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The effects of a home exercise programme on the exercise endurance of children infected with HIV

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THE EFFECTS OF A HOME EXERCISE PROGRAMME ON THE EXERCISE ENDURANCE OF CHILDREN INFECTED WITH HIV

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A dissertation submitted to the Faculty of Health Sciences, University of the Witwatersrand, in fulfilment of the requirements for the degree of Master of Science in Physiotherapy.

Johannesburg 2019

DECLARATION

I, Candice Noelle Naidoo, solemnly declare that this dissertation is my own unaided work.

Signed this day in Johannesburg



Signature

14/05/2019

Date

ABSTRACT

Background: Reduced exercise endurance is commonly seen in individuals with Human Immunodeficiency Virus (HIV) infection. Little research is available on the impact that a home exercise programme (HEP) would have on the exercise endurance of children infected with HIV.

Aim: To investigate the effects of a HEP on the exercise endurance of children infected with HIV.

Methods: This study was comprised of two phases which were conducted at the Rahima Moosa Mother and Child Hospital, Johannesburg. In phase I, a literature review was completed to guide the structuring of the HEP. The Nominal Group Technique (NGT) was used to validate the HEP. In phase II, the participants were randomly allocated into an intervention or control group. The control group did not receive any exercise programme within the 12 weeks and participants in this group were told to continue with their usual lifestyle. The intervention group received a 12 week HEP. Participants' endurance was assessed using the six minute walk test (6MWT) at baseline and at the 12 week follow- up visit. Feedback regarding the enjoyment of the HEP was collected from both participants and their caregivers at follow- up.

Results: Literature review results showed an effective HEP as being 12 weeks long, done three times a week, without the use of equipment. Five participants were involved in the NGT and one meeting was held. Valuable changes were made to the HEP based on feedback from the NGT. The highest ranked suggestion was age range. The most commonly occurring theme (as a result of the thematic analysis) was also 'age range'. An age range of five- nine years was initially set in this study, the group advised that a smaller age range (seven- nine) would be more appropriate. Other suggestions mentioned by the nominal group were; excluding children who are

unable to perform the exercise, allow siblings to be involved, making the HEP more appealing and having few repetitions.

For phase II, 62 children infected with HIV were enrolled, aged between seven through nine years. Groups were well matched in terms of age, gender, height and weight. There were no statistically significant differences in six minute walk distance (6MWD) in the two groups from baseline to follow-up (Intervention group: p=0.91, control group: p= 0.23). At baseline the control group walked 429.15m (SD= 56.73) and the intervention group walked 432.46m (SD= 82.01). Participants in the intervention group walked 11.2m further than participants in the control group at follow-up. Males walked significantly further than females regardless of the group at baseline (males: 449.15m, females: 412.46m, p= 0.04). Participant's walked 213.6m (SD=69.37) less at baseline and 196.9m (SD=64.62) less at follow-up, than the expected 6MWD for children in this age group. Positive feedback regarding the enjoyment of the HEP was received by all participants and caregivers attending the follow- up visit.

Conclusion: A well-structured HEP can potentially improve endurance in children with HIV. Further research is needed on the effects of a HEP on the exercise endurance of children infected with HIV.

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LIST OF ABBREVIATIONS

6MWD	Six Minute Walk Distance
6MWT	Six Minute Walk Test
ATS	American Thoracic Society
ADLs	Activities of Daily Living
AIDS	Acquired Immune Deficiency Syndrome
ART	Antiretroviral Therapy
BMI	Body Mass Index
BP	Blood Pressure
BPM	Beats per minute
HEP	Home Exercise Programme
HIV	Human Immunodeficiency Virus
HR	Heart Rate
LIP	Lymphocytic Interstitial Pneumonia
m	Metres
NGT	Nominal Group Technique
PJP	Pneumocystic Jirovecii Pneumonia
PMTCT	Prevention of Mother to Child Transmission
QoL	Quality of Life
RMMCH	Rahima Moosa Mother and Child Hospital
SA	South Africa
SD	Standard Deviation
SpO_2	Oxygen Saturation
SSA	Sub-Saharan Africa
TB	Tuberculosis
UNAIDS	United Nations Programme on HIV/AIDS

CHAPTER 1: INTRODUCTION

1.1 Background

Across the full age spectrum people are at risk of acquiring Human Immunodeficiency Virus (HIV) infection (Somarriba et al., 2010). In 2018 it was estimated that 13.1% of South African were infected with HIV. There are approximately 12 000 children who are infected with HIV through vertical transmission (UNAIDS, 2018).

