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STATUS OF PHYSICAL ACTIVITY AND PHYSICAL FITNESS AMONG INTERMEDIATE-PHASE SCHOOLCHILDREN FROM MARGINALISED COMMUNITIES IN PORT ELIZABETH

SESETHU NCANYWA

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STATUS OF PHYSICAL ACTIVITY AND PHYSICAL FITNESS AMONG INTERMEDIATE-PHASE SCHOOLCHILDREN FROM MARGINALISED COMMUNITIES IN PORT ELIZABETH

By

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Submitted in fulfilment of the requirements for the degree of Master of Human Movement Science in the Faculty of Health Science at the Nelson Mandela University

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In accordance with Rule G5.11.4, I hereby declare that the above-mentioned thesis is my own work and has not previously been submitted for assessment to any other University or for any other qualification.

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LIST OF ACRONYMS

BF%	Body fat percentage
BMI	Body mass index
CRF	Cardiorespiratory fitness
GS	Grip strength
HRPF	Health related physical fitness
LO	Life Orientation
MPA	Moderate physical activity
MVPA	Moderate to vigorous physical activity
PA	Physical activity
PE	Physical education
PF	Physical fitness
VPA	Vigorous physical activity
WHO	World Health Organization

ABSTRACT

The purpose of the study was to investigate the current status of physical activity (PA) and physical fitness (PF) of intermediate-phase schoolchildren from marginalised communities in Port Elizabeth. A total of 985 schoolchildren (n=505 boys, n=474 girls) aged 8 to 16 years, from eight quintile 3 government schools participated in this study. These schools included four schools from the Township area and four from the Northern areas in Port Elizabeth. The tests included in the study were PA (Actigraph accelerometer), PF (20 m shuttle run test and grip strength), and body composition (body mass index and body fat percentage). Results showed that girls had higher body mass index (BMI) and body fat percentage (BF%), lower VO_2max, less time spent on average per day on moderate to vigorous physical activity (MVPA) and lower grip strength (GS) as compared to boys ($p<0.05$). However, when controlling for confounding variables, there were no significant differences found between the two genders in reference to BMI ($p=0.0746$) and GS ($p=0.3645$). The younger age group (9-10 years) presented higher VO_2max, lower GS, lower BMI and BF% than the older age group (11-12 years) ($p<0.05$). No significant differences were found between the two age groups and between the two geographic areas in respect of MVPA ($p>0.05$). No significant differences were found between the two geographic areas with regards to VO_2max, GS, BMI and BF% ($p>0.05$). However, when confounding variables were considered, there was a significant difference in the BMI ($p=0.0007$), BF% ($p=0.0003$) and GS ($p=0.0004$) of the children from the two geographic areas. A negative correlation was found between VO_2max and BMI ($p<0.0001$), as well as MVPA and BMI ($p<0.0001$). A positive correlation was found between VO_2max and MVPA ($p<0.0001$). Overall, girls seem to be more at risk than boys for future non-communicable diseases. These findings highlight the importance of promoting PA and monitored PF in children, and particularly in girls from marginalised communities.

Keywords: body composition, lower socioeconomic communities, physical activity, physical fitness, primary schoolchildren.

CHAPTER 1

PROBLEM IDENTIFICATION

1.1 INTRODUCTION

While aiding normal growth and development during childhood, physical activity (PA) essentially establishes a foundation for habits of activity in the children's future (Kliziene et al., 2018; Moselakgomo et al., 2014). Therefore, it is important to monitor the PA and physical fitness (PF) of children so as to identify the limitations and subsequent effects on their future health. With a primary purpose to introduce the study, the sections of this chapter contextualise the study, define its aim and objectives furthermore, outlining its scope and significance. Conclusively, the chapter clarifies relevant concepts and outlines the chapters to follow.

1.2 CONTEXTUALIZATION OF THE STUDY

Promoting regular PA, more especially in disadvantaged communities in South Africa, is a challenge (Walter, 2014). The Healthy Active Kids South Africa (HAKSA) report emphasizes the need for special efforts to promote PA for young children (Uys et al., 2016). Schools are well placed to promote PA in children since children spend much time at school (Walter, 2014). However, schools in disadvantaged communities face many challenges in this regard, including the lack of qualified physical education (PE) teachers, inadequate facilities and resources, as well as the side-lining of the subject in the school curriculum (Van Deventer, 2012).

According to Draper and colleagues, numerous academics argue for more research to be conducted to enable the monitoring of PA in schools, at a national level (Draper et al., 2018). Currently, there is limited research on the PA and PF status of schoolchildren in South Africa, and more specifically within the Eastern Cape and amongst lower socioeconomic communities (Uys et al., 2016). However, the few studies that have been conducted in South Africa have shown that PA and PF levels among children are low (De Vos et al., 2016; Uys et al., 2016). This study, thus significantly contributes to scholarly discourse by investigating the status of PA and PF among intermediate-phase schoolchildren from marginalised communities.

1.3 RESEARCH AIM

The study aimed at investigating the current status of PA and PF among intermediate-phase schoolchildren from marginalised communities in Port Elizabeth[1].

1.4 RESEARCH OBJECTIVES

- To describe and compare the PA patterns per age, gender and geographic area of the relevant intermediate-phase schoolchildren.
- To describe and compare the PF components (Cardiorespiratory fitness – CRF, Strength and Body composition) per age, gender and geographic area of the relevant intermediate-phase schoolchildren.
- To determine the interrelationship between PA and PF of the relevant intermediate-phase schoolchildren.

1.5 SCOPE OF THE STUDY

This study falls under the auspices of a larger, three-year research project entitled 'The *KaziBantu* project', a joint research project between the Nelson Mandela University in South Africa and the University of Basel in Switzerland. The larger study is a 32-week controlled trial where participating schools were randomly selected into either an intervention or a control group. Only one class per grade, was randomly selected, from each of the eight schools involved in the study.

This study is a subproject of the larger one, and focuses only on the baseline testing phase pertaining to the PA and PF status of the intermediate-phase children from all eight participating schools. The research project was conducted in eight schools situated in the townships and northern areas of Port Elizabeth, respectively. The only children who participated in the study are those whose parents provided written informed consent while the children themselves ought to have given oral and written assent to willingly participate in the data assessment. Furthermore, the children were only allowed to participate if they were not participating in any other similar project and were not suffering from any medical conditions that could have prevented them from participating in the PF assessment.

[1] The city of Port Elizabeth has been renamed and is now known as Gqeberha (gazetted on 23 February 2021). The name of Port Elizabeth is retained in this document as this was the name of the city at the time of the study's registration.

Moreover, before any PA and PF testing was conducted, qualified nurses performed a physical assessment to ensure that the children did not have any medical condition that could prevent them from delivering their best during the assessment or for whom participation in the test would be detrimental to their health. Following, is a brief description of the tests that were conducted during the study.

1.5.1 Physical activity

PA was measured using accelerometers (Actigraph wGT3x-BT, Shalimar, FL, USA) which the children had to wear around the hip. The children were shown how to wear the Actigraph and were told to wear these for seven consecutive days so that a full week was assessed, after which the Actigraphs were collected. Moreover, it was explained to the children that they should wear the Actigraph at all times, including when sleeping, but excepting when they took a bath or a shower.

1.5.2 Physical fitness

PF was assessed through two components, CRF and muscle strength. CRF was measured using the standardised 20m shuttle run test (Leger, Mercier, Gadoury & Lambert, 1988) and the outcome was used to predict the child's VO_2max for his/her age and gender. This test was performed at the sport fields of the respective schools. Strength was assessed by testing the grip strength (GS) of both the left and right hands of the children. The GS of the children was assessed using the Saehan hydraulic hand dynamometer (MSD Europe BVBA; Tisselt, Belgium).

1.5.3 Body composition

Body composition was measured by calculating body mass index (BMI) and determining body fat percentage (BF%). BMI was assessed by measuring the weight (measured to the nearest 0.1 kg) and height (measured to the nearest 0.1 cm) of the children (Ashwell, 2011), and calculated through the following formula; body weight divided by the height in meters squared (Ogden et al., 2002). The BF% was measured using the Tanita scale. The tests conducted in the study determined the extent to which schoolchildren are physically active and their level of PF, as these are good indicators of health. The obtained data contributes to literature by adding to the knowledge of the status of PA and PF of children living in marginalized settings in Port Elizabeth, Eastern Cape, South Africa.

The data analysis incorporated descriptive statistics as this study was quantitative in nature. Descriptive statistics were used to explain the results obtained, and the measures of central tendencies (mean and median) as well as measures of distribution (range and standard deviation) were reflected. Furthermore, inferential statistical analyses were implemented to conduct comparisons (differences and relationships) between groups such as age, gender and geographic area in respect of the variables that were tested.

1.6 CONCEPT CLARIFICATION

This section defines the main concepts utilized in the study.

- **Physical activity:** Any bodily movement produced by skeletal muscles that requires energy expenditure (Caspersen et al., 1985). PA can be related to daily individual movements which can be categorised as leisure, daily physical work, sport activity, or any other activities (Caspersen et al., 1985).
- **Physical fitness:** The ability to fully perform daily tasks without feeling overly tired, and still be able to enjoy resolving sudden and unexpected events (Cvejic et al., 2013).
    - PF can be divided into two types, namely health-related physical fitness (HRPF) and motor fitness (Monyeki & Kemper, 2007). This study focused on the health-related fitness. PF can also be seen as a combined measure of muscle-skeletal, cardio-respiratory, hemato-circulatory, psycho-neurological functions, which might include all of the bodily functions that are part of daily physical activity (Cvejic et al., 2013). This study focused on the CRF and muscle strength of the children.
    - **Strength:** The ability of muscle groups to exert maximum external force against a given set of conditions defined by body position, the body movement when force is applied, movement type (concentric, eccentric, isometric, plyometric) and movement speed (Harman, 1993). Muscle strength is a primary component of PF and increases with age from the early childhood years up to adolescence (Coetzee, 2016).
    - **Cardiorespiratory fitness:** The body’s ability (circulatory and respiratory systems) to supply fuel and oxygen during continuous physical activity and

to eliminate the fatigue products after the fuel is supplied (Caspersen et al., 1985).

- **Body composition:** Is referred to as a HRPF component that relates to the relative amounts of muscle, fat, bone, and other vital parts of the body (Caspersen et al., 1985). BF% and BMI are used in this study to provide a more defined report for the children's body composition.
- **Body fat percentage:** The amount of total fat in the body based on the individual's total weight, it accounts for both essential fat and storage fat (Hoeger & Hoeger, 2016). Body fat mass can also be seen as the difference between total body mass and fat-free mass or lean body mass (Cohn et al., 1981).
- **Body Mass Index:** Is used to measure weight compared to height by using a simple formula. The formula is as follows: body weight in kilograms (kg) divided by height in metres squared (m^2) (American College for Sports Medicine [ACSM], 2014).
- **Exercise:** Defined as planned, structured, and repetitive bodily movement done to improve or maintain one or more components of PF (Caspersen et al., 1985).

1.7 SIGNIFICANCE OF THE STUDY

There is dearth of literature or research that focuses on the PA and PF of children, especially young South African girls (Visagie et al., 2017) and children living in marginalized settings (Skaal et al., 2015). More research is needed in establishing the foundational knowledge of PA, and to establish behaviour-change intervention programmes for children (Aubert et al., 2018). Moreover, the PA of children needs to be monitored and interventions implemented to improve their current and future health (Aubert et al., 2018). To achieve this, it is important to track the trends in PA and PF of children. Despite the evidence from regional studies reporting on PA and PF of children, these are limited and thus restrict the identification of trends at national level (Draper et al., 2018). The present study seeks to contribute to filling the gap in literature by reporting on the status of PA and PF of intermediate-phase primary schoolchildren in marginalised communities in Port Elizabeth.

1.8 OUTLINE OF CHAPTERS

Below is an outline of the rest of the chapters to follow on Chapter 1.

- **Chapter 2 (LITERATURE REVIEW)**

Chapter 2 reviews literature on other related research studies and their findings.

- **Chapter 3 (METHODS AND PROCEDURES)**

Chapter 3 details the research methods and procedures followed to obtain the relevant data to achieve the objectives set for this study.

- **Chapter 4 (RESULTS)**

In Chapter 4 data collected in the study is analysed to depict the findings of this study. More specifically, it provides an outline of the descriptive results of the data collected, the comparisons found between groups such as age, gender and geographic area in respect of the variables assessed as well as the relationship of an independent and specific dependent variable, when controlling for other confounding variables.

- **Chapter 5 (DISCUSSION AND CONCLUSION)**

Chapter 5 provides a summary of findings in relation to reviewed literature, further discussing the limitations of the study as well as conclusions and recommendations for future research.

In the following chapter, a review of literature related to this study is discussed.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

Physical inactivity of children is a major concern as it is associated with negative outcomes such as low PF and low PA later in adulthood, with subsequent negative health implications (Aubert et al., 2018). This necessitates more research to be conducted on the levels of PA in children, in an effort to justify the establishment of behaviour change intervention programmes for children (Aubert et al., 2018); thus, the motive of this study to significantly contribute to research aimed at tracking the trends in changes of PA and PF levels amongst children. To complement this present study, this chapter reviews literature on the PA and PF status of children. The first section describes the concepts of PA and PF, and the relationship between the two concepts. In addition, the importance of PA and PF will be demonstrated while outlining relevant guidelines and recommendations. Conclusively, this chapter critically reviews existing empirical studies, demonstrating the trends of PA and PF levels of children over the years. Reviewed studies will also inform the assessment methods used and provide guidance in the interpretation of the relevant results.

2.2 DEFINING PHYSICAL ACTIVITY AND PHYSICAL FITNESS

The terms PA and PF are frequently used synonymously and confused with one another. These are however, different concepts with different meanings (Caspersen et al., 1985), thus the imperative to define and unpack these concepts.

2.2.1 Physical activity

PA can be defined as any bodily movement by the skeletal muscles that results in energy expenditure (Caspersen et al., 1985). There are many ways to take part in PA such as free movement, unstructured play, formal exercise, dancing, PE lessons, sport, carrying out work and other unmentioned forms (Monyeki & Kemper, 2007; Monyeki, 2014).

Young children usually enjoy running, jumping, throwing and kicking in unstructured play, where the PA is unmonitored (Boreham & Riddoch, 2001). Moreover, PA can be in the form of active play (cycling or bike riding, walking, running), organised PA lessons (PE lessons during school), training programmes or organised sports (soccer, basketball, volleyball, hockey, dancing, swimming and others) (Faigenbaum, 2015; Monyeki, 2014). It is important though to distinguish PA from PF. The latter is therefore defined in the section to follow.

2.2.2 Physical fitness

PF can be defined as the ability to fully perform daily tasks with vigour and alertness without feeling overly tired, but instead retain the ability to enjoy leisure time pursuits and to meet unforeseen emergencies (Caspersen et al., 1985). This concept can be thought of as a combined measure of muscle-skeletal, cardio-respiratory, hemato-circulatory and psycho-neurological function (Cvejic et al., 2013). Moreover, PF can be divided into two categories which are health-related fitness (cardiorespiratory endurance, muscular strength, muscular endurance, body composition and flexibility) and skill-related fitness (agility, balance, coordination, power, reaction time, and speed) (Caspersen et al., 1985; Fang et al., 2017).

Health-related fitness focuses on components that impact the health and wellbeing of an individual (Monyeki & Kemper, 2007). These components are important to public health, as decreased fitness can lead to greater chances of developing health-related illnesses such as non-communicable diseases (Batista et al., 2017; Cadenas-Sanchez et al., 2019). Skill-related fitness components underlie the development of proficient motor skills which later contribute to skill related tasks and athletic abilities (Caspersen et al., 1985). It is therefore important for children growing into adolescence and adulthood, to develop their skill-related fitness and subsequent motor development (Coetzee, 2016). Having distinguished the concepts, PA and PF from one another, the relationship between the two concepts is explored in the next section.

2.3 RELATIONSHIP BETWEEN PHYSICAL ACTIVITY AND PHYSICAL FITNESS

PF is defined as a set of characteristics possessed or achieved by individuals that relate to the ability to perform physical activity (ACSM, 2014). Exercise can then be defined as a type of PA that consists of structured and repetitive body movement, done to improve or maintain one or more components of PF (Caspersen et al., 1985). Given this relationship, it can be concluded that PF is a state that can be improved, and that PA is the behaviour that needs to be repeated to achieve and maintain improved PF.

PF is seen as an important factor in the prevention of childhood obesity, and an important marker of health in children (Fang et al., 2017). Similarly, PA is suggested to have a significant effect on the health of children (Fang et al., 2017). It is reported that moderate to vigorous physical activity (MVPA) is a good predictor of PF in children (Fang et al., 2017). Moreover, researchers agree that PA and PF continue to contribute positively towards the health of the child in their adulthood (Fang et al., 2017; Monyeki & Kemper, 2007; Monyeki, 2014). This shows that the importance and the significance of the relationship not only between PA and PF, but also of both constructs with the health of children. In the following section, guidelines to improve physical activity and physical fitness are discussed.

2.4 RECOMMENDATIONS FOR PHYSICAL ACTIVITY AND PHYSICAL FITNESS

The World Health Organization (WHO, 2018) guidelines state that children aged between 5-17 years should participate in an average of 60 minutes per day of moderate-to-vigorous intense physical activity (mostly aerobic), throughout the week (Bull et al., 2020). It is further recommended that in addition to vigorous-intensity during aerobic activities, muscle and bone strengthening activities should also be incorporated in the PA programme at least 3 days a week (Bull et al., 2020). Bull et al. (2020) recommend that children should limit the time spent being sedentary, especially in relation to recreational screen time.

Further advocacy is for PA to vary and to be age-appropriate (WHO, 2018) and that structured play or sports activity should be based on play and not competition (Tucker, 2008). The variation in activities should offer aerobic activities as well as muscle and bone strengthening activities (Kutlay et al., 2018). For bone and muscle strength to be maintained, children should participate in PA that is weight-bearing (Kutlay et al., 2018). The WHO (2018) also added that PA should be programmed such that children gain both increased fitness and improved movement skills to achieve optimal health and wellness.

PA should also be enjoyable for children (Kutlay et al., 2018). When children enjoy PA, this may motivate them to continue participation and may determine how physically active they will be through to adulthood (Konstabel et al., 2019). Researchers also argue that factors such as children’s perception of their competence may influence how they react to PA. For example, children who view themselves as lacking PA skills might rarely experience enjoyment and fun while taking part in PA (Shen et al., 2016).

Given the above recommendations, it would be suggested that interventions ensure that children are able to participate freely and enjoy PA. While PE is important, PA interventions are able to ensure that the activities are beneficial to the HRPF of children, are developmental and improve competence, are fun and enjoyable, and that children are able to continue participating in PA without the fear of assessment, judgement or failure.

Researchers warn that even though PA benefits have been indicated in several reviews, there is an estimate of 80% of youth worldwide who do not meet the global recommendation of 60 minutes of MVPA per day (Aubert et al., 2018; Aubert, Barnes et al., 2018). The WHO (2018) also indicated similar trends in that less than half the number of children and an even lesser number of adolescents meet the 60 minutes of MVPA recommended for a gain in health benefits. These findings seem to support the call for interventions to PA and PF, and to establish the healthy habits needed (Neshteruk et al., 2017).

Some researchers have recommended a shift in the focus on the category of PF in children, from skill-related fitness to a focus on health-related fitness, mainly due to health concerns in adulthood (Monyeki & Kemper, 2007). The premise for this recommendation is that the promotion of health-related fitness through regular PA from childhood through to adolescence, would have long term benefits into adulthood (Monyeki & Kemper, 2007). However, WHO suggests that health-related fitness and skill-related fitness are of equal importance in children, and therefore both categories should be emphasised (Bull et al., 2020).

Promotion of PA and PF in children is also dependent on other factors including the involvement of parents and teachers. In a study conducted by Bodnarchuk et al. (2018), researchers recommend forming a relationship between school teachers and parents or families, especially for foundation phase schoolchildren, to motivate participation in PA. Some examples are, involving parents in sports events, parents consulting with the school PE teacher, hosting teacher-parent meetings aimed at educating parents and involving them in the learning process, as well as motivating parents to engage in personal PA with their children at home (Bodnarchuk et al., 2018).

These recommendations were made as it was noted that parents tend to distance themselves from school programmes and also teachers sometimes excluded parents from these programmes. It was emphasized that the school alone cannot work on learning and improving children's health without the assistance from parents of the children (Bodnarchuk et al., 2018). When parents are involved, it helps create a relationship between children, their teachers and their parents, promotes PA and sport in children, and improves the perspective that children have towards PA (Bodnarchuk et al., 2018).

Throughout this section, guidelines and recommendations for PA have been discussed. In summary, the researcher highlighted the WHO guidelines of participation in an average of 60 minutes of MVPA, which includes bone and muscle strengthening activities 3 times per week. Furthermore, it has been recommended that PA should be age-specific, should have variety, and should be enjoyable to children to keep them interested and to develop positive perception towards PA through to their adulthood. The following section further elaborates the importance and benefits of PA and PF in children.

2.5 BENEFITS OF PHYSICAL ACTIVITY AND PHYSICAL FITNESS

Children can gain both physical and psychological benefits from participating in PA (Craggs et al., 2011). The WHO (2018) stated that regular PA during childhood improves the quality of life at adulthood. It is therefore imperative to motivate children to be physically active throughout their childhood as this sets the basis for maintaining an active lifestyle in their adulthood, with accompanying health benefits (Cragg & Cameron, 2006).

Participation in PA, particularly MVPA contributes positively to PF (Kliziene et al., 2018). Elmagd (2016) found that taking part in PA with appropriate intensity on a regular basis significantly reduces the risk of non-communicable diseases such as cardiovascular diseases, diabetes and obesity. Moreover, the WHO (2018) also agrees on benefits of PA in decreased risks of heart disease, stroke and diabetes in adulthood. Arguably, a majority of cardiovascular diseases that emerge and demand treatment during adulthood, have their origins dating back to their childhood (Froberg, 2014).

It is further shown that participating in PA is necessary for optimal growth in children (Kutlay et al., 2018). Some researchers argue that PA can enhance growth if it is supplemented with a good nutritional diet, however, irrespective of diet, they still agree that PA plays a positive role in the growth of children (Kruger et al., 2012). Furthermore, PA could improve muscular strength and endurance, and improve body composition, all of which are important for optimum growth and development (Fang et al., 2017; Kliziene et al., 2018).

There are also psychological health benefits that children can gain from PA. Researchers state that regular PA assists with improved psychological health such as decreased stress, improved sleep and decreased risks of depression (Salvini et al., 2018). Regular PA in children may also assist with improved self-image (Monyeki et al., 2012). This positive relationship between PA and psychological health is further supported by other researchers, who argue for its contribution toward emotional and social development (Protic-gava et al.,2019). These research findings all affirm that PA is not only essential for children’s physical health, but also psychological health and development.

Researchers also found that there is a positive relationship between PA, PF and academic performance (Kliziene et al., 2018; Monyeki et al., 2012). It is suggested that the PA related improvement in brain function and cognition is important for gains in academic performance (Donnelly et al., 2016). The WHO also confirms that PA has a positive effect on academic performance of children (Bull et al., 2020).

Throughout this section the benefits of physical activity and physical fitness were highlighted. In summary, physical activity and physical fitness are said to contribute positively to children’s lives as they contribute to the decreased risk of cardiovascular disease, stroke and diabetes in the long-term. Moreover, improved physical fitness and physical activity can contribute to increased psychosocial health, improved academic performance and better overall health. These attributes indicate the importance of motivating for improvement of measuring and keeping track of physical activity and fitness in children. In the following section the measurements of PA and PF are discussed.

2.6 MEASURING PHYSICAL ACTIVITY AND PHYSICAL FITNESS OF CHILDREN

Monitoring PA and PF of children is important as it provides an opportunity to improve their health (Uys et al., 2016). Early detection of health risks can result in the implementation of necessary preventive measures or interventions (Uys et al., 2016). The accurate measurement of children's PA is a challenge as their PA occurs at irregular intervals rather than being continuous (Bailey et al., 1995). It is therefore important to use reliable methods, measuring and quantifying children's PA (Lynch et al., 2019). In this section, different methods of assessment used over the years will be discussed, with specific justification for assessments employed in this study.

2.6.1 Physical activity

As defined earlier, PA can be defined as any bodily movement produced by the skeletal muscles resulting in energy expenditure (Caspersen et al., 1985). Since the PA of children consists of frequent short bouts that make it a challenge to measure, a few assessment methods were developed over the years in an efforts to find the most accurate measurements (Rowlands & Eston, 2007). These methods include PA questionnaires, heart rate telemetry, pedometry, and accelerometry. Each of these methods' strengths and limitations are elaborated.

