PHYSICAL ACTIVITY, PHYSICAL FITNESS, SEDENTARY BEHAVIOUR AND SCREEN TIME PROFILES OF PRIMARY SCHOOL CHILDREN IN A SCHOOL WITHIN THE MAKANA MUNICIPALITY, EASTERN CAPE, SOUTH AFRICA

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Abstract

Background: There is a lack of data on the physical activity, physical fitness and sedentary behaviour of children in South Africa. Furthermore chronic diseases such as type II diabetes and coronary heart disease have been linked to childhood inactivity, and improving cardiorespiratory fitness and increasing levels of physical activity has been shown to be beneficial in reducing the risk of such diseases. In South Africa more broadly there is a lack of information on levels of physical activity and sedentary behaviour as well as physical fitness measures particularly in children. **Objective:** The purpose of this study was to enhance the existing body of knowledge on this, by measuring the prevalence of physical inactivity, sedentary behaviour and screen time of primary school children in a private school from the Makana Municipal region in the Eastern Cape Province of South Africa, where the evidence is most sparse. A secondary aim was to assess levels of physical fitness in this cohort, as well as to compare across grades and sexes. **Method:** After ethical approval was granted, stature and body mass measurements were taken and body mass index was computed for primary school children (Grade one to seven) from a private school in the Makana Municipality. Sitting stature was measured in order to determine each child’s peak height velocity and maturity offset. Five different physical fitness tests were conducted on the children and blood pressure and heart rate values were measured at rest. Physical activity and screen time questionnaires were completed by the children’s parents for a seven day period. **Results:** Females were found to mature faster than males. In addition females were more physically active (Females= 916 min/week; Males= 669 min/week) while also accumulating more sedentary time (Females= 1241 min/week; Males= 970 min/week) as compared to males, although no significant differences were found between males and females for these variables. The sample participated in more than 60 minutes of moderate-to-vigorous physical activity and less than two hours of screen time daily, which is in accordance with guidelines. No differences were found between grades and sexes for accumulated screen time. Strength increased significantly with grade and age, and there were also statistical differences between the sexes for all three strength measures with males being stronger than females. Females were more flexible than males and no statistical differences were found between sexes for the shuttle run test. Blood pressure correlated positively with mass, as did all the strength measures as well as maturity offset. No correlations were found between screen time and all other variables. A negative relationship was recorded between screen time and physical activity, although not significant. For females a strong positive correlation was found between sedentary behaviour and physical activity. **Conclusion:** The study was successful in adding to the body of knowledge regarding the prevalence of physical inactivity, sedentary behaviour and screen time within school children from the Makana Municipality in the Eastern Cape Province of South Africa. The sample was considered physically active as they accumulated on average more than 60 minutes of moderate-to-vigorous physical activity daily (Males= 96 min/day; Females 130 min/day), which is in accordance with guidelines recommended by the World Health Organization (World Health Organization, 2018). The sample accumulated more sedentary behaviour than physical activity, although not significant. Screen time was below regulations of two hours daily, indicating this population participated in more non screen related sedentary behaviour. More research is needed into the risks presented with different forms of sedentary behaviour. Physical fitness increased with increasing grade and age and males were considerably more fit. The current study did not present any concern with regards to the effects of increased physical activity and fitness levels within school aged children. More research into the current levels of physical activity, physical fitness and sedentary behaviour of school aged children in South Africa in general, and in the Eastern Cape Province, is needed.

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CHAPTER I

Introduction

Moderate to high levels of cardiorespiratory fitness and physical activity have been consistently shown to be beneficial in reducing the risks of obesity and coronary heart disease (Ekelund et al., 2006;) and type II diabetes (Sigal et al., 2004; Jeon et al., 2007; Venditti, Emery, & Kolko, 2020). These chronic diseases in adulthood have been linked to childhood inactivity (Kelishadi, & Heidari-Beni, 2019; Weihrauch-Blüher, Schwarz, & Klusmann, 2019). This has resulted in the need for early identification of risk factors for reduced physical fitness, low/poor levels of physical activity and high levels of sedentary behaviour mostly attributed to screen time (Tomkinson et al., 2003).

Levels of physical activity have decreased rapidly within children (Draper et al., 2018). This decline has been documented to continue throughout adulthood as it has been determined that the less active you are as a child, the less active you will be as an adult (Micklesfield et al., 2014; Prioreshi et al., 2017; Kallio et al., 2018). This, in turn, increases the risk of obesity and has been linked to many other chronic diseases (Mendoza et al., 2012; Janssen et al., 2013; Lahey & Khan, 2018). Physical inactivity and sedentary behaviour have been described as two separate concepts (Caspersen, Powell, & Christenson, 1985; Clemes et al., 2015). While someone can be classified as sedentary they still may reach physical activity guidelines daily (Draper et al., 2018). Therefore, a person would be classified physically inactive if they do not obtain the recommended level of 60 minutes moderate-to-vigorous physical activity daily (Clemes et al., 2015; Draper et al., 2018). Sedentary behaviour is a behaviour that utilizes less than 1.5 METs (Metabolic equivalent: 1 MET, 1 kilocalorie per kg per hour) (Clemes et al., 2015; Kinnett-Hopkins et al., 2019). A person is considered sedentary when their daily routine comprises mostly of these activities (Clemes et al., 2015).

While physical activity has been declining in children (Micklesfield et al., 2014); sedentary behaviour is increasing due to greater access to technology and more screen time (Council, 2016; Swanson, 2016). School is a very useful vessel to ensure that children are getting the required 60 minutes of moderate-to-vigorous physical activity per day, through Physical Education classes and compulsory sports participation (Draper et al., 2014; Draper et al., 2018).

Schools in South Africa are separated into public and private schools. Due to the country's unique history the scholars in such schools are typically of a high social economic status for private schools and a lower social economic status for public schools (Van Deventer, 2012; Cleophas, 2014). The reason for this is that private schools cost more to attend and therefore, the attendees are of a higher socioeconomic background (Van Deventer, 2012; Cleophas, 2014). Due to these differences it is important to look at the two sectors and children thereof, separately (Van Deventer, 2012; Cleophas, 2014). For example, private schools have access to certain facilities that aid in the increase of overall physical activity and organised sports participation, whereas public schools do not have the funds for these facilities nor the instructors needed to perform the classes and sports practices (Van Deventer, 2012). Private schools also have access to more technology such as computers and children of a higher social economic status have more access to television and cellular mobiles (Cleophas, 2014). This makes these children more vulnerable to an increased sedentary behaviour levels as compared to public school children (Van Deventer, 2012; Cleophas, 2014). The Healthy Active Kids South Africa Report Card from the year 2014 found less than 50% of rural children in South Africa took part in organised sport as compared to 66% of urbanised children (Draper et al., 2014). This is due to most private schools making it compulsory to participate in one or more school sporting activities (Draper et al., 2014). Furthermore in the 2016 and 2018 report cards, it was established that less than half of the children and youth were participating in organised sport (Uys et al., 2016; Draper et al., 2018).

Apartheid is a strong driver of disparities in South African communities (Cleophas, 2014), and Physical Education in schools is no exception. Physical Education classes used to be a compulsory subject within urban schools and only presented to the "unique Afrikaaner" or white children specifically (Cleophas, 2014). In 1994 when the African National Congress came into government they placed very little, if any, emphasis on the importance of Physical Education classes and maximizing overall physical activity levels within school time as they were not aware of its benefits (Cleophas, 2014). Therefore, in 1994 Physical Education was not presented as its own subject, but rather as a subset of the Life Orientation subject (Kloppers & Jansen, 1996; Cleophas, 2014). Through this development Physical Education classes were removed from almost all school curriculums or were significantly decreased with regard to the time and classes given weekly (Kloppers & Jansen, 1996; Cleophas, 2014).

With this history we can assume overall physical activity and physical fitness levels have dropped within the country over the past twenty years/ two decades, however there is a large lack of research and data to support this. To assist with building a case for Physical Education classes and for increasing opportunities to participate in a physically active lifestyle both in and outside the school environment, there is a need to establish current levels of physical activity and sedentary behaviour as well as levels of physical fitness.

In the Healthy Active Kids South Africa 2014 Report Card, a study from the Western Cape reported 81% of school principals in the area stated that their schools did not have the facilities or the teachers with adequate experience nor time to conduct such classes (Draper et al., 2014). In 2018 Healthy Active Kids South Africa reported that in a study of 12 countries South Africa had the lowest number of children participating in Physical Education at school (Draper et al., 2018). Despite policies introduced in 2016 there has been no change (Uys et al., 2016; Draper et al., 2018). If South African children are proven physically inactive, this would present evidence to support the full reintroduction of Physical Education as a subject within school curriculums. Therefore, more data is required on the current physical activity, physical fitness and sedentary behaviour levels of South African school children.

Furthermore a study by Armstrong, Lambert and Lambert (2011) assessed baseline physical fitness data for South African children based on ethnic groups, finding relevant differences between white and black children in South Africa. However, no comments on age or gender differences were forth coming. This presents an opportunity whereby these differences may be established to further determine gender and age based differences in overall physical activity and fitness abilities. The Eastern Cape Province within South Africa, which ranks third in provincial breakdown in the 2011 census (Brand & Geyer, 2017), also seems under-researched in terms of children physical activity and sedentary behaviour studies.

More research is required to inform these policies and ensure the benefits of overall physical activity and fitness are understood and valued (Poitras et al., 2016; Larouche, Garriguet, & Tremlay, 2017). A few benefits of increased physical activity and physical fitness include improved cognitive function and attention span (Taras, 2005; Larouche, Garriguet, & Tremblay, 2017) along with the physical benefits of decreased obesity risk and other metabolic risk factors such as elevated blood glucose and blood pressure levels (Poitras et al., 2016; Janz et al., 2009; Mendoza et al., 2012; Janssen et al., 2013). It is important to note that the World Health Organization recently modified it's classification of physical inactivity as a modifiable risk factor alongside tobacco, salt intake and alcohol (World Health Organization, 2018). The World Health Organization also listed obesity and overweight as metabolic risk factor alongside blood glucose levels, blood lipids and blood pressure (World Health Organization, 2018). Therefore one can conclude that obesity is a risk factor that may only be modified through an increase in physical activity or a decrease in salt and fatty foods intake (World Health Organization, 2018). More benefits of physical activity are outlined in detail in the literature review.

Physical activity and physical fitness are two separate concepts and therefore need to be addressed separately. Physical activity is seen as everyday tasks that produce a bodily movement and results in energy expenditure (Caspersen, Powell, & Christenson, 1985; Helgadottir et al., 2017). While physical fitness is a result of any planned and structured form of exercise in addition to daily physical activity (Caspersen, Powell, & Christenson, 1985; Helgadottir et al., 2017). Therefore the health benefits for being physically active are accentuated by being physically fit, with some additional health benefits such as cardio-respiratory fitness. Studies found that both physical activity and physical fitness have academic benefits; however the type, frequency and duration of these activities and the benefits thereof need to be researched. Kriemer et al, 2011, found that long bout of physical activity and fitness during academic time where less effective as short bouts. Therefore longer sessions of physical activity that are intended to increase physical fitness should be kept to structured lessons outside of academic time (Kriemer et al., 2011).

1.1 Relevant gaps in research based on Healthy Active Kids South Africa Report Cards

The Healthy Active Kids Global Alliance was developed alongside the global matrix of physical activity grades, to address the rising obesity pandemic worldwide as well as the increased level of physical inactivity and sedentary behaviour resulting in decreased physical activity and fitness levels (Draper et al., 2014; Uys et al., 2016; Draper et al., 2018; Aubert et al., 2019). Through presenting letter grades for different indicators namely overall physical activity levels, early childhood physical activity, organised sport participation, active play, active transportation, sedentary behaviours, early childhood sedentary behaviours, physical fitness, school (Physical Education), community and environment, and government, the Healthy Active Kids Report Cards present a snap shot of the country's current situation, relevant research gaps as well as recommendations for improvement (Aubert et al., 2019). The grades given are explained as a percentage of children meeting a defined benchmark: A, 81-100%; B, 61-80%; C, 41-60%; D, 21-40%; and F, 0-20%; with INC, indicating insufficient evidence to present a grade (Draper et al., 2018).

In the most recent Healthy Active Kids South Africa Report of 2018 there was no new evidence found for a number of the physical activity indicators, namely; overall physical activity (C), organised sport participation (D), active transportation (C), sedentary behaviour (F), physical fitness (INC) and school (D-) (Draper et al., 2018). All of the scores were below average, indicating no improvement from previous report cards (Draper et al., 2018).

According to the Healthy Active Kids South Africa Report Cards, South African children received very poor scores for screen time and sedentary behaviour (Draper et al., 2014; Uys et al., 2016; Draper et al., 2018). From the years 2014 until 2018, the sedentary behaviour grade has remained an F (0-20%), showing no improvement or decrease in the use of media devices such as TV and mobile phones (Draper et al., 2014; Uys et al., 2016; Draper et al., 2018). The grade for overall physical activity improved from a D (21-40%), in 2014 to a C (41-60%), in 2016 and remained a C (41-60%) in 2018. While these results remain unsatisfactory, they do present a certain trend between sedentary behaviours as well as overall physical activity and physical fitness levels (Draper et al., 2014; Uys et al., 2016;

Draper et al., 2018). More research is required to properly diagnose the extent of sedentary behaviour and physical inactivity and the effect thereof on physical activity and overall health of South African children (Draper et al., 2014; Uys et al., 2016; Draper et al., 2018). With this information Physical Education classes can be formed that will benefit all body types and fitness levels. It can also serve as a guideline for overall physical activity improvement and what aspects of fitness need to be focused on based on these results (Draper et al., 2014; Uys et al., 2016; Draper et al., 2018).

Available studies on physical inactivity, sedentary behaviour, screen time and physical fitness among South African children have mostly focused on older children (11-12, 14-15 years) (Micklesfield et al., 2014) and adolescents (19-20 years) (Prioreshi et al., 2017). Micklesfield et al. (2014) found a positive linear relationship between puberty and sedentary behaviour. Males also had higher levels of overall physical activity and organised sport participation, outside of Physical Education, than females. Lastly, this study showed a decrease in physical activity and sports participations with increased age (Mickelsfield et al., 2014).

A study conducted in a rural town in Gauteng Province revealed that the physical activity levels of children (aged: 5-6 years, 9-11years and 12-14 years) are far lower than the recommended international normative levels as more than 50% of children were not meeting the guidelines of 60 minutes of moderate-to-vigorous physical activity daily (Minnaar et al., 2016; Draper et al., 2018). Furthermore, the Healthy Active Kids South Africa Report Cards from 2014, 2016, and 2018 all found that children were not meeting the guidelines of only two hours of screen time daily but rather exceeding this amount (Draper et al., 2014; Uys et al., 2016; Draper et al., 2018).

1.2 Problem statement

There has been a decline in physical activity and physical fitness rates in South African and, children are also becoming more sedentary. However, from the Healthy Active Kids South Africa Report Cards it is apparent that more data is needed. Indeed there is a lack of information on children in schools in the Eastern Cape Province. Therefore, this study aimed to add to the national database metrics on prevalence of physical inactivity, sedentary behaviour and screen time of primary school children in a school in the Eastern Cape Province of South Africa. A secondary aim was to assess levels of physical fitness in this cohort.

1.3 Report outline

Chapter 1- Introduction describes the lack of research on the sedentary behaviours, physical activity, and physical fitness levels of South African children currently. It also explores the current opportunities put in place for children to increase their daily physical activity levels such as organised sport participation and Physical Education classes.

Chapter 2- This chapter reviews the literature regarding physical activity, physical fitness and health, and sedentary behaviour as well as the benefits and pitfalls of media device use by children and within schools. It also reviews the history of Physical Education in SA.

Chapter 3- The methodology of the study is described in this chapter, including the population and fitness testing protocols explained. Ethical considerations and statistical analyses methods are discussed.

Chapter 4- The description and presentation of the data and the results of the statistical analyses are presented in Chapter 4.

Chapter 5- The findings of the study are detailed and explained and all efforts to relate them to existing literature are presented. The limitations of the study are also explained to substantiate the limited results.

Chapter 6- The conclusion of the study is discussed. Recommendations for future studies and research directions regarding the protocol are mentioned.

CHAPTER II

Review of literature

2.1 Physical activity levels within children and youth

2.1.1 Physical activity vs. exercise

Physical activity can be described as any bodily movement produced by skeletal muscles resulting in energy expenditure (Caspersen, Powell, & Christenson, 1985). This concept is different from that of exercise. Physical activity is part of one's lifestyle, it is the activity involved in everyday tasks. These tasks may be categorised into occupational, household, conditioning and others (Caspersen, Powell, & Christenson, 1985; Helgadottir et al., 2017). Exercise, however, can be described as any form of planned, structured, orchestrated and repetitive subset of physical activity with the purpose of increasing overall fitness (Casperson, Powell, & Christenson, 1985; Helgadottir et al., 2017). Physical activity is vital to the psychological, physiological, physical, social and cognitive health of children and therefore, needs to be maximised throughout their waking day (Caspersen, Powell, & Christenson, 1985; Draper et al., 2014; Uys et al., 2016; Helgadottir et al., 2017; Draper et al., 2018). The current guidelines for physical activity in children are a minimum of 60 minutes of moderate-to-vigorous physical activity per day (Draper et al., 2014; Poitras et al., 2016; Uys et al., 2016; Draper et al., 2018; Piercy et al., 2018). There is a lack of research around the benefits of low intensity exercise, although it is beneficial at the expense of sedentary time (Ekelund et al., 2006; Poitras et al., 2016; Helgadottir et al., 2017).

2.1.2 Benefits of physical activity in children and adults

There are many obvious benefits of keeping physically active such as, weight control, improved functionality and performance, reduced stress, better sleep and better self-esteem (Poitras et al., 2016; Draper et al., 2018; Piercy et al., 2018). These benefits are true for both children and adults. One benefit of physical activity specifically within children would be that of bone health (Cliff et al., 2016; Larouche, Garriguet, & Tremblay, 2017; Poitras et al., 2016). It is known that bone mineral density is developed during youth and later in adulthood maintained through exercise (Cliff et al., 2016). Thus, to maximize bone health as an adult, individuals should maximize their physical activity as children (Cliff et al., 2016; Larouche, Garriguet, &

Tremblay, 2017; Poitras et al., 2016). One longitudinal study found that children who maintained high levels of physical activity throughout a three-year follow up period, had higher bone mineral content compared to their less active peers (Janz et al., 2009). Poitras et al. (2016) found favourable relationships between total physical activity and adiposity, cholesterol, blood pressure, insulin resistance, aerobic fitness, muscular strength and endurance, and bone health. Maximising physical activity as a child also aids in alleviating heart disease, high blood glucose levels and cholesterol, thus reducing the risk of type II diabetes and obesity in adulthood (Mendoza et al., 2012; Janssen et al., 2013; Whooten et al., 2018). It is also known that exercise and outdoor play can enhance social skills (Larouche, Garriguet, & Tremblay, 2017), resulting in better psychosocial health and fewer peer relationship problems, although more research is required (Poitras et al., 2016; Larouche, Garriguet, & Tremblay, 2017).

Physical activity also improves academic performance in school children (Taras, 2005; Singh et al., 2019; Sember et al., 2020). It increases blood flow to the brain through improving circulation, increasing the release of endorphins and nor-epinephrine (Taras, 2005). This can improve mood, reduce stress and induce a calming effect after exercise, all of which have the potential to improve academic achievement (Taras, 2005). Secondly physical activity has been documented to increase the expression of the brain-derived neurotrophic factor (Slutsky & Etnier, 2019). This is a mechanism that improves cognitive performance through mediating the age-related changes to the hippocampus, specifically hippocampal memory and volume (Slutsky & Etnier, 2019). Therefore, physical activity positively affects the brains ability to absorb and hold information for longer periods of time (Slutsky & Etnier, 2019). Systematic reviews on the effect of physical activity on cognitive function concluded that there is no evidence to suggest a negative effect (Donnelly et al., 2016; Singh et al., 2019). Another systematic review found physical activity interventions during school time had positive effects specifically when delivered by practitioners who had qualifications in the field (Sember et al., 2020). This indicates the potential need for more qualified Physical Education teachers to ensure the most effective outcome (Sember et al., 2020). More research is needed to determine what type, frequency and time of physical activity is most beneficial (Donnelly et al., 2016; Singh et al., 2019). However, with increased physical activity and fitness, a child gains improved psychosocial skills and self-esteem, which has the potential to decrease the dropout rate from school (Taras, 2005; Trudeau & Shephard, 2008). Physical activity breaks during standard classroom time have positive associations with some aspects of cognitive function (Trudeau & Shephard, 2008; Rasberry et al., 2011). Specifically through improving concentration, academic behaviour and classroom conduct, as well as test scores (Taras, 2005; Trudeau & Shephard, 2008; Coe et al., 2006; Rasberry et al., 2011). Physical activity during school time can also improve memory and therefore, reduce ones risk of obtaining Alzheimer's disease in adulthood and old age (Trudeau & Shephard, 2008).

Kredlow et al. (2015) found increased physical activity improves many aspects of sleep such as total sleep time, sleep efficiency, sleep onset latency and sleep quality. Uchinda et al, (2012), reports on a specific study that included 10 physically active and fit college students that participated in afternoon and evening exercise within their normal daily routine. The study compared the effects of afternoon, evening and no exercise on slow wave sleep, finding that afternoon exercise significantly improved slow wave sleep (Uchinda et al., 2012). Slow wave sleep is phase three of the sleep cycle and is the deepest phase of non-rapid eye movement sleep, slow wave sleep is also important for memory consolidation (Della Monica et al., 2018). On the contrary they found that evening exercise and no exercise had similar effects on slow wave sleep with no significant improvements documented from either (Uchinda et al., 2012). Similarly the study found that evening exercise produced a stress effect reducing the amount of slow wave sleep significantly (Bailey, & Heitkemper, 2001; Uchinda et al., 2012).

The circadian rhythm and biological clock are affected by light exposure and sleep timing, and evolved according to the natural light-dark cycle (Wright et al., 2013; Akacem, Wright & LeBourgeois, 2016). Increased amounts of outdoor physical activity daily results in increased natural light exposure which can improve slow wave sleep (Uchinda et al., 2012; Larouche, Garriguet, & Tremblay, 2017). More time spent outdoors can also decrease daily sedentary time, thus decreasing the risk of obesity, type II diabetes and other non-communicable diseases (Mendoza et al., 2012; Janssen et al., 2013; Whooten et al., 2018). Obesity can interrupt sleep through sleep apnoea; the excess weight causes significant breathing problems that can cause a person to wake repeatedly during the night (Carrera et al., 2004; Larouche, Garriguet, & Tremblay, 2017). When sleep is interrupted one can suffer from mental fatigue which would result in a higher amount of effort needed to perform tasks (Wright et al., 2013; Moreno et al., 2015).

2.1.3 Physical inactivity: A global pandemic

Lack of physical activity within youth is becoming a global problem. Studies done on physical activity levels of children have found that more than half of the sampled population are not meeting the guidelines of 60 minutes of moderate-to-vigorous physical activity per day (Ainsworth, 2016; Tremblay et al., 2016; Uys et al., 2016). In South Africa, it was estimated that only 40% of girls meet the requirements and overall only 50% of learners are active enough (Uys et al., 2016). When looking at the global matrix where grades have been given to countries globally based on their physical activity levels, it was found that only three of 38 countries were given a B (61-80% are meeting prescribed guidelines) grade (Tremblay et al., 2016). The others a C (41-60%) or D (21-40%) grade, leaving the assumption that less than half the global youth population are abiding by physical activity guidelines (Tremblay et al., 2016; Ainsworth, 2016). This also shows a late start in recognising physical inactivity as a global public health problem that affects the health and well-being of a large number of people (Ainsworth, 2016). Although much has been done to improve awareness of physical inactivity as a health concern, there are still large cultural, social, political, and economic factors that characterize physical inactivity, specifically, in the youth of today (Ainsworth, 2016; Uys et al., 2016; Draper et al., 2018).

When studying South Africa’s 2014, 2016 and 2018 Healthy Active Kids Report Cards on physical activity for children and youth, it is evident that physical fitness, organized sport participation, the school (Physical Education) or built environment, as well as overweight and obesity are of concern (Draper et al., 2014; Uys et al., 2016; Draper et al., 2018). Each of these factors obtained a D (21-40%) grade indicating there is much to be improved within these areas of the country as a whole (Draper et al., 2014; Uys et al., 2016; Draper et al., 2018). While physical fitness levels were found to be poor within girls and fair for boys, cardiorespiratory fitness levels were poor for all and levels of physical activity were satisfactory (Uys et al., 2016). Thus more opportunity to improve physical fitness needs to be made a priority, and the lack thereof may explain the high levels of obesity in children in South Africa (Draper et al., 2014; Uys et al., 2016; Draper et al., 2018). The grade given for sedentary behaviour was an F (<21%), stating that more than half the countries' youth spend 3 hours or more utilizing screens, with 30% spending more than five hours (Draper et al., 2014; Uys et al., 2016; Draper et al., 2018). Sedentary behaviour has previously positively correlated with body mass and the likelihood to become overweight and obese (Uys et al., 2016).

Countries that obtained the highest grades for physical activity levels in 2016 have systems in the school curriculum to monitor and maintain physical activity in children (Ainsworth, 2016; Tremblay et al., 2016; Uys et al., 2016). They use physical fitness testing where the schools physical activity programs are modified based on the fitness scores (Tremblay et al., 2016). However, in places like the United States of America and South Africa, the importance of physical activity within schools has become over clouded by the changes in educational goals and economic challenges (Rasberry et al., 2011; Tremblay et al., 2016; Uys et al., 2016). This is also true for many other countries as schools are more concerned with improving standard test scores and, as a result, physical activity in the classroom, during recess and Physical Education classes is reduced or eliminated (Rasberry et al., 2011; Tremblay et al., 2016). This information calls for countries and communities to adopt efforts that ensure programmes, infrastructures and policies are put in place that can provide the opportunity for children to have active lifestyles (Tremblay et al., 2016; Ainsworth, 2016).