Cardiovascular fitness is a reflection of how capable the heart, lungs and blood cells are of supplying oxygenated blood to the muscle tissues that are being exercised. It also refers to the ability of the muscles to use this oxygen to produce the necessary energy for movement (Deary et al., 2010). Various factors affect the exercise endurance of an individual, such as abnormalities of the cardiovascular, haematological and pulmonary systems (Steele et al., 2008). Children with HIV often present with pulmonary complications. Pneumocystis Jirovecii pneumonia (PJP) occurs most frequently, bacterial pneumonia and lymphocytic interstitial pneumonia (LIP) are also common. Untreated HIV in children can give rise to cardiomyopathy which results in other complications of cardiac failure (Patel et al., 2012).

Although HIV infection cannot be cured, antiretroviral therapy (ART) is used to halt disease progression by inhibiting viral replication and improving the functional ability of the immune system (Zar, 2008). There is strong evidence to show that the use of combination ART reduces mortality and morbidity in children (Brahmbhatt et al., 2006, Fenner et al., 2010, Janssens et al., 2007, Kumarasamy et al., 2008, Newell et al., 2004, Sutcliffe et al., 2008). ART is also said to improve quality of life (QoL), as well as normalise growth and development in children infected with HIV (Penazzato et al., 2012). It is important to keep the immune system healthy and continue viral suppression, however to ensure the best QoL it is vital to have a holistic approach to treatment. Therefore, the exercise endurance of HIV infected children needs to be considered too.

Recently physical activity is becoming more recognised as being vital in improving QoL for children of all ages by maintaining good health (Riner and Sellhorst, 2013). Exercise has been proven to improve QoL in both healthy children and children with chronic diseases (Fanelli et al., 2007, Gates et al., 2012). Children infected with HIV living in South Africa (SA) have a reduced exercise endurance when compared to uninfected children (Walker, 2015). Previously it was common to test exercise endurance using treadmills or cycle ergometer in both adults and children (Wise and Brown, 2005). More recent research shows interest in simple exercise tests, without the use of equipment and providing a more accurate representation of daily activities (Walker, 2015).

There has been much emphasis on the vital role of physical fitness in children's health. By positively affecting the cardiovascular and pulmonary systems ART plays a crucial role in improving the exercise endurance of HIV-infected patients (Schlabe et al., 2017). Exercise can have an immense impact on the exercise endurance of chronically ill patients (Baigis et al., 2002). A study looking at the effects of a hospital-based, as well as a home-based, exercise intervention in HIV-infected children showed beneficial effects. This was seen in important components such as aerobic capacity and lean body mass from both exercise interventions (Miller et al., 2010).

There is a lack of research on whether a home exercise programme (HEP) will have a positive impact on the exercise endurance of children infected with HIV, especially in a South African setting. A shortage of staff at South African provincial hospitals is one of the challenges for physiotherapists in providing regular therapy to all children who are HIV-infected (Potterton et al., 2009). Therefore, it may be beneficial for physiotherapists to provide exercise programmes for children with HIV which can be performed in the home environment aimed at improving exercise endurance and cardiovascular fitness.

1.2 Problem Statement

Children living with HIV in SA are not receiving sufficient physiotherapy to address their reduced cardiovascular fitness. Due to budgetary constraints in the SA

department of health, there is a shortage of physiotherapists at public hospitals (Potterton et al., 2009). High quality studies demonstrating the outcomes of a HEP on the exercise endurance of children infected with HIV have not been conducted.

1.3 Aim of Study

To investigate the effects of a HEP on the exercise endurance of children infected with HIV.

1.4 Objectives of the Study

Phase I

- To develop a HEP to improve the exercise endurance of children infected with HIV.
- To validate the HEP using the Nominal Group Technique (NGT).

Phase II

- To investigate the outcomes in terms of exercise endurance of the HEP when provided to a group of children infected with HIV.
- To investigate the adherence to the HEP by the participants in the intervention group.
- To attain qualitative feedback from participants in the intervention group and their caregivers with regards to the HEP.

CHAPTER 2: LITERATURE REVIEW

This literature review begins by providing an overview of the pathophysiology of HIV infection. HIV comorbidities are then discussed, with elaboration on haematological, pulmonary and cardiovascular complications of HIV. The effects these complications have on exercise endurance are highlighted on in this chapter. The epidemiology of HIV – worldwide and specifically in SA follows. This literature review then focuses extensively on the links between exercise, endurance and HIV. The effects of ART on HIV progression is discussed next. The NGT is briefly discussed. The last topic covered in this review is exercise endurance tests with focus on the six minute walk test (6MWT).

Electronic databases that were used to source articles referenced in this review include; CINAHL, EBSCO host, the Cochrane Collaboration, Medline and PubMed. Literature used dated between 2000 through 2018. Articles that were not used as part of this literature review include; research relating to paediatrics with physical or mental disability associated with HIV and non-English written literature. Articles related to physical and mental disability in children may limit the child's ability to accurately follow a HEP and therefore not provide a valuable contribution to this study. Key words used were: HIV and children, endurance, lung conditions and HIV, cardiovascular exercise and cardiomyopathy, physical fitness, exercise and physiotherapy, antiretroviral therapy, HIV and haematology.

