or maximum with 30 sec rest between sets

This will help address problems identified in core muscle strength

Finish with cool down and stretching

Figure 11: Proposed physical activity intervention programme

7 Chapter 7 Conclusion

7.1 Research questions

The thesis set out to not only to establish the prevalence of obesity in adolescents, but also to identify key problem areas related to PA and PF and the contributing factors. This study also examined the relationship between BMI, PA and PF. Results observed from the study has shown that adolescent PA and PF are on a downward spiral while obesity prevalence, especially in KZN, is on an upward trajectory. Cardiovascular function, muscle strength and power were shown to be predictors for BMI. This was in keeping with results observed in the study as poor cardiovascular function, low muscle endurance, reduced muscle power and muscle strength were identified as key areas related to PF that need to be addressed. Based on the problems identified and using evidence-based research, an intervention programme was designed to focus on the areas identified. Intervention programmes implemented in previous research may not have been specific to the sample studied and could account for poor outcome measures and sustainability. This study has shown that in order to help tackle the prevalence of obesity, key areas should be identified and an appropriate intervention designed to target these specific sites.

7.2 Limitations

The following limitations have been recognised in our study:

Our study included the low SES school setting only. Inclusion of private schools would have provided comparative results from both settings. However most private schools approached were reluctant to participate in this study.

The 20m shuttle run was conducted in open areas during recess so children that were not participating were spectators and some of the test results could have been influenced by the jeering and comments from the non-participating children.

One of the schools visited had a dance function planned for the afternoon and many of the children who had signed consent and assent forms, participated with some reluctance as it required them to change out of their smart attire and do physical activity. This could have played some part in the outcome measures obtained.

The study was also conducted in one district of the eThekwini Municipality and may not have been a fair representation of the population.

7.3 Recommendations

7.3.1 Recommendations for practice

1. PA should be advocated in schools (curriculum) by qualified teachers. There is currently limited time for PA, and priority is not given to PA versus curricular activities. Recommendations should be made to the South African Department of Education for these implementations.
2. Resources on healthy behaviour and benefits of PA should be readily available to learners at schools and can be incorporated into the Life Orientation curriculum.
3. Teachers and parents need to be educated on the importance and benefits of PA and encouraged to become more involved in information sharing and implementing PA programmes with the adolescents.
4. Annual anthropometric measurements should be done at schools to monitor children's growth patterns and for early detection of problems (e.g., early onset NCDs and other health-related conditions).
5. Recommendations should be made to the South African Department of Health on shifting some of the focus from undernutrition to the prevalence of obesity.

7.3.2 Recommendations for research

1. Comparative values for PF and WHR in South African adolescents are sparse and normative values for these measures would enable appropriate analysis.
2. A standardised measure of PA, BMI and PF should be advocated across research studies, so proper comparisons can be made between studies. There is presently no accepted 'gold standard' of the instrumentation used for these measures.
3. Research studies in different populations, study cohorts and settings will yield different outcomes. The design of interventions should be specific for the sample

where key areas of risk factors are identified prior to the implementation of the intervention.

7.4 Conclusion

A descriptive study such as this study, by its nature, cannot resolve the complex coaction between the different factors that contribute to BMI z-scores and is unable to establish which factors are causative and which are consequences of overweight and obesity. There is however indication that although there might be an interaction effect, there is an inverse relationship between PA/PF levels and the BMI z-score. Adolescent overweight and obesity is a complex condition to manage, while interventions and weight control have had effect with some success. Early identification and action are crucial to help curb the growing prevalence of adolescent obesity. Relevant stakeholders should collaborate and share information with parents, teachers and children as successful outcomes requires a collated effort. Physiotherapists are skilled partners in the management of weight status and should provide guidance to parents, adolescents, and relevant stakeholders. This may be accomplished by facilitating the design and implementation of comprehensive intervention programmes, by identifying risk factors for specific populations and cohorts. This would support the development of intervention programmes that target key areas to address the growing prevalence of obesity. The ripple effect of obesity transcends negatively into the economic, social and health sectors. Intervention programmes to target overweight and obesity will have impact on the health status of the population, burden on the health system, and ultimately on the productivity and quality of life of the population.

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9 Chapter 9 Appendices

Appendix 1: Letter to KwaZulu Natal Department of Education

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Tel: +27 (0) 21 406 6401/ 6428/ 6628/ 6534
Fax: +27 (0) 21 406 6323

The KwaZulu Natal Department of Education – eThekwini Education District

PRIVATE BAG X9137

PIETERMARTIZBURG

3200

REQUEST FOR PERMISSION TO CONDUCT STUDY WITHIN SCHOOLS IN THE eThekwini MUNICIPALITY EDUCATION DISTRICT

Dear Sir/Madam

I, Shane Naidoo, am a registered post-graduate Physiotherapy student in the Division of Physiotherapy, Department of Health and Rehabilitation Sciences, Faculty of Health Science, University of Cape Town. I wish to conduct a research study entitled, The Design and of an Intervention Program to address the Prevalence of Obesity and Physical Fitness of Adolescents at High Schools.

The primary aim of the study is to design and implement an effective intervention to address obesity, overweight and increase physical fitness in adolescent scholars within the eThekwini Municipality. The study will also set out to determine if there is a difference in various measures of obesity and physical fitness between scholars in private and public schools. The study will be conducted by myself as well as 4 research assistants, all under the supervision of Dr Nirmala Naidoo (Lecturer: University of Cape Town). The tests are easy and short in duration and will be done during recess or interval so that it does not disturb the school curriculum. I am applying for ethical approval from the Human Research Ethics Committee at UCT.

Cardiac Disorders, Diabetes and Cancer are some of the conditions that fall under the classification of Non-Communicable Diseases. These diseases accounted for 55% of death globally in 2012. Obesity and overweight are one of the contributing factors that lead to non-communicable diseases. Studies have shown that obesity is a condition that generally starts in adolescents and transcends into adulthood. Physical activity is defined as any bodily movement produced by skeletal muscles that results in energy expenditure while physical fitness is a set of attributes that are either health- or skill-related. Most schools promote physical activity, but scholars may still be overweight although physically fit. This still places them in a risk category of becoming obese. This study will critically analyse all research that has been done to determine the prevalence of obesity and physical fitness in adolescent scholars. Based on the results an appropriate intervention will be designed to address problems areas in physical fitness and obesity. The study consists of three phases. During the first phase I will randomly select schools within the eThekwini Municipality to make up the required sample set. I will then take measurements of height, weight, waist and hip circumferences to determine the prevalence of obesity and overweight. A physical activity questionnaire (PAQ-A) will be used to determine self-reported physical activity levels. During this phase, different components of physical fitness (strength, endurance, flexibility and respiratory fitness) will also be assessed. Phase two will involve the systematic review of all studies done globally to determine the prevalence of obesity and physical fitness in adolescent scholars. Phase three of the study will be the design of an intervention addressing problem areas identified from the data in phases one and two.

Once permission is granted from KZNDE, I will liaise with the principals of the selected schools eligible for this study. Informed written consent will then be obtained from each school as well as parents of students participating and assent from the students for their participation. This research can help promote healthy lifestyles in adolescents and its benefits will contribute to address global concerns of adolescent obesity and decrease the prevalence of non-communicable diseases.

The study will be supervised by Dr Nirmala Naidoo, Division of Physiotherapy, School of Health and Rehabilitation Sciences, Faculty of Health Sciences, University of Cape Town.

Contact Details:
Tel: (Work) 021-4066314
Fax: 021-4066401
E-mail: niri.naidoo@uct.ac.za

You may contact the HREC if you have any questions or concerns about the student's rights or welfare as a research participant.
Chair of Human Research Ethics Committee (HREC),
Professor Marc Blockman on 021 4066 411 or marc.blockman@uct.ac.za.

Your permission will be greatly appreciated.
Kind Regards
Shane Naidoo– 083 777 5164 (Researcher)
physioinkzn@gmail.com

Appendix 2: Cover letter for School Principals

UNIVERSITY OF CAPE TOWN

Faculty of Health Sciences

Department of Health and Rehabilitation Sciences

Divisions of Communication Sciences and Disorders; Nursing and Midwifery; Occupational Therapy; Physiotherapy; Disability Studies

F45 Old Main Building, Groote Schuur Hospital
Observatory, Cape Town, W Cape, 7925
Tel: +27 (0) 21 406 6401/ 6428/ 6628/ 6534
Fax: +27 (0) 21 406 6323

Dear Sir/Madam

I, Shane Naidoo, am a registered post-graduate Physiotherapy student in the Division of Physiotherapy, Department of Health and Rehabilitation Sciences, Faculty of Health Science, University of Cape Town. I wish to conduct a research study entitled, The Design and of an Intervention Program to address the Prevalence of Obesity and Physical Fitness of Adolescents in High School. The following forms the basis of my research.

Significance of the study

The study aims to address a global issue, which largely stems from childhood. If the study has positive outcomes the results will be made available to schools which can then be used to help reduce the prevalence of overweight and obesity and improve physical fitness.

Description of Research

In the study we plan to recruit a total of approximately 300 scholars from 10 randomly selected schools within the eThekwini Municipality. This is a testing phase where body mass index (BMI), waist to hip ratios (WHR), physical fitness (strength, endurance, flexibility and respiratory fitness), are recorded as well as a self-reported physical activity questionnaire (PAQ-A). The data obtained will be used to determine the prevalence of obesity and physical fitness in adolescent students. The tests will be measured, and results taken by myself and my research assistants. Phase two will involve the systematic review of all studies done globally to determine the prevalence of obesity or BMI and physical fitness in adolescent scholars. Phase three of the study will be the design of an intervention addressing problem areas identified from the data in phase one and the results of the systematic review. All participants in this study will be allocated a research identification number so that the information remains anonymous and confidential except to the researcher and the research assistants.

Selection of Participants

Students, aged between 13 and 16 attending grades eight to ten in an urban Secondary School within the eThekwini Municipality, will be randomly selected to be part of the study. Your school has been selected to participate in the study.

What will be required of the students?

If your school is selected for this study, a day will be identified to perform the baseline tests for BMI, WHR, physical fitness. A self-reported physical activity questionnaire will be completed by the scholars during this phase of the study. These tests are relatively short and will be done during intervals so that the academic curriculum is not disturbed. Testing measures will consist of: Hip, waist, height and weight measurements to be taken for BMI and waist to hip ratio. Physical fitness will be measured using 20m Bleep Test to measure Respiratory and Cardiovascular Levels, sit-ups to measure trunk strength and endurance, sit and reach to measure flexibility, standing broad jump to measure explosive lower limb muscle power and grip strength to measure muscle strength. The PAQ-A will be used to determine level of physical activity.

The students will only have to cooperate and undress as necessary (remove shoes and any baggy clothing). They will not be pushed to perform or hurt in any way. The tests are simple and will be monitored by the members of the research team. This data will only be used for the original purpose of this study which was explained in the beginning of this letter. Should we wish to use it for any other purpose, you will be informed, and we will send out another information letter and informed consent form prior to using it.

What will be required of you?

Once informed consent is obtained, you will be required to identify a suitable day for pre-testing to be done at a venue in the school.

What will be the risks involved?

The risks in this study are relatively low as phase one is anthropometric measurements of BMI and WHR. Physical activity levels will be done using the PAQ-A survey so there are no risks. The only risks are with the simple tests for physical fitness that the scholars will be performing, but I will demonstrate and ensure that all participants can perform the tests safely and correctly. I will also detail the correct guidelines for exercising and stress the point of reporting to any member of the research team or school if they feel unwell or dizzy during any part of the testing.

What payment will be received or what costs will be incurred

Participants will not receive any payment and the school, parents and participants will not have to pay anything to participate in the study. The testing phase will be done at the participant's school, so no transportation costs will be incurred. All participants will receive a healthy beverage and snack after testing.

Voluntary Participation

Participation in this study is completely voluntary and the school, principal, teacher as well as the participants are under no obligation to participate. Even if the parent gives consent for the student to participate and on the day the student decide that they don't want to, for whatever reason, no penalties will be incurred.

Right to withdraw from the study

Once consent from parents, principal and assent have been obtained, the student is under no obligation to complete the study and they can pull out at any time with no penalties. We will encourage students to complete the study, but should they not want to, they will be free to withdraw at any time.

Confidentiality

Confidentiality will be maintained at all times. We, as the research team, will know the schools and student's names for means of data capturing but from the start of the study the participants and schools will be allocated a number which will replace their name or any other personal details for the rest of the study. Full confidentiality will be maintained during publication of this thesis and the student/schools name will never be mentioned and there will be no way for anyone that is not part of this group to relate any of the data back to a specific school or student. All data and names will be kept on one computer in a locked environment so that there is no way for anyone but the researcher to have access to it. All data will be maintained securely for up to a year after the study has been completed.

What if Something Goes Wrong?

The University of Cape Town (UCT) undertakes that in the event of you suffering any significant deterioration in health or well-being, or from any unexpected sensitivity or toxicity, that is caused by your participation in the study, it will provide immediate medical care. UCT has appropriate insurance cover to provide prompt payment of compensation for any trial-related injury according to the guidelines outlined by the Association of the British Pharmaceutical Industry, ABPI 1991. Broadly-speaking, the ABPI guidelines recommend that the insured company (UCT), without legal commitment, should compensate you without you having to prove that UCT is at fault. An injury is considered trial-related if, and to the extent that, it is caused by study activities. You must notify the study doctor immediately of

any side effects and/or injuries during the trial, whether they are research-related or other related complications.
UCT reserves the right not to provide compensation if, and to the extent that, your injury came about because you chose not to follow the instructions that you were given while you were taking part in the study. Your right in law to claim compensation for injury where you prove negligence is not affected. Copies of these guidelines are available on request.

Who to contact for further information

My contact details are as follows
Shane Naidoo 0837775164 physioinkzn@gmail.com
My supervisor's details are as follows
Dr N Naidoo 021 4066401 niri.naidoo@uct.ac.za

You may contact the HREC if you have any questions or concerns about the student's rights or welfare as a research participant.
Chair of Human Research Ethics Committee (HREC),
Professor Marc Blockman on 021 4066 411 or marc.blockman@uct.ac.za.
Thank you for taking the time to read this.

Appendix 3: Informed Consent for School Principals

UNIVERSITY OF CAPE TOWN

Faculty of Health Sciences

Department of Health and Rehabilitation Sciences

Divisions of Communication Sciences and Disorders; Nursing and Midwifery; Occupational Therapy; Physiotherapy; Disability Studies

F45 Old Main Building, Groote Schuur Hospital
Observatory, Cape Town, W Cape, 7925
Tel: +27 (0) 21 406 6401/ 6428/ 6628/ 6534
Fax: +27 (0) 21 406 6323

TITLE: ***The Design and of an Intervention Programme to address the Prevalence of Obesity and Physical Fitness of Adolescents in High School***

I,_________________have read the information sheet. I understand what is required of my school and I and I have had all my questions answered. I do not feel that my school or I am forced to take part in this study and am doing so of my own free will. I know that I/my school can withdraw at any time if I so wish and that it will have no bad consequences for me or my school.

Signed:

______________________________	____________________
Principal	Date and Place
______________________________	____________________
Researcher	Date and Place
______________________________	____________________
Witness (if necessary)	Date and Place

Appendix 4: Information letter for parents

UNIVERSITY OF CAPE TOWN

Faculty of Health Sciences

Department of Health and Rehabilitation Sciences

Divisions of Communication Sciences and Disorders; Nursing and Midwifery; Occupational Therapy; Physiotherapy; Disability Studies

F45 Old Main Building, Groote Schuur Hospital
Observatory, Cape Town, W Cape, 7925
Tel: +27 (0) 21 406 6401/ 6428/ 6628/ 6534
Fax: +27 (0) 21 406 6323

Dear Parent/Guardian

I, Shane Naidoo, am a post graduate Physiotherapy student from the University of Cape Town.

The school your child attends has been selected to participate in my study. Should you give permission, your child will be allowed to take part in the study. The information which follows makes up the basis of my project:

Title of the research Project

The Design of an Intervention Program to address the Prevalence of Obesity and Physical Fitness of Adolescents in High School

Purpose of the Study

Many extra-curricular programs have been implemented into school curriculums to help students physically and mentally. It is important for all children to have some physical activity daily to help them grow into healthy adults. My study aims to find out if the programs that are used in various schools are effective in growing a healthy child, providing them with appropriate amount of physical activity. The results of my study will be made available to the school and the parents so effective measures can be taken if there are negative outcomes. I have also included some information on obesity, overweight and physical activity as set out by The World Health Organisation.

Selection of Participants

This study is designed to be done on adolescents (between 13 to 16) students attending urban schools within the eThekwini Municipality. Students from different schools will be chosen to make up the study group. Your child has been chosen as well as some of his/her classmates.

Description of Research

300 students will be included from 10 randomly selected schools within the eThekwini Municipality. This is a testing phase where simple measurements of height, weight and fitness levels will be recorded. Your child will be required to do some simple tests which involve jumping and running between cones. All students will receive an identification number on the testing day and this will be used for the rest of the study. This will ensure that the information collected from each student remains confidential. Data collected will be entered in computer which will be password protected, with access limited to the researchers and the supervisor. The data will be stored in a locked room for safety and security. Data collected will then be analysed to determine if the children are engaging in appropriate activities to help them grow into healthy adults. If there are negative outcomes an appropriate activity program will be designed, and this will be made available to the school and parents.

What will be required of the students?

A day convenient for the school and the researcher will be identified in order to perform the baseline tests of Body Mass Index (BMI), Waist-Hip Ratio (WHR), and physical fitness. A physical activity questionnaire will be completed by the participants during this phase of the study. These tests are relatively short and will be done during intervals so that the academic programme is not disturbed. Physical fitness will be measured using a test involving running between two cones. Sit-ups will be used to measure trunk strength and endurance and another test which involves stretching while sitting will measure flexibility. A test to measure the strength of the legs will be and your child will have to squat and jump forward as far as he/she can. We shall also measure the strength of your child's hands.

The students will be fully supervised by myself and my research team. They will not be pushed to perform or hurt in any way. The tests are simple and will be monitored by the members of the research team. This data will only be used for the original purpose of this study which was explained in the beginning of this letter. Should we wish to use it for any other purpose, you will be informed, and we will send out another information letter and informed consent form prior to using it. Your child will not require any special equipment to be part of the study. On the identified day of testing he/she must attend school with a pair of shorts and a loose T-Shirt.

What will be required of you?

You will be required to fill out the questionnaire attached to this information letter and sign the informed consent form that will accompany this letter.

What will be the risks involved?

The risks in this study are relatively low as phase one is measurements of BMI and WHR with a questionnaire. The only risks are with the simple tests for physical fitness that the students will be performing, but I will demonstrate and ensure that all students can perform the tests safely and correctly. I will also detail the correct guidelines for exercising and stress the point of reporting to any member of the research team or school if they feel unwell or dizzy during any part of the testing.

What benefits will there be for taking part in the study

There will be no direct benefit to the participants. However, the results obtained will be of benefit to all school children in your age group who attend schools in various areas in KZN. The information we gather will be used to determine how best to implement physical activity that target certain areas of the body of children attending high schools in KZN.

What payment will be received or what costs will be incurred

Participants will not receive any payment and the school, parents and participants will not have to pay anything to participate in the study. The testing will be done at the participant's school, so no transportation costs will be incurred. All participants will receive a healthy beverage and snack after testing.

Voluntary Participation

Participation in this study is completely voluntary and the school, principal, teacher as well as the participants are under no obligation to participate. Even if you give consent for the student to participate and on the day the student decides that they don’t want to, for whatever reason, no penalties will be incurred.

Right to withdraw from the study

Once consent from parents, teachers, principal and assent have been obtained, the student/teacher is under no obligation to complete the study and they can pull out at any time with no penalties. We will encourage students to complete the study, but should they really not want to, they will be free to withdraw at any time.

Confidentiality

Confidentiality will be maintained at all times. We, as the research team, will know the schools, principals, teachers and student's names for means of data capturing but from the start of the study the students and schools will be allocated a number which will replace their name or any other personal details for the rest of the study. Full confidentiality will be maintained during publication of this thesis and the students/schools name will never be mentioned and there will be no way for anyone that is not part of this group to relate any of the data back to a specific school or student. All data and names will be kept on one computer in a locked up environment so that there is no way for anyone but the researcher to have access to it. All data will be maintained securely for up to a year after the study has been completed.

What if Something Goes Wrong?

The University of Cape Town (UCT) undertakes that in the event of you suffering any significant deterioration in health or well-being, or from any unexpected sensitivity or toxicity, that is caused by your participation in the study, it will provide immediate medical care. UCT has appropriate insurance cover to provide prompt payment of compensation for any trial-related injury according to the guidelines outlined by the Association of the British Pharmaceutical Industry, ABPI 1991. Broadly-speaking, the ABPI guidelines recommend that the insured company (UCT), without legal commitment, should compensate you without you having to prove that UCT is at fault. An injury is considered trial-related if, and to the extent that, it is caused by study activities. You must notify the study doctor immediately of any side effects and/or injuries during the trial, whether they are research-related or other related complications.

UCT reserves the right not to provide compensation if, and to the extent that, your injury came about because you chose not to follow the instructions that you were given while you were taking part in the study. Your right in law to claim compensation for injury where you prove negligence is not affected. Copies of these guidelines are available on request.

Who to contact for further information

My contact details are as follows
Shane Naidoo 0837775164 physioinkzn@gmail.com
My supervisor's details are as follows
Prof N Naidoo 021 4066401 niri.naidoo@uct.ac.za

You may contact the HREC if you have any questions or concerns about your child's rights or welfare as a research participant.

Chair: Human Research Ethics Committee (HREC)
Professor Marc Blockman
Phone: 021 4066 411 or
E-mail: marc.blockman@uct.ac.za.

Thank you for taking the time to read this.

Shane Naidoo
MSc candidate
Division of Physiotherapy
University of Cape Town

Appendix 5: Informed Consent for Parents

UNIVERSITY OF CAPE TOWN
Faculty of Health Sciences
Department of Health and Rehabilitation Sciences
Divisions of Communication Sciences and Disorders; Nursing and Midwifery; Occupational Therapy; Physiotherapy; Disability Studies

F45 Old Main Building, Groote Schuur Hospital
Observatory, Cape Town, W Cape, 7925
Tel: +27 (0) 21 406 6401/ 6428/ 6628/ 6534
Fax: +27 (0) 21 406 6323

TITLE OF STUDY: ***The Design and of an Intervention Program to address the Prevalence of Obesity and Physical Fitness of Adolescents in High School***

I,___________________________have read the information sheet. I understand what is required of my child/legal ward and I have had all my questions answered. I do not feel that I or my child are forced to take part in this study and am doing so of my own and child's free will. I know that I/my child can withdraw at any time if I/they so wish and that it will have no bad consequences for me or my child.

Please indicate here whether your child has any health/medical condition/s:

____

____

Signed:

______________________	______________________
Participant	Date and Place
______________________	______________________
Researcher	Date and Place
______________________	______________________
Witness (if necessary)	Date and Place

Appendix 6: Information letter for children in study

UNIVERSITY OF CAPE TOWN

Faculty of Health Sciences

Department of Health and Rehabilitation Sciences

Divisions of Communication Sciences and Disorders; Nursing and Midwifery; Occupational Therapy; Physiotherapy; Disability Studies

F45 Old Main Building, Groote Schuur Hospital
Observatory, Cape Town, W Cape, 7925
Tel: +27 (0) 21 406 6401/ 6428/ 6628/ 6534
Fax: +27 (0) 21 406 6323

I, Shane Naidoo, am a qualified physiotherapist who is undertaking a research project through the University of Cape Town.

Purpose of the Study

The reason for this study is to determine if the exercises that you are doing daily is appropriate to keep you fit and healthy.

Selection of Participants

We would like you to take part in our study.

Description of Research

My research team is made up of myself and four research assistants. We will take simple measurements of your height, weight and waist size. You will be given a question form to complete, where you will answer simple questions on your daily activity. We will also record results from a few fitness tests. Physical fitness will be measured using 20m Bleep Test to measure how well your lungs and heart are working. During this test, you will be required to run between cones. Sit-ups will be used to measure body strength and the sit and reach test will be used to measure your flexibility. The standing broad jump is a test used to measure the power in your legs and you will have to squat and jump forward as far as you can. We will also test the power in your hand using a hand-held machine and asking you to squeeze as hard as you can. The tests are fun and you may have done some of them before, however I will demonstrate all of them to you.

What will be needed from you

All testing will be conducted at your school. You will be required to change into your gym attire and all tests will be performed without socks or shoes.

What will be the risks involved?

The risks in this study are very small and limited to performing your exercises. Should you feel any dizziness or tiredness during your exercise regime please report this to any member of the research team or myself.

What benefits will there be for taking part in the study

There are no direct benefits for you taking part in the study, however the results can be used to ensure that school children are growing up to be fit and healthy and doing the correct exercises.

What payment will be received or what costs are involved

There is no cost to you the student, all material required will be supplied by the research team.

Voluntary Participation

You should not feel that you are forced to take part in my project. You should be taking part out of your own free will. You should know that you can pull out of the project at any time if you wish and that it will have no negative impact.

What if Something Goes Wrong?

The University of Cape Town (UCT) undertakes that in the event of you suffering any significant deterioration in health or well-being, or from any unexpected sensitivity or toxicity, that is caused by your participation in the study, it will provide immediate medical care. UCT has appropriate insurance cover to provide prompt payment of compensation for any trial-related injury according to the guidelines outlined by the Association of the British Pharmaceutical Industry, ABPI 1991. Broadly-speaking, the ABPI guidelines recommend that the insured company (UCT), without legal commitment, should compensate you without you having to prove that UCT is at fault. An injury is considered trial-related if, and to the extent that, it is caused by study activities. You must notify the study doctor immediately of any side effects and/or injuries during the trial, whether they are research-related or other related complications.

UCT reserves the right not to provide compensation if, and to the extent that, your injury came about because you chose not to follow the instructions that you were given while you were taking part in the study. Your right in law to claim compensation for injury where you prove negligence is not affected. Copies of these guidelines are available on request.

Who to contact for further information

If you have any questions, please raise your hand and ask your question until you fully understand what is needed of you.

Contact Details

My contact details are as follows

Shane Naidoo 0837775164 physioinkzn@gmail.com

My supervisor's details are as follows

Prof N Naidoo 021 4066401 niri.naidoo@uct.ac.za

You may contact the HREC if you have any questions or concerns about your rights or welfare as a research participant.

Chair: Human Research Ethics Committee (HREC)
Professor Marc Blockman
Phone: 021 4066 411 or
E-mail: marc.blockman@uct.ac.za.

Thank you for taking the time to read this.

Shane Naidoo
MSc candidate
Division of Physiotherapy
University of Cape Town

Appendix 7: Assent form for children/students

UNIVERSITY OF CAPE TOWN
Faculty of Health Sciences
Department of Health and Rehabilitation Sciences

Divisions of Communication Sciences and Disorders; Nursing and Midwifery; Occupational Therapy; Physiotherapy; Disability Studies

F45 Old Main Building, Groote Schuur Hospital
Observatory, Cape Town, W Cape, 7925
Tel: +27 (0) 21 406 6401/ 6428/ 6628/ 6534
Fax: +27 (0) 21 406 6323

TITLE OF STUDY: ***The Design of an Intervention Program to address the Prevalence of Obesity and Physical Fitness of Adolescents in High School***

I,______________________(name and surname) have read (or had read to me by__ ______) the information sheet. I understand what is needed of me and have had all my questions answered. I do not feel that I am forced to take part in this study and I am doing so out of my own free will. I know that I can pull out of the study at any time if I so wish and that it will have no bad consequences for me.

Signed: (write name and surname)

______________________________	____________________
Participant	Date and Place
______________________________	____________________
Researcher	Date and Place
______________________________	____________________
Witness (if necessary)	Date and Place

Appendix 8: HREC approval

HUMAN RESEARCH
ETHICS COMMITTEE
05 FEB 2019
HEALTH SCIENCES FACULTY
UNIVERSITY OF CAPE TOWN

UNIVERSITY OF CAPE TOWN

FACULTY OF HEALTH SCIENCES
Human Research Ethics Committee

FHS016: Annual Progress Report / Renewal

HREC office use only (FWA00001637; IRB00001938)			
This serves as notification of annual approval, including any documentation described below.			
☐ Approved	Annual progress report	Approved until/next renewal date	30.01.2020
☐ Not approved	See attached comments		
Signature Chairperson of the HREC		Date Signed	6/2/2019

Comments to PI from the HREC
Thank you for the deviation document

Principal Investigator to complete the following:

1. Protocol information

Date (when submitting this form)	24 01 2019		
HREC REF Number	850 /2016	Current Ethics Approval was granted until	30 05 2018
Protocol title	THE DESIGN OF AN INTERVENTION PROGRAM TO ADDRESS THE PREVALENCE OF OBESITY AND PHYSICAL FITNESS ON ADOLESCENTS ATTENDING HIGH SCHOOL.		
Protocol number (if applicable)			
Are there any sub-studies linked to this study?		☐ Yes ☒ No	
If yes, could you please provide the HREC Ref's for all sub-studies? **Note:** A separate FHS016 must be submitted for each sub-study.			
Principal Investigator	Dr N. Naidoo		
Department / Office Internal Mail Address	Health and Sciences - Physiotherapy nirri.naidoo@uct.ac.za		

12 March 2018 Page 1 of 5

(Note: Please complete the Closure form (FHS010) if the study is completed within the approval period) FHS016

Appendix 9: Letter from KZN Department of Education

KWAZULU-NATAL PROVINCE
EDUCATION
REPUBLIC OF SOUTH AFRICA

KWAZULU-NATAL DEPARTMENT OF EDUCATION
Private Bag X 08 Mobeni . Durban. 4060. RSA
Cnr of Maurice Gumede Dr and Schoeman Lane. U Section Umlazi
Tel: 031 909 9400

UMLAZI DISTRICT
Management

PHUMELELA CIRCUIT MANAGEMENT CENTRE
EXCELLENT SERVICE THROUGH COMMITMENT AND ACTION

Enquiries: G.L. Myende
Enimibuzo:
Navrae:

Ref: 2020/ 01
Inkomba:
Verwysing:

Date: 15.01.2020
Usuku:
Datum:

15 January 2020

TO WHOM IT MAY CONCERN

Kindly be informed, that Shane Naidoo NDXSHA092 a student at the University of Cape Town has been granted permission to conduct research in the Ethekwini Muncipality under the KZN Department of Education, Karanja Circuit.