2.1.4 Difference between sedentary behaviour and physical inactivity

Sedentary behaviour has become an increasing problem worldwide as it can increase an individual's risk of non-communicable diseases such as type II diabetes and cardiovascular disease (Kazi et al, 2014; Uys et al., 2016; Kinnett-Hopkins et al., 2019). Sedentary behaviour is any activity using less than 1.5 METS and is approximately equivalent to the energy cost of sitting quietly (Clemes et al., 2015; Kinnett-Hopkins et al., 2019). These activities are equivalent to television viewing time, complete screen time, including computer and play station/Xbox games and using a mobile phone. Commuting time includes taking the bus/train/driving a car and simply sitting doing nothing such as listening to the radio or reading a book (Tremblay et al., 2010; Clemes et al., 2015; Uys et al., 2016; Kinnett-Hopkins et al., 2019). Many sedentary activities fall outside this threshold and this, paired with the fact that it is impractical to measure energy expenditure, means that these behaviours should be defined as any sitting behaviour conducted outside of structured exercise (Henson et al., 2016). Physical inactivity and sedentary behaviour are two separate concepts (Henson et al., 2016; Kinnett-Hopkins et al., 2019). People who are considered sedentary may still reach daily physical activity guidelines, however, those who do not reach these guidelines would be considered physically inactive (Henson et al., 2016; Kinnett-Hopkins et al., 2019). It is important to note that individuals who sit for prolonged periods still face the potential risks associated with sedentary behaviour, despite meeting daily physical activity guidelines (Tremblay et al., 2010; Henson et al., 2016; Kinnett-Hopkins et al., 2019).

2.1.5. Socio-economic status, private vs. public schools in South Africa

Socio economic status defines a person's position in the community based on their familial income, house facts and assets, parental education and occupational status (Bradley & Corwyn, 2002). Socio-economic status is associated with cognitive, socio-emotional and health factors (Bradley & Corwyn, 2002). In 2000, it was determined that 3.3 % of deaths in South Africa were attributed to inactivity (Malambo et al., 2016). Physical inactivity along with the current nutritional, lifestyle and socio-economic changes within the country contributes to the increased incidence of non-communicable diseases (Phaswana-Mafuya et al., 2013; Malambo et al., 2016).

Schools in South Africa are separated into public and private schools (Van Deventer., 2012; Cleophas, 2014). Due to this distinction it is important to look at the two sectors, and children thereof, separately as their data is affected by different variables (Van Deventer, 2012; Cleophas, 2014). For example, private schools have access to certain facilities that aid in the increase of physical activity and organised sport participation (Van Deventer, 2012). Most public schools do not have the funds for these facilities or the instructors needed to conduct the classes and sports practices (Van Deventer, 2012). The Healthy Active Kids South Africa Report Card from 2014, found less than 50% of rural children in public schools take part in organised sport compared to 66% of urbanised children in private schools (Draper et al., 2014). This is most likely due to most private schools making it compulsory to participate in one or more school sporting activity (Draper et al., 2014). Furthermore, the 2016 and 2018 Healthy Active Kids South Africa Report Cards revealed a very poor grade of D (21-40% are meeting prescribed guidelines) for organized sport participation, revealing no improvement over the three years respectively (Draper et al., 2014; Uys et al., 2016; Draper et al., 2018).

Sandercock, Angus and Barton (2010) found no major differences between socio-economic status and levels of cardiorespiratory fitness. However, they did find that the built environment of private schools contributed to the promotion of physical activity (Sandercock, Angus, & Barton, 2010).This finding supports the statement that there is more access to certain facilities and physical fitness classes within the private schools in South Africa (Van Deventer, 2012). In addition it was found that public schools did not include a Physical Education class within their syllabus as most public schools do not have the facilities required to do so (Van Deventer, 2012).

2.2 Media device use among children and adolescents

2.2.1 What are these? Prevalence thereof and use

Media devices can be either “broadcast” or “interactive” and include social media. Broadcast are devices such as television (and radio) programmes or movies, while interactive media includes online social networking and gaming which allows interaction and the sharing of information (Swanson, 2016). Media devices are currently a worldwide epidemic and are extremely difficult to avoid (Swanson, 2016; Council, 2016). The potential danger of this has resulted in new research focused on the effects of these devices on humans, specifically children, and their health and development (Arango et al., 2014; Council, 2016). Children are currently growing up surrounded by new and old technologies, which they are rapidly adapting to (Arango et al., 2014; Swanson et al., 2016; Council, 2016). Media devices are quickly becoming very useful for educational purposes (Council, 2016). The issue is that children are beginning to use these devices at a young age during a time of essential brain development, establishing health behaviours and relationship building (Council, 2016).

Most of the research to date on the association between media devices and physical activity or fitness levels has focused specifically on screen time (Aggio, Ogunleye, & Sandercock, 2012; Sandercock & Ogunleye, 2013; Arrango et al., 2014). The recommended daily dose of screen time for children and adults is two hours (Sandercock & Ogunleye, 2013; Uys et al., 2016; Draper et al., 2018), however, it has been noted that after the age of eight, overall screen time increases (Swanson, 2016). Reasons for this could be an increase in the need for computers for school work (Swanson, 2016; Council, 2016). A further increase in screen time has been documented after thirteen years of age; a prominent reason for this is the age limit for most social media sites such as Facebook is thirteen years (O'keeffe & Clarke-pearson, 2011; Swanson, 2016). This is aligned with the average age that a child or teenager receives their first mobile device (Swanson, 2016). It is important for a child to have an understanding of how technology such as computers, laptops and mobile devices function, as most occupations include this understanding. However, this should not take time away from physical activities recommended daily (Swanson, 2016; Uys et al., 2016).

2.2.2 Benefits and pit falls of media use

The policy statement released from the American Academy of Paediatrics aimed to explore the potential benefits of technology for educational purposes, and the health concerns thereof for young children aged zero to five years (Council, 2016). During the developmental years of a child's life, i.e. their first two years, they need hands-on interaction and exploration in order to develop motor and social-emotional skills, language and cognitive skills (Chassaikos et al., 2016; Council, 2016). At this age their memory is immature, therefore, they do not learn as well from digital interactions as they would human interactions (Council, 2016; Chassaikos et al., 2016). The child also has difficulty transferring information from a two dimensional or a digital state to a three dimensional, real life state (Council, 2016; Chassaikos et al., 2016). For these reasons it is important for a parent or caregiver to use technology with a child and not leave them on their own (Council, 2016; Chassaikos et al., 2016). Although benefits have been found for media as an educational tool, for certain functions such as impulse control, flexible, creative thinking and emotion regulation, interactive play would be a better tool to use (Hsin et al., 2014; Council, 2016).

Media device use in children and adolescents could be constituted as more dangerous as it is far more difficult to control and limit (Council, 2016). Naturally, there are risks and benefits around the effects of media within children and adolescents (Stott, Maceachron, & Gustavsson, 2016). The benefits include opportunity for social content and exposure to new ideas and information (Stott, Maceachron, & Gustavsson, 2016). The use of certain mobile applications to control and monitor the amount of time a child spends on the internet and in physically active behaviours is also a benefit (Stott, Maceachron, & Gustavsson, 2016). The risks are effects on health, sleep and body mass index (BMI) as well as the exposure to inappropriate content and compromised privacy (Swanson, 2016; Council, 2016).

2.2.3 Health consequences

The health and developmental concerns of media use in children aged zero to five years are obesity and sleep loss due to increased exposure to artificial light (Council, 2016). Language and social-emotional delays and poor family function are also some health concerns (Council, 2016; Chassaikos et al., 2016; Beyens & Nathanson, 2019). It was found that excessive use of television can impair emotional and self-regulation, this is because a child uses the television to regulate their emotions and does not learn to do this on their own (Council, 2016; Beyens & Nathanson, 2019; Viner et al., 2019). For children of this age group it was recommended that they should limit their time on these devices to one hour per day (Council, 2016; Viner et al., 2019). This will allow them enough time to participate in other activities that benefit their health and decrease their risk of obesity (Poitras et al., 2016).

Media is a beneficial tool to raise awareness of current events and ideas, communicate across the world and promote community engagement (Domoff et al., 2019). However, the health consequences of media use within adolescents far outweigh the benefits, the first of these risks being that of obesity (Council, 2016; Swanson, 2016). Children who spend more than five hours per day in front of a screen are at five times more risk of becoming obese as compared to their peers who spend less than two hours (Swanson, 2016). Sleep can be affected by media through exposure to artificial light that affects melatonin levels and can result in lost or impaired sleep (Council, 2016; Swanson, 2016; Beyens & Nathanson, 2019).

Sleep is an important risk factor as disturbances can lead to attention disruptions at school, which could negatively affect school performance (Beyens & Nathanson, 2019). Evidence suggests that using media while engaging in educational tasks, such as homework, can have a negative impact on learning (Swanson, 2016). The effects of media use are, however, multifactorial and depend on a number of factors such as the time of use, type of media and individual characteristics (Swanson, 2016; Beyens & Nathanson, 2019). Therefore, these are important to take into account when assessing the effects of media on a certain variable (Swanson, 2016).

2.2.4 Media devices, physical activity, sedentary behaviour and cardiorespiratory fitness

Evidence suggests that sedentary behaviour is an independent risk factor for health issues (Sandercock & Ogunleye, 2013). However, it remains unclear whether sedentary behaviour is a risk factor because it negatively affects physical activity or if the risks may be more complex (Sandercock, Alibrahim, & Bellamy, 2016). Therefore, research is still aiming to define the link and association between sedentary behaviour and physical activity as well as cardiorespiratory fitness (Sandercock & Ogunleye, 2013; Marques et al., 2015; Sandercock, Alibrahim, & Bellamy, 2016). Media device ownership is known to have a negative effect on sedentary time; consequently, it is important to understand the risks or effects of this (Sandercock, Alibrahim, & Bellamy, 2016).

It is known that sedentary behaviour and physical activity are separate concepts and both are independent predictors of metabolic risk and children’s fitness (Sandercock & Ogunleye, 2013). Cardiorespiratory fitness is an adaptation of multiple physiological systems, and is determined by factors such as growth, sex, age, genetics as well as moderate-to-vigorous physical activity and sedentary behaviour (Marques et al., 2015). Research shows that this is a more powerful predictor of health and may be able to predict habitual physical activity better than a self-report tool aimed at only determining ones level of physical activity (Swift et al., 2013).

Cardiorespiratory fitness is declining rapidly in children all over the world. Studies involving English and Columbian youth show that with this decline there is also a decline in physical activity and an increase in body mass as well as sedentary behaviour (Arango et al., 2014; Sandercock, Alibrahim, & Bellamy, 2016; Cabanas-

Sanchez et al., 2019). Interestingly, studies show a link between physical activity and cardiorespiratory fitness but not with sedentary behaviour or screen time (Sandercock & Ogunleye, 2013; Sandercock, Alibrahim, & Bellamy, 2016). This may suggest that sedentary behaviour influences physical activity levels and this would negatively affect cardiorespiratory fitness albeit not directly (Sandercock & Ogunleye, 2013; Sandercock, Alibrahim, & Bellamy, 2016). This supports why looking at all three factors together is the most ideal. While someone can still be classified as physically active, they may not engage in high intensity training which can limit their cardiorespiratory fitness (Cabanas-Sanchez et al., 2019). While screen time does not directly correlate with physical activity as both are independent, cardiorespiratory fitness provides an important end point where the impact of excessive sitting in youth may be measured (Sandercock & Ogunleye, 2013; Cabanas-Sanchez et al., 2019). Cardiorespiratory fitness is also easier to measure, better related to health outcomes, and is easily traceable in children (Marques et al., 2015; Sandercock & Ogunleye, 2013). Sandercock and Ogunleye (2013) found a negative association between a composite screen time measure of television, computer, iPad and mobile phone screen time and cardiorespiratory fitness in boys, but not girls (Sandercock & Ogunleye, 2013).Very little research on the link between television viewing and fitness has been carried out and most findings are inconsistent or inconclusive.

For research purposes, screen time is used as a common predictor of sedentary time as it remains the most prevalent (Biddle et al., 2009; Cabanas-Sanchez et al., 2019). Screen time is also useful in predicting the time a child spends on media devices and therefore, provides an appropriate measure for health concerns regarding the use of technology within children (Domoff et al., 2019; Viner et al., 2019). Excessive screen time results in increased energy intake and increased adiposity (Marques et al., 2015; Cabanas-Sachez et al., 2019). This is independent of physical activity, but has been shown to affect cardiorespiratory fitness, which can be the reason for increased BMI (Marques et al., 2015; Sandercock & Ogunleye, 2013; Swanson, 2016; Cabanas-Sachez et al., 2019). Sitting time is an independent predictor of fitness regardless of physical activity (Viner et al., 2019). Screen time is not a complete measure of sedentary behaviour and this may provide inconsistencies within research, however, for research specific to effects of media devices, this is an ideal measurement (Biddle et al., 2009; Domoff et al., 2019; Viner et al., 2019).

Media device ownership has been shown to negatively impact fitness levels through increasing sedentary behaviour (Tandon et al., 2012; Domoff et al., 2019). In a study by Sandercock, Angus, & Barton (2010) social media was the main predictor of excessive screen time in girls and boys. When assessing the temporal relationships between cardiorespiratory fitness, physical activity and screen time over a two year period, it was found that children were more likely to adopt unhealthy sedentary behaviours than become unfit (Aggio et al., 2012). This is not the ideal outcome as it still shows the negative effects of excessive sitting and use of media devices (Aggio et al., 2012). Aggio et al. (2012) found that with a low baseline and follow up physical activity, risk for lack of physical fitness increased. However, they also found that a high screen time both at baseline and follow up, increased the likelihood of becoming unfit by more than two fold (Ekelund et al., 2006; Aggio et al., 2012). These studies provide ground for further research due to the complicated casual pathways of metabolic risk (Ekelund et al., 2006; Aggio et al., 2012; Viner et al., 2019). Cardiorespiratory fitness has complex interactions with other factors that also have an influence; sport participation, physical self-concept and body composition all effect or are affected by cardiorespiratory fitness (Viner et al., 2019). For example, children who are unfit are less likely to participate in school sports and physical activity (Aggio et al., 2012). This may result in more screen time which could lead to increased BMI (Poitras et al., 2016). Alternatively, this association may also be due to an already high BMI causing the child to be inactive and uncomfortable performing in group activities in school (Aggio et al., 2012; Poitras et al., 2016; Domoff et al., 2019).

Sandercock and Ogunleye (2013) found that when boys had a high screen time they were less likely to be fit, this association is specific to boys as they are typically more active than girls (Sandercock & Ogunleye, 2013). They suggested that girls who exceeded four hours of screen time per day and boys, who only exceeded two hours of screen time per day, were more likely to be unfit, independent of their physical activity levels (Sandercock & Ogunleye, 2013). This is interesting when comparing higher (private school) socio-economic status children, and lower (public school) socio-economic status children. Lower socio-economic status children are considered more physically active (Peer et al., 2013). They are found to walk farther and have physically demanding jobs after school; however, they are classified as more overweight or obese due to poor eating habits (Peer et al., 2013). This information is based on physical activity levels and not cardiorespiratory fitness levels, and therefore, provides grounds for more research to be done on these children (Peer et al., 2013). Cardiorespiratory fitness is important to consider as it is a health outcome of a typical lifestyle represented in children, whereas physical activity is behaviour that can be easily modified and is constantly changing (Marques et al., 2015).

Time spent in moderate-to-vigorous physical activity is a better indicator of overall physical activity or fitness levels (Draper et al., 2014; Uys et al., 2016; Draper et al., 2018). Increased moderate-to-vigorous physical activity levels are associated with higher hamstring flexibility and a healthy lower back flexibility (Armstrong, lambert, & Lambert, 2011(1); Marques et al., 2015). This type of activity is also more likely to affect overall fitness as compared to screen time according to Marques et al. (2015). Very few studies have looked at the link between screen time, physical activity and cardiorespiratory fitness in public and private schools specific to South Africa. This is an interesting focus as most research done in this area focused on the poorer parts of developed countries, therefore, developing countries such as South Africa may have a different outcome (Cleophas et al., 2014).

There are large variances in the data based on obesity levels within children in South Africa. With the rising influence and use of media devices within schools and households, there is assumed to be a decrease in physical activity and cardiorespiratory fitness levels, which in turn could affect body mass index and obesity levels (Poitras et al., 2016; Viner et al., 2019). The link between physical activity, cardiorespiratory fitness, obesity and media device use within children from public and private schools is largely under researched within developing countries, specifically South Africa (Cleophas et al., 2014). This link is important due to the health impact of all three factors. However, other factors such as nutrition, transport and housework also need to be considered (Cleophas et al., 2014).

2.3 Puberty and physical fitness

Puberty or biological maturation can be described as the structural and functional changes the human body surpasses in order to reach maturity (Rogol, Roemmich, & Clark, 2002; Sherar et al., 2010). Puberty typically occurs around the age of 11 years for females and 13 years for males but, will differ between individuals with regard to onset and duration (Rogol, Roemmich, & Clark, 2002; Bailey et al., 2010). Biological maturation stimulates the release of specific hormones that result in human growth and sexual maturity (Bailey et al., 2010). The easiest way to identify human growth is through the measurement of stature (Rogol, Roemmich, & Clark, 2002). Peak height velocity is known as the imperative growth spurt that occurs during and throughout puberty. The method of peak height velocity testing has provided as a non-invasive way of identifying when a child is undergoing biological maturation (Rogol, Roemmich, & Clark, 2002).

It is important to consider the individual differences between children in terms of their biological maturation or puberty levels when conducting a physical activity study (Metcalf et al., 2015). It has been determined that puberty levels can have a negative effect on physical fitness levels, specifically through decreasing them. Metcalf et al. (2015) supported this fact when they demonstrated a direct link between biological age and physical activity. The study shows that with biological change physical activity decreases and, the decrease is accelerated during and after puberty (Metcalf et al., 2015). No visible decrease was documented before three years prior to puberty (Metcalf et al., 2015). This study also showed that the stage of puberty affected physical activity levels independent of age and that this was more evident in girls as compared to boys but appeared in both sexes (Metcalf et al., 2015). Metcalf et al. (2015) concluded that most children who are not physically active while growing up are more likely to be less active or inactive in the later stages of adulthood. It was also concluded that the decline of activity in adolescence may be biologically driven (Metcalf et al., 2015). In another review the link between biological maturation and physical activity was also supported by another six studies (Sherar et al., 2010).

While puberty has been documented to decrease physical activity levels within children, it has also been documented that puberty increases physical strength

(Rogol, Roemmich, & Clark, 2002). Through body compositional changes fat free mass increases as well as lean muscle mass, where males have been documented to have greater increases in these compared to females (Rogol, Roemmich, & Clark, 2002). The increases in muscle mass and bone development results in an increase in the length of limbs allowing for more efficient physical and mechanical actions to occur (Bailey et al., 2010).

Physical activity levels have been shown to decrease with puberty onset, where some fitness components, such as strength, have been documented to increase with puberty onset (Metcalf et al., 2015; Rogol, Roemmich, & Clark, 2002). With puberty onset, an increase in injury risk as well as a decrease in flexibility and motor proficiency has also been documented (Mills et al., 2017). Studies have determined certain reliability in measuring and calculating peak height velocity as a predictor of maturity onset and age at maturation (Mills et al., 2017; Kozieł & Malina, 2018). Individual differences in biological maturation have also been found to be an important consideration when looking at youth and physical activity (Mills et al., 2017).

2.4 Physical Education within the school environment

2.4.1 Benefits of Physical Education

There are numerous benefits for the inclusion of physical activity breaks during school time. For most children the Physical Education classes and after school activities are their main source of physical activity during the week (Bailey, 2006; Coe et al., 2006). This implementation of physical activity during school can also take pressure off parents as their children would have already completed their necessary 60 minutes of moderate-to-vigorous physical activity each day (Bailey, 2006; Coe et al., 2006). According to Bailey (2006) the benefits for Physical Education are in close relation to the overall benefits of physical activity, however hold more benefits with regards to their social activity (Bailey, 2006; Viner et al., 2019). Physical Education can help children understand and respect their bodies as well as their peers, and they will also develop an understanding of the importance of physical activity, fitness and health (Bailey, 2006; Poitras et al., 2016; Larouche, Garriguet, & Tremblay, 2010; Viner et al., 2019). The interactive environment that Physical Education takes place in largely benefits the children in the development of team work skills, respect for peers and can teach them to work together towards a common goal (Taras, 2005; Trudeau & Shepard, 2008; Viner et al., 2019). There is strong evidence that suggests a positive effect on self-image and self-confidence (Taras, 2005; Viner et al., 2019). Physical Education can also positively impact psychological factors such as anxiety, depression, energy, mood and overall well-being (Taras, 2005; Trudeau & Shepard, 2008; Poitras et al., 2016; Viner et al., 2019).

Physical Education helps develop fundamental movement skills in children at an early age, and children who learn these skills early are more likely to be active both as children and as adults (Aggio et al., 2012; Mendoza et al., 2012). Children who have not learnt these skills are more likely to be excluded from organised sport in school and active play with their peers, as they have not acquired the basic skills to properly participate (Poitras et al., 2016; Larouche, Garriguet, & Tremblay, 2017). Physical Education is a cost effective way to influence the children of the next generation to lead active lives and gives them the fundamentals to do so (Larouche, Garriguet, & Tremblay, 2017). Evidence suggests that Physical Education could potentially increase school attendance and make the school day more attractive to some children (Taras, 2005). Many studies have shown the positive effects of physical activity on mental alertness, mood and overall cognitive function through an increased blood flow to the brain (Taras, 2005; Coe et al., 2006; Rasberry et al., 2011).

2.4.2 Concerns of Physical Education

There are however, some concerns with regards to Physical Education in schools and the overall participation. In countries such as South Africa, most schools cannot afford to hire a specialized Physical Education teacher (Draper et al., 2014). Thus the schools will use any volunteer to conduct the classes and this individual may not have the necessary background knowledge on the subject and may not conduct the classes in a manner that will benefit the children (Draper et al., 2014; Uys et al., 2016). This can be overcome simply by doing research into the matter and ensuring that the teacher conducting the lessons has an integrated understanding of the subject. There are also beneficial activities that may be done during these lessons that do not need professional assistance, such as encouraging the children to play soccer or touch rugby (Draper et al., 2014).

The complexity of the concept of Physical Education is interesting within the South African context where there is an array of cultures with differing beliefs around body image, exercise and diet. This in turn influences willingness to participate in physical activity and/or organised sport (Kearns, Kleinert, & Dupont-Versteegden, 2019). Due to this the Physical Education classes cannot only cater to one body type, for example, and need to consider all types of children (Kearns, Kleinert, & Dupont-Versteegden, 2019). It is important to ensure all children are being challenged and that the programme benefits them in all aspects of fitness, such as cardiorespiratory, core, lower and upper body strength (Kearns, Kleinert, & Dupont-Versteegden, 2019). In connection with the different body types, there are also different capabilities of all children; this may lead to some social inclusion and exclusion within groups of children (Bailey, 2006). This is why it is crucially important to separate the children into groups of mixed capabilities (Bailey, 2006), and to assist the children in understanding that everyone is different, but goals can be achieved when working together. In addition this will also separate the children from their friends and increase their social circle (Bailey, 2006).

The highest concern of parents specifically is that Physical Education during school times will take time away from academics (Kriemler et al., 2011; Donnelly et al., 2016; Singh et al., 2019). However, many studies have suggested that there are benefits of short bouts of activity during school time (Donnelly et al., 2016; Singh et al., 2019). It is shown to increase attention span as well as school attendance (Donnelly et al., 2016; Singh et al., 2019). A study that purposefully took time away from academics and replaced this time with Physical Education, showed no decrease in academic scores (Donnelly et al., 2016; Singh et al., 2019). However, another study found that longer bouts of Physical Education breaks during school time were not as successful as the shorter breaks (Kriemler et al., 2011). Therefore, one can conclude that during academic lessons short bouts of exercise are beneficial, but the longer bouts should be reserved for the Physical Education school period (Donnelly et al., 2016; Singh et al., 2019).

2.5 Physical Education in the South African context: A brief history

The subject of Physical Education in South Africa is lacking in professional and qualified teachers (Draper et al., 2018). The necessary facilities and appropriate time given during school hours to provide for physical activity and education is also lacking (Van Deventer, 2012; Draper et al., 2014; Uys et al., 2016; Draper et al., 2018). Due to South Africa's unique history of Apartheid and the effect of politics on the South African school system, the subject of Physical Education has received much critique over the past decade (Cleophas, 2014). Soon after the Apartheid era came to an end, a new educational experiment was implemented in South African schools; this was known as outcome-based education and placed the subject of Physical Education in the learning area of Life Orientation. This was the first time the subjects of Physical Education and Life Orientation were merged (Cleophas, 2014). Many were dissatisfied with the integration these of subjects as it left little time for both subjects to be efficiently taught (Cleophas, 2014). There was also concern with regard to subject specializing and extended duties for the teachers. However the integration was inevitable as the South African Educational Department were pressed for a decision post-Apartheid (Cleophas, 2014).