2.1 HIV Pathophysiology

A characteristic feature of HIV infection is the number and variety of cells that are involved in the immune response (Khan et al., 2006). The loss of $CD4^{+}$-T cells is a hallmark of the disease and is due to pyroptosis, 'a highly inflammatory form of programmed cell death'. This is a process whereby immune cells detect uncommon danger signals internally, then, releasing pro-inflammatory cytokines, become inflamed, burst and ultimately die (Fink and Cookson, 2006). This implies that instead of the virus having the major role in cell death, it is the host responding to

viral DNA produced during destructive infection which triggers $CD4^+$-T cell death. This process has the potential to further prolong immune activation and chronic inflammation (Doitsh and Greene, 2016). The standard procedure for assessing the severity of immunodeficiency related to HIV infection involves measuring the percentage and the absolute number of $CD4^+$-T cells in the patient's blood. The decline of the $CD4^+$-T cells is proportionally linked to the progression of HIV and an increased risk of acquiring opportunistic infections (Vajpayee et al., 2005). It has been proven that both short and long- term physical exercise has an impact on the amount and functional ability of circulating immune responsive cells (Walsh et al., 2011).

- **Staging of HIV**

The typical progression of HIV to Acquired Immune Deficiency Syndrome (AIDS), when the patient is not using ART, can be described using four different stages (Khan et al., 2006). The first stage - primary HIV infection - lasts between two to ten weeks, and may differ between individuals. This stage begins with sero-conversion when the patient is initially infected with HIV. During this time there is a sudden decrease in the number of circulating $CD4^+$-T cells and a brisk replication of the virus (De Rossi, 2002). The patient may experience symptoms such as fever, headaches, pharyngitis and skin rashes. These flu-like symptoms occur in 30-60% of patients. Immediate ART at this early stage can be effective in decreasing the viral load to undetectable levels (Gulick et al., 2004).

The second stage, known as the asymptomatic stage, can last between seven to ten years; however, this time frame can vary between patients. During this stage, the patient seems to be recovering physiologically. The $CD4^+$-T cells circulating in the blood return to a close to the normal level and the viral load also drops drastically (Hazenberg et al., 2003). The patient may not have any major signs or symptoms during this stage and therefore may not be aware that they are carrying the virus. However, the virus is continuing to infect new cells and replicate itself (Hazenberg et al., 2003). Individuals infected with HIV may remain healthy and symptom free for many years, while others may deteriorate quickly, progress to AIDS and die within a few months.

Early and minor symptoms start to present in the third stage of HIV infection. The viral load is high at this point and the immune system is unable to cope with the presence of opportunistic infections (Messele et al., 2001). This stage begins in children (under the age of 15) infected with HIV when they present with some of the following symptoms; diarrhoea and/ or anaemia with no known cause, oral candidiasis, unexplained moderate wasting and malnutrition. Pulmonary tuberculosis (TB), and recurrent severe bacterial pneumonia - characterised by a wheezing cough, nasal flaring, grunting and coughing with rapid breathing. Other pulmonary symptoms include; chronic lung diseases such as bronchiectasis and symptomatic LIP (Gulick et al., 2004, Soogoor and Daar, 2005). Pulmonary pathology is discussed further in the pulmonary complications section of this literature review (2.4.2 Pulmonary complications). Exercise endurance is dependent on the function of the respiratory system. Therefore with the pulmonary symptoms present at this stage of HIV, children often have compromised endurance levels (Grubb et al., 2006).

AIDS is the final stage. This stage is defined by a $CD4^+$-T cell count of below 200 cells/mm^3. During this stage of the disease there will be a final increase in the viral load and a decline in the number of $CD4^+$-T cells circulating the body (Ye et al., 2004). The symptoms that present at this stage are indicative of the deteriorating function of the immune system. The following symptoms, among others, are seen in children younger than 15 years of age; severe unexplained wasting, pneumocystis pneumonia, extrapulmonary TB and cardiomyopathy (De Rossi, 2002, Rouet et al., 2006).

Clinical staging is helpful in the assessment and diagnosis of a patient. Survival, progression and prognosis of the disease, where there is no ART, (in both adults and children) can be determined by the clinical stages (Bonnet et al., 2005).

- **Immunology and HIV**

Healthy HIV uninfected infants have a higher CD4% and absolute $CD4^+$-T cell count when compared to HIV uninfected adults (Carey, 2005). By the age of six years, a child's $CD4^+$-T cell count has decreased to that of an adult (Ochieng et al., 2006).

Therefore, age is a factor that needs to be taken into account when considering CD4% and $CD4^+$-T cell count (Bunders et al., 2005, Shah, 2006). There is a somewhat 'normal' level of immune inadequacy seen in infants and young children, with HIV infection this immune-deficient state is even further compromised (Somarriba et al., 2010). Therefore, children progress faster from HIV to AIDS as compared to adults (Moreira-Silva et al., 2013). Due to the fact that HIV presents with so many varying symptoms and a potential asymptomatic period, children are often diagnosed late if HIV infection is not suspected and mild illnesses are treated at home. This is seen more in poorer communities (Bracher et al., 2007).