MS G.L. MYENDE
SEM: KARANJA CIRCUIT

Appendix 10: ISCOLE demographic and family health questionnaire

UNIVERSITY OF CAPE TOWN

Faculty of Health Sciences

Department of Health and Rehabilitation Sciences

ISCOLE Demographic and Family Health Questionnaire- South Africa

A. GENERAL INFORMATION

Child's Name:

Last First Middle

Name of Child's School:

Parent's Name:

Last First Middle

Home Address:

Street Address Apt. # Town or City State Postal/Zip Code

Nearest Cross-Street to Home (intersection):

Phone Number: ( ) E-Mail:

Area Code

How long have you lived at the current address?__________years and __ ______months

B. DEMOGRAPHICS OF CHILD

Birth date _____/_____/_____ Age _____years Gender: ☐ Male ☐ Female

mm/dd/yyyy

To which ethic group do you belong? (Self-Identified Ethnic Group):

1. White
2. Black South African
3. Mixed Ancestry or "Coloured"
4. Indian
5. Asian
6. Don't know
7. Other_______________

Are you of Hispanic origin? ☐ Y☐ No

In what country was the child born? __________________

How many siblings does the child have? ____________

What are their ages? _____yrs _____yrs _____yrs _____yrs _____yrs

_____yrs _____yrs _____yrs _____yrs _____yrs

C. Health history OF CHILD

1.Birth Weight: _______kgs Birth Length: _______cm

2. Term of Pregnancy:_______weeks

3. Did mother develop gestational diabetes during pregnancy with **THIS** ☐ild? ☐

Yes No

4.Fed breast milk? ☐ Yes N☐ If No, please skip to question 5.

Age when **COMPLETELY** stopped being fed breast milk: _____months

Age when **FIRST** fed formula: _____months

1. Age when **COMPLETELY** stopped drinking formula: _____months

D. FAMILY DEMOGRAPHICS AND HEALTH

6. What is the marital status of the child's parents?

1. Married or living together as married
2. Divorced or separated
3. Never married, single or unmarried
4. Widowed parent

7. How many people live in your household?_____

8.What is the **COMBINED**annual income for your household (before taxes)?

1. Less than R11,500
2. Between 11,500-R19,000
3. Between 19,000-R30,000
4. Between R30,000-R65,000
5. Between R65,000-R100,000
6. Between R100,000-R300,000
7. Between R300,000-R500,000
8. More than R500,000

9. How many functioning automobiles are available for use at your house?

1. 0
2. 1
3. 2
4. 3
5. 4
6. 5 or more

10. How many television sets are in your household?

7. 0
8. 1

9. 2
10. 3
11. 4
12. 5 or more

11. What best describes your type of television service for the primary television in the house?

1. No television
2. No cable (pay for TV channel, such as MNET)
3. Basic cable (pay for TV channel, such as MNET)
4. Satellite dish and pay for TV channels (DSTV)
5. Don't know

12. What best describes your type of internet service?

1. No internet access
2. Dial-up modem
3. DSL model
4. Cable modem
5. Don't know

13. What is the **MOTHER'S** highest level of education completed?

1. Less than high school
2. Some high school
3. High school diploma/GED
4. Associate's degree or 1-3 years of college or diploma
5. Bachelor's degree (university)
6. Post-graduate/professional degree

14. How many hours per week does the **MOTHER** work outside the home?

1. None or less than 15 hours/week
2. Part-time (15-35 hours per week)
3. Full time (36+ hours per week)

15. What is the **FATHER'S** highest level of education completed?

1. Less than high school
2. Some high school
3. High school diploma/GED
4. Associate's degree or 1-3 years of college or diploma
5. Bachelor's degree (university)
6. Post-graduate/professional degree

16. How many hours per week does the **FATHER**work outside the home?

1. None or less than 15 hours/week
2. Part-time (15-35 hours per week)
3. Full time (36+ hours per week)

17. Is this child adopted? Yes☐ No ☐

18. Please answer the following questions with regard to the child's **BIOLOGICAL MOTHER**:

Height: _____ cm Weight: _______kg Age:_____ years

Age at child's birth: ____ years

19. Please answer the following questions with regard to the child's **BIOLOGICAL FATHER:**

Height: _____ cm Weight: _______kg Age:_____ years

Appendix 11: Data recording sheet

UNIVERSITY OF CAPE TOWN

Faculty of Health Sciences

Department of Health and Rehabilitation Sciences

DATA RECORDING SHEET

PARTICIPANT Name/Number:

School :

PAQ					
WEIGHT kg	1.	2.	3.	Ave	**BMI**
HEIGHT cm	1.	2.	3.	Ave	
WAIST cm	1.	2.	3.	Ave	**HIP-Waist**
HIP cm	1.	2.	3.	Ave	
SIT & REACH cm	1.	2.	3.	Ave	
HAND GRIP kg	1.	2.	3.	Ave	
BROAD JUMP cm	1.	2.	3.	Ave	
SIT UP				No.	
BLEEP				No.	

Appendix 12: PAQ-A handbook

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

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CHAPTER 1: INTRODUCTION

"*An important challenge in determining the relationship between health and physical activity is valid assessment*."

Various levels of physical activity participation are associated with health benefits and/or health risks. As a result, it is important that we have valid tools for assessing physical activity at various ages. This becomes particularly important with longitudinal research, which might span a number of years. The Physical Activity Questionnaire for Older Children (PAQ-C) and the Physical Activity Questionnaire for Adolescents (PAQ-A) provide a general measure of physical activity for youth from grades 4-12 (approximately ages 8-20).

The purpose of the PAQ manual is to ensure that you can easily administer the PAQ measures in research and to provide you with a library of studies utilizing the PAQ-C and the PAQ-A.

Physical Activity Questionnaire for Older Children (PAQ-C)

The PAQ-C is appropriate for elementary school-aged children (grades 4-8; approximately ages 8-14) who are currently in the school system and have recess as a regular part of their school week.

Physical Activity Questionnaire for Adolescents (PAQ-A)

The PAQ-A is appropriate for high school students (grades 9-12; approximately ages 14-20) who are currently in the school system.

This manual provides a comprehensive overview of the PAQ-C and PAQ-A.

- Chapter 1: Describes why the PAQ-C and the PAQ-A were created and the limitations and strengths of these measures.

- Chapters 2 and 3: Includes keys to successful administration of the PAQ-C and the PAQ-A, scoring the questionnaires, validation and reliability studies, and the actual measures.

- Chapter 4: Summarizes the studies that we are aware of (as of August 2004) that have used or reviewed the PAQ-C or PAQ-A.

1.1 Why were the PAQ-C and the PAQ-A Created?

It is difficult to determine the best instruments to assess physical activity when a gold standard does not exist. Examples of instruments that have been used include a variety of physiological indicators, laboratory methods, direct observation, motion sensors, and self-report measures (Sallis & Saelens, 2000; Tremblay, Shephard, McKenzie, & Gledhill, 2001; Welk & Wood, 2000). Self-report measures are most frequently utilized for the assessment of physical activity levels in children and adolescents because they are typically low in cost and can be easily administered to large populations. However, few recall instruments have strong validity and are feasible for large-scale research (Crocker, Bailey, Faulkner, Kowalski, & McGrath, 1997).

In response to the need for a valid and feasible self-report measure for large-scale research with children and adolescents, the Physical Activity Questionnaire for Older Children (PAQ-C; Crocker, Bailey, Faulkner, Kowalski, & McGrath, 1997; Kowalski, Crocker, & Faulkner, 1997) and the Physical Activity Questionnaire for Adolescents (PAQ-A; Kowalski, Crocker, & Kowalski, 1997) were developed and validated. The PAQ-C and PAQ-A are self-administered, 7-day recall questionnaires that measure general moderate to vigorous physical activity levels during the school year. Generally, the PAQs have had relatively strong correlation coefficients with other physical activity measures compared to other recall measures (Kowalski, Crocker, & Faulkner, 1997; Kowalski, Crocker, & Kowalski, 1997).

The PAQ-C and the PAQ-A may be advantageous for use in longitudinal research. The PAQs' low cost, reliable and valid assessment of physical activity from childhood through adolescence, and ease of administration make the PAQs feasible for large-scale studies. The questionnaires use a common scoring scheme and were used successfully in the University of Saskatchewan's longitudinal bone mineral accrual study (Bailey, McKay, Mirwald, Crocker, & Faulkner, 1999).

1.2 The Limitations and Strengths of the PAQ Measures

All physical activity measures, including the PAQ-C and the PAQ-A, have their strengths and limitations. For example, some tools may or may not be feasible for large-scale research, be cost and time efficient, have good adherence, have participant demand, and/or have acceptable distribution properties.

The PAQ-C's and the PAQ-A's limitations

1) The PAQ-C and PAQ-A were developed to assess general levels of physical activity. They do not provide an estimate of caloric expenditure or specific frequency, time, and intensity information.
2) The PAQs do not discriminate between specific activity intensities, such as moderate and vigorous activities; they simply provide a summary activity score (see the scoring section in Chapters 2 and 3).
3) The PAQ-C and the PAQ-A are only appropriate when used during the school year; they should *not* be used to assess physical activity in the summer or holiday periods. Therefore, the PAQ-C and the PAQ-A only assess activities for individuals in the school system.

The PAQ-C's and the PAQ-A's strengths

1) The PAQ-C and the PAQ-A have been supported as valid and reliable measures of general physical activity levels from childhood to adolescence (see the validation/reliability studies in Chapters 2 and 3). The PAQs' measurement of general physical activity levels is one its strengths because it is difficult to precisely measure intensity, frequency, and duration of young people's activities, especially with self-report (Kowalski, Crocker, & Faulkner, 1997)
2) The PAQs utilize memory cues such as lunch and evening items to enhance the recall ability of children and adolescents (see the PAQ measures in Chapters 2 and 3).
3) The PAQ-C and PAQ-A are cost and time efficient, easy to administer to large-scale populations, and display normal distribution properties (see the validation reliability studies in Chapters 2 and 3). .

1.3 References

Bailey, D. A., McKay, H. A., Mirwald, R. L., Crocker, P. R. E., & Faulkner, R. A. (1999). A six-year longitudinal study of the relationship of physical activity to bone mineral accrual in growing children: The University of Saskatchewan bone mineral accrual study. *Journal of Bone and Mineral Research, 14*, 1672-1679.

Crocker, P. R. E., Bailey, D. A., Faulkner, R. A., Kowalski, K. C., & McGrath, R. (1997). Measuring general levels of physical activity: Preliminary evidence for the Physical Activity Questionnaire for Older Children. *Medicine and Science in Sports and Exercise, 29,* 1344-1349.

Kowalski, K. C., Crocker, P. R. E., & Faulkner, R. A. (1997). Validation of the Physical Activity Questionnaire for Older Children. *Pediatric Exercise Science, 9,* 174-186.

Kowalski, K. C., Crocker, P. R. E., & Kowalski, N. P. (1997). Convergent validity of the Physical Activity Questionnaire for Adolescents. *Pediatric Exercise Science, 9,* 342-352.

Sallis, J. F., & Saelens, B. E. (2000). Assessment of physical activity by self-report: Status, limitations, and future directions. *Research Quarterly for Exercise and Sport, 71,* 1-14.

Tremblay, M. S., Shephard, R. J., McKenzie, T. L., & Gledhill, N. (2001). Physical activity assessment options within the context of the Canadian Physical Activity, Fitness, and Lifestyle Appraisal. *Canadian Journal of Applied Physiology, 26*, 388-407.

Welk, G. J. & Wood, K. (2000). Physical activity assessments in physical education: A practical review of instruments and their use in the curriculum. *Journal of Physical Education, Recreation and Dance, 71,* 30-40.

CHAPTER 2: Physical Activity Questionnaire for Older Children (PAQ-C)

2.1 What is the PAQ-C?

The PAQ-C is a self-administered, 7-day recall instrument. *It was developed to assess general levels of physical activity throughout the elementary school year for students in grades 4 to 8 and approximately 8 to 14 years of age.* The PAQ-C can be administered in a classroom setting and provides a summary physical activity score derived from nine items, each scored on a 5-point scale.

2.2 Keys to Successful Administration

1) *When the PAQ-C is administered it is important to stress 2 points:*
 a) Explain it is **NOT A TEST**
 b) Explain you are interested in **ACTUAL** activity during the last **7 DAYS**

2) *To Prevent Missing Data, have the research assistants quickly glance through the questionnaires when they are gathered from the students.*
 a) Missing one response for an activity on item 1 has little effect on the overall score, but you don't want the students missing entire items (ie. not having a response for item 6).
 b) Explain to the students that the research assistants are not looking at their activity levels, but rather just making sure they haven't missed any of the questions.

3) *Overhead projectors may be helpful with younger age groups.*
 a) This allows researchers to read along with the students as they fill out their questionnaires.

Scoring

Overall process - Find an activity score between 1 and 5 for each item (excluding item 10)

Five Easy Steps

1) *Item 1 (Spare time activity)*
 - Take the mean of all activities ("no" activity being a 1, "7 times or more" being a 5) on the activity checklist to form a composite score for item 1.

2) *Items 2 to 8 (PE, recess, lunch, right after school, evening, weekends, and describes you best)*
 - The answers for each item start from the lowest activity response and progress to the highest activity response
 - Simply use the reported value that is checked off for each item (the lowest activity response being a 1 and the highest activity response being a 5).

3) *Item 9*
 - Take the mean of all days of the week ("none" being a 1, "very often" being a 5) to form a composite score for item 9.

4) *Item 10*
 - Can be used to identify students who had unusual activity during the previous week, but this question is **NOT** used as part of the summary activity score.

5) *How to calculate the final PAQ-C activity summary score*

the activity checklist items were changed to represent adolescent activity choices. Using generalizability theory, the results suggested that the use of 3 and 2 PAQ-C scores as a yearly activity composite score were reliable for younger participants (G = 0.86 and G = 0.80 respectively) and older participants (G = 0.90 and G = 0.85 respectively). Sex, F (1,199) = 20.22, $p < 0.01$, and time, F (2,398) = 34.34, $p < 0.01$, effects were found. The marginal mean male activity score was higher than females' (3.11 and 2.71 respectively). Students were more active in April than Oct-Nov (3.10 and 2.79 respectively). In summary, the PAQ-C had acceptable measurement properties, internal consistency, and reliability for using the average of either two or three PAQ-C scores gathered during fall, winter, and spring. These results provided initial support that the PAQ-C is a valid measure of physical activity in children.

Kowalski, K. C., Crocker, P. R. E., & Faulkner, R. A. (1997). Validation of the Physical Activity Questionnaire for Older Children. *Pediatric Exercise Science, 9,* 174-186.

Two studies by Kowalski, Crocker, and Faulkner (1997) supported the PAQ-C as a valid measure of general physical activity levels. Two independent samples (N = 89 and N = 97) of children grades 4 to 8 completed the PAQ-C along with other physical activity measures.

In the first study, the convergent, construct, and divergent validity of the PAQ-C were examined. Thirty-eight boys and 51 girls ages 8 to 13 completed a behavioural conduct scale (M = 2.92, SD = 0.53), an athletic competence scale (M = 2.94, SD = 0.58), the PAQ-C (M = 3.23, SD = 0.78), and an activity rating (M = 3.62, SD = 1.02). Following the questionnaires, the classroom teachers completed a teacher's rating of physical activity questionnaire (M = 68.13, SD = 10.97), and the children completed the moderate to vigorous physical activity (MVPA) each day for 1 week.

Convergent validity was supported by moderate relationships with the activity rating (r = 0.63), week summation of 24-hr moderate to vigorous activity recalls (r = 0.53), and teacher's rating of physical activity (r = 0.45). The PAQ-C's moderate correlation with perceptions of athletic competence (r = 0.48) provided support for the construct validity of the PAQ-C. Divergent validity of the PAQ-C was supported by no relationship between the behavioural conduct scale and the PAQ-C. Gender differences were found on the PAQ-C and teacher's rating of physical activity.

In the second study, the convergent and construct validity of the PAQ-C was further examined. Forty-one boys and 56 girls completed the PAQ-C (M = 3.35, SD = 0.68), an activity rating (M = 3.67, SD = 0.97), the Leisure Time Exercise Questionnaire ([LTEQ]; M = 75.31, SD = 58.20), the Canadian home fitness test ([step test]; M = 4.09, SD = 1.68), the seven-day recall inteview ([PAR]; M = 37.72, SD = 4.13), and wore the Caltrac motion sensor ([Caltrac]; M = 426.54, SD = 131.61). The children completed the Caltrac and PAR during a different week from the other measures due to possible carry over effects. The PAQ-C was moderately related to the activity rating (r = 0.57), LTEQ (r = 0.41), Caltrac (r = 0.39), PAR (r = 0.46), and the step test of fitness (r = 0.28). Unlike the first study, no gender differences were found for the PAQ-C. Overall, the results of these studies supported the validity of the PAQ-C.

2.4 The PAQ-C Measure

See the following page.

- Once you have a value from 1 to 5 for each of the 9 items (items 1 to 9) used in the physical activity composite score, you simply take the mean of these 9 items, which results in the final PAQ-C activity summary score.

- A score of 1 indicates low physical activity, whereas a score of 5 indicates high physical activity.

2.3 Validation Reliability Studies Concerning the PAQ-C

The following paragraphs summarize the original development, validity, and reliability studies for the PAQ-C. The summaries provide a brief synopsis of each study's findings (we recommend that the complete studies be reviewed as the final reference).

Crocker, P. R. E., Bailey, D. A., Faulkner, R. A., Kowalski, K. C., & McGrath, R. (1997). Measuring general levels of physical activity: Preliminary evidence for the Physical Activity Questionnaire for Older Children. *Medicine and Science in Sports and Exercise, 29,* 1344-1349.

Evidence was provided that supported the PAQ-C as a reliable and valid measure of general physical activity levels in children during the school year. In three studies, Crocker, Bailey, Faulkner, Kowalski, and McGrath (1997) administered the PAQ-C to (N = 215, N = 84, and N = 200) elementary school children during the school year. The children were between the ages of 8 to 16 and attended a public school.

In the first study, the item and scale properties of the PAQ-C were examined. Ninety girls and 125 boys (ages 9-15) completed the PAQ-C on the same day. The mean activity score for females was 2.96 (SD = 0.69) and 3.44 (SD = 0.68) for males. Boys were significantly more active than girls with respect to the PAQ-C mean scores, t (213) = 5.15, $p < 0.01$, and each item score ($p < 0.05$), excluding the physical education item ($p < 0.08$). The item scale correlations were all above 0.30, and the scale reliability was acceptable for both females (α = 0.83) and males (α = 0.80). Recess and lunch items had the lowest correlations with the other items for males (r = 0.33 and 0.30 respectively) and females (r = 0.42 and 0.55 respectively). Most PAQ-C items had means close to the center of the range and the variability was acceptable. Overall, the PAQ-C was found to have acceptable measurement properties.

The second study examined the PAQ-C's test re-test reliability, internal consistency, and sensitivity to gender differences. Forty-three boys and 41 girls (ages 9-14) completed the PAQ-C. The children were assessed twice during school hours with one week in between assessments. The PAQ-C was relatively stable over the one-week assessment period (males, r = 0.75 and females, r = 0.82). However, further analysis showed significant increases in PAQ-C activity scores for both males, 2.85 (SD = 0.73) to 3.16 (SD = 0.91) and females, 2.56 (SD = 0.65) to 2.79 (SD = 0.80) over the two assessments, F (1,83) = 22.26, $p < 0.01$. Crocker et al. (1997) suggested a possible rationale for the increase in activity might be due to the change in weather. The first assessment week was cold and snowy, whereas the second assessment week was much warmer. The internal consistency for the first assessment was (α = 0.79) and (α = 0.89) for the second assessment. In general, the boys were found to be more active than the girls for weeks one and two, t (82) = 1.93, $p < 0.05$ and t (82) = 1.97, $p < 0.05$ respectively. The results of this study provide support for the test-retest reliability of the PAQ-C, and, similar to study 1, showed that the PAQ-C was sensitive to gender differences in physical activity levels.

The third study examined the reliability of the averages of 2 or 3 PAQ-C scores as a composite yearly activity score for children. Ninety-eight boys and 102 girls (ages 8-16) who were participants in the Saskatchewan pediatric bone study completed the PAQ-C. The PAQ-C was slightly modified for the adolescent participants with the recess item omitted, and some of

Physical Activity Questionnaire (Elementary School)

Name:_________________________ Age:___________

Sex: M_______ F_______ Grade:__________

Teacher:_______________________

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.

---

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 circle per row.)

	No	1-2	3-4	5-6	7 times or more
Skipping	❍	❍	❍	❍	❍
Rowing/canoeing	❍	❍	❍	❍	❍
In-line skating	❍	❍	❍	❍	❍
Tag	❍	❍	❍	❍	❍
Walking for exercise	❍	❍	❍	❍	❍
Bicycling	❍	❍	❍	❍	❍
Jogging or running	❍	❍	❍	❍	❍
Aerobics	❍	❍	❍	❍	❍
Swimming	❍	❍	❍	❍	❍
Baseball, softball	❍	❍	❍	❍	❍
Dance	❍	❍	❍	❍	❍
Football	❍	❍	❍	❍	❍
Badminton	❍	❍	❍	❍	❍
Skateboarding	❍	❍	❍	❍	❍
Soccer	❍	❍	❍	❍	❍
Street hockey	❍	❍	❍	❍	❍
Volleyball	❍	❍	❍	❍	❍
Floor hockey	❍	❍	❍	❍	❍
Basketball	❍	❍	❍	❍	❍
Ice skating	❍	❍	❍	❍	❍
Cross-country skiing	❍	❍	❍	❍	❍
Ice hockey/ringette	❍	❍	❍	❍	❍
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 do most of the time *at recess*? (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, 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 .... ❍

5. 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 .... ❍

6. 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 .... ❍

7. *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 .... ❍

8. 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.

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

B. 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) .... ❍

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

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

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

9. 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	❍	❍	❍	❍	❍

10. 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? ________________________________

CHAPTER 3: Physical Activity Questionnaire for Adolescents (PAQ-A)

3.1 What is the PAQ-A?

The PAQ-A (a slightly modified version of the PAQ-C with the "recess" item removed) is a self-administered, 7-day recall instrument. *It was developed to assess general levels of physical activity for high school students in grades 9 to 12 and approximately 14 to 19 years of age.* The PAQ-A can be administered in a classroom setting and provides a summary physical activity score derived from eight items, each scored on a 5-point scale.

3.2 Keys to Successful Administration

1) *When the PAQ-A is administered it is important to stress 2 points:*

a) Explain it is **NOT A TEST**

b) Explain you are interested in **ACTUAL** activity during the last **7 DAYS**

2) *To Prevent Missing Data, have the research assistants quickly glance through the questionnaires when they are gathered from the students.*

a) Missing one response for an activity on item 1 has little effect on the overall score, but you don't want the students missing entire items (ie. not having a response for item 6).

b) Explain to the students that the research assistants are not looking at their activity levels, but rather just making sure they haven't missed any of the questions.

Scoring

Overall process - Find an activity score between 1 and 5 for each item (excluding item 9)

Five Easy Steps

1) *Item 1 (Spare time activity)*

- Take the mean of all activities ("no" activity being a 1, "7 times or more" being a 5) on the activity checklist to form a composite score for item 1.

2) *Item 2 to 7 (PE, lunch, right after school, evening, weekends, describes you best)*

- The answers for each item start from the lowest activity response and progress to the highest activity response
- Simply use the reported value that is checked off for each item (the lowest activity response being a 1 and the highest activity response being a 5).

3) *Item 8*

- Take the mean of all days of the week ("none" being a 1, "very often" being a 5) to form a composite score for item 8.

4) *Item 9*

- Can be used to identify students who had unusual activity during the previous week, but this question is **NOT** used as part of the summary activity score.

5) How to calculate the final PAQ-A activity summary score

- Once you have a value from 1 to 5 for each of the 8 items (items 1 to 8) used in the physical activity composite score, you simply take the mean of these 8 items, which results in the final PAQ-A activity summary score.

- A score of 1 indicates low physical activity, whereas a score of 5 indicates high physical activity.

3.3 Validation Reliability Study Concerning the PAQ-A

The following paragraphs summarize the development, validity, and, reliability study for the PAQ-A. The summary provides a brief synopsis of the study's findings (we recommend that the complete study be reviewed as the final reference).

Kowalski, K. C., Crocker, P. R. E., & Kowalski, N. P. (1997). Convergent validity of the Physical Activity Questionnaire for Adolescents. *Pediatric Exercise Science, 9,* 342-352.

The PAQ-A (a modified version of the PAQ-C) was developed to measure general levels of physical activity in adolescents. Kowalski, Crocker, and Kowalski (1997) administered the PAQ-A along with other physical activity measures to 85 high school students during the school year. The students consisted of 41 males and 44 females (grades 8 through 12), ages 13 to 20.

Two schools were assessed separately (late March-early April and late May-early June). The assessments were scheduled over two-week periods that avoided any special school events. The students were administered the PAQ-A (M = 2.31, SD = 0.63), an activity rating (M = 3.15, SD = 0.93), Leisure Time Exercise Questionnaire ([LTEQ]; M = 54.02, SD = 30.23), Caltrac motion sensor ([Caltrac]; M = 355.88, SD = 126.01), and the 7-day physical activity recall interview ([PAR]; M = 36.21, SD = 3.24). To ensure no carry over effects, the Caltrac and PAR were administered over a different 1-week period than the other measures. The PAQ-A was the only measure sensitive to gender differences, t (83) = 3.01, $p < 0.05$. The males were more active than the females (mean scores of 2.52 and 2.12 respectively).

The PAQ-A was significantly correlated to all self-report measures (activity rating, r = 0.73; LTEQ, r = 0.57; and PAR, r = 0.59). The PAQ-A was also related to the Caltrac (r = 0.33). A limitation of this study was that only 56.47% of students' Caltrac data were usable. The main problem with the Caltrac devices was that the students tampered with them. The PAQ-A scores differed significantly between those who had usable Caltrac data and those that did not, t (83) = 2.78, $p < 0.05$. These results provided support for the convergent validity of the PAQ-A.

3.4 The PAQ-A Measure

See the following page.

Physical Activity Questionnaire (High School)

Name:________________________ Age:__________

Sex: M_______ F_______ Grade:__________

Teacher:______________________

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:

3. There are no right and wrong answers — this is not a test.
4. Please answer all the questions as honestly and accurately as you can — this is very important.

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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 circle per row.)

	No	1-2	3-4	5-6	7 times or more
Skipping	❍	❍	❍	❍	❍
Rowing/canoeing	❍	❍	❍	❍	❍
In-line skating	❍	❍	❍	❍	❍
Tag	❍	❍	❍	❍	❍
Walking for exercise	❍	❍	❍	❍	❍
Bicycling	❍	❍	❍	❍	❍
Jogging or running	❍	❍	❍	❍	❍
Aerobics	❍	❍	❍	❍	❍
Swimming	❍	❍	❍	❍	❍
Baseball, softball	❍	❍	❍	❍	❍
Dance	❍	❍	❍	❍	❍
Football	❍	❍	❍	❍	❍
Badminton	❍	❍	❍	❍	❍
Skateboarding	❍	❍	❍	❍	❍
Soccer	❍	❍	❍	❍	❍
Street hockey	❍	❍	❍	❍	❍
Volleyball	❍	❍	❍	❍	❍
Floor hockey	❍	❍	❍	❍	❍
Basketball	❍	❍	❍	❍	❍
Ice skating	❍	❍	❍	❍	❍
Cross-country skiing	❍	❍	❍	❍	❍
Ice hockey/ringette	❍	❍	❍	❍	❍
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.

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

G. 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) ……………❍

H. 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 ……...❍

J. 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? ________________________________

4.1 How has the PAQ-C and the PAQ-A been utilized in research?

The Physical Activity Questionnaire for Older Children (PAQ-C) and the Physical Activity Questionnaire for Adolescents (PAQ-A) have been used to classify children and adolescents into different activity levels (e.g., Mackelvie, McKay, Khan, & Crocker, 2001a; Kowalski, Crocker, Kowalski, 1997) and to investigate the relationship between physical activity and health outcomes (e.g., Bailey, McKay, Mirwald, Crocker, & Faulkner, 1999; Mackelvie, McKay, Khan, & Crocker, 2001b). In the following paragraphs, every study that we are aware of that has used the PAQ-C and/or the PAQ-A (as of August 2004) will be summarized (interested readers should consult the *Web of Science* citation indexes for updates). The reference for each study summary will be provided at the beginning of its summary. *The following study summaries focus on how the PAQ-C and the PAQ-A were utilized in the research.* These summaries should be considered brief overviews only, and you are encouraged to consult the primary sources when referencing these studies.