The philosophy for teaching Physical Education in South Africa was first provided by the Christian National Education System (Kloppers & Jansen, 1996). The Christian National Education System presented the subject of Physical Education as a simple tool to provide all children with the necessary health and nutritional information (Kloppers & Jansen, 1996). However, the Christian National Education System was supportive of the Apartheid movement and thus only wished to provide the Physical Education subject to the so called "unique Afrikaaner" residing in the urban schools at the time (Cleophas, 2014). Due to the subject of Physical Education being so discriminatory and bias in its practises during the Apartheid period, it seemed just that the subject be taken away or merged into Life Orientation. This was done to allow all children to participate and for the subject to hold value for physical practises only and no other political teachings (Cleophas, 2014).

Once Apartheid came to an end, there was a push to rid the government of its military element as well as the history of white power and supremacy (Cleophas, 2014). Physical Education was seen as a luxury by the new Government and therefore, merged into Life Orientation as a "quick fix" (Cleophas, 2014). Herein lies the problem, as with the merging of the two subjects, less importance was placed on Physical Education and its health benefits (Cleophas, 2014). Studies that emerged after 1994 showed physical education offerings were different for different racial groups due to apartheid and segregation (Cleophas, 2014). Due to the lack of qualified teachers in more rural areas, the subject of Physical Education was not delivered appropriately resulting in inadequacies in physical literacy in these children post-apartheid (Cleophas, 2014). This fact, alongside the increased importance placed on education and not physical health, as well as the feasibility of the subject, aided in reducing Physical Education classes and eventually contributed to the non-existence of the subject in most South African schools (Cleophas, 2014).

2.6 Physical Education in South African schools

Physical Education is currently the only subject in South African schools that prepares children from a young age for an active lifestyle (Van Deventer, 2012; Micklesfield et al., 2014; Prioreshi et al., 2017; Kallio et al., 2018). Ironically, it was noted that the delivery of the importance of the subject of Physical Education was adequate but the actual teaching fell short in schools in South Africa, which may be related to the lack of qualified teachers (Van Deventer, 2012). When surveyed, it was found that 50% of teachers in the Free State, North West and Eastern Cape Provinces, and 60% of teachers in the Western Cape, were not qualified in the teaching of Physical Education (Van Deventer & Van Niekerk, 2009). Furthermore, in 2018, the Healthy Active Kid's South Africa Report Card confirmed that the policy-implementation of Physical Education classes was widening (Draper et al., 2018). During that year a large percentage (32%) of learners were not participating in Physical Education classes at school (Draper et al., 2018).

2.7 Physical activity levels and obesity rates within the Eastern Cape Province of South Africa

Overall there is a large gap in the research done in the Eastern Cape Province of South Africa. The research on physical activity levels of school-aged children in the Eastern Cape Province is specifically lacking. In 2017, a study on obesity levels and factors thereof was conducted in the Nkonkobe Municipality of the Eastern Cape Province (Otang-Mbeng, Otunola, & Afolayan, 2017). This study found the combined prevalence of both being overweight and obesity in this specific area was as high as 57% (Otang-Mbeng, Otunola, & Afolayan, 2017). Lack of physical activity was concluded to be a significant risk factor amongst this population; however more research is required specifically on children within this area (Otang-Mbeng, Otunola, & Afolayan, 2017).

Another study conducted in the Eastern Cape Province assessed the correlations between health related and anthropometrical fitness components of rural and urban boys aged seven to ten years (Muhumbe & Van Gent, 2014). This study omitted the prevalence of physical activity or fitness, therefore, it is evident that more research is needed to properly determine the necessary levels and interactions of physical activity, physical fitness and sedentary behaviour and/or screen time within school aged children in the Eastern Cape Province of South Africa. This data will aid in diagnosing the obesity and physical inactivity pandemic in the Eastern Cape Province, and further the progress of understanding and recognizing of key actions needed in South Africa as a whole.

CHAPTER III

Methodology

This study was an observational and cross sectional study designed to: (1) Collect data of baseline physical activity levels, sedentary behaviour and screen time of primary school children from a private school in Makana, Eastern Cape Province, South Africa, (2) assess levels of physical fitness in this cohort and compare this along with physical activity levels, sedentary behaviour and screen time across grades and sexes, and (3) determine a possible relationship between screen time and sedentary behaviour and physical activity and physical fitness levels.

3.1 Ethical approval

Approval for the study was granted by the Human Kinetics and Ergonomics Ethics Committee as well as the Research Ethics Committee of Rhodes University, ethical approval number: 2019-0750-816. The written permission of school heads/principals was obtained before the commencement of testing (Appendix A) and the necessary teachers involved were informed of the study by means of a staff meeting with the researchers, where the project and testing was explained. The parent or guardian of each pupil provided informed written consent, and each pupil also provided verbal and written assent before being allowed to participate in the study (Appendix B).

3.2 Participant information

The participants for the study were school children from Grades one to seven recruited from a private primary school in the city of Makana (Makana Local Municipality, Eastern Cape Province, South Africa).

3.2.1 Inclusion criteria

i. Primary school children from the Eastern Cape Province, South Africa.

ii. Male and female children between the ages of 6-13 years i.e. primary school level (grade one to seven).

3.2.2 Exclusion Criteria

i. The only children excluded from the study were those who did not give assent and those whose parents did not give consent.

3.3 Measurements and instrumentation

3.3.1Anthropometric measures

Stature – A portable stadiometer (Millor, South Africa) was fixed to a vertical wall to measure the stature of each child. Children were instructed to stand barefoot with their backs to the wall, arms at their sides, and heels touching the wall. They were asked to raise their heads and look forward and place their hands on their thighs with their palms facing inwards. The stature was recorded as the distance from the floor to the vertex, in the mid-sagittal plane, recorded to the nearest 1.0 mm.

Mass: A digital weighing scale (Micro T7E electronic platform scale, Optima Electronics; George, South Africa) was used to measure body mass. The children wore no shoes and were in their Physical Education clothing during measurement.

Body mass index: The values of stature and body mass obtained above were used to calculated body mass index using the formula: Body mass index = body mass/stature^2 (kg/m^2). The children were classified as either, underweight, healthy, at risk and overweight according to their BMI by use of percentiles presented by the Centres for Disease Control and Prevention (Harrington et al., 2013).

Waist Circumference: An inelastic tape measure (Millors, South Africa) was used to measure waist circumference using the umbilicus (belly button) as the reference point.

Peak height velocity: Using body mass, stature and sitting stature measures, as well as date of birth, the age at peak height and maturity offset was calculated for each child. All formulae's for the calculation of peak height velocity were taken from Mirwald et al. (2002), the maturity offset equation that was used was as follows (-9.236 + 0.0002708 x Leg Length and Sitting Height interaction) + (-0.001663 x Age and Leg Length interaction) + (0.007216 x Age and Sitting Height interaction) + (0.02292 x Weight by Height ratio).

3.3.2 Cardiovascular Measures

An electronic blood pressure monitor (Omron Healthcare, Kyoto, Japan) was used to measure resting systolic and diastolic blood pressure and heart rate of each subject. These were measured in the sitting position, after five minutes of rest. Two measurements per child were recorded at two minute intervals and the averages of the two measurements were used in analysis (Ekelund et al., 2006). Blood pressure and heart rate were recorded and expressed in units of mmHg and beats/minute (BPM) respectively.

3.3.3 Physical Fitness Measures

Physical fitness measures were assessed using the EUROFIT testing battery described by Armstrong, Lambert, & Lambert (2011). All fitness tests used from the EUROFIT testing battery have been validated (Tsigilis, Douda, & Tokmakidis, 2002).

a. Sit-and-reach flexibility test – This was used to test each child's hamstring flexibility. The children sat with legs extended and feet dorsi-flexed, with the surface of the foot placed against a purpose-built wooden box with a height of 33 cm and overhang of 50 cm. The test was performed as the child extended forward with arms straight and tried to reach as far forward as possible. A facilitator held the legs to prevent them from bending. Measurements were recorded as centimeters (cm), with 15 cm coinciding with the toes of the child. The child repeated the test twice, with the highest reading of the two (rounded to the nearest cm) was recorded as the final score.

b. Standing long jump – This was used to test lower body strength and explosiveness. The child stood barefoot with knees bent, feet together, and arms back. The child was then asked to swing their arms forward and jump as far forward as possible, landing with feet together. Each child was allowed two attempts to complete the test. The better of the two scores was recorded as the test result. If a child lost balance during the test, they were granted an additional attempt. The score was for the shortest distance, measured in cm, from where the child started, to the point at which the closest heel touched the ground following the jump.

c. Sit-ups – This was used to test core strength and endurance. The child was positioned with knees at 90°, feet flat on the ground, hands behind the head, and both shoulder blades touching the floor. The children were in pairs and took turns with one holding the feet while the other performed the sit-ups. The child sat up and touched both knees with the elbows, then returned to the starting position. This was repeated as many times as possible during 30 s. If the elbows did not touch the knees, the shoulder blades did not touch the ground, or the hands were moved from behind the head, the repetition was not counted. The protocol required that the feet remain on the ground throughout the testing.

d. 5-m Shuttle run test – The shuttle run test was used to assess speed and agility. Marker cones were placed 5-m apart. Two lines were drawn along the ground at these points to clearly indicate the start and finish lines of the 5-m distance. The child started behind the line on one side of the shuttle. After a countdown (“1, 2, 3, go”), the child ran as fast as possible between the cones, crossed the line with both feet, and ran back to the starting point. This was repeated until 10 shuttles were completed (i.e., 50-m) in as short a time as possible. The time taken to complete 10 shuttles was recorded to the nearest 0.1 s. If the children did not cross the line with both feet they were required to repeat the test following a short rest.

e. Cricket ball throw – This was used to assess upper body strength. The cricket ball throw test required the child to throw a 135 g cricket ball as far as possible. A restraining line was demarcated. The child had to stand in front of a demarcated restraining line while throwing and remain within a second line marked out 2-m away, during the test. A run-up was allowed, provided that the child remained within the delineated 2-m area, even during the follow-through. Each child was allowed two attempts. Distance of best throw was recorded as the score.

3.3.4 Physical Activity and sedentary behaviour

After the physical fitness assessment, physical activity was measured qualitatively using the Children’s Physical Activity Questionnaire (C-PAQ). The C-PAQ is a domain specific questionnaire where the parents of both the boarding and non-boarding children were asked to fill in the hours and minutes their child spent in the different physical activities per week and during weekends, there is also a subsection where sedentary behaviour is recorded (Appendix C).

3.3.5 Screen time

Total daily screen time was measured in hours (h) and minutes (min) using a self-adapted domain specific questionnaire given to the parents/guardians of each child (Appendix C). The parents/ guardians were required to complete this screen time diary for seven consecutive school days. A meeting was arranged with the boarding house heads whereby the screen time for the boarding school children was determined. A controlled screen time result was given to the boarders, per grade, according to how much time they were allowed to spend on their devices.

3.4 Procedure

After ethical approval was received from the Human Kinetics and Ergonomics Ethical Committee and the Rhodes University Ethical Committee, a briefing session was hosted at the school prior to testing week where the procedures, objectives, risks and benefits of the study were explained to the teachers. The principal of the school, parents/guardians, and participants were then required to provide their written informed consent/assent (Appendix A, Appendix B). It was also made clear that participation was voluntary and participants could opt out of the study at any time if they did not wish to participate any longer. Once parental consent was received a week where the physical fitness testing could be conducted was determined according to the availability of the venue to be used, the schools high performance centre. During the testing day the children were introduced and the reason for their participation in the tests was explained. Assent was then requested and received from each individual child (Appendix B). Thereafter the following were tested, after an *ad libitum* warm up of five minutes involving all children (Armstrong, Lambert, & Lambert, 2011(2)).

1. Stature and body mass (for BMI)
2. Sitting stature (for peak height velocity)
3. Blood pressure (mmHg)
4. Heart rate (BPM)
5. Number of sit ups (30 s)
6. Shuttle runs, time to complete 10 x 5 m (s)
7. Hamstring flexibility (cm)
8. Standing long jump, in distance measured (cm)
9. Cricket ball throw, distance measured (m)

The children were assigned numbers written on their hand using a hypoallergenic black marker, facilitators at each station recorded subject data according to the number given. The children were separated into two groups. One group was assigned to the waist circumference and body mass station, which was separated from all other stations with each child being tested in an isolated room with two facilitators. The children were also encouraged to stand on the scale backwards. The second group of children proceeded to the stature station where both standing and sitting stature were measured. Once complete, each child moved onto the stature station and vice versa. After the children completed these two stations they were required to sit on the floor in the middle of the high performance centre basketball court where the third station was explained and practised. The children were placed in pairs where one child held the feet of the other while they performed the sit-up test. One facilitator was assigned to one pair to count and control while the other facilitator timed for all the separate pairs. When all children had completed testing at the sit-up station they moved onto the shuttle run station where they were encouraged to practise the run to ensure correct placing of both feet over the line each time. Once ready, each child was assigned to a facilitator with a stopwatch. One facilitator initiated the test by stating out loud, 1, 2, 3 GO and the children started running while the other facilitators timed them and told them when to stop once they had completed 10 shuttles. Thereafter the testing followed a round robin structure with 3 stations (1 sit-and-reach station (5 facilitators for 5 sit-and-reach blocks), 1 standing long jump station (2 facilitators) and 1 cricket ball throw station (3 facilitators). Blood pressure and heart rate measures were carried out on a separate day to testing; each child was called out of their classroom one by one to have their blood pressure and heart rate measured.

After consent was received, and the physical fitness testing completed, parents were asked to complete the physical activity questionnaire (C-PAQ) for their child based on physical activity levels and sedentary behaviour and the screen time questionnaire (Appendix C). The Questionnaires were sent to parents via email from the school administrative officer, with an explanation of the questionnaires in detail as an attachment and contact details should they have questions (Appendix C).

3.5 Statistical analysis

Statistical analyses were conducted using the programme R (version 3.5.2). The level of significance was set at $p<0.05$ meaning a confidence interval of 95%. Simple descriptive statistics such as mean and standard deviations were calculated for all variables; body mass (kg), stature (cm), waist circumference (cm), heart rate (BPM), systolic blood pressure (mmHg), diastolic blood pressure (mmHg), sit-and-reach (cm), standing long jump (cm), cricket ball throw (m), sit-ups (number of sit-ups done in 30 s), shuttle run (s), physical activity and sedentary behaviour (min), and screen time (h).

The data was tested for normality first. Thereafter means and standard deviations were first calculated on female and male basis, then for separate grades (sexes combined) and lastly for all males in separate grades and all females in separate grades. Data was generated as box plots with two factor variables (i.e. grades and sexes) and a two-way interaction plot, to determine how the results for different sexes interacted across grades. This was done based on the means determined for each grade and each sex within each grade, to control for different values within different data sets. Two-way analysis of variance (ANOVA) models were conducted for all variables to determine any significant differences between grades and sexes. Post hoc Tukey HSD tests were used to conduct multiple comparisons of means (Grades and sexes) using a 95% confidence level. To check the ANOVA assumptions and the homogeneity of the variance assumptions (outliers) fitted vs. residual plot was used. The Levene test was used to check for no significance and to determine if the two-way ANOVA test was appropriate for this specific data set.

Pearson's correlations were set at a significance level of $p = 0.05$. The correlation coefficient was "r" and ranged from -1 to +1. As per the Guilford method, if the correlation coefficient was >0.3 it was interpreted as a weak but positive correlation. If it was >0.4 it was interpreted as moderately positive and if it was >0.7 it was a strong and positive correlation (Aswegen & Engelbrecht, 2009). These correlations were conducted on screen time with all variables (mass, stature, waist circumference, heart rate, systolic blood pressure, diastolic blood pressure, sit-and-reach, standing long jump, cricket ball throw, sit-ups, shuttle run, physical activity), heart rate with all variables, body mass with all variables and maturity offset with body mass and all fitness variables.

CHAPTER IV

Results

There has been a decline in physical activity and fitness rates in South Africa and, children in particular are becoming more sedentary which is of concern from a health point of view. Non-communicable diseases are rated as an epidemic in South Africa and are responsible for 71% of all deaths globally, and 51% of all deaths in South Africa specifically (World Health Organisation, 2018). Since there is a paucity of information on physical activity in children of school-going age in the Eastern Cape Province, this study focused mainly on the prevalence of physical activity, sedentary behaviour and screen time of primary school children in a school in the Eastern Cape Province of South Africa. Also, it was of interest and opportune to assess levels of physical fitness in this cohort. In this section only correlations of significance were reported on and those with no significance were left out, and were addressed in the discussion rather than depicted in graph form.

4.1 Anthropometric findings

The basic anthropometric characteristics of the female and male primary school learners who voluntarily participated in this study is summarised in Table 1.

Table 1: Mean (± standard deviation) stature, body mass and waist circumference measures for both male and female primary school children from grades one to seven.

Grades	Males			Females		
	M	**SD**	***n***	**M**	**SD**	***n***
Stature (cm)						
1	125.87	5.93	6	125.70	5.41	4
2	130.66	4.88	7	129.53	3.82	6
3	136.01	3.60	12	137.38	5.11	9
4	138.35	4.13	12	139.83	0.76	8
5	145.13	149.18	10	149.84	5.41	5
6	149.18	7.97	12	156.85	4.97	6
7	155.40	8.19	15	159.00	7.75	5
Adj. M	142.66		74	142.57		43
Mass (kg)						
1	25.33	4.85	6	29.38	3.64	4
2	29.86	6.34	7	26.83	2.23	6
3	32.21	3.82	12	37.06	7.41	9
4	35.36	9.31	12	33.67	2.52	8
5	41.70	12.94	10	46.30	12.31	5
6	45.08	9.42	12	52	11.10	6
7	48.37	11.32	15	51	7.97	5
Adj. M	38.72		74	39.80		43
WC (cm)						
1	55.55	3.37	6	62.05	5.88	4
2	60.01	5.92	7	55.63	3.10	6
3	59.47	3.30	12	66.66	10.71	9
4	74.72	14.84	12	71.50	21.50	8
5	64.51	12.68	10	65.68	9.37	5
6	67.08	6.88	12	68.32	7.78	6
7	66.77	9.08	15	65.40	3.65	5
Adj. M	65.10		74	64.80		43

SD- Standard Deviation; WC- Waist Circumference; M-Mean; n- number of participants; Adj.M- Mean of all grades combined

4.1.1 Stature

Stature increased significantly (p= 0.00) with increasing grade. Specifically between grades one and five, six and seven, grade two and six, grade two and seven, and grade three and six. There were no sex differences within grades although, again, females tended to be taller in most grades.

4.1.2 Body Mass

Body mass increased significantly (p= 0.00) with increasing grade. Specifically between grades one and five, six and seven, grade two and five, six and seven, grade three and six, grade three and seven, and lastly between grades four and six and, four and seven. There was a large variance in body mass for both males (30%) and females (30%) across all grades. There were no sex differences within grades although in many of the grades, the females were heavier. Body mass correlated positively and significantly with waist circumference (r= 0.6; p= <0.0001), systolic blood pressure (r= 0.6; p= <0.0001) (Figure 6, p 46), and diastolic blood pressure (r= 0.3; p= 0.001) (Figure 7, p 47).

4.1.3 Waist circumference

Waist circumference increased significantly (p= 0.0002) in learners between grade one and four, between grade two and four, and between grade three and four. There were no significant differences between any other grades, although waist circumference tended to decrease between grade four and seven learners. There was a large variance in waist circumference for both males (16%) and females (15%) across all grades. There were no sex differences within grades although females tended to have greater waist circumference values in most grades. Waist circumference correlated positively and significantly with body mass (r= 0.6; p= <0.0001).

4.2 BMI results

Body Mass Index (BMI) is shown in Table 2 and Table 3.

Table 2: Mean (± standard deviation) BMI values for males and females separated within grades one to seven.

	Grade													
	1		2		3		4		5		6		7	
	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
Males	15.83	1.78	17.33	2.58	17.41	1.93	18.29	4.27	20.41	5.92	20.15	3.20	19.84	3.21
Females	18.53	1.90	16.02	1.40	19.47	2.87	17.20	1.25	19.34	3.89	20.98	3.60	20.04	1.30

Table 3: Number of Males and females classified underweight, healthy, at risk and overweight, within each grade and percentage of overall.

	Underweight		Healthy		At risk		Overweight	
Grade	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**
1	0	0	5	1	1	2	0	1
2	0	0	3	6	4	0	0	0
3	1	0	9	5	2	2	0	2
4	0	0	9	3	1	0	1	0
5	0	1	6	4	0	2	2	0
6	0	0	9	4	2	1	1	1
7	0	0	11	5	3	0	1	0
% of Total	0.9	0.9	46.9	25.2	11.7	6.3	4.5	3.6

Of the total sample, 1.8% (males=0.9%; females=0.9%) were underweight, 72.1% (males=46.9%; females= 25.2%) were healthy weight, 18% (males= 11.7%; females= 6.3%) were at risk of being overweight, and 8.1% (males= 4.5%; females= 3.6%) were overweight.

4.3 Puberty and peak height velocity findings

Peak height velocity (PHV) is that period in which a child experiences the fastest upward growth in stature i.e. the time when growth is fastest and, together with puberty, is considered an important health marker. In this study, puberty and peak height velocity was measured in order to assess certain changes in physical activity and fitness levels with age and puberty onset. Peak height velocity was calculated using formulae's from Mirwald et al. (2002).

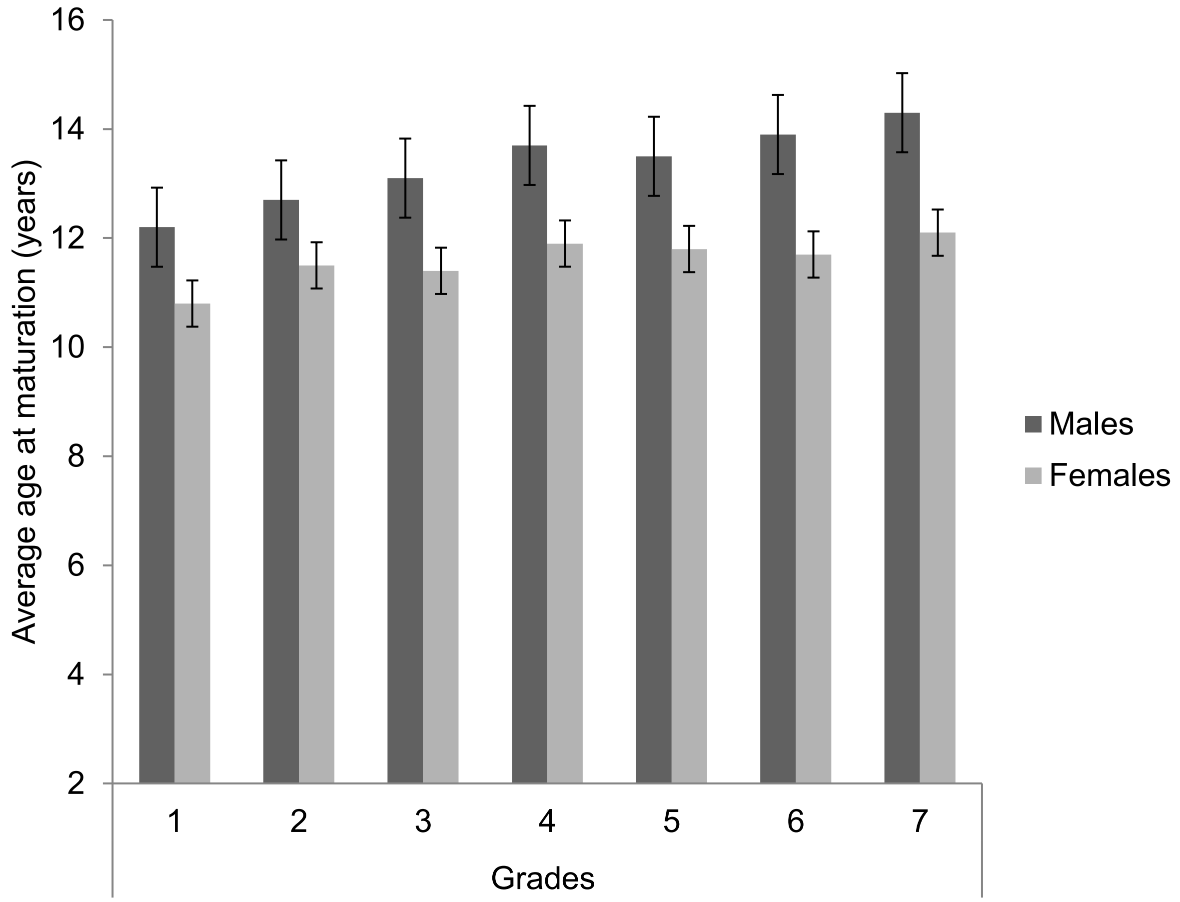


Figure 1: Mean (± standard deviation) age at puberty (years and months) according to peak height velocity of primary school children from grades one to seven.

Table 4: Differences (denoted by p values) between grades for age at maturation (* refers to significant differences).

	Significant differences between grades for age at maturation						
Grades	**1**	**2**	**3**	**4**	**5**	**6**	**7**
1							
2	0.366						
3	0.015 *	0.878					
4	<0.000 ***	<0.000 ***	<0.000 ***				
5	<0.000 ***	0.001 **	0.023 *	0.454			
6	<0.000 ***	<0.000 ***	<0.000 ***	0.998	0.729		
7	<0.000 ***	<0.000 ***	<0.000 ***	0.136	<0.000 ***	0.017 *	

Significance codes: p= 0.0001 (***), p= 0.001 (**), p= 0.01 (*)

4.3.1 Age at puberty

The average age at puberty and maturity increased significantly (p= <0.000) with increasing grade, apart from between grades one and two, two and three, four and five, six, seven, and five and six. There were significant (p= <0.000) sex differences where females matured faster and at a younger age. The average age of puberty for this sample of females was 11 years six months and for males 13 years five months.