- **Mother to Child Transmission of HIV**

The most common way in which a child may become HIV infected is through mother to child transmission (Goga et al., 2012). Prevention of mother to child transmission (PMTCT) programmes were only implemented in SA in 2002 (Barron et al., 2013). These programmes assist women to continue a healthy pregnancy and prevent HIV transmission in utero, during labour and while breastfeeding. The services available for ART, PMTCT of HIV as well as HIV counselling have resulted in a rise in the number of children and adults who have been tested for and diagnosed with HIV since 2006 (Bekker et al., 2015).

Despite these programmes, children continue to become infected perinatally, during labour or while breastfeeding (Bekker et al., 2015). Other ways in which a child may be infected include; sexual abuse, unsafe incision practices and exposure to infected blood (Prendergast et al., 2007).

2.2 HIV-related comorbidities

- Risk of Infection

Medical treatment may be unable to fully restore the health of a person with HIV. However, it has been found that patients who are adherent to their ART will no longer suffer the burden of AIDS-related illnesses. Rather, an emergence of HIV-associated complications, which can persist throughout life, will be seen in these

patients (Deeks et al., 2013).There are various factors which are responsible for the activation of the immune system seen in patients infected with HIV. Some of these causes include co-infections and viral replication; these often persist despite good virological responses to treatment (Younas et al., 2016). Hyperactivity of the immune system has been linked to the onset of morbidities such as atherosclerosis, kidney failure, metabolic syndromes, osteoporosis, fatty liver and malignancies (Younas et al., 2016). There is usually a higher occurrence of infection, such as recurrent fever and diarrhoea, persistent upper respiratory tract infections and chronic cough, in children diagnosed with HIV as compared to children who are HIV uninfected. These infections are usually more aggressive in children infected with HIV (Moreira-Silva et al., 2013).

- Obesity and Diabetes

There has been evidence of an increasing prevalence of obesity seen in patients with HIV; these figures are similar to the general population (Jaime et al., 2004, Leite and Sampaio, 2008). Obesity is an aggravating factor precipitating complications such as dyslipidaemia and insulin resistance commonly seen in adults with HIV (Hendricks et al., 2008). Diabetes is also commonly seen in patients with HIV. Brown et al.in 2005 found that diabetes occurred four times more frequently in HIV-infected individuals than in the uninfected population. A link between diabetes and obesity has been found (Brown *et al.*, 2005).

- Underweight

Underweight HIV infected patients are also frequently seen. A meta-analysis focusing on predictors of mortality in untreated children infected with HIV was done in Africa and Brazil. The study found that the highest predictors of mortality were; low weight-for-age scores and low levels of haemoglobin (Currie et al., 2009). Research has shown that infants infected with HIV are also at high risk of growth failure. It was found that the weight- and height-for-age was much lower than that of healthy uninfected children (Isanaka et al., 2009).

2.2.1 Haematological Complications

In patients infected with HIV, anaemia is known to be one of the most frequently occurring haematological manifestations (Subbaraman et al., 2009). It commonly occurs due to the effects of the HIV infection and the lack of food intake. (Subbaraman et al., 2009). However, the aetiology of anaemia is not restricted to these causes, there are many causes of anaemia in children infected with HIV (Subbaraman et al., 2009). A study done in 2013 by Moreira-Silva et al. looking at the comorbidities of HIV in children and adolescents, found that anaemia was the leading comorbidity amongst all age groups at admission to hospital. However, this was seen more frequently in children under the age of 12 months. Children with severe immunological changes had a higher prevalence of anaemia. Research has shown that bone marrow suppression is the initial pathophysiological process of anaemia in patients infected with HIV (Moreira- Silva et al., 2013). In a child, anaemia can cause symptoms such as congestive cardiac failure, weakness, tachypnoea and fatigue (Calis et al., 2008). These symptoms result in decreased exercise endurance.

Moderate intensity exercise can be done by children with mild anaemia, as the cardiac output is increased to compensate for the reduced arterial oxygen content (Owens and Gutin, 2000). However, with severe anaemia even the increased cardiac output cannot compensate for the decreased blood oxygen carrying capacity and exercise intolerance is experienced by these patients. Strenuous exercise in these patients can result in hypoxemia and metabolic acidosis (Owens and Gutin, 2000). Studies done on patients with anaemia as a result of chronic diseases found that moderate intensity exercise can improve the formation of all blood cells (Dimeo et al., 2004). In this current study there was no screening done for severe anaemia, as blood tests were not routinely done as part of the visit. Instead, patients were screened for increased respiratory rate before the test and were given the opportunity to rest or stop the test if they experienced shortness of breath, fatigue or dizziness - which may have been as a result of severe anaemia.