Bailey, D. A. (1997). The Saskatchewan pediatric bone mineral accrual study: Bone mineral acquisition during the growing years. *International Journal of Sports Medicine, 18,* S191-S194.

The six-year bone mineral accrual study described by Bailey (1997) examined the bone mineral accretion from childhood to adolescence. Sixty-eight elementary school boys and 72 elementary school girls were assessed. The children were recipients of Dual x-ray scans once a year and anthropomorphic measures every six months. As well, the children completed the PAQ-C and a nutrition questionnaire at least three times per year for the first three years and then twice a year every year after.

The results of Bailey's (1997) bone mineral accrual study suggest that adolescents' growth period is an important time for bone mineral accretion. The focus of this study was on physical growth; unfortunately the physical activity results were not reported. Bailey suggested that more research was needed to examine the relationship between physical activity and bone mineral accrual during adolescents' peak growth period (see Bailey, McKay, Mirwald, Crocker, & Faulkner, 1999, for the physical activity data in this study).

Bailey, D. A., McKay, H. A., Mirwald, R. L., Crocker, P. R. E., & Faulkner, R. A. (1999). A six-year longitudinal study of the relationship of physical activity to bone mineral accrual in growing children: The University of Saskatchewan bone mineral accrual study. *Journal of Bone and Mineral Research, 14*, 1672-1679.

The PAQ-C was used successfully in longitudinal research to measure children's general physical activity levels from childhood to adolescence. The above study investigated the relationship between physical activity levels and bone mineral accrual as children matured into adolescents. Two hundred and twenty-eight children were recruited from the Saskatchewan pediatric bone mineral accrual study. All children were Caucasian and 8 to 14 years of age. After 6 years of data collection, 68 boys and 72 girls remained and most provided acceptable longitudinal data for analyses. The measures administered were DEXA scans to assess bone mineral content, height and weight measurements, 24-hr recalls to assess dietary calcium, and the PAQ-C to assess general levels of physical activity (note that the PAQ-C was incorrectly called the PAC-Q in this study).

The children completed the PAQ-C at least 3 times per year for the first three years, and every additional year after the third year the PAQ-C was completed twice per year. Based on the PAQ-C mean activity score and *SD* for each age group, every child was given an age-gender specific *Z* score that signified the child's activity level as either active, average activity, or inactive. Fifteen boys and 13 girls were categorized as active, 30 boys and 27 girls were of average activity, and 15 boys and 13 girls were inactive.

Children's physical activity scores were significantly correlated with peak total body bone mineral accrual and total amount of bone mineral accumulated during the 2 years around the age of peak bone mineral content velocity ([PBMCV]; $r = 0.39$, $r = 0.40$ respectively for males; $r = 0.41$, $r = 0.38$ respectively for females; and both $p < 0.05$). For the lumbar spine, girls produced the highest correlation between physical activity and PBMCV ($r = 0.47$). The active boys and girls combined had a significantly different magnitude of total body bone mineral accrual at peak and total amount of bone mineral accumulated during the 2 years around PBMCV compared to inactive boys and girls combined.

Ball, G. D. C., Marshall, J. D., & McCargar, L. J. (2003). Fatness and fitness in obese children at low and high health risk. *Pediatric Exercise Science, 15*, 392-405.

To investigate whether or not physical activity levels predict the presence of metabolic risk factors of cardiovascular disease (CVD) and type 2 diabetes, the PAQ-C was used to classify children's physical activity levels. Body composition, physical inactivity, and cardiorespiratory fitness were also investigated in this study to determine their prediction ability. Obese children ($N = 83$) ages 6 to 12 years of age from Edmonton and the surrounding area participated in this study.

Children were tested for CVD and type 2 diabetes risk factors. Dyslipidemia, insulin resistance, and elevated blood pressure were measured for; as well, assessments of height, weight, BMI, skinfolds, and total body and regional body composition (as assessed by Dexa scans) were completed. The sum of 5 skinfolds was used to classify children as obese. The children completed the PAQ-C and a physical maturation questionnaire, and the parents filled out a questionnaire classifying their social economic status. Physical inactivity was estimated from the previous 7 days of self-reported time spent watching television and playing video/computer games. Ethnic background, CVD, and type 2 diabetes histories were reported by parents. The children completed a cardiovascular test, blood samples were taken, and blood pressure, insulin levels, and glucose levels were measured. Children were categorized as either low health risk (LHR) or high health risk (HHR). Those children with 1 or more risk factor for CVD or type 2 diabetes were categorized as HHR, whereas no risk factors produced a LHR status. Risk factors for CVD and type 2 diabetes included dyslipidemia, insulin resistance, and elevated blood pressure.

Fifty-three children were categorized as HHR and 30 children were categorized as LHR. Together, 24/83 children had 2 or more risk factors. The LHR children and the HHR children had almost identical activity levels as assessed by the PAQ-C (M = 3.01, SD = 0.65 and M = 3.00, SD = 0.66; respectively). Significant predictors of an HHR classification were central body fat mass and the sum of 5 skinfolds. LHR children and HHR children differed significantly (p = 0.05) in mean total body lean mass, mean total body fat mass, and mean central body fat mass. Physical activity along with other lifestyle variables did not predict metabolic risk for CVD and type 2 diabetes. Central body fat mass was the strongest predictor of an HHR categorization.

Carter, L. M., Whiting, S. J., Drinkwater, D. T., Zello, G. A., Faulkner, R. A., & Bailey, D. A. (2001). Self-reported calcium intake and bone mineral content in children and adolescents. Journal *of the American College of Nutrition, 20,* 502-509.

The physical activity levels of children and adolescents were assessed by the PAQ-C to determine whether or not physical activity has a relationship to bone mineral density. Two hundred and twenty-seven children from the Saskatchewan pediatric bone mineral accrual study were assessed in the fall of 1993. Additional measurements administered were DEXA scans to assess bone mineral, two to four 24-hour recalls monitoring dietary intake, maturity ratings, anthropomorphic measures such as height, weight, and adiposity. High school students were given a modified PAQ-C that omitted the recess item (i.e., PAQ-A).

Generally, in comparison to females, the males had higher activity scores. Males had a mean physical activity score of 3.1 (SD = 0.6, n = 107) and the females mean activity score was 2.7 (SD = 0.6, n = 117). For both males and females, there were no significant correlations between activity scores and lumbar spine bone mineral content or total body bone mineral content. Using a multiple linear regression model of lumbar spine bone mineral content in males and females, the activity score was a significant predictor of lumbar spine bone mineral content only for females.

Crocker, P. R. E., Eklund, R. C., & Kowalski, K. C. (2000). Children's physical activity and physical self-perceptions. *Journal of Sports Sciences, 18,* 383-394.

The PAQ-C and the Physical Self-Perception Profile (PSPP) were used to study the relationship between children's physical activity levels and physical self-perceptions. Two hundred and twenty boys and 246 girls were recruited. The children were in grades 5 to 8 and were selected from five different schools.

The PAQ-C scores differed significantly between the boys and the girls ($p < 0.008$). The mean activity scores for boys, girls, and boys and girls combined were 3.21(*SD* = 0.67), 2.95 (*SD* = 0.64), and 3.07 (*SD* = 0.67) respectively. A multivariate analysis of variance of the PAQ-C activity checklist displayed that the frequency of reporting certain activities differed between boys and girls (Wilks' lambda = 0.638, $F_{22, 451} = 11.63$, $p < 0.001$). However, the effect sizes for most activity differences reported were small. The authors suggested caution when interpreting the differences between the boys' and the girls' activities because the PAQ-C questionnaire is based only on the previous 7 days.

Children's physical activity levels were significantly correlated with self-perceptions of sport competence, body attractiveness, physical conditioning, physical strength, and general physical self-worth ($r = 0.26$-0.47 for girls and $r = 0.28$-0.47 for boys, $p < 0.05$). The physical self-perception model with pathways from physical condition and sport competence to the PAQ-C predicted 27 to 29 percent of the variance in boys' and girls' activity scores.

Crocker, P. R. E., Holowachuk, D. R., & Kowalski, K. C. (2001). Feasibility of using the Tritrac motion sensor over a 7-day trial with older children. *Pediatric Exercise Science, 13,* 70-81.

To assess the feasibility of the Tritrac-R3D activity monitor (Tritrac), the PAQ-C along with other physical activity measures were compared to the Tritrac. Seventy-nine children in grades 4 to 8 participated. The final sample consisted of 34 girls and 27 boys who were predominately Caucasian and lived in a middle class area. The Tritrac and the Caltrac personal activity computer (Caltrac) were used by the children. The children also completed the PAQ-C and the 7-day physical activity recall interview (PAR). They wore the Tritrac and Caltrac monitors for 7 consecutive days.

The PAQ-C was significantly correlated with the PAR summary score ($r = 0.39$); however, the PAQ-C was not related to the Tritrac (r = 0.13), and the Tritrac was related to the Caltrac (r = 0.86). One explanation as to why the Tritrac was not correlated with the PAQ-C may be due to adherence issues with the Tritrac. Problems with the Tritrac included mechanical problems, social embarrassment, discomfort, and forgetting to wear the device. Of the 79 students that participated in this study, 22 students did not reach 56 hours of Tritrac data per week. The adherence problems with the Tritrac may have distorted the children's normal activity patterns, which may explain the low correlations between subjective and objective measures. The results of this study suggest that the Tritrac may not be feasible for studies of longer duration assessing general levels of physical activity in children.

Crocker, P. R. E., Sabiston, C., Forrestor, S., Kowalski, N. P., Kowalski, K. C., & McDonough, M. (2003). Predicting change in physical activity, dietary restraint, and physique anxiety in adolescent girls. *Canadian Journal of Public Health, 94,* 332-337.

The PAQ-A was used in this two-year study to measure adolescent females' physical activity levels. The girls' body mass index (BMI), global self-esteem (GSE), physical self-perceptions, social physique anxiety (SPA), and dietary restraint were also examined. Of most importance were the changes in these constructs and the relationships that followed.

Six hundred and thirty-one female adolescents (ages 15-16) participated. The girls were enrolled in schools in Saskatoon and the surrounding area. They completed the Physical Self-Perceptions Profile, the Dutch Eating Behavior Questionnaire-Restrained Eating (DEBQ-R), the PAQ-A, and the Social Physique Anxiety Scale during class time. BMIs were also calculated (range = 14.8-36.9) based on self-reported height and weight.

The adolescent females' physical activity scores decreased (year 1 $M = 2.65$, $SD = 0.59$; year 2 $M = 2.40$, $SD = 0.55$; $p < 0.05$). Cross-sectional analysis for the first year revealed that the PAQ-A was significantly correlated ($p < 0.05$) to GSE, BMI, and physical self-perceptions of physical self-worth (PSW), body appearance, conditioning, sport, and strength (range = 0.12-0.51). For year 2, the PAQ-A was correlated to the same variables as year 1 (range = -0.12-0.58), except for BMI (and also with the addition of SPA). Pearson product moment correlations displayed that a change in physical activity was related to a change in each self-perception (excluding BMI), and physical conditioning was found to be the strongest predictor of physical activity change.

Ernst, M. P., & Pangrazi, R. P. (1999). Effects of a physical activity program on children's activity levels and attraction to physical activity. *Pediatric Exercise Science, 11,* 393-405.

The impact of both an activity intervention (termed P.L.A.Y.) and a modified P.L.A.Y. placebo intervention on elementary school children was partially assessed by the PAQ-C. The PAQ-C was used to monitor activity levels from the start of the study to following the intervention. The teachers from 5 elementary schools ($N = 28$) and their students participated. Each class consisted of approximately 25 students. The students were in either grades 4, 5, or 6 and the ratio of boys to girls was approximately balanced. The majority of teachers and students were Caucasian and were of middle economic status. The children were categorized as either high or low activity levels from their pre-test PAQ-C scores. The PAQ-C and the Children's Attraction to Physical Activity (CAPA) scale were administered at the same time.

The children were randomly assigned to either the intervention group or the placebo group before the study began. The P.L.A.Y. intervention and the P.L.A.Y. placebo intervention were 12 weeks in length and consisted of 2 steps. The first step (a duration of 4 weeks) included a 15-minute activity break during the school day. During these weeks, the P.L.A.Y intervention group was encouraged to participate in activity and their teachers taught a new activity game each day (total of 15 games), whereas the placebo group was not encouraged to be active and no games were taught. The children were given a logbook to complete step 2 (8 weeks in duration). The P.L.A.Y intervention group logged their activity hours from the previous day, and the P.LA.Y. placebo group recorded the number of hours spent watching television. At this step the 15-minute activity breaks were discontinued for both groups.

The intervention group consistently had significantly higher activity scores compared to the placebo group ($p < 0.05$). The intervention boys' and girls' mean baseline physical activity scores were 3.05 (*SD* = 0.68) and 2.89 (*SD* = 0.54) respectively, whereas the control boys' and girls' mean baseline physical activity scores were 3.01 (*SD* = 0.72) and 2.77 (*SD* = 0.50) respectively. The mean activity scores for the intervention boys' at the midpoint and at the end of the intervention were 3.40 (*SD* = 0.57) and 3.37 (*SD* = 0.48) respectively, whereas the placebo boys' mean activity scores were 2.93 (*SD* = 0.66) and 3.02 (*SD* = 0.56) respectively. The girls had similar results. The intervention girls' mean activity scores at the midpoint and at the endpoint were 3.16 (*SD* = 0.43) and 3.09 (*SD* = 0.40) respectively, whereas the placebo girls' mean scores were 2.80 (*SD* = 0.52) and 2.76 (*SD* = 0.39) respectively. The effect size for both the intervention boys and girls were significant at the midpoint and post-test (0.71 and 0.63 respectively for boys and 0.69 and 0.85 for girls). The P.L.A.Y. intervention children who were classified in the high activity group always had higher activity scores than the placebo group. The majority of children with high and low physical activity levels who participated in the P.L.A.Y intervention improved their physical activity status.

Gurd, B., & Klentrou, P. (2002). Physical and pubertal development in young male gymnasts. *Journal of Applied Physiology, 95,* 1011-1015.

This study measured adolescent boys' weekly energy expenditure with the help of the PAQ-A. The boys were gymnasts and had intense training programs. Their physical growth and sexual maturation were investigated for training effects.

Twenty-one elite male gymnasts and 24 controls (enrolled in a martial arts school) were recruited to participate. Each gymnast was participating in at least 15 hours of training per week, whereas the controls completed 2 hours or less per week (*M* age = 13.3 years, *M* age = 13.5 years; respectively). Measurements of height, weight, pubertal maturation, salivary testosterone, and relative body fat (as assessed by bioelectrical impedance) were taken once before the adolescents' regular training. As well, the adolescents reported the number of training sessions and training hours per week. The PAQ-A assisted the measurement of weekly energy expenditure [metabolic equivalents (MET)/wk].

The PAQ-A general physical activity scores were not reported. Energy expenditure (MET/wk), training sessions/wk, and training duration (h/wk) made up the males' physical activity characteristics. The elite male gymnasts had significantly (*p* □ 0.05) greater energy expenditures, training duration, and training sessions per week compared to the controls. Training variables and energy expenditure were significantly (*p* □ 0.05) correlated to relative body fat but not to physical growth or sexual maturation.

Heinonen, A., McKay, H. A., Whittall, K. P., Forster, B. B., & Khan, K. M. (2001). Muscle cross-sectional area is associated with specific site of bone in prepubertal girls: A quantitative magnetic resonance imaging study. *Bone, 29,* 388-392.

In this study, a modified PAQ-C was used to estimate the duration (hours per week) of loaded physical activity children performed. The possible relationship between muscle cross-sectional area and total cortical bone area in prepubertal and early pubertal girls was of greatest importance. Specifically, this study investigated whether or not a region-specific relationship existed.

Prepubertal and early pubertal girls (*N* = 17) who were participating in regular physical education classes; of tanner stage I-II; had no metabolic disorders and musculoskeletal complications; and were not taking medications that would influence bones, balance, or strength participated in this study. The girls attended elementary school and were between the ages of 9 to 11 years. The children's height and weight were measured, and a maturity rating was established. Calcium intake and health history were also assessed. Muscle and bone measurements were measured by an MRI, lower limb explosive performance capacity was assessed, and drop jump and side-to-side jump ground reaction forces were evaluated. The duration (h/week) of loaded physical activity was estimated from the PAQ-C's after school and during school items.

The PAQ-C scores were not reported; however, all girls were reported to be moderately active. The mean time that children spent in loaded physical activity was 5 hours/week (*SD* = 3.5).

MacKelvie, K. J., McKay, H. A., Khan, K. M., & Crocker, P. R. E. (2001a). Lifestyle risk factors for osteoporosis in Asian and Caucasian girls. *Medicine and Science in Sports and Exercise, 33*, 1818-1824.

The PAQ-C was used to assess the level of children's participation in loaded physical activity. MacKelvie, McKay, Khan, and Crocker (2001) studied 191 young girls' (9-12 years of age) bone mineral content and associated lifestyle factors. The girls were classified as either Tanner breast stage I or Tanner breast stage II. There were 56 Asian girls and 75 Caucasian girls from 14 schools outside of Vancouver in the Richmond school district. The girls were classified into ethnic groups and the following measurements were taken: maturity ratings, bone mineral measures assessed by DEXA scans, height and weight measurements, calcium intake assessed by a food frequency questionnaire, and physical activity participation assessed by a modified PAQ-C. The modified PAQ-C included a measurement of time ($h \times wk^{-1}$) spent in loaded physical activities (impact > walking) and a record of how often the child participated in evening organized sports and/or activity lessons per week.

The Tanner I Asian girls participated significantly less in general physical activity ($p < 0.05$) and had significantly lower calcium intake ($p < 0.001$) than the Tanner I Caucasian girls. The Tanner I Asian girls' mean scores for general physical activity, sport nights per week, and time spent in loaded physical activity (hr/wk) were 2.7(*SD* = 0.5), 1.0 (*SD* = 1.3), and 4.2 (*SD* = 4.0) respectively, whereas the Tanner I Caucasian girls' mean scores were 3.0 (*SD* = 0.6), 1.5 (*SD* = 1.7), and 4.6 (*SD* = 3.5) respectively. The Tanner I Caucasian girls spent 66% of their time in sport outside of school, whereas the Tanner I Asian girls spent 40% of their time in extracurricular sports. The Tanner I Caucasian girls contributed 9% more of their time in loaded physical activity per week compared to Tanner I Asian girls.

The Tanner II Caucasian girls had significantly higher loaded physical activity participation ($p < 0.01$), sports nights per week ($p < 0.05$), and calcium intake ($p < 0.001$) than the Tanner II Asian girls. The Tanner II Caucasian girls' mean scores for general physical activity, sport nights per week, and time spent in loaded physical activity (hr/wk) were 2.9 (*SD* = 0.6), 2.5 (*SD* = 1.8), and 5.9 (*SD* = 4.1) respectively. In comparison to the Tanner II Caucasian girls, the Tanner II Asian girls' mean score for general physical activity was similar (2.7, *SD* = 0.6), lower for sport nights per week (1.3, *SD* = 2.0), and lower for time spent in loaded physical activity (3.3, *SD* = 2.7). The Tanner II Caucasian girls had approximately 41% higher calcium intake, more participation in out-of-school sports per week, and 44% more time in loaded activity.

MacKelvie, K. J., McKay, H. A., Khan, K. M., & Crocker, P. R. E. (2001b). A school-based exercise intervention augments bone mineral accrual in early pubertal girls. *The Journal of Pediatrics, 139*, 501-508.

The PAQ-C was used to examine whether or not physical education exercise interventions may be beneficial for bone health in prepubertal and early pubertal girls. Fourteen mixed ethnic schools from the Richmond school district outside of Vancouver participated in a school-based physical activity intervention. The schools were randomly assigned to either the control or the intervention group. This study focused on the girls who participated (26 prepubertal (PRE) control, 44 PRE intervention, 64 Early puberty (Early) control, and 43 Early intervention). The girls underwent the following measurements: maturity ratings, bone mineral measurements assessed by DEXA scans, height and weight, calcium intake assessed by a food frequency questionnaire, and physical activity participation assessed by a modified PAQ-C. The modified PAQ-C included a measurement of time spent in loaded activities and in common sports, as well as a measurement of how often the child participated in evening organized sports. The children in the intervention group participated 3 times per week in a 10-12 minute, high impact, weight bearing training program where the intensity of the program was increased progressively.

The intervention group and the control group for both prepubertal and early puberty girls had a similar mean calcium intake, general physical activity level (PRE control = 2.80 [0.47], PRE intervention = 2.96 [0.52], Early control = 2.90 [0.52], and Early intervention = 2.90 [0.51]), loaded physical activity (PRE control = 4.5 [3.2], PRE intervention = 4.9 [3.0], Early control = 5.7 [3.7], and Early intervention = 5.7 [4.1]), and extracurricular sport participation per week (PRE control = 1.2 [1.2], PRE intervention = 1.2 [1.4], Early control = 1.7 [1.5], and Early intervention = 1.6 [1.4]). Compared to the Early girls in the control group, the Early girls who participated in the intervention accumulated 1.5% to 3.1% more bone at the lumbar spine and femoral neck ($p < 0.05$).

MacKelvie, K. J., McKay, H. A., Petit, M. A., Moran, O., & Khan, K. M. (2002). Bone mineral response to a 7-month randomized controlled, school-based jumping intervention in 121 prepubertal boys: Associations with ethnicity and body mass index. *Journal of Bone and Mineral Research, 17*, 834-844.

Prepubertal boys' general physical activity levels were determined by the PAQ-C. Modifications were made to the PAQ-C so that the researchers could estimate the children's time spent in loaded activity and common sports. Of most interest to this study were the bone mineral changes in prepubertal boys after a 7-month jumping intervention. These changes were then compared to the control boys' bone mineral changes.

Fourteen schools outside of the Vancouver area volunteered to participate after being recruited. Three hundred and eighty-three children (ages 8.8-11.7 years) participated. The children were categorized as either Asian or Caucasian. If a child was taking medications or had a medical complication that could influence physical activity or bone development they were excluded from the study. A health history questionnaire assessing the children's health was completed by the parents. The following measurements were also taken: maturity rating, bone mineral, height, weight, calcium, and physical activity. A modified PAQ-C estimated the time (h/week) the boys spent in out-of-school sports and loaded activities (impact > walking). The mean general physical activity scores reported in this study are an average of three assessments by the PAQ-C during the school year (baseline, winter, and a final measurement).

The intervention group participated in a school-based jumping exercise intervention 3 times per week (2 physical education class times and one supervised session). The exercise intervention included high-impact, weight-bearing activity for 10 to 12 minutes. The program's difficulty and loading progressed throughout the school year.

There was no change in prepubertal boys' physical activity scores and loaded activity time for control, intervention, Asian, and Caucasian groups over the 7 months. The baseline mean physical activity score for the control boys was 3.1 (SD = 0.5) and 3.1 (SD = 0.6) for the intervention group. Asian and Caucasian control groups with an average body mass index (BMI) had mean baseline physical activity scores of 3.0 (SD = 0.4) and 3.0 (SD = 0.5) respectively. The intervention Asian and Caucasian groups with an average BMI had mean baseline physical activity scores of 3.0 (SD = 0.6) and 3.1 (SD = 0.6). The mixed ethnicity control boys had a mean baseline PAQ-C score of 3.1 (SD= 0.6). The mean was 3.0 (SD = 0.4) for the mixed ethnicity intervention group. At several different sites, the intervention boys (Asian and Caucasian) with low or average BMI gained significantly ($p < 0.01 – p < 0.05$) more bone mineral accrual than their controls. No changes were found in prepubertal intervention and control boys with a high BMI over the 7 months. The jumping intervention was reported as successful in increasing bone mineral accrual in Asian and Caucasian prepubertal boys with a low or average BMI.

MacKelvie, K. J., Petit, M. A., Khan, K. M., Beck, T. J., & McKay, H. A. (2004). Bone mass and structure are enhanced following a 2-year randomized controlled trial of exercise in prepubertal boys. *Bone, 34,* 755-764.

Prepubertal boys' general physical activity levels were determined by the PAQ-C. Modifications were made to the PAQ-C so that the researchers could estimate the children's time spent in loaded activity and common sports. Of most interest to this study were the prepubertal boys' changes in proximal femur bone geometry and strength after a

2-year loaded physical activity intervention. These results were compared to the control boys' changes. As well, the intervention boys' and the control boys' total body, proximal femur, and lumbar spine bone mineral content and bone area changes were of importance.

Fourteen schools outside of the Vancouver area volunteered to participate after being recruited. All schools were randomly assigned to either the intervention or the control groups (intervention = 7 and control = 7). Thirty-one intervention boys and 33 control boys participated. A health history questionnaire assessing the children's health was completed by the parents. The following measurements were also taken at baseline, 8 months, 12 months, and 20 months: maturity rating, bone mineral content, bone area, height, weight, calcium intake, leg length, long jump, vertical jump, and physical activity. Structural and geometric characteristics of the proximal femur were assessed by a Hologic Inc. QDR-4500 bone densitometer. These measurements were analyzed using hip structural analysis. A modified PAQ-C assessed the number of nights the boys spent in common sports per week and the time spent in loaded activities (h/week). The mean general physical activity scores reported in this study are an average of 6 assessments by the PAQ-C over the 2 school years (fall, winter, and spring completion).

The intervention group participated in a school-based jumping exercise intervention. The intervention included 3 sessions per week with high-impact, weight-bearing activity for 10 to 12 minutes. The program's difficulty and intensity progressed throughout the 2 school years.

The PAQ-C average 20-month physical activity scores were similar between the intervention and control boys, M = 3.2 (SD = 0.6) and M = 3.1 (SD = 0.5) respectively. Further, the scores for average number of sports nights per week and average time spent in loaded activity were similar between the two groups.

Mahon, A. D., Anderson, C. S., Hipp, M. J., & Hunt, K. A. (2003). Heart rate recovery from submaximal exercise in boys and girls. *Medicine and Science in Sports and Exercise, 35,* 2093-2097.

The PAQ-C was used to assess 11 boys' and 10 girls' physical activity levels. This study was interested in their heart rate (HR) changes that occurred after two separate submaximal exercise sessions.

The children's pubertal status, height, weight, and 6 skinfolds were measured. The parents completed the PAQ-C (with help from their children). To measure peak VO_2, a graded cycle ergometer test was completed by the children on two different sessions. During these sessions resting HR, exercise HR, and postexercise HR were measured.

The boys and girls had similar physical activity levels (M = 3.1, SD = 0.6; M = 3.0, SD = 0.4; respectively). In this study, peak VO_2 was less effective in accounting for variations in postexercise HR in comparison to resting HR.

McKay, H. A., Petit, M. A., Khan, K. M., & Schutz, R. W. (2000). Lifestyle determinants of bone mineral: A comparison between prepubertal Asian- and Caucasian-Canadian boys and girls. *Calcified Tissue International, 66,* 320-324.

McKay, Petit, Khan, and Schutz (2000) compared Caucasian and Asian children's lifestyle factors that could affect bone mineral content. Ten Canadian multi-ethnic schools participated. Fifty-eight prepubertal Asian children and 110 prepubertal Caucasian children (mean age 8.9) were assessed. The children received Dexa scans of the proximal femur, lumbar spine, and total body. The following measurements were taken: stretch statures as assessed by a wall stadiometer, maturity ratings, and weight. The children completed a food frequency questionnaire to classify calcium intake and the PAQ-C to classify physical activity levels. The scoring of the PAQ-C was modified. The original PAQ-C provides an activity rating from 1 to 5 for each child (where a 1 represents a low activity level and a 5 represents a high activity level). In this study, the physical activity score was calculated from the amount of loaded physical activity that was recalled by the children in the prior week and was not scored on a 5-point scale. Additionally, the children were asked if the activity reported for the previous week was consistent with their usual activity participation.

The PAQ-C activity scores demonstrated the differences in Asian and Caucasian children's physical activity levels. Overall, Asian children had a significantly lower calcium intake and physical activity participation than the Caucasian children (70.2 [*SD* = 19.2] vs. 82.0 [*SD* = 16.5] respectively; $p < 0.001$). The mean activity score for Asian children was 67.4 (*SD* = 16.6) for boys and 73.3 (*SD* = 21.5) for girls, whereas the mean activity score for Caucasian children was 87.8 (*SD* = 17.1) for boys and 76.0 (*SD* = 13.5) for girls. Only 14% of Asian boys reported participating in sport, compared to 73% of Caucasian boys reporting involvement in organized sport. Bone mineral free lean mass, sex, and physical activity were significant predictors of areal bone mineral density at the femoral neck and the total proximal femur.

McKay, H. A., Petit, M. A., Schutz, R. W., Prior, J. C., Barr, S. I., & Khan, K. M. (2000). Augmented trochanteric bone mineral density after modified physical education classes: A randomized school-based exercise intervention study in prepubescent and early pubescent children. ***The Journal of Pediatrics, 136,*** **156-162.**

The PAQ-C was used to classify children's activity levels in order to determine the impact of an 8-month exercise intervention on children's areal bone mineral density. One hundred and forty-four children in grades 3 and 4 from 10 different elementary schools were assessed. Forty-nine children were Asian and 95 children were Caucasian. The schools were randomly placed into either the intervention or the control group. The intervention group participated in a loaded activity physical education intervention, whereas the control group participated in their usual physical education class. The intervention was performed 3 times per week and included 10 minutes of loaded activity, 10 tuck jumps at the beginning of class, and 10 to 30 minutes of total activity. The intensity of the intervention progressed throughout the 8 months. The children received Dexa scans and anthropometric measurements. They also completed calcium intake questionnaires, a healthy history form, a self-assessment of maturity, and the PAQ-C. The

PAQ-C was modified in order to focus on the children's loaded activity levels and the final activity score was not based on a 5-point scale.