The physical activity questionnaire (PAQ) is one of the first methods to measure PA, and over the years the PAQ has been improved to quantify PA more accurately (Adamo et al., 2009). However, the use of the PAQ still poses challenges such as the overestimation or underestimation of the PA, high probability to be bias, and the difficulty for young children to recall specific amounts of time (Adamo et al., 2009). Regardless of these challenges, the PAQ is still being used by researchers since it has been improved to accommodate specific age groups, moreover, it is cost effective and still provides valuable information on the PA behaviours of children (Lynch et al., 2019; Marasso et al., 2021).

The heart rate telemetry, pedometry and accelerometry are considered the objective measures or direct measures of PA (Konstabel et al., 2019). Heart rate telemetry is suitable for measuring sustained periods of MVPA, however, the measuring device presents some limitations, for instance, it is easily influenced by other factors (feeling of anxiety, emotional stress, fitness levels), and that its ability to capture the pattern of

PA could be questionable as heart rate can rapidly change even at low-intensity activity (Rowlands & Eston, 2007). Pedometry uses a simple mechanical motion sensor that records the acceleration and deceleration of movement in one direction; it is known for providing valid measurements of total activity for a period of time hence it is recommended when only the total amount of PA is needed (Rowlands & Eston, 2007). Pedometry however, has further limitations for instance, its inability to measure the intensity of activity and its inability to record activity under certain circumstances (Konstabel et al., 2019).

Accelerometry determines the measurement of activity duration and provides the pattern and intensity of activity (Crouter et al., 2013). This places the accelerometry at an advantage when compared to the pedometry and heartrate telemetry, which only determine the total time of PA and is easily influenced by external factors, respectively. The Actigraph accelerometer is able to detect PA from three planes, which means it can detect PA across the different speeds performed in different directions, namely, horizontal, vertical and anteroposterior directions, and also distinguishes between PA of different intensities (John & Freedson, 2012). Also, Actigraph accelerometer provides counts with the sampling frequency of 30 Hz, and uses counts per time (10 to 60 seconds); the higher the count, the higher the acceleration during that time. Based on the raw Actigraph counts and the ActiLife computer software, the time per day spent in moderate physical activity (MPA) (>3 MET- metabolic equivalent of task) and vigorous physical activity (VPA) (>6 MET) is determined, utilising cut-off values (Freedson et al., 1998).

Moreover, the accelerometry is suggested to be relatively affordable, small in size, able to detect sedentary behaviour and provides the opportunity to estimate energy expenditure in free-living physical activity (John & Freedson, 2012; Lynch et al., 2019). The Actigraph accelerometer has been internationally validated with children and provides a valid, reliable and objective assessment of the pattern of activity, as well as total PA (Konstabel et al., 2019; Lynch et al., 2019; Rowlands & Eston, 2007).

Earlier studies used a number of variations of the PAQ, and is still being used by researchers as it provides valuable information on pattern of PA. While later studies have used accelerometry, there are various cut-off values used to determine the range of PA levels, depending on the formula used. This could prove difficult when comparing results across studies that have used different methods of testing PA.

2.6.2 Physical fitness

The measurement of PF in children has been widely researched for many years and has culminated in the development of a number of test batteries (Cvejic et al., 2013). These test batteries have been improved over time to provide standardised measurements to accommodate diverse cultures and geographic locations (Kolimechkov, 2017). Amongst the test batteries that have been developed, is the AAHPERD fitness test, a skill oriented test battery, revised in 1976 in the USA (Freedson et al., 2000). The Recreation (CAHPER) Fitness Performance Test was developed in Canada in 1980, and focused more on HRPF components (Cvejic et al., 2013). The Fitnessgram developed in 1982 in the USA mainly focuses on HRPF components such as body composition (using skinfold measurement), cardiovascular component (assessed via progressive aerobic cardiovascular endurance run), strength (assessed via curl-ups, bent arm hang, push-ups, modified pull-ups, trunk lift tests), flexibility (assessed via sit and reach and shoulder stretch tests) (Freedson et al., 2000). There is also the Eurofit test battery that was developed in 1983 in Europe which includes measurements and tests such as skinfold measurement, 20m shuttle run test, bicycle ergometer test, handgrip strength, standing broad jump, bent arm hang, sit-ups, shuttle run, plate tapping, sit and reach, flamingo balance test; and indicates a focus on both health-related and skill-related physical fitness components (Kolimechkov, 2017).

As PF was described earlier, this concept can be divided into categories such as skill-related and health-related fitness (Fang et al., 2017), which is why some test batteries are focused on one category or both. This study is focused on HRPF, tests for the relevant components are discussed in the subsections to follow.

2.6.2.1 Cardiorespiratory fitness

CRF can be referred to as maximal aerobic power or aerobic fitness, and is seen as an important marker of health for both adults and children (Batista et al., 2017; Kerr et al., 2018). CRF is generally assessed based on the maximum amount of oxygen that the individual can consume per minute, the VO_2max (Batista et al., 2017). The latter can be measured directly in the laboratory or estimated via field tests. Given the nature of the present study, only field tests for this purpose are reviewed. The most common field tests are the 12-minute Cooper walk/run test, the 3-minute step test, and 20-meter shuttle run test. The 20-meter shuttle run test has been reported to be valid for children, adolescents and adults (Matsuzaka et al., 2004).

The test was developed by Léger and Lambert (1982) and was later adapted for children in 1988 (Leger et al., 1988). As the test is being conducted, the running speed is gradually increased until the participant is exhausted, thereafter, the VO_2max is estimated using the maximal running speed of the final stage or total number of laps (Leger et al., 1988) There are several advantages to the test, for instance, it can be easily conducted indoors or outdoors, it is not affected by participants choosing to run at a certain pace as the pace is set, and the test can be conducted in groups, thus saving time and helping to keep participants motivated to do well (Matsuzaka et al., 2004).

2.6.2.2 Strength

Strength can be defined as a HRPF component that relates to the amount of external force a muscle can exert (Caspersen et al., 1985). Strength can be assessed using the following field assessments such as pull-ups, push ups and bench press, however, the most commonly used test for children is the handgrip strength test (Espana-Romero et al., 2008; Ozaki et al., 2021; Svensson et al., 2008). This test gives a measure of the upper body strength (Espana-Romero et al., 2008). There are several factors that can affect measuring handgrip strength, such as age, gender and positioning of the body during the test (Espana-Romero et al., 2008). It is known that handgrip strength can be affected by the handgrip position and the hand span, however, the dynamometers available to measure GS, can be adjusted to accommodate different hand spans (Espana-Romero et al., 2008). The handgrip strength test is an affordable test with a few additional advantages such as an indirect indication of bone health and joint disorders (Espana-Romero et al., 2008).

2.6.2.3 Body composition

Body composition is defined as a HRPF component that refers to the relative amounts of muscle, fat, bone, and other vital parts of the body (Caspersen et al., 1985). The assessment of body composition is particularly important in determining cardiovascular risk by measuring levels of overweight and obesity (Unick et al., 2006).

This is why it is important to make use of methods that are reliable and valid (Uys et al., 2016).

There are laboratory methods that can be used to assess body composition such as hydrostatic weighing, dual-energy x-ray absorptiometry, the arm-to-leg tetrapolar bioelectrical impedance analysis, and underwater weighing. The aforementioned methods might not be suitable for large sample studies due to their high costs, their need for trained personnel, and the duration of the tests (López-Sánchez et al., 2019). A number of field tests have been used to measure body composition such as skinfold analysis and BMI. Of those methods listed, the skinfold analysis is argued to be affordable and easy to administer, however, it has been argued to bear inaccuracies for younger children who are overweight or obese (Wells & Fewtrell, 2006). The BMI is calculated using the equation (weight divided by height), and is said to be valid to predict high risk of being overweight or obese in children; however, it may not consider bone and muscle weight (Freedman & Sherry, 2009).

The bioelectrical impedance analysis is also used to estimate body composition, which uses a weak electric current flow through the body to estimate the impedance. It can be conducted in three different approaches such as hand-to-foot, foot-to-foot, and hand-to-hand method (Khalil et al., 2014). These methods are non-invasive, making them easy to use in field testing (Unick et al., 2006). The Tanita scale (Tanita MC-580; Tanita Corp., Tokyo, Japan) is portable, easy to use and provides a simple and accurate method of assessment for body composition in children and adolescents (Lu et al., 2003). Some researchers argued that the scale may be time consuming for large scale projects and also requires trained assessors (Bammann et al., 2013); however, other researchers believe the scale is quick and easy to use (López-Sánchez et al., 2019; Lu et al., 2003).

In summary, this section highlighted the field tests and or measurements available to evaluate HRPF and the relevant suitability for the present study. Even though there are multiple tests available, a selection must be made to ensure that the tests chosen are suitable for the aim and objectives of the current study. In the following section a table with similar studies to the current study in terms of test batteries used and the findings of the studies are discussed, and later a comparison of these studies will be elaborated and discussed in relation to the health status of children.

2.7 STATUS OF PHYSICAL ACTIVITY AND PHYSICAL FITNESS OF CHILDREN

The Healthy Active Kids South Africa report (Uys et al., 2016) indicated that less than 20% of children worldwide meet the PA requirement of at least 60 minutes of MVPA a day, and less than 50% of children in South Africa meet the PA requirement. Draper et al. (2018) commented on the Healthy Active Kids South Africa report indicating that there were no improvements in the PA of children from 2016 to 2018. It was indicated that about 48% to 51.7% of children meet PA requirements, 21% to 40% of children play sport, and 32% of children do PE in school (Draper et al., 2018). These relatively low levels of PA are concerning and emphasise the importance of evaluating children's HRPF on a regular basis so that early interventions can be initiated when necessary.

Tables 2.1 and 2.2 present findings from relevant studies conducted with children from 2010 to 2021. Table 2.1 reflects international studies, and Table 2.2 summarises findings from South African studies. The studies identified, focused on children aged 5 to 15 years and used similar tests to the ones implemented in the current study. The international study Table 2.1 includes studies from Uganda, England, Finland as well as a 12-country study on childhood obesity, lifestyle and the environment. The studies also compare relationships between physical activity, physical fitness and health. The South African study, Table 2.2 includes studies conducted in the North West Province (Potchefstroom), Gauteng (Pretoria Central) and Eastern Cape (Port Elizabeth).

Table 2.1 International studies on physical activity and physical fitness of children

Reference	Aim of Study & Tests used	Participant demographics	Findings
Hsieh et al. (2014)	❖ Aim: To examine the relationship between physical activity, body mass index, and cardiorespiratory fitness levels of Taiwanese children ❖ Tests: Anthropometric measurements (Height, weight, Body mass index Physical activity (self-administered habitual physical activity questionnaire) Cardiorespiratory fitness (800m run)	❖ 2419 children (1230 boys and 1189 girls) ❖ Age 12 years ❖ Southern Taiwan County, Taiwan	❖ Overall, body mass index (BMI) was reported as 20.09 kg/m^2 + 4.12. The prevalence of overall combined overweight and obese children was 29.6%. There were more boys that were overweight/obese than girls (34.0% vs. 25.0%), and the difference was significant ($p<0.001$). Prevalence of underweight in boys was 16.0% and 16.2% in girls. ❖ Overall, 53.9% of the participants had irregular physical activity (participated in sports and/or vigorous free play less than three times per week for less than 30 min), while 46.1% had regular physical activity (participated in sports and/or vigorous activity at least three times weekly with each session lasting at least 30 min). ❖ Boys performed significantly ($p < 0.001$) better in the 800-m run (276.65 vs. 287.13 seconds) than girls did.
Nsibambi et al. (2015)	❖ Aim: To determine the cardiovascular fitness of paediatric population ❖ Tests: cardiovascular fitness endurance (9-minute distance run/walk test)	❖ 1929 children (901 boys and 1028 girls) ❖ Age 6-9 years ❖ Wakiso and Mukono districts, Central Kampala, Uganda	❖ Of the 1929 children, 71.0% (1372 children) met the recommended levels of cardiovascular fitness (≥50^{th} percentile), 18.8% (363 children) had weak cardiovascular fitness and 10.1% (194 children) had critically low levels of cardiovascular fitness. ❖ Children in day schools reported significantly higher cardiovascular fitness (1538.02m ± 309.09) than children in boarding schools (1486.27m ± 305.22). ❖ There was a significant gender difference, where boys were reported to have higher levels of cardiovascular fitness (1591m ± 356.76) as compared to girls (1440.64m ± 236.72)
Ingle et al. (2016)	❖ Aim: To compare and contrast habitual physical activity profiles and muscular fitness in schoolchildren ❖ Tests: Physical activity questionnaire (PAQ-A) Hand grip strength test Body Mass Index (BMI)	❖ 597 children ❖ Age 11-15.9 years ❖ England	❖ With regards to BMI, there was a significantly higher percentage of underweight boys (South East= 7.8%; North East= 15.2%; $p<0.001$) as compared to obese boys (SE= 5.8%; NE= 7.2%). Boys from the south east (SE) reported a significantly higher BMI than boys from the north east (NE). Girls from the NE were reported to weigh more (53.6 ± 15.6 kg) but with insignificant lower BMI as they were said to be taller than expected for their age (19.9 ± 4.4 kg/m^2 vs. 20.3 ± 4.7 kg/m^2; $p= 0.22$) than girls from the SE. There were more girls from the NE reported as underweight compared to the girls from SE (SE= 7.8%; NE= 15.2%; $p<0.001$).

			❖ Self-reported physical activity was recorded as girls from NE presenting an insignificantly lower physical activity than girls from SE (p= 0.06). Also, boys from SE reported significantly higher physical activity levels than boys from NE. ❖ Boys from the SE reported significantly stronger hand grip (HG) strength (26.3 ± 7.61kg) as compared to boys from the NE (22.8 ± 5.92kg). In girls, the opposite trend was evident. Girls from the NE reported a significantly higher HG score (27.9 ± 9.76kg) than girls from the SE (22.4 ± 5.71kg). The recorded HG strength for boys was lower than the recommended level of strength for age in both groups, even though the boys from SE were closer to this level. However, the girls from the SE had HG strength that was at the recommended level for their age, and girls from the NE performed well above this level.
Roman-Viñas et al. (2016)	❖ Aim: To evaluate adherence to the 3 recommendations most strongly associated with health outcomes in new 24-h movement guidelines and their relationship with adiposity ❖ Tests: Body Mass Index (BMI) Physical activity (Actigraph)	❖ 6128 children (2763 boys and 3365 girls) ❖ Age 9-11 years ❖ 12 countries of International Study of Childhood Obesity, Lifestyle and the Environment (ISCOLE)	❖ The recommendations included in the study are moderate to vigorous physical activity (MVPA) (60 minutes of MVPA per day), screen time (ST) (≤2 hours per day), and sleep duration (SLEEP) (9 to 11 hours per night for children aged 5-13 years) recommendations. It is reported that overall, 44% of the children met the recommendations for MVPA, 39% of the children met the ST recommendations, and 42% of the children met the SLEEP recommendations. ❖ For MVPA, the mean overall time spent in MVPA was 60 min/day, which ranged from 45 min/day in China to 72 min/day in Kenya. The highest adherence to the recommendations was 61% (Finland) and the lowest was 15% (China), for South Africa, the adherence was 51.7%. ❖ Children who met recommendations for either MVPA, ST or SLEEP, two of the recommendations or all of the recommendations, all had a significantly lower BMI as compared to those not meeting any of the recommendations. ❖ When comparing the individual recommendations, the MVPA was the one recommendation that yielded a lower BMI for the children meeting the recommendation than those who did not meet them. ❖ There was a low percentage of children that were found to be obese (12.3%), however, the children not meeting all recommendations (MVPA, ST and SLEEP) were at a higher risk of being obese than those who met all recommendations.

Joensuu et al., (2018)	❖ Aim: To examine and quantify the cross-sectional associations of body composition, physical activity and sedentary time with physical fitness in children and adolescents ❖ Tests: Anthropometric measures Physical activity (Actigraph) Physical fitness: cardiorespiratory fitness (CRF) (20 m shuttle run test), muscular fitness (push-ups and curl-ups)	❖ 594 children (263 boys and 331 girls) ❖ Age 9-15 years ❖ Finland	❖ Boys reported a significantly higher MVPA as compared to girls (58.2 ± 23.3 min/day vs 47.3 ± 18.0 min/day; $p<0.001$). Similarly, boys reported significantly higher CRF than the girls (48.3 ± 19.5 laps vs 38.0 ± 15.6 laps $p<0.001$). Boys had an insignificantly lower BMI than girls (18.2 ± 3.1 kg/m^2 vs 18.8 3.0 kg/m^2; p=0.03); moreover, the body fat% of boys was significantly lower than that of girls (14.7 ± 7.8% vs 20.4 ± 6.9%; $p<0.001$). ❖ During physical fitness tests, it was found that boys performed better in certain tests as opposed to girls, whereas girls also performed better in other tests than boys. For example, boys performed better in weight bearing tests, and girls performed better in throw-catch tests. However, both girls and boys with increased body fat mass performed poorly in weight bearing tests. It was found that boys with a higher fat mass index performed better in catch-throw tests as compared to all girls. ❖ The relationship between MVPA and physical fitness was positive (R^2= 0.321; $p<0.001$), where children with higher MVPA performed better in physical fitness tests. ❖ Also, there was a negative relationship between weight status and physical fitness performance (R^2= -0.471; $p<0.001$), where a higher body weight was related to poorer performance in physical fitness tests. ❖ Fat mass index (kg/m^2) had the strongest and inverse association with muscular strength in boys and girls ($p<0.001$ and $p<0.001$, respectively). For example, a 5kg increase in fat mass (155 cm tall children) was equal to −4 and −6 repetitions in curl-ups in boys and girls, respectively. ❖ There was no significant association between sleep time and physical fitness (R^2= 0.012; p=0.951).
López-Gil et al., (2020)	❖ Aim: to describe, examine, and compare the level of physical fitness, physical activity, and sedentary behaviour in children	❖ 370 children (204 boys and 166 girls) ❖ Age 6-13 years ❖ Region of Murcia, Spain	❖ Results were reported based on three categories which were normal weight, overweight, and obesity for both boys and girls. ❖ Boys in the normal weight category reported a BMI of 16.34 ± 1.12 kg/m^2, boys in the overweight category reported a BMI of 19.23 ± 1.47 kg/m^2, boys in the obesity category reported a BMI of 23.47 ± 3.34 kg/m^2, and the difference between all the groups was significant ($p< 0.001$).

	❖ Tests: Anthropometric measures (height, weight, body mass index, waist circumference, skinfolds (biceps, triceps, subscapular, and iliac crest) Physical fitness -CRF (20 m shuttle run test) -Muscle strength (hand dynamometer, standing broad jump) -Physical activity (Krece Plus Short Test: questionnaire)		❖ This was similar for girls, girls in the normal weight category reported a BMI of 16.30 ± 1.36 kg/m^2, girls in the overweight category reported a BMI of 19.67 ± 1.55 kg/m^2, girls in the obesity category reported a BMI of 24.73 ± 3.62 kg/m^2, and the difference was significant between all categories (p< 0.001). ❖ For body fat percentage, there were significant (p< 0.001) differences between the three categories increasing from normal weight to obesity category, for both boys (6.2 ± 2.6%; 10.0 ± 4.1%; a 17.2 ± 8.0%) and girls (6.7 ± 2.5%; 10.8 ± 4.1%; 18.1 ± 5.8%). ❖ With regards to hand grip strength, there were no significant (p= 0.124) differences for boys in all three categories (12.98 ± 3.58 kg; 13.95 ± 4.18 kg; 14.25 ± 4.16 kg). There were significant (p= 0.002) differences for girls in normal weight and overweight/obesity categories (11.25 ± 3.40 kg; 13.01 ± 4.18 kg; 13.60 ± 3.64 kg). ❖ For CRF, there were significant differences for both boys (25.7 ± 15.0; 22.7 ± 13.3; 11.9 ± 7.0) and girls (19.3 ± 10.5 laps; 16.2 ± 8.3 laps; 10.7 ± 3.4 laps) between all three categories (p<0.001). ❖ There was a significant (p= 0.030) difference between boys in all 3 categories (3.2 ± 1.6 hours/week; 2.8 ± 1.8 hours/week; 2.4 ± 1.7 hours/week) for sport activity, and there were significant (p< 0.005) differences for all categories in girls (2.8 ± 1.5 hours/week; 2.6 ± 1.6 hours/week; 1.8 ± 1.3 hours/week). ❖ For boys, normal weight children displayed a higher CRF, comparative handgrip strength, and higher sport activity hours than overweight or obese children. ❖ For girls, the normal weight group had higher CRF, comparative handgrip strength, higher sport activity hours as well as PA level compared to children in the overweight and obese category.

Table 2.2 below describes South African studies published from 2010 to 2021.

Table 2.2 South African studies on physical activity and physical fitness of children

Reference	Tests used	Participant demographics	Findings
Truter et al. (2010)	❖ Aim: To determine relationships between overweight, obesity and physical fitness of 9-12-year-old South African children ❖ Tests: Anthropometric measures Body mass index (BMI), fat percentage as estimated from skinfolds (triceps, sub-scapular, medial calf) ❖ Physical fitness: cardiovascular endurance (PACER subtest), muscle strength (long-jump), muscle endurance (knee push-ups, bent leg sit-ups, wall-sitting and aeroplane lying), flexibility (sit and reach)	❖ 280 children (128 boys & 152 girls) ❖ Age 9 to 12 years ❖ Potchefstroom, North West, South Africa	❖ Of all learners, 219 (78.2%) had normal weight, 43 (15.5%) were overweight, and 18 of the learners (6.5%) were obese. The girls had a higher percentage for overweight (8.3% vs 7.2%) and obesity (4% vs 2.5%) than boys, however, the difference is insignificant. ❖ The mean BMI of the normal-weight learners was (17.12 ± 1.7 kg/m^2), compared to that of the overweight learners (22.30 ± 1.5 kg/m^2) and obese learners (29.5 ± 3.7 kg/m^2). ❖ The Body Fat percentage for normal weight learners was reported as 17.70 ± 5.20%, for overweight learners as 28.20 ± 6.00% and for obese learners as 38.20 ± 7.70%. The body fat percentage of both boys and girls became significantly larger with an increase in BMI. ❖ Both normal-weight boys and girls had significantly higher muscle strength (127.1 ± 21.4 cm and 114.1 ± 22.5 cm, respectively) than the obese boys and girls (94.3 ± 20.9 and 94.7 ± 10.3 cm, respectively). ❖ The cardiovascular endurance of the boys of normal weight (32.9 ± 17.0 laps) differed further from that of the overweight (18.7 ± 10.4 laps) as well as the obese boys (11.7 ± 7.7 laps), while there were no differences between the girls.
Goon et al. (2013)	❖ Aim: To explore gender and racial profiling of percentage body fat of 1136 urban South African children ❖ Tests: Body mass, stature, skinfolds (subscapular and triceps)	❖ 1136 children (548 boys and 588 girls) ❖ age 9 to13 years ❖ Pretoria Central, South Africa	❖ All the anthropometric measurements were significantly different across gender. The mean values for body mass and skinfolds were significantly higher in girls compared to boys (p = 0.001), however, boys were significantly taller compared to girls (p = 0.001). When gender comparison is done as per mean age, there were significant gender differences found for all ages (p< 0.001). ❖ Girls had a significantly higher percentage body fat compared to boys (p = 0.001). The mean percentage body fat for boys was 16.1 ± 7.7% (95% CI = 15.5, 16.8) while the percentage body fat of girls was 22.7 ± 5.7% (95% CI = 22.3, 23.2). ❖ Percentage body fat varied with age in both boys and girls; There was an increase in girls' body fat percentage as age increased, for boys, the increase was insignificant.