2.2.2 Cardiovascular Complications

Infection with HIV can be detrimental to the cardiovascular system, complications include; coronary artery disease, pericardial effusion and pulmonary hypertension. These dysfunctions are as a result of the heart muscle being infected by the virus as well as due to the effects of ART (Patanè et al., 2011). Cardiovascular fitness, when decreased, is one of the risk factors for cardiovascular disease (Tanwani and Mokshagundam, 2003). Isolated left or right ventricular dysfunction and dilated cardiomyopathy can result from myocardial dysfunction (Khunnawat et al., 2008).

These cardiovascular complications are often not recognised and go untreated, which then results in a higher risk of cardiovascular associated morbidity and mortality as well as a decreased life quality. Clinicians have associated the signs of cardiovascular abnormalities with either infection or pulmonary dysfunction (Dubé et al., 2008). Patients can present with tachycardia and dyspnoea (Patanè et al., 2011),which is also commonly seen with either malnutrition or dehydration, therefore cardiovascular abnormalities may be masked (Dubé et al., 2008).

Cardiomyopathy is apparent in the final stage of HIV according to the World Health Organisation (WHO) stages of HIV (World Health Organization, 2007). Myocarditis can be described as inflammation of the myocardium. A variety of opportunistic and viral infections can cause the onset of myocarditis when HIV is not controlled (Twu et al., 2002). The leading cause of pericardial disease amongst patients with HIV is TB. This is especially common in endemic areas such as parts of Sub- Saharan Africa (SSA). TB accounts for as much as 70% of all pericardial effusions in the HIV uninfected population and 90% of pericardial effusions in individuals with HIV (Ntsekhe and Mayosi, 2009).

By identifying early indicators of myocardial abnormalities, in patients with HIV who are at high risk of cardiac disease, it will be possible to provide timely intervention that can be lifesaving (Singh et al., 2015). Cardiomyopathy was previously considered to be one of the major non-infectious causes of death in children with HIV (Patel et al., 2012). The North American Paediatric Cardiomyopathy Registry reported that 0.57 per 100 000 HIV uninfected children have cardiomyopathy. Dilated

cardiomyopathy accounts for more than half of these cases. The mortality rate in children who are diagnosed with dilated cardiomyopathy has not changed from 17% over the past 20 years despite progress being made in medical care (Kaddourah et al., 2015). Almost 40% of children who present with symptomatic cardiomyopathy either received a heart transplant or died within the initial two years after diagnosis in the past decade (Lipshultz, 2000). In children infected with HIV, the initiation of ART has been shown to decrease the prevalence of HIV-associated cardiomyopathy (Bijl et al., 2001).

As this study is aimed at improving the endurance of children with HIV through the use of exercise, cardiomyopathy is an important factor that needs to be considered. In paediatric patients cases of exercise intolerance are linked to dysfunction of the cardiovascular, pulmonary and neuromuscular systems (Owens and Gutin, 2000). Heart rate (HR) and cardiac output are factors which are affected directly by exercise (Mahon et al., 2005). This means that the HR and cardiac output increases in order to supply oxygenated blood to the muscles that are working during exercise. With cardiomyopathy the ability to pump blood is compromised, therefore, exercise cannot be carried out at an optimal level without causing strain to the heart (Ross Jr, 2002) .

2.2.3 Pulmonary Complications

HIV causes alterations to the respiratory tract as well as the defence mechanism of the lungs; this can result in the elevated risk of lung complications in these persons (Shellito, 2004).

Children with HIV can present with more than one lung condition at a time which can be either infectious or non-infectious. This was seen in a study done by Da Cunha *et al.* (2013) conducted in SA with 125 children that were younger than seven years old. Children were admitted to hospital with HIV and various respiratory conditions. The study found that of the children who had TB and PJP two thirds of these children also had a bacterial lung infection (Da Cunha et al., 2013). Infections caused by multiple pathogens, as well as bacterial infections which are resistant to antibiotics, are seen more often in children who are HIV infected when compared to uninfected

children. This increases the morbidity and mortality in children infected with HIV (Enarson et al., 2010).

- Pneumonia

Diarrhoea and pneumonia are the major infectious causes of death in children under the age of five. Pneumonia accounted for 1.3 million deaths in 2011 (Walker et al., 2013). Hospitalisation of children with HIV is often due to pneumonia. Chances of contracting pneumonia are three to six times higher in children with HIV when compared to uninfected children (Zar, 2008). Bacterial pneumonia, TB, cytomegalovirus, PJP and Gram-negative infections are some of the more common causes of pneumonia in HIV-infected children. Between the ages of two to six months, PJP and cytomegalovirus pneumonia are most common (Walker et al., 2013).