According to the baseline measurements of the PAQ-C, the children in the control group had significantly higher physical activity levels than the intervention group (control = 86.0, exercise = 80.5, $p = 0.002$). The children who participated in the exercise intervention had significantly greater gains in femoral trochanteric areal bone mineral density than the control group (4.4% vs. 3.2 %, $p = 0.05$). Interestingly, the control group had greater activity levels compared to the intervention group at the 8-month final assessment.

Muratova, V. N., Islam, S. S., Demerath, E. W., Minor, V. E., & Neal, W. A. (2001). Cholesterol screening among children and their parents. *Preventive Medicine, 33*, 1-6.

The PAQ-C was used to classify children's physical activity levels in a school-based cholesterol-screening program. Seven hundred and nine children in the fifth grade from rural Appalachian countries participated. The children were comprised of 326 boys and 383 girls (mean age 10.8) where the majority of children were Caucasian. The cholesterol-screening program was comprised of three phases: screening, diagnosis, and intervention. The children's nonfasting finger-stick total blood cholesterol, high-density lipoprotein cholesterol, anthropomorphic measures, and dietary history were assessed in the screening phase. Additionally, physical activity levels were assessed by the PAQ-C, parental smoking was measured by a questionnaire completed by the parents, and anxiety levels were assessed on a 5-point Likert scale. The children's mean physical activity score was 2.89 ($N = 707$, $SD = 0.64$). The PAQ-C physical activity score displayed a relationship with diastolic blood pressure; however, the magnitude of the relationship was weak ($r = -0.07$).

Paxton, R. J., Estabrooks, P. A., & Dzewaltowski, D. (2004). Attraction to physical activity mediates the relationship between perceived competence and physical activity in youth. *Research Quarterly for Exercise and Sport, 75,* 107-111.

To determine children's physical activity levels, the PAQ-C was used. Relationships among children's physical activity, perceived physical competence, and attractions to physical activity were investigated. Further, this study examined whether or not attraction to physical activity mediates the relationship between perceived physical competence and physical activity.

The children of four 4-H youth development clubs were asked to participate. Sixty-three Caucasian children (ages 9-14 years) from the entire sample of 94 children provided parental consent to participate. Thirty-four percent of children were boys. A modified Perceived Physical Competence Scale for children, The Children's Attraction to Physical Activity Scale (CAPAS), and the PAQ-C were completed during the winter (*Note. In this study the PAQ-C was called the PAQ-OC*).

The children had low physical activity levels (M = 1.83, SD = 0.64). Significant ($p < 0.01$) bivariate correlations were found between physical activity and attraction to physical activity (r = .45) and perceived physical competence (r = .34). Further, attraction to physical activity mediated the relationship between perceived physical competence and physical activity.

Petit, M. A., McKay, H. A., MacKelvie, K. J., Heinonen, A., Khan, K. M., & Beck, T. J. (2002). A randomized school-based jumping intervention confers site and maturity-specific benefits on bone structural properties in girls: A hip structural analysis study. *Journal of Bone and Mineral Research, 17,* 363-372.

Prepubertal and early pubertal girls' general physical activity levels were assessed by the PAQ-C. This study focused on what geometric and structural bone changes occurred in the girls as a result of a school-based jumping exercise intervention.

Fourteen schools outside of the Vancouver area volunteered to participate after being recruited. One hundred and seventy-seven girls (ages 9-12 years) volunteered to participate. The schools were randomly assigned to either the intervention or control group. The girls' stretch statures, sitting heights, weights, calcium intakes, maturity ratings, and physical activity levels were measured. A modified PAQ-C was used so that a measure of loaded activity (impact > walking, h/week) and the number of nights the girls' participated in organized sport per week could be calculated. The girls completed the PAQ-C three times during the year.

The loaded exercise intervention included high-impact, 10 to 12 minutes sessions, and a variety of jumping activities. Two sessions per week were held during the girl's physical education class, while the third session was completed in class time on a different day. The difficulty and the intensity of the intervention progressively increased throughout the year.

The PAQ-C scores were not included. However, this study reported that the baseline measurements of physical activity for the intervention and control group showed no differences. Further, the abstract reported that physical activity levels were similar for both groups over the 7 months.

Rosendo da Silva, R. C., & Malina, R. M. (2000). Level of physical activity in adolescents from Niteroi, Rio de Janeiro, Brazil. *Cadernos-de-saude-publica-Ministerio-da-Saude,-Fundacao-Oswal do-Cruz,-Escola-Nacional-de-Saude-Publica, 16,* 1091-1097.

Rosendo da Silva and Malina (2000) created a Portuguese version of the PAQ-C to assess general physical activity levels in Brazilian children and adolescents. The manuscript and the PAQ-C were in Portuguese; therefore, this study summary is based on its English written abstract and observations made from the Portuguese PAQ-C.

Rosendo da Silva and Malina (2000) focused on Brazilian adolescents' (N = 325) activity levels. Anthropomorphic measures, hours of television viewing per day, and general activity levels were measured. The males' mean PAQ-C activity score was 2.3

($SD = 0.6$, $p < 0.01$) and the females' mean activity score was 2.0 ($SD = 0.6$, $p < 0.01$). The most frequently chosen activity was soccer for males and soccer and walking for females. A high percentage of children were classified as inactive from their PAQ-C scores (85% of males and 94% of females were inactive). The authors of this study were concerned with the high percentage of inactive children because these children may be more likely to be inactive adults. Interestingly, the mean activity scores for the Brazilian females and males were slightly lower than the mean activity scores found in the English PAQ-C validation reliability studies (see Chapter 2 for the English PAQ-C scores).

The Portuguese PAQ-C has content and scoring differences compared to the English PAQ-C. The Portuguese PAQ-C has additional items and includes a television item quantifying the number of hours children and adolescents watch television per day (this item is not included in the final activity score). Both questionnaires have an activity checklist item; however, the number of activity choices differ. The Portuguese version of the PAQ-C has 15 activity choices, whereas the original PAQ-C has 23 activity choices. Therefore, researchers should be cautious in interpreting the mean value of the activity checklist item because the Portuguese activity checklist item may be prone to producing a higher or lower activity score than the original PAQ-C.

Rourke, K. M., Brehm, B. J., Cassell, C., & Sethuraman, G. (2003). Effect of weight change on bone mass in female adolescents. *Journal of the American Dietetic Association, 103,* 369-372.

The activity levels of obese female adolescents were assessed by the PAQ-C. This study was interested in obese adolescents' changes in bone mineral density and bone mineral content as a result of participating in a weight reduction program. Ninety-two obese girls (mean age = 11) were recruited through newspaper advertisements and recommendations by pediatricians. The children received Dexa scans, anthropomorphic measures, and a body composition measure. They also completed the PAQ-C. The authors used the PAQ-C data to calculate the adolescent's energy expenditure.

However, the physical activity data were not presented, although the authors stated that the activity levels of the obese adolescent girls were similar to those of a normal weight adolescent population. Also, physical activity levels were not significant predictors of bone loss or gain.

Sirard, J. R., & Pate, R. P. (2001). Physical activity assessment in children and adolescents. *Sports Medicine, 31,* 439-454.

The strengths, limitations, and validity of subjective and objective measures of physical activity in children and adolescents were reviewed. This study reviewed criterion standards (direct observation, doubly labelled water, and indirect calorimetry), secondary measures (heart rate, pedometers, and accelerometers), and subjective measures (self-report, interview, proxy-report, and diary).

Self-report questionnaires' time frames, participants, reliability, criterion measure, and validity were reported in a table. The PAQ-C was one of the measures listed, but was not discussed in the text. Limitation in subjective measures discussed included children's recall ability and their struggle to recall intensity and type of activity. The authors suggested that survey measures be validated against strong standards of physical activity assessment.

Thompson, A. M., Baxter-Jones, A. D. G., Mirwald, R. L., & Bailey, D. A. (2003). Comparison of physical activity in male and female children: Does maturation matter? ***Medicine and Science In Sports and Exercise, 35,*** **1684-1690.**

In this longitudinal study (from years 1991-1997), children's general physical activity levels were assessed using the PAQ-C. The boys' and girls' biological ages (chronological age at peak height velocity subtract chronological age at time of measurement) were considered during the analysis of their physical activity levels.

Seventy boys and 68 girls from the Saskatchewan bone mineral accrual study participated. Data collected when the children were ages 9 to 18 years were analyzed. The children's chronological age, height, body mass, biological age, and physical activity levels were measured. During the first 3 years of the study, the children completed the PAQ-C 3 times per year. Every year after, the PAQ-C was completed twice per year. The PAQ-C assessment scores for one year were averaged to make up a yearly summary activity score. The PAQ-A (the PAQ-C omitting the recess item) assessed high school students' physical activity levels.

When physical activity scores were analyzed by chronological age, significant ($p < 0.05$) sex differences were found between the ages of 10 to 16 years. The boys had higher activity scores compared to the girls. Further, boys' and girls' physical activity levels decreased as chronological and biological age increased. No sex differences were found (with an exception at 3 years before peak height velocity) in physical activity levels when biological age was controlled for ($p < 0.05$).

Welk, G. J., Corbin, C. B., & Dale, D. (2000). Measurement issues in the assessment of physical activity in children. ***Research Quarterly for Exercise and Sport, 71,*** **59-73.**

The PAQ-C's strengths and limitations were mentioned in this study's review of physical activity assessment. However, the PAQ-C was not included in the comparison of self-report measures. It was mentioned as an assessment tool that measures children's general physical activity levels. The authors noted that the PAQ-C's general measurement is beneficial for studies that do not need estimates of time or amounts of activity. Further, the PAQ-C was recommended as an instrument that may have the ability to differentiate between active and inactive children. The authors reported that the PAQ-C does not provide a measurement of duration, frequency, and intensity.

Welk, G. J., & Wood, K. (2000). Physical activity assessments in physical education: A practical review of instruments and their use in the curriculum. ***Journal of Physical Education, Recreation and Dance, 71,*** **30-40.**

Welk & Wood (2000) reviewed a variety of physical activity measures, and concluded that the PAQ-C, along with other self-report measures have the potential to be used in physical education evaluation. This study reported two limitations of the PAQ-C. First, each item is scored on a 5-point scale and the final activity score is a composite score made up of 9 items. Giving equal weight to each item was viewed as a possible limitation because the items have different time periods for possible activity. Second, the PAQ-C does not provide an estimate of caloric expenditure. The PAQ-C was recognized for its ability to differentiate children into either active or non-active categories.

Welk, G. J., Wood, K., & Morss, G. (2003). Parental influences on physical activity in children: An exploration of potential mechanisms. *Pediatric Exercise Science, 15,* 19-33.

A parent's influence on their child's physical activity level was examined with the help of the PAQ-C. Children in grades 3 to 6 from three schools participated in this study. There were 994 students (505 boys and 489 girls) along with 536 parents. Only one parent from each family was asked to participate (82% were mothers, 17% fathers, and 1% were guardians). The children completed the PAQ-C and the Children's Physical Activity Correlates (CPAC) instrument during their physical education class. The CPAC consisted of an attraction to sport scale, a perceptions of competence scale, a parental influence scale, a parental role modelling scale, a parental support scale, a parental encouragement scale, a parental involvement scale, and a parental facilitation scale. The parents completed two physical activity measures at home, which assessed their physical activity level and categorised them as inactive, moderately active, or regularly active.

The boys had significantly higher activity levels than the girls, F (1,986) = 10.7, $p <$ 0.01. The mean activity score for boys was 3.29 (SD = 0.66), whereas the mean activity score for girls was 3.16 (SD = 0.62). The effect size was small for the difference between boys' and girls' activity scores (0.20).

The PAQ-C was moderately related to the attraction scale, perceptions of competence scale, and the parental influence scale (r = 0.38 to r = 0.52). Together, the parental support and parental role modelling variables predicted 19.7% of the variance in the PAQ-C scores, F (2,991) = 121.3, p < 0.001. The parents' activity levels (NOT assessed with the PAQ-C) were weakly correlated to their children's (r = 0.13 to r = 0.16).

Appendix 13: BMI percentiles for Boys and Girls

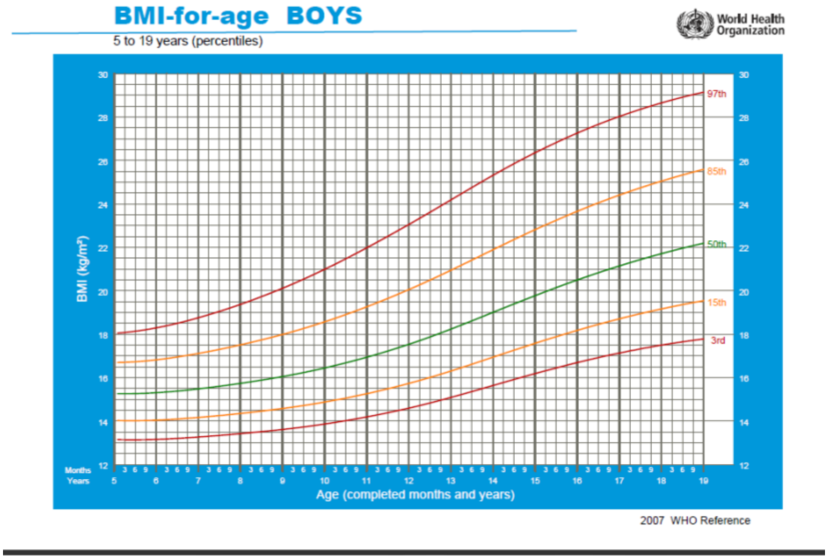


Figure 12 BMI percentile for boys (WHO, 2016f)

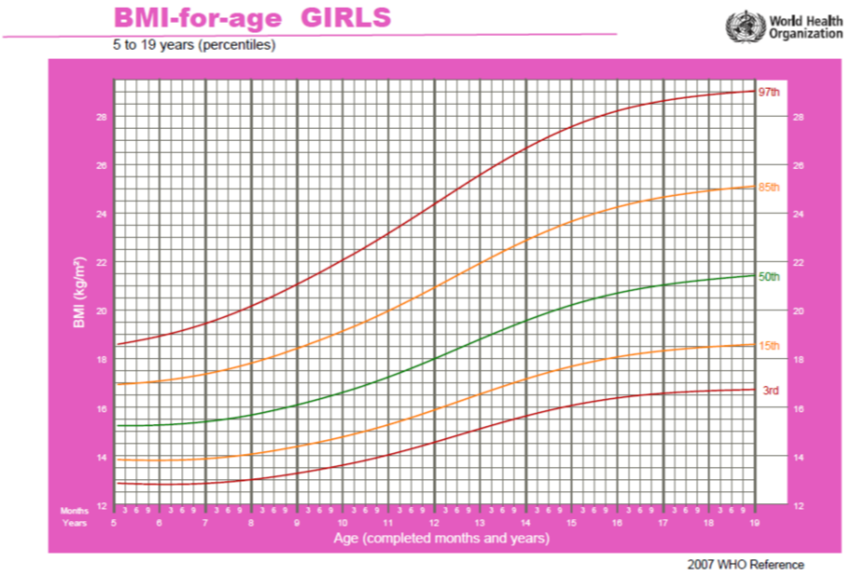


Figure 13 BMI percentile for girls(WHO, 2016f)

Appendix 14: Norms for waist-hip ratio

Boys									
Age		WC			HC			WHR	
Years	−2 SD	0 SD	+2 SD	−2 SD	0 SD	+2 SD	−2 SD	0 SD	+2 SD
0.25	33.0	39.4	45.4	31.6	37.3	43.9	0.899	1.041	1.196
0.50	35.9	42.0	48.0	35.5	41.4	48.3	0.885	1.013	1.152
0.75	37.4	43.4	49.5	37.6	43.4	50.4	0.879	0.998	1.128
1.0	38.3	44.3	50.6	39.1	44.7	51.6	0.875	0.988	1.111
2.0	41.1	46.9	53.7	42.9	48.5	55.6	0.869	0.968	1.077
3.0	44.0	49.7	56.9	45.5	51.4	59.0	0.866	0.962	1.070
4.0	45.5	51.2	59.0	47.8	54.2	62.5	0.849	0.945	1.053
5.0	46.3	52.1	60.7	49.8	56.7	66.0	0.827	0.923	1.032
6.0	47.2	53.3	62.9	51.5	59.0	69.6	0.810	0.905	1.015
7.0	48.4	54.8	65.5	53.2	61.3	73.2	0.796	0.891	1.002
8.0	49.7	56.5	68.5	55.3	64.2	77.5	0.784	0.878	0.990
9.0	51.0	58.2	71.4	57.8	67.4	81.7	0.773	0.866	0.978
10.0	52.3	59.9	74.3	60.2	70.4	85.2	0.763	0.855	0.966
11.0	53.8	61.8	77.2	62.4	73.3	88.4	0.755	0.846	0.957
12.0	55.4	63.9	80.0	64.7	76.3	91.7	0.748	0.838	0.949
13.0	57.2	66.1	82.8	67.4	79.8	95.5	0.741	0.831	0.942
14.0	59.1	68.2	85.2	70.7	83.7	99.1	0.735	0.825	0.937
15.0	60.9	70.3	87.4	74.2	87.1	102.0	0.730	0.821	0.933
16.0	62.6	72.3	89.4	76.9	89.6	104.0	0.729	0.820	0.934
17.0	64.1	74.0	91.1	78.6	91.3	105.4	0.729	0.821	0.936
18.0	65.4	75.6	92.6	79.8	92.3	106.3	0.731	0.824	0.941
19.0	66.6	77.0	94.0	80.6	93.1	107.0	0.733	0.827	0.946
20.0	67.7	78.3	95.4	81.2	93.6	107.5	0.735	0.831	0.951
21.0	68.8	79.6	96.6	81.6	94.1	107.9	0.738	0.834	0.956

Figure 14 WHR Norms Girls (Fredriks et al., 2005)

Age		WC			HC			WHR	
Years	−2 SD	0 SD	+2 SD	−2 SD	0 SD	+2 SD	−2 SD	0 SD	+2 SD
0.25	32.1	38.4	44.2	31.4	36.8	43.7	0.885	1.031	1.174
0.50	35.0	41.0	47.0	35.3	41.1	48.4	0.868	0.997	1.128
0.75	36.4	42.3	48.5	37.2	43.1	50.4	0.863	0.982	1.105
1.0	37.4	43.2	49.6	38.5	44.4	51.6	0.863	0.973	1.091
2.0	40.9	46.4	53.0	42.3	48.4	55.8	0.864	0.959	1.063
3.0	43.5	49.2	56.6	45.4	52.0	60.1	0.856	0.946	1.047
4.0	44.6	50.6	58.7	47.6	54.8	63.9	0.835	0.923	1.028
5.0	45.1	51.3	60.4	49.2	57.0	67.0	0.809	0.899	1.008
6.0	45.9	52.5	62.7	51.0	59.6	70.9	0.788	0.879	0.993
7.0	47.1	54.0	65.5	53.0	62.4	75.3	0.772	0.863	0.981
8.0	48.3	55.7	68.5	55.1	65.5	80.0	0.757	0.849	0.970
9.0	49.6	57.3	71.4	57.6	69.0	85.0	0.743	0.834	0.958
10.0	50.9	59.0	74.2	59.9	72.1	89.4	0.730	0.820	0.946
11.0	52.3	60.6	76.9	62.2	75.2	93.2	0.716	0.806	0.934
12.0	53.8	62.4	79.3	65.1	79.0	97.2	0.703	0.792	0.922
13.0	55.3	64.1	81.4	68.5	83.2	101.2	0.691	0.779	0.911
14.0	56.6	65.6	83.2	71.4	86.6	104.3	0.681	0.768	0.903
15.0	57.8	66.8	84.6	73.5	89.0	106.4	0.673	0.760	0.898
16.0	58.8	67.9	85.7	74.9	90.6	107.9	0.667	0.755	0.897
17.0	59.6	68.8	86.7	76.1	91.9	109.1	0.664	0.752	0.898
18.0	60.3	69.5	87.5	77.1	93.0	110.3	0.662	0.750	0.900
19.0	60.9	70.2	88.3	77.8	93.8	111.0	0.661	0.750	0.904
20.0	61.4	70.8	88.9	77.9	93.9	111.2	0.661	0.750	0.908
21.0	61.9	71.3	89.5	78.5	94.5	111.7	0.660	0.750	0.912

Figure 15 WHR Norms Boys (Fredriks et al., 2005)

Appendix 15: Procedure for 20m Bleep Test

The 20m bleep test is a commonly used maximal running aerobic fitness test. It is also known as the 20-meter shuttle run test, beep or bleep test among other names.

Equipment and Space – Cones, Mobile Phone Bleep App, was implemented in an open space

Procedure - All members of the research team was involved in this test. The researcher explained what test is being done. The research assistants were responsible for recording while the researcher controlled the bleep application. This test involved continuous running between two lines 20m apart in time to recorded beeps. For this reason, the test is also often called the 'beep' or 'bleep' test.

Instructions to Participants - The participants stood behind one of the lines facing the second line and began running when instructed by the recording. The speed at the start is quite slow. The participant continued running between the two lines, turning when signalled by the recorded beeps. After about one minute, a sound indicates an increase in speed, and the beeps are then closer together. This continued each minute (level). If the line was reached before the beep sounds, the participant must wait until the beep sounds before continuing. If the line was not reached before the beep sounds, the participant was given a warning and must continue to run to the line, then turn and try to catch up with the pace within two more 'beeps'. The test was stopped if the participant failed to reach the line (within 2 meters) for two consecutive ends after a warning.

Scoring - The participants score is the number of laps (20m) completed within the bleeps.

1. 
2.

Figure 16 Illustration for Bleep Test

Appendix 16: Procedure for sit-ups

This test measures the endurance of the abdominal and hip-flexor muscles.

Equipment and space - The required equipment is a floor mat and a stopwatch.

Instructions to Participants - The researcher at this station was the research assistant 1. The researcher explained to the participant what they will be doing and reasons. The researcher explained that the aim of the test is to perform as many sit-ups as he/she can in 30 seconds.

Procedure - The participant was instructed to lie on the mat with the knees bent at right angles and with the feet flat on the floor. The researcher held down the student's feet. The participants fingers were interlocked behind their head. On the command 'Go', the researcher started the timer on the stopwatch. The participant raised his/her chest so that the upper body was vertical, and then returned to the floor. This was be done for 30 seconds. For each sit up the back must return to touch the floor to be counted.

Scoring - The maximum number of correctly performed sit ups in 30 seconds was recorded. The sit up was not counted if the participant failed to reach the vertical position; failed to keep their fingers interlocked behind his/her head, arched or bowed his/her back or raised their buttocks off the ground in an attempt to raise their upper body; or let their knees exceed a 90-degree angle.

Figure 17 Illustration of sit-ups

Appendix 17: Procedure for Broad Jump

BROAD JUMP

The Broad jump is a common and easy to administer test of explosive leg power.

Equipment and space - The equipment used for this test was a tape measure, a marker and a soft-landing surface (an exercise mat was used).

Instructions to Participants - The researcher at this station was research assistant two. Firstly, the researcher introduced himself and explained to the participant what they would be doing. The researcher explained to the participant that he/she must stand behind the marked line on the floor with his/her feet slightly apart. The participant was then instructed to jump forward with both feet as far as possible ensuring that he/she lands on both feet without falling backwards.

Procedure - They were given three attempts.

Scoring -The measurement was taken from take-off line to the nearest point of contact on the landing (back of the heels) using a tape measure. The distances jumped of the three attempts were recorded.

Figure 18 Illustration of standing broad jump

Appendix 18: Procedure for hand grip strength

The purpose of this test was to measure the maximum isometric strength of the hand and forearm muscles. Handgrip strength is important for any sport in which the hands are used for catching, throwing or lifting. Also, as a general rule people with strong hands tend to be strong elsewhere, so this test is often used as a general test of strength.

Equipment and space - CAMRY Digital Hand Dynamometer Grip Strength Measurement Meter

Procedure - Researcher three tested the hand grip strength. The researcher introduced himself and explained what he was doing. The participant held the dynamometer in the hand to be tested, with the arm at right angles and the elbow by the side of the body. The handle of the dynamometer was adjusted if required. The base should rest on first metacarpal (heel of palm), while the handle should rest on middle of four fingers.

Instructions to Participants - When ready the participant squeezed the dynamometer with maximum isometric effort, which was maintained for about 5 seconds. No other body movement was allowed. The participant was strongly encouraged to give a maximum effort.

Scoring -The best 3 results from several trials for each hand was recorded, with at least 15 seconds recovery between each effort. Measurement was recorded in kg

Figure 19 Digital Handheld Dynamometer

Appendix 19: Sit-and-reach procedure

The sit and reach test is an important functional measure of hip region flexibility, including the lower back and hamstring muscles (the back of the legs).

Equipment and Space - The required equipment is a tape measure and a wooden box.

Procedure - The researcher at this station was research assistant four. The researcher introduced himself and explained to the participant what they would be doing. He then instructed the participant to sit on the floor with their back and head against a wall. The participants legs should be out straight ahead and knees flat against the floor. The researcher then placed a large wooden sit and reach box against the participant's feet, so that the feet was flat against it.

Instructions to Participants - The researcher gave the instructions: 'Keeping your back and head against the wall, stretch your arms out as far as possible, aiming to touch your toes with your fingertips.' The researcher then made note of where the participants fingertips reached, and the distance was measured from this point to the level on the box that corresponded with the participants big toe. If the participant reached beyond the level of their toes, the distance measured and recorded as a positive value. If their maximum reach is before the level of their toes, this distance was measured and recorded as a negative value. The participant was instructed not to jerk or bounce to reach further and to hold the full reached position for two seconds. Three attempts were given and recorded.

Scoring - The score was recorded to the nearest centimetre as the distance reached, either as a positive or negative value.

Figure 20 Illustration of sit-and-reach flexibility test

Appendix 20: Normative values for physical fitness tests

Table 29 Mean normative values of physical fitness test boys (Tomkinson et al., 2018)

Age	Sit and Reach (cm)	Hand Grip (kg)	Sit Ups	Broad Jump (cm)	20m Shuttle Run
12	16.1	22.6	21	160.7	45
13	16.5	28.4	22	169.7	49
14	18.0	34.6	23	181.4	55
15	20.3	39.5	24	192.9	59
16	21.4	42.9	25	200.8	61
17	22.6	45.0	25	205.8	66

Table 30 Mean normative values of physical fitness tests girls (Tomkinson et al., 2018)

Age	Sit and Reach (cm)	Hand Grip (kg)	Sit Ups	Broad Jump (cm)	20m Shuttle Run
12	21.4	20.6	19	147.1	32
13	23.1	24.6	19	150.4	32
14	24.5	27.1	19	152.5	32
15	25.4	28.0	20	153.9	32
16	25.9	28.2	20	154.6	32
17	26.1	28.4	20	156.4	32

Appendix 21: Procedure for recording BMI and WHR

This procedure was conducted in a screened area to maintain privacy of the participants. Anthropometric measures of height, weight, hip circumference and waist circumference was recorded using an inelastic tape measure and a digital weight scale.

Table 31 Procedure for recording measurements of BMI and WHR

<table>
<tr><th>Measurement</th><th colspan="2">Procedure</th></tr>
<tr><td>Hip circumference</td><td>A non-elastic tape measure was used to measure the hip measurement. The hip measurement was the circumference around the widest part of the hips and was measured at the level of the greater trochanter.</td><td rowspan="4">All measures were taken twice, and a third measure was done if there is was a difference of more than 0.5cm between the first two readings.</td></tr>
<tr><td>Waist circumference</td><td>A non-elastic tape measure was used to measure the waist measurement. The waist circumference was taken at the midline between the last palpable rib and the top of the iliac crest.</td></tr>
<tr><td>Height</td><td>Height was measured with the participant standing upright without shoes/socks and with their back against the height rod.</td></tr>
<tr><td>Weight</td><td>Weight was measured using a digital scale read to one decimal place.</td></tr>
</table>

Appendix 22 : Information for Parents and Participants

Physical activity

Fact sheet World Health Organisation (WHO, 2017, February)

Updated February 2017

Key facts

1. Insufficient physical activity is one of the leading risk factors for death worldwide.
2. Insufficient physical activity is a key risk factor for noncommunicable diseases (NCDs) such as cardiovascular diseases, cancer and diabetes.
3. Physical activity has significant health benefits and contributes to prevent NCDs.
4. Globally, 1 in 4 adults is not active enough.
5. More than 80% of the world's adolescent population is insufficiently physically active.
6. Policies to address insufficient physical activity are operational in 56% of WHO Member States.
7. WHO Member States have agreed to reduce insufficient physical activity by 10% by 2025.

What is physical activity?

WHO defines physical activity as any bodily movement produced by skeletal muscles that requires energy expenditure – including activities undertaken while working, playing, carrying out household chores, travelling, and engaging in recreational pursuits.

The term "physical activity" should not be confused with "exercise", which is a subcategory of physical activity that is planned, structured, repetitive, and aims to improve or maintain one or more components of physical fitness. Beyond exercise, any other physical activity that is done during leisure time, for transport to get to and from places, or as part of a person’s work, has a health benefit. Further, both moderate- and vigorous-intensity physical activity improve health.

How much of physical activity is recommended?

WHO recommends:

Children and adolescents aged 5-17years

1. Should do at least 60 minutes of moderate to vigorous-intensity physical activity daily.
2. Physical activity of amounts greater than 60 minutes daily will provide additional health benefits.
3. Should include activities that strengthen muscle and bone, at least 3 times per week.