			❖ In addition, girls had significantly higher percentage body fat measurements at all ages compared to boys (p = 0.001). ❖ When comparing races, black children reported a significantly (p = 0.010) higher body fat percentage (20.1 ± 7.5) than white children (19.0 ± 7.4). Black children had a higher percentage body fat than white children at ages 9 (25.0 ± 10.3 vs 22.5 ± 7.2; p0=0.119), 10 (20.0 ± 6.4 vs 19.4 ±7.2; p=0.461), 11 (19.6 ±7.3 vs 20.0 ± 8.3; p= 0.773) and 13 (21.0 ± 9.8 vs 19.9 ± 7.7) years, with a significant difference observed at 12 years (22.7± 8.7 vs 20.0 ± 8.3; p = 0.009).
Minnaar et al. (2016)	❖ Aim: To describe the physical activity measured in boys and girls from section 21, quintile 5 pre-primary and primary schools ❖ Tests: Physical activity (piezoelectric pedometer)	❖ 78 children (33 boys and 45 girls) ❖ Age 5-14 years ❖ Small rural town, South Africa	❖ Most of the children were classified as having normal weight, however, 20% of the children were overweight or obese where 62.5% of them are girls. ❖ The level of physical activity for the children was reported to be lower than the recommended physical activity levels both for boys (5-6 years= 11.377-13.195; 9-10 years= 11.894-13.826; 12-14= 10.711-12.766) and girls (5-6 years= 10.648-12.046; 9-10 years= 10.560-12.078; 12-14 years= 9405-11.058). ❖ Boys and girls in the 12-14 years' age group had mean steps of 8524 and 6967 per day respectively. For boys and girls in the 9-10 years' age group reported mean steps of 12808 and 9367 per day respectively. Boys and girls in the 5-6 years' age group reported the lowest number of steps a day, with 7198 and 6376 steps respectively. ❖ Among the children, boys took a significantly higher number of steps a day as compared to girls (p<0.05). It is also indicated that the school-going children had fewer steps a day during the weekends (12-14 years- boys<8000, girls<5000; 9-10 years- boys<12000, girls<9000), and highlighted that those preschool children have more steps on Saturday than any other day of the week (5-6 years>8000).
Salvini et al. (2018)	❖ To determine whether higher self-reported PA and higher CRF levels are associated with better Health Related Quality of Life (HRQoL) in South African school children from disadvantaged neighbourhoods.	❖ 832 children (415 boys and 417 girls) ❖ Age 8–12 years ❖ Port Elizabeth, South Africa	❖ The overall mean BMI was indicated as 17.0 ± 3.0 kg/m^2. Of all children, 27.5% reported low physical activity (0-1 days/week), 45.2% reported moderate physical activity (2-5 days/week), and 27.3% reported high physical activity (6-7 days/week). Reporting on cardiorespiratory fitness, 28.4% had low (37.78 to 45.68 ml/kg/min), 45.9% had moderate (45.69 to 51.96 ml/kg/min), and 25.7% of the children had high (51.97 to 61.86 ml/kg/min) cardiorespiratory fitness ❖ Comparing genders, boys reported a significantly lower BMI than girls (16.8 ± 2.6 vs 17.3 ± 3.3; p=0.013).

	❖ Tests: Physical activity (Questionnaire, days/week) Cardiorespiratory fitness (20 m shuttle run test) HRQoL (KID-SCREEN Questionnaire)		❖ Boys reported a higher cardiorespiratory fitness (50.8 ± 4.3 ml/kg/min) compared to girls (47.2 ± 3.5 ml/kg/min), and the difference was significant ($p<0.001$). ❖ With regards to physical activity, boys reported a slightly higher number of days (3.7 ± 2.4 days/week) meeting the physical activity recommendations (60 min of MVPA per day) than girls (3.3 ± 2.5 days/week), however, the difference is not significant ($p=0.057$). ❖ Children that reported low physical activity levels had the lowest scores across all HRQoL dimensions, and this was significantly different from children that reported moderate physical activity levels in both physical and psychological wellbeing ($p<0.001$).
Müller et al. (2020)	❖ Aim: To describe the cardiovascular health risk, physical activity (PA) behaviour and cardiorespiratory fitness (CRF) levels. To examine differences in these variables in respect of children's age, sex, SES and ethnicity. To investigate whether PA and CRF are independently associated with a composite measure of children's cardiovascular health risk. ❖ Tests: Anthropometric measures Physical activity (Actigraph) Cardiorespiratory fitness (20m shuttle run test)	❖ 650 children (299 boys and 351 girls) ❖ Age 10-15 years ❖ Port Elizabeth, South Africa	❖ Of the 650 children, 40.8% of the children did not meet the recommended physical activity (PA) levels, where the children achieved less than 60 minutes MVPA per day. ❖ The 13 to 15 years old children participated more in MVPA as compared to the children in 10-12 years' group (77.5 ± 33.4 min/day vs 69.3 ± 32.3 min/day), and this difference was significant ($p<0.01$). The older children also had a significantly ($p<0.001$) higher cardiorespiratory fitness (41.1 ± 21.7 laps vs 33.3± 18.7 laps). ❖ Looking at gender, boys had a significantly lower cardiovascular risk and had a significantly higher cardiorespiratory fitness (48.0 laps) as compared to girls (26.4 laps), ($p<0.001$). The boys also participated more in MVPA (91.0 ± 33.5 min/day) as compared to girls (56.8 ± 22.8 min/day), and the difference was significant ($p<0.001$). ❖ Children who participated more in MVPA were reported to have a lower clustered cardiovascular risk ($b= -0.01$; $p<0.05$). ❖ Children who reported a higher socioeconomic status (SES) were reported to have performed slightly poorer in the cardiorespiratory fitness test compared to children with lower SES (35.0 ± 20.1 laps vs 40.0 ± 20.7 laps; $p<0.01$). However, no significant difference was found between the two groups with regards to MVPA (71.3 ± 33.0 min/day vs 72.7 ± 32.2 min/day; $p>0.05$).
Nqweniso et al. (2021)	❖ Aim: To describe the cardiovascular health risk, physical activity (PA) behaviour and cardiorespiratory fitness (CRF)	❖ 823 children (403 boys and 420 girls) ❖ Age 5-13 years ❖ Port Elizabeth, South Africa	❖ Overall, only 24.2% of the study participants did not meet recommended PA levels of 60 min MVPA per day. Similar results were found among younger (5-8 years) and older (9-13 years) children not achieving recommended PA standards ($\chi^2(1832) = 1.3$, $p = 0.259$, 23.0% vs. 26.6%).

	levels, and to examine the associations between PA/CRF and a composite measure of cardiovascular risk of South African primary school children ❖ Tests: PA (Actigraph) CRF (20 m shuttle run test) Cardiovascular risk (Cholesterol) Blood pressure Body fat percentage (Tanita scale)		❖ Comparing genders, girls had lower MVPA compared to boys (68.5 ± 21.6 min/day vs 94.9 ± 28.0 min/day), and had lower CRF than boys (20.3 ± 10.7 laps vs 23.7 ± 15.4 laps) and the differences were significant ($p<0.001$). Girls were less likely to meet international PA recommendations than boys ($\chi^2(1823) = 95.7$, $p = 0.000$, 38.3% vs. 9.2%). No significant difference was found for Vo_2max (47.5 ± 3.5 ml/kg/min vs 47.8 ± 4.1 ml/kg/min; $p> 0.05$). ❖ For overall CRF, the children reported a total mean lap of 21.9 ± 13.3, with minimum as 3 laps and maximum as 113 laps. Older children were more sedentary (623.3 ± 68.0 min/day) and completed more laps in the shuttle run test (25.7 ± 16.2 laps) compared to younger children (604.8 ± 67.8 min/day; 20.1 + 11.1 laps), and these differences were significant ($p< 0.001$). Older children had lower MVPA levels compared to younger children (80.8 ± 28.3 min/day vs 81.7 ± 28.2 min/day), however, the difference was insignificant ($p>0.05$). Similarly, older children had lower VO_2max scores (45.6 ± 4.4 ml/kg/min) compared to younger children (48.6 ± 3.1 ml/kg/min), and the difference was significant ($p< 0.001$). ❖ Girls displayed higher body fat percentage compared to boys (24.5 ± 5.1% vs 20.7 4.8%), and the difference is significant. Girls displayed a higher clustered cardiovascular risk score compared to boys (0.5 ± 2.5 vs −0.5 ± 2.4), and the difference is significant ($p< 0.001$). With regards to age, younger children displayed higher body fat percentage (22.8 ± 5.0% vs 22.3 ± 5.9%) and lower clustered risk score (−0.1 ± 2.4 vs 0.1 ± 2.6) compared to the older children, however, the differences were insignificant ($p> 0.05$). ❖ A negative association was found between estimated VO_2max and percentage body fat, triglycerides, and clustered cardiovascular risk. Higher sedentariness levels were positively correlated with higher percentage body fat and higher triglycerides levels. MPA was negatively correlated with body fat percentage. High VPA and MVPA were both associated with lower percentage body fat and lower clustered cardiovascular risk.

In this section, results related to the main components of this study are discussed. Worthy to note, is that the total number of participants for each study vary, and even though this is so, the results generally show similar trends. These are discussed further in the following sections.

2.7.1 Physical activity

Throughout the studies in Table 2.1 and 2.2, there was a high number of children who did not meet the recommended physical activity levels of 60 minutes per day of MVPA. The average time spent in MVPA calculated overall for the 12-country study, was below the recommended value of 60 min per day for less than 50% of the children (Roman-Viñas et al., 2016). Another study conducted in South Africa comparing the mean number of steps taken per day to normative values, also reported that none of the average number of steps calculated per age group between 5 to 14 years met the normative criteria (Minnaar et al., 2016). Furthermore, the advantage of participating more in MVPA is highlighted by Joensuu et al. (2018), who found that children who participated more in MVPA reported a significantly lower BMI, and another study also found that these children were at a lower risk of cardiovascular disease (Müller et al., 2020).

In a study conducted in Port Elizabeth, Eastern Cape, that used a self-reported questionnaire as a measure for PA, it was found that 27.5% had low, 45.2% had moderate, and 27.3% had high PA levels (Salvini et al., 2018). An international 12-country-study that used an Actigraph to measure PA reported that only 44% of the 6128 children tested, met the recommended levels of MVPA (Roman-Viñas et al., 2016), while in a study conducted in Port Elizabeth, South Africa that also made use of an Actigraph, reported that 40.8% of the children did not meet the recommended PA levels (Müller et al., 2020). Further findings revealed that the number of children who did not meet the international PA recommendations was higher among younger children (44.6% vs 34.9%; $p<0.01$), girls (59.3% vs 19.1%; $p<0.001$) and black African children (47.1% vs 32.8%; $p<0.001$) (Müller et al., 2020). Notably, the study that used a self-reported questionnaire found higher levels of MVPA as compared to studies that used the Actigraph, and may point to the possibility of obtaining inflated results when using the self-reported recall method of assessment (Ingle et al., 2016).

Two studies conducted among South African children utilising two different assessment tools, indicated that PA levels do not necessarily increase with age. Minnaar et al. (2016) used step counts (piezoelectric pedometer) and found different results stating that the younger children (5-6 years) reported a lower step count than the older children (9-10 years and 12-14 years), however the children in the 9-10 years' group reported significantly higher steps than children in the 12-14 years' group. A recent study using the Actigraph accelerometer as a measure, reported similar results, stating that older children had lower MVPA levels compared to younger children (80.8 ± 28.3 min/day vs 81.7 ± 28.2 min/day), however, the difference was not significant (p>0.05) (Nqweniso et al., 2021).

With regards to gender differences, an international study found that boys participated in significantly higher MVPA (58.2 min/day) as compared to girls (47.3 min/day) (p<.001) (Joensuu et al., 2018). This finding is similar to results from South African studies, although the measuring instruments used were different. Minnaar et al. (2016) using a step count, found that boys took a significantly higher number of steps per day as compared to girls (p<0.05), while Müller et al. (2020) using the IPAQ also found that boys participated significantly (p<0.001) more in MVPA (91.0 ± 33.5 min/day) as compared to girls (56.8 ± 22.8 min/day). Salvini et al. (2018) on the other hand showed inconclusive evidence (p=0.057) of boys reporting a slightly higher number of days (3.7 ± 2.4 days/week) meeting the PA recommendations (60 min of MVPA per day) than girls (3.3 ± 2.5 days/week).

2.7.2 Physical fitness

In this section, the relevant results from international and SA studies are discussed in relation to CRF and strength. While none of these studies investigated the interrelationship between strength and CRF, there were similarities in the results of the studies for both components.

2.7.2.1 Cardiorespiratory fitness

An international study conducted in Uganda found that a total of 18.8% (out of 1929 children) had weak cardiovascular fitness and 10.1% had critically low levels of cardiovascular fitness (Nsibambi et al., 2015). Another study conducted in Spain reported that normal weight children had higher CRF compared to children in the overweight and obesity category (López-Gil et al., 2020). In respect of gender differences, both the international (Hsieh et al., 2014; Joensuu et al., 2018; Nsibambi et al., 2015) and local South African studies (Minnaar et al., 2016; Müller et al., 2020; Nqweniso et al., 2021; Salvini et al., 2018) reported that boys performed significantly better in respect of CRF than girls. Boys also reported lower cardiovascular risks than girls (Müller et al., 2020).

Children who were more physically active performed significantly better in PF tests. Moreover, children that had normal weight were reported to possess significantly higher cardiovascular fitness and increased aerobic capacity than overweight participants (Joensuu et al., 2018). Furthermore, it is clear that aerobic capacity among overweight and obese boys is significantly weaker than that of normal-weight boys (Truter et al., 2010). Additionally, a positive association was found between higher CRF and lower body fat percentage and lowered clustered cardiovascular risk ($p<0.05$) (Nqweniso et al., 2021).

2.7.2.2 Strength

There was agreement between one international and one South African study, both revealing that children with poor body composition performed worse in PF testing including strength tests, whereas children with normal weight had significantly better muscle strength (Joensuu et al., 2018; Truter et al., 2010). Further, Joensuu et al. (2018) found that fat mass index (kg/m^2) had the strongest and inverse association with muscular strength in boys and girls ($p<0.001$ and $p<0.001$, respectively). Another study found differing results, as it was reported that there were no significant ($p=0.124$) differences for boys within the normal weight, overweight and obese categories regarding their GS results (12.98 ± 3.58 kg; 13.95 ± 4.18 kg; 14.25 ± 4.16 kg), but for girls, a significant difference was found between normal weight and overweight/obesity categories (11.25 ± 3.40 kg; 13.01 ± 4.18 kg; 13.60 ± 3.64 kg) (López-Gil et al., 2020). The hand grip increased with increasing weight categories (López-Gil et al., 2020).

2.7.2.3 Body composition

An international study conducted in England found that there were significantly more children who fell in the underweight category as compared to the overweight and obese categories (Ingle et al., 2016). Also, there were significantly more boys that were underweight as compared to girls; girls were significantly more overweight and obese as compared to boys (Ingle et al., 2016). In contrast, another international study conducted in Taiwan found that there were significantly ($p<0.001$) more boys who were overweight/obese compared to girls (Hsieh et al., 2014), which could be due to cultural or ethnic reasons, as reported in previous studies. An earlier study from Taiwan also reported that overweight and obesity was significantly higher in boys than girls (19.8% in 1999 and 26.8% in 2001 vs 15.2% in 1999 and 16.5% in 2001) (Chen et al., 2006). An earlier also reported that in 1980, obesity prevalence was highest for boys in Taiwan, and in 2015 it was found that Taiwan was the 2nd highest country with highest obesity in boys (Di Cesare et al., 2019).

When comparing the findings of international studies to SA studies, the results in terms of gender differences are similar, girls were significantly more overweight than boys (Joensuu et al., 2018; Minnaar et al., 2016; Truter et al., 2010). Another South African study also reported similar gender differences where the mean BF% for boys was 16.1± 7.7% (95% CI = 15.5, 16.8) while the BF% of girls was much higher at 22.7 ± 5.7% (95% CI = 22.3, 23.2) (Goon et al., 2013).

There was a similar trend in international and SA studies with regards to poor body composition, where children with poor body composition performed worse in PF tests and these children were found to at a higher risk of cardiovascular diseases (Roman-Viñas et al., 2016; Truter et al., 2010). A progressive but insignificant decline was found in muscle endurance with increasing BMI, and the BF% of the boys and girls became significantly larger with an increase in BMI (Truter et al., 2010). Aerobic capacity decreased progressively as the BMI increased (Nqweniso et al., 2021; Truter et al., 2010).

The findings from these studies further emphasise the detrimental consequences of the lack of PA on the physical health of children. This further reiterates the need to not only increase efforts to motivate children to be more physically active, but also to regularly monitor these levels and to ensure timeous intervention and subsequent future health of these children.

2.8 FACTORS IMPACTING PHYSICAL ACTIVITY AND PHYSICAL FITNESS

This section discusses relevant factors that affect the PF of children and limit participation in PA. Many factors and influences on the PA of the youth have been identifies, some of which are a variety of psychological, social and physical environmental factors (Froberg, 2014). These factors are discussed further in the subsections to follow.

2.8.1 Environment with lack of facilities and equipment

Recent research indicates that the environment has an impact on children's PA, as children from lower socioeconomic status communities face a challenge of the lack of safe facilities to utilise for PA (Tomaz et al., 2020). The lack of facilities and equipment may hinder children from participation in PA. The level of children's participation in PA is affected by the availability of playgrounds, play under supervision and their accessibility to equipment, (Uys et al., 2015). Boreham and Riddoch (2001) further argue that due to safety concerns the rate at which children walk or cycle to school and play in the field and the streets has decreased as such activities have become unusual behaviour. Due to this concern, children have opted for more screen time than playing outside (Boreham & Riddoch, 2001). The WHO (2018) noted that the differences in inactivity could vary from country to country and is affected by economic development, change in modes of transportation, technological developments and cultural differences.

2.8.2 Inequality among groups

The WHO (2018) observed major inequalities within groups where rural and poor communities, girls and women have little access to safe, affordable, and proper spaces where they can be physically active. This is a challenge faced by South Africa as well. In the Healthy Active Kids South African Report Card from 2014, there was a comparison made between gender and communities (Draper et al., 2014). It was reported that about 22% of boys (10-17 years), and about 27% of girls (10-17 years) spend almost 3 hours a day watching television (Draper et al., 2014). It was further reported that boys (72%) are more likely to take part in sports as compared to girls (43%). Moreover, children (66%) living in urban areas were reported to be participating in more sports than children (less than 50%) living in rural areas (Draper et al., 2014). These findings show that South Africa is facing a challenge of inequality among these different groups.

2.8.3 Lack of physical education in schools

A study conducted by Hardman and Marshall (2000) reported that regions with the highest lack of PE were Africa (75%), Asia (67%) Central and Latin America (50%)

and Southern (including Mediterranean) Europe (50%). In a follow up survey in 2008, it was reported that some of the countries improved their level of PE implementation to 33% in Central and Latin America and the Middle East, 40% in Africa, and 67% in Asia and North America; while in Europe only 11% of countries reported a lack of implementation of PE (Hardman, 2008). Furthermore, PE is reported as an examinable subject in 61% of the countries that were surveyed, while in Africa this is only relevant in 20% of the countries (Hardman, 2008).

In South Africa, PE was a stand-alone subject which was well-resourced in Model-C schools as compared to under-resourced township and rural schools as a result of segregation from apartheid laws (Van Deventer, 2012). In 1994 there was a change of government and a large-scale transformation occurred in the Department of Basic Education. Curriculum changes followed and PE was made part of the Life Orientation (LO) subject (Van Deventer, 2012). Unfortunately, since PE became part of the subject LO, there has been insufficient delivery of the subject; this is said to be due to limited time, teachers' workloads and teachers' reluctance to participate in non-compulsory activities (Uys et al., 2016). Other reasons for lack of implementation of PE is said to be due to lack of equipment and structures, and lack of support for PE programmes (Ho et al., 2019). Moreover, other researchers state that the school environment could sometimes discourage participation in PA due to poor sports and recreation facilities, shortage of qualified teachers and unplanned PE programmes (Yap et al., 2015). Draper et al. (2018) argued that PE is not a priority in schools as children participate less in PA while at school than outside school premises. This gives children less opportunities to participate in PA and organised sport (Kerr et al., 2018), as schools are best suited to promote PA given that children spend most time at school (Walter, 2014).

2.8.4 Health status of children

A concern was noted for the differences found within the same community, where there are children who are overweight and/or underweight, especially at a young age (Howard et al., 2016). This study by Howard et al. (2016) identified the potential effects of malnutrition on the level of PA those children engage in. For instance, lower socioeconomic status communities could be faced with a double-burden of both overweight (which can lead to obesity) and underweight (which can result in impaired growth) children depending on the socioeconomic status of the family. Both these groups of children need interventions aimed at improving their health and monitoring the type of PA they engage in, such an approach improves children's health and motivation (Howard et al., 2016).

In summary, the importance of PA has been demonstrated throughout this chapter. Reviewed literature showed that PA can be carried out in many different forms such as walking and cycling as a form of transportation, participation in organised sport, engaging in active or free play, participating in PE lessons in schools (WHO, 2018), and many others. Empirical literature also proved that when PA is monitored throughout childhood, its benefits continue into adulthood. Moreover, research showed that PA and PF assessment helps to predict the performance level of children, assists in screening their health, and where applicable facilitate programmes that help to limit non-communicable diseases as children develop into adulthood (Cadenas-sanchez et al., 2019).

The present study contributes to literature by examining the status of PA and PF levels of primary schoolchildren from low socioeconomic status communities. The following chapter outlines the methods and measuring techniques that were employed to investigate phenomena, and to collect and analyse data. The use of a specific, well-defined, structured and justified research approach enables replicability which further increase the validity and reliability of the study.

CHAPTER 3
METHODS AND PROCEDURES

3.1 INTRODUCTION

This study investigated the PA and PF status of intermediate-phase schoolchildren from marginalised communities in Port Elizabeth. Chapter 3 describes the methodology employed to achieve the aim and objectives of this study. This chapter specifically details the research design, population and sampling technique, measuring instruments, and the data collection procedures. It further describes the statistical analyses and ethical considerations undertaken.

3.2 RESEARCH DESIGN

"The study design is the key to having control over the outcomes of the research" (Thomas, Nelson & Silverman, 2015, p. 79). This study utilized a quantitative descriptive research design to explore and describe the PA and PF status of intermediate-phase schoolchildren from marginalised communities in Port Elizabeth. The research was conducted under the auspices of the *KaziBantu* project, a joint research project between the Nelson Mandela University in South Africa and the University of Basel in Switzerland.

The larger *KaziBantu* study is a 32-week randomized controlled trial where schools were randomly selected into either an intervention or a control group. One class per grade (for grades 4 to 6), was randomly selected from each of the eight schools involved in the larger study. The present study, which is a subproject of the larger one, focuses on the baseline testing phase pertaining to the PA and PF status of the intermediate-phase schoolchildren from all eight participating schools.

3.3 POPULATION AND SAMPLING

The research project was conducted in eight quintile 3 schools situated in northern and township areas of Port Elizabeth. Figure 3.1 depicts the geographic location (only) of the eight schools (not the name of the schools).

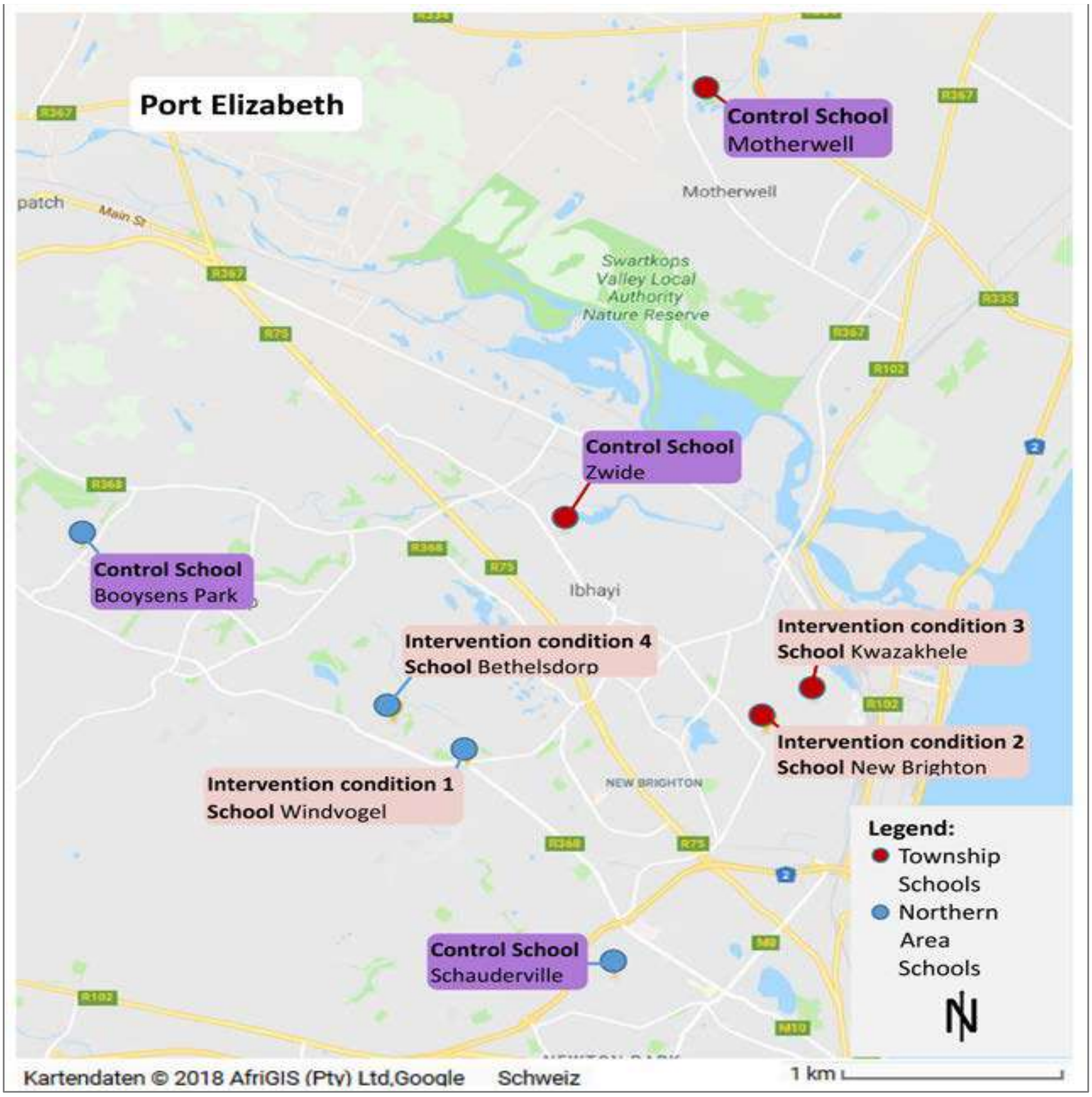

Figure 3.1 Location of the eight schools participating in the *KaziBantu* study, Port Elizabeth, South Africa (Müller et al., 2019).