- Lymphocytic Interstitial Pneumonia

When comparing comorbidities in adults and children, LIP is commonly seen in children with HIV and not often seen in adults with HIV (Bocchi et al., 2012). LIP is known to be one of the defining features of HIV in children younger than13 years. Chronic lung disease in children with HIV can be caused by opportunistic fungal infection and LIP (Graham, 2007). Before ART, approximately 35% of children infected with HIV also had chronic lung disease, usually as a result of LIP. However, these chronic lung disease responds well to ART and are not often seen in older children with HIV (Rylance et al., 2016). LIP presents as a diffuse interstitial pneumonia that can progress to a cor pulmonale as a result of cardiac dysfunction. Interstitial lymphoid aggregates and lymphocytes surround the airways which leads to a constant increase in pulmonary vascular pressure (Moreira-Silva et al., 2012). Pulmonary hypertension is discussed later in this literature review. Prolonged periods of dyspnoea, tachypnea and coughing are some of the most common symptoms of LIP. On pulmonary function tests, there is found to be restrictive ventilatory dysfunction (Hoey and Mankad, 2009).

- Tuberculosis

People with HIV are at higher risk of contracting TB. TB can cause an increase in HIV replication (leading to an increase in mortality, morbidity and opportunistic diseases) (Swaminathan, 2004). It was estimated that of the 10.4 million cases of TB worldwide in 2015, 1.2 million of those cases were people infected with HIV (UNAIDS, 2017). *Mycobacterium TB* is the main cause of pneumonia in HIV-infected children living in areas where TB is an endemic. This type of pneumonia is usually acute and severe. In 2004, the Western Cape of SA recorded one of the highest incidences of TB at a rate of 988 per 100 000 children (Zar, 2008).

- Pulmonary Hypertension

Before recent years, primary pulmonary hypertension had a poor prognosis. This was seen more in children than in adults and the mean survival rate was less than a year in children (Widlitz and Barst, 2003) . Timely and accurate diagnosis is vital as therapeutic advice and treatment requires accurate diagnosis. Early initiation of therapeutic treatment can improve outcomes in patients with pulmonary hypertension (Beghetti et al., 2013) . This allows for more effective treatment, an improved survival rate and QoL in children with pulmonary hypertension (Widlitz and Barst, 2003).

This increased pulmonary pressure puts a larger demand on the right ventricle of the heart. A prolonged demand on this ventricle results in inadequate filling of the left heart and ultimately right heart failure (Widlitz and Barst, 2003). Children with pulmonary hypertension can present with fatigue, syncope and dyspnoea with increased physical activity. Dyspnoea and syncope are important precautions to be aware of when children exercise. Blood pressure (BP), HR and respiratory rate would need to be monitored closely (Barst et al., 2011).

All pulmonary complications described above have a detrimental effect on the exercise endurance of children. Studies done in SA found that approximately 30% of older African children infected with HIV also have chronic respiratory symptoms such as chronic cough and reduced exercise tolerance (McHugh et al., 2016, Mwalukomo

et al., 2015, Owens and Gutin, 2000, Rylance et al., 2016) . Breathlessness and tachypnoea as a result of pulmonary complications can cause difficulty in exercising (van de Weert-van Leeuwen et al., 2013).

2.3 Epidemiology

According to the Joint United Nations Programme (UNAIDS) report on HIV/AIDS in 2017, huge strides have been made to reduce the number of deaths caused by HIV. In 2017, Gauteng had 17.6% of people living with HIV in SA. In the Eastern and Southern region of Africa, approximately 11.7 million people had access to ART, which made up 60% of the HIV population living in these regions in 2016 (UNAIDS, 2017). Great progress has also been made in reducing the number of new HIV infections in children. By providing HIV infected pregnant women with ART, there were approximately 900 000 less newly infected children in 2016, since 2009 (World Health Organization, 2016b). There was a 56% decrease in new HIV infections in children since 2010 in the Eastern and Southern region of Africa when estimated in 2016 (UNAIDS, 2017). Young children including infants that are infected with HIV have an extremely high risk of poor outcomes and mortality. Approximately 52% of children who are living with HIV and not on treatment often die before their second birthday (World Health Organization, 2016a).

2.4 Endurance, Exercise and HIV

- **Endurance and HIV**

There are various causes for decreased exercise endurance some of which include; anaemia, pulmonary dysfunction and cardiovascular complications (Stringer, 2000). Individuals with HIV are more at risk of cardiovascular and pulmonary diseases (Bull et al., 2004). This is discussed in more detail under the cardiovascular and pulmonary complications section of this literature review.

A study conducted by Keyser et al in 2000 found a marked reduction in the anticipated exercise capacity in a group of adolescents infected with HIV. This study further proved that a decreased exercise capacity resulted in a decreased ability in carrying out activities forming part of daily living (Keyser et al., 2000). Reduced

cardiovascular fitness and exercise endurance was noted in HIV-infected preadolescents when compared to non-infected participants in a study done in 2012 (Ramos et al., 2012). This study used 15 preadolescent participants in each group, with a mean age of 11 years. The study highlights that the aim of improving anaerobic power is to improve short term function in activities that are high intensity- such as sports. This allows preadolescents with HIV to live an active life which limits the onset of further complications caused by HIV.