Adults aged 18–64 years

1. Should do at least 150 minutes of moderate-intensity physical activity throughout the week or do at least 75 minutes of vigorous-intensity physical activity throughout the week, or an equivalent combination of moderate- and vigorous-intensity activity.
2. For additional health benefits, adults should increase their moderate-intensity physical activity to 300 minutes per week, or equivalent.
3. Muscle-strengthening activities should be done involving major muscle groups on 2 or more days a week.

Adults aged 65 years and above

1. Should do at least 150 minutes of moderate-intensity physical activity throughout the week, or at least 75 minutes of vigorous-intensity physical activity throughout the week, or an equivalent combination of moderate- and vigorous-intensity activity.
2. For additional health benefits, they should increase moderate-intensity physical activity to 300 minutes per week, or equivalent.
3. Those with poor mobility should perform physical activity to enhance balance and prevent falls, 3 or more days per week.
4. Muscle-strengthening activities should be done involving major muscle groups, 2 or more days a week.

The intensity of different forms of physical activity varies between people. To be beneficial for cardiorespiratory health, all activity should be performed in bouts of at least 10 minutes duration.

Benefits of physical activity and risk of insufficient physical activity

Regular physical activity of moderate intensity – such as walking, cycling, or doing sports – has significant benefits for health. At all ages, the benefits of being physically active outweigh potential harm, for example through accidents. Some physical activity is better than doing none. By becoming more active throughout the day in relatively simple ways, people can quite easily achieve the recommended activity levels.
Regular and adequate levels of physical activity:

1. improve muscular and cardiorespiratory fitness;
2. improve bone and functional health;
3. reduce the risk of hypertension, coronary heart disease, stroke, diabetes, various types of cancer (including breast cancer and colon cancer), and depression;
4. reduce the risk of falls as well as hip or vertebral fractures; and
5. are fundamental to energy balance and weight control.

Insufficient physical activity is one of the leading risk factors for global mortality and is on the rise in many countries, adding to the burden of NCDs and affecting general health worldwide. People who are insufficiently active have a 20% to 30% increased risk of death compared to people who are sufficiently active.

Levels of insufficient physical activity

Globally, around 23% of adults aged 18 and over were not active enough in 2010 (men 20% and women 27%). In high-income countries, 26% of men and 35% of women were insufficiently physically active, as compared to 12% of men and 24% of women in low-income countries. Low or decreasing physical activity levels often correspond with a high or rising gross national product. The drop in physical activity is partly due to inaction during leisure time and sedentary behaviour on the job and at home. Likewise, an increase in the use of "passive" modes of transportation also contributes to insufficient physical activity.
Globally, 81% of adolescents aged 11-17 years were insufficiently physically active in 2010. Adolescent girls were less active than adolescent boys, with 84% vs. 78% not meeting WHO recommendations.
Several environmental factors which are linked to urbanization can discourage people from becoming more active, such as:

1. fear of violence and crime in outdoor areas
2. high-density traffic
3. low air quality, pollution
4. lack of parks, sidewalks and sports/recreation facilities.

How to increase physical activity?

Countries and communities must take action to provide individuals with more opportunities to be active, to increase physical activity.
Policies to increase physical activity aim to ensure that:

1. in cooperation with relevant sectors physical activity is promoted through activities of daily living;
2. walking, cycling and other forms of active transportation are accessible and safe for all;
3. labour and workplace policies encourage physical activity;
4. schools have safe spaces and facilities for students to spend their free time actively;
5. quality physical education supports children to develop behaviour patterns that will keep them physically active throughout their lives; and
6. sports and recreation facilities provide opportunities for everyone to do sports.

Policies and plans to address physical inactivity have been developed in about 80% of WHO Member States, though these were operational in only 56% of the countries in 2013. National and local authorities are also adopting policies in a range of sectors to promote and facilitate physical activity.

Obesity and overweight

Fact sheet from World Health Organisation (WHO, 2016f)
Updated June 2016

Key facts

1. Worldwide obesity has more than doubled since 1980.
2. In 2014, more than 1.9 billion adults, 18 years and older, were overweight. Of these over 600 million were obese.
3. 39% of adults aged 18 years and over were overweight in 2014, and 13% were obese.
4. Most of the world's population live in countries where overweight and obesity kills more people than underweight.
5. 41 million children under the age of 5 were overweight or obese in 2014.
6. Obesity is preventable.

What are overweight and obesity?

Overweight and obesity are defined as abnormal or excessive fat accumulation that may impair health. Body mass index (BMI) is a simple index of weight-for-height that is commonly used to classify overweight and obesity in adults. It is defined as a person's weight in kilograms divided by the square **of his height in meters (kg/m^2).**

Adults

For adults, WHO defines overweight and obesity as follows:

1. overweight is a BMI greater than or equal to 25; and
2. obesity is a BMI greater than or equal to 30.

BMI provides the most useful population-level measure of overweight and obesity as it is the same for both sexes and for all ages of adults. However, it should be considered a rough guide because it may not correspond to the same degree of fatness in different individuals.

For children, age needs to be considered when defining overweight and obesity.

Children under 5 years of age

For children under 5 years of age:

1. overweight is weight-for-height greater than 2 standard deviations above WHO Child Growth Standards median; and
2. obesity is weight-for-height greater than 3 standard deviations above the WHO Child Growth Standards median.

Children aged between 5–19 years

Overweight and obesity are defined as follows for children aged between 5–19 years:

1. overweight is BMI-for-age greater than 1 standard deviation above the WHO Growth Reference median; and
2. obesity is greater than 2 standard deviations above the WHO Growth Reference median.

Facts about overweight and obesity

Some recent WHO global estimates follow.

1. In 2014, more than 1.9 billion adults aged 18 years and older were overweight. Of these over 600 million adults were obese.
2. Overall, about 13% of the world's adult population (11% of men and 15% of women) were obese in 2014.
3. In 2014, 39% of adults aged 18 years and over (38% of men and 40% of women) were overweight.
4. The worldwide prevalence of obesity more than doubled between 1980 and 2014.

In 2014, an estimated 41 million children under the age of 5 years were overweight or obese. Once considered a high-income country problem, overweight and obesity are now on the rise in low- and middle-income countries, particularly in urban settings. In Africa, the number of children who are overweight or obese has nearly doubled from 5.4 million in 1990 to 10.6 million in 2014. Nearly half of the children under 5 who were overweight or obese in 2014 lived in Asia.

Overweight and obesity are linked to more deaths worldwide than underweight. Globally there are more people who are obese than underweight – this occurs in every region except parts of sub-Saharan Africa and Asia.

What causes obesity and overweight?

The fundamental cause of obesity and overweight is an energy imbalance between calories consumed and calories expended. Globally, there has been:

1. an increased intake of energy-dense foods that are high in fat; and
2. an increase in physical inactivity due to the increasingly sedentary nature of many forms of work, changing modes of transportation, and increasing urbanization.

Changes in dietary and physical activity patterns are often the result of environmental and societal changes associated with development and lack of supportive policies in sectors such as health, agriculture, transport, urban planning, environment, food processing, distribution, marketing, and education.

What are common health consequences of overweight and obesity?

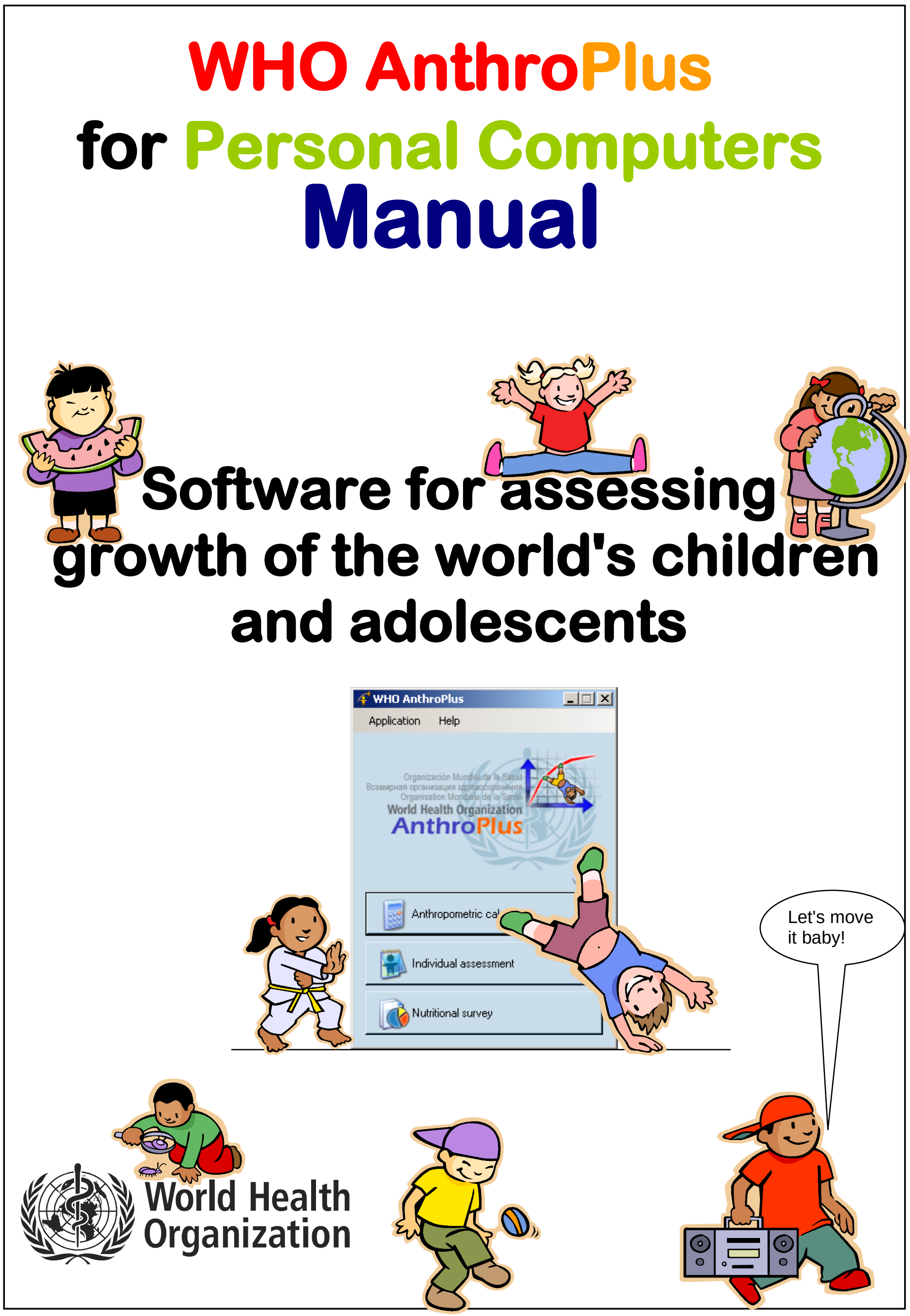
Raised BMI is a major risk factor for noncommunicable diseases such as:

1. cardiovascular diseases (mainly heart disease and stroke), which were the leading cause of death in 2012;
2. diabetes;
3. musculoskeletal disorders (especially osteoarthritis – a highly disabling degenerative disease of the joints);
4. some cancers (including endometrial, breast, ovarian, prostate, liver, gallbladder, kidney, and colon).

The risk for these noncommunicable diseases increases, with increases in BMI.

Childhood obesity is associated with a higher chance of obesity, premature death and disability in adulthood. But in addition to increased future risks, obese children experience breathing difficulties, increased risk of fractures, hypertension, early markers of cardiovascular disease, insulin resistance and psychological effects.

Appendix 23: WHO AnthroPlus Software Manual



WHO AnthroPlus
for Personal Computers

Software for assessing growth of the world's children and adolescents

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Table of contents

Abbreviations

The following abbreviations are used in this manual:

AC	Anthropometric calculator module
BAP	BMI-for-age percentile
BAZ	BMI-for-age z-score
BMI	Body mass index (weight in kg divided by height in metres squared)
DoB	Date of birth
DoV	Date of visit
FAO	Food and Agriculture Organization of the United Nations
HAP	Length or height-for-age percentile
HAZ	Length or height-for-age z-score
IA	Individual assessment module
ID	Identification number
MGRS	WHO Multicentre Growth Reference Study
MS	Microsoft
NA	Not available
NCHS	National Center for Health Statistics
NS	Nutritional survey module
OS	Operating system
PC	Personal computer
SALB	Second Administrative Level Boundaries
SD	Standard deviation
WAP	Weight-for-age percentile
WAZ	Weight-for-age z-score
WHO	World Health Organization

What is WHO AnthroPlus for personal computers

WHO AnthroPlus is a software for use on desktop personal computers or laptops using MS Windows. It was developed to facilitate the application of the WHO Reference 2007 for 5-19 years to monitor the growth of school-age children and adolescents. To show the continuity with the WHO Child Growth Standards for 0-5 years (see www.who.int/childgrowth) these are included in AnthroPlus for the three indicators that apply, i.e. weight-for-age, height-for-age and BMI-for-age. This software enables monitoring growth in individuals and populations of children from birth to 19 years of age.

WHO Anthro, in turn, is a software which was published in 2006 together with the first set of the WHO Child Growth Standards (i.e. weight-for-age, height-for-age, weight-for-height, BMI-for-age and windows of achievement for six gross motor milestones). In 2008 WHO Anthro was updated to include the second set of attained growth indicators: Head-circumference-for-age, arm-circumference-for-age, triceps and subscapular skinfold-for-age, and to allow users to choose a French or Spanish language version.

With the launch of the WHO Reference 2007 for children 5-19 years users expressed the need for a software to facilitate data analysis for this age group. AnthroPlus allows users to import the data previously collected in WHO Anthro and to continue monitoring children's weight, body mass index and height as they grow older (Individual assessment module) and to analyze survey data including preschool, school age children and adolescents (Nutritional survey module). Thus AnthroPlus facilitates the detection of thinness, underweight, overweight and obesity in individuals and populations from 0-19 years. In addition, it includes the option to change from the default language English to French, Spanish and Russian.

WHO AnthroPlus consists of three modules:

- *Anthropometric calculator (AC)*
- *Individual assessment (IA)*
- *Nutritional survey (NS)*

Each module has specific functions, i.e. to assess an individual's nutritional status, follow a child's growth from birth to 19 years, and conduct nutritional surveys covering the same age group, respectively.

This manual provides a brief overview of the WHO Child Growth Standards and the WHO Reference 2007 as well as instructions on how to apply them with this software. It provides guidance on software installation and management, navigation through the fields, entering data and deriving results.

WHO AnthroPlus for personal computers (PCs) mirrors the functionalities of WHO Anthro for 0-5 years with the exception that this software derives nutritional status information only for the indicators weight-for-age (up to 10 age 10 years), height-for-age and BMI-for-age. As both software are MS Windows-based, data can easily be transferred, the logical direction being that data from WHO Anthro is imported into AnthroPlus. Both software use common command icons, enabling the user familiar with the one software to easily execute the same functions in the other. Importing data from WHO Anthro into AnthroPlus is a straightforward process and exporting to common file formats is possible. WHO AnthroPlus applies the WHO Child Growth Standards for children aged 0-60 months and the WHO Reference 2007 for the older children and adolescents, i.e. 5-19 years (61-228 months).

The WHO AnthroPlus software for PC and its manual can be downloaded from www.who.int/growthref/software.

For more information, please contact:

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Or go to web site www.who.int/growthref

Organization of this manual

The first section of this manual provides background information and presents the application of the WHO child growth standards and the WHO reference 2007.

The next part describes the various software products and provides information on general installation options and technical requirements.

Given that several software features and applications are common in all modules, such as data-entry, these are outlined beforehand.

A separate section describes the specifications of the PC platform with step-by-step working examples for each of the modules.

In the last sections the user will find guidance on other functions and troubleshooting.

Typographic conventions

This manual uses the following typographic conventions:

Item	Example/description
Interface buttons with text	Click <*Search*>
Interface icon	Click (same as <*Add*>)
Keyboard keys	Press <*Ctrl* + *Alt* + *Delete*>
Menu paths	Click < → *File* → *Open*>
Interface fields/items (labels, boxes etc.)	*Name*
User input	Type [Jane] in the *Name* field
System menu paths	Click <*Start* → *Programs*>
Interface windows	*Main*

Whenever the manual refers to titles or names that appear on the software interface, these are printed in italics.

Important notes to users appear grey-shaded, as shown here, to be distinguished from the running text.

1. Background and technical details on WHO standards and WHO reference

1.1 WHO Child Growth Standards (0-5 years)

In 1990 the WHO constituted a Working Group on Infant Growth to develop recommendations for appropriate uses and interpretation of anthropometry in infants and young children. The Working Group's report (WHO, 1994) led to the conclusion that the National Center for Health Statistics (NCHS)/WHO international reference was flawed and failed to depict physiologic growth adequately. Its scientific weaknesses were sufficient to interfere with the sound nutritional management of young children, and the Working Group concluded that new growth curves were needed.

Consequently the WHO Multicentre Growth Reference Study (MGRS) was implemented to provide data to construct growth curves from birth to 5 years of age (de Onis et al., 2004a). A key characteristic of the new standard is that it makes breastfeeding the biological "norm" and establishes the breastfed infant as the normative growth model. Health policies and public support for breastfeeding should thus be strengthened by having breastfed infants as the reference for normal growth and development.

The pooled sample from the six countries (Brazil, Ghana, India, Norway, Oman and the USA) that participated in the MGRS allowed the development of a truly international standard, reiterating the fact that children grow similarly when their health and care needs are met.

The wealth of data collected allowed the replacement of the international NCHS/WHO references on attained growth (weight-for-age, length/height-for-age, and weight-for-length/height) and the development of new standards for body mass index (BMI)-for-age, head circumference-for-age, arm circumference-for-age, triceps skinfold-for-age and subscapular skinfold-for-age. In addition, the accompanying windows of achievement for six gross motor development milestones provide a unique link between a child's physical growth and motor development.

Detailed descriptions of how the MGRS was implemented and the WHO Child Growth Standards were constructed are available elsewhere (de Onis et al., 2004b; de Onis et al., 2006, WHO, 2006).

In the AnthroPlus software three of the child growth standards are included (i.e. weight-for-age, length/height-for-age, and BMI-for-age). These three are the same indicators for which the WHO reference has been developed, enabling continuity in growth monitoring throughout childhood and adolescence.

1.2 The WHO Reference 2007 (5-19 years)

Previously WHO recommended the National Center for Health Statistics (NCHS)/WHO international reference for assessing growth in children and adolescents above 5 years of age. However this reference had several drawbacks: The BMI reference data starts only at 9 years of age and has a limited percentile range, 5^{th}-95^{th}. In addition the NCHS reference curves were constructed using a different (by now outdated) method compared to what was used for the WHO standards.

Given that the NCHS sample of 1977 included children who had reached their full height potential while not yet being overweight, it was considered as a valid approach to use these data, conduct data cleaning, i.e. identifying outliers and excluding those. The NCHS data were merged with the records of the 18-71 year-olds of the WHO standards sample and this new data set was used to derive a new reference by applying state-of-the-art growth curve construction methods (de Onis et al, 2007).

The WHO Reference 2007 provides a smooth transition from the child growth standards for 0-5 years to the older age group. The data tables and charts cover the 1st to the 99^{th} percentile and from -3 to +3 standard deviations (SD).

Indicators	**Age ranges**
Height-for-age	5-19 years
Weight-for-age	5-10 years
BMI-for-age	5-19 years

The weight-for-age curves enables countries that routinely measure only weight to monitor growth throughout childhood. In older children, i.e. 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 having excess weight (by weight-for-age) when in fact they are just tall. BMI-for-age is the recommended indicator for assessing thinness, overweight and obesity in children 10-19 years.

1.3 Technical details on indicators in the software

For each indicator there are separate tables and charts for boys and girls and the user can choose between the z-score and percentile classification system.

The age ranges for each indicator are:

Indicators	**Age ranges**
Weight-for-age	0-120 completed months
Length/height-for-age	0-228 completed months
BMI-for-age	

For all standards involving length or height measurements, recumbent length should be used for children younger than 24 months and standing height, for children 24 months and older. The software provides a tick box, alongside the child's length or height data, to specify whether the measurement was taken in recumbent or standing position. **This information is mandatory for all children 0-60 months**. The software will automatically convert height to length for a child younger than 24 months whose height has been measured instead of length, and length to height for a child aged 24 months or older whose length was measured instead of height. The length-height conversion is not done for children above 60 months of age.

The standards' data tables (0-5 years) for all age-based indicators are in days and the reference data tables (5-19 years) in months. The tables and charts of the WHO Child Growth Standards are accessible in electronic format at www.who.int/childgrowth/standards/en; and the tables and charts of the WHO Reference 2007 can be found at www.who.int/growthref. Detailed descriptions of the technical aspects of the WHO standards has been published (de Onis et al., 2006; WHO, 2006; WHO, 2007), as well as a paper on the WHO Reference 2007 (de Onis et al., 2007). All documents and articles can be downloaded from the respective web sites.

1.4 Standard growth measurement procedures

Before applying the WHO growth standards or the WHO reference 2007 it is important to follow standardized measurement procedures in order to collect reliable data. Detailed measuring protocols can be found in:

1) de Onis M, Onyango AW, Van den Broeck J, Chumlea WC, Martorell R for the WHO Multicentre Growth Reference Study Group. Measurement and standardization protocols for anthropometry used in the construction of a new international growth reference. Food and Nutrition Bulletin 2004;25(Supplement1):S27-36 (see http://www.who.int/childgrowth/mgrs/en).

2) World Health Organization. Training Course on Child Growth Assessment (http://www.who.int/childgrowth/training/en).

Among the most important points to ensure the collection of accurate anthropometric data are:

- Make sure all equipment is correctly calibrated on a regular basis.
- Conduct training based on recommended measurement protocols as well as standardization sessions for those who collect the data.
- Take the child's date of birth from a written record if available. Otherwise ask for both the child's date of birth and age on the day measured, since the year of birth is frequently reported incorrectly. If birth dates are not recorded or known with certainty, probe the caregiver for the approximate date of birth based on a local events calendar.

- Measure recumbent length in children younger than 24 months of age and standing height from 24 months onwards. In case this cannot be adhered to because, e.g. a child is too sick to stand, the software is designed to automatically convert the measurement.
- Always enter the information on whether recumbent length or standing height was measured.
- Children who can stand up and are willing to stand should be measured standing whereas children who cannot stand up or are too weak to do so should be measured in recumbent position.
- Always indicate if the child has oedema or not.
- After the age, sex, weight, and length/height information have been entered, the user should check the results by using the graphing option to view single and multiple measurements. If a child appears to have extreme values beyond the flag boundaries s/he should be re-measured immediately.

2. WHO AnthroPlus setup

2.1 Requirements

The WHO AnthroPlus software is meant to be applied by a wide range of users, including people with limited software handling knowledge. Therefore this section is intentionally as non-technical as possible. It presents the minimum information necessary for the user concerning requirements, installation of the software and the default configurations.

Before the application can be installed, the PC or laptop must have the following Operating System (OS) and software pre-installed:

- Operating System: Windows 2000, Windows Server 2003, Windows XP, or Windows Vista.
- The .NET 2.0 runtime (22.4 Mb)

To check installed version of Windows:

- Go to *Start* → *Control Panel* → *System* → *General*

If the necessary OS is missing, please contact your IT Support.

To check if the .NET 2.0 runtime is installed:

- Go to *Start* → *Control Panel* → *Add or Remove Programs*, then verify if 'Microsoft .NET Framework 2.0' is listed under *Currently installed programs* (e.g. Windows Vista comes with .NET 2.0 pre-installed)

If .NET Framework 2.0 is missing, go the following link to download it:

- http://www.microsoft.com/downloads/details.aspx?familyid=0856EACB-4362-4B0D-8EDD-AAB15C5E04F5&displaylang=en

Minimum available disk space needed is around 6 Mb (for the application itself), plus sufficient additional disk space for Windows to function properly. Please note that the application size on disk (i.e. database size) will grow proportionally to the amount of data manipulated in the application (and thus stored in the database). To check available space on the hard drive:

- Right click on the hard drive (usually it's the C drive), then select *Properties* → *General*

2.2 Installation

The user may choose either to download the software from the WHO Reference 2007 web site www.who.int/growthref/tools/en or to install it from a CD-ROM.

The WHO Anthro and the present WHO AnthroPlus are two independent software applications. Users may choose to install only one of them or operate both in parallel.

To install the application:

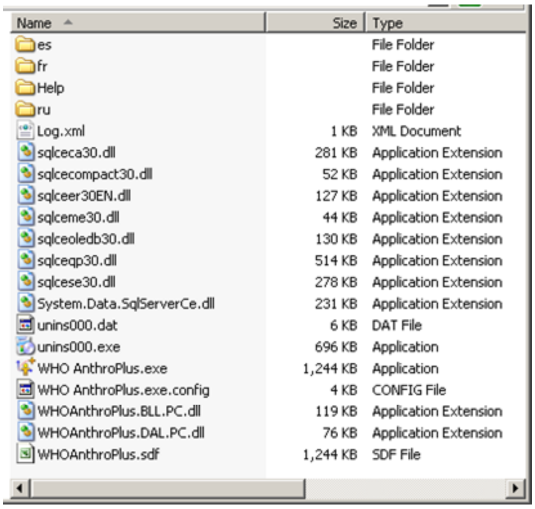
- Run *WHO AnthroPlus setup.exe* and follow the instructions on the screen

To run the application, do either of the following:

- On your desktop, double-click the WHO AnthroPlus icon, or
- In *Start → Programs → WHO→ WHO AnthroPlus*

Program files

When you open the folder WHO AnthroPlus it should contain 16 program files and 4 folders (see image to the right).



Name	Size	Type
es		File Folder
fr		File Folder
Help		File Folder
ru		File Folder
Log.xml	1 KB	XML Document
sqlceca30.dll	281 KB	Application Extension
sqlcecompact30.dll	52 KB	Application Extension
sqlceer30EN.dll	127 KB	Application Extension
sqlceme30.dll	44 KB	Application Extension
sqlceoledb30.dll	130 KB	Application Extension
sqlceqp30.dll	514 KB	Application Extension
sqlcese30.dll	278 KB	Application Extension
System.Data.SqlServerCe.dll	231 KB	Application Extension
unins000.dat	6 KB	DAT File
unins000.exe	696 KB	Application
WHO AnthroPlus.exe	1,244 KB	Application
WHO AnthroPlus.exe.config	4 KB	CONFIG File
WHOAnthroPlus.BLL.PC.dll	119 KB	Application Extension
WHOAnthroPlus.DAL.PC.dll	76 KB	Application Extension
WHOAnthroPlus.sdf	1,244 KB	SDF File

2.3 Re-installation

If the software is re-installed (with the same or a new version), note that AnthroPlus will keep intact the database file WHOAnthroPlus.sdf . If for some reason, users want to remove the software before re-installing then they are advised to first copy the database file WHOAnthroPlus.sdf to a safe location before un-installing WHO AnthroPlus.

To un-install:

- In *Add or Remove Programs* (from the Windows control panel), find WHO AnthroPlus and choose *Remove* (confirm when prompted to)

WHO AnthroPlus has another component that should not be removed in case other installed software uses the same:

- Microsoft .NET 2.0 Compact Framework (note that for example, Windows Vista comes with .NET 2.0 pre-installed)

To re-install:

- Follow installation instructions

2.4 Configurations

The date format in WHO AnthroPlus is automatically set to match the user's date format as selected on the PC set-up functions. The user interface screens are fixed in size and colours, and cannot be altered.

Changing the language can only be done from inside the Application menu.

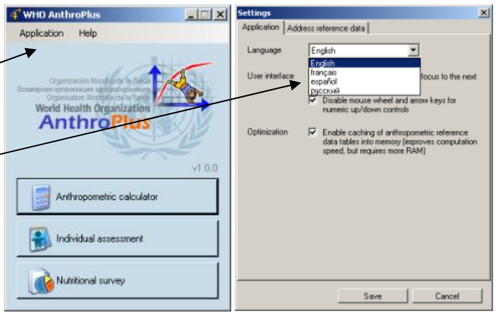
To change from the default language (English) to French, Russian or Spanish, the user has to change the regional settings by clicking:

Application → *Settings*

Click on drop-down menu <▼>and select the preferred language.

Click <*Save*> and then <*OK*> button in the message window *"The application must be restarted for all the new settings to take effect."*

Close the program by clicking on [X] or the corresponding icon and then restart WHO AnthroPlus.



When French, Russian or Spanish language have been selected but the operating system language of the PC is English, the buttons on message boxes will still read, e.g. <*OK*> and <*Cancel*>. This behaviour is standard in .Net.

Note that the software by default runs in English (independent of the OS language). Users have to manually select the preferred alternative language. Once selected the language remains set until it is changed again in *Settings*.

There are other default enhancements concerning the user interface and performance:

- 'Enter key' enabled to facilitate moving easily from one data-entry field to the next
- Mouse wheel disabled to avoid accidental changes on numeric up/down controls when entering measurements
- Reference data tables are automatically cached in memory to improve application performance

To produce an output, e.g. report of results, the application looks for Excel and uses it if present; if not, the software opens the default program set by the user for reading TXT files.

Data from the *IA* and *NS* modules are saved to the database file *WHOAnthroPlus.SDF*.

Note: If the database file has become corrupted, the application will notify that there is a problem connecting to the database. In that case the software needs to be reinstalled.

3. Basic software functions

The following section outlines the module functions that are similar throughout the software.