In South Africa, public schools are classified into five quintile groups, where quintile 5 represents the least poor and quintile 1 represents the poorest (Kanjee, 2009). This classification is based on the socioeconomic status of communities and is determined by the use of a national poverty table. The latter ranks areas based on income levels, dependency ratios, and literacy rates of the population in that specific area (Sayed & Motala, 2012). Moreover, the quintiles assist government authorities to decide the extent of funding to that specific school per child. Schools in quintile 1 to 3 are classified as no-fee paying schools from previously disadvantaged communities, whereas schools in quintile 4 to 5 are classified as fee paying schools from advantaged communities (Sayed & Motala, 2012). The participants involved in the study are from quintile 3 schools.

An invitation to attend information sharing sessions was sent out to the quintile 3 (no-fee paying) schools, and 200 principals and representatives out of 349 quintile 3 primary schools attended the sessions. The information sharing sessions were held with the intention to include and inform as many interested school principals as possible about the study. In addition, the information sessions were held at the Eastern Cape Department of Education (ECDoE) in October 2018. In total, 64 responses were received from interested schools, however, only eight of those responses (representative of the typical quintile 3 schools) matched the following criteria:

- Geographical location and representation of the target communities: township areas predominantly inhabited by black African people, and northern areas which are predominantly inhabited by coloured people.
- The predominant language spoken in that area (English, isiXhosa, and Afrikaans).
- The school principal’s commitment to support the project activities.

Visits to the schools were conducted to assess the environment of the school and to find out the number of children in each school (as the total number of children in each school needed to be comparable to other schools). Meetings with schools’ teachers and later with parents were conducted to inform them of the project objectives and methods in a language they could understand.

All participating children were recruited through the schools. Principals and teachers from selected schools were informed about the objectives of the study, procedures to be followed, and potential risks and benefits of the study. Thereafter, parents were informed about the study through a parents’ school meeting and their children were invited to participate in the study. Before participants were enrolled into the study, an information sheet with the consent form (Appendix 5) was issued to the parents or guardians of the children and were asked to return the signed consent form the following day with the child if they granted permission for their child to participate in the study. Also, oral and written assent (Appendix 6) from all children was obtained.

Children were enrolled into the study if they met the following inclusion criteria:

- the parent or guardian had given written informed consent
- the child had given oral and written assent
- the child was not suffering from severe medical conditions as determined by qualified medical personnel
- the child was not participating in any other clinical trial during the study period
- the child was willing to participate in the study and take part in the data assessment

The research study focused on 985 children in grade four, grade five and grade six of the selected schools and classes. Figure 3.2 indicates how the final sample size was reached for this study.

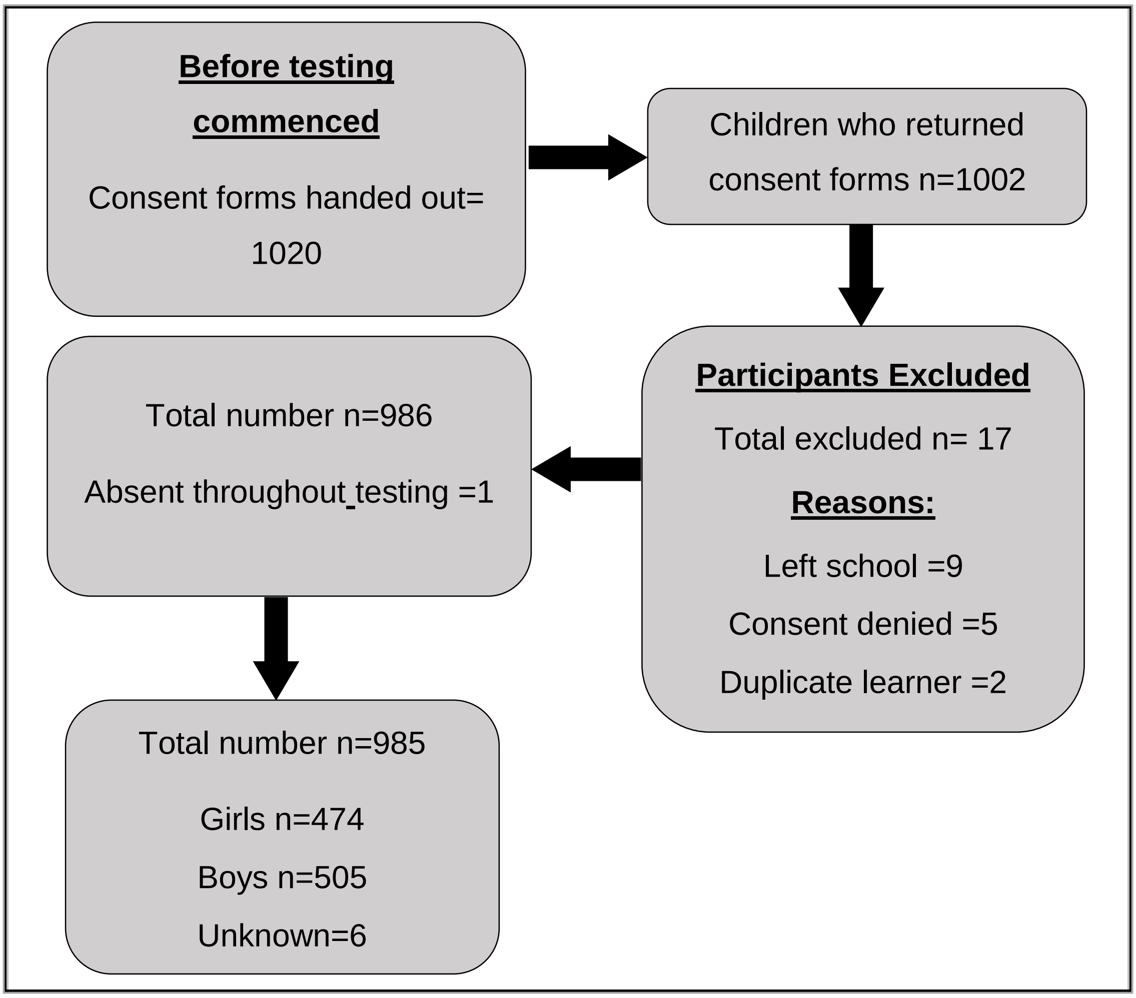

Figure 3.2 Sample ultimately involved in the study

The following section focuses on the measuring instruments and techniques used in the study.

3.4 MEASURING INSTRUMENTS

The biographical information of the children was collected from the class lists that were collected from schools. Their names, surnames, ages and dates of birth were recorded into a master file and the children were given participant numbers to avoid the use of personal information in the data analysis process and reporting of results. Two components were assessed in this study, PA and PF. PA was assessed using an Actigraph accelerometer whereas PF was assessed through the CRF (20m shuttle run test), body composition (BMI and BF%), and strength (grip strength). Further details pertaining to the tests and measurements employed in the study are provided in the subsections below.

3.4.1 Physical activity

PA was measured using accelerometers (Actigraph wGT3x-BT, Shalimar, FL, USA), indicated in Figure 3.3 below.

(https://actigraphcorp.com/support/activity-monitors/)

Figure 3.3 Actigraph

Purpose of the measurement: It was to measure the PA levels of the schoolchildren.
Equipment: An Actigraph and a belt that keep the Actigraph around the waist, were used. Figure 3.4 below indicates how the Actigraph was worn.

Figure 3.4 Child wearing Actigraph with belt around the waist

Method: The children were shown how to wear the Actigraph, and the following was explained to them in a language they could understand.

- They were told to wear the Actigraph for seven consecutive days so that a full week is assessed and the Actigraph was collected after seven days.
- It was explained to the children that they should wear the Actigraph at all times including during sleep, with an exception of baths or showers only.
- If the Actigraph was lost, the children were informed that it would be the responsibility of the project.
- Posters reminding the children about the Actigraph were put in display inside classrooms for the children to see when they get to school.

Unit of measure: The Actigraph uses counts per time (counts/60 seconds); the higher the count, the higher the acceleration during that time.

Trials: The children wore the Actigraph for one week, once.

Scoring: Based on the raw Actigraph counts and the ActiLife computer software, the time per day spent in MPA (>3 MET- metabolic equivalent of task) and VPA (>6 MET) is determined, with cut-off values derived from Freedson and colleagues (Freedson et al., 1998). For the purposes of this study the time the child spent in moderate to vigorous physical activity (MVPA) (>3 to >6 MET- metabolic equivalent of task) was calculated and expressed as an average per day for weekdays, weekends and over the total number of days in the week, respectively.

Validity and Reliability: Validity: 0.90 (Romanzini et al., 2014); Reliability: 0.75 (Aadland & Johannessen, 2015).

3.4.2 Physical fitness

PF status was assessed focusing on the following components: CRF, body composition, and strength. Details pertaining to the assessment of each of these components are described below.

3.4.2.1 Cardiorespiratory fitness

CRF was measured using the standardised 20m shuttle run test.

Purpose of measurement: It was to measure the number of laps completed and subsequently to determine the VO_2max estimate of the children.

Equipment: A CD player with the recorded sound and speaker, a score board to count laps as well as colour coded cones were used.

Method: This test was performed at the sports fields of the respective schools. Figure 3.5 shows the area layout for the test.

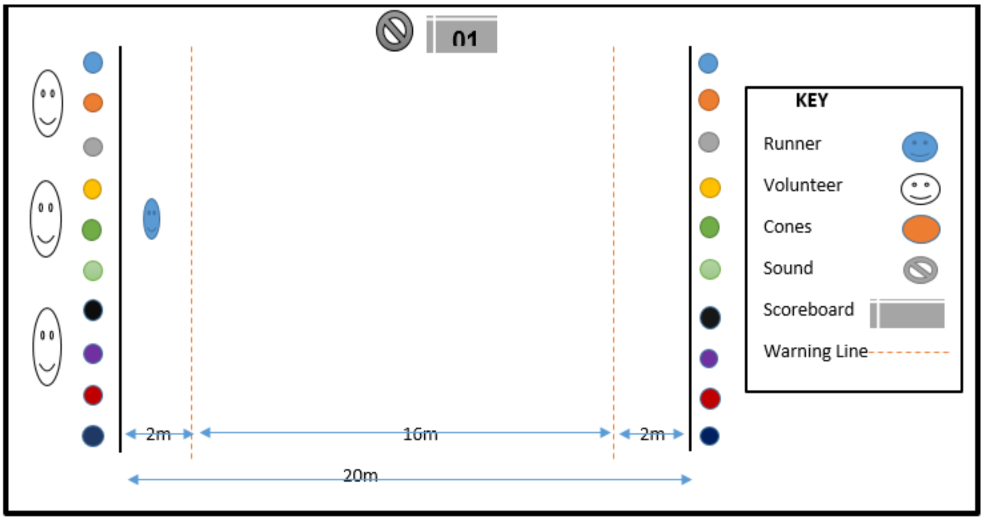

Figure 3.5 Area layout for the 20m shuttle run test

- A pre-recorded sound signal was played to the children as they did a trial run of two intervals (40m).
- After they understood the instructions, the children ran in groups of ten to fifteen with one volunteer running with them. Each child had a specific colour coded cone to run to and from, following the pace of the sound signal.
- The frequency of the sound signal increased every minute by the equivalent of 0.5km/h, and when a child failed to follow the pace in two consecutive intervals,

the number of laps completed was recorded. Volunteers assisted with marking down the scores of the children.

- The child was then taken aside and given a refreshment.

Unit of measure: The number of laps completed by a child was captured.

Trials: The children performed the test once.

Scoring: The age of the child and the speed at which the child stops running were used to calculate VO_2max estimates (Leger et al., 1988).

Validity and reliability: The 20m shuttle run test was validated as an aerobic test by Matsuzaka et al. (2004).

Reference for the test: Leger et al. (1988).

3.4.2.2 Body composition

Body composition was assessed by measuring the weight and height of the child, and thereafter calculating the BMI (Ashwell, 2011). Furthermore, body composition was also assessed by measuring the BF% of the children.

3.4.2.2.1 Weight

Purpose of the measurement: To measure the weight of the child.

Equipment: A Tanita scale (Tanita MC-580; Tanita Corp., Tokyo, Japan), wet wipes and paper towels were used to clean the standing surface of the scale between participants.

Method: The scale was put on a level floor to ensure its stability.

The child was asked to take off shoes and socks, wipe off the bottom of the feet with wet wipes and thereafter stand at the centre of the scale with as minimal movement as possible while facing forward. Figure 3.6 reflects a photo of the Tanita scale with and without a participant being weighed.

Figure 3.6 Tanita scale

Unit of measure: Weight was measured in kilograms (kg)

Trials: The weight was measured once.

Scoring: Body weight was measured to the nearest 0.01 kg.

Validity and reliability: Measurements were taken by trained and qualified assistants and face validity accepted.

Reference for the test: Tanita MC-580; Tanita Corp., Tokyo, Japan.

3.4.2.2.2 Height

Purpose of the measurement: To measure the standing height of the children.

Equipment used: A Stadiometer (Portable Stadiometer-Seca Model 213), paper towels and wet wipes were used.

Method: The stadiometer is set up in a room, against a wall on a level floor (see Figure 3.7).

- The participants needed to take off their shoes and socks.
- They were asked to stand against the stadiometer with his/her back erect and shoulders relaxed.
- Body height was measured to the nearest 0.1 cm.

Figure 3.7 Stadiometer

Unit of measure: Height was measured in centimetres (cm)

Trials: The height was measured once.

Scoring: Body height was measured to the nearest 0.1 cm.

Validity and reliability: Measurements were taken by trained and qualified assistants and face validity accepted.

Reference for the test: Norton and Eston (2018).

3.4.2.2.3 Body mass index

The BMI was calculated using the following formula:

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

body weight divided by the standing height in meters squared (Ogden et al., 2002).

3.4.2.2.4 Body fat percentage

Purpose of the measurement: It was to measure the total body fat of the child

Equipment used: A Tanita scale (Tanita MC-580; Tanita Corp., Tokyo, Japan), wet wipes and paper towels were used.

Method: BF% was measured at the same time as the weight. The scale was placed on level floor and the child was asked to wipe off the bottom of the feet with wet wipes after taking off shoes and socks. Thereafter, the child was asked to stand in the centre of the scale with as minimal movement as possible while facing forward and holding the handle of the scale. See Figure 3.6 above.

Unit of measure: Body fat was measured as a Percentage (%).

Trials: The body fat percent was measured once.

Scoring: Body fat was measured to the nearest 0.1 percent.

Validity and reliability: Measurements were taken by trained and qualified assistants and face validity was accepted.

Reference for the test: Tanita MC-580; Tanita Corp., Tokyo, Japan.

3.4.2.3 Strength

Strength was assessed by measuring the GS of both left and right hands of the child. Figure 3.8 below indicates an image of the hand dynamometer and a demonstration of how the hand dynamometer was held.

Figure 3.8 Saehan hydraulic hand dynamometer

Purpose of the measurement: It was to measure the upper body strength of the children.

Equipment: Saehan hydraulic hand dynamometer (MSD Europe BVBA; Tisselt, Belgium) (see Figure 3.8) was used.

Method: Firstly, the hand span (distance from the tip of the thumb to the tip of the little finger with the hand opened widely) of the dominant hand of the child was measured to the nearest 0.5 cm and the dynamometer was adjusted accordingly (Espana-Romero et al, 2008). The hand span was used to determine the optimum grip span through equations provided by Espana-Romero et al. (2008). Thereafter the child was told to sit on a chair in a relaxed position and to hold the dynamometer in the dominant hand with the arm at a 90-degree angle. No other body part was allowed to touch the dynamometer. The child was subsequently instructed to grip as hard as s(he) can, and the measurement was recorded.

Unit of measure: GS was measured in kilograms (kg).

Trials: Each child received three trials per hand with 30-seconds rest in between trials while alternating the hands.

Scoring: The maximum reading was taken to the nearest 1 kg.

Validity and reliability: Face validity was accepted, Reliability: 0.97 - 0.99 (Espana-Romero et al., 2008).

Reference for the test: Espana-Romero et al. (2008).

3.5 DATA COLLECTION

Before testing commenced, each child was given a four-digit numeric ID (e.g., 8599). The first number represents the school the learner was attending, the second number represents the grade or class the child was in, and the last two numbers represented the child in the alphabetic order of the class list. A testing schedule was planned and adhered to, so as to avoid inconvenient disruption of the school programme. All physical assessments were conducted at the respective schools, utilizing the field at the school as well as available indoor facilities. The umbrella study focused on the following measurements: anthropometric measurements, questionnaires, clinical examinations, PF tests, PA measurements, and cognitive performance. This particular study, a subproject of the umbrella project, focused on the anthropometric, PA and PF assessments obtained during the baseline data collection phase.

3.5.1 Anthropometric measurements

The anthropometric measures were conducted in a private setting, in a room provided by the schools, and undertaken by qualified biokineticists. The children were advised to voice out any uncomfortable feelings at any point of the testing. For purposes of hygiene, the equipment was cleaned before the next child was assessed. For measuring height and weight, the children were asked to wipe the bottom of their feet to maximise accuracy of the assessment.

3.5.2 Physical fitness

PF was assessed in groups under the supervision of the class teacher and trained field workers. Before the shuttle run test commenced, the weather and the condition of the field was assessed. The children were encouraged to voice out any discomfort or pain they might feel during the run. It was important for all children to fully understand the process before the test began. It was also important to ensure that the PF test was not conducted while the children were wearing the Actigraph to prevent the Actigraph from collecting inaccurate data. The strength test was conducted in an area provided by the school (classroom). The dominant hand of the child was noted and based on the hand span measured, the positioning of the hand on the grip dynamometer was determined before the test commenced. The child was first shown how to grip the dynamometer, and the child was motivated to grip as hard as (s)he could to get maximum reading.

3.5.3 Physical activity

For the PA assessment, all children received an accelerometer device (Actigraph), which the children were required to wear for seven days (for example, if the Actigraph was dropped off on a Monday, it was collected the following Monday). The children were also informed that they could report to the teacher if they felt any discomfort from wearing the Actigraph (e.g., skin irritation).

3.6 STATISTICAL ANALYSIS

This study is quantitative in nature. Descriptive statistics were used to describe the results obtained. The measures of central tendencies (mean and median) and measures of distribution (standard deviation) were therefore determined. Furthermore, inferential statistical analysis was implemented to make comparison between groups using Student t-tests. The inferential statistics focused on the differences and relationships between groups such as age, gender and geographic areas in respect of the variables tested. A difference was considered statistically significant when $p<0.50$ was depicted. When statistically significant differences were identified, practical significance was determined by means of Cohen’s d tests. The following criteria was used for Cohen’s d: $d<0.2$ not of practical significance; $0.2\leq d<0.5$ small practical significance; $0.5\leq d<0.8$ medium practical significance and $d\geq 0.8$ large practical significance. A qualified statistician based at the Nelson Mandela University was consulted for appropriate analysis and accurate interpretation of the data obtained.

3.7 ETHICAL CONSIDERATION

Ethics approval and/or approval to conduct the overall study was obtained from the following authorities:

- Research Ethics Committee (Human) at the Nelson Mandela University, South Africa (H18-HEA-HMS-001) (Appendix 1)
- Department of Education, Eastern Cape, South Africa on 09 May 2018 (Appendix 2)
- Department of Health, Eastern Cape, South Africa (Appendix 3)
- The study was also registered at the ethical review board of North-Western and Central Switzerland (EKNZ), reference R-2018-00047 on 01 March 2018.

Ethics approval was also received for this particular study (a subproject of the umbrella project) from the following authorities:

- Research Ethics Committee (Human) at the Nelson Mandela University, South Africa (H19-HEA-HMS-002). (Appendix 4).

"The principle of ethics is about the research participant being treated well" (Ritchie et al., 2014, p. 79). Therefore, "ethics should be at the core of research from the planning of the research right through to reporting results and beyond" (Ritchie et al., 2014, p. 80). This study implemented the following aspects in line with the Belmont Report (The Belmont Report, 1979) on the Guidelines for Protection of Human Rights:

3.7.1 Voluntary participation

Participants were informed that their participation is voluntary and were allowed to withdraw their participation at any stage of research if they felt uncomfortable.

3.7.2 Justice and beneficence

In administering the study, the researcher ensured (to the best of her ability) that the procedures of the study were non-invasive, non-exploitative and well-thought-out. Moreover, the researcher ensured (to the best of her ability) that there is minimal risk to the research participants, and that the children are not exposed to more harm than they would normally be exposed to. As this study focused only on the baseline assessment, there were no benefits, however, the children benefited from the larger study as there was an intervention and a second testing period where children, schools and interested parents received feedback.

3.7.3 Informed consent and assent

Parents or guardians of the children were asked to give informed written consent on behalf of the children to allow their children to participate in the study (see Appendix 5). Moreover, the children were verbally informed of what the study entails, and the children were given the opportunity to verbally agree or disagree to participate in the research project (Appendix 6).

3.7.4 Confidentiality and anonymity

The participants were informed of their rights to confidentiality and anonymity. The participants were also informed that their personal information on identity would be kept separate from the results, securely locked away and their identities would not be revealed at any time during the study.

3.7.5 Responsibility of the Researcher

The researcher is responsible for participants' safety during the data collection process, and thus, the researcher ensured (to her best ability) that the participants are not harmed. Moreover, the researcher informed the participants of the aims and objectives of the study as well as their right to withdraw their participation from the research whenever they felt uncomfortable.

3.7.6 Plagiarism

"Plagiarism is the use of ideas, writings, or drawings of other researchers by one researcher as their own" (Thomas et al., 2015, p. 84). It is considered plagiarism when a researcher uses ideas and writings or drawings without acknowledging the researcher that created the work. "This is unacceptable in the research process" (Thomas et al., 2015, p. 84), thus the researcher made sure to provide in-text references to acknowledge all the work that is not of her own origin.

This chapter discussed the methods and procedures followed in the study. The research design, population and sampling process, measuring instruments, the data collection procedures, the statistical analyses and ethical considerations were detailed according to their relevance in carrying out the study. The information provided enhances the understanding of the results obtained and facilitates the replicability of the study by other researchers. The following chapter provides a detailed report of the results and findings of the present study.

CHAPTER 4

RESULTS

4.1 INTRODUCTION

This study investigated the status of PA and PF of intermediate-phase schoolchildren from marginalised communities in Port Elizabeth. This chapter presents the results of the study in relation to the research objectives. The first section focuses on the demographic information of the participants with regards to the age, schools, geographic area and gender. This is followed by descriptive and inferential statistics for the measurements of PA using Actigraph accelerometer data and PF as reflected by the measurements of CRF, strength and body composition, all in relation to age, gender, and geographic area. The last section focuses on the interrelationship between PA and PF components controlling for age, gender and geographic area.

4.2 DEMOGRAPHIC INFORMATION OF PARTICIPANTS

Table 4.1 reflects the descriptive information about the participants with regards to age, number of participants involved per school, geographic area, as well as per gender. It needs to be noted that the intermediate phase grades, namely 4 to 6, included children aged 8 years as well as children aged 13 years and older. While the latter age groups are not normally expected in the intermediate phase, they were nevertheless included in the cohort of children involved in the study. Due to the smaller numbers of these age groups they were omitted when comparisons between the younger (9-10 years) and older age group (11 -12 years) were made. However, they were included when the interrelationship analyses were conducted.