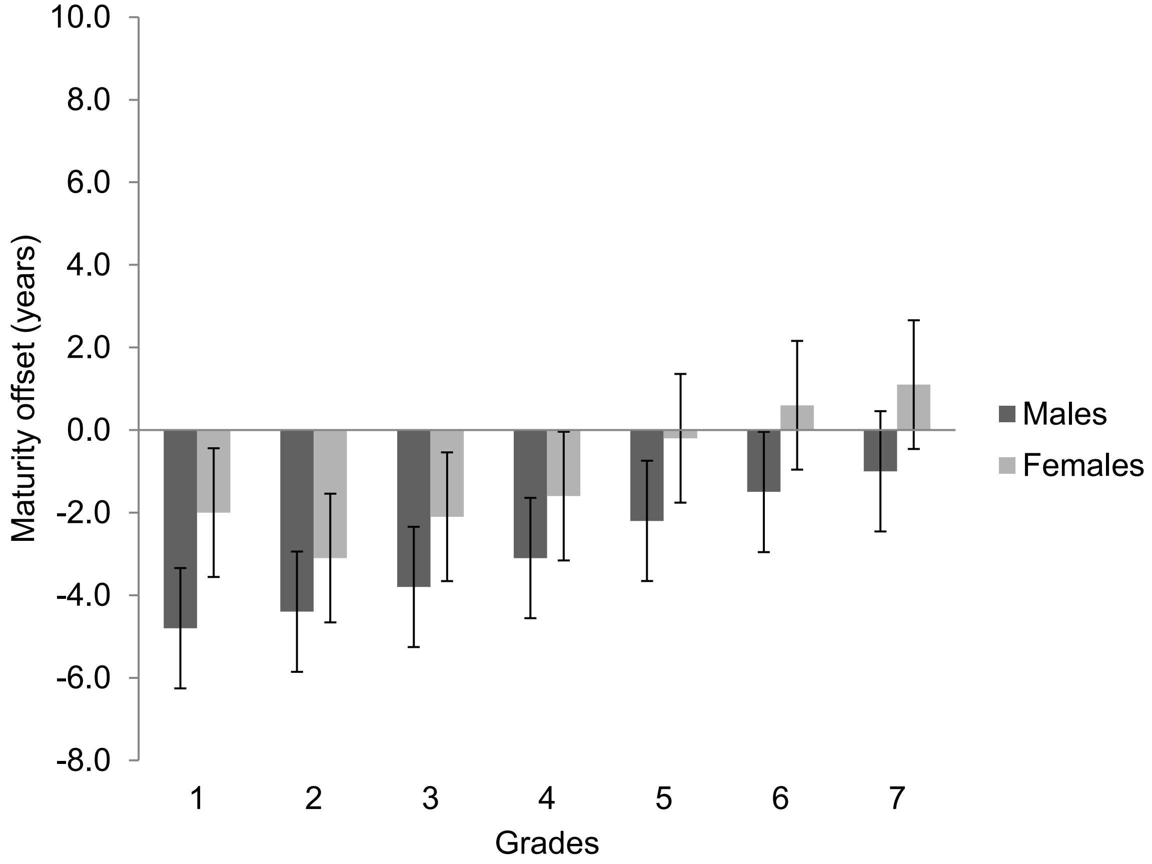


Figure 2: Mean (± standard deviation) maturation offset (years and months) according to peak height velocity of primary school children from grades one to seven.

Table 5: Differences (denoted by p values) between grades for maturity offset (* refers to significant differences).

	Significant differences between grades for maturity onset						
Grades	**1**	**2**	**3**	**4**	**5**	**6**	**7**
1							
2	0.159						
3	<0.000 ***	0.005 **					
4	<0.000 ***	<0.000 ***	0.699				
5	<0.000 ***	<0.000 ***	<0.000 ***	<0.000 ***			
6	<0.000 ***	<0.000 ***	<0.000 ***	<0.000 ***	0.002 **		
7	<0.000 ***	<0.000 ***	<0.000 ***	<0.000 ***	<0.000 ***	0.723	

Significance codes: p= 0.0001 (***), p= 0.001 (**), p= 0.01 (*)

4.3.2 Maturity offset (years)

The length of time each grades males and females are from maturity is depicted in Figure 2. Maturity offset increased significantly (p= <0.000) with increasing grade, except between grades one and two, three and four and six and seven (Table 5). Statistical significance (p= <0.000) was found between the sexes where females were closest to maturation than males in all grades. No males had reached maturation, whereas some of the grade six and seven females had, as seen by the amount of years from the children's peak height and stature spurt associated with the onset of puberty.

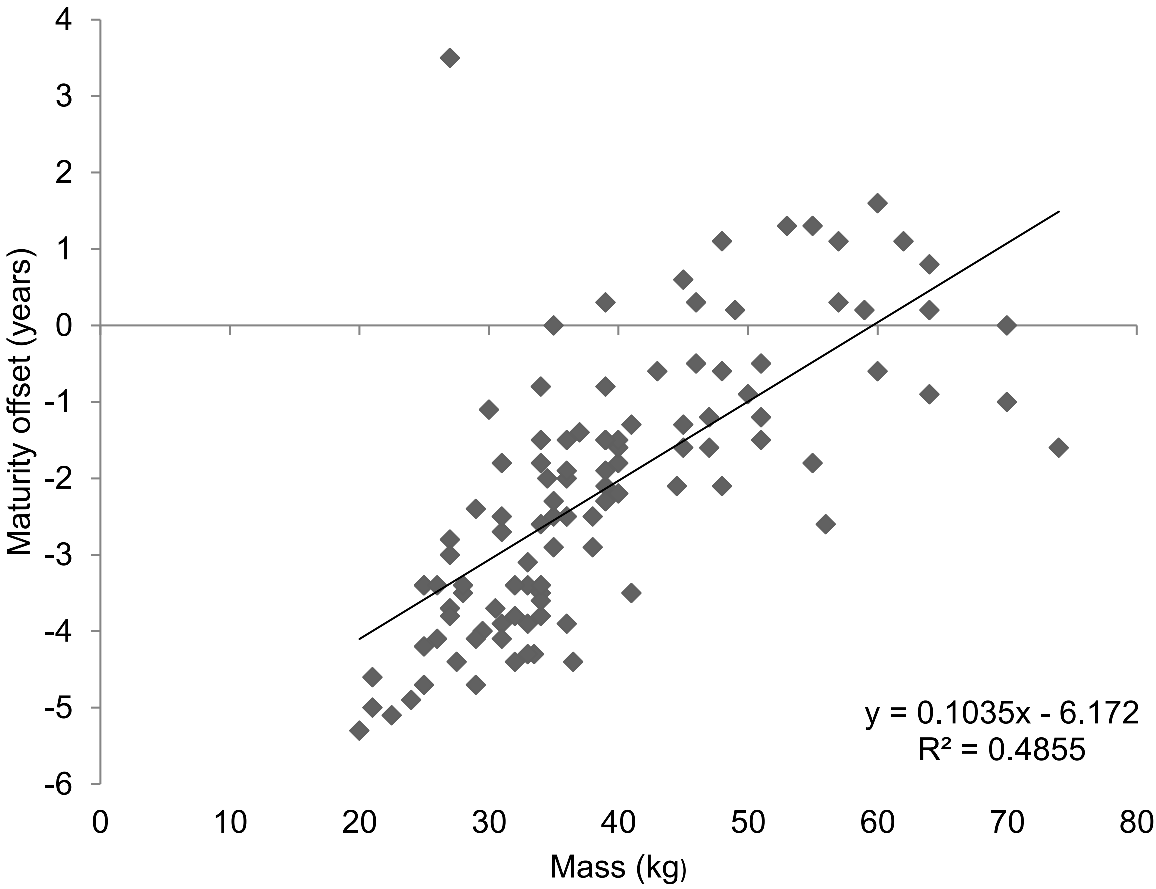


Figure 3: Association between maturity offset and body mass of primary school children from grades one to seven.

There was a significant positive and strong association between body mass and maturity offset (r= 0.6, p= <0.001).

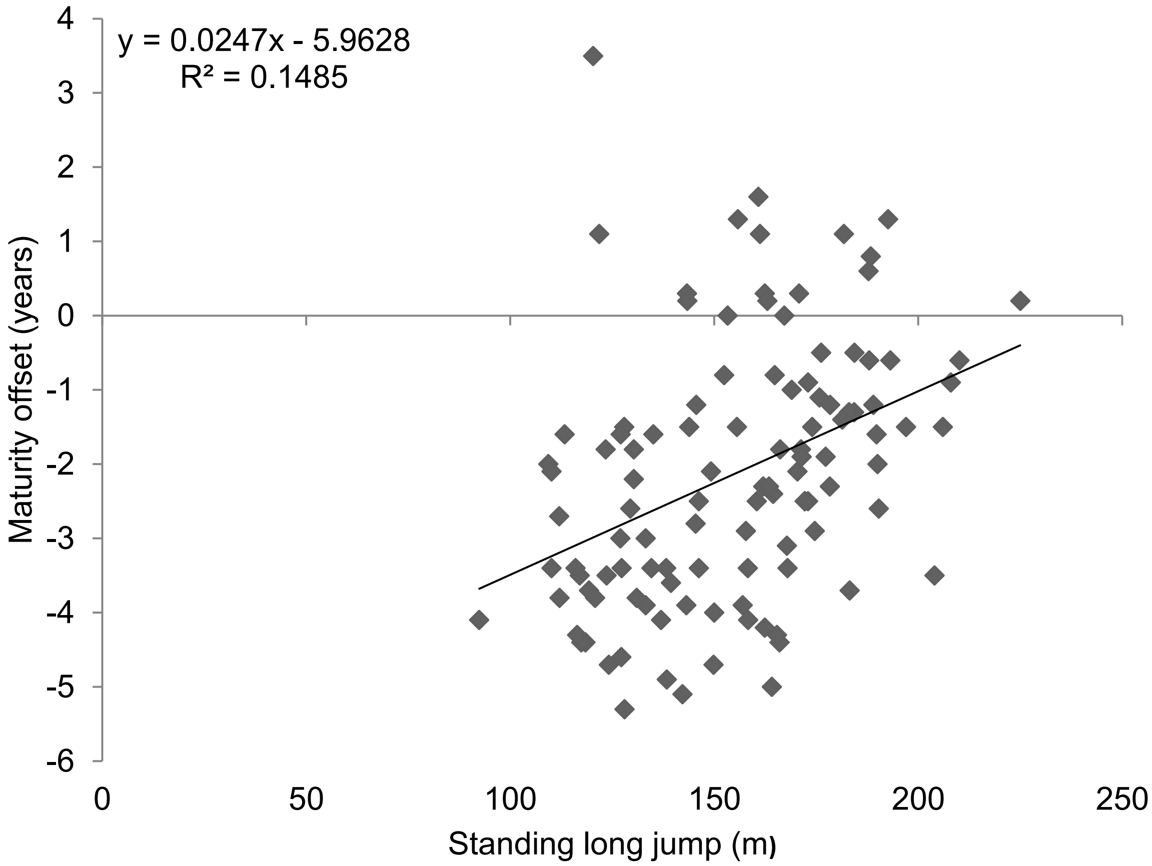


Figure 4: Association between standing long jump and maturity offset of primary school children from grades one to seven.

There was a significant positive but moderate association between standing long jump and maturity offset (r= 0.38, p= <0.001).

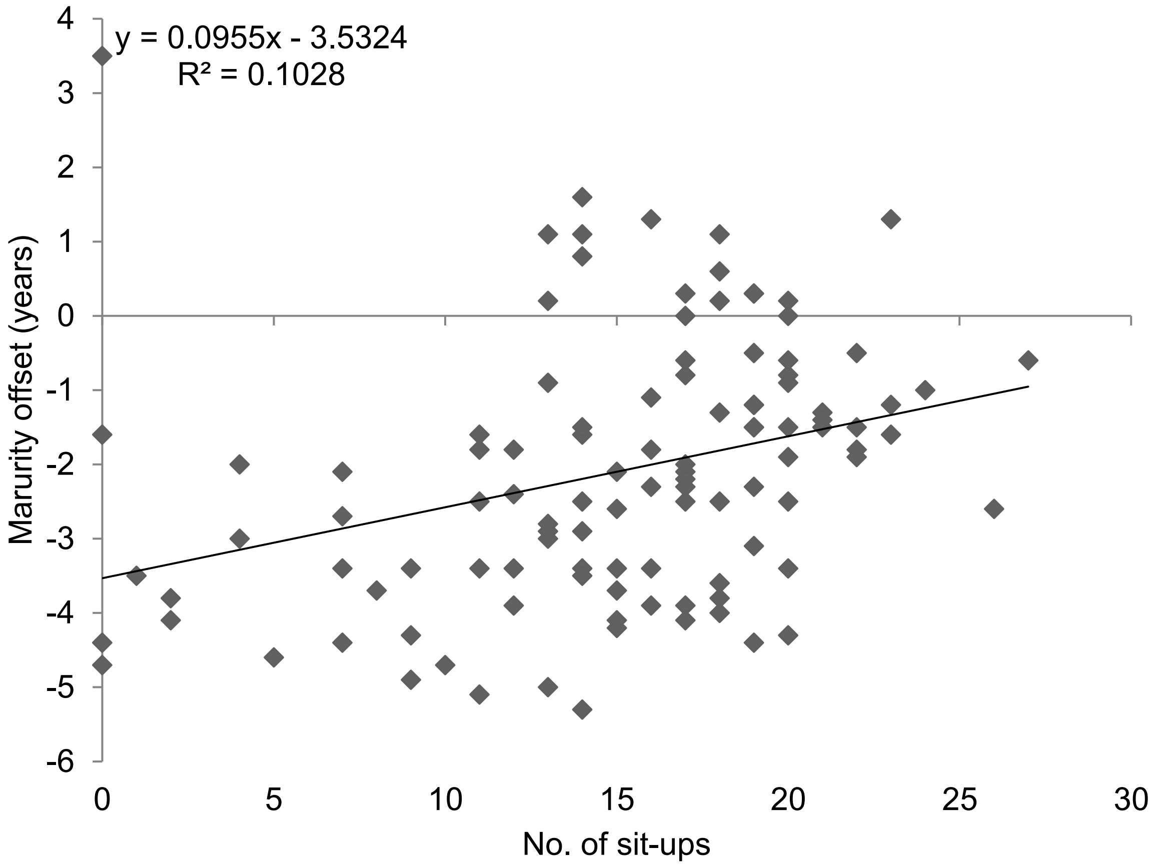


Figure 5: Association between no. of sit-ups and maturity offset of primary school children from grades one to seven.

There was a significant positive but weak association between number of sit-ups and maturity offset (r= 0.32, p= 0.001).

4.4 Cardiovascular findings

A record of the cardiovascular parameters measured for participating primary school learners from grade one to Grade seven is shown in Table 4.

Table 6: Mean (± standard deviation) heart rate, and blood pressure of both male and female primary school children from grades one to seven.

Grades	Males			Females		
	M	**SD**	***n***	**M**	**SD**	***n***
HR (bpm)						
1	73	12.12	6	83	12.12	4
2	85	8.07	7	83	5.12	6
3	80	7.92	12	72	18.55	9
4	77	13.82	12	81	10.91	8
5	72	11.24	10	72	12.47	5
6	78	16.53	12	85	7.29	6
7	64	8.41	15	82	13.22	5
Adj.M	76		74	80		43
SBP (mmHg)						
1	94.71	9.07	6	95	8.49	4
2	95	11.14	7	98.50	8.60	6
3	105.36	11.93	12	99.89	12.71	9
4	108	8.06	12	109.63	4.21	8
5	107.88	12.55	10	114.5	16.34	5
6	116.25	12.20	12	116	5.05	6
7	112.73	11.52	15	107.4	8.02	5
Adj.M	105.7		74	105.85		43
DBP (mmHg)						
1	59.86	5.40	6	56.05	2.12	4
2	58.29	8.52	7	62	8.22	6
3	66.91	8.22	12	64.67	9.22	9
4	66.33	9.50	12	73.50	9.62	8
5	69.88	6.96	10	72	13.37	5
6	73.33	19.94	12	69	3.74	6
7	64.20	10.08	15	67.20	7.69	5
Adj.M	65.54		74	66.41		43

SD- Standard Deviation; M-Mean; n- number of participants; Adj.M- Mean of all grades combined

4.4.1 Heart rate

Heart rate (HR) varied significantly (p= 0.001) between grades, however, did not present a distinct trend. Only grades two and seven differed significantly. There were no sex related differences although there was a tendency for females to have higher heart rates in most of the grades, specifically in grade one, grade four, grade six and grade seven. Further the grade seven males had the lowest heart rates. These findings were, however, not significant.

4.4.2 Systolic blood pressure

Systolic blood pressure (SBP) increased significantly (p= 0.00) between grades one and six and seven as well as between grades two and four, five, six, seven and between grades three and six. There were no differences between females and males with an adjusted mean for each population of 105.85 mmHg and 105.70 mmHg respectively (Table 4).

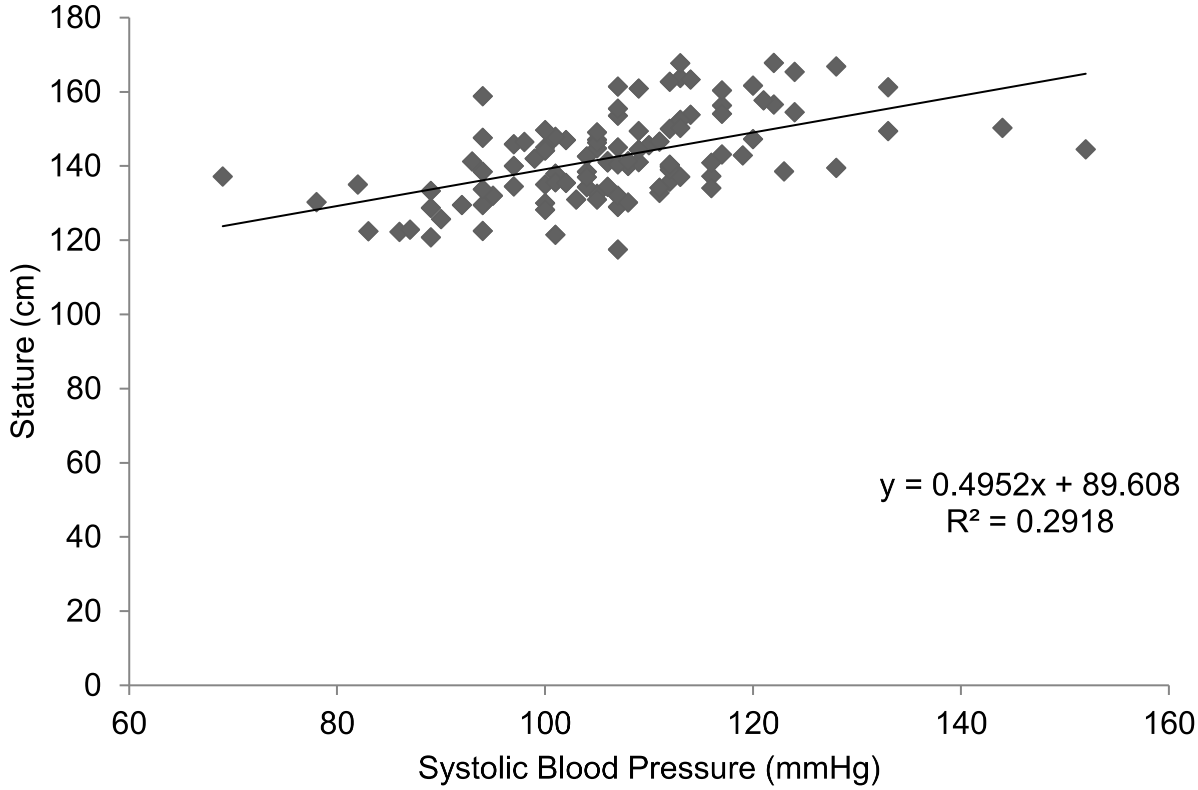


Figure 6: Association between systolic blood pressure and stature in primary school children from grades one to seven.

There was a significant positive and moderate association between stature and systolic blood pressure (r= 0.5, p= <0.001) (Figure 1).

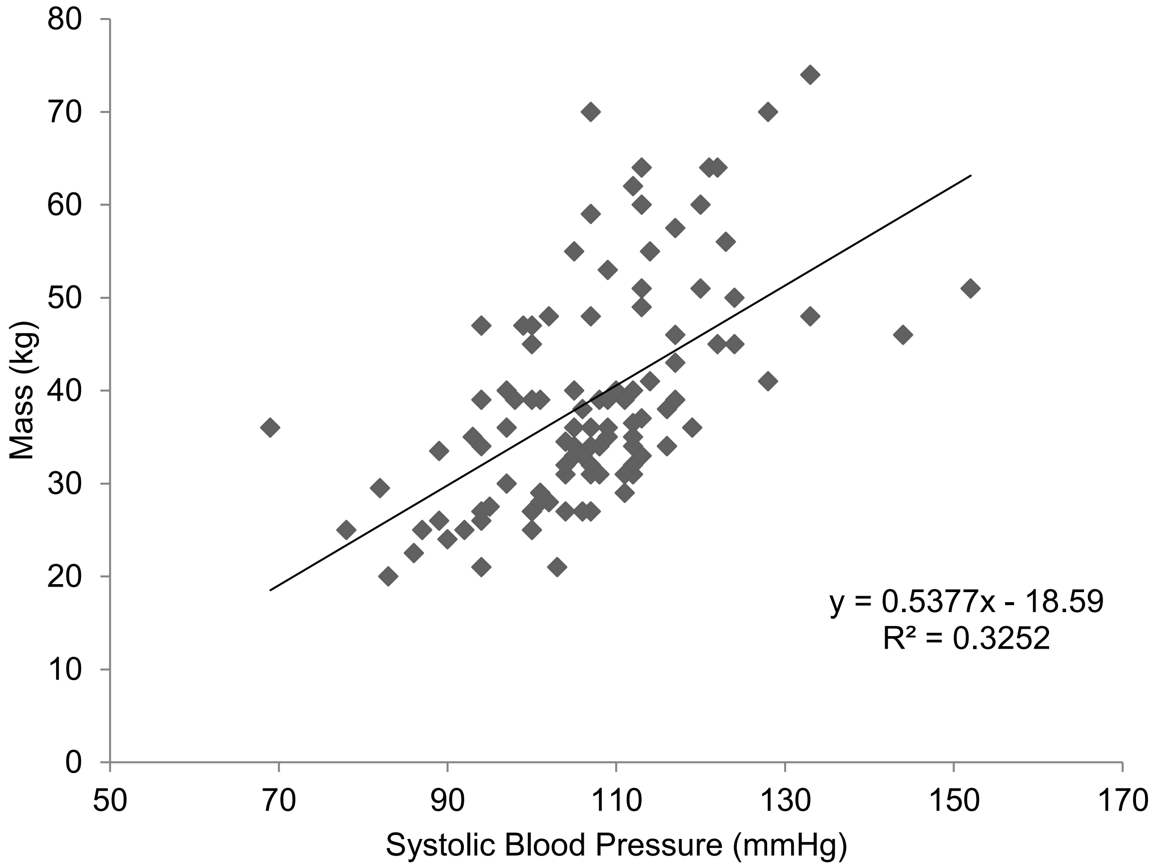


Figure 7: Association between systolic blood pressure and body mass in primary school children from grades one to seven.

There was a significant positive and moderate association between body mass and systolic blood pressure (r= 0.6, p= <0.001) (Figure 1).

4.4.3 Diastolic blood pressure

Diastolic blood pressure (DBP) was significantly (p= 0.04) higher in the grade six cohort than the grade two cohort. There were no differences found between any other grades. There were no sex related differences; however, the grade four females had the highest diastolic blood pressure (Table 4).

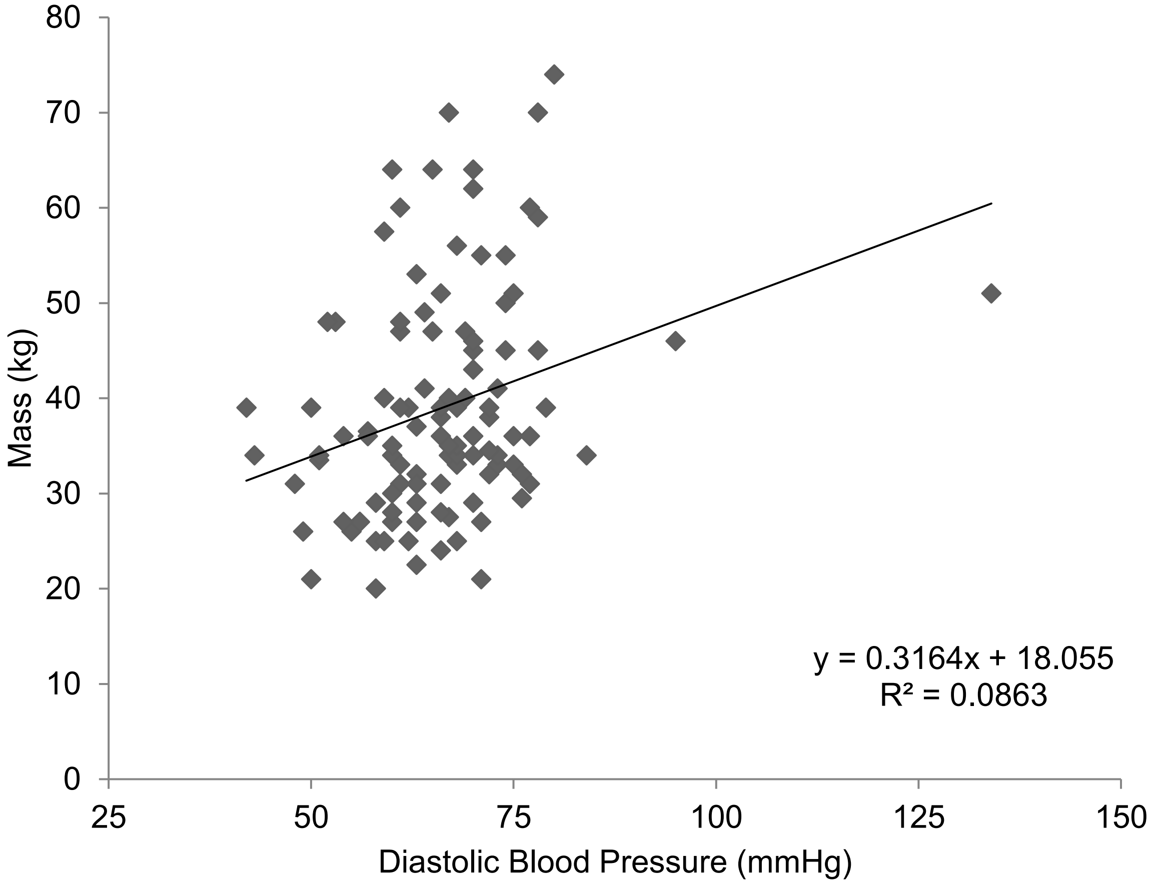


Figure 8: Association between diastolic blood pressure and body mass in primary school children from grades one to seven.