3.1 Icons

WHO AnthroPlus uses the following command icons with consistent functions:

Icon	Description
	Add
	Back/Return to the higher-level screen
	Cancel
	Delete (child, record, survey, etc.)
	Edit
	Graph
	Reset graph to original dimensions
	Import
	Open
	Reset
	Restore
	Save
	Search
	Add new section (for managing additional data)
	Add new variable (for managing additional data)
	Archive
	Add to Archive
	Copy to clipboard
	Standard report (Excel)
	Estimates report (Excel)
	Export
	Filter
	Clear filter
	Options
	Print

3.2 Data entry

The child's age, weight, oedema status (yes/no), length/height and type of measurement (recumbent or standing) for 0-60 months are the basic variables required to derive the nutritional status in terms of weight-for-age, height-for-age and BMI-for-age. For children 61 months and older the "type of measurement" information is not required, hence the box appears greyed out. Tab and Enter keys as well as the mouse-click allow the user to move from one field to the next.

3.2.1 Age

The software uses date of birth (DoB) and date of visit (DoV) to derive and display age in years and completed months (total completed months in parenthesis). Age: 1yr 3mo (15mo)

The user is advised to double check this derived age with the caregiver to confirm that it is correct.

Age in days is derived using the formula: Number of months · 30.4375. For example age in days at 24 months is: 24 · 30.4375 = 730.5 (rounded to 731 days).

In order to account for leap years, age in completed months is calculated on the principle that one year has 365.25 days, and thus one month (365.25 divided by 12 [months]) is equal to 30.4375 days. Therefore, a child born 11 November 2007 and measured 11 November 2008 appears as having an age of 11 completed months (365 divided by 30.4375 equals 11.99).

Given that the WHO standards are in units of days and WHO reference tables are in months, the age information is derived accordingly. If a child is between 0 and 60 months old, the nutritional status indicators are derived using the child's exact age in days in order to refer to the WHO standards tables.

If a child is 61 months and older the software derives the age in months with decimals and refers to the WHO reference tables, where a precise z-score is derived by interpolation.

DoV is by default set to the current system (today's) date and DoB to the same date of the previous year .

The user is asked to enter the child's exact date of birth (DoB). The date can be entered either by typing it in or selecting a date via the calendar window (see image below). To open the calendar, click on <▾> on the right side of the date field.

The calendar has multiple modes of selecting dates.

Clicking on a date within the open month.

Clicking on the ***Today*** text will automatically shift the calendar and selected date to the current system date.

Clicking on the <◂>=<*Previous month*> or <▸>=<*Next month*> buttons changes the display one month at a time in the direction selected.

Clicking on the month opens a list with all months in the year from where the user can select again by clicking on the name of the chosen month.

Clicking on the year, e.g. <2008> opens scroll buttons that facilitate scrolling the year forward and backward.

To apply the WHO standards for 0-5 years the software uses DoB and DoV to calculate the precise age in days:

Age (in days) =DoV-DoB

The reason for deriving age in days is that all age-based indicator tables of the WHO Child Growth Standards are by units of days.

For the older children 5-19 years the reference tables are in completed months (see www.who.int/growthref) but the software derives the exact z-scores based on interpolation using the LMS values (see notes on "Computation of centiles and z-scores" for each indicator on the web site http://www.who.int/growthref/).

To apply the WHO reference 2007 for 5-19 years, the software uses DoB and DoV to calculate the age in months.

Age (in months) =DoV-DoB

The software was specifically designed to enhance the quality of age estimation. If the exact day of birth is unknown, the user should fill in the year and month of birth and tick the box next to "*Approximate date*". When that field is ticked, the software attributes a random day to complete the date of birth. This date is then used to derive an exact age in months.

The child's age is an important piece of information and the observers collecting the data should probe the child's caregiver to obtain at least an approximated date of birth (i.e. year and month). A useful tool to obtain an approximate DoB is a local events calendar. For example, Annex 1 of the FAO field manual (FAO, 1990) provides information on how to develop such a local calendar.

Note: When importing a child record with age being 24 months the software will derive 731 days and not 730.5.

The exact age is used for obtaining z-scores and percentiles and is stored in the Individual assessment (*IA*) and Nutritional survey (*NS*) modules.

For children less than 61 months (1857 days), the child's age influences how the software handles the variables *Length/Height* and *Measured.* For example, if a child is 24-60 months old (731-1856 days) and has a length measurement, 0.7 cm is subtracted to derive an estimated height. Similarly, if a child is younger than 24 months and is measured standing, the software adds 0.7 cm to derive an estimated length.

3.2.2 Oedema

Children with oedema have swollen limbs and may look well fed. Oedema, however, is a clinical sign of severe undernutrition. Ideally, any suspected oedema case should be assessed before measuring the child's weight.

To determine whether oedema is present, grasp the child's foot so that it rests in your hands with your thumb on top of the foot. Press the thumb down gently for a few seconds. The child has oedema if a pit (dent) remains in the foot after lifting your thumb. If the child has oedema of both feet, fluid retention increases the child's weight, masking what may actually be very low weight. In case the child has oedema the user should tick the respective box in the data-entry window. Consequently no weight measurement needs to be taken as it will be flawed. In case the user measures the child's weight and ticks the "*Yes"* button for oedema, the software discards the weight value for such a child and computes the z-scores and percentiles for length/height-for-age only. In deriving prevalences at population level, however, a child with oedema has to be counted as below <-3 SD for all weight-related indicators. This logic is followed in all analysis options in the *Nutritional survey* module.

The default status for the data-entry window in all modules is that a new child has "*No*" oedema. If the child has oedema the user has to click the respective radio button.

3.2.3 Anthropometric data

Detailed procedures for measuring anthropometry can be found in the anthropometric training video and in the module, *Measuring a Child's Growth*, of the WHO child growth assessment course (available at www.who.int/childgrowth/training). It is recommended that those responsible for measuring anthropometry use these resources or be trained to take reliable measurements.

To enhance validity at data-entry and data-import, the software is programmed to accept the following measurement ranges (inclusive for minimum and maximum limits). Should the user enter a value outside those ranges, the entry field returns to blank.

Measurement	Min	Max
Weight (kg)	0.9	275.0
Length/height (cm)	38.0	230.0

Weight

Measurements should be entered in kilograms with maximum 2 decimals.

Recumbent length and standing height

Length and height measurements should be entered in centimetres with maximum 2 decimals.

In line with standard measurement procedures, the software derives for children younger than 24 months length-based indicators, and for children 24 months and older height-based indicators. There exist settings and scenarios, however, where it is not possible to comply with this recommendation and a child older than 24 months has to be measured lying down — for example when a child is too sick and too weak to stand, or when, because of time/equipment constraints, it is only possible to measure all children lying down. In these instances the software makes the necessary adjustment by subtracting 0.7 cm from the child's length to derive an estimated height. Similarly, if a child is measured standing when s/he should be measured in the recumbent position, given his/her age, the software adds 0.7 cm to derive an estimated length. The 0.7 cm difference between length and height is based on the analysis of the MGRS sample of children (18-30 months of age) who had both length and height measurements taken.

Note: This conversion applies only to children 0-60 months. If a child belongs to that age group the user must always specify and tick the appropriate button, indicating how the child was measured, i.e. in recumbent or standing position.

When interpreting the results, the following should be kept in mind: The software converts the length/height measurement for children 0-60 months to conform to the foregoing recommendation and uses that converted value for deriving all relevant indicator results (including BMI, see 3.3.4). The software interface always shows the corresponding indicator name, i.e. length-for-age for all children younger than 2 years (or up to 730 days, inclusive) and height-for-age for all children 2 years and older (731 days or more). Therefore for a child that was measured lying down but is older than 2 years, the indicators will read: Weight-for-height and height-for-age; and the BMI as well as the BMI-for-age z-score are derived based on the height converted from length.

If neither age nor type of measurement is known, the software considers any measurement below 87 cm as length and any measurement 87 cm and above as height. The cut-off point of 87 cm reflects the standards' median of boys' and girls' length and height at 24 months. According to the WHO standards the median height is 87.1 cm for boys and 85.7 cm for girls, and the median length is 87.8 cm for boys and 86.4 cm for girls. The mean of these four values is 86.75 cm.

Depending on the child's age the software applies either the WHO standards or the WHO reference; if age is unknown only the BMI value is calculated.

For boys and girls ≥61 months the software uses the WHO Reference. Given that all children 5-19 years should be measured standing, no distinction has to be made how the child was measured.

For children 0-60 months it is important to specify how the child was measured, ie. recumbent or standing. According to that information and the child's age the calculation is adjusted if necessary.

Length/height-for-age

Sex	Age group (months)	Type of measurement (l/h)[1]	Conversion	Data tables
Boys and girls	<24	l		Length-for-age
	<24	h	h + 0.7 cm	Length-for-age
	≥24 & <61	l	l – 0.7 cm	Height-for-age
	≥24 & <61	h		Height-for-age

[1] l = length; h = height

When age is known but not the type of measurement:

Sex	Age group (months)	Data tables
Boys and girls	<24	Length-for-age
	≥24 & <61	Height-for-age

3.3 Results

All software modules enable the user to derive nutritional status information (in z-scores and percentiles) for the following indicators based on the WHO standards for preschool children and based on the WHO reference for the older children (see Table below).

Indicators	WHO standards	WHO reference
Length/height-for-age	0-60 months	61-228 months
Weight-for-age	0-60 months	61-120 months
BMI-for-age	0-60 months	61-228 months

For details on how to interpret each of the nutritional status indicators, users are referred to the WHO training course on Child Growth Assessment, Module C: Interpreting Growth Indicators (www.who.int/childgrowth/training) for children 0-60 months of age. For older children the interpretation of height-for-age and weight-for-age is as for children 0-60 months, however, for BMI-for-age the recommended cut-offs for overweight and obesity are not the same as in preschool children. For children 5-19 years the +1 SD in the WHO reference (equivalent to the 85^{th} percentile) coincides at 19 years with the adults cut-off of BMI =25 [kg/m^2], which is the cut-off for overweight. Similarly, the +2 SD (equivalent to the 97^{th} centile) coincides at 19 years with the adults cut-off of

BMI=30 [kg/m^2], which is the recommended cut-off for obesity. Consequently the +3 SD cut-off will be considered severely obese (corresponding to a BMI of above 35 [kg/m^2]). For thinness and severe thinness the cut-offs are -2 and -3 SD, respectively.

3.3.1 Percentiles and z-scores

The default classification system used to present child nutritional status is that of z-scores or standard deviation (SD) scores. This classification system has been recommended by WHO for its capability to describe nutritional status including at the extreme ends of the distribution and allow derivation of summary statistics, i.e. means and SDs of z-scores (WHO, 1995).

Given their widespread use in clinical settings the software also derives percentiles. The percentiles are based on exact z-scores, with all decimal points. Therefore, using the displayed z-score value (rounded to 2 decimals) to hand-calculate the percentile might yield a slightly different result from that displayed by the software.

Z-scores and percentiles are derived using the exact age in days for the WHO standards and months for the WHO reference 2007. For the latter even though the reference tables are in completed months the software uses an interpolation to derive the nutritional status for the exact age in months.

The z-scores appear as not available (*NA*) when:

- child's age is above 120 completed months, consequently weight-for-age is *NA*
- child's age is above 228 completed months, consequently all indicators are *NA*
- child's age is unknown, consequently WAZ, HAZ and BAZ are *NA*

Please note that percentiles read "NA" for all z-score values <-3 SD and >+3 SD because percentiles beyond ±3 SD (equivalent respectively to the 0.135th and 99.865th percentiles) are invariant to changes in respective z-scores.

In the *NS* module if age is missing or unknown the software derives only the BMI value.

If *Weight* is missing, the software can derive only HAZ and HAP; while WAZ, WAP, BAZ, BAP and BMI cannot be calculated.

If *Length/Height* is missing, the software derives only WAZ and WAP; while HAZ, HAP, BAZ, BAP and BMI cannot be calculated.

If a child has oedema the software derives only HAZ and HAP; while WAZ, WAP, BAZ, BAP and BMI are not calculated.

3.3.2 Colour coding

The following colour codes are applied to visually distinguish the different levels of severity:

Colour	Applied to	z-scores (z)	Percentiles
Green	numeric range	-1 SD ≤ z ≤+1 SD	
	graph line	Median	50th percentile
Gold	numeric range	-2 SD ≤ z < -1 SD; or +1 SD < z ≤+2 SD	
	graph line	-1 SD and +1 SD	15th and 85th percentiles
Red	numeric range	-3 SD ≤ z < -2 SD; or +2 SD < z ≤+3 SD	
	graph line	-2 SD and +2 SD	3rd and 97th percentiles
Black	numeric range	z <-3 SD; z >+3 SD	
	graph line	-3 SD and +3 SD	NA*

* NA = not available

3.3.3 Graphs

Graphing results enables the user to visualize the child's growth. For this purpose the 0-60 months WHO standards curves and the reference curves for 5-19 years are joined together. This display feature provides a means to visually assess the growth pattern over time and to share the results with the child's caregiver. In view of the likely continuation of using paper charts, the graphing option allows the user to check that the plot on paper is correct and corresponds with the display on the computer screen.

It is recommended to always maximize the graph window by clicking on (or corresponding icon in your MS version) to take full advantage of this viewing feature. This will also avoid that some text appears truncated.

The user can view the graph for each indicator using either the z-score or percentile classification system.

- Weight-for-age from birth to 10 years (0-120 completed months as shown on the x-axis)
- Adjacent length-for-age and height-for-age from birth to 19 years (0-228 completed months as shown on the x-axis)with a vertical line at 24 months (2 years) of age to mark the separation of length and height
- Adjacent length- and height-based BMI-for-age from birth to 19 years (0-228 completed months as shown on the x-axis) with a vertical line at 24 months (2 years) of age to mark the separation of length and height

Note that measurements corresponding to missing z-score values, presented as "NA", are not plotted.

The cut-off classification lines presented on the charts are:

- Weight-for-age:-3 SD, -2 SD, +2 SD and +3 SD
- Length/height-for-age: -3 SD, -2 SD, +2 SD and +3 SD
- BMI-for-age: -3 SD, -2 SD, -1 SD, +1 SD, +2 SD and +3 SD

In the percentile classification system charts for all indicators present the following classification lines: 3rd, 15th, 50th, 85th and 97th percentiles.

Even though percentile values smaller than 0.135^{th} and beyond 99.865^{th} (equivalent to -3.00 and +3.00 SD respectively) read "*NA*" in the results window, the corresponding anthropometric measurements are plotted as long as they fall within the limits of kg and cm represented in the respective graphs.

3.3.4 BMI

When weight and length/height measurements have been entered the software derives the BMI (kg/m^2). This index has been added to the other indicators of nutritional status as it is commonly used to assess nutritional status in adults. Similar to BMI-for-age, BMI values are derived based on length for children younger than 2 years, and on height for children 2 years and older. If a child younger than 2 years has been measured standing — the standard procedure is to measure in recumbent position — 0.7 cm is added to the child's height and the converted length is used to calculate the BMI. In case a child aged 2 years or older has length measured, 0.7 cm is subtracted to convert it to a height measurement before the BMI is derived. In case the age of the child is unknown the measurement in cm given is used without any conversion to derive the BMI value. A BMI value based on kg/m^2 has to be distinguished from the BMI-for-age z-score value which is based on the WHO standards or the WHO reference depending on the child's age.

Note that for BMI-for-age the recommended cut-offs for overweight and obesity are not the same as in preschool children. For children 5-19 years the +1 SD in the WHO reference (equivalent to the 85th percentile) coincides at 19 years with the adults cut-off of BMI =25 [kg/m2], which is the cut-off for overweight. Similarly, the +2 SD (equivalent to the 97th centile) coincides at 19 years with the adults cut-off of BMI=30 [kg/m2], which is the recommended cut-off for obesity. Consequently the +3 SD cut-off will be considered severely obese (corresponding to a BMI of above 35 [kg/m2]). For thinness and severe thinness the cut-offs are -2 and -3 SD, respectively.

In the window for parents' data the user has the option to collect the adults' weight and height data to derive their BMI. This information can be useful in the interpretation of the child's nutritional status. For details on the measurements and the interpretation of BMI in adults users are referred to the relevant WHO publications (WHO, 1995; WHO, 2003).

3.4 Variables and codes

3.4.1 Data codes

Complete lists of data formats and variable codes for the different file formats in *IA* and *NS* module are presented in 5.5.3 and 5.5.4.

3.4.2 Flags and error tracking

The software uses default lower and upper SD boundaries as flag limits to identify any extreme or potentially incorrect z-score values. The tables below list the default flag limits by indicator for the WHO standards and the WHO reference:

WHO standards (0-60 months):

Indicator	Lower SD	Upper SD
WAZ	-6	+5
HAZ	-6	+6
BAZ	-5	+5

WHO reference (61 months-19 years):

Lower SD	Upper SD
-6	+5
-6	+6
-5	+5

In the *AC* and *IA* modules users should check the results against these limits. A black background colour alerts the user if a resulting z-score is beyond -3 or +3 SD which is plausible but reflects extreme nutritional status. SD values beyond any of the corresponding limits shown above are considered implausible and the user is encouraged to check for data-entry errors.

In the *NS* module where data-entry can happen very fast and under strenuous conditions, any resulting z-score beyond these limits is automatically flagged and the flag code appears in the column next to the results. When that happens the user should immediately check if there is a data-entry error and if that's not the case, re-measure the child.

In the analysis of nutritional survey data all flagged z-scores should be excluded. The report options in WHO AnthroPlus are thus programmed to exclude any z-score value beyond these flag limits. However, flagged z-scores remain available when the data are exported. Thus, users who export the data into a different software for analysis should apply the same flag limits as exclusion criteria in order to obtain consistent results.

4. Software modules: use and functions

To open the WHO AnthroPlus *Start* window either double-click on the icon

created on the desktop in the installation process or go to:

Start→ All Programs→ WHO → WHO AnthroPlus

4.1 Start window

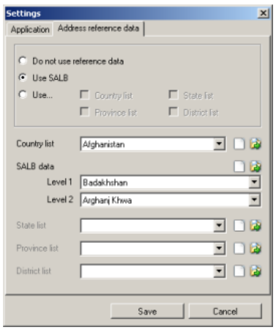
From the start window the user can open the three modules: *Anthropometric calculator (AC), Individual assessment (IA), Nutritional survey (NS)*.

To open a module use tab or arrow keys to select the respective button name and press <*Enter*>, or point with the mouse on the name and left click.

Another possibility is to click on *Application* and select a module.

The menu icons on the top right work as in any other MS application, to minimize and close the application. Resizing to fill the screen is not possible.

Menu options



The menu under *Application* enables the user to open the *Settings* window which consists of two tab-sections:

1) Application settings: To choose the language and to change default configurations (see 2.4)

2) Address settings to facilitate the collection of address data:

- Do not use existing address reference data, i.e. manually key in all information
- Use available UN Second Administrative Level Boundary files (SALB) (see http://www.who.int/whosis/database/gis/salb/salb_home.htm)
- Use lists for country, state, province, district, as specified by the user.

Selection can be turned on or off on this page by ticking or un-ticking the respective radio button on the upper part of the window. According to the choice made the selections appear active or inactive (grey). For example, the image above shows that SALB is active (which is linked to country list) while State, Province and District lists are grey and thus inactive.

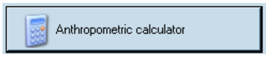
The use of address reference data is outlined in section 5.1.

4.2 Anthropometric calculator (*AC*)

This module facilitates deriving nutritional status results for an individual child or adolescent based on the WHO standards (0-5 years) or WHO reference (5-19 years) depending on his/her age for the indicators weight-for-age, length/height-for-age and BMI-for-age. Results are presented in z-scores and percentiles and include the BMI unrelated to age derived by dividing weight in kg by height in meters squared. The user can view, print and copy the plotted measurements in relation to the standards and reference curves. In this graphing feature the user can switch between using the z-score and percentile classification system. In this module, the user cannot save any data. In order to keep a copy of the data-entry window, press jointly the <*ALT+ Print Screen*> keys and paste the image into e.g. a MS Word file. Users who would like to save the data should use the *Individual assessment* module.

4.2.1 Data-entry window

To open the module click on the button
or select the *AC* from the application menu.



The module consists of one window which serves to enter the data and view the results.

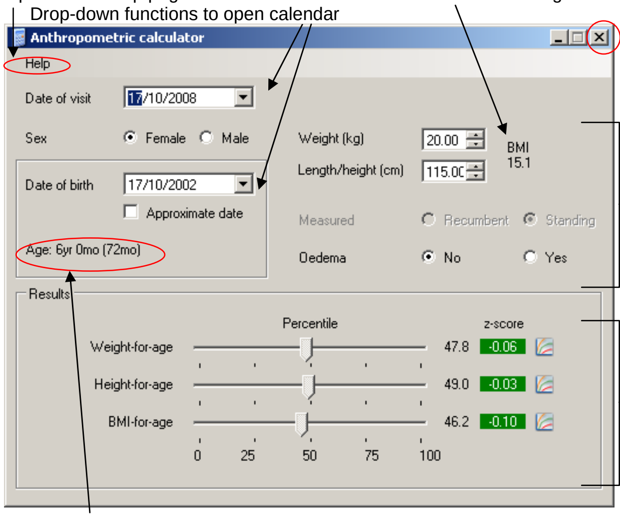
To enter data and move from one field to the next one can use the keyboard and press the <*Tab*> (<*Shift + Tab*> to go back) or <*Enter*> keys, or else use the mouse to point the cursor on an empty field and left mouse click to activate the field.

The displayed anchor values correspond to a healthy child of 6 years. To enter any new data either overwrite the anchor values or use the scroll up/down buttons to select the exact measurement in kg or cm. The maximum level of precision for any measurement is 2 decimal places.

Open online help page

Drop-down functions to open calendar

BMI value based on kg/m^2



Click here to close and return to main menu.

Enter anthropometric data using scrollbar or keyboard; if child <61 months specify how length/height was measured; always specify if child has oedema

Results in percentiles (slider control display and value with 1 decimal); z-scores with 2 decimals and coloured background.
Click on [icon] to open the corresponding graph.

Calculated age is derived based on date of birth (DoB) and date of visit (DoV). Double check with the caregiver that the displayed age is correct.

If the year and month of birth are known but it is impossible to obtain the exact day of birth, the observer is advised to tick the box *Approximate date.* The program then randomly selects a day within the given month and year.

If the year and month of birth are not known the observer is advised to use a local events calendar to identify two events between which the birth took place (see 3.2.1) and thus estimate an approximate month and year of birth.

Always specify the child's sex and if s/he has oedema. The default selection is set to female and No oedema. The radio button to specify how length/height was measured is only active and can be changed for children between 0-60 completed months. For older children the selection is inactive and greyed out.

The *Results* are displayed for the percentile and the z-score classification system based on the WHO standards for 0-60 months and on the WHO reference for 61 months to 19 years. A slider control gives the percentile position of the measurement within the range 0-100%, and to the right of each slider image the corresponding percentile value is displayed rounded to one decimal. The next column presents the respective z-score value with two decimals.

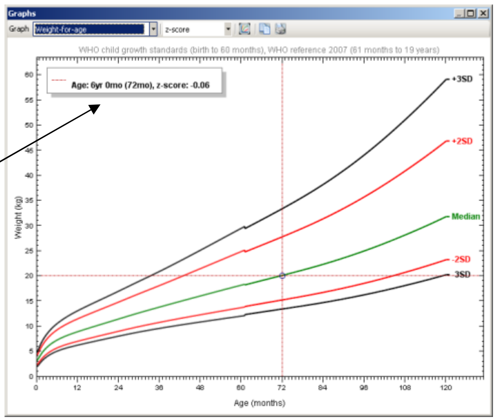
4.2.2 Graphs

Clicking on next to the z-score result opens a plot of the respective measurement compared to the curves of the WHO standards (0-60 months) and WHO reference (61 months-19 years).

Click on (or corresponding icon) to maximize window.

The result (z-score or percentile) is displayed in the top left corner of the plot area.

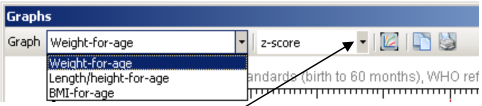
On top of the graph the user is reminded that these curves depict the WHO standards for 0-60 months and the WHO reference for older children.



If a measurement cannot be plotted the message (No data) appears on a blank screen. This happens when a measurement is outside the plotting range (but possibly valid z-score), or if a z-score is NA due to missing data or the raw data are beyond the standard/reference tables' ranges (see section 1.3).

To close the graph click on at the top right corner or the corresponding icon of your MS version.

From any open graph the user can select all the other graphs (see image with open drop-down list).



This drop-down menu allows users to switch from the default z-score classification to the percentile system.

Additionally, with the left mouse click the user can select and enlarge a part of the graph. This zoom-in function can also be repeated to select an even more detailed section. To resize the graph to the original dimensions, click on .

To copy the image to the clipboard, click on .

To send the graph to a printer, click on .
The graph has no title so when copying from the clipboard users should add this information to tailor the image to their needs. The axis labels will help identify the indicator shown on the graph.

Note: In this module no data can be saved.

4.3 Individual assessment (*IA*)

This module enables the user to collect and save data for children who are repeatedly examined up to the age of 19 years. The child's nutritional status can be derived and graphically displayed based on the WHO standards (for 0-5 year olds) and the WHO reference (for 5-19 year olds), using the z-score and percentile classification system for the three indicators weight-for-age, height-for-age and BMI-for-age. The graphing feature in this module offers views of single or multiple visits. This function helps to visualize trends in child growth. This module is particularly useful for paediatricians who want to monitor the growth of children and adolescents attending their clinics or for researchers gathering longitudinal data.

For children 0-5 years we recommend users to continue collecting the data with WHO Anthro (see www.who.int/childgrowth/software) which includes other growth indicators and motor milestones. Once the child is 61 months of age these data can be imported into WHO AnthroPlus for further monitoring. **To transfer data from WHO Anthro to WHO AnthroPlus, please choose XML format.**

The module also allows users to define additional data variables to be collected during each child visit. For consistency purpose users should define these variables before starting the data collection as this template will then be applicable to all children.

To open, click on the respective button on the start window or select the *IA* from the application menu.

4.3.1 Main window

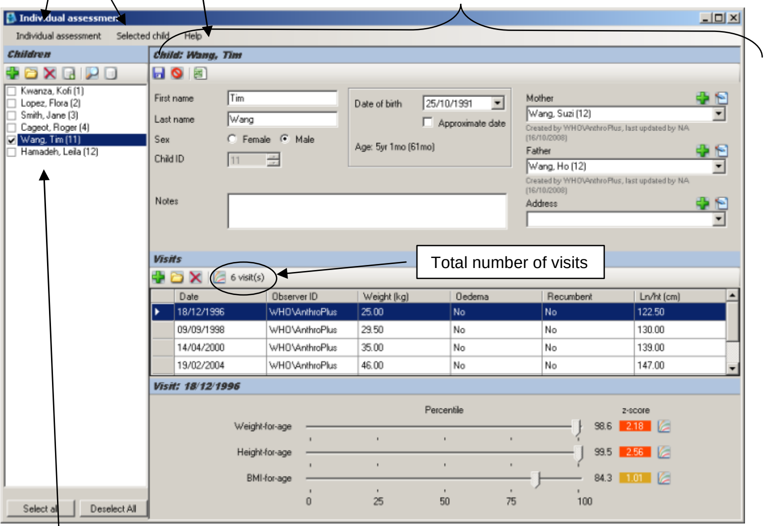
The module's main window consists of two parts: To the left is the active list, showing some example children; to the right is the child-specific window.

Tick the box next to child's name and click on to open a child record. The child's details, parental data and list of visits appear in the window section to the right.

Menu options

Access to online help page

Child window section with fields to enter the child's name, DoB, specify sex, ID and open sub windows to enter parental data as well as address information and general notes that one would like to be reminded of each time the child comes to be measured (e.g. LBW).



Active list with example children and their ID number in parentheses

Icons on top enable user to manage the list (i.e. add, open, delete, archive, search and view archive)

List of visits (1 row = 1 visit) with selected visit highlighted in blue; visit results by indicator below. Click on to open graph.

Use arrow, <*Enter*> key, or mouse to select other visits.

Icon functions: to add new visit ; to open a visit or double-click on selected (highlighted) row; to delete selected visit .

Notes

This field enables the user to collect child-specific data such as birth conditions, metabolic diseases, special conditions, which might be important to recollect when the child comes for an assessment. These notes are also exported and will appear for every visit.

Graphs

Click on (or corresponding icon) to maximize the graph.

To select other indicators or view percentiles use respective drop-down menus at the top.

To change display **single or multiple points** use the drop-down menu.

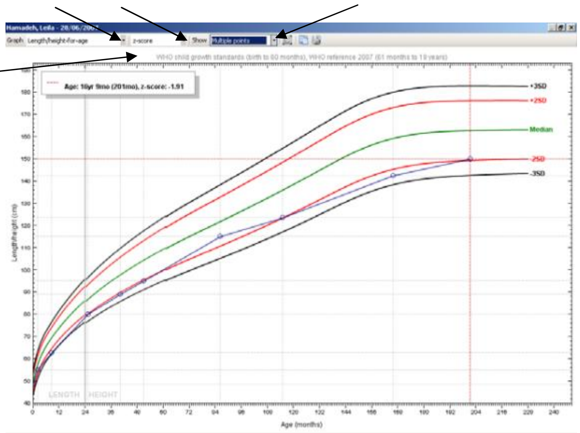
An explanation on top of the graph reminds users that the curves are based on WHO standards and WHO reference.

The currently open visit is marked by the red grid lines.

With the left mouse click the user can select and enlarge a part of the graph. To resize the graph to the original dimensions, click on .