Looking specifically at South African literature, a study was done by Walker in 2015 using the six minute walk test (6MWT) to determine whether there was a difference in exercise endurance between HIV-infected children and those that were uninfected. The results of the study showed that HIV-infected participants walked 57.86 m less than the uninfected participants. These results show a clinically significant difference between the distance walked by the HIV-infected and non-infected participants (Walker, 2015).

Persons with HIV generally have a decreased ability to do activities of daily living (ADLs). These persons can also incur impairments and have a decreased ability to participate in the community (World Health Organization, 2001). Endurance has a negative impact on the QoL in an individual. QoL can be described as the consequence of a person's health and their ability to carry out a life that is fulfilling. Although many definitions of QoL exist, it has been agreed that it is a concept which is multidimensional (Nachega et al., 2011). How effective health care is will be evaluated according to the impact it has on the patient's QoL (Wright et al., 2010). The QoL experienced by an HIV-infected individual can be determined by the clinical stage of infection and the rate at which the patient's condition is progressing. An individual with a more advanced stage of HIV will need more care and assistance with regards to their physical, environmental, psychological, spiritual and social needs (Rai et al., 2010).

Poverty is an important factor to consider as many patients attending public-service hospitals and clinics live in poverty stricken areas. Poverty can result in; inadequate nutrition, infection, maternal depression/stress, inadequate stimulation and poor

sanitation (Engle et al., 2007, Grantham-McGregor et al., 2007). A study done by Potterton et al. in 2009 found that HIV-infected children who were found in poor socioeconomic environments were generally stunted and underweight when they were compared to the expected values (Potterton et al., 2009). A decrease in muscle mass is often seen in individuals with HIV, this is directly linked to functional status and strength. This decrease in strength will negatively impact an individual's ability to exercise efficiently (Scott et al., 2007). Published literature has shown that habitual exercise improves exercise endurance in some chronically ill populations (Baigis et al., 2002).

- **Exercise**

Exercise can be defined as "planned, structured and repetitive bodily movement done to improve or maintain one or more component of physical fitness" (Dwyer et al., 2011). Children and adolescents who are physically active generally have lower levels of BP, higher bone density, favourable lipoprotein levels and reduced adiposity when compared to their less active counterparts (Dwyer et al., 2011). The results of inactivity in children and adolescents have been linked to an increased risk of many chronic diseases later on in life (Gutin and Owens, 2011, Kvaavik et al., 2009, Shaibi et al., 2008). Including exercise as part of a lifestyle from a young age leads to good exercise habits that generally follow into adulthood. Evidence shows that an appropriate amount of exercise is beneficial in assisting with the recovery and management of a variety of health problems (Morris, 2008). Regular physical activity should be done by persons with HIV across all age groups (Somarriba et al., 2010).

Children with chronic diseases are encouraged to exercise. The intensity, progression and choice of equipment can be modified to accommodate the disease state. In order to have a successful exercise programme, the correct exercise technique and equipment needs to be used. It needs to be taken under consideration that children with chronic conditions may have; limited strength, poor balance and vision or cognitive fallout, which can lead to injury (Robinson et al., 2007). Supervision is also necessary (Better Health Channel, 2018). Safety precautions and guidelines need to be followed when supervising children while they exercise. The

following precautions and guidelines are suggested in order to improve safety in exercise for children;

- Exercise needs to start with low intensity and build up gradually.
- Appropriate foot gear and clothing needs to be worn- for support and suitable for the weather.
- The supervisor needs to be aware of the exercise environment and identify possible harmful risks.
- The child needs to stay hydrated when exercising, by drinking water before, during and after exercise.
- The child needs to be monitored for signs of fatigue, breathlessness and dizziness.
- With endurance exercise the child should not over exert themselves to a point where their respiratory rate increases and they are unable to speak (Harvard Health Publishing, 2010).

Children who suffer from physical limitations as a result of chronic health conditions are usually prevented from participating in physical activities and sport (Bar-Or and Rowland, 2004). Children with chronic health conditions are often viewed as 'vulnerable' by their parents. Parents are generally hesitant to allow their child with a chronic health condition to participate in sports or other physical activities with healthy children. The benefits of physical activities and exercise programmes often outweigh the possible adverse effects (Riner and Sellhorst, 2013). Evidence shows that in some chronic conditions exercise therapy is equally as effective as medical treatment and can even be more effective (Pedersen and Saltin, 2006). HIV infected individuals are encouraged to begin an exercise programme while in the initial phase of HIV (Baigis et al., 2002).