There was a significant positive but weak association between body mass and diastolic blood pressure (r= 0.3, p= 0.001).

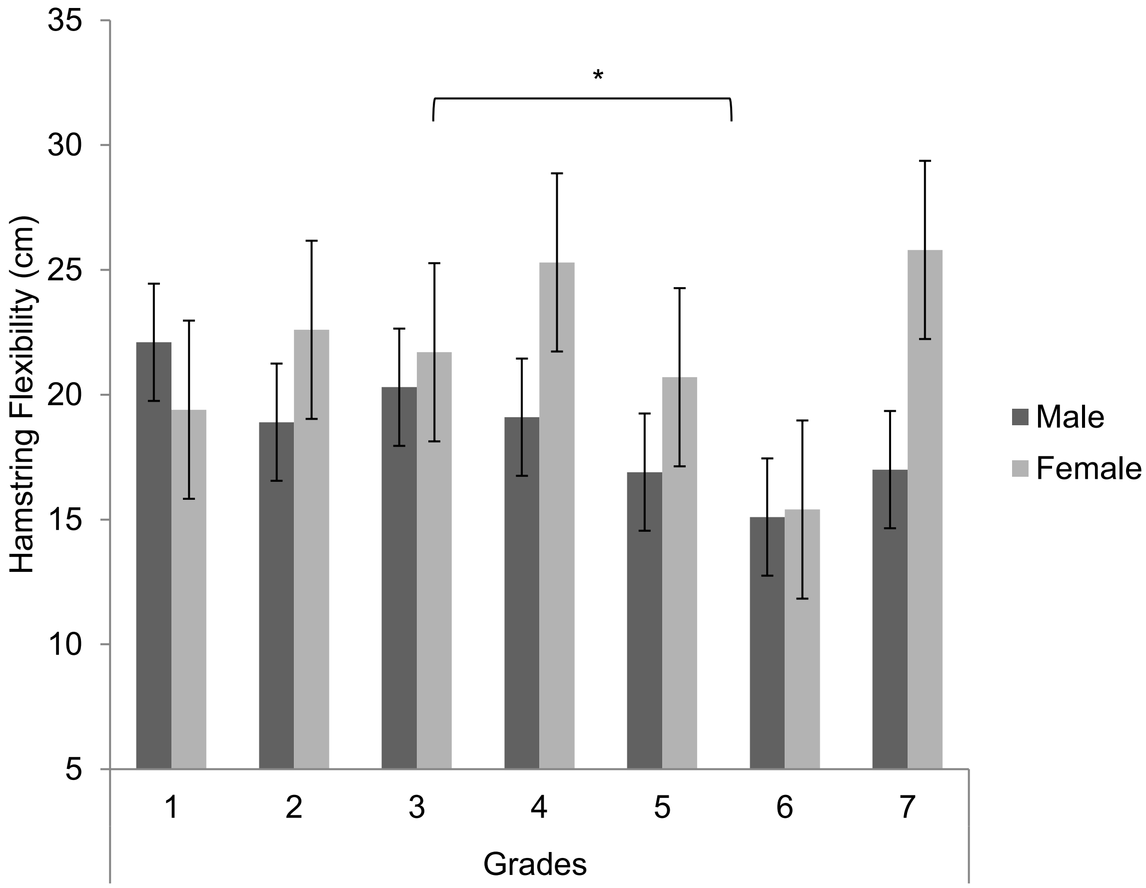
4.5 Physical Fitness findings

Physical fitness of the school participants was assessed using standard tests / criteria as proposed by Armstrong, Lambert, & Lambert, (2011)(2).

Table 7: Mean (± standard deviation) five fitness tests of primary school males and females in grades one to seven.

Grades	Males			Females		
	M	SD	*n*	M	SD	*n*
Sit-and-reach (cm)						
1	22.12	5.64	6	19.38	3.27	4
2	18.94	2.13	7	22.58	4.19	6
3	20.27	5.56	12	21.68	4.63	9
4	19.13	4.49	12	25.27	1.36	8
5	16.90	6.92	10	20.73	1.83	5
6	15.08	6.82	12	15.40	8.13	6
7	16.99	6.50	15	25.76	9.94	5
Adj.M	18.20		74	21.60		43
Standing long jump (cm)						
1	132.38	17.94	6	112.25	13.31	4
2	141.14	17.42	7	124.05	13.76	6
3	152.42	23.01	12	133.34	23	9
4	148	21.10	12	146	19.24	8
5	160.77	19.77	10	157.94	14.24	5
6	179.99	19.60	12	162.58	24.71	6
7	181.93	20.63	15	172.36	15.08	5
Adj.M	148		74	143.60		43
Sit-up (score/30s)						
1	7.50	6.28	6	2.75	3.59	4
2	12.14	5.18	7	10.50	3.21	6
3	15.18	5.02	12	8.78	5.31	9
4	15.40	2.63	12	13.75	9.74	8
5	16.10	4.38	10	17	2.74	5
6	18.50	2.47	12	15.67	2.25	6
7	21.20	2.34	15	18	3.39	5
Adj.M	16.20		74	12.20		43
Shuttle run (s)						
1	22.43	0.96	6	24.17	0.95	4
2	22.66	1.68	7	22.97	1.59	6
3	22.23	1.57	12	24.11	1.48	9
4	23.25	4.23	12	21.68	1.50	8
5	21.41	2.69	10	21.42	0.27	5
6	20.29	1.46	12	20.88	0.68	6
7	19.94	0.95	15	21.03	1.46	5
Adj.M	21.50		74	22.40		43
Cricket ball throw (m)						
1	20.17	2.39	6	10.94	1.26	4
2	17.51	7.27	7	12.08	3.94	6
3	22.07	7.13	12	15.92	3.79	9
4	26.77	7.16	12	15.82	2.28	8
5	26.12	7.35	10	18.42	6.43	5
6	34.80	7.12	12	20.90	4.61	6
7	41.96	9.11	15	22.59	8.94	5
Adj.M	29.20		74	16.80		43

SD- Standard Deviation; M- Mean for school tested; *n*- Sample Size; Adj. M- Mean of all grades combined.

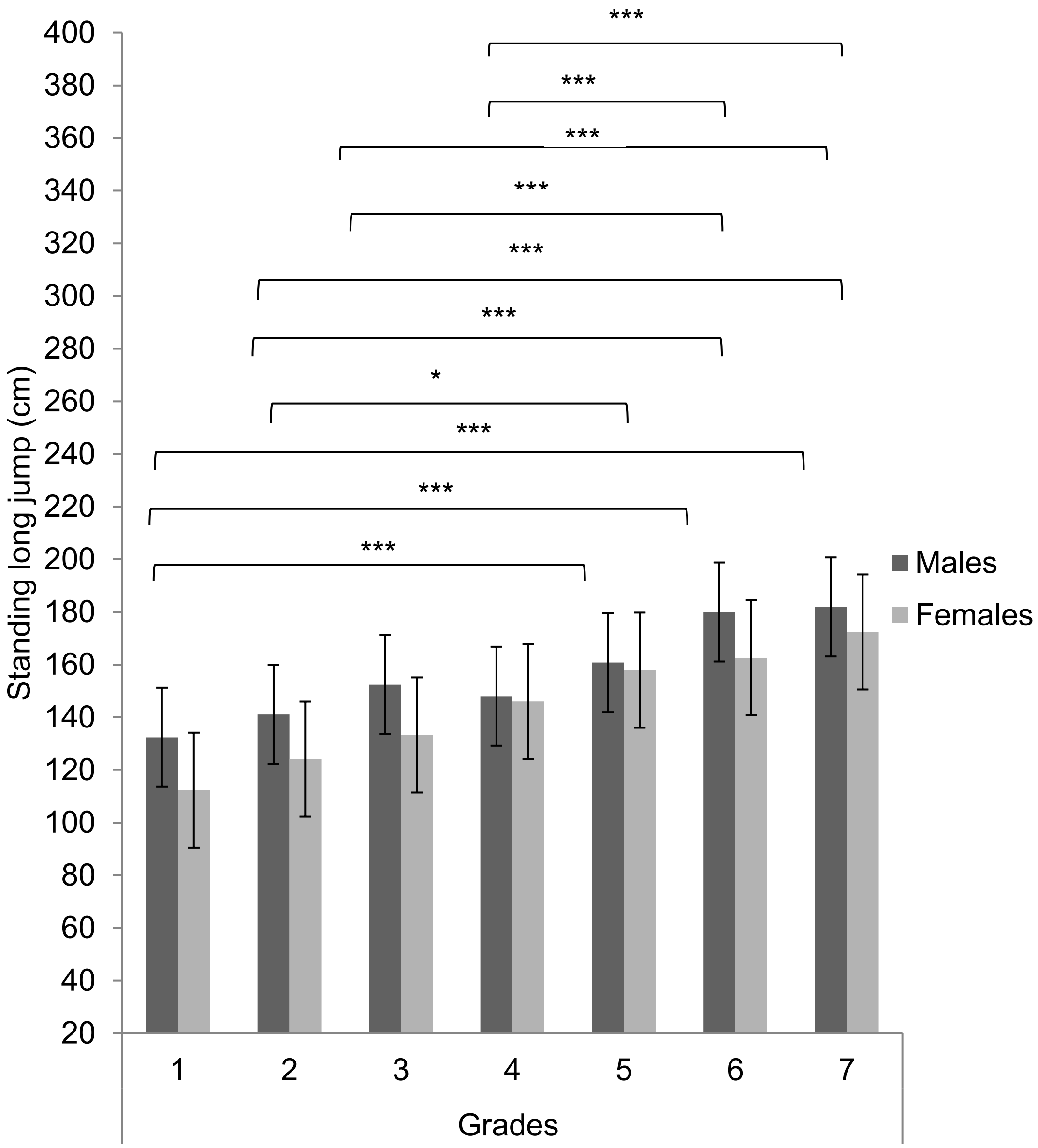


Significance codes: p= 0.0001 (***), p= 0.001 (**), p= 0.01 (*)

Figure 9: Mean (± standard deviation) hamstring flexibility (sit-and-reach) of primary school children compared across grades and sexes.

4.5.1 Sit-and-reach

Hamstring flexibility was significantly ($p = 0.01$) lower in the grade six cohort compared to the grade three cohort. There were no significant differences found between any other grades. Females were significantly ($p = 0.01$) more flexible than males in every grade (Figure 5).



Significance codes: p= 0.0001 (***), p= 0.001 (**), p= 0.01 (*)

Figure 10: Mean (± standard deviation) lower body strength (standing long jump) of primary school children compared across grades and sexes.

4.5.2 Standing long jump

Standing long jump increased significantly (p= 0.00) with increasing grade, except between grades one and four and grades five and seven. Males had significantly (p= 0.00) greater lower body strength than the females across all grades; this is not shown in the figure because of the number of significant differences (Figure 6).

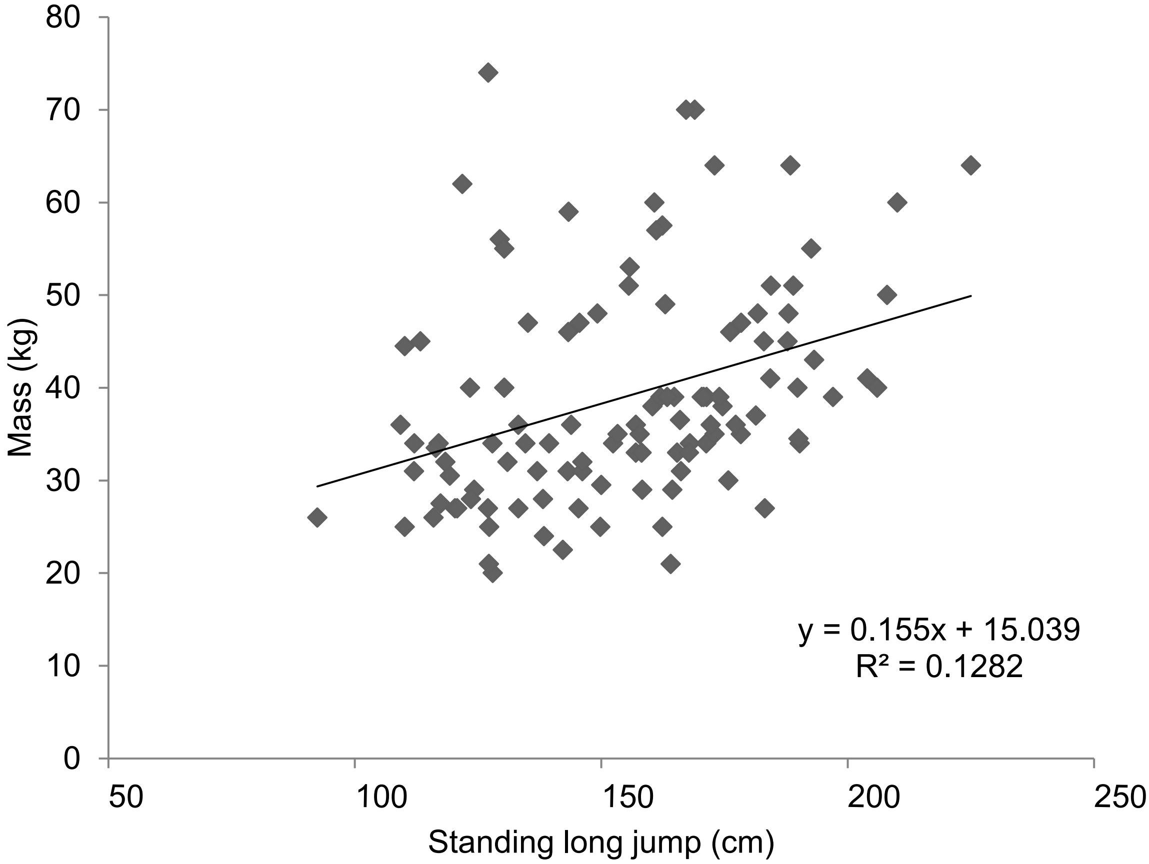
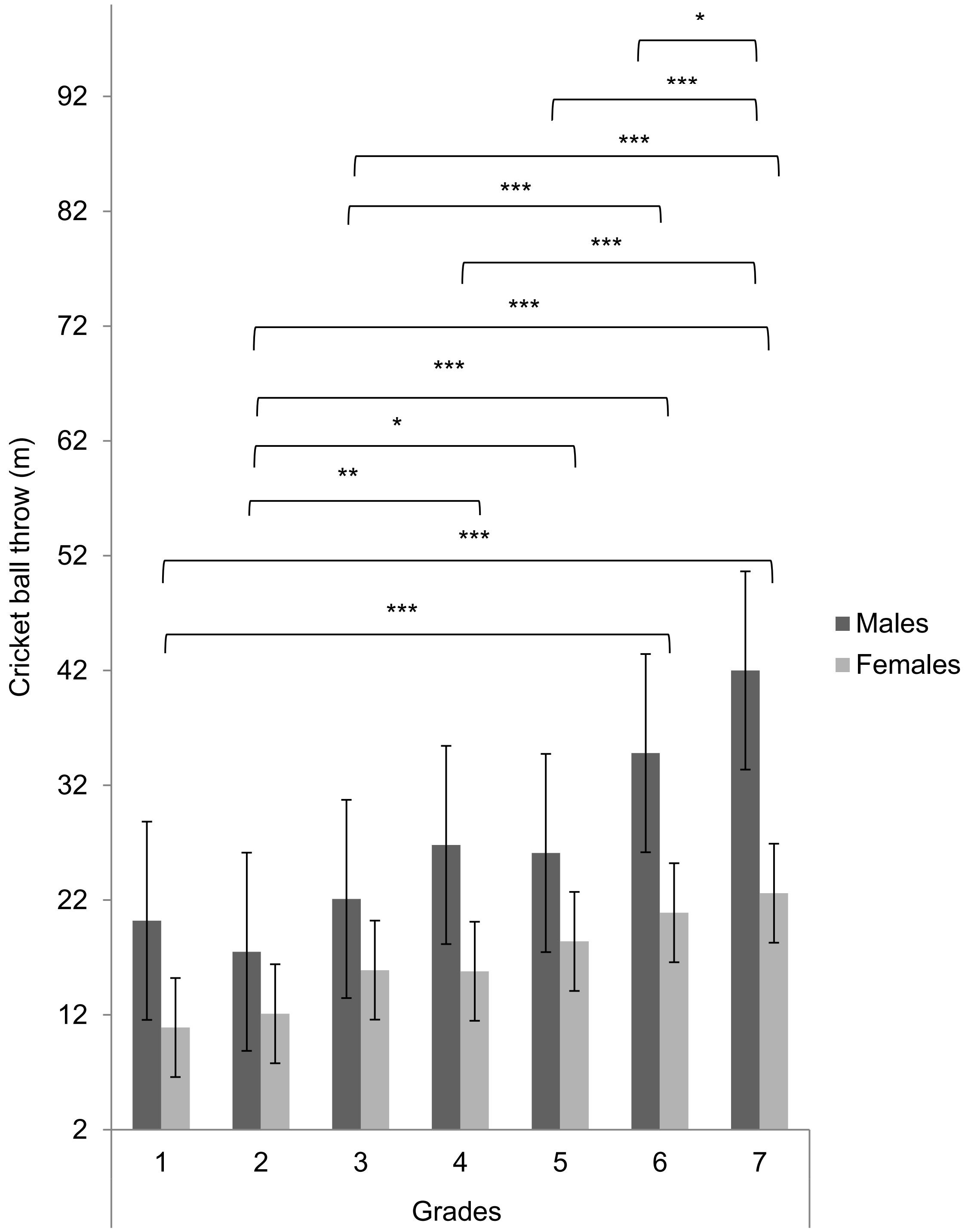


Figure 11: Association between standing long jump and body mass of primary school children from grades one to seven.

There was a significant positive but moderate association between body mass and standing long jump (r= 0.35, p= <0.001).



Significance codes: p= 0.0001 (***), p= 0.001 (**), p= 0.01 (*)

Figure 12: Mean (± standard deviation) upper body strength (cricket ball throw) of primary school children compared across grades and sexes.

Table 8: Differences (denoted by p values) between grades for cricket ball throw (* refers to significant differences).

	Significant differences between grades for cricket ball throw						
Grades	**1**	**2**	**3**	**4**	**5**	**6**	**7**
1							
2	0.998						
3	0.894	0.478					
4	0.078	0.008 **	0.394				
5	0.145	0.019 *	0.602	0.999			
6	<0.000 ***	<0.000 ***	<0.000 ***	0.216	0.089		
7	<0.000 ***	<0.000 ***	<0.000 ***	<0.000 ***	<0.000 ***	0.034 *	

Significance codes: p= 0.0001 (***), p= 0.001 (**), p= 0.01 (*)

4.5.3 Cricket ball throw

Upper body dominant arm strength increased significantly (p= 0.00) with increasing grade except between grades one and five. There were statistical differences (p= 0.00) found between the sexes with males having the highest upper body strength (Table 5). Cricket ball throw correlated positively and significantly with body mass (p= <0.0001) (Figure 8), and also correlated negatively and significantly with heart rate (p= 0.002).

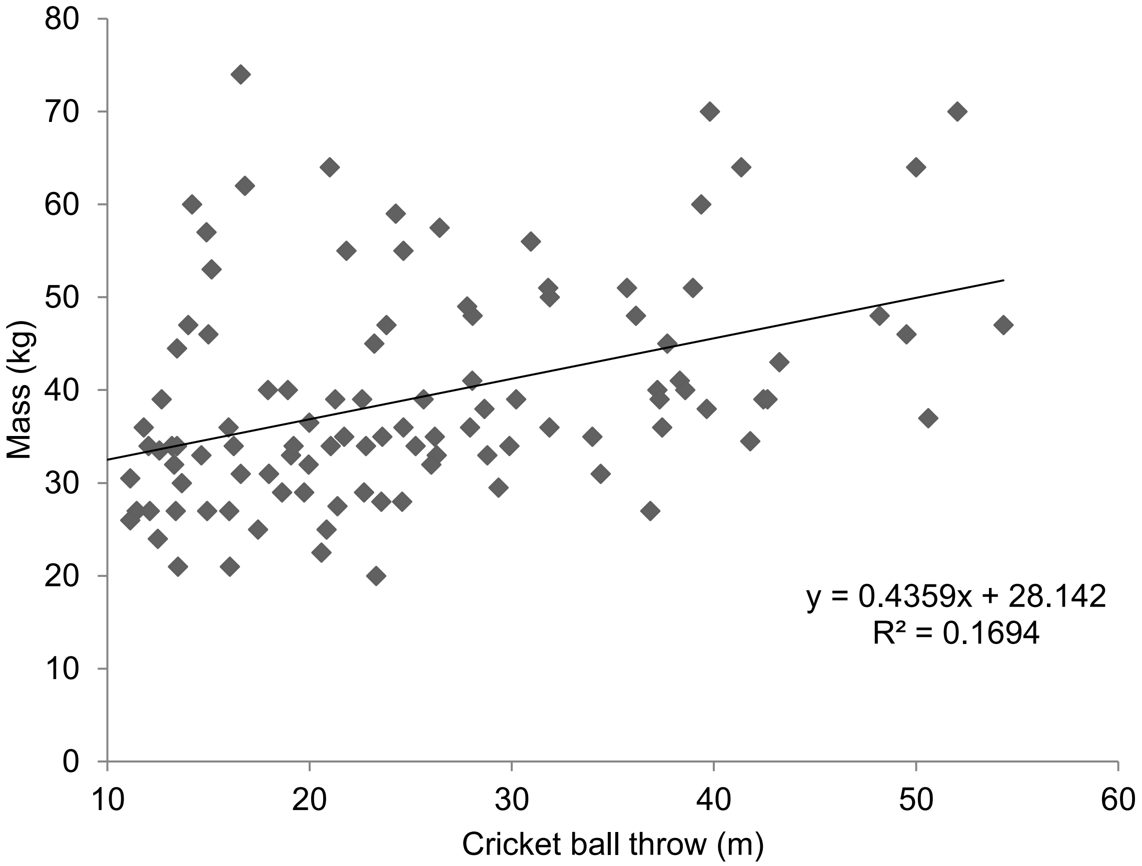
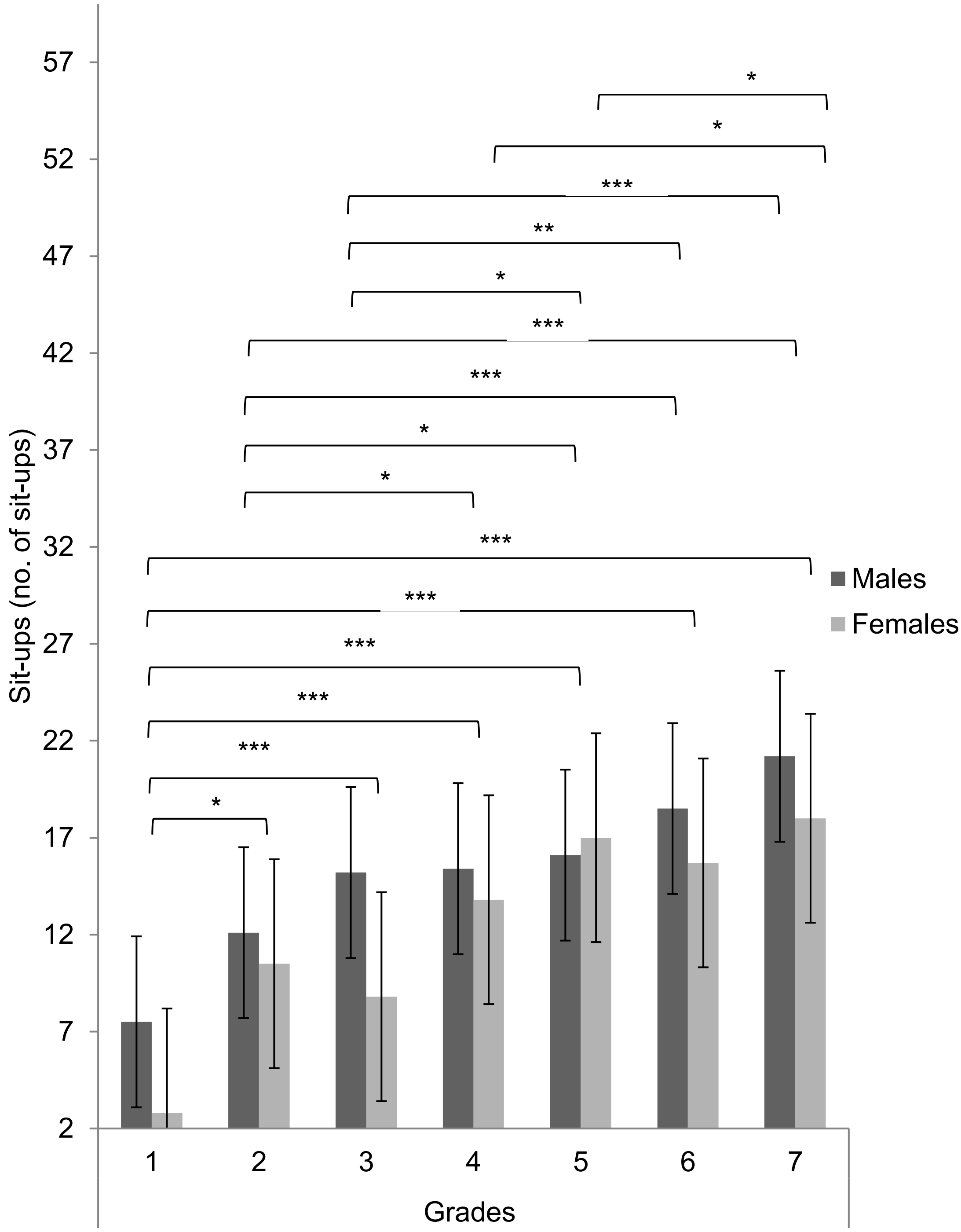


Figure 13: Association between cricket ball throw and body mass of primary school children from grades one to seven.

There was a significant positive and strong association between body mass and cricket ball throw (r= 0.4, p= <0.001).



Significance codes: p= 0.0001 (***), p= 0.001 (**), p= 0.01 (*)

Figure 14: Mean (± standard deviation) core strength (sit ups) of primary school children compared across grades and sexes.

Table 9: Differences (denoted by p values) between grades for sit-ups (* refers to significant differences).

Significant differences between grades for sit-ups							
Grades	**1**	**2**	**3**	**4**	**5**	**6**	**7**
1							
2	0.008 **						
3	<0.000 ***	0.993					
4	<0.000 ***	0.034 *	0.088				
5	<0.000 ***	0.012 *	0.033 *	0.999			
6	<0.000 ***	<0.000 ***	<0.000 ***	0.935	0.976		
7	<0.000 ***	<0.000 ***	<0.000 ***	0.030 *	0.041 *	0.253	

Significance codes: p= 0.0001 (***), p= 0.001 (**), p= 0.01 (*)

4.5.4 Sit-ups

Core strength increased significantly (p= 0.00) with increasing grade except between grades two and three, between grades three and four, between grades four, five and six, between grades five and six and between grades six and seven. There was a large variance in the number of sit ups for both males (33%) and females (52%) across all grades. Significant differences (p= 0.00) were found between the sexes with the males having the highest core strength, excluding the grade five females who had more core strength compared to the grade five males. Core strength correlated positively and significantly with body mass (p= 0.0004).

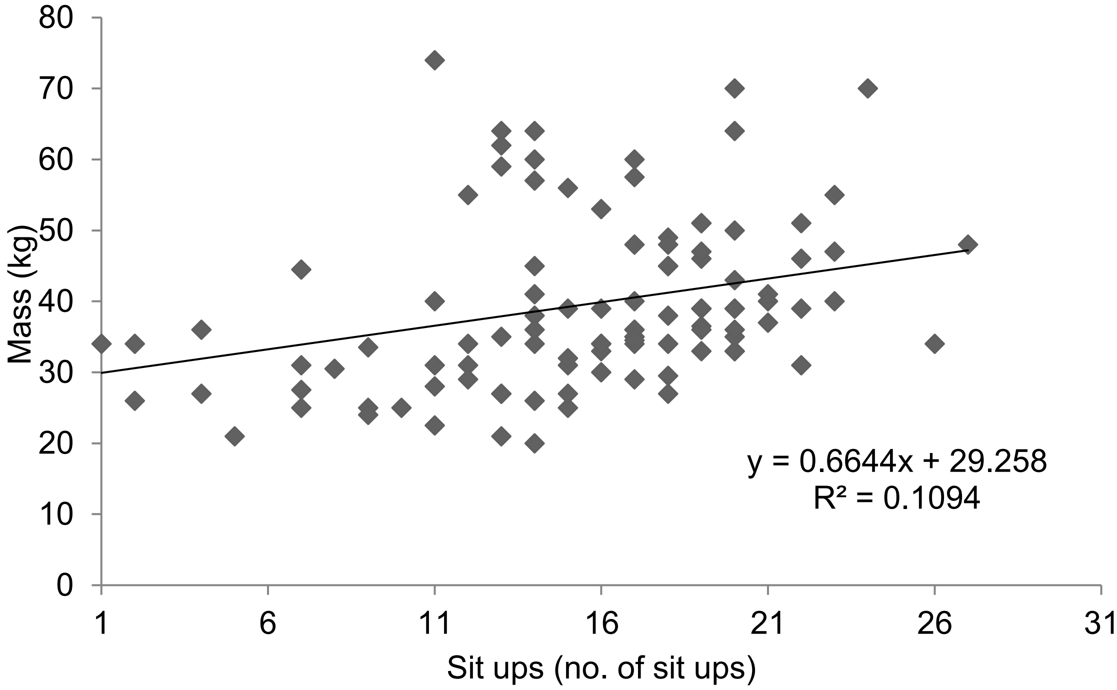
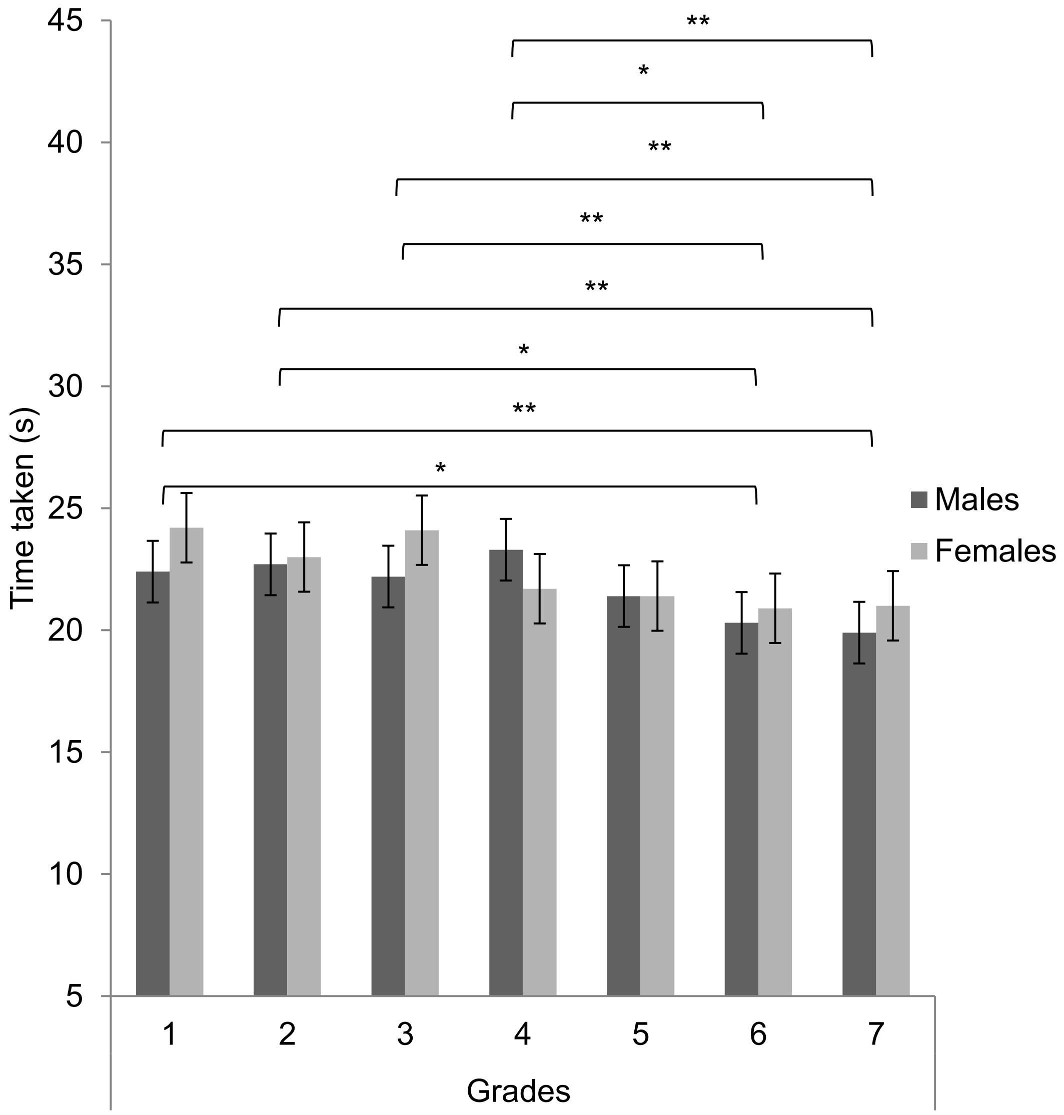


Figure 15: Association between core strength and body mass of primary school children from grades one to seven.

There was a significant positive but weak association between body mass and core strength (no. of sit-ups) (r= 0.33, p= 0.001) (Figure 10).



Significance codes: p= 0.0001 (***), p= 0.001 (**), p= 0.01 (*)

Figure 16: Mean (± standard deviation) speed and agility (shuttle run test) of primary school children compared across grades and sexes.

4.5.5 Shuttle run

Time to shuttle run completion decreased significantly (p= 0.00) with increasing grade specifically between grades one and six, one and seven, between grades two and six, two and seven, between grades three and six, three and seven, and between grades four and six, four and seven. No sex differences were found although females were slower in most grades.

4.6 Physical activity and sedentary behaviour findings

In order to determine physical activity levels and time spent in activity during a seven-day week, C-PAQ questionnaires were given to all parents who consented. Initially, physical activity was going to be objectively measured using Actiwatches, however, due to the small number of Actiwatches available, this was not possible. Due to communication barriers, only a small percentage of the C-PAQ questionnaires were completed accordingly. The average amount of time (min) a small percentage of the sample (27%) spent being physically active as well as sedentary can be seen in Figure 17.

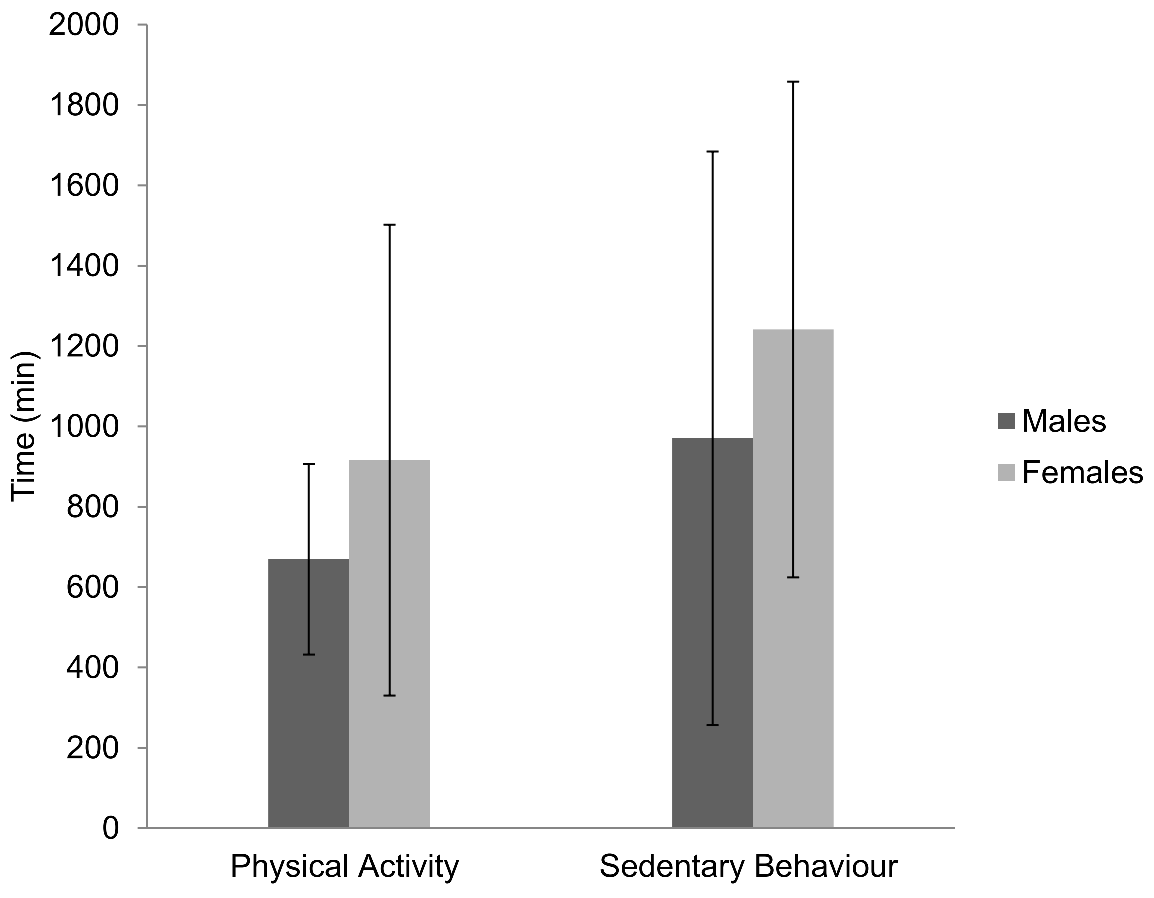


Figure 17: Mean (± standard deviation) total time spent in physical activity and sedentary behaviour's (min/ seven days) for both male and female primary school children from grades one to seven.

The males in this cohort spent an average of 11 hours and six minutes (669 min) Males= 669 min; Females= 916 min) in physical activity and 16 hours and 10 minutes in sedentary behaviours per seven-day week. The females spent an average of 15 hours and 16 minutes in physical activity and 20 hours and 41 minutes in sedentary behaviours per seven-day week. On average, the children in this study spent more time in sedentary behaviours than in physical activity. The females accumulated more than the males for both physical activity and sedentary behaviour.

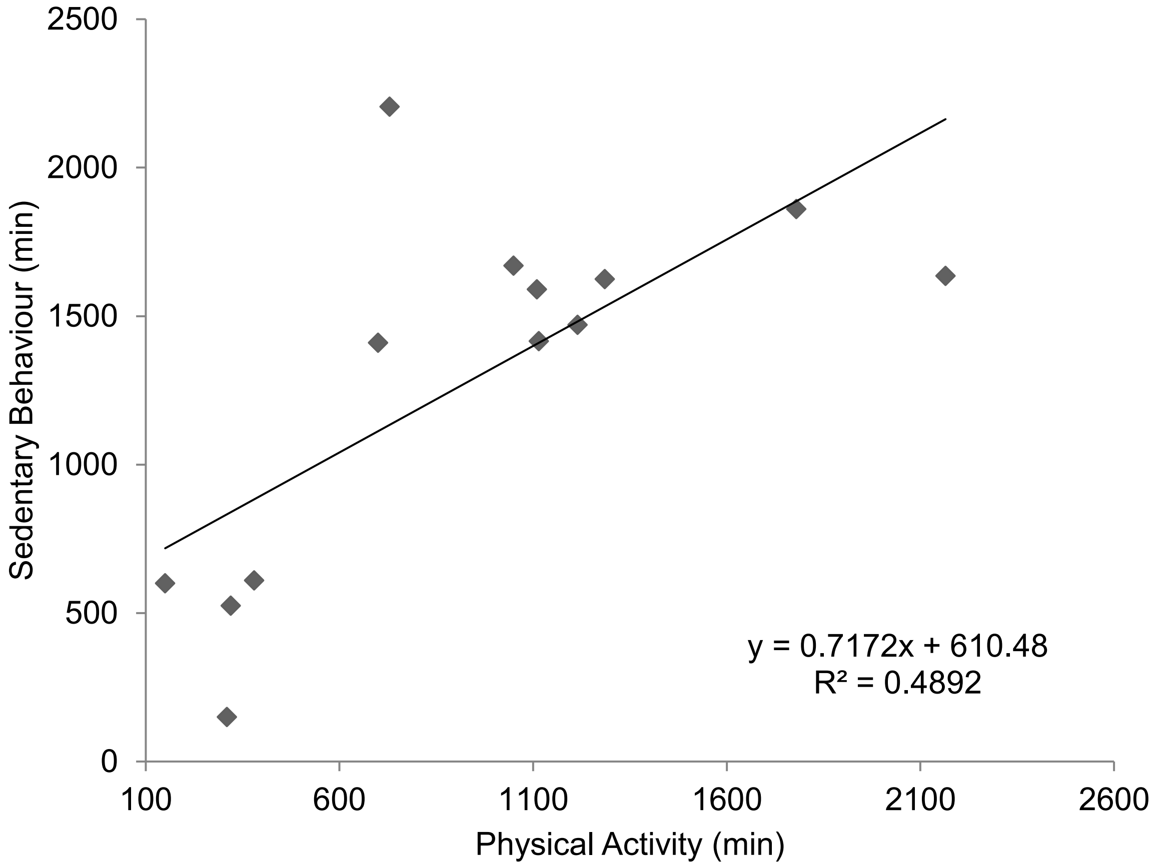


Figure 18: Association between sedentary behaviour and physical activity levels for female primary school children.

There was a significant positive strong association between sedentary behaviour and physical activity amongst females (r= 0.7, p= 0.001).

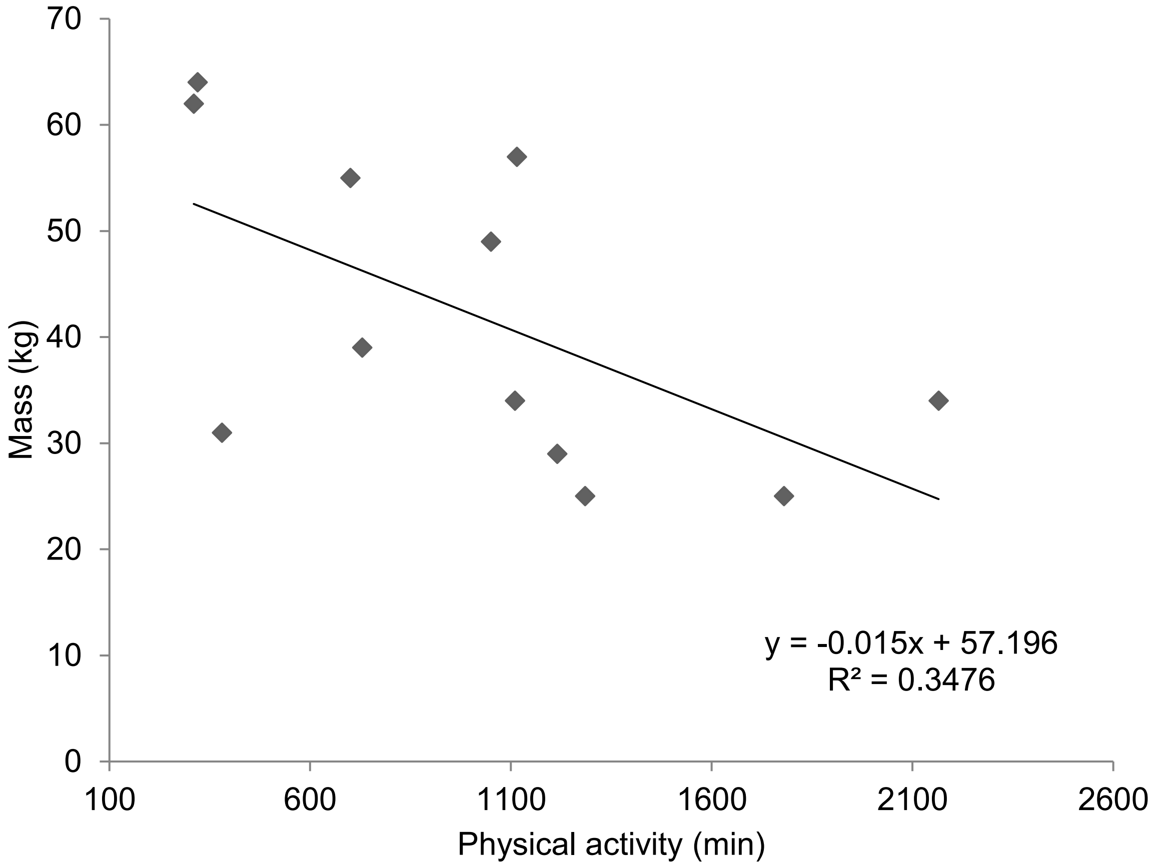


Figure 19: Association between physical activity and body mass for female primary school children.

There was a significant negative and strong association between physical activity and body mass (r= -0.6, p= 0.04) (Figure 18).

4.7 Screen time findings

Screen time is the amount of time spent using a device with a screen such as a smartphone, computer, television, or video game console and is important in the context of the present study as it may impact both physical and physiological health of affected primary school children. Here, 'screen time' was assessed to determine the total hours and minutes each child spends using screens during a seven-day week. The response rate for screen time questionnaires was larger (66 %) than that of the C-PAQ as the screen time values for the boarding school children were controlled. The increased number of questionnaires received allowed for comparison across grades and sexes.

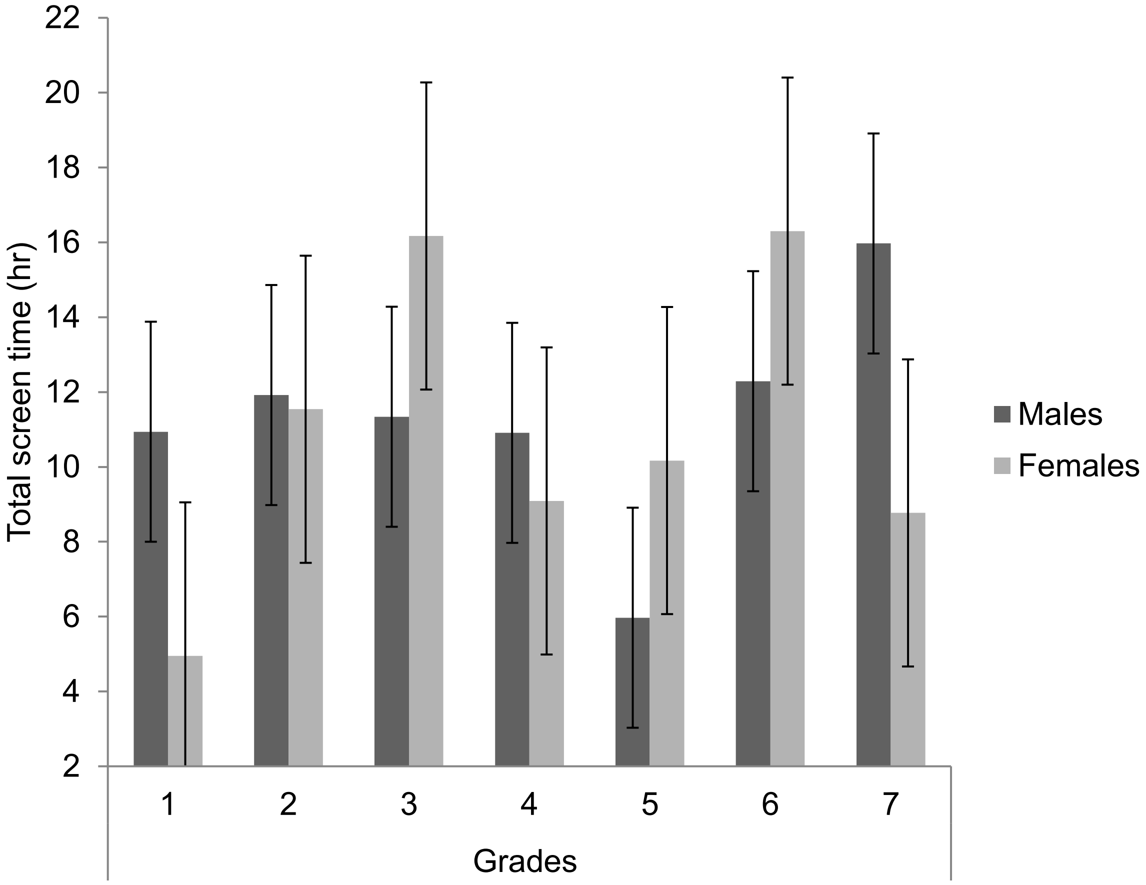


Figure 20: Mean (± standard deviation) total screen time (7 days) for both male and female primary school children from grades one to seven.

4.7.1 Screen time

No significant differences were found between grades or sexes, although the males tended to accumulate more screen time in grades one, two, four and seven. The regulations for screen time use in children are two hours daily (i.e. 14 hours per seven-day week). In this sample, the grade three females were 15.50% above regulations, grade six females were 16.40% above regulations and grade seven boys were 14.10% above regulations. No significant correlations were found between screen time and any other variables. A negative relationship was found between physical activity and screen time, however not significant.

4.8 Conclusion of strong associations

In conclusion it was found that both body mass and strength measures increased with age and grade and there was a positive relationship between the two. Further, it was found that blood pressure also increased with body mass and there was a positive relationship between blood pressure and mass.

The males of this sample were stronger than the females; however, the females presented higher flexibility than their male counterparts. It was found that a very small portion of this cohort had undergone puberty and puberty was correlated negatively with all strength measures.

Females accumulated more physical activity time as well as sedentary time within a seven-day week as compared to the males, although not significant. Females spent significantly more time in sedentary behaviours as compared to physical activity. Males also accumulated more sedentary behaviour although not significant. Both males and females maintained the recommended 60 minutes of moderate-to-vigorous physical activity daily. For the females, physical activity correlated significantly and negatively with mass.

Lastly the average amount of screen time accumulated was under the two-hours per day regulations and therefore, no significant correlations were found between screen time and any other variable. A negative relationship was found between physical activity and screen time, however not significant.

CHAPTER V

Discussion

This study aimed to contribute to the database on South African children in terms of levels of physical activity, sedentary behaviour, screen time and physical fitness. Children are particularly vulnerable to lowering levels of physical activity and fitness, as well as increasing levels of sedentary behaviour and screen time (Armstrong, Lambert, & Lambert, 2011(1)). Past studies on South African children as well as other global studies have shown an inverse relationship between physical activity and fitness levels and being overweight and obesity (Armstrong et al., 2006; Truter, Pienaar, & Du Toit, 2010; Arango et al., 2014; Sandercock, Alibrahim, & Bellamy, 2016; Swanson, 2016; Cabanas-Sanchez et al., 2019).

The findings must be seen within the context of the following limitations:

1. There was limited data received for both screen time and levels of physical activity. Initially, physical activity was going to be objectively measured using Actiwatches, however due to the small number of Actiwatches, this was not possible particularly with the time constraints associated with school terms.
2. Some of the C-PAQ questionnaires and screen time questionnaires were not completed and so the dataset is small.
3. There were small samples of data within all grades and both sexes.
4. The data was only collected from one private school in an affluent area.

5.1 Anthropometric findings

Males and females in this study were taller (males mean (142.66cm); females mean (142.57cm)), weighed more (males mean (38.72kg); females mean (39.80kg)) and had a greater waist circumference (males mean (65.10cm); females mean (64.80cm)) than previous studies done on African children (Armstrong et al., 2006 Armstrong, Lambert, & Lambert, 2011(1); Armstrong, Lambert, & Lambert, 2011(2)). This appears to be a global trend with data from around the world suggesting that children are becoming taller and stronger (Armstrong et al., 2006; Armstrong, Lambert, & Lambert, 2011(1); Armstrong, Lambert, & Lambert, 2011(2); Muthuri, 2014). As children progressed in the grades there was a significant increase in mass, waist circumference and stature which is to be expected as all of these are known to increase with age (Armstrong et al., 2006; Armstrong, Lambert, & Lambert, 2011(1); Armstrong, Lambert, & Lambert., 2011(2)). Males and females in this study had similar anthropometric data within grades which is in contrast to other South African studies that have found that females are heavier than males and that males are taller than females (Muthuri, 2014; Uys et al., 2016; Draper et al., 2018). Possible reasons for this would be that the majority of the children were still young and had not yet reached puberty; none of the males, in this study, had reached puberty yet. Therefore, they have not undergone the large changes that come with puberty such as weight gain and an increase in stature (Sherar et al., 2010; Metcalf et al., 2015; Mills et al., 2017).

For waist circumference, the mean values for both males (m= 65.10cm) and females (m= 64.80cm) were within the normal healthy values for primary school children (62.48cm and 73.26cm) as reported by, Hirschler et al. (2007). The grade four males (m= 74.72cm) had higher waist circumference measures which would be considered outside the norm and place them at higher risk of metabolic syndrome (Hirschler et al., 2007; Janssen et al., 2013; Andonian et al., 2019). According to Hirschler et al. (2007) the grade four males of the present study fall into the overweight category according to their waist circumference values (m= 74.72), thus putting them at risk of adulthood obesity, heart disease, high blood sugar levels and cholesterol (Mendoza et al., 2012; Janssen et al., 2013; Whooten et al., 2018). Furthermore, a study done on young children of six years in Sweden found specifically that children with higher waist circumferences had significantly higher systolic and diastolic blood pressure values and suggested that waist circumference was a more reliable tool in identifying children at risk of metabolic syndrome (Kjellberg et al., 2018).

According to studies on the patterns of puberty, it is assumed that puberty begins at approximately eight years of age for females and ten years of age for males (Metcalf et al., 2015; Alotaibi, 2018; Sawyer et al., 2018). We found that, according to peak height velocity measures, the grade four males were 3.1 years from reaching their peak height and puberty which was determined to be at the age of 13.7 years, whereas the grade four females were 1.6 years from reaching their peak height and puberty which was determined to be at the age of 11.9 years. This suggests that the grade four boys have not grown in stature as fast as their female counterparts. However, maintaining no significant differences between the two we can assume that the females have started puberty but are still in the early stages explaining the lack of significance found between the sexes of this sample group. This coincides with research suggesting that females start puberty earlier than males (Metcalf et al., 2015; Alotaibi, 2018; Sawyer et al., 2018) however the method of testing for puberty was indirect therefore this can only be an assumption.

For the overall sample group, 1.8% were underweight, 72.1% were healthy weight, 18% were at risk of being overweight and 8.1% were overweight. Although these results are favourable as more than 50% of the sample group is considered healthy, a percentage of the sample are still at risk or already overweight. As these participants are young and still in their developmental stages this is an important area for interventions as it increases their risk of becoming obese in adulthood (Armstrong et al., 2006; Hirschler et al., 2007; Janssen et al., 2013; Metcalf et al., 2015; Kjellberg et al., 2018; Andonian et al., 2019). A study on overweight and obesity levels of South African primary school children from 1994 - 2004 supports this finding as they concluded that the prevalence of these variables was increasing over time (Armstrong et al., 2006).

5.2 Puberty findings

Females were found to mature faster and begin puberty at an earlier age compared to the males; this finding is supported by other research (Widen et al., 2012; Metcalf et al., 2015). The average age that the females began puberty was 11 years and six months while the average age that the males were reaching puberty was 13 years and five months. These ages are within average age of puberty onset brackets set between eight years and 14 years for females and nine years and 14 years for males (Lee, 1980; Widen et al., 2012; Haapala et al., 2019; Cronholm et al., 2020). Of the sample only some grade six and seven females had reached puberty (Figure 7).

5.2.1. Puberty correlates

Maturity offset correlated significantly and strongly with body mass, with children with a higher body mass reaching puberty earlier which is well established (Dunger, Ahmed, & Ong., 2006; Widen et al., 2012; Metcalf et al., 2015). Body mass also correlated with lower body and core strength measures. Other significant but weak positive correlations were found between maturity offset and lower body strength as well as core strength. Where these outcomes increased the closer the children were to puberty. While puberty is associated with definite weight gain, the positive correlations found for these strength measures may suggest that muscle mass gain is also a factor (Branta, Haubenstricker, & Seefeldt, 1984; Dunger, Ahmed, & Ong., 2006; Armstrong, Lambert, & Lambert, 2011(1); Lockie et al., 2019).

5.3 Cardiovascular findings

5.3.1 Blood pressure and heart rate

Systolic and diastolic blood pressure increased with increasing age; which was to be expected and is congruent with other research (Sconolfi et al., 1985; Jaquet, Goldstein, & Shapiro, 1998; Nemoto et al., 2007). The grade four females had the highest blood pressure values; this was due to two outliers that had increased diastolic blood pressure measurements of 113/86 and 109/89 that impacted the data for the grade. It is important to note that the grade seven group had lower blood pressure compared to their younger counterparts. Their values were still within the lower limit of normal which is 90mmHg/ 60mmHg, therefore, not of concern (Jaquet, Goldstein, & Shapiro, 1998). The lower blood pressure values within this cohort may be attributed to a higher level of physical activity, as seen in Knowles et al. (2013), where blood pressure had a linear increase with physical activity levels amongst school aged children (Knowles et al., 2013). Tu et al. (2009), found that systolic blood pressure peaked at the same time as pubertal growth spurt or peak height velocity within adolescents (Tu et al., 2009). While only a very small amount of females had reached their peak height velocity within this sample, the lower blood pressure amongst the grade seven group could be attributed to this (Tu et al., 2009). Resting heart rate was significantly different between grades and decreased with increasing age; however, the older females of this sample had higher heart rates, which may be due to a lower level of physical activity (Knowles et al., 2013; Piercy et al., 2018); however more evidence is needed to support this finding within this cohort. This group of females also had increased blood pressure which has been shown to increase resting heart rate in adolescents, however no significant correlations were found between the two variables for the grade seven females (Christofaro et al., 2017). No significant differences were found between the sexes for heart rate. While there were no significant sex differences for heart rate, females had higher heart rates in most of the grades, which has also previously been observed (Jaquet, Goldstein, & Shapiro, 1998; Patel et al., 2016).

5.3.2 Blood pressure and heart rate correlates

Significant correlations were found between mass, stature and blood pressure, as well as between all strength fitness measures, i.e. cricket ball throw (upper body strength), standing long jump (lower body strength), sit-ups (core strength) and body mass and blood pressure. Significantly positive correlations were found for both systolic and diastolic blood pressure measurements and body mass as well as for stature and systolic blood pressure. This is also indicated in other research that suggests an increase in body mass as well as stature will increase blood pressure (Armstrong et al., 2006; Tu et al., 2009; Armstrong, Lambert, & Lambert, 2011(2); Draper et al., 2014; Uys et al., 2016; Draper et al., 2018). It is known that with being overweight or obese, comes a risk of hypertension; however this samples blood pressure was considered normal, below 120/80 mmHg. Therefore, the correlation between blood pressure and body mass found for this sample group is a result of an increase in age-related mass, not being overweight or obese (Mendoza et al., 2012; Janssen et al., 2013).

5.4 Physical fitness findings

5.4.1 Hamstring flexibility

The decline in hamstring flexibility with increasing grade, specifically grades three and six, may be associated with changes in collagen and physical inactivity as has been previously found (Armstrong et al., 2006; Armstrong, Lambert, & Lambert, 2011(1); Kulkarmi & Fernandes, 2017; lockie et al., 2019). Females are known to have a higher flexibility than males; this is seen in the present study and can be related to females having a higher range of motion (A Becerra-Fernández et al., 2016; Miyamoto et al., 2018; Faherty et al., 2019). In comparison to a study done in 2011 on South African children aged six to 13 years, the sample of the current study had lower flexibility scores for both males and females. Possible reasons for this would be that the sample of the current study had higher body mass values and it is known that body mass and flexibility can have an inverse relationship (Armstrong, Lambert, & Lambert, 2011(1); O'Malley, Hussey, & Roche, 2012).

5.4.2 Lower body strength

Lower body strength increased significantly with increasing age, body mass and stature, which supports previous literature (Branta, Haubenstricker, & Seefeldt, 1984; Lemmer et al., 2000; Armstrong, Lambert, & Lambert, 2011(1); Lockie et al., 2019). This was excluding the fact that there was no difference between grades one and four as well as between grades five and seven. The grade four group had higher waist circumferences than all the other grades which is associated with high body mass index and can have a negative effect on physical strength and fitness (Milton & Martina, 2019). Further, the lack of difference between grades five and seven could be because of the variable age of puberty onset which typically occurs in this age range and which is associated with lower levels of physical activity and fitness (Sherar et al., 2010; Metcalf et al., 2015).

The males in this sample had higher lower body strength scores than their female counterparts for every grade which, is supported by other research that suggests males are stronger than females (Rice et al., 2017; Lockie et al., 2019). While the males were stronger, grade four males had lower scores when compared to their younger peers, this finding is not supported in other research and may be due to the small sample size, therefore, more research is needed. Furthermore, although speculative, the lower result of the grade four males could also be due to a lower competitiveness in this grade of males as some studies have shown that motivation is a factor in males (Weakley et al., 2019). In comparison to the same study in 2011 the males of the current study had lower values of standing long jump and the females had higher values. Due to the fact that the current sample were found to be both taller and heavier than that of the sample used by Armstrong, Lambert and Lambert (2011)(1), it can be assumed that the decreased lower body strength values for the current study's male sample is not related to the stature and mass, but rather the level of physical fitness (Armstrong, Lambert, & Lambert, 2011)(1)).

5.4.3 Upper body strength

The children were significantly stronger the older they were which is to be expected as strength is known to increase with age (Lemmer et al., 2000; Armstrong, Lambert, & Lambert, 2011(1): Lockie et al., 2019). No significance was found between grades one and five; this could be due to a lower competitiveness in the lower grades or simply an anomaly (Poitras et al., 2016; Novosád et al., 2017). The large significant differences noted between the males and females could be attributed to better technique acquired from playing cricket as a sport at school, this particular school did not offer cricket to females; therefore, the males had an advantage (Novosád et al., 2017). There was a larger variance between the males as compared to the females; this again could be attributed to some males playing more cricket than others and gaining more practice (Poitras et al., 2016; Novosád et al., 2017). There are also differences within team practice time and professional play. A team gets more cricket game time than lower level teams and females do not play cricket at this school hence the lower variability there. This finding made the cricket ball throw test biased towards the males for this particular sample and is therefore, a limitation. More research is needed to determine a test that levels the playing field between the sexes so as to make the scores more reliable and comparable. Both males and females had better upper body strength scores as compared to that of the sample used by Armstrong, Lambert and Lambert (2011)(1).

5.4.4 Core strength

Core strength increased significantly with age and grades and is consistent with other research showing that strength increases with age (Branta, Haubenstricker, & Seefeldt, 1984; Lemmer et al., 2000; Armstrong, Lambert, & Lambert, 2011; Lockie et al., 2019). Core strength does not necessarily vary from grade to grade as no significance was found between close grades e.g. two and three; therefore, the large variance found is mainly between the lower and higher grades e.g. grades one to seven. Males had significantly increased core strength; this is congruent with other research showing that males are stronger than females for most strength tests, including core and upper and lower body strength (Lemmer et al., 2000; Rice et al., 2017; Lockie et al., 2019). The lower grades in this sample had very poor core strength scores; this may be because of the large variance or because of declining levels of physical activity and active play resulting in less developed muscles (Poitras et al., 2016; Larouche, Garriguet, & Tremblay, 2017). It is difficult to regulate a child's activity outside of school, therefore, physical education programs are a perfect vessel to ensure that children get this strength training daily (Bailey, 2006; Poitras et al., 2016; Draper et al., 2018). Surprisingly the values of males and females from both the current study and that of Armstrong, Lambert and Lambert (2011)(1), are virtually the same, showing no improvement or increase in core strength over the years, however, no decrease either. More research is needed into school programs where children can improve their core strength outside of every day routines.

5.4.5 Speed and force exertion

The increases in speed with age is expected and is found in other research that suggests an increase in speed and strength/ force exertion with increasing age and stature (Armstrong, Lambert, & Lambert, 2011(1); Poitras et al., 2016; Lockie et al., 2019). No significance was found between grade five and lower or higher grades, potential reasons could be that puberty onset can be pronounced from grades five to seven (Metcalf et al., 2015). Growth spurts can happen in these grades, potentially explaining the larger differences between the grade ones and the grade sevens (Metcalf et al., 2015; Poitras et al., 2016; Lockie et al., 2019). Although no significance was found between sexes, the females were slower than the males in most grades. The shuttle run test was only 5 m shuttles repeated 10 times which may explain the low variance in these scores; it could be argued that the distance of the shuttles needs to be increased to approximately 20m shuttles which were found moderately reliable for comparison between sexes (Arsa et al., 2018). In comparison to the findings of Armstrong, Lambert, & Lambert (2011)(1) the males and females of the current study were faster, one reason could be that this was the case because the current sample were taller.

5.4.6 Physical fitness correlates

Significant positive correlations were found between body mass and cricket ball throw (upper body strength), standing long jump (lower body strength), and sit-ups (core strength). Other studies have found through puberty and body compositional changes, fat free mass increases as well as lean muscle mass, with these increases and bone development there is an increase in the length of the limbs allowing for more efficient physical and mechanical actions to occur (Branta, Haubenstricker, & Seefeldt, 1984; Bailey et al., 2010; Armstrong, Lambert, & Lambert, 2011(1); Lockie et al., 2019). It should be noted that the association found between body mass and core strength was weaker than that of upper and lower body strength. It is known that differences in strength depends largely on differences in stature and mass, therefore, the weak association for this variable may be due to the large variances found for stature and body mass (Armstrong, Lambert, & Lambert, 2011(1)).

5.4.7 Important findings for physical fitness measures in relation to all other variables

Significant increases in values with increasing age were found for mass, stature, waist circumference, blood pressure, lower body strength, upper body strength and core strength (Branta, Haubenstricker, & Seefeldt, 1984; Armstrong, Lambert, & Lambert, 2011(1); Lockie et al., 2019). This is congruent with other studies suggesting a linear relationship between age, mass, stature, and strength for both male and female children and adolescents (Branta, Haubenstricker, & Seefeldt, 1984; Armstrong, Lambert, & Lambert, 2011(1); Lockie et al., 2019). However with puberty there is a significant growth spurt, otherwise known as the peak height velocity that should be taken into account when assessing these relationships as, during this growth the relationship between age and stature is not linear (Bailey et al., 2010).

Significant decreases with increasing age were found for; hamstring flexibility and shuttle run time; other studies have also shown a decrease in muscle flexibility with age and collagen changes and physical inactivity (Armstrong, Lambert, & Lambert, 2011(1); Kulkarmi & Fernandes, 2017; Cejudo et al., 2019; Faherty et al., 2019). A decrease in the time it takes to complete the shuttle run test is also expected and seen in other research where speed improves with age, growth and increases in the length of limbs specifically for force exertion (Armstrong, Lambert, & Lambert, 2011(1); Poitras et al., 2016). The increase in the length of limbs through puberty also results in load distribution in bones resulting from larger mineral deposits and reduced energy expenditure (Naughton et al., 2000).

Males were significantly superior for all the strength measures, namely; lower and upper body and core strength. This is seen in other research where males are reported to be stronger than their female counterparts (Armstrong et al., 2006; Armstrong, Lambert, & Lambert, 2011(1); Draper et al., 2014; Uys et al., 2016; Rice et al., 2017; Draper et al., 2018; Lockie et al., 2019). This is, however, of concern as although it is congruent with the research, it is still not an ideal outcome as the significant difference between the males and females should not be present at such an early age. According to Metcalf et al. (2015), females mature and grow faster than males; therefore, due to the linear relationship between strength and age/ maturation, the females should be stronger than their male counterparts in this study (Metcalf et al., 2015). Metcalf et al. (2015), report that with the onset of puberty there is a clear decrease in physical activity; therefore, this may be the reason behind this sample of females having lower scores for the physical fitness measures as compared to the males (Sherar et al., 2010; Metcalf et al., 2015). More females of this sample had undergone the onset of puberty compared to males according to the peak height velocity measures; therefore, this finding supports the above statement.

5.5 Physical activity and sedentary behaviour findings according to C-PAQ

The females of this sample accumulated more physical activity and sedentary behaviour time compared to the males. While it is congruent with other research that suggests females are more sedentary (Draper et al., 2014; Uys et al., 2016; Draper et al., 2018), it is not consistent with research that suggests males are, more commonly, more physically active than females (Armstrong et al., 2006; Armstrong, Lambert, & Lambert, 2011(1); Draper et al., 2014; Uys et al., 2016; Rice et al., 2017; Draper et al., 2018; Lockie et al., 2019). The males of this sample also showed better strength measures as compared to the females which may contribute to the assumption that the males participated in more organised sport and strength related activities, whereas the females participated in more general physical activity such as walking (Novosád et al., 2017). While both males and females had higher sedentary behaviour levels, both were still considered physically active as keeping to the 60 minutes of moderate-to-vigorous physical activity daily (Draper et al., 2014; Poitras et al., 2016; Uys et al., 2016; Draper et al., 2018; Piercy et al., 2018).

In 2014 the Healthy Active Kids South Africa Report Card showed that less than 50% of children engaged in 60 minutes of moderate-to-vigorous physical activity daily (Draper et al., 2014). More specifically young boys spent no more than four hours in moderate-to-vigorous physical activity weekly and girls one hour (Draper et al., 2014). Further in 2016 the Healthy Active Kids South Africa Report Card showed no improvement in overall physical activity levels since 2014 (Uys et al., 2016) In 2018 the Healthy Active Kids South Africa Report Card reported a slight improvement since 2016, showing that just half of the country’s children engaged in between 57-65 minutes of moderate-to-vigorous physical activity per day (Draper et al., 2018).

The physical activity results presented in the current study suggest an increase in this time as it was found that the children accumulated an average of 110 minutes of moderate-to-vigorous physical activity per day, however, more research is needed to properly determine physical activity levels country wide.

Similarly the Healthy Active Kids South Africa Report Cards showed no improvement with the sedentary behaviour scores over time with F (0-21% are meeting prescribed guidelines) scores for the years 2014, 2016 and 2018 (Draper et al., 2014; Uys et al., 2016; Draper et al., 2018). The sample of the current study presented as less sedentary as they accumulated an average of 155 minutes spent in sedentary behaviours daily whereas, in the 2014 Healthy Active Kids South Africa Report Card the children spent a total of 545 min in sedentary behaviours daily (Draper et al., 2014).

5.5.1 Physical activity and sedentary behaviour correlates

For the females of the sample, specifically, there was a positive and strong correlation between physical activity levels and sedentary behaviour according to the C-PAQ results. Indicating that sedentary behaviour increases with physical activity levels, this is congruent with other research that suggests increased levels of sedentary behaviour do not necessarily take time away from physical activity as they are independent of each other (Henson et al., 2016; Kinnet et al., 2019). More research is needed to determine the risks of prolonged sedentary behaviour while adhering to the prescribed daily physical activity guidelines. There was a significant negative relationship found between physical activity and body mass for the females of this sample suggesting that when body mass is increased, physical activity is decreased, which is supported by other research (Armstrong et al., 2006; Poitras et al., 2016).

5.6 Screen time findings

5.6.1 Screen time

No significance was found between grades or sexes for screen time. However it is important to note that all but the grade three females (15.5% above), six females (16.4% above) and seven males (14.1% above), were above the two-hour daily regulations (Sandercock & Ogunleye, 2013; Uys et al., 2016). The finding that most of the sample were under regulations of daily screen time is favourable especially as in 2016 more than 50% of children tested watched more than three hours of television a day (Uys et al., 2016). Furthermore the 2018 Healthy Active Kids South Africa Report Card found no evidence to suggest a decline in overall screen time (Draper et al., 2018). Therefore, the current study shows a potential change in the accumulated screen time values for primary school children in South Africa, although more research is needed (Uys et al., 2016; Draper et al., 2018).

The current regulations are two hours a day across all ages ranging from six to 18 years (Sandercock & Ogunleye, 2013; Uys et al., 2016; Draper et al., 2018). Due to the younger ages being crucial for bone mass density development as well as cognitive development, muscle development and innovation/ imagination, it is recommended to present age-specific regulations (Council, 2016; Chassaikos et al., 2016; Swanson, 2016).

5.6.2 Screen time correlates

No correlations of significance, as well as any moderate or strong relationships, were found between screen time and all other variables. There was a negative relationship found between physical activity and screen time. Although not significant, this shows the trend suggesting that with an increase in screen time there is a decrease in physical activity, however, more research is needed to properly diagnose this trend. The finding of no direct or significant correlations indicates that for this sample, screen time did not influence physical activity or physical fitness levels. A reason for this could be that most of the sample accumulated under the regulations of two hours of screen time per day (Sandercock & Ogunleye, 2013; Uys et al., 2016). Therefore, it can be concluded that for this sample, the lack of fitness in the children is not a result of screen time but rather a prevalence of inactivity and non-screen related sedentary behaviour (Tremblay et al., 2010; Clemes et al., 2015; Henson et al., 2016). These results prove no negative effects if the screen time is kept to regulations, therefore, validating the regulations set by, Sandercock & Ogunleye, (2013). More research also needs to be done on developing regulations for different age groups as we found no significant differences between the ages for this variable. There were also some exceptionally low physical fitness scores for the younger males as compared to males of the same age in a different study, therefore, this may be due to the increased amount of screen time these younger males are accumulating (Armstrong, Lambert, & Lambert, 2011(1); Sandercock & Ogunleye, 2013).

When studying the potential association between physical activity and sedentary behaviour it has been shown that increased sedentary behaviour can put children at risk of decreased physical activity levels (Armstrong, Lambert, & lambert, 2011(1); Draper et al., 2018). However, a study done on primary school children in Finland found no association between sedentary behaviour and physical activity (Ali, 2014). This is congruent with the present study that found no correlation between screen time and physical fitness. Thus one can speculate that physical activity and physical fitness is not associated with sedentary behaviour in children of younger ages (6-13). This is stated in a study by Tanaka et al. (2017) where they found potential increases in moderate-to-vigorous physical activity and decreases in sedentary behaviour were independent of each other in primary school children. It has, however, been shown in previous studies that screen time increases with age (Sjöström et al., 2006; O'keeffe & Clarke-pearson, 2011; Ali, 2014; Swanson, 2016). Although no direct significances were found between the grades for the current study, the grade six females and grade seven males accumulated more than the two hour regulations of screen time daily. Therefore, more studies need to be done on older children to properly associate physical activity and fitness with screen time and sedentary behaviour.

5.7Limitations

The school included in this study was very cooperative thus allowing all fitness tests to be performed for all grades within the same working week. The school also accepted school time testing of blood pressure and heart rate measures outside of the fitness tests. However, a limitation of the current study would be that it included only one school from the private sector, limiting comparison between children of different socio-economic strata. The sample size obtained was also small and is therefore, a limitation.

We used a reliable fitness battery, giving us reliable results, however a limitation of this battery would be the cricket ball throw test for upper body strength as this test is subject to practise and most males play cricket as a school sport where the females do not, thus creating a certain bias towards the males for this fitness test. The shuttle run test was also considered a limitation of this fitness battery as it was too short in distance to properly distinguish between fitness levels of different children. The EUROFIT test battery is used to test speed, strength and agility, rather than cardiorespiratory fitness, therefore another limitation of this battery is that it did not offer a test of cardiovascular fitness which is important for children.

Another limitation of this study would be the use of physical activity and screen time questionnaires. There were certain communication barriers presented between the parents and the researchers, therefore, the questionnaires were not filled out during the same week for all children, limiting direct comparison. Self-report methods also present a certain bias; therefore, the results from objective measures may be more reliable.

CHAPTER IV

Conclusions and recommendations

6.1 Conclusion

In conclusion, the study was successful in adding to the body of data regarding the prevalence of physical inactivity, sedentary behaviour and screen time within school children from the Makana Municipality in the Eastern Cape Province of South Africa. The sample was considered physically active as they accumulated more than 60 minutes of moderate-to-vigorous physical activity daily. The sample accumulated more sedentary behaviour than physical activity, although not significant.

Screen time was below regulations of two hours daily, indicating this population participated in more non screen related sedentary behaviour. More research is needed into the risks presented with different forms of sedentary behaviour. Physical fitness increased with increasing grade and age and males were considerably more fit. The current study did not present any concern with the effects of increased physical activity and fitness levels within school aged children. More research is needed to properly diagnose the physical inactivity, increased sedentary behaviour and lack of physical fitness pandemic within South Africa presently.

6.2 Recommendations

The objective of this study was to add to the body of evidence on children in South Africa by measuring the prevalence of physical inactivity, sedentary behaviour and screen time of primary school children in the Eastern Cape Province of South Africa where the evidence is most sparse. A secondary aim was to assess levels of physical fitness in this cohort. Other studies seeking to investigate these similar aims need to consider the following recommendations:

1. Research is needed into a more accurate and reliable test for upper body strength that is not bias and will create comparability between males and females.
2. Future research into this topic needs to include a more accurate and objective test of physical activity such as acti-watches or fitness watches that can assess daily activity and inactivity as well as sedentary behaviour.

3. More research is required on school of different socio economic backgrounds such as private vs. public schools in South Africa as due to our diverse economy, these results and data may vary largely.
4. Investigations into age related screen time regulation is also needed.
5. Future studies should also consider assessing the implementation of Physical Education classes within school as a separate subject as, although the results of the fitness battery within the current study were satisfactory, more research is still needed.

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Appendices

7.1 Appendix A: School consent form

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CONSENT ISSUES

School Consent form

I, ……………………………………………………., the Head of (name of school) have been fully informed of the research project entitled; Physical activity sedentary behaviour and physical fitness profile among primary school children in Eastern Cape Province, South Africa: levels, patterns and correlates

I have read the letter of information accompanying this form and I am fully aware of the nature of the research and the procedures involved as well as the potential risks and benefits associated with my learners' participation as explained to me in writing and verbally. Any questions I may have had, have been answered to my satisfaction.

I am aware that I may withdraw my consent and may withdraw my learners from taking part in the research at any time without consequences. I am aware that my learners' privacy will be protected and their data will be kept confidential at all times. I also understand the researcher will ensure anonymity of the school by referring a primary school in the Eastern Cape of South Africa" in any publications that may result from this research.

By voluntarily consenting to participate in this research I waive any legal recourse against the researcher, or against Rhodes University, in the event of any personal injuries sustained. This waiver shall be binding upon my heirs and legal representatives. My pupils will inform the researcher immediately if at any point they experience distress or abnormality, and they are fully aware that they may withdraw from participation in this study at any time.

I, hereby, consent that the students attending my school may participate in this research study, provided that the parents and the children have also given their consent and assent respectively.

SCHOOL HEAD'S CONSENT:

_________________ __________________ ______________

WITNESS:

________________ _________________ ______________

PRINCIPAL RESEARCHER:

________________ _________________ ______________

7.2 Appendix B: Participant information booklet

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Participant Information Booklet

Study Title:
Physical Activity and Fitness profile Among Primary School Children in Makana Municipality: Levels, Patterns and Correlates

Main Investigator:
Professor Candice Christie

Co-investigator:
Andrea Kade (Msc)

Department of Human Kinetics and Ergonomics

Rhodes University, 2016

Grahamstown, South Africa

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Background information

Dear parent/guardian

This information package serves to inform you of a study we wish to undertake at the Kingswood College Junior School looking at physical fitness, physical activity levels and sedentary behaviour (time spent not moving) in Grade 1-7 pupils which will be tracked through their junior school period i.e. at the same time every year as they progress through the school. The testing will be used by the school to inform the design of a physical literacy programme (physical education) by identifying fitness weaknesses identified. It will also be used to inform interventions for improving general levels of physical activity during the day and reducing sedentary behaviour which are both individual risk factors for the development of cardiovascular disease. Ultimately we hope to install good physical activity habits in the children to protect health in the future.

Herewith a brief background to why this study is important:

Moderate to high levels of cardiorespiratory fitness (CRF) and physical activity (PA) have consistently been shown to be beneficial in terms of reduction of the risks of coronary heart disease and type 2 diabetes. These chronic diseases in adulthood have been linked to childhood inactivity. Hence, the need for early identification of risk factors for reduced physical fitness, low/poor levels of physical activity and high levels of sedentary behaviour mostly attributed to screen time.

The diversity between economic and social classes and ethnic groups in South Africa is a reflection of the legacy of apartheid and has occasioned an uneven distribution of the country’s ethnic groups across the various socioeconomic strata. Socioeconomic status (SES) has been shown to be associated with physical fitness among school children in South Africa and South America. A study by Armstrong, Lambert, &, (2011)(1) found differences between white and black ethnic groups, after adjusting for socioeconomic status, with regards to their stature and mass measurements. A separate study did not observe significant SES differences in cardiorespiratory fitness levels of their participants; however their comparison of public versus private schools showed that private school children were fitter than their public school counterparts. This finding suggests that there is potentially more access to certain facilities and physical fitness classes within the private schools and correlates with South African findings with regards to rural vs. urbanised schools. However, this needs to be investigated. Rural schools in South Africa do not include a physical education class in their syllabus as most of these schools do not have the facilities required for practice at that level. When comparing PA levels within rural vs. urban communities, rural adults are less physically active than their urban counterparts. However, a South African health and demographic survey found that urbanised youths were more likely to be physically inactive when compared to their rural peers. Other studies specific to developing countries found that urbanised adults were more inactive, whereas in the USA, the urbanised community were more active. The level of physical activity of rural and urbanised communities potentially differ in different countries according to their development status due to the availability of facilities, as well as the countries demographic history. More information is needed on children from both developed and developing countries specifically, South Africa.

A study completed in 2007 reported significant associations between physical activity, cardiorespiratory fitness and metabolic risk factors (waist circumference, Blood pressure, fasting glucose, insulin, triacylglycerol and HDL-cholesterol levels) among European children. Interestingly, black SA school children have been found to have lower scores of physical fitness than their white and Indian counterparts. Interestingly they found that when excluding waist circumference from the outcome variable the link between cardiorespiratory fitness and metabolic risk was somewhat attenuated and weaker than the link between PA and metabolic risk. This suggesting that waist circumference may be part of the causal pathway between low CRF and metabolic risk. It also indicates the independence of the association of PA and CRF to certain metabolic risk factors and confirms the need to consider these factors separately.

Sedentary behaviour represents a different paradigm rather than a lack of physical activity, and is said to be a unique human behaviour. Sedentary behaviour is defined as behaviour when awake, with an energy expenditure of less than 1.5 metabolic equivalents (METs) during a sitting or reclining posture. Studies have shown that physical activity levels have been decreasing over the past few decades, whereas the prevalence of sedentary behaviour has increased, most likely due to an increase of technology and such devices in homes and within schools. It is noteworthy that a person can be physically active and still engage in too much sedentary behaviour (e.g. sitting for more than 2 hours a day), thus still being exposed to higher risks of developing chronic diseases. Evidence suggests that sedentary behaviour is an independent risk factor for health issues. However it remains unclear whether SB is a risk factor because it negatively affects PA or if the risks may be more complex, therefore, research is still aiming to define the link and association between SB and PA as well as CRF. Media device ownership is known to have a negative effect on sedentary time consequently, it is important to understand the risks or effects of this.

Available studies on physical activity, sedentary behaviour, screen time and physical fitness among South African younger population have focused more on older children (11-12, 14-15 years) and adolescents (19-20 years). The study by Armstrong, Lambert, & Lambert (2011)(1) did not assess physical activity; they assessed baseline physical fitness data for South African children based on ethnic groups. Furthermore, the Eastern Cape Province, which ranks third in provincial breakdown in the 2011 census (Brand South Africa, 2017), seems under-researched in terms of children physical activity and SB studies. A study conducted in a rural town in Gauteng Province revealed that the physical activity levels of children (aged: 5-6, 9-11 and 12-14 years) are far lower than the recommended international normative levels.

Therefore, this study is designed to: (1) describe baseline, objectively measured physical activity, sedentary behaviour, screen time and physical fitness outcomes of primary school children in the Eastern Cape Province, South Africa and possibly compare with existing data from other provinces of South Africa, comparisons will be made to normative data, other schools and other regions of south Africa using unrelated t-tests; (2) compare physical activity, sedentary behaviour, screen time and physical fitness profiles of primary school children across socioeconomic status and ethnic group of ancestry; and (3) explore the associations of physical activity, sedentary behaviour, screen time and physical fitness scores with children’s anthropometric indices and cardiovascular risk factors. This project tends to track these children throughout their junior phases of school, these children will be the baseline measurements and thereafter there will be additional measurements of the same children in the years to come, in order to track their progress. Information obtained from the study may assist in the development of more appropriate physical activity and SB guidelines and make a case for increasing formal sports participation and physical education within South African schools.

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HUMAN KINETICS & ERGONOMICS

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Written Information to the school teachers and parents

To whom it may concern

Thank you for showing an interest in our research titled: 'Physical activity, sedentary behaviour and physical fitness profile among primary school children in Eastern Cape Province, South Africa levels, patterns and correlates'.

This letter will inform you about the purpose of the study, the protocol and equipment used, as well as any benefits and/or risks that your learners may be exposed to. Please ensure that you read everything carefully before giving consent.

Purpose of the study

The purpose of our research is three fold: (1) to describe baseline objectively measured physical activity and physical fitness data of primary school children in the Eastern Cape Province, South Africa and possibly compare with existing data from other provinces of the country; (2) to compare physical activity profiles, physical fitness profiles and screen time behaviour of primary school children across socioeconomic status and ethnic group of ancestry; and (3) to explore the associations of physical activity and physical fitness scores with children's anthropometric indices and cardiovascular risk factors.

The reason why this study is important is because there is limited research and data available in this area, especially concerning communities in the Eastern Cape. Physical activity refers to any movement of the body produced by skeletal muscles that requires energy expenditure, such as when playing, running and walking. The available research so far has shown that levels of physical activity are constantly decreasing worldwide, including

South Africa, leading to numerous chronic diseases, such as cardiovascular disease, cancer and diabetes, developing from a young age. Research reports have shown that physical fitness is associated with socioeconomic status where; increased access to fitness programs and facilities, physical education classes, and organised sport resulted in increased physical fitness measures. fundamental movement skills ensure that children are not only health, but are physically capable of executing activities of daily lifestyle and participation to the best of their ability.

The objective of our study is to determine the levels of physical activity, sedentary behaviour/ screen time (sedentary behaviour can be explained as any activity that utilizes a minimum amount of energy such as sitting or lying down) and physical fitness of primary school children in the Eastern Cape Province, South Africa. We also intend to determine if these levels meet the international minimum requirements for health. Our research will also explore the influence of socioeconomic status and ethnicity as well as association of these measures with selected cardio-metabolic measures within the children

It is envisaged that our findings will stimulate future research and lead to interventions to increase physical activity and fitness levels and reduce sedentary behaviour. Information obtained from the study may also assist in the development of more appropriate activity guidelines for South African children.

Protocol

Our focus group will be boys and girls between the ages of 6-13 years.

The first part of the study will require us and our research assistants to measure basic anthropometric measures such as stature/height, body mass/weight and waist circumference of eligible and consented children. This will be done using a tape measure fixed on the wall for stature, a flexible tape measure for waist circumference, as well as a digital bathroom scale for body mass. Cardiovascular health will be measured using an electronic blood and heart rate monitor for blood pressure and heart rate. These measurements are quick and non-invasive. Puberty onset measures of height, sitting height and date of birth will also be recorded and peak height velocity will be determined to describe the children’s time to puberty.

Physical fitness will be assessed using a set of established, international tests which have been used in a previous research (in order for us to compare our findings) to assess the fitness levels of the children. The tests are: sit- and-reach flexibility test (to measure flexibility of the hamstrings/back of the legs), standing long jump (to determine lower body power), sit-ups (to measure muscle endurance), 5-m shuttle run test (to measure speed, agility and cardiovascular/cardiorespiratory fitness) and cricket ball throw (to determine upper body power). Physical activity and sedentary behaviours levels will be measured using a type of accelerometer called an Actiwatch and a screen time questionnaire given to the parents or house heads/student assistants (in case of boarders) to fill in on behalf of the scholars. The screen time questionnaire is used to assess how much time children spend per day behind a screen i.e. TV, computer or iPad for example. The children will be required to wear the Actiwatch on their right wrist at all times during the day for 7 days (except when bathing or sleeping), while continuing with their normal daily routine. Research staff will continually follow up with them and boarding staff and teachers to ensure children are wearing the devices. Following the measurement, the monitor will be returned and downloaded, processed and stored in a confidential file on our computer.

The data and information gained from the Actiwatch will be used to quantify the levels of physical activity, sedentary behaviour and physical fitness in the children. The anthropometric and cardiovascular measures will be used to determine whether there are any associations between the anthropometric characteristics, cardiovascular parameters of the children and their physical activity/fitness levels.

Risks and benefits of the study

The few minor risks that may be associated with this study are likely to be of a temporary and emotional nature. For example, participants may feel intimidated and/or embarrassed during anthropometric measures. These risks will be minimized by performing these measurements in isolation where participants come into a classroom one at a time with only the researchers and teacher present. Additionally, these measurements will only require the children to temporarily remove their shoes and any bulky jerseys or jackets, but no other items of clothing. There is also a risk regarding the feedback process, children whose fitness levels are low, BMI results high and screen time high we will approach with caution. We will do this by explaining the child’s results in a sympathetic manner while also emphasizing the importance of fitness and activity in alleviating the risks that come with their child’s results. Thereafter we will propose fun and everyday activities that will help in improving the child’s activity profile. No children will be pushed beyond their limits and they will be reassured to let us know if they cannot continue with the physical fitness measures. Children can voluntarily withdraw at any stage and their results will not be linked to them; the Sports Department will be given coded findings which cannot be linked to individual children.

Your children and pupils involvement in this study will be beneficial to them as well as the school and future school programs through improving knowledge of the benefits of a physically active lifestyle. It can also inform the school and parents which can then be used to change lifestyle behaviours and thereby improve quality of life

Your children's personal result will be reported to you once the results are analyzed and any outcomes of the study will be given as feedback, either by email or in person.

Thank you for showing your interest and agreeing to participate in the study. Please do not hesitate to contact me if you have any further questions.

Yours sincerely,

Professor Candice Christie, Dr Oladapo Michael Olagbegi and Andrea Kade (MSc candidate)

DEPARTMENT OF HUMAN KINETICS & ERGONOMICS
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RHODES UNIVERSITY
Grahamstown • 6140 • South Africa

Parent consent form

Should you be interested in our study and wish to include your child, please fill in the parent consent form below. Please ensure you sign for all children involved, should you have more than one child participating in the study.

I, ……………………………………………………… (parent/guardian's name), parent / guardian of ………………………………………………. (child's name) have been fully informed of the research project entitled;' Physical activity sedentary behaviour and physical fitness profile among primary school children in Eastern Cape Province, South Africa: levels, patterns and correlates'.

I have read the letter of information accompanying this form and I am fully aware of the nature of the research and the procedures involved as well as the potential risks and benefits associated with my child's participation as explained to me in writing.

By voluntarily consenting to participate in this research I waive any legal recourse against the researcher, or against Rhodes University, in the event of any personal injuries sustained. This waiver shall be binding upon my heirs and legal representatives. My child will inform the researcher immediately if at any point he/she experience distress or abnormality, and I am fully aware that they may withdraw from participation in this study at any time.

I am aware that I may withdraw my consent and may withdraw my child from taking part in the research at any time without consequences. I am aware that my child's privacy will be protected and their data will be kept confidential at all times. I agree that the information collected may be used and published for statistical or scientific purposes only.

I, hereby, consent that my child may voluntarily participate in this research study.

PARENT/GUARDIAN CONSENT:

________________ __________________ ______________

WITNESS:

________________ _________________ ______________

PRINCIPAL RESEARCHER:

________________ _________________ ______________

RHODES UNIVERSITY
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Human Kinetics and Ergonomics Department

ASSENT SCRIPT

For research involving human participants

TITLE OF THE RESEARCH PROJECT: Physical activity sedentary behaviour and physical fitness profile among primary school children in Eastern Cape Province, South Africa: levels, patterns and correlates.

RESEARCHERS NAME(S): Prof Candice Christie and Andrea Kade

ADDRESS: Department of Human Kinetics and Ergonomics, Upper African Street, Grahamstown, 6139

CONTACT NUMBER: 046 603 8471

What is RESEARCH?

Research is something we do to find new knowledge about the way things (and people) work. We use research projects or studies to help us find out more about disease, illness or fitness. Research also helps us to find better ways of helping children become physically fit and active or treating children who are sick.

What is this research project all about?

This study will look at how much time you spend on your media devices and compare this to your physical fitness levels. If we can find out this information we can provide your school with new and exciting ways to exercise and keep healthy all while keeping to your normal school routine and time spent on your media devices.

Why have I been invited to take part in this research project?

You have been invited to take part in this research as there is limited work that has looked at children your age within the Eastern Cape province of South Africa. By doing this project you will be helping not only yourselves, but also other people of your age, you school and your community.

Who is doing the research?

The research is been done by Candice and Andrea - we work at the Human Kinetics and Ergonomics Department at Rhodes University and are doing this project to help with your overall activity levels and health.

What will happen to me in this study?

Nothing bad will happen to you by helping us in this study. We will only ask you to perform 5 short exercises to measure different types of physical fitness, these exercises will be fun and will not be hard for you to complete. We will also record some other things regards your overall body composition and health bit these measures are non invasive, which means you will not be asked to do anything during them except sit or stand still. The researchers and coach will ensure that we can collect this information.

Will anyone know I am in the study?

You and your class mates will be involved in this study (if you want to), but you can pull out at any time. Also all the information that we collect from you will be kept confidential which means that no one will know it is your information.

Who can I talk to about the study?

If you have any questions you can phone Candice or Andrea at the HKE department (046 603 8471)

What if I do not want to do this?

Even if your parents have agreed to your participation you may refuse to take part in this study, even though it may benefit you. You can also stop being in the study at any time without getting in trouble.

Do you understand this research study and are you willing to take part in it?

YES	NO

Has the researcher answered all your questions?

YES	NO

Do you understand that you can pull out of the study at any time?

YES	NO

__________________________ _____________________

Signature of Child Date

We thank you very much for your choice in participation in our study. It is greatly appreciated and we hope the outcome can provide you, your child and his/her school with great improvements in the fields of health and fitness.

7.3 Appendix C: Questionnaire documents for parents

Dear Parents

We thank you very much for choosing to be a part of our study and hope that you will find value in you childs' participation. The first section of the study; the physical fitness measures, have been completed, therefore, we are moving onto the qualitative part i.e. the necessary questionnaires to be completed.

The first questionnaire in this document is that of a baseline physical activity measurement. This is a once off questionnaire and must be completed accurately and in full. This must also ideally be filled in with the participant in question present. As you will see, this questionnaire has been separated into four sections based on the different types of activity your child potentially participates in during an average school week. You are required to fill in hoe many time your child has participated in each activity during the past seven days as well as the approximate accumulated time spent doing each activity. Examples have been given to you at the start of each activity section.

Secondly we have the slightly more time consuming questionnaire, the domain specific screen time questionnaire, that will take part over the course of one typical school week, 12/11/2018- 18/11/2018. At the end of each day you will be required to fill in the approximate time, in hours and minutes, that your child spends on different screen based devices, these being; cell phone, television, computer/laptop and IPad/tablet. This needs to be filled out as accurately as possible; therefore, honesty will be much appreciated.

Thank you again for participating and helping us improve you r children's quality life at school. Should you have any queries with regards to the study please feel free to send us an email.

Kind Regards
Prof. Candice Christie (c.christie@campus.ru.ac.za)
Andrea Kade (Msc) (g13k4049@campus.ru.ac.za)

Questionnaires begin on the next page.

CHILDREN'S PHYSICAL ACTIVITY QUESTIONNAIRE (C-PAQ)

Parent Questionnaire

Your child's name: ....
Your child's date of birth (dd/mm/yy): .... / .... / ....
Are you the child's: mother / father / guardian / other

Please note: - this questionnaire will take approximately 10 minutes to complete

- please answer the questions in relation to the child named above
- please **complete every line** in the questionnaire

For further information, please contact:

Which of the following PHYSICAL activities did your child do in the PAST 7 DAYS?

Please complete this questionnaire for the following days: ………………………… to ……………………………

Did your CHILD do the following activities in the **past 7 days?**			MONDAY – FRIDAY		SATURDAY – SUNDAY	
			How many times **Mon–Fri**?	**Total** hours/minutes **Mon-Fri**?	How many times **Sat-Sun**?	**Total** hours/minutes **Sat-Sun**?
EXAMPLE: **Bike riding**	**No**	**Yes**	**2**	**40 mins**	**1**	**15 mins**
SPORTS ACTIVITIES Aerobics	No	Yes				
Baseball/softball	No	Yes				
Basketball/volleyball	No	Yes				
Cricket	No	Yes				
Dancing	No	Yes				
Football	No	Yes				
Gymnastics	No	Yes				
Hockey (field or ice)	No	Yes				
Martial arts	No	Yes				
Netball	No	Yes				
Rugby	No	Yes				

Did your CHILD do the following activities in the **past 7 days?**			MONDAY – FRIDAY		SATURDAY – SUNDAY	
			How many times **Mon–Fri**?	**Total** hours/minutes **Mon-Fri**?	How many times **Sat-Sun**?	**Total** hours/minutes **Sat-Sun**?
Running or jogging	No	Yes				
Swimming lessons	No	Yes				
Swimming for fun	No	Yes				
Tennis/badminton/squash/ other racquet sport	No	Yes				
LEISURE TIME ACTIVITIES Bike riding (not school travel)	No	Yes				
Bounce on the trampoline	No	Yes				
Bowling	No	Yes				
Household chores	No	Yes				
Play in a play house	No	Yes				
Play on playground equipment	No	Yes				
Play with pets	No	Yes				
Rollerblading/roller-skating	No	Yes				
Scooter	No	Yes				

Did your CHILD do the following activities in the **past 7 days?**			MONDAY – FRIDAY		SATURDAY – SUNDAY	
			How many times **Mon–Fri**?	**Total** hours/minutes **Mon-Fri**?	How many times **Sat-Sun**?	**Total** hours/minutes **Sat-Sun**?
Skateboarding	No	Yes				
Skiing, snowboarding, sledging	No	Yes				
Skipping rope	No	Yes				
Tag	No	Yes				
Walk the dog	No	Yes				
Walk for exercise/hiking	No	Yes				
ACTIVITIES AT SCHOOL Physical education class	No	Yes				
Travel by walking to school (to and from school = 2 times)	No	Yes				
Travel by cycling to school (to and from school = 2 times)	No	Yes				
OTHER please state:	No	Yes				

Did your CHILD do the following activities in the **past 7 days?**			MONDAY-FRIDAY **Total** hours/minutes	SATURDAY-SUNDAY **Total** hours/minutes
EXAMPLE: **Watching TV/videos**	**No**	**Yes**	**15hrs**	**6hrs 30mins**
Art & craft (eg. pottery, sewing, drawing, painting)	No	Yes		
Doing homework	No	Yes		
Imaginary play	No	Yes		
Listen to music	No	Yes		
Play indoors with toys	No	Yes		
Playing board games / cards	No	Yes		
Playing computer games (e.g. playstation / gameboy)	No	Yes		
Playing musical instrument	No	Yes		
Reading	No	Yes		
Sitting talking	No	Yes		
Talk on the phone	No	Yes		
Travel by car / bus to school (to and from school)	No	Yes		

Domain Specific Screen Time Questionnaire

Monday	Hours	Minutes
Cell phone		
Television		
Computer/ laptop		
IPAD/tablet		
Total screen time		

Tuesday	Hours	Minutes
Cell phone		
Television		
Computer/ laptop		
IPAD/tablet		
Total screen time		

Wednesday	Hours	Minutes

Cell phone		
Television		
Computer/ laptop		
IPAD/tablet		
Total screen time		

Thursday	Hours	Minutes
Cell phone		
Television		
Computer/ laptop		
IPAD/tablet		
Total screen time		

Friday	Hours	Minutes

Cell phone		
Television		
Computer/ laptop		
IPAD/tablet		
Total screen time		

Saturday	Hours	Minutes
Cell phone		
Television		
Computer/ laptop		
IPAD/tablet		
Total screen time		

Sunday	Hours	Minutes

Cell phone		
Television		
Computer/ laptop		
IPAD/tablet		
Total screen time		

7.4 Appendix D: Letter confirming language editing

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glyniswelbourne0@gmail.com

June 2020

Andrea Kade
caddykade@gmail.com
Newcastle
KZN

Dear Andrea

Proof of Language Editing

Herewith proof that I edited your Master's thesis entitled Physical Activity, Physical Fitness and Sedentary Behaviour Profiles of Primary School Children in a School within the Makana Municipality, Eastern Cape, South Africa on 26 June 2020.

Regards

Glynis Welbourne