To copy the image to clipboard, click on .

To send image to printer, click on .



To close graph, click on or the corresponding icon in your MS version.

If a measurement cannot be plotted, the message "*(No data)"* appears on an otherwise blank screen. This happens when a measurement is outside the plotting range, even if the z-score is valid. It also happens when z-score is NA due to missing data or when raw data are beyond the standard tables' ranges (see section 1.3).

Copied graphs do not include titles. Thus users need to create customized titles in the word processor environment. The exis labels will help identify the indicator.

Clicking on the menu bar *Individual assessment* enables the user to activate the following functions:

- *New child* --------------------------→ •
- *Delete selected* ------------------→ •
- *Archive selected* -----------------→ •
- *Search list* -------------------------→ •
- *View archive* ----------------------→ •

Icons on top of active list of children

- *Manage additional data*
- *Options*
- *Import from file*
- *Export to file*

See details in section 4.3.2, 4.3.5 and 4.3.6

- *Close module* → Same as • or corresponding icon in your MS version

Once a child's window has been opened the user can select from the menu bar *Selected child* the functions:

- Save changes → same as
- Cancel changes → same as
- Generate child report → same as (see section 4.3.4)

4.3.2 New child

The steps to enter a new child are:

- First click on at the top of the active list of children to open a blank *New child* window.
- In the active *New child* window enter his or her first and last name and specify sex (the ID attribution by default is set to automatic).
- Use the keyboard or drop-down calendar to enter DoB.
- Click on to save and the new child's name with ID will be appear added to the list on the left section.

Mother, Father, Address data

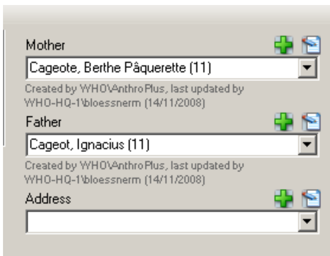
Fields for data on parents and address appear to the right of the child window. These fields are optional and can also be left blank. Once completed, the fields show the parents' names with ID in parenthesis and the address information.

Each of the mother/father/address windows have separate <*Save*> and <*Cancel*> buttons that are not linked to the child and thus the child and parental ID numbers can be different.

It is possible to link the same parent/address data to several children.
Note that free text typed into the fields without activating this function will not be saved and no ID will be assigned.
To add information, click on .

To edit existing information, click on .

To select data from an existing record (e.g. sibling) click on <▼>. If there is no text entered in the box, the entire list of available data appears in alphabetical order. Entering some text before opening the drop-down list will activate a filter function.

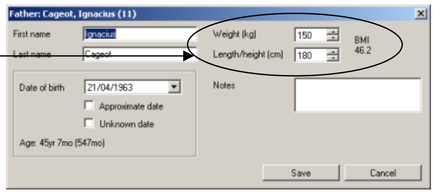


If the user opens the father/mother/address window and saves **without entering names**, the system displays (No data). Saving the field automatically triggers the allocation of an ID for the parents (list of mothers/fathers) regardless of whether data have been entered or not. Note that the parental ID is not linked to the one of the child.

Both the mother's and father's window include the option to enter their weight and height data; if entered the software derives the BMI (kg/m^2).

To enter DoB either use the keyboard or drop down calendar. The derived age appears below.

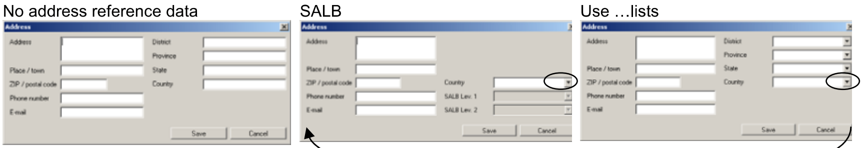
A separate *Notes* field enables the user to collect additional information for each parent.



Click on next to *Address* to add new information and open the respective data-entry window.

Depending on what has been selected in *Settings* the Address window can look like one of the images below:

No address reference data SALB Use …lists



Free text can be entered into all fields.

In either of those two options, the *Address* window includes a comprehensive list of countries and territories and the user can select the appropriateone from the drop-down menu.

The address data can be useful to track a child in the future. All fields are optional and the user can complete as many or as few fields as deemed important. For example: ZIP/postal code (maximum 15 characters); Phone number (maximum 20 characters).

To activate SALB level 1 and 2 fields the user first has to upload the relevant country SALB file under *Settings* in the *Start* window (see section 4.1). Once that is done, go to the address window, select country with the drop-down menu and the SALB fields will be activated automatically. Consequently the user can select the country's administrative levels from the drop down lists of SALB level 1 and level 2 without having to type anything.

For more information on the use of address reference data and of SALB files see section 5.1.

Delete

In the list of children, click on the tick box next to the child's name to select child and then on or select from menu *Individual assessment* → *Delete selected*. A message window will pop up where the user has to confirm that s/he wants to delete the selected child. If a child is deleted all her/his visit data will be deleted.

Note that a deleted child's record cannot be restored.

Archive

The archive function allows the user to temporarily move one or several children from the active list into the archive.

Tick the box in front of child's name to select and click on ; or select and go to menu *Individual assessment → Archive selected*. The selected children disappear from the active list and are moved into the archive.

To retrieve a child from the archive click on or go to menu *Individual assessment → View archive*. Select the child(ren) and click on . To return to the active list click on .

Note: There is no space limit in the archive, but the user should be aware that operations may take longer to perform on this file as its size increases. If children's data are no longer needed, it is better to export them and archive them outside the software.

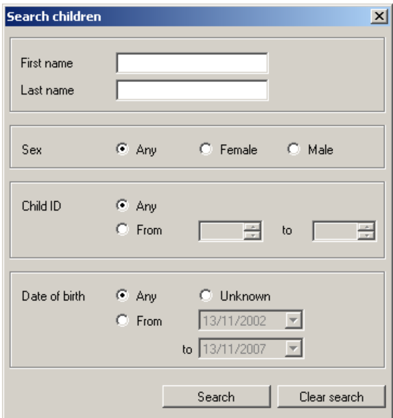
Search

To search for a child (or several children) in the active list click on or select *Individual assessment → Search list*. This opens the search window.

Possible search criteria are:

- First and last name of the child
- Child's sex
- Child's ID: click on *From* to activate the entry fields for a range with inclusive lower upper end limits
- Date of birth: To enter a range with inclusive lower and upper date, click on *From* to activate the date fields

Enter one or several criteria and click <*Search*>.



The search for names is not case-sensitive and uses pattern-matching to give best possible search results. An asterisk "*" can be used as a wildcard if the full name is unknown, e.g. entering [L*] will find Lopez. This allows for searching for a name even if only part of it is known, e.g. searching for *a* in first name will list both Flora and Jane; searching for *an* will only list Jane. Similarly searching for *anz* in family name will list only Kwanza.

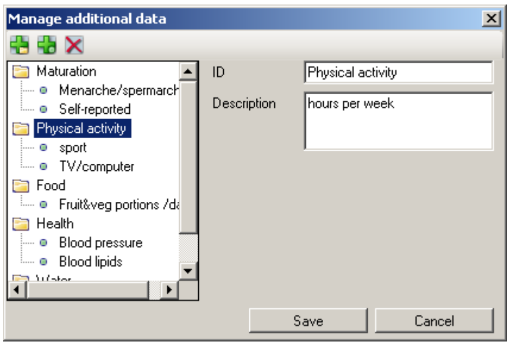
The active list will show all the children that match the specified search criteria. A search can be further refined with additional search criteria. To return to the complete list click on <*Clear search*>, and click on (or corresponding icon in your MS version) to close the *Search* window.

Note the search does not consider any children who have been moved into the archive.

Manage additional data

This function facilitates the systematic collection of clinical and other data. As in the design of a questionnaire, the user can define new sections and then variables within that section. Once defined these variables will apply to all children in the module. It is thus highly recommended that the user defines first the additional data variables before starting with the data collection. At present the template contains some examples e.g. maturation, physical activity, fruit and vegetable consumption.

To open the template click *Individual assessment → Manage additional data*.



Click on [icon] to add a new section. Enter ID name (mandatory) and a description (optional).

Click on [icon] to add a new variable to a created section. Enter ID name (mandatory), a description (optional) and specify the value type: text, numeric ranges or date.

Users are advised to create all sections and variables first and only when finished click on <*Save*>.

To delete a variable or section select the text on the left window and click on [icon]. If a section is deleted all variables within that section are automatically deleted. A warning message will pop up asking the user to confirm the action. The data already collected for these variables will remain in the previous visits. To avoid confusion it is recommended to clarify the desired additional data t before starting a database of individual assessment.

The current example template can be deleted or changed to suit the user's needs. Click on <*Save*> to close the window; click <*Cancel*> to discard unsaved changes and close the window.

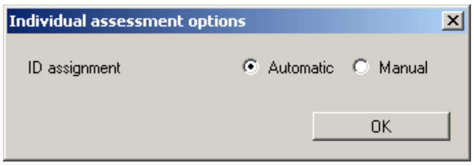
These additional data sections and variables apply to all new child visits in the *IA* module; the corresponding data can be collected in the visit window (see sections 4.3.1).

The created variables and sections always appear in the language the user applied when adding them, i.e. they are not translated when the user changes the language in *Settings*.

Note: This function is not designed to replace a comprehensive questionnaire and it should only be used for a limited number of additional variables necessary in context of the child growth and development assessment. They increase the size of the SDF database file and reduce operational speed.

Options: ID assignment

To change from the default setting of automatic ID attribution to manual the user has to click on the *IA* menu on top and select *Options*.

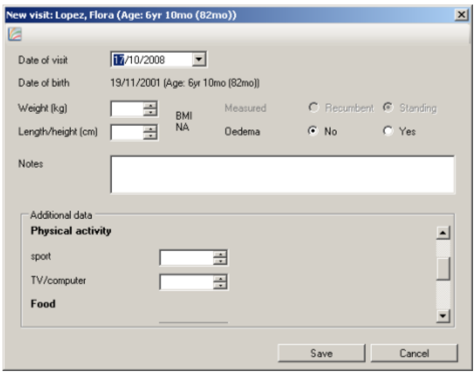


The *IA* options window allows the user to change the ID assignment by clicking the respective radio button. This selection will remain active until changed again.

If manual ID assignment is the selected the user can enter any number with a maximum of 32 digits.

4.3.3 New visit

Click on in the visits section of the child window to open a new blank visit window (see image below).



- DoV is automatically set to today's date but can be changed. To change DoV use either keyboard or calendar. The calculated age in years and completed months is displayed below (see also 3.2.1).
- Enter the measurements and specify how length/height was measured if the child is < 61 months.
- Specify if the child has oedema (see 3.2.2).
- The *Notes* field in this window is visit-specific and allows one to record important notes relevant to this visit.
- The additional data variables as defined beforehand appear in the lower window section.
- Click on at the top left corner to view the plotted measurements of this visit. The weight-for-age graph opens by default and from this window other indicators and options can be selected from the respective drop down menus.

Note that for a child above 10 years of age no weight measurement can be plotted because the WHO reference table for that indicator stops at 120 months. In this case a blank screen appears. To open the graph of another indicator select it from the drop-down list (see 4.3.1).

- To close the graphs window, click on or corresponding icon in your MS version.
- Click on the <*Save*> button to save and close visit window.
- Click on <*Cancel*> to close the visit window without saving the entries made.
- To save changes made to the child's data file, click on at the top of the child window, or use the menu: *Selected child → Save changes*.
- To enter another child repeat the steps outlined above.

Note: Measurement data from previous visits can be opened and edited at any time.

To delete a child visit select the row and click on , and confirm with <Yes>. The application removes the visit from the *Visits* table.

To edit a previous visit, select the row and double click with the mouse or click on .

Note: Measurement data from previous visits can be opened and edited at any time. The date of a previous visit, however, cannot be changed.

To close the module, click on (or corresponding icon) or use the menu, *Individual assessment → Close module*.

4.3.4 Child report

The *IA* module enables the user to generate a child report including for all visits the basic anthropometric data and results in z-scores.

To generate the report click on in the child window or go to the menu *Selected child → Generate child report*. The software will request the user to specify the location where the *.TXT file should be saved. The file will automatically open in the program assigned to read *.TXT files. The column labels are self-explanatory. The notes created on the child level, e.g. concerning birth conditions are not included in this report.

To obtain percentiles the user can go to Excel and create columns next to the z-scores and enter the formula "=NORMSDIST(select cell with z-score)". E.g. a z-score of -2.20 is converted to 0.01390, meaning the 1.4th percentile. To return to a z-score the formula needed is "=NORMSINV(select cell with percentile)".

4.3.5 Import from file

Into the *IA* module the user can import child visit data only from files in XML format previously created in WHO Anthro or WHO AnthroPlus. Hence if the user intends to re-import data later into AnthroPlus, s/he should choose the export format XML. Exported IA files can be carefully edited using a XML editor and then re-imported into AnthroPlus as long as the expected format remains unchanged and the specific rules are followed, see below.

Data files to be imported need to follow the specific *IA* file schema (see section 5.5.3). The software is programmed to check that only valid data are being imported. For example, measurement data beyond valid ranges (see 3.2.3) are not imported and cells are turned to blank.

Note: The imported measurements when mapped are truncated after 2 decimal places which is the assumed highest level of precision.

Specific rules:

- When importing children into *IA*, each child's visits must be ordered chronologically. Visits going back in time will cause the imported file to be rejected.
- The first visit date must be equal or later than the date of birth.

4.3.6 Export to file

Child records that are no longer used should be exported and then deleted from the software. This will ensure that the database is not growing endlessly, and that the software functions do not slow down. The export function also allows the user to create a file for further analysis including all notes and additional data variables.

To activate the *Export* function select one or several children from the list by ticking the boxes in front of their names. Then open the menu *Individual assessment → Export to file*.

Select the folder, specify the file name under which you want to save the child data and choose the format. Child visits data in the *IA* module can be exported to XML, CSV and TXT formatted files. As mentioned before, if it's uncertain whether the data need to be re-imported into the software, the user should choose XML.

This pop-up window will appear next where the user has to click on <Yes> or <No>.

The exported file contains all basic data, the raw measurements including *Notes, Mother, Father, Address* and *Additional data* variables, and if selected also the results in z-scores. The software also includes the information on who created the data-entry. This information is linked to the registered logged-in user.

Note that the exported results include all calculated z-scores even if they lie beyond the flag limits. In case of further analysis users are encouraged to apply the recommended flag limits, see section 3.4.2.

When exporting files as TXT or CSV (not XML), all additional data variables will be exported in separate columns. The name of each column corresponds to the ID name of the variable, while the section ID name will be lost. Users are thus advised to create unique self-explanatory variable ID names.

When exporting the *IA* data as XML (which is a hierarchical file format) all additional data will appear in a single element (column). After re-importing XML files the additional variables appear again separated and the user can edit and change the data-entries.

4.4 Nutritional survey (NS)

This module facilitates:

- Collecting new nutritional data based on a sample of children (one record per child)
- Deriving and displaying individual results using z-scores and percentiles based on the WHO standards and the WHO reference depending on the child's age for the indicators weight-for-age, length/height-for-age and BMI-for-age
- Opening, editing, saving and deleting existing surveys and survey records
- Moving surveys temporarily into and retrieving them from the archive
- Deriving standardized summary results with and without 95% CIs
- Correcting the 95% CIs for surveys with cluster sample design
- Importing survey data files in *.REC, *.DBF, *.TXT, *.CSV or *.XML formats
- Exporting survey data files in *.TXT, *.CSV or *.XML formats

The *NS* has the following differences compared to the *IA* module

- A child can only have one assessment
- The user can collect data on: Cluster, Household and Team
- *Survey options* allow changing ID attribution, flag limits and age groupings

To open the module click on the respective button on the *Start* window or select it from the *Application* menu.

When opening the module, the column to the left shows the list of active surveys which contains one example while the right window section is grey and inactive.

4.4.1 Survey window

To open the *Sample survey* highlight the name with left mouse and click on icon above. The data-entry tab window to the right becomes activated and shows the sample survey's records with the first record selected (highlighted in blue) and the child record's results below the spreadsheet (similar to *AC* and *IA* modules).

To select any other record use arrow or <*Enter*> keys or left mouse click.

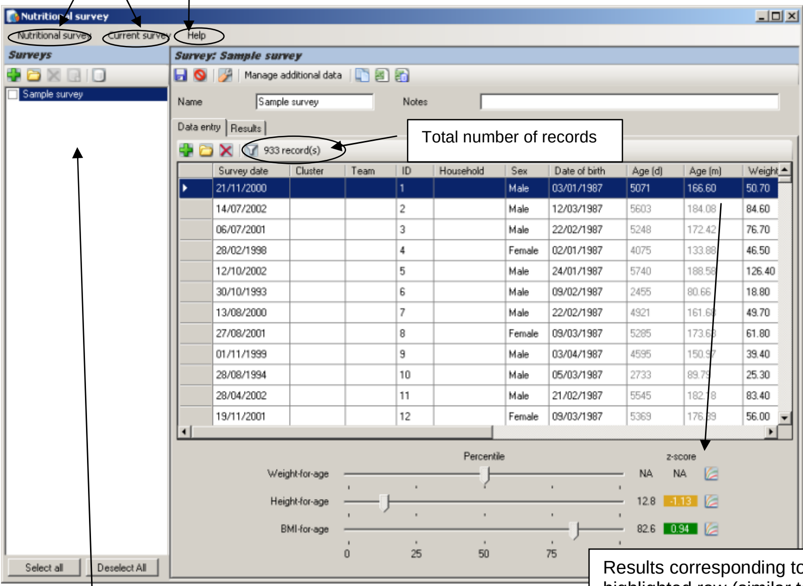
The user can click on any column header to sort the records in ascending order (alphabetically or numerically); clicking again sorts records in descending order. In case the order of records does not resemble the one shown below, click on the ID header.

Note that the date format (e.g. dd/mm/yyyy) depends on what the user selected in his/her computer settings.

Menu options

Open online help page

Window with child records of open survey with on top the fields to enter/edit survey *Name* and *Notes*.



Total number of records

Results corresponding to highlighted row (similar to *IA*); WAZ is NA because child >10 yrs

Active list with sample survey; icons on top enable user to manage the surveys (e.g. add, open, delete, archive and view archive)

List of records (1 row = 1 record) with selected record highlighted in blue; respective results by indicator below. Click on to open graphs. The z-scores are also included in the spreadsheet. Scroll to the right to find the grey shaded columns.

Click icons: to add new record; to open selected record or double-click on highlighted row; to delete selected record(s); and to filter and select a sub-sample.

Name

This field is mandatory, and the user has to fill in a specific name to the survey. If the user opens an existing survey and changes the name the new name will overwrite the old one.

Notes

This field enables the user to collect data that describe the survey, such as geographic location, which accounts for all records. The information included here will also be exported next to the survey name.

Nutritional survey

Clicking on the menu *Nutritional survey* enables the user to activate the following functions:

- *New survey* --------------------------------→
- *Delete selected* ---------------------------→
- *Archive selected* -------------------------→
- *View archive* -------------------------------→

Icons on top of active list of surveys

- *Import from file*
- *Export to file*

See details in section 4.4.8 and 4.4.9

- *Close module* ⟶ Same as: (or corresponding icon in your MS version)

Current survey

Once a survey has been opened the user can select from the menu bar *Current survey* the functions related to the open survey:

- *Save changes* ----------------------------→
- *Cancel changes* -------------------------→
- *Survey options* ---------------------------→
- *Manage additional data* ----------------→ *Button with same name*
- *Copy records to clipboard* ------------→
- *Standard report with CIs (Excel)* →
- *Estimates without CIs (Excel)* ------- →

Icons and button on top of open survey

The results in z-scores and percentiles below the open survey records refer to the selected (highlighted) child record.

The following icons and corresponding functions are available on top of the records list:

Click on to add a new record

Click on to open a selected child record

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Click on to delete one or several selected child records

Click on to open *Filter records* window which enables users to select a sub-sample

Manage additional data

This function is similar to *IA* (see details in section 4.3.2). Every new user-defined variable is added as a new column to the right of the spreadsheet.

Note that only for new children added will this variable be available for data collection. Thus, ideally the additional variables should be defined before data collection starts.

To add additional data variables go to *Current survey* → *Manage additional data* and create sections and variables as outlined in 4.3.2.

As in the *IA*, the created variables and sections always appear in the language the user applied when adding them, i.e. they are not translated if the language is changed in *Settings*.

When an existing survey data file (e.g. *.REC or *.DBF) is imported into AnthroPlus, the additional data variables (e.g. hemoglobin, dehydration, etc.) are retained as such. The user can continue collecting this information in the AnthroPlus environment and also edit existing records. Users are advised though to limit the additional data variables as these increase the software's database size and thus slow down its functioning.

If the user deletes a variable, it is automatically deleted from the spreadsheet and the column disappears permanently. Changing the additional data template half way through a survey will only affect the records created after the change. Existing records are left with their existing additional data structure. Exported records will always show the columns of the additional data variables as defined in the template. If this information has not been collected for some records the corresponding cells will be blank.

In the exported file formats CSV and TXT the additional variables are presented in separate columns to facilitate further analysis. To ensure that there is no confusion users are reminded to label the variables with unique names. In case a name is repeated the software will append a number to avoid duplicates, e.g. Sport, Sport2 etc. in the exported data. If there is more than one variable with the same section ID and variable ID, the values for the duplicate variables will be lost when exporting (as they are indistinguishable the retained value is always that of the first variable matching the section ID/variable ID combination).

Note that XML is now the only format keeping all data strictly intact (TXT/CSV files lose additional data section structure as discribed).

Best practice is to export a survey data set after analysis and when it is no longer used. Once archiving outside the software is completed, delete the survey from the software in order to keep the database file as small as possible.

As a guidance, below are the sizes occupied on disk by a survey with more than 10'000 records including additional data variables:

- Original DBF file ~2.5 MB
- Exported as TXT ~1 MB
- Exported as XML ~9 MB
- Size in SDF database ~35 MB

Note that the software's database *.SDF file can be as large as 2 GB.

4.4.2 New record

Clicking on [icon] opens a data-entry window similar to the one in the *IA* module.

The new fields are:

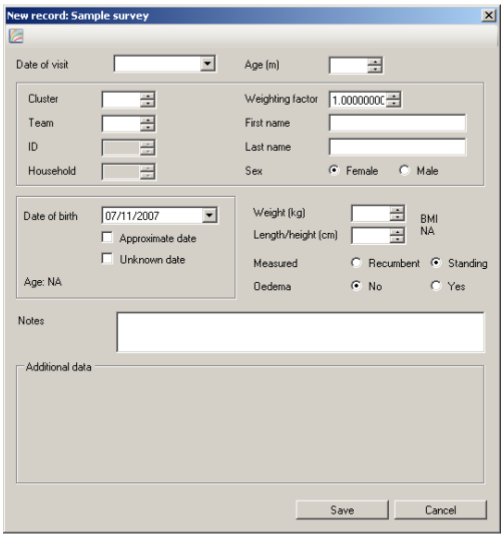
Age in months if DoB is not available; in that case tick the box next to "*Unknown date*" under DoB and then enter age in months into the *Age (m)* field.

Cluster, Team, ID and Household (automatic or manual depending on selection in *Survey options*) with maximum 10 digits

Weighting factor (default set to 1.00, maximum with 16 decimals)

All measurements can be entered with precision up to 2 decimals.

Click on [icon] to open the graph window.



The graph's zoom-in function works as in the *AC* and *IA* modules. To reset to original dimensions, click on [icon].

The *Notes* field is record-specific and enables the user to collect information that may be important in relation to the interpretation of the visit results (e.g. child was restless, very sick, needs referral, etc.)

To edit an existing record select row and click on [icon]. Click on the <*Save*> or <*Cancel*> button to return to list of records.

To delete a record, select first one or several records (CTRL + click, or SHIFT + click) and then click on [icon]. User is prompted to confirm the wish to delete. Once deleted the records cannot be recovered.

4.4.3 A special note on age

When the user has entered DoV and DoB, the age is automatically derived in years and completed months for the calculation of the z-scores (depending on whether the WHO standards or the WHO reference are used). Age in days and in months are then reported in separate columns on the spreadsheet.

There are several scenarios for deriving the age information:

1) If the exact birth day is not known the user should probe the caregiver to obtain at least month and year of birth and then tick the box next to *Approximate date*. A randomization process will select a day within the given month and complete the DoB. In this case the randomly derived DoB is used but on the column in the spreadsheet the day of birth is displayed as "XX" to make up a DoB that reads something like **XX**/mm/yyyy. In the export process the derived date is exported in full (without "XX") and the column *ApproxDateOfBirth* is set =1. Alternatively some researchers may prefer to enter consistently the middle of the month as the day of birth (dd=15).

2) If the caregiver remembers only the child's age in months, enter that information into the field at the top right of the *New record* window. If the age is less than 61 months the software derives age in days (see 3.2.1); if the age is 61 months and older this information in completed months is used to refer to WHO reference tables.

3) If the user wants to import a survey data set with only age in years s/he has first to create a new variable, e.g. "agemons" and convert the years into months by multiplying the number of years by 12. If on the other hand, age was measured in days, users are advised to first create a new variable (e.g agemons = agedays/30.4375) before using the import panel "Age (in month)" option.

The converted age information in months is displayed as an un-rounded value with two decimal places on the spreadsheet, while age in days appears as whole number. To classify the results into age groups the completed months are used and not age in days.

In the *NS* module, if age cannot be derived because of missing dates only a BMI value will be calculated and the child will thus not contribute to any prevalence calculations.

4.4.4 Survey options

To open *Options* window click on or select the respective function from the *Current survey* menu. The user can change the ID attribution (if ticked automatic), z-score flag limits and age groupings.

The flag limits can be changed using the scroll bars or with the key board. Any flag changes affect the analysis results. They thus have to be documented and reported together with the prevalence results.

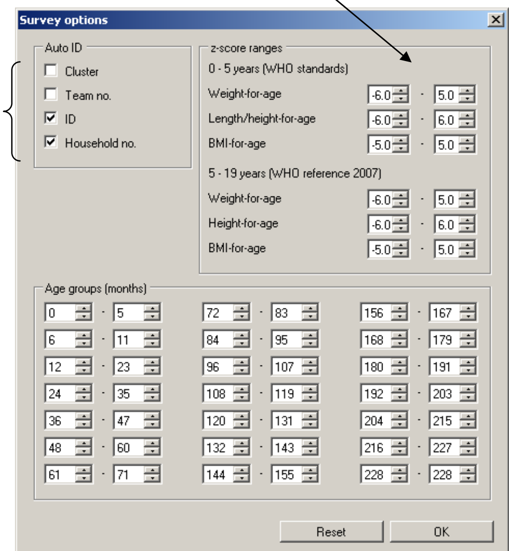
The default setting is to have automatic child and household ID assignment, while IDs are assigned manually for the variables Cluster and Team.

The default age groupings are as shown in the lower part of the window.

Lower and upper limits are inclusive.

Changes should be made to the lower limit (the upper adjust automatically) - the only exception being the upper end of 228 months.

Click the <Reset> button to restore the default settings.



If not all age groups exist in the data set the corresponding rows in the report will be empty.

4.4.5 Flagging

According to the set flag limits, the software flags out in purple on the spreadsheet any extreme, potentially incorrect or out-of-range values (see section 3.4.2). As mentioned above, the default flag limits can be changed in the *Options* window.

Note that on the selected row due to the dark blue background the colour purple is difficult to see.

If z-scores appear as flagged the user is advised to check for potential data-entry errors (age, weight, length/height) and, if possible, to correct the data before proceeding. After editing a file or altering the flag limits, the user is advised to save the file. All flagged z-scores (highlighted in purple) will be excluded from the analysis.

Missing z-score values appear as blank cells and are taken into consideration in assigning flag codes (see below).

Flag codes

In the FLAG column adjacent to the z-scores the software displays a record-specific flag.

Flag	**Error tracking**
None	Valid z-scores were derived for all indicators.
HAZ	This could be an extremely short or tall child, or length/height data missing. If missing the HAZ and BAZ cells are empty. It is recommended to double check the height data to assure that it is correct and consistent on the data collection form and the computer file. Alternatively, the age could be incorrect or missing; therefore one should look at the WAZ value to see if it is extreme as well or blank.
WAZ	Either weight or age may be incorrect or missing.
HAZ & WAZ	Age information may be incorrect, out of range or missing.
BAZ	This may indicate an unusual combination of WAZ and HAZ.

4.4.6 Special spreadsheet functions

Move, sort and filter child records

Besides the scrollbars, there are the following keyboard shortcuts to move easily through the list of records:

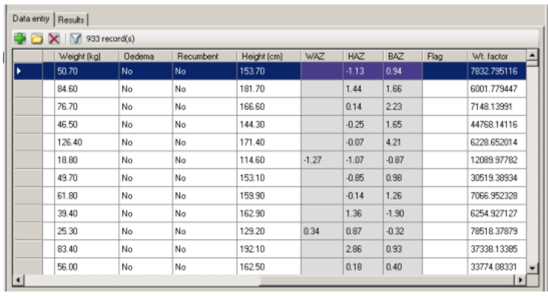
CTRL + ↑ = go to top of list

CTRL + ↓ = go to bottom of list

CTRL + → = go to the right of list

CTRL + ← = go to the left of list

The columns with the calculated z-scores in the spreadsheet are grey-shaded to easily distinguish them from the rest.