- **Exercise Programmes**

Supervised hospital-based exercise programmes have previously shown to have better outcomes in terms of cardiopulmonary measures when compared to both home and community based programmes (Huang and Ness, 2011). Two similar

studies were compared, where both studies implemented exercise programmes in a small sample size of children who were in the same phase of acute lymphoblastic leukaemia. It was found that the study using a home-based exercise programme had more favourable outcomes than the study using a community-based exercise programme (Gohar et al., 2011, Takken et al., 2009) While hospital-based programmes have been shown to be most effective, supervised training can be costly and unrealistic for families travelling long distances to get to their health care facility. Taking this into consideration, within a South African context, a home-based programme would be most suitable for the majority of patients (Huang and Ness, 2011).

A review of published data investigating the effects of exercise programmes, consisting of continual or intermittent aerobic exercise, or a combination of aerobic and resistance exercise for adults with HIV was published by O'Brien et al. (O'Brien et al., 2010). The results showed that exercise seems to be safe and produced beneficial physiological results in these patients. These exercise programmes were done at a minimum of three times a week for at least five weeks and each session was at least 20 minutes long. Some of the improvements noted in the reviewed studies included; better body composition, increased cardiopulmonary fitness and less depressive symptoms (O'Brien et al., 2010).

Modified basketball, soccer, running activities, stair climbing and walking exercise are some of the most commonly used exercises/activities in exercise programmes for children and adolescents (Bushman and American College of Sports Medicine, 2017). Research shows that children often find long durations of aerobic exercise to be monotonous and are therefore more reluctant to continue following these exercise programmes on a daily basis. International studies use equipment such as bicycle ergometers or treadmills which are unavailable in the public sectors of SA. However, studies using this equipment found that children/adolescents lacked motivation to continue with the exercise programme (O'brien et al., 2004). It has been reported that it is better to get children to perform activities that include running rather than activities that involve cycling. Cycling requires more coordination and muscle strength than running. Children have underdeveloped muscular strength which will

affect their endurance results (O'brien et al., 2004). A review of literature shows that resistance training that is adequately progressed has been beneficial in improving both muscular strength and endurance (Dudgeon et al., 2004).

- **Exercise and HIV**

Adults with diabetes and cardiovascular morbidities often have a sedentary lifestyle (Biswas et al., 2015). A moderate amount of physical activity done by patients with HIV can have a positive effect on their ability to combat metabolic abnormalities and decrease the risk of acquiring acute infections (Biswas et al., 2015).

There has been a much interest in the efficacy and safety of exercise programmes in the HIV infected population (Walker, 2015). Studies done on adults with HIV, at different stages of infection, showed that endurance levels could be safely improved over a short term period by doing aerobic exercise (Baigis et al., 2002). A systematic review by Gomes Neto et al. 2012, found that consistent strength and endurance exercise resulted in a decrease in functional limitations and physical disability (Gomes Neto et al., 2013). Research has also shown that HIV-infected individuals who do regular exercise can have improvements in their general mood, life satisfaction, QoL questionnaire scores and a decrease in reported depression (O'Brien et al., 2004).

A review of literature shows that exercise intervention is safe for children with HIV (Somarriba et al., 2010). New research has shown that short term as well as long term exercise promotes children's executive function (Best, 2010). Physical activity done at a moderate level is also proven to have a positive impact on a child's immune system. Studies conducted in Miami on children with HIV and reduced endurance have shown that children who are active have improved muscular strength, motor skills and cardiovascular fitness as compared to inactive children (Steele et al., 2008). Specific programmes that were structured to improve children's strength, endurance and flexibility were shown to be safe in children who were six years and older (Faigenbaum, 2000).

A study was conducted by Miller et al., in 2010 on a group of 34 HIV-infected children aged six years and older. The participants completed a 24 session exercise

training programme over a 12 week period, each session was approximately one and a half hours long. Results from the study reported a clinically significant improvement in strength, flexibility, cardiorespiratory fitness and lean body mass (Miller et al., 2010). The study also showed that an exercise programme for children infected with HIV was carried out with no reported adverse effects to the participants. This programme was done over a 12 week period with each session being approximately one and a half hours long (Miller et al., 2010). While the study conducted by Miller provides valuable contribution to research it is important to consider some of the limitations in this study. No control group formed part of the study. It was pilot study and highlights the importance of a randomised control trial to further prove the results obtained. The study used both hospital- and home-based programmes so therefore it was difficult to distinguish which programme was more beneficial. The study further recommends that the effects of a home-based programme be analysed as the only form of therapy (Miller et al., 2010). This current study is aimed at addressing the limitations mentioned in the study by Miller et al. By including a control group, using a randomised control trial study design and using solely home-based therapy, a more accurate presentation on the effects of an exercise programme is hoped to be achieved.

Physiotherapists working with children infected with HIV need to have sound knowledge on HIV transmission in children and the clinical presentation of HIV (Potterton and Van Aswegen, 2006). Where respiratory complications are present the physiotherapist is able to provide education to the caregiver regarding disease progression and management of the disease from home. The physiotherapist is also able to address the symptoms of these respiratory complications