Table 4.1 Demographic information of participants

Age (years)	8	9	10	11	12	9-10	11-12	≥13	Total
n (%)	33 (3.5)	189 (20.0)	296 (31.3)	255 (27.0)	135 (14.3)	485 (51.3)	390 (41.3)	37 (3.9)	945
School	1	2	3	4	5	6	7	8	
n (%)	139 (14.1)	105 (10.7)	126 (12.8)	119 (12.1)	108 (11.0)	106 (10.8)	115 (11.7)	167 (17.0)	985
Geographic area	Northern area				Township area				
n (%)	316 (33.3)				632 (66.7)				948
Gender	Girls				Boys				
n (%)	474 (48.4)				505 (51.6)				979

(n- total number; (%)- percentage)

Table 4.1 reveals that the total numbers for all sections vary. This is due to missing data that could not be obtained from the participants. The total number of participants was 985, however, there were 40, 37 and 6 children for age, geographic area, and gender categories respectively, who did not report the relevant details. There were more children in the younger age group (9-10 years; 51.3%) as compared to the older age group (11-12 years; 41.3%). Moreover, Table 4.1 indicates that there were more children from the township area (66.7%) as compared to northern area (33.3%). For the gender category, the numbers between boys and girls are almost equal, boys (51.6%) having a slightly higher representation than girls (48.4%).

4.3 COMPARISON OF PHYSICAL ACTIVITY LEVELS AS PER AGE, GENDER AND GEOGRAPHIC AREA

Physical activity was measured using the Actigraph accelerometer over seven days. Results based on MVPA are presented below as weekdays (WD_MVPA; Monday to Friday), weekend days (WND_MVPA; Saturday and Sunday), and the total time (TOT_MVPA; all days). The WD_MVPA and WND_MVPA do not add up to Tot_MVPA, as WD_MVPA is the daily average MVPA obtained over a 5-day period (Monday to Friday), WND_MVPA is the daily average MVPA taken over the weekend and Tot_MVPA is the weighted average of WD_MVPA and WND_MVPA. Table 4.2 presents the comparison of the average MVPA per day on weekdays, weekend days, and of the total number of days respectively, as per age, gender and geographic area. Only the results of the two age categories, 9-10 and 11-12 years old were used for analysis since other age groups in comparison had insignificant numbers.

Table 4.2 Comparison of physical activity levels per age, gender and geographic area

AGE										
	9-10 years			11-12 years						
	n	M	SD	n	M	SD	% Diff	t-value	p-value	Cohen's d
WD_MVPA (min/day)	463	73.5	27.7	377	72.2	29.0	1.8	0.68	0.4973	0.0471
WND_MVPA (min/day)	431	75.2	35.5	359	71.0	35.8	5.6	1.65	0.0996	0.1178
Tot _MVPA (min/day)	463	73.9	27.9	377	71.8	29.0	2.8	1.07	0.2867	0.0739
GENDER										
	Girls			Boys						
	n	M	SD	n	M	SD	% Diff	t-value	p-value	Cohen's d
WD_MVPA (min/day)	456	62.0	22.8	464	83.9	29.0	-35.2	-12.69	<0.0001	-0.8370
WND_MVPA (min/day)	431	58.5	27.1	434	87.5	36.6	-49.6	-13.24	<0.0001	-0.9001
Tot _MVPA (min/day)	456	61.0	22.0	464	84.8	28.8	-39.0	-14.07	<0.0001	-0.9277
GEOGRAPHIC AREA										
	Northern area			Township area						
	n	M	SD	n	M	SD	% Diff	t-value	p-value	Cohen's d
WD_MVPA (min/day)	301	72.3	28.3	598	73.7	28.4	-2.0	-0.71	0.4793	-0.0500
WND_MVPA (min/day)	282	74.5	37.2	563	72.4	34.6	2.7	0.79	0.4315	0.0574
Tot _MVPA (min/day)	301	72.8	29.0	598	73.3	28.0	-0.7	-0.26	0.7953	-0.0183

(MVPA- moderate to vigorous physical activity; WD- weekdays; WND- weekend days; Tot- total days; n-total number; M- mean; SD- standard deviation; %diff- percentage difference; Cohen's d: d<0.2 not significant; 0.2≤ d<0.5 small; 0.5≤d<0.8 medium and d≥0.8 large)

As presented in Table 4.2, there is no evidence that the two age groups differ with respect to their MVPA levels during weekdays (p=0.4973), weekend days (p=0.0996) nor in time spent in MVPA on average per day when the total period of days were considered (p=0.2867). For all three categories of MVPA, the girls recorded significantly lower PA levels than the boys (p<0.05).

In another observation, the girls spent on the average 39% less time over the total weekdays on MVPA than boys. This difference is highly significant (p<0.0001). Interestingly, compared to weekday MVPA, girls reduce their MVPA during the weekend by almost 6% while boys increase their weekend MVPA by just over 4%. This difference in PA behaviour is also statistically significant (p<0.0001). The comparisons between participants from the township and northern areas in respect of MVPA levels indicate that even though the children from the northern area reported slightly lower values, these differences were not of statistical significance (p>0.05). A comparison of the PF components is presented in the following section.

4.4 COMPARISON OF PHYSICAL FITNESS COMPONENTS AS PER AGE, GENDER AND GEOGRAPHIC AREA

In this section, the results pertaining to the PF components selected in this study, are presented. The relevant PF components are CRF (expressed as predicted VO_2max obtained from the 20m shuttle-run test), strength (represented by GS) and body composition (represented by BMI and BF%). Table 4.3 below shows the results of the participants are compared as per the respective categories of age, gender and geographic area.

Table 4.3 Comparison of physical fitness components as per age, gender, and geographic area

AGE										
	9-10 years			11-12 years						
PF COMP	n	M	SD	n	M	SD	% Diff	t-value	p-value	Cohen's d
CRF (ml/kg/min)	465	45.8	3.8	378	44.5	4.9	3.0	4.51	<0.0001	0.312003
GS (kg)	468	13.6	2.9	385	16.0	3.8	-18.3	-10.72	<0.0001	-0.73753
BMI (kg/m^2)	467	17.7	3.5	364	18.5	4.0	-4.4	-3.01	0.0027	-0.21064
BF (%)	467	8.4	4.7	364	9.8	6.5	-16.5	-3.58	0.0004	-0.25005
GENDER										
	Girls			Boys						
PF COMP	n	M	SD	n	M	SD	% Diff	t-value	p-value	Cohen's d
CRF (ml/kg/min)	451	43.8	3.7	457	46.7	4.7	-6.5	-10.15	<0.0001	-0.67355
GS (kg)	459	14.3	3.7	470	15.0	3.6	-4.9	-2.93	0.0035	-0.19213
BMI (kg/m^2)	451	18.5	4.0	471	17.5	3.2	5.0	3.87	0.0001	0.254794
BF (%)	451	10.2	5.8	471	7.6	4.9	25.3	7.31	<0.0001	0.481903
GEOGRAPHIC AREA										
	Township area			Northern area						
PF COMP	n	M	SD	n	M	SD	% Diff	t-value	p-value	Cohen's d
CRF (ml/kg/min)	591	45.2	4.4	297	45.4	4.5	-0.3	-0.41	0.6834	-0.02902
GS (kg)	607	14.5	3.6	302	15.0	3.8	-3.3	-1.83	0.0672	-0.12902
BMI (kg/m^2)	605	18.2	3.7	295	17.7	3.7	2.6	1.83	0.0683	0.12962
BF (%)	605	9.1	5.5	295	8.6	5.7	6.1	1.42	0.1556	0.100921

(PF COMP- physical fitness components; CRF- cardiorespiratory fitness measured in VO_2max; GS- grip strength; BMI- body mass index; BF (%)- body fat percentage; n-total number; M- mean; SD- standard deviation; %diff- percentage difference; Cohen's d: d<0.2 not of practical significance; 0.2≤ d<0.5 small practical significance; 0.5≤d<0.8 medium practical significance and d≥0.8 large practical significance)

As depicted in Table 4.3, the younger age group has a 3% larger mean VO_2max value than the older age group (p<0.0001), similarly boys presented a 6.5% larger average VO_2max value than girls (p<0.0001), with the schoolchildren from the northern area showing a slightly higher mean value than those from the township area, but this difference is statistically inconclusive (p=0.6834). When comparing the average GS, it is evident that there is a significant difference between the age groups (p<0.0001) which is also of a high practical significance (Cohen's d=0.73753) favouring the older age group. As expected, boys presented a significantly higher mean GS value (p=0.0035), however, the difference was of no practical significance. In respect of the geographic area, the schoolchildren from the northern area showed a slightly higher GS mean value, but the difference was inconclusive (p=0.0672).

When comparing average BMI, there was a significant difference between the age categories (p=0.0027) with the older age group presenting a higher value, but which is of low practical significance (Cohen's d=-0.211). The girls presented with a significantly higher mean BMI than the boys (p=0.0001) which is also of low practical significance (Cohen's d=0.255). There were differences between the geographic areas, however, the statistical significance of this difference was inconclusive (p=0.0683). The BF% for all comparisons had similar results to that of BMI. There was a significant difference between the age categories (p=0.0004), with children in the 9-10 years' age category reporting a lower BF% than the 11-12 years' age category. Girls reported a 25.3% significantly higher BF% than the boys (p<0.0001), and the practical difference between the two categories was moderately significant (Cohen's d=0.482). Even though there was a difference between the geographic areas, the difference was not significant (p=0.1555).

The distribution of the BMI and BF% can be illustrated by using box and whisker plots. Figure 4.1 illustrates an example for BMI and BF% using the age category. Both gender and geographic area box and whisker plots follow the same trend of data distribution.

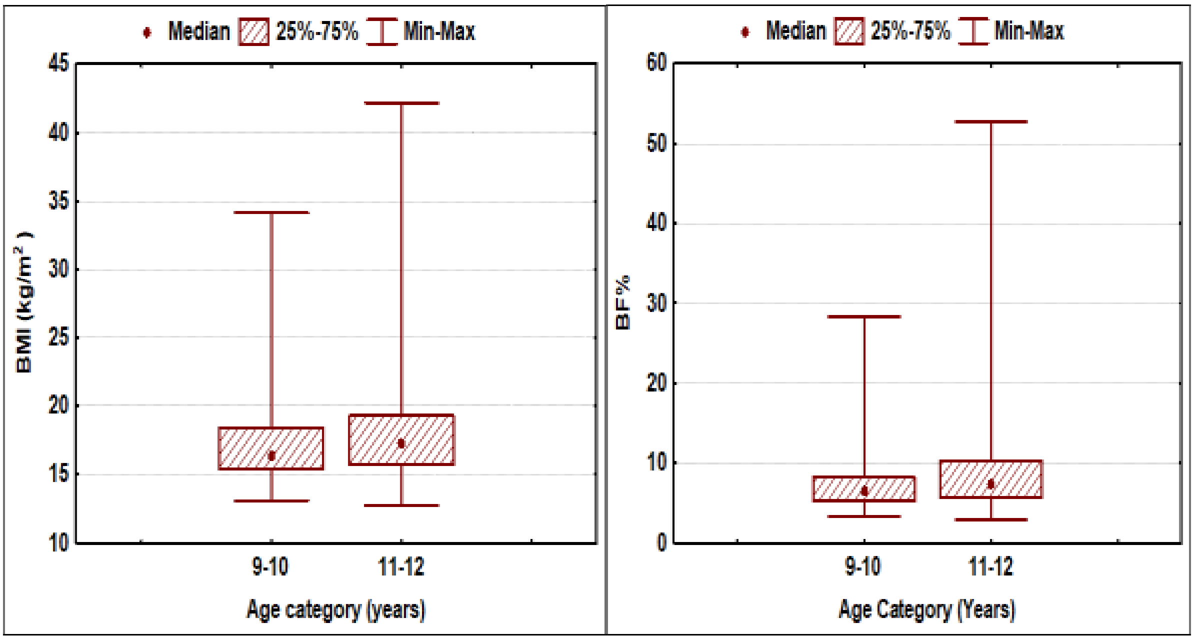

Figure 4.1 Box and whisker plots of the BMI (left) and BF% (right) distributions of the age categories

As shown in Figure 4.1 above, the data for BMI and BF% is positively skewed, which means that the median is a more representative measure of centrality than the arithmetic mean. However, the mean can also be used for statistical tests as a measure of central tendency due to the large number of the participants in this study. It can also be noted that in both diagrams for BMI and BF%, the medians are at a similar range for both age categories.

The following section reflects the interrelationship between physical activity and physical fitness components when controlling for age, gender and geographic area.

4.5 INTERRELATIONSHIP BETWEEN PHYSICAL ACTIVITY AND PHYSICAL FITNESS COMPONENTS

In this section, the interrelationship between PA and PF as per age, gender and geographic area are presented. Multiple regression models were used to investigate the simultaneous effect of age, gender and geographic area on the measured PF components. Covariates such as BMI and MVPA were also included in the list of independent variables. The initial regression model contained all two-way interactions between the independent variables as well as the squares of the continuous independent variables. Starting with the initial full model, stepwise regression was used to eliminate insignificant terms from the model. The regression models are validated by using residual analysis. It must be noted that the explained variance for all regression models (given by the coefficient of determination, R^2) is generally low (<0.2) but compares favorably to similar studies based on biological and kinesiological data. Statistical conclusions only apply to the range of the ages of the sampled children that is from 8 to 13+ years. For the interrelationship analysis the data available for the full age range was used as this provides a more precise prediction for the results of the study compared to when analysis is done on the separate age groups.

4.5.1 Cardiorespiratory fitness

The CRF of the sampled children is measured by obtaining their VO_2max values. Table 4.4 below gives the regression output obtained by least squares regression with VO_2max as the dependent variable.

Table 4.4 Regression output for VO_2max (Independent variables: age, geographic area and gender; Covariates: BMI and MVPA)

Variable	b	SE	t-value	p-value
Intercept	68.2771	2.7498	24.8297	<0.0001
Age	-1.1917	0.1621	-7.3524	<0.0001
Geographic Area	-0.1668	0.2629	-0.6344	0.5260
Gender	-6.6809	2.3788	-2.8085	0.0051
Age*Gender	0.8109	0.2180	3.7204	0.0002
BMI	-0.9111	0.2126	-4.2855	<0.0001
BMI^2	0.0111	0.0049	2.2851	0.0226
MVPA	0.0205	0.0049	4.1556	<0.0001

(b- estimated regression coefficients; SE- Standard Error; t-value- test statistic; p-value)

Controlling for geographic area, gender, BMI and MVPA, it is shown that the average VO_2max is significantly correlated with the age of the children ($p<0.0001$). This relationship is inversely proportional; as these children age, their average VO_2max values tend to decrease. No difference between the children from schools in the Northern area and the township area with respect to their average VO_2max is detected ($p=0.5260$). The effect of age on the average VO_2max differs for both genders ($p=0.0002$), the decrease of the average VO_2max with age is much more pronounced for girls than for boys.

Figure 4.2 below, shows the correlation between age and VO_2max separately for girls and boys. Since the geographic location of the schools does not show any effects on the average VO_2max of the children, the VO_2max values obtained from the schools in the Northern area and from the township area have been combined.

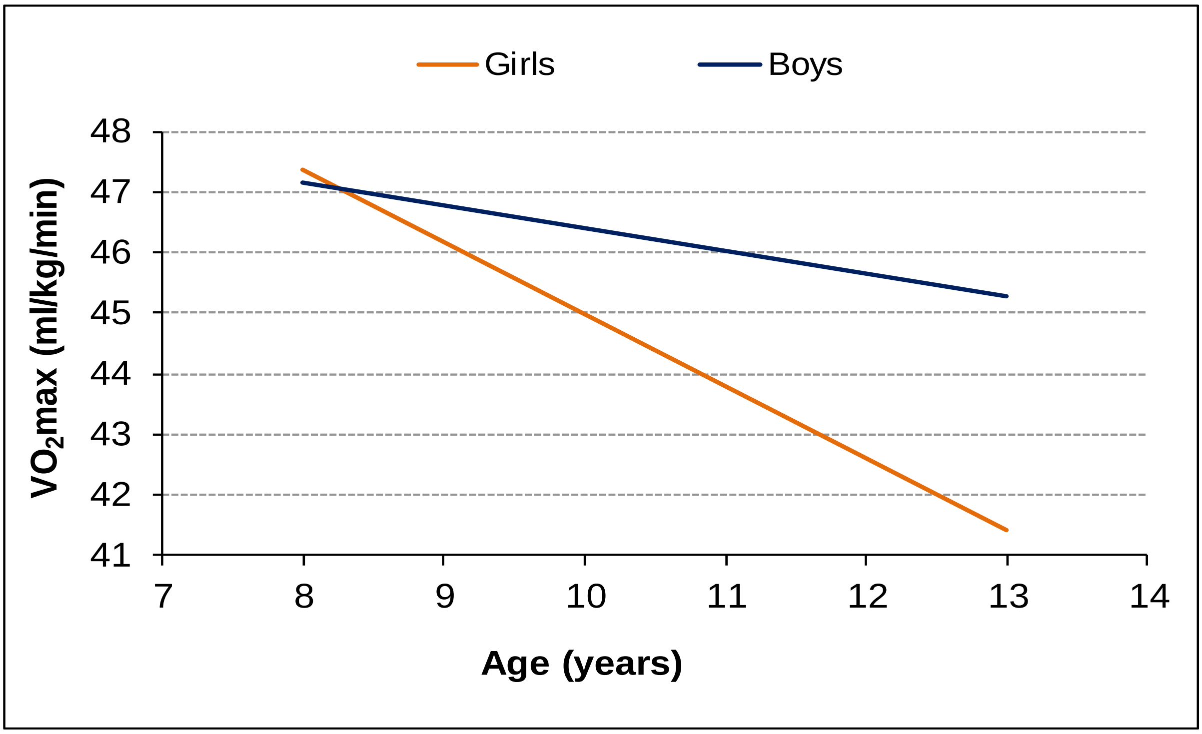

Figure 4.2 Trend lines illustrating the correlation between VO_2max and age, separately for girls and boys from both geographic areas

The average VO_2max decreases by 3.8% for girls and 1.2% for boys every year as they get older. The BMI of the sampled children has a non-linear effect on their average VO_2max ($p=0.0226$). This trend is clearly visible in Figure 4.3 below. Again, the difference between the average VO_2max measurements at the two geographic areas is not statistically significant, implying that the VO_2max data from these two areas could be combined.

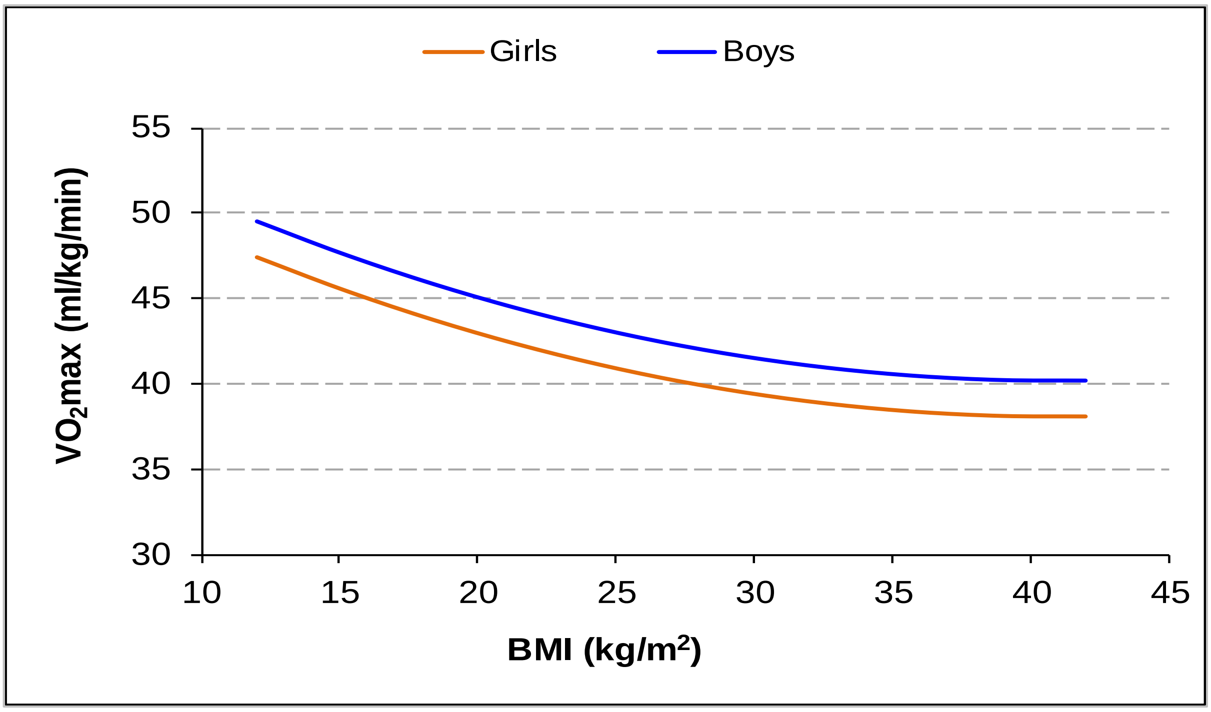

Figure 4.3 Trend lines showing the association between BMI and VO_2max separately for boys and girls from both geographic areas

From the regression output given in Table 4.4, it can also be noted that after controlling for age and BMI, the level of MVPA has a strong significant effect on the mean VO_2max values of the sampled children ($p<0.0001$). Figure 4.4 shows this correlation between MVPA and VO_2max separately for girls and boys.

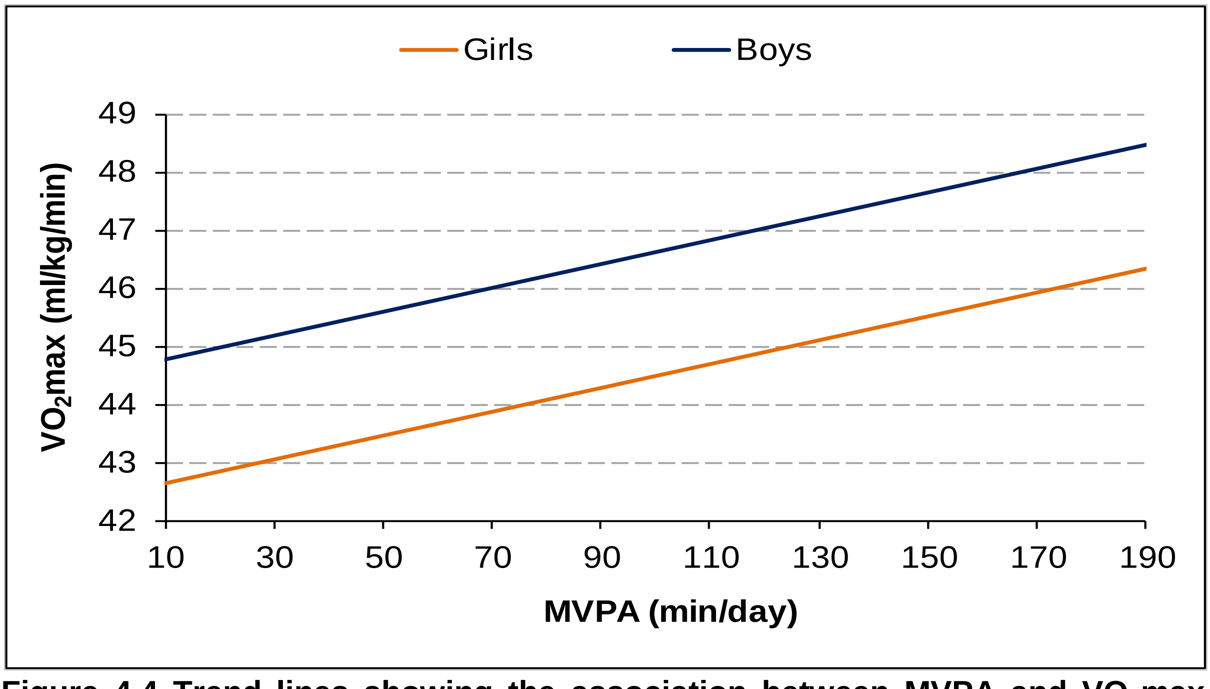

Figure 4.4 Trend lines showing the association between MVPA and VO_2max separately for girls and boys

For both girls and boys, the average VO_2max values increase by 2.8% for every extra hour of moderate to vigorous physical exercise.

4.5.2 Grip strength

Table 4.5 below reflects the regression output for GS. This was obtained by applying a multiple regression model to describe GS as a function of age, geographic area and gender, using BMI and MVPA as covariates.

Table 4.5 Regression output for grip strength (Independent variables: age, geographic area and gender; Covariates: BMI and MVPA)

Variable	b	SE	t-value	p-value
Intercept	-18.4189	2.6739	-6.8882	<0.0001
Age	1.5069	0.0902	16.6937	<0.0001
Geographic Area	0.7556	0.2125	3.5552	0.0004
Gender	0.2086	0.2299	0.9072	0.3645
BMI	0.8128	0.1736	4.6794	<0.0001
BMI^2	-0.0107	0.0039	-2.7049	0.0069
VO_2max	0.1119	0.0277	4.0401	0.00006
MVPA	0.0027	0.0040	0.6639	0.5069

(b- estimated regression coefficients; SE- Standard Error; t-value- test statistic; p-value)

It can be noted that after controlling for age, gender, BMI, VO_2max and MVPA, the average GS of the children at schools from the northern area differs from the average GS of the children from schools in the township area. For the age group between 8 and 13+ years old, no difference between the average GS of girls and boys could be detected (p=0.3645); for this reason, the grip strengths of girls and boys can be combined. Also, no correlation between the time spent on average per day in MVPA and GS has been found (p=0.5069). The relationship between BMI and GS is shown in Figure 4.5.

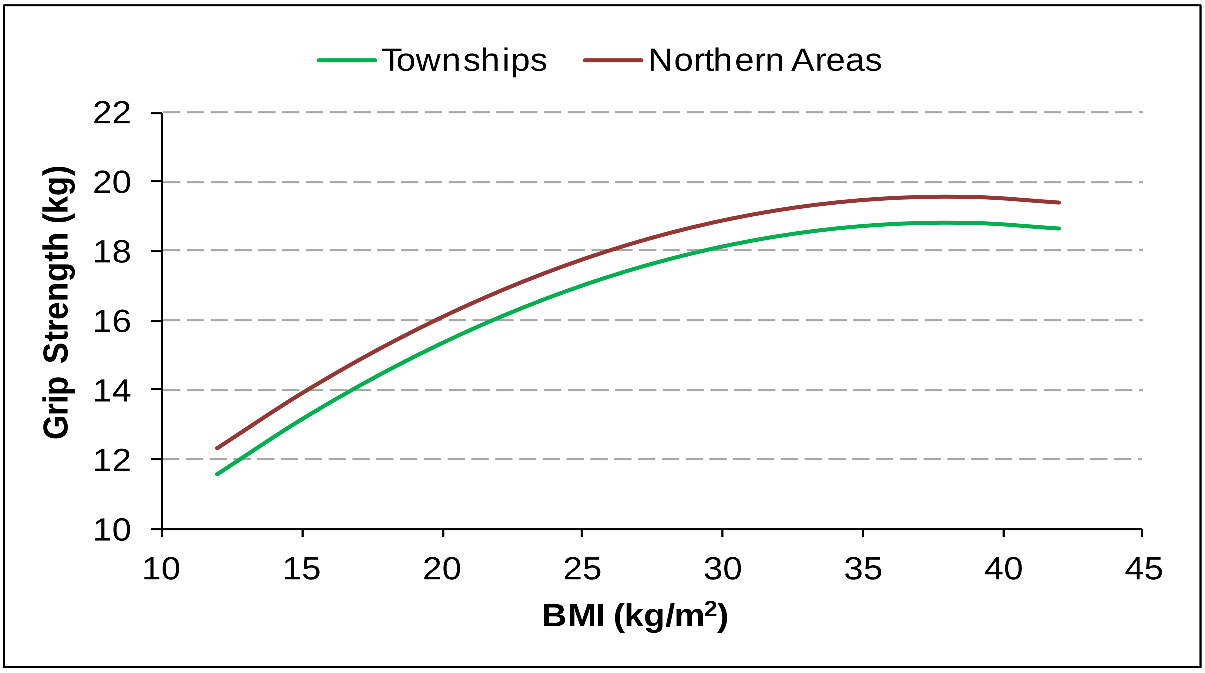

Figure 4.5 Trend lines showing the nonlinear association between BMI and GS separately for the children from schools in the township and northern areas

It must be emphasized that the association between GS and BMI as depicted in Figure 4.5, is shown at a fixed average age and average VO_2max. Stated differently, the trend lines given in Figure 4.5 show the functional relationship between average GS and BMI where the confounding effects of the covariates age and VO_2max have been removed. The BMI of this sample of children has a non-linear effect on their average GS. Predictably, average GS increases significantly with BMI, however, as the BMI's get higher than 25, the GS increase starts to plateau.

The regression output given in Table 4.5 also shows that VO_2max has a significant effect on the average GS of the children in this sample. Figure 4.6 depicts the trend lines for the average GS as a function of VO_2max controlling for age and BMI.

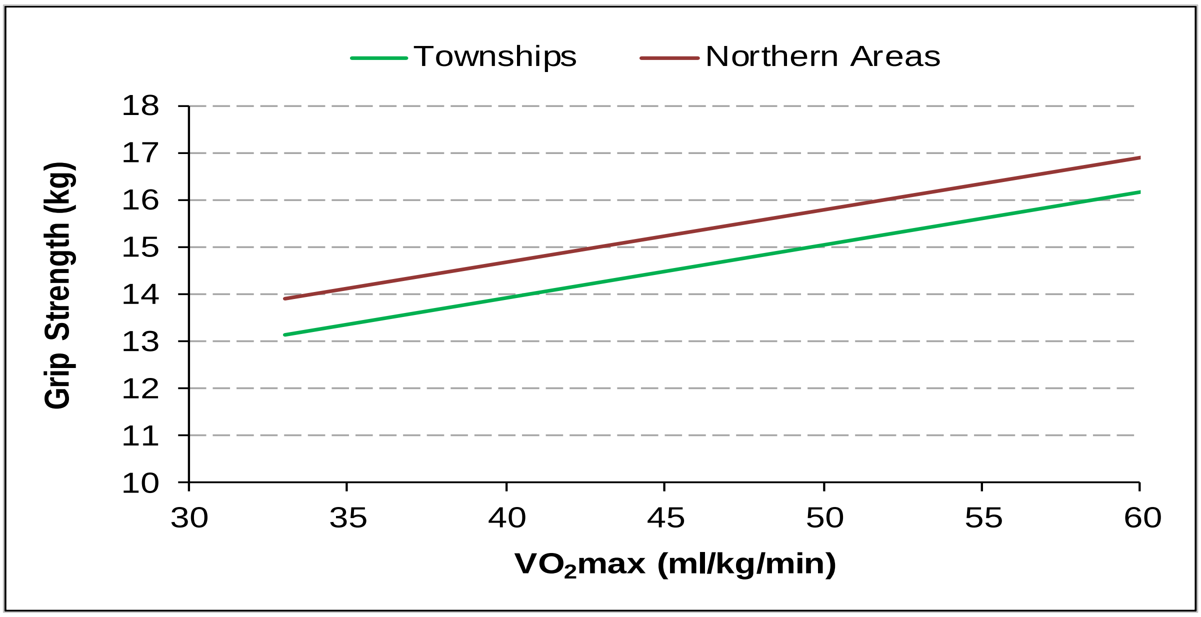

Figure 4.6 Trend lines showing the linear relationship between VO_2max and GS separately for the children from schools in the township and the northern areas

Within the sample range of the measured VO_2max values, for every increase of 10 ml/kg/min of VO_2max, the average GS of the children in this sample increases by 8%.

4.5.3 Body mass index

Since the distribution of the BMI is extremely positively skewed, BMI was transformed to an approximate normal distributed variable by using the Box-Cox transformation technique. The transformed BMI was then used as the dependent variable for a regression model which included age, gender and geographic area of the schools as independent variables. To control the confounding influence of VO_2max and MVPA, these covariates were again included in the model. Table 4.6 presents the outcome of the regression analysis for BMI which includes the independent variables.

Table 4.6 Regression output for transformed BMI (Independent variables: age, geographic area and gender; Covariates: VO_2max and MVPA)

Variable	b	SE	t-value	p-value
Intercept	0.4290692	0.0009517	450.85	<0.0001
Age	-0.0001593	0.0000535	-2.9782	0.0030
Geographic Area	-0.0000418	0.0000122	-3.4186	0.0007
Gender	0.0000238	0.0000133	1.7855	0.0746
VO_2max	-0.0001589	0.0000311	-5.1151	<0.0001
VO_2max^2	0.0000009	0.0000003	3.5413	0.0004
Age*VO_2max	0.0000034	0.0000011	2.9661	0.0031
MVPA	-0.0000091	0.0000021	-4.2765	<0.0001
VO_2max*MVPA	0.0000002	0.00000005	4.0686	0.0001

(b- estimated regression coefficients; SE- Standard Error; t-value, p-value)

The average BMI is positively correlated with the age of the children. More interestingly, the average BMI's of children from the schools in the township area and those in the northern area differ significantly ($p=0.0007$). There is some suggestive but inconclusive evidence of a significant difference between the average BMI's of the girls and boys ($p=0.0746$). Figure 4.7 shows the relationship between BMI and VO_2max.

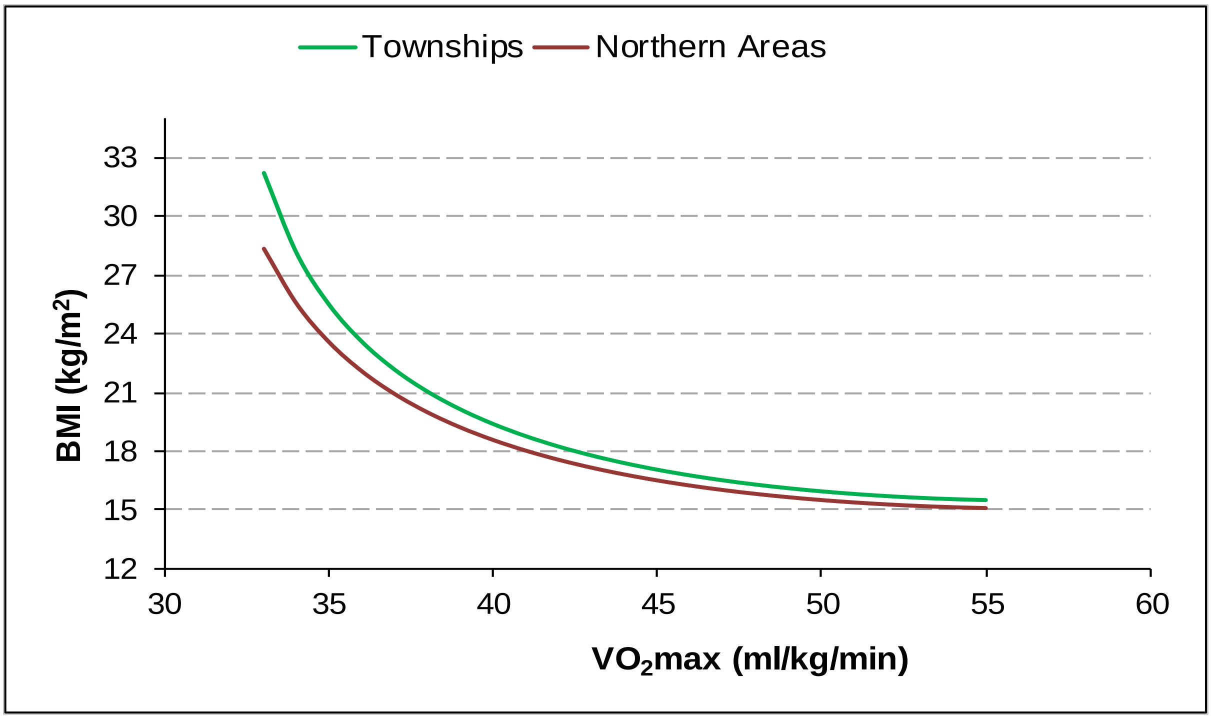

Figure 4.7 Trend lines showing the linear relationship between VO_2max and BMI separately for the children from schools in the township and northern areas

VO_2max shows a non-linear association with BMI ($p<0.0001$) and the effect of age on BMI is significantly modified by VO_2max ($p=0.0001$).

Figure 4.8 below shows the relationship between PA and BMI.

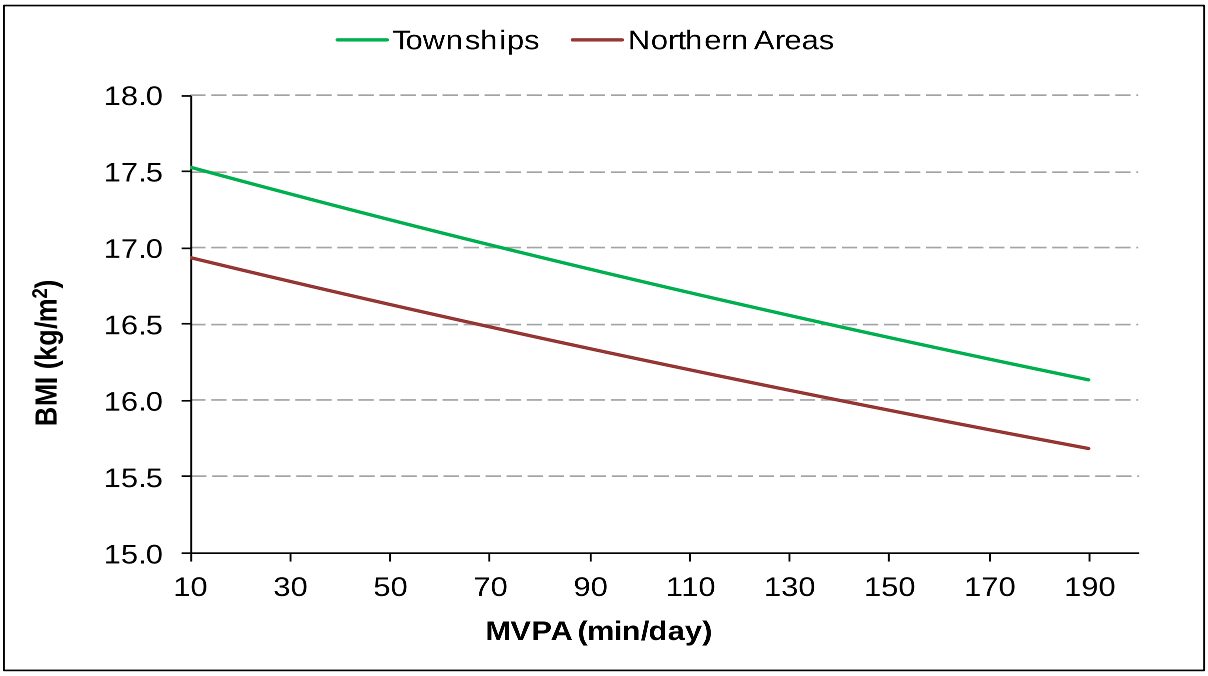

Figure 4.8 Trend lines showing the linear relationship between MVPA and BMI separately for the children from schools in the township and northern areas

The time spent in MVPA has a strong influence on BMI and the effect of MVPA on BMI is also dependent on the VO_2max levels.

4.5.4 Gender and body mass index

The difference between the average BMI of the girls and the average BMI of the boys in this sample, is according to the t-test given in Table 4.3, statistically significant (p=0.0001). This seems contradictory with the result obtained from the regression analysis presented in this section, where no difference between the average BMI's of the girls and boys was detected (p=0.0746). The reason for the apparent contradiction, is that the t-test ignores the effects of PA, age and CRF. The confounding effect of MVPA on the relation between gender and BMI can be illustrated by categorizing MVPA in 5 quintiles, and then comparing the average BMI's of the girls and boys for each quintile.

Table 4.7 below gives the number and percentage of the girls and boys in each quintile as well as their average BMI. The last column in the table gives the p-value associated with the comparison of the BMI's within each quintile.

Table 4.7 Numbers, percentages and mean BMI's for girls and boys in 5 increasing levels of MVPA categories

MVPA	Girls			Boys			
	n	%	mean BMI	n	%	mean BMI	p-value
Very Low	135	30.9	19.5	39	8.9	20.1	0.9958
Low	116	26.5	18.4	61	14.0	18.2	0.9999
Middle	89	20.4	18.1	84	19.2	17.4	0.9339
High	67	15.3	17.8	107	24.5	17.2	0.9930
Very High	30	6.9	16.7	146	33.4	16.9	0.9995

The reason why the overall average BMI of the girls is higher than the average BMI of the boys, is that girls are less physically active than boys. Only 7% of the girls are classified as being very active, whereas this is 33.4% for the boys. However, within each quintile of MVPA, there is no significant difference between the average BMI's of the girls and boys. Figure 4.9 below shows the average BMI's for girls and boys together with their corresponding 95% confidence intervals confirming the mentioned non-significant difference between the genders in respect of BMI at Comparative MVPA categories.

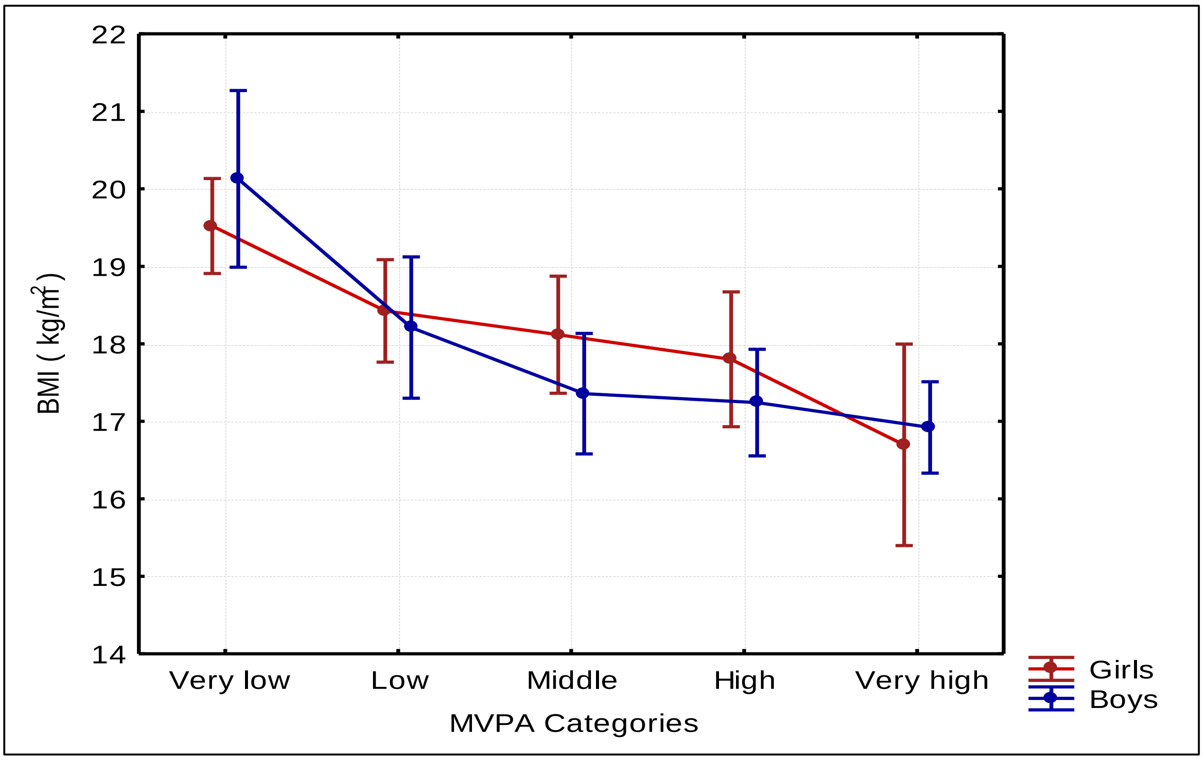

Figure 4.9 Mean BMI's for girls and boys together with their corresponding 95% confidence intervals for each of 5 MVPA quintiles

It is shown in Table 4.7 and Figure 4.9 that there are more girls that have low MVPA values and therefore will be representative of the mean BMI for girls, however, girls that have MVPA values equal to that of the boys falling in the high MVPA category, have similar BMI to the boys.

4.5.5 Body fat percentage

BF% was transformed to an approximate normal distributed variable by using the Box-Cox transformation technique as it was positively skewed. The transformed BF% was then used as the dependent variable for a regression model which again included age, gender and geographic area of the schools as independent variables. Table 4.8 presents the regression output after stepwise regression for BF%. This was obtained by applying a multiple regression model to describe BF% as a function of age, geographic area and gender, using VO_2max and MVPA as covariates.

Table 4.8 Regression output of the predicted body fat percentage (Independent variables: age, geographic area and gender; Covariates: VO_2max and MVPA)

Variable	b	SE	t-value	p-value
Intercept	2.813	0.262	10.756	<0.0001
Age^2	-0.003	0.001	-3.619	0.0003
Geographic Area	-0.019	0.005	-3.651	0.0003
Gender	-0.028	0.006	-5.046	<0.0001
VO_2max	-0.064	0.011	-5.606	<0.0001
VO_2max ^2	0.000	<0.0001	3.639	0.0003
VO_2max *Age	0.001	<0.0001	3.748	0.0002
MVPA	-0.003	0.001	-3.386	0.0007
VO_2max *MVPA	0.0001	<0.0001	3.023	0.0026

(b- estimated regression coefficients; SE- Standard Error; MVPA-moderate to vigorous physical activity)

As presented in Table 4.8, age, gender and geographic area are highly correlated to the BF% of the children with p=0.0003, p=0.0001 and p<0.0003, respectively. MVPA and VO_2max also indicated a highly significant correlation to the BF% of the children (p=0.0007 and p<0.0001, respectively). Table 4.8 also includes two significant two-way interactions which are "VO_2max*Age" and "VO_2max*MVPA". The first two-way interaction (VO_2max*Age) indicates that the effect of VO_2max on BF% is significantly influenced by the age of the child (p=0.0002). The second two-way interaction (VO_2max*MVPA) indicates that the effect of VO_2max on BF% is significantly influenced by the time spent in MVPA (p=0.0026).

Figure 4.10 present the effect of MVPA on BF% separately for girls and boys from the two geographic areas and a fixed age and VO_2max.

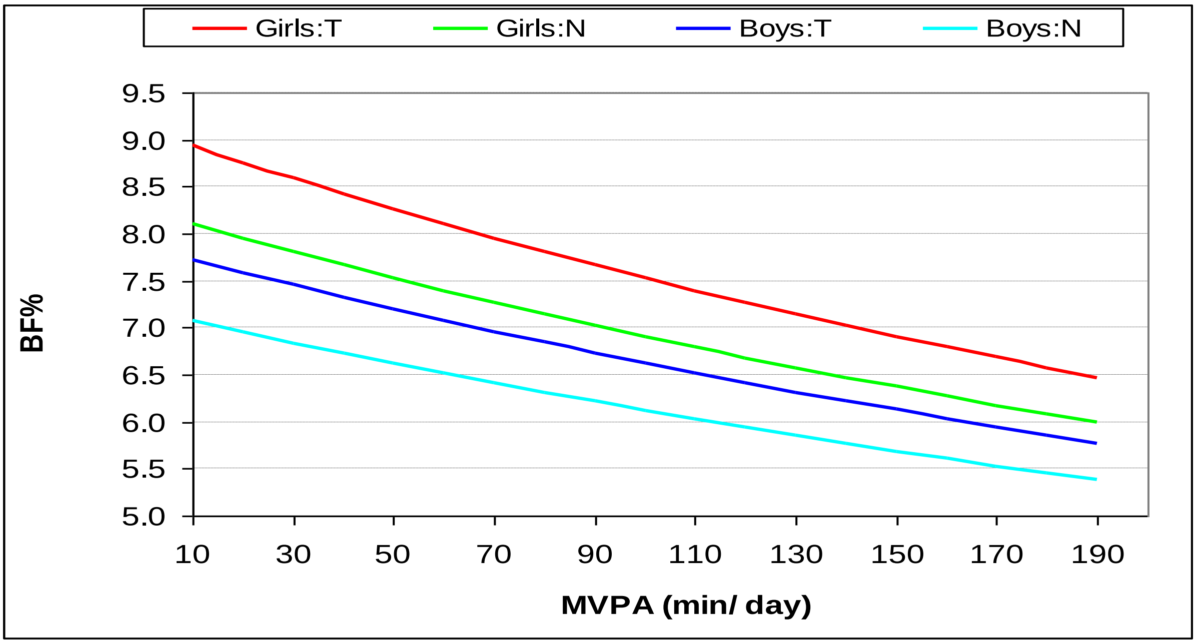

Figure 4.10 Trend lines illustrating the effect of MVPA on BF% separately for girls and boys from two geographic areas (northern (N) and township (T) areas)

Figure 4.10 shows the non-linear effect of MVPA on BF% quite clearly, indicating that as MVPA increases the BF% decreases. However, there is also an indication that the predicted BF% will plateau.

Figure 4.11 depicts the effect of MVPA on the BF% at three fixed levels of VO_2max, with the girl's data used as an example for illustration.

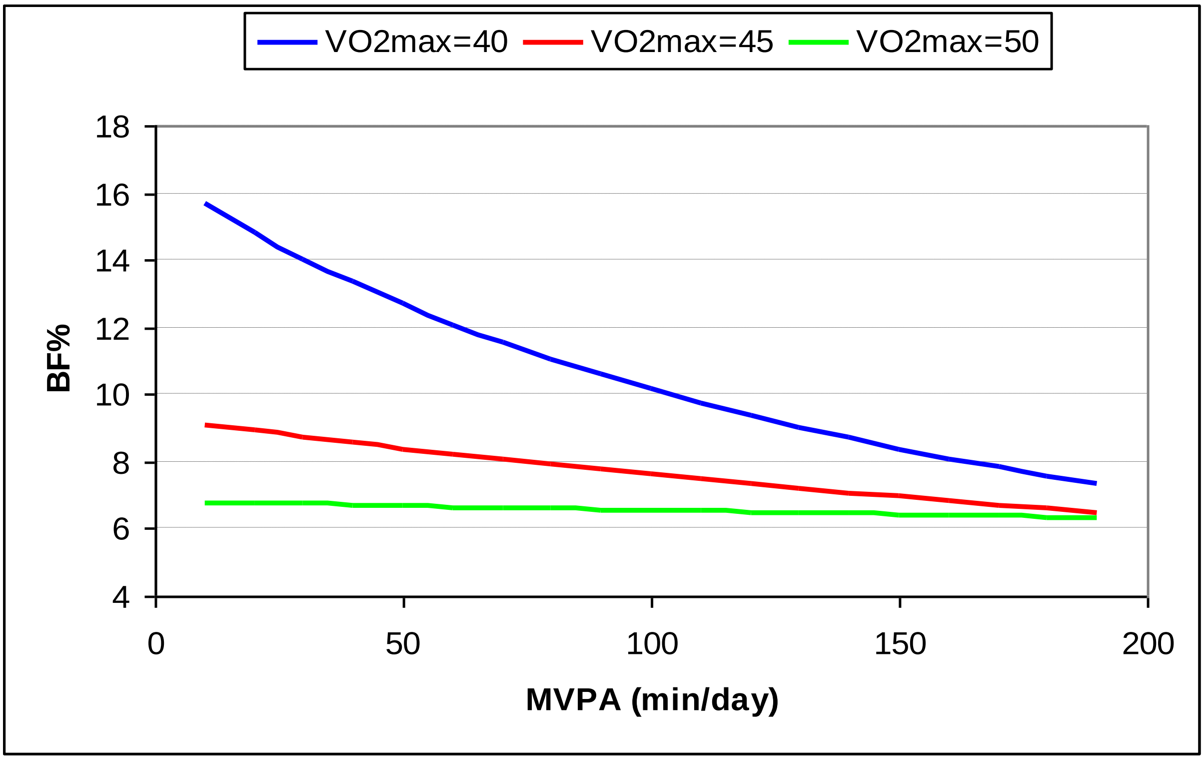

Figure 4.11 Trend lines illustrating the effect of MVPA on BF% for girls at schools in the northern areas at three levels of VO_2max and at a fixed age of 11 years

The trend lines in Figure 4.11 show the influence of VO_2max on the effect of MVPA on BF%. For girls with a relatively low VO_2max of 40 ml/kg/min, physical activity has a profound effect on BF%, but for girls with a relatively high level of VO_2max of 50ml/kg/min, physical activity has hardly any effect on their BF%.

According to the regression output given in Table 4.8, VO_2max also interacts with age. Figure 4.12 illustrates the combined effects of MVPA and age on BF%, at three different ages and when VO_2max is fixed at its mean value of 45.25 ml/kg/min. The data from girls is used as an example for illustration.

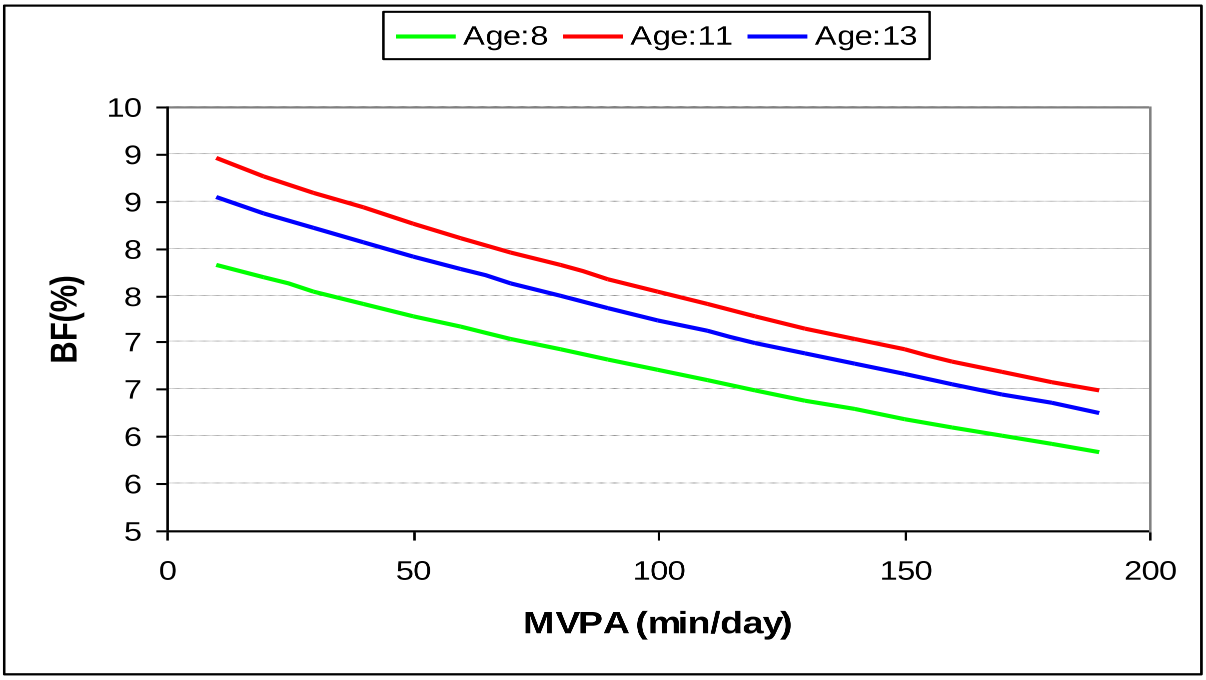

Figure 4.12 Trend lines illustrating the effect of MVPA on BF% for girls from the northern areas at ages 8, 11 and 13 years when VO_2max is fixed at its mean level of 45.25 ml/kg/min

The set of three lines depicted in Figure 4.12 confirm an earlier observation that the effect of age on BF% is non-linear. BF% increases for girls between the age of 8 to 11 years, however there is some evidence of a slight decrease again.

This chapter presented the results and findings of the present study. The following chapter discusses the findings reported in further detail and also in relation to relevant literature.

CHAPTER 5

DISCUSSION, CONCLUSION, LIMITATIONS AND RECOMMENDATIONS

5.1 INTRODUCTION

The aim of this study was to investigate the status of PA and PF among intermediate-phase schoolchildren from marginalised communities in Port Elizabeth. This chapter discusses the results presented in Chapter 4, which are then related to the literature discussed in Chapter 2. The literature is used to interpret and provide comparisons to the empirical research in Chapter 2, section 2.7. The PA measurements and PF components presented in Chapter 4 are discussed in relation to the following demographics; age, gender and geographical area. This discussion chapter commences with a section on the demographics of participants, followed by PA measurements and PF components. A summary of findings and conclusion follow and this chapter is concluded with a brief discussion of the limitations of the study and recommendations for future research.

5.2 PARTICIPANT DEMOGRAPHICS

The final study population consisted of 985 participants, of which 48.4% were girls and 51.6% were boys (Table 4.1) and in terms of age, more than half of the schoolchildren were in the 9 to10 years old category (51.3%) as compared to the 11 to 12 years old category that represented 41.3% of the participants (Table 4.1). Worthy to note, is that there were children of age 13 years and older, the oldest child being 16 years old. The presence of the older than 13 years' participants can be due to a repetition of one or more grades since they joined school. There were more participants residing in the township area (66.7%) than in the northern area (33.3%), however, the study population was similar in terms of both geographic areas falling in the lower socioeconomic category.

5.3 PHYSICAL ACTIVITY MEASUREMENTS

Table 4.2 indicates the results for the two age categories, 9 to 10 and 11 to 12 years old, as the other age groups had insignificant numbers. Furthermore, it must be noted that the value representing Tot_MVPA, is the weighted average of time per day spent in MVPA over the two respective periods, 'weekdays' and 'weekend days' and is therefore not merely the average of time spent on MVPA for the two respective periods (see Table 4.2).

Table 4.2 reflected that there was no evidence that the two age groups differ with regards to their MVPA levels during weekdays (p=0.4973), weekend days (p=0.0996) nor in time spent in MVPA on average per day when the total period of days were considered (p=0.2867). These findings are contradictory to what was found in some other studies also conducted in Port Elizabeth, South Africa, among children from the same socioeconomic status (Table 2.2), where it was reported that a younger age group (10-12 years) had significantly (p<0.01) lower MVPA compared to older children (13-15 years) (Müller et al., 2020), while in yet another study younger children (5-8 years) were found to have insignificantly (p>0.05) higher MVPA levels than older children (9-13 years) (Nqweniso et al., 2021). This can be due to the latter study comparing a younger age group (5-8 and 9-13 years) as compared to the current study (9-10 and 11-12 years), however, the difference was insignificant and hence can be ascribed to chance.

The international and South African studies reported that boys had a significantly higher participation in MVPA as compared to girls (Joensuu et al., 2018; Minnaar et al., 2016; Müller et al., 2020). These results are in agreement with the current study where it was found that for all three categories (WD_MVPA, WND_MVPA, Tot_MVPA) of MVPA, the girls recorded significantly lower PA levels than the boys (p<0.05). In fact, it was observed that the girls spent on the average 39% less time on MVPA than boys (p<0.0001). Interestingly, when comparing weekend to weekday MVPA, girls reduced their MVPA on the weekend by almost 6% while boys increased their weekend MVPA by just over 4% (p<0.0001). This could be explained by the evidence of studies that found that girls were participating in less PA as compared to boys, this due to limited access to proper, safe and affordable spaces for physically activities (section 2.8, Chapter 2) (Draper et al., 2014; Tomaz et al., 2020; WHO, 2018), however, an international study found no negative relationship between availability of facilities and physical activity (Villanueva et al., 2015). Moreover, girls may be tasked with household responsibilities (cooking and cleaning) which may limit MVPA participation (Kinsman et al., 2015).

The present study presented no significant differences between geographic areas ($p>0.05$), even though the children from the township area reported slightly higher values for weekdays and total time of MVPA (Table 4.2). These findings could be considered similar to those of an international study (Table 2.1), which indicated that there were no significant differences between girls from North East (NE) and South East (SE) region of England, however the researchers did find significant differences between boys from SE and NE (Ingle et al., 2016). This could be attributed to the significant ($p<0.001$) difference in age as boys from NE had lower MVPA than boys from SE. It has been noted in previous literature that PA tends to decrease with increasing age (Neshteruk et al., 2017).

5.4 PHYSICAL FITNESS COMPONENTS

The physical fitness components relevant to the present study are CRF (expressed as predicted VO_2max obtained from the 20m shuttle run test), strength (represented by GS), and body composition (represented by BMI and BF%). The two age categories, 9-10 and 11-12 years old are discussed, as the other age groups had insignificant numbers (as explained earlier).

5.4.1 Cardiorespiratory fitness

According to Table 4.3, the younger age group had a significantly ($p<0.0001$) larger mean VO_2max value (45.8 ± 3.8 ml/kg/min) than the older age group (44.5 ± 4.9 ml/kg/min). This is in agreement with another South African study (Table 2.2) which also found that younger children (5-8 years) had significantly ($p< 0.001$) higher VO_2max scores than older children (9-13 years) (Nqweniso et al., 2021). The latter study further found that older children were more sedentary (623.3 ± 68.0 min/day) as compared to younger children (604.8 ± 67.8 min/day) (Nqweniso et al., 2021), and this could be due to older children having a higher screen time than younger children. However, another South African study found that younger children had fewer steps a day compared to older children (Minnaar et al., 2016), which contradicts the findings of this study which could result from the use of different testing methods.

A South African study found that boys reported a higher CRF (50.8 ± 4.3 ml/kg/min) compared to girls (47.2 ± 3.5 ml/kg/min), and the difference was significant ($p<0.001$) (Salvini et al., 2018). However, another South African study found no significant difference for VO_2max between boys and girls (47.5 ± 3.5 ml/kg/min vs 47.8 ± 4.1

ml/kg/min; p> 0.05) (Nqweniso et al., 2021). The present study concurs with the study by Salvini et al. (2018), where boys presented with a significantly ($p<0.001$) larger average VO_2max value than girls (46.7 ± 4.7 ml/kg/min vs 43.8 ± 3.4 ml/kg/min). This could be due to boys being more physically active than girls, as it is widely assumed that boys are also more likely to participate in sport than girls (Draper et al., 2014). The difference between South African studies could be due to differences in study populations and consideration of other contributing factors.

When comparing studies that used other methods for CRF, these studies are in agreement with the present study, where it was reported that boys had performed significantly better than girls. For instance, a study that reported on the number of laps completed in the 20m shuttle run test, found that there were significant ($p<0.001$) differences among both boys (25.7 ± 15.0 laps; 22.7 ± 13.3 laps; 11.9 ± 7.0 laps) and girls (19.3 ± 10.5 laps; 16.2 ± 8.3 laps; 10.7 ± 3.4 laps) between all three categories of BMI (normal weight, overweight, and obesity) (López-Gil et al., 2020). Other studies that used a walk/run test found that there were significant gender differences, where boys were reported to have higher levels of CRF (1591m ± 356.76) as compared to girls (1440.64m ± 236.72) during a 9 minute walk/run test (Nsibambi et al., 2015), and boys performing significantly ($p < 0.001$) better in the 800m run (276.65 vs. 287.13 seconds) than the girls (Hsieh et al., 2014). It is evident that gender differences generally exist in respect of CRF among younger and older children, with boys reporting significantly higher CRF values than girls.

5.4.2 Grip strength

In this study (Table 4.3), boys overall presented a significantly higher mean GS value (15.0 ± 3.6 kg) as compared to girls overall (14.3 ± 3.7 kg), and the difference is significant ($p=0.0035$). Similar results on gender differences were found in a study, where for all categories (normal, overweight, and obese), boys had higher mean GS (12.98 ± 3.58 kg; 13.95 ± 4.18 kg; 14.25 ± 4.16 kg) than girls (11.25 ± 3.40 kg; 13.01 ± 4.18 kg; 13.60 ± 3.64 kg) (López-Gil et al., 2020). A South African study using the standing long jump, also found gender differences as well as weight category differences in that both normal-weight boys and girls had significantly higher muscle strength (127.1 ± 21.4 cm and 114.1 ± 22.5 cm) than the obese boys and girls (94.3 ± 20.9 cm; 94.7 ± 10.3 cm, respectively) (Truter et al., 2010).

It was further found that there was an overall significant difference ($p<0.0001$) between the younger and older age groups (13.6 ± 2.9 kg vs 16.0 ± 3.8 kg), which is also of a high practical significance (Cohen's d=-0.73753) favouring the older age group (Table 4.3). In respect of the geographic area, the schoolchildren from the northern area showed a slightly higher GS mean value, but the difference was inconclusive ($p=0.0672$).

5.4.3 Body composition (body mass index and body fat percentage)

The findings for both BMI and BF% in the present study are similar. When comparing average BMI, there was a significant difference between the overall age categories ($p=0.0027$), where the younger age group had a significantly ($p= 0.0027$) lower BMI (17.7 ± 3.5 kg/m^2) than the older age group (18.5 ± 4.0 kg/m^2). When comparing genders, the girls presented a significantly ($p= 0.0001$) higher mean BMI (18.5 ± 4.0 kg/m^2) than the boys (17.5 ± 3.2 kg/m^2), however, when confounding variables were considered (PA, age and CRF), no significant difference was found between the average BMI's of the girls and boys ($p=0.0746$). Minnaar et al. (2016) reported a similar tendency, where it was found that 20% of the 78 children assessed were overweight or obese and 62.5% of these were girls. Other South African studies also found similar results, where boys reported a lower BMI (16.8 ± 2.6 vs 17.3 ± 3.3; $p=0.013$) and BF% (24.5 ± 5.1% vs 20.7 4.8%) compared to girls (Nqweniso et al., 2021; Salvini et al., 2018). There was some difference between the geographic areas, however, the statistical significance of this difference was inconclusive ($p=0.0683$). It can be concluded that BMI increases with age, and that girls have a higher BMI than boys if no other confounding variables are considered.

For BF%, there was a significant difference between the age categories ($p=0.0003$), with children in the younger age category reporting a lower BF% (8.4 ± 4.7 %) than the older age category (9.8 ± 6.5%). Girls overall reported a significantly ($p<0.0001$) higher BF% than the boys (10.2 ± 5.8% vs 7.6 ± 4.9%). Findings from another study agree with the tendency found in the present study. It was found that girls reported a significantly higher BF% measurements at all ages compared to boys ($p=0.001$), and BF% increased with age, but insignificantly so for boys (Goon et al., 2013). An international study found that boys had an insignificantly lower BMI than girls (18.2 ± 3.1 kg/m^2 vs 18.8 3.0 kg/m^2; $p=0.03$), and the BF% of boys was significantly lower than that of girls (14.7 ± 7.8% vs 20.4 ± 6.9%; $p<0.001$) (Joensuu et al., 2018), this finding is similar to that of this study when confounding variables are considered.

In South Africa, Nqweniso et al. (2021) found that younger children (5-8 years) displayed higher BF% (22.8 ± 5.0% vs 22.3 ± 5.9%) and lower clustered risk score (−0.1 ± 2.4 vs 0.1 ± 2.6) compared to the older children (9-13 years), however, the differences were insignificant ($p> 0.05$). These findings differ from those of the present study, and this could be explained by the differences in the age categories between the current study (9-10 years and 11-12 years) and the aforementioned study (5-8 years and 9-13 years). Based on the findings in this section, it can be concluded that girls present a higher BMI and BF% than boys, and the higher the BMI the higher the BF%.

5.5 RELATIONSHIP BETWEEN PHYSICAL ACTIVITY AND PHYSICAL FITNESS COMPONENTS

Multiple regression models were used to investigate the simultaneous effect of age, gender, and geographic area on the interrelationship between physical activity (in particular time spent in MVPA on average per day) and the measured PF components. These are discussed in relation to the empirical literature reviewed in Table 2.1 and 2.2 of Chapter 2.

According to Table 4.4 and Figure 4.4, the level of MVPA had a strong significant correlation with the mean VO_2max values of the sampled children in the present study ($p<0.0001$). This is similar to findings from an international study indicating a positive relationship between MVPA and PF ($R^2= 0.321$; $p<0.001$), where children with higher MVPA performed significantly better in PF tests (Joensuu et al., 2018). Another study found that children that did not meet the recommendations in relation to MVPA, screen time and SLEEP, were at a higher risk of being obese than those who met all recommendations (Roman-Viñas et al., 2016). Findings of the present study are similar to those of a study conducted by Müller et al. (2020), where it was reported that children who participated more in MVPA had a lower clustered cardiovascular risk ($b=-0.01$; $p<0.05$). However, according to Table 4.5, there was no correlation between the time spent on average per day in MVPA and GS ($p=0.5069$). In this study, it is evident that there is only a positive correlation between MVPA and CRF when controlled for age, gender and geographic area, and it can be concluded that the higher the MVPA level, the better the performance in CRF for the age range 8 to 13 years.

The age of the children is significantly correlated with average VO_2max ($p<0.0001$) and this relationship is inversely proportional (Figure 4.2). For instance, it was found that as the children grow older, their average VO_2max values tend to decrease. It was also found that the correlation between average VO_2max and age, differed for both genders ($p=0.0002$), where it was found that the decrease of the average VO_2max with age was much more pronounced for girls than for boys. The latter finding may be related to the fact that the female body increases BF% in preparation for maturity, with the subsequent detrimental effect on their CRF. Furthermore, there was a positive correlation between VO_2max and GS, reporting an increase in GS for every increase of 10 ml/kg/min of VO_2max (Figure 4.6).

Comparing VO_2max and BMI, a non-linear association between the two components was found to be significant ($p<0.0001$), this is evident from Figure 4.3. The non-linear association indicated that as BMI increases, the VO_2max decreases, however once BMI is larger than 25, the VO_2max starts to plateau. These findings are similar to other studies. For instance, utilising the PACER fitness test measuring completed laps, it was found that the cardiovascular endurance of the boys of normal weight (32.9 ± 17.0 laps) differed further from that of the overweight (18.7 ± 10.4 laps) as well as the obese boys (11.7 ± 7.7 laps), while there were no differences between the girls (Truter et al., 2010). A negative association was also found in another study between estimated VO_2max and BF%, triglycerides, and clustered cardiovascular risk (Nqweniso et al., 2021). Lastly, another study found that for boys and girls, normal weight children displayed a higher CRF and comparative lower GS than overweight or obese children (López-Gil et al., 2020). It can be concluded that there is supportive evidence for the significant negative correlation found in the present study between CRF and BMI.

The average BMI of this study sample is positively correlated with the age of the children, indicating that as the children grow older, the BMI increases (Table 4.6). The BMI of this sample of children also has a non-linear effect on their average GS. Predictably, average GS increases significantly with BMI, however, as the BMI's go higher than 25, the GS increase starts to plateau. The present study also found that the time spent in MVPA has a strong negative influence on BMI and the effect of physical exercise on BMI is also dependent on the VO_2max levels. These findings are similar to the results from a South African study, where MPA was negatively correlated with BF%, and high VPA and MVPA were both associated with lower BF% and lower clustered cardiovascular risk (Nqweniso et al., 2021).

Interestingly, it was indicated in Chapter 4 that no gender differences were found for BMI when controlled for MVPA. This can be explained by Table 4.7 and Figure 4.9, where it is indicated that there are more girls with low MVPA values and therefore will be representative of the mean BMI for girls reporting a higher BMI and lower MVPA. However, girls that have MVPA values equal to that of the boys falling in the high MVPA category, have similar BMI to the boys. These findings are similar to a study indicating that the MVPA recommendation yielded a lower BMI for the children meeting the recommendation than those who did not meet them (Roman-Viñas et al., 2016). This is evidence that there is a negative association between MVPA and BMI. Furthermore, it is evident that for the age range of children involved in the present study there is no significant difference between the BMI of girls and boys when controlled for the confounding effect of physical activity, age and CRF. This emphasizes the importance of and benefits to girls of meeting the PA recommendations, and the need for targeted interventions for the promotion of PA in girls.

5.6 SUMMARY OF FINDINGS

The previous section presented a discussion and interpretation of the results. Literature was further utilised to compare the results obtained. The following section provides a summary of the findings of the study, reflecting the research objectives indicated in Chapter 1.

With regards to PA:

- There were no significant differences found between the two age groups during WD_MVPA, WND_MVPA, and Tot_MVPA.
- Girls did not meet the recommended MVPA during WND_MVPA, however, were on average just above the recommended level for WD_MVPA and Tot_MVPA.
- Girls spent on the average 39% less time on MVPA than boys.

- Girls decrease their MVPA during the weekend by almost 6% while boys increase their weekend MVPA by just over 4%.
- No significant differences were found between the two geographic areas.

With regards to the PF components:

- The younger age group presented a higher mean VO_2max value than the older age group (45.8 ± 3.8 ml/kg/min vs 44.5 ± 4.9 ml/kg/min).
- Boys reported a larger mean VO_2max value than girls (46.7 ± 4.7 ml/kg/min vs 43.8 ± 3.4 ml/kg/min).
- The younger age group reported a significantly lower GS than the older age group (13.6 ± 2.9 kg vs 16.0 ± 3.8 kg).
- The boys presented a higher GS (15.0 ± 3.6 kg) compared to girls (14.3 ± 3.7 kg). However, when controlling for age, BMI, VO_2max and MVPA, no differences between the two genders was found (p=0.3645).
- No significant differences were found for VO_2max and GS between the two geographic areas. However, when controlled for confounding variables (age, gender, BMI and MVPA) a significant association between geographic area and grip strength was found with children from the northern areas presenting with higher grip strength.

With regards to body composition:

- The younger age group reported a significantly lower BMI (17.7 ± 3.5 kg/m^2) than the older age group (18.5 ± 4.0 kg/m^2).
- The girls had a significantly higher mean BMI (18.5 ± 4.0 kg/m^2) than the boys (17.5 ± 3.2 kg/m^2). When controlling for confounding variables (age, geographic area, VO_2max and MVPA), no significant differences were found between the two genders (p=0,0746).
- The younger age category reported a lower BF% (8.4 ± 4.7 %) than the older age category (9.8 ± 6.5%).
- Girls had a significantly higher BF% (10.2 + 5.8%) than the boys (7.6 + 4.9%).
- No significant differences were found between the geographic areas for both BMI and BF%. However, when confounding variables (age, gender, VO_2max, and MVPA) were considered, there was a significant difference in the BMI

(p=0.0007) and BF% (p=0.0003) of the children from the two geographic areas, with the township area presenting with higher values than the northern area.

- When comparing age for girls, it was indicated that BF% increases between age 8-11 years and slightly decreases between age 11-13 years, which indicates a non-linear correlation between BF% and age.

With regards to PA and PF components:

- Age was found to be negatively correlated with average VO_2max ($p<0.0001$), however the effect of age on the average VO_2max differs for gender (p=0.0002), the decrease of the average VO_2max with age is much more pronounced for girls than for boys.
- There was a negative non-linear correlation between VO_2max and BMI.
- When controlled for VO_2max, girls with lower VO_2max (40 ml/kg/min) levels indicated a negative non-linear association between MVPA and BF%, however, girls with higher VO_2max (50 ml/kg/min) levels indicated MVPA having little to no effect on their BF%.
- There was a strong positive correlation between VO_2max and MVPA. For both girls and boys, the average VO_2max values increase by 2.8% for every extra hour of MVPA.
- There was a non-linear correlation between BMI and GS. The average GS increases significantly with BMI, however, as the BMI rises higher than 25 kg/m^2, the grip strength increase starts to plateau.
- No difference between the average grip strengths of girls and boys could be detected (p=0.5069). Also, no correlation between the time spent on average per day in MVPA and grip strength was evident (p=0.5069).
- A positive correlation between VO_2max and GS was found. For every increase of 10 ml/kg/min of VO_2max, the average grip strength of the children in this sample increases by 8%.
- A significant association between geographic area and grip strength was found with children from the northern areas presenting with higher grip strength.
- There was a negative non-linear association between VO_2max and BMI. As VO_2max increases, the BMI decreases and plateaus. Furthermore, the effect of age on BMI is significantly modified by VO_2max.

- There was a negative correlation between MVPA and BMI and the effect of PA on BMI is also dependent on the VO_2max levels.
- No difference between the BMI of girls and boys was found at comparative MVPA categories and therefore once more emphasising the importance of controlling for relevant confounding variables when comparing values for the same variable across ages, gender and geographic location (the latter potentially representing participants of different socioeconomic status, cultures and other characteristics).

5.7 CONCLUSION

The results of the present study provided insight into the status of physical PA and PF of intermediate-phase schoolchildren from marginalised communities in Port Elizabeth. The descriptive statistics for the PA and PF components provided in this study quantify the performance of the relevant sample of schoolchildren, particularly in the age groups of 9-10 years and 11-12 years old. Comparisons between the two relevant age groups, the two genders and the two geographic areas they reside in, were provided respectively for each of the dependent variables: PA, CRF, GS, BMI and BF%. However, the subsequent regression analysis that were done to consider the simultaneous effect of age, gender geographic area and all the other variables (PA and PF component variables), have provided valuable insight into the comparisons of groups and highlighted the caution with which single variable comparisons should be interpreted.

Furthermore, overall girls seem to be more at risk than boys for future non-communicable diseases and for the following reasons; on average they did not meet the recommended MVPA during weekend days; they spent 39% less time on average on MVPA per day than boys; no difference between boys and girls in respect of BMI at similar levels of MVPA were found, thus implying that girls can reduce their BMI if they are more active; and girls presented a steeper decline in VO_2max with age than boys. These findings therefore highlight the importance of promoting PA and monitored PF of children, more particularly girls in marginalised communities.

5.8 LIMITATIONS

All efforts were made to ensure the study is conducted as best as possible; however, the following limitations were experienced and may have affected the study outcomes:

- The study was conducted in disadvantaged communities and incorporated only quintile three primary schools. This means there was relatively little variation in socioeconomic status, limiting the outcomes of the study to the relevant level of socioeconomic status.
- There was no randomised selection of schools, as selection was based on the willingness of the school to participate.
- Even though motivation was given to the children during testing, the level of motivation might have affected the performance in children, especially for the GS and 20m shuttle run test.

Despite these limitations, the results of this research study are still relevant and provide further baseline data for the larger *KaziBantu* study. Furthermore, the physical activity and physical fitness status of children living in disadvantaged areas of Port Elizabeth are now known (in addition to the interrelationships between the components), and can contribute to gaps in literature.

5.9 RECOMMENDATIONS

The following are recommendations for future research in relation to the current study:

- Larger studies with a bigger sample of schools within the Eastern Cape province and other provinces, as well as socioeconomic status variances are recommended.
- Programmes to regularly monitor the PA and PF of children from disadvantaged communities are recommended.
- Other intervention programmes that educate the learners about the value of healthy lifestyles are recommended.
- Targeted interventions, particularly aimed at girls in marginalised communities are needed.

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LIST OF APPENDICES

APPENDIX 1: NMU Ethics Approval letter

NELSON MANDELA

UNIVERSITY

PO Box 77000, Nelson Mandela University, Port Elizabeth, 6031, South Africa mandela.ac.za

Chairperson: Research Ethics Committee (Human)
Tel: +27 (0)41 504 2235
charmain.cilliers@mandela.ac.za

Ref: [H18-HEA-HMS-001 / Approval]

26 March 2018

Prof C Walter
Faculty of Health Sciences
South Campus

Dear Prof Walter

EFFECTS OF A SCHOOL-BASED HEALTH INTERVENTION PROGRAMME IN MARGINALISED COMMUNITIES IN PORT ELIZABETH, SOUTH AFRICA: THE KAZIBANTU PROJECT

PRP: Prof C Walter
PI: Prof R du Randt

Your above-entitled application served at the Research Ethics Committee (Human) for approval.

The ethics clearance reference number is **H18-HEA-HMS-001** and is valid for three years. Please inform the REC-H, via your faculty representative, if any changes (particularly in the methodology) occur during this time. An annual affirmation to the effect that the protocols in use are still those for which approval was granted, will be required from you. You will be reminded timeously of this responsibility, and will receive the necessary documentation well in advance of any deadline.

We wish you well with the project.

Yours sincerely

CB Cilliers

Prof C Cilliers
Chairperson: Research Ethics Committee (Human)

Cc: Department of Research Capacity Development
Faculty Officer: Health Sciences

APPENDIX 2: Department of education Ethics Approval letter

Province of the
EASTERN CAPE
EDUCATION

STRATEGIC PLANNING POLICY RESEARCH AND SECRETARIAT SERVICES
Steve Vukile Tshwete Complex • Zone 6 • Zwelitsha • Eastern Cape
Private Bag X0032 • Bhisho • 5605 • REPUBLIC OF SOUTH AFRICA
Tel: +27 (0)40 608 4773/4035/4537 • Fax: +27 (0)40 608 4574 • Website: www.ecdoe.gov.za

Enquiries: B Pamla Email: bobo[illegible].pamla@ecdoe.gov.za Date: 09 May 2018

Professor Cheryl Walter

Department of Human Movement Science

Nelson Mandela University

Port Elizabeth

77000

Dear Prof. Walter

PERMISSION TO UNDERTAKE A RESEARCH PROJECT: EFFECTS OF A SCHOOL-BASED HEALTH INTERVENTION PROGRAMME IN MARGINALISED COMMUNITIES OF PORT ELIZABETH, SOUTH AFRICA – THE KAZIBANTU PROJECT

1. Thank you for your application to conduct research.
2. Your application to conduct the abovementioned research involving 800 participants from four Primary Schools of Nelson Mandela Bay District under the jurisdiction of the Eastern Cape Department of Education (ECDoE) is hereby approved based on the following conditions:
    a. there will be no financial implications for the Department;
    b. consent will be sought from parents of minor children;
    c. institutions and respondents must not be identifiable in any way from the results of the investigation;
    d. you present a copy of the written approval letter of the Eastern Cape Department of Education (ECDoE) to the Cluster and District Directors before any research is undertaken at any institutions within that particular district;
    e. you will make all the arrangements concerning your research;
    f. the research may not be conducted during official contact time;

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g. should you wish to extend the period of research after approval has been granted, an application to do this must be directed to Chief Director: Strategic Management Monitoring and Evaluation;

h. your research will be limited to those institutions for which approval has been granted, should changes be effected written permission must be obtained from the Chief Director: Strategic Management Monitoring and Evaluation;

i. you present the Department with a copy of your final paper/report/dissertation/thesis free of charge in hard copy and electronic format. This must be accompanied by a separate synopsis (maximum 2 – 3 typed pages) of the most important findings and recommendations if it does not already contain a synopsis.

j. you present the findings to the Research Committee and/or Senior Management of the Department when and/or where necessary.

k. you are requested to provide the above to the Chief Director: Strategic Management Monitoring and Evaluation upon completion of your research.

l. you comply with all the requirements as completed in the Terms and Conditions to conduct Research in the ECDoE document duly completed by you.

m. you comply with your ethical undertaking (commitment form).

n. you submit on a six-monthly basis, from the date of permission of the research, concise reports to the Chief Director: Strategic Management Monitoring and Evaluation

3. The Department reserves a right to withdraw the permission should there not be compliance to the approval letter and contract signed in the Terms and Conditions to conduct Research in the ECDoE.

4. The Department will publish the completed Research on its website.

5. The Department wishes you well in your undertaking. You can contact the Director, Ms. NY Kanjana on the numbers indicated in the letterhead or email nelisa.kanjana@ecdoe.gov.za should you need any assistance.

NY KANJANA
DIRECTOR: STRATEGIC PLANNING POLICY RESEARCH & SECRETARIAT SERVICES

FOR SUPERINTENDENT-GENERAL: EDUCATION

APPENDIX 3: Department of Health Ethics Approval letter

Province of the
EASTERN CAPE
HEALTH

Enquiries: Zonwabele Merile

Email: Zonwabele.Merile@echealth.gov.za

Tel no: 083 378 1202

Fax no: 043 642 1409

Date: 05 JUNE 2018

RE: EFFECTS OF A SCHOOL-BASED HEALTH INTERVENTION PROGRAMME IN MARGINALISED COMMUNITIES IN PORT ELIZABETH, SOUTH AFRICA: THE KAZIBANTU PROJECT. (EC_201804_007)

Dear Prof C. Walter and Prof R. Du Randt

The department would like to inform you that your application for the abovementioned research topic has been approved based on the following conditions:

1. During your study, you will follow the submitted amended protocol with ethical approval and can only deviate from it after having a written approval from the Department of Health in writing.

2. You are advised to ensure, observe and respect the rights and culture of your research participants and maintain confidentiality of their identities and shall remove or not collect any information which can be used to link the participants.

3. The Department of Health expects you to provide a progress on your study every 3 months (from date you received this letter) in writing.

4. At the end of your study, you will be expected to send a full written report with your findings and implementable recommendations to the Eastern Cape Health Research Committee secretariat. You may also be invited to the department to come and present your research findings with your implementable recommendations.

5. Your results on the Eastern Cape will not be presented anywhere unless you have shared them with the Department of Health as indicated above.

Your compliance in this regard will be highly appreciated.

SECRETARIAT: EASTERN CAPE HEALTH RESEARCH COMMITTEE

APPENDIX 4: Ethics Approval Letter for the Current Study

NELSON MANDELA
UNIVERSITY

PO Box 77000, Nelson Mandela University, Port Elizabeth, 6031, South Africa mandela.ac.za

Chairperson: Research Ethics Committee (Human)
Tel: +27 (0)41 504 2235
charmain.cilliers@mandela.ac.za

NHREC registration nr: REC-042508-025

Ref: [H19-HEA-HMS-002] / Approval]

5 June 2019

Prof C Walter / Prof R du Randt
Faculty: Health Sciences

Dear Profs Walter and Du Randt

STATUS OF PHYSICAL ACTIVITY AND PHYSICAL FITNESS AMONG INTERMEDIATE-PHASE SCHOOL CHILDREN FROM MARGINALISED COMMUNITIES IN PORT ELIZABETH

PRP: Prof C Walter / Prof R du Randt
PI: Ms S Ncanywa

Your above-entitled application served at the Research Ethics Committee (Human) (meeting of *27 March 2019*) for approval. The study is classified as a medium risk study. The ethics clearance reference number remains **H19-HEA-HMS-002** and approval is subject to the following conditions:

1. The immediate completion and return of the attached acknowledgement to Imtiaz.Khan@mandela.ac.za, the date of receipt of such returned acknowledgement determining the final date of approval for the study where after data collection may commence.
2. Approval for data collection is for 1 calendar year from date of receipt of above mentioned acknowledgement.
3. The submission of an annual progress report by the PRP on the data collection activities of the study (form RECH-004 to be made available shortly on Research Ethics Committee (Human) portal) by 15 November this year for studies approved/extended in the period October of the previous year up to and including September of this year, or 15 November next year for studies approved/extended after September this year.
4. In the event of a requirement to extend the period of data collection (i.e. for a period in excess of 1 calendar year from date of approval), completion of an extension request is required (form RECH-005 to be made available shortly on Research Ethics Committee (Human) portal)
5. In the event of any changes made to the study (excluding extension of the study), completion of an amendments form is required (form RECH-006 to be made available shortly on Research Ethics Committee (Human) portal).
6. Immediate submission (and possible discontinuation of the study in the case of serious events) of the relevant report to RECH (form RECH-007 to be made available shortly on Research Ethics Committee (Human) portal) in the event of any unanticipated problems, serious incidents or adverse events observed during the course of the study.
7. Immediate submission of a Study Termination Report to RECH (form RECH-008 to be made available shortly on Research Ethics Committee (Human) portal) upon unexpected closure/termination of study.
8. Immediate submission of a Study Exception Report of RECH (form RECH-009 to be made available shortly on Research Ethics Committee (Human) portal) in the event of any study deviations, violations and/or exceptions.
9. Acknowledgement that the study could be subjected to passive and/or active monitoring without prior notice at the discretion of the Research Ethics Committee (Human).

Please quote the ethics clearance reference number in all correspondence and enquiries related to the study. For speedy processing of email queries (to be directed to Imtiaz.Khan@mandela.ac.za), it is recommended that the ethics clearance reference number together with an indication of the query appear in the subject line of the email.

We wish you well with the study.

Yours sincerely

CB Cilliers

Prof C Cilliers
Chairperson: Research Ethics Committee (Human)

Cc: Department of Research Capacity Development
Faculty Officer: Health Sciences

Appendix 1: Acknowledgement of conditions for ethical approval

APPENDIX 5: Information Sheet and Consent form

Project title: Effects of a school-based health intervention programme in marginalised communities of Port Elizabeth, South Africa: The *KaziBantu* project

Information Sheet for Parents/Guardians

Identity of researchers and sponsoring institution: This study will be carried out in collaboration with Prof. Cheryl Walter, Prof. Rosa du Randt from the Nelson Mandela University, Port Elizabeth, South Africa and Prof. Pühse from the University of Basel, Switzerland. The following institutions will be part of the research team, namely the Swiss Tropical and Public Health Institute (Swiss TPH) and the Department of Sport, Exercise and Health, University of Basel, Switzerland. The study is funded by the Novartis Foundation, a non-profit organization located in Basel, Switzerland.

Study objectives: To assess the efficacy of a school-based health promotion program on risk factors for non-communicable chronic diseases (e.g., type 2 diabetes, obesity, hypertension) and health behaviours (e.g., physical activity) in grade 4 to 6 primary schoolchildren from selected communities in Port Elizabeth. This study will further our knowledge about the potential of school health interventions to improve children's health and wellbeing.

Research procedures: This research project takes place over 12 months (1 school year). Approximately 1080 children from 8 different schools in Township and/or Northern Areas of Port Elizabeth will take part in this study. Official authorities (Eastern Cape Department of Education, Eastern Cape Department of Health) have approved the study, and the school principals have agreed to participate in the study. Out of the 8 schools, 6 schools are randomly assigned to an intervention condition and 2 schools to a control condition. From each school only one class per grade will be randomly selected for testing. Each child will be assessed twice. The first assessment will be during January 2019 before the intervention, and the second assessment during October 2019 after the intervention. Each data assessment period will take up to 3 school days per school. However, each tested class will be involved for no longer than ±3 hours during each assessment period.

Consent: Permission for your child's participation in the project is sought, but due to a cap on the number of participants that can be assessed in the given time for the research, not all children with signed consent from their parents/ legal guardian will be selected for testing. If your child attends a school that is randomly identified as an intervention school, your child will receive the intervention program irrespective of wheather he/she has been tested. If your child attends a school that is identified as a control school, your child can also receive the intervention program, but only from 2020. The contents of the intervention program (physical activity and health lessons) is taught during regular school hours. The intervention schools will implement an intervention program consisting of one weekly Physical Education lesson (40 min), one weekly Moving-to-Music lesson (40 min), 3 Health Education lessons, and 3 Nutritional Education lessons for each grade per year.

Voluntary participation: It is your choice whether to have your child participate or not. If you choose not to consent, all school services for your child will continue and nothing will change. Should you decide to withdraw your consent before the project commences in January, kindly inform your child's class teacher or contact the researchers (see contact details on page 2). You may also choose to change your mind later and stop participating, even if you agreed earlier. However, we would like to inform you that the data gathered before withdrawal can be used for reports and publications.

Confidentiality: All information collected in this study will be coded with a unique personal identification number and stored in a safe place. Only members of the study will have access to the data. The officials of the national committee of ethics and research can ask for access to the collected information for the monitoring of good clinical practice. We will publish the key findings of this study but names and personal identities will not be revealed.

Sharing of the Results: Confidential information will not be shared. Reseach results will be published.

Risks: There are no specific risks associated with this study. Risks for capillary blood sampling are minimal and present a frequently used procedure. Nevertheless, finger prick might be a slightly uncomfortable procedure. A qualified professional nurse will examine your child before he/she engages in the maximal fitness test (20m shuttle run). The project nurse will determine whether a child suffers from a medical condition, which prevents participation in such a maximal physical fitness test.

NOVARTIS | The Novartis Foundation NELSON MANDELA UNIVERSITY University of Basel Swiss TPH

Project title: Effects of a school-based health intervention programme in marginalised communities of Port Elizabeth, South Africa: The *KaziBantu* project

Benefits
If your child participates in this research, it will have the following benefits:

- Clinical Examination: All children receive a free clinical examination by a registered nurse. In case of detection of severe medical conditions, children will be referred to a local clinic.
- Health and Nutritional Education: All children receive two health and nutritional education lessons per term.
- Food and Drinks: Refreshments will be served after blood testing and the physical fitness testing.

Data Assessment: The two measuring occasions will involve the following tests:

Clinical Examination 	The clinical examination involves anthropometric indicators (e.g. height, weight), body composition and blood pressure, which are all non-invasive. To assess blood lipids, a small quantity of capillary blood is needed (a few blood drops). Therefore, the finger will be pricked with a small lancet. This is a slightly uncomfortable procedure but does not cause any long-lasting pain. Blood tests will be done fasting (meaning not eating or drinking). More information about the fasting will be provided to all study participants before testing. HIV/AIDS testing will **NOT** be done.
Physical Fitness 	Children's physical fitness will be assessed with the 20m shuttle-run test.
Physical Activity 	Physical activity levels will be assessed via accelerometry. Therefore, we will ask your child to wear an accelerometer device for 7 days around the hip.

Who to Contact: If you have any questions, you may ask our present research assistant(s) now or later, even after the study has started. If you wish to ask questions later, you may contact any of the following:

Professor Cheryl Walter (South African principal investigator)
Tel.: +27 41 504-2499/7
E-Mail: Cheryl.Walter@mandela.ac.za

Danielle Smith (local coordinator)
Tel.: +27 41 504-4692
E-Mail: Danielle.Smith@mandela.ac.za

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Project title: Effects of a school-based health intervention programme in marginalised communities of Port Elizabeth, South Africa: The *KaziBantu* project

KaziBantu

Healthy Schools for Healthy Communities

I have read the foregoing information regarding the planned study or it has been read to me in a language that I understand. I have also had the opportunity to ask questions about the study and these have been answered to my satisfaction. I am aware of the purpose, objectives and procedures, risks and benefits of the study. I understand that I can withdraw my child from the study at any time without further consequences.

I hereby consent for my child to participate in the research which will include the relevant assessments and where applicable the interventions indicated. I also acknowledge and accept that:

- Only one class per grade in my child's school will be included in the assessment/testing involved in this research process.
- The class to be tested per grade will be randomly selected in January 2019 when class lists have been finalised.
- My child may therefore not form part of the relevant class.

Statement by the parent/legal guardian

I, as the parent/legal guardian, I consent voluntarily for my child to participate in the *KaziBantu* study.

Name of child:

Surname of child:

Name of parent/legal guardian:

Surname of parent/legal guardian:

Signature of parent/legal guardian:____________________ Date: ____________________

If parent/legal guardian is illiterate: A literate witness must sign. Participants who are illiterate should include their thumbprint as well.

I have witnessed the accurate reading of the consent form to the parent of the potential participant, and the individual has had the opportunity to ask questions. I confirm that the individual has given consent freely.

Name of witness:

Surname of witness:

Signature of witness: ____________________

Date: ____________________

AND Thumbprint of parent/legal guardian

Project title: Effects of a school-based health intervention programme in marginalised communities of Port Elizabeth, South Africa: The *KaziBantu* project

KaziBantu

Participant release for the use of audio and visual content

Name of parent/legal guardian:

Surname of parent/legal guardian:

Name of child:

Surname of child:

Child's permission:

I hereby give Novartis Foundation and other *KaziBantu* partners permission to use the images and their audio and visual content, together with my name and any information or comments that I may provide (the "Information") free of charge (except if explicitly agreed otherwise in a separate written agreement) in any media for any Novartis Foundation or *KaziBantu* related purpose which may include, among others, Novartis or *KaziBantu* internet activities, and internal and external social media channels (e.g., Twitter, Facebook, etc.), and waive any right to inspect or approve any final product. I agree that the information may be combined with other images, sound, text and graphics, and cropped/cut, altered or modified. I acknowledge that the information may be published on the internet. Images shall include photographs and films including spoken language.

If participant is under 18 years old, parent warrants and represents that parent is the legal guardian of the participant and has the full legal capacity to consent to the shoot and to execute this release.

To be completed by the child's parent/legal guardian:

Parent's/Legal Guardian's signature: ______________________

Date: ______________________

I represent and warrant that I have understood the content above.

To be completed by the child:

Child's signature: ______________________

Date: ______________________

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APPENDIX 6: Assent Form

Assent form template for child participants

TITLE: Effect of a school-based multi-component physical activity intervention on the growth and non-communicable disease risk status of grades 4 to 6 schoolchildren from disadvantaged communities in Nelson Mandela Bay, South Africa.

Directions: These explanations will be discussed verbally with the children

Explanation of the study (What will happen to me in this study?)

The purpose of this study is to see how physically active and fit children are so that we can help make them exercise and become healthy. We will ask you to take part in running, and exercise activities.

Risks or discomforts of participating in the study (Can anything bad happen to me?)

You may feel a bit tired during and after the exercises. If you feel sick or have any pain after the exercises, please tell your parents or your teacher.

Benefits of participating in the study (Can anything good happen to me?)

It will be fun to exercise with your friends at school and you can see how fit and physically active you are.

Confidentiality (Will anyone know I am in the study?)

Nobody will know that you were in the study. We will not list your name on any of the reports.

Compensation for participation/medical treatment (What happens if I get hurt?)

Your parents or caregiver have been given information about the study. You should not get hurt in any way. But if you do, your parents will let us know and you will be taken to a doctor for treatment.

Contact information (Who can I talk to about the study?)

You can contact Danielle Smith on 078 222 7252, if you have any questions about the study.

Voluntary participation (What if I do not want to do this?)

You can stop being in the study at any time without getting in trouble.

Do you understand this study and are you willing to participate? YES NO

I am taking part in the study because I want to, and I have been told that I can stop at any time I want to and I won't get into trouble – nothing bad will happen to me if I want to stop.

_________________________ _________________________

Signature of Child Date