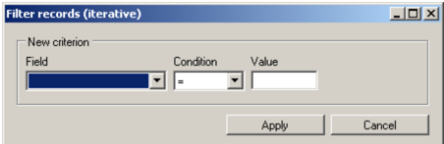
Weight (kg)	Oedema	Recumbent	Height (cm)	WAZ	HAZ	BAZ	Flag	Wt. factor
50.70	No	No	153.70		-1.13	0.94		7832.795116
84.60	No	No	181.70		1.44	1.66		6001.779447
76.70	No	No	166.60		0.14	2.23		7148.13991
46.50	No	No	144.30		-0.25	1.65		44768.14116
126.40	No	No	171.40		-0.07	4.21		6228.652014
18.80	No	No	114.60	-1.27	-1.07	-0.87		12089.97782
49.70	No	No	153.10		-0.85	0.98		30519.38934
61.80	No	No	159.90		-0.14	1.26		7066.952328
39.40	No	No	162.90		1.36	-1.90		6254.927127
25.30	No	No	129.20	0.34	0.87	-0.32		78518.37879
83.40	No	No	192.10		2.86	0.93		37338.13385
56.00	No	No	162.50		0.18	0.40		33774.08331

To sort the survey records by any variable click on the header cell. Whether the result is in ascending or descending order can be seen by the added symbol, i.e. □ = ascending, □ = descending. For text variables, sorting in descending order auto-resizes the column width to display all the characters.

Filter function

By clicking on the iterative filter function the user can select a sub-sample of the current survey for further analysis.

Select a variable from the drop-down menu under *Field*; specify *Condition* and complete *Value* field.



To obtain the selected sub-sample click <*Apply*>; or <*Cancel*> to undo the filter selection. This filter function can be applied stepwise, i.e. first select males, then a certain age range, etc.

When a filter has been applied a new icon is added and the number of records re-counted (see image to the right using the sample survey and the filter sex = male).

Clicking on clears the filter and returns to the complete list of survey records.

The filter function can be used to obtain a sub-sample for further analysis in case estimates are required by another stratifying variable; similarly the user can quickly view e.g. all children with WAZ<-2 SD.

Copy to clipboard

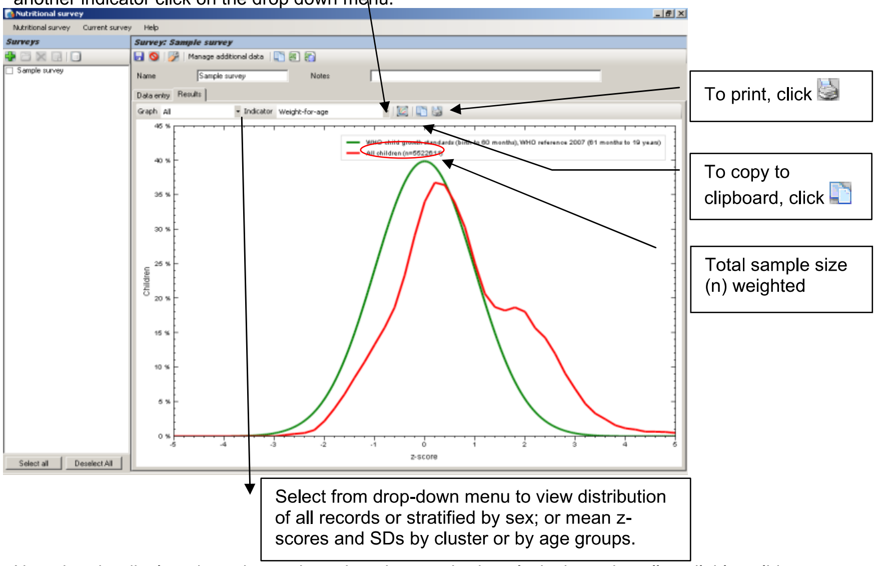
The user has the option to copy all or part of the survey records to a clipboard and paste them into another spreadsheet program, e.g. Excel. To select the rows either point the cursor, click and drag over the number of lines to copy, or use keys <SHIFT + □ (down cursor). To select multiple single lines, <CTRL + left mouse click> on each of the rows to be copied. Click on in the survey menu bar and the selected rows are always copied automatically with the column headings.

4.4.7 Results

The *Results* tab window can be opened when a survey has at least 12 records. It allows the user to visually check the distribution of survey data for outliers.

The first graph shows the shift of the surveyed population's weight-for-age compared to the normal distribution. From the drop-down menu the user can select other indicators and further graphical overviews, i.e. by sex, cluster and age.

On this tab section the user can choose to display the z-score distributions by indicator for the survey data compared to the normal distribution curve. To select another indicator click on the drop down menu.



Note that the displayed graphs are based on the standard analysis, i.e. using all available valid z-scores lying within the chosen flag limits for the graphed indicator. This option may result in different sample sizes by indicator. In case the survey contains sample weights, the sample size given is the weighted N. The formula used to produce the distribution graph is based on Kernel smoothing (Fox J, 1990).

If a distribution looks unusual or indicates the inclusion of outliers, the user may want to return to the spreadsheet and edit the raw data. If no (more) anomalies are identified the user may proceed to run the survey analysis.

To change the age groupings and flag limits click on , or open the menu *Current survey* → *Option*s.

Weighted N is derived using the sample weight in the sample survey. If no sample weights are entered the programme attributes the weight 1.0 and unweighted and weighted N are identical.

Analysis and report options

The user can choose several analysis report options. S/he can select them either from the menu *Current survey* or by clicking on respective icons. When sampling weights are available the full precision is used (maximum 16 decimal points) even though in the spreadsheet they appear truncated.

The report options are:

Standard report (): Under this option the user can further specify if a correction for clustering needs to be applied in case of a cluster sample design. The *Standard* analysis makes maximum use of the

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collected data and includes for each indicator all valid z-scores. With or without correcting for cluster sampling, the outputs show prevalence by age groups and totals, stratified by sex for the common cut-offs, with means and SDs of z-scores, and 95% confidence intervals.

The differences are:

- When choosing standard analysis corrected for cluster sampling, the formula to derive the 95% CIs is changed to correct for this specific sampling method; the resulting CIs are slightly wider than without this correction. Beforehand the user has to have loaded the cluster identification variable into the corresponding "Cluster" field.

- When choosing the standard analysis without the correction for cluster sampling, the 95% CIs are derived for a survey based on a random sample; and in this case the survey analysis can produce stratified results for any variable e.g. "Area (urban/rural)" that has been mapped into the AnthroPlus field "Cluster".

The age-stratified results follow the age grouping defined in *Options* (see 4.4.4). Due to the inclusion of all valid z-scores, the sample sizes per indicator in the result tables may differ. Child records with missing age do not contribute and are excluded from any analysis.

Given that children with oedema should not be weighed because of their flawed weight, no individual WAZ or BAZ can be derived. Therefore these children do not contribute to the respective mean and standard deviation statistics in the analysis report. However, oedema cases are included as severely malnourished children in the prevalences of <-3 SD (and <-2 SD) weight-for-age and BMI-for-age. A child with oedema and unknown age contributes to the **overall** sample size and prevalence of low weight-for-age, and low BMI-for-age, i.e. %<-3 SD and %<-2 SD. However, s/he will not be considered for the age disaggregated sample sizes and prevalences. The number of total oedema cases in the survey is reported in a footnote of the table.

Estimates report ( ): This option produces an analysis output following a standard data-entry format without 95% CIs. The analysis also uses all valid z-scores to make full use of the available data in the survey, similar to the *Standard report*. The sample sizes pertaining to the weight-for-age indicator are used as the overall and disaggregated N for reporting purposes in this report. Given that this report does not include the CIs, the correction for cluster sampling is irrelevant and the user does not have to make a choice.

Children with oedema or missing age are treated in this analysis option in the same way as for the *Standard* analysis (see above).

4.4.8 Data import

Data can be imported into the *NS* module from files in CSV, TXT, DBF, REC (EpiInfo) and XML (previously created in WHO Anthro or AnthroPlus) formats.

Before importing data sets it is recommended to ensure that there is a unique identifier field. In importing ensure to map the corresponding variable with the AnthroPlus field *ID*. This facilitates merging of records in case of later export.

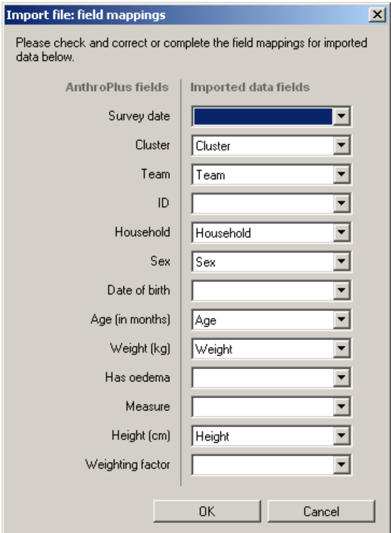
Variables in the original data file with names labelled "WAZ", "HAZ", "BAZ" (e.g. z-scores based on the former NCHS reference) should be renamed before importing to avoid confusion. If there remain any similar variables the software will add the number "2" to the name.

Files coming from WHO Anthro, including children 61 months and older, are best imported in XML format. AnthroPlus recognizes the origin and if needed automatically converts the age in days into age in months. In case of WHO Anthro exported files in TXT and CSV format that have no DoB and DoV variable but only age in days, the user needs to convert the age in days into months before importing into AnthroPlus. The conversion is to derive age in months by dividing age in days by 30.4375.

For any data file with only age in years [ageyrs] and no DoV nor DoB, users have first to create a new variable for age in months (e.g agemons = ageyrs ×12) before importing into AnthroPlus. It is recommended to round age in months to 4 decimals.

From Excel it is best to save a file as TXT (tab-separated) and import into AnthroPlus. CSV files need to have semi colons as separators to be accepted into AnthroPlus. Semi colons were chosen as they are rarer in the data sets, thus minimizing potential errors with badly formatted files. To change the separator from comma to colon go to the Control Panel → Regional and Language Options. Open → Customize and specify value for field List separator.

To import files in TXT, CSV, REC (EpiInfo data files) and DBF format, the user has to map all basic AnthroPlus fields with the variable in the original file (see image).



To map variables click on the drop-down menu button for each and select its match from the list. If there is no match leave it blank.

Imported weight and height measurements are truncated after 2 decimal places.

To enable the programme to produce stratified results by another variable than age and sex the user can load this variable in the AnthroPlus field "Cluster", which has to be an integer. For example, the variable "Area" in the data set with coding 1=urban, 2= rural.

If DoV, DoB and age in months are imported together, the age is derived using DoV-DoB as these data take precedence over the imported age in months

Variables that require specific formats are:

- Cluster, Team, ID and Household: numeric integer value
- Sex: numeric value with 1= male and 2= female
- Age in months: numeric values with max. 5 decimals
- Weight: numeric value (in kg) with max. 2 decimals
- Height: numeric value (in cm) with max. 2 decimals
- Oedema: text variable with y=yes and n=no
- Sampling weight: numeric value with max. 16 decimals

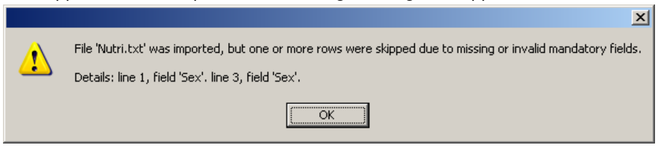
Notes on import:

Surveys with the same name are imported independently. Nevertheless to avoid confusion it is best to give unique names to each survey.

Cluster survey data should have the clustering variable as integer values.

It is highly recommended to include in the import a unique identifier variable and map that into the AnthroPlus ID variable.

Records with missing or invalid mandatory data, e.g. sex = 5 (as opposed to 1=male, 2=female), will be dropped from the import and a warning message will appear.



Note that sex is the only mandatory data field, other missing fields may generate warning messages but the record will still be accepted.

Missing values in *Survey date, Date of birth, Age (m), Weight* and *Height* will appear as blank cells.

If survey data have no sampling weight the software attributes a sampling weight=1 (Wt factor). If a child record should be excluded from the analysis, the user is advised to insert "0" into the record's Weighting factor field. When the 'weighting factor' field is mapped on the import dialog, then every missing (empty), out-of-range (i.e. negative) or other invalid sampling weight in the imported records will also be set to "0" and in a weighted analysis such records will be ignored.

The following message appears when for example an AnthroPlus field e.g. Cluster, Team, Household which expect integer values is mapped with a text field, e.g. urban/rural or regions.

In case the value is not needed for later disaggregation in the analysis the user can simply continue by clicking <OK>. If the variable is needed for producing stratified results, any text variable has to be converted into numeric integer values before mapping in the import process to the AnthroPlus field "Cluster".

After the import the software highlights in purple any extreme or potentially wrong z-scores in the grey-shaded results columns (see section 3.4.2). This way the user can scroll through the file and check the data.

Where age appears as 24 months (= 730.5 days) in imported *.WNS (old file format of WHO Anthro), *.REC and *.DBF files, age is rounded to 731 days before deriving age-based estimates for children less than 61 months.

Additional variables are imported and appear to the right end of the spreadsheet.

Good practice

If a data file contains many variables, it is recommended to import into WHO AnthroPlus only the relevant data variables needed for deriving z-scores and then export the data back and merge with the original file. For that purpose it is important to include in the imported file a variable that defines a unique ID for each record.

Always keep a copy of the original raw data as a backup.

Once no longer needed in WHO AnthroPlus export the file and delete from the module.

4.4.9 Data export

In case the user is interested to run the survey analysis using another software, s/he may:

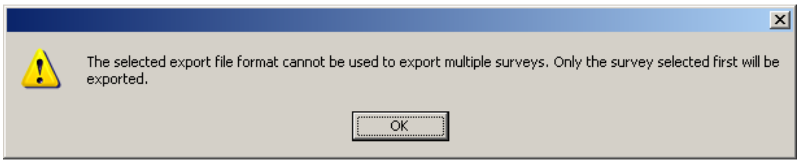
1) Select the desired rows on the spreadsheet and click to copy to clipboard. When pasting the rows into another programme, e.g. Excel, the header row is automatically copied over as well.

2) Save the survey and then export it, including results, to *.CSV, *.TXT or *.XML format.

The second is the preferred option as it ensures that all records are exported and no information accidentally missed.

The exported additional data variable will match the variables defined in the survey's additional data template (any variables present in records but not in the template will not be exported).

Given that different surveys may have different additional data variables it is not possible to export several surveys in TXT or CSV format. In this case the following pop-up message appears:



Note that the first selected survey refers to the survey that is first on the active list

Exporting several surveys and appending them will thus only be possible in XML format.

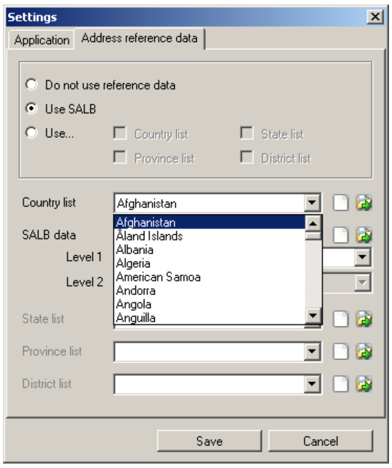
AnthroPlus generates several variables in exported files (see 5.5.4). An example is "*DateOfBirthIsApprox*" which is placed in a column next to DoB. This variable is coded "1" if DoB was approximated and "0" otherwise. The estimated DoB will be exported in full.

When including in the export the resulting z-scores, the flag column is not retained in the exported *NS* files and the user has to redefine and apply the flag limits (see 3.4.2) for further analysis.

Note that the codes for sex in the exported file are: female =0 and male =1.

5. Other functions

5.1 Address reference data



The *IA* module facilitates the collection of detailed address data for each child. This information can help to trace the child for follow-up investigation.

As a first step the user has to specify in the *Settings* how s/he wants to collect the address information (see section 4.1).

In the *Address reference data* section the user can choose to not use the reference data (default setting), to use the Second Administrative Level Boundaries (SALB) datasets, or to apply user-defined country, state, province and district lists.

A comprehensive *Country list,* including territories and areas, comes with the installation. From this list the user can select a country/territory from the drop-down menu.

If the user chooses to not use any reference data s/he can type in freely whatever information s/he deems important into the IA address window.

To use the SALB data file the user has to prepare and upload one file per country.

To tailor lists for province, state and district to match the covered area, follow instructions in 5.1.3.

5.1.1 Country list

The *Country list* comes with ISO ALPHA-3 letter codes (not displayed) which are based on the United Nations Standard Country or Area Codes for statistical use found at: http://unstats.un.org/unsd/methods/m49/m49.htm.

In order to reset and replace this list click on ☐ and then [import icon] to import the revised file. It is important when replacing or changing the country list to maintain its file structure, i.e. 1st column ISO ALPHA-3 code and 2nd column country name. Empty fields are not allowed.

5.1.2 SALB data

The SALB data are boundary files that are provided for the first and the second administrative sub-national level of a country. These datasets form part of the UN geographic database and can be downloaded from http://www.who.int/whosis/database/gis/salb/salb_home.htm (registration is free). Predefined SALB lists are available for most countries. SALB files facilitate the address data collection as users can select e.g. state and province names from the drop-down menu and do not have to type anything (no risk of typing errors). The advantages are that these files are up-to-date, enable the user to perform stratified analysis and mapping of results according to the country's administrative structure.

Note that the definitions of SALB levels 1 and 2 depend on the internal structure and size of the country i.e. in Switzerland these levels have a different meaning than they do in Brazil (for further information, see http://www.who.int/whosis/database/gis/salb/salb_home.htm.

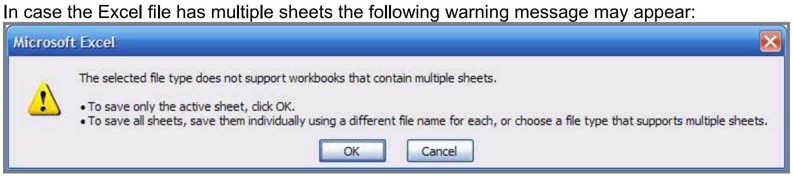
When selecting SALB, the user has to specify the country where s/he will collect the data and then import the respective SALB data file.

To add or update a country's SALB file, the user has to download and convert the SALB Excel file to a tab delimited text file before uploading it to the PC.

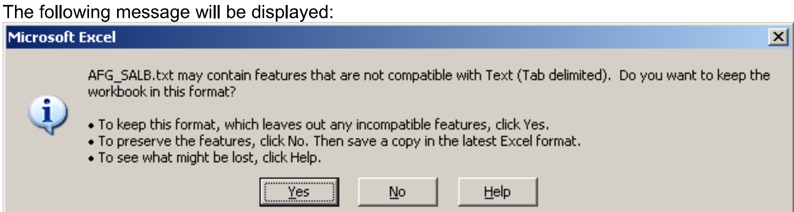
The steps to prepare the SALB files are as follows:

After registering click on "Codes and historic changes download", which opens the URL page: http://www.who.int/whosis/database/gis/salb/salb_coding.htm#DATA%20DOWNLOAD.

- Select the country and year version of the SALB file to be imported, download and save
- Open the file in Excel and select the worksheet with
- Delete all header and footer rows so that the file contains only the following columns: 1st administrative level names, 1st administrative level codes, 2nd administrative level names and 2nd administrative level codes.
- In Excel go to < → *File* → *Save As*> and select: "Text (tab delimited) (*.TXT)"
- In case the Excel file has multiple sheets the following warning message may appear:

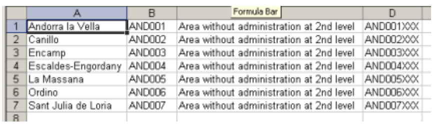


- Select <*OK*>
- The following message will be displayed:



- Select <*Yes*>
- Copy the created file to a predefined folder for the address data.
- Open *Settings* from the Main window and click on to the right of *SALB data.* Select the file and click <*Open*> or simply double click on the file.

Countries with SALB data for only the first administrative level (e.g. Andorra, Botswana, Jamaica, Liechtenstein etc.) need further preparation: Once the TXT file has been created, open in EXCEL and add a 3rd column with the text "Area without administration at 2nd level" and in the 4th column enter the same code as in corresponding column 2, adding "XXX" before saving as TXT (tab delimited).



	A	B	C	D
1	Andorra la Vella	AND001	Area without administration at 2nd level	AND001XXX
2	Canillo	AND002	Area without administration at 2nd level	AND002XXX
3	Encamp	AND003	Area without administration at 2nd level	AND003XXX
4	Escaldes-Engordany	AND004	Area without administration at 2nd level	AND004XXX
5	La Massana	AND005	Area without administration at 2nd level	AND005XXX
6	Ordino	AND006	Area without administration at 2nd level	AND006XXX
7	Sant Julia de Loria	AND007	Area without administration at 2nd level	AND007XXX
8				

Even when SALB data collection has been specified in *Settings*, the user can still collect other address information, i.e. postal code, phone number, e-mail, etc.

When exporting IA records with SALB data, the location names are converted to their numeric codes as seen in the imported TXT files.

Removing *SALB data*

To remove SALB data files go to *Settings*:

- Click on to reset *SALB data.*

- Click on <*Yes*> to confirm and then <*Save*>

Note: When reset is activated, all currently imported SALB files will be deleted.

5.1.3 State, Province and District list

State, province and district lists can be tailored to meet user-specific needs and facilitate the collection of address information according to specific administrative or geographical settings, e.g. local administrative structures and codes. This is also helpful for the collection of address data in countries that do not yet have SALB data.

In *Settings* the user can specify which lists to use and upload those for use in the *IA* module.

To construct these *.TXT files follow the formats outlined in section 5.5.3.

Rules for importing address reference data

When a given item (e.g. country) appears more than once in the imported file, the first occurrence is taken into account and subsequent ones are ignored. Items are identified by their ID fields, i.e. ISO-3 code for countries, level 1 or level 2 code for SALB data (this rule does not apply to states, provinces and districts as they only have one field).

Imported SALB files can only contain data for one country (i.e. SALB data for more than one country must be loaded from distinct files).

Deleting address reference data

Countries can only be deleted if they are not referenced by SALB data. This means that SALB data must be deleted first if necessary.

5.2 Online help

In case the user does not have the manual available, contextual online help pages provide instantaneous, concise guidance on key module functions. To open any help page with a module click on *Help* on the menu bar. To close a help page, click on the icon at the top right corner. These online help pages are only available in English and are intentionally kept short.

5.3 About

To open the *About* window go to *Start* window and click on *Help* → *About*. This window presents the software's objective, contact details and links to the web sites of the WHO reference 2007 and the WHO child growth standards.

5.4 Error log and error reporting

A log function documents any major errors in the *Log.XML* file which is located in the application folder.

Even though exhaustive testing was performed to ensure that this software works properly, virtually all software programmes have "bugs". It would thus be appreciated if users could send a brief report on any encountered problems (random or systematic) when using WHO AnthroPlus.

Please send a bug-report describing in detail:

- The problem found
- Whether the problem appeared systematically or randomly
- Where exactly and in what module interface it occurred
- How it occurred, including what sequence of commands and/or buttons led to it
- What the expected result had been
- If you managed to circumvent/solve the problem, how you did that

Additionally users can use screenshots and include a copy the log file when sending the bug report to the following address:

WHO AnthroPlus
Department of Nutrition
World Health Organization
Avenue Appia 20
CH - 1211 Geneva 27

fax: +44 22 791 4156

who_anthro@who.int (add "AnthroPlus" in the subject line)

Please note: This is not a helpline address.

5.5 File formats

5.5.1 General rules

All imported or exported files must follow the rules below:

- File encoding must be Unicode UTF-8 (which includes ASCII).
- Within files, new lines must be encoded by carriage return/line feed (CR/LF) character pairs (Windows standard).
- When importing: If the imported file contains any invalid data, the whole file is considered invalid – the file is rejected and no data are imported.

About *.TXT, *.CSV and *.XML files (concerning data exchange)

- For data that include 'change tracking' fields (i.e. CreatedBy, LastUpdatedBy and LastUpdatedAt):
    - import/export files only include CreatedBy.
    - when importing, LastUpdatedBy and LastUpdatedAt will be set to the current user's name and current date/time, respectively.
- Exported files can include the calculated values (anthropometric indicators + BMI).

About ASCII (*.TXT or *.CSV) files specifically:

- These text files will hold all data in a flat format.
- *.TXT and *.CSV files only differ by the character used to separate fields:
    - *.TXT files use a tab (Unicode 9)
    - *.CSV files use a semicolon (Unicode 59). The format specifications below use semicolons to delimitate fields.
- The order of the fields is fixed and follows the format defined in the following sections.
- The first line in each file contains the field header names, but its purpose is purely informative in the context of the WHO AnthroPlus applications: when importing, the first line's content will be ignored.

5.5.2 File formats

Field types

The text format use for Datetime fields is: yyyy-MM-dd [HH:mm:ss] e.g. 2007-04-16, or 2007-04-16 16:52:31

Symbols

The following symbol conventions are used when describing text file formats (*.TXT, *.CSV and address reference data):
¶ = CR/LF
¬ = tab
[##] = character with hexadecimal value ##
<x> = value for field 'x'

6. References

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Appendix 24: Height-for-age Growth Reference Charts

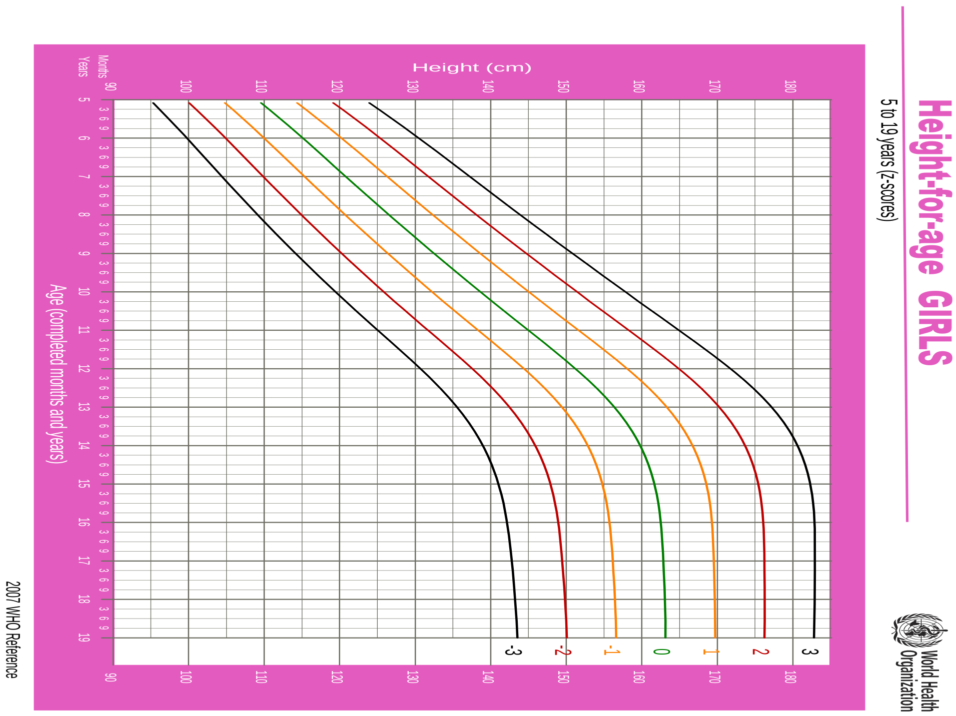

Figure 21 Height-for-age z-scores girls (WHO, 2007d)

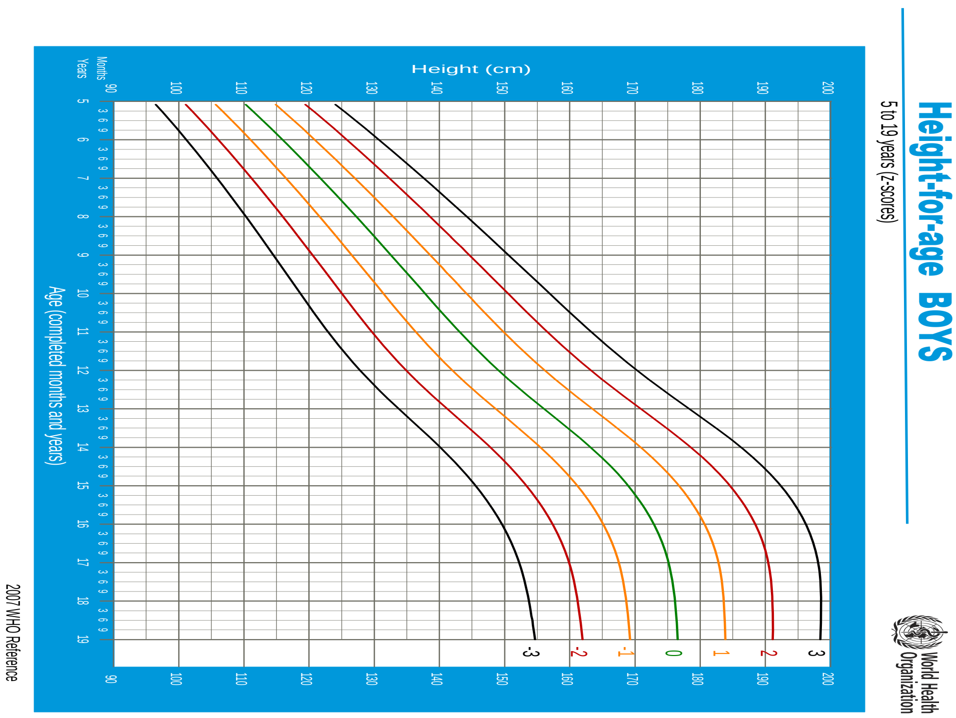

Figure 22 Height-for-age z-scores boys (WHO, 2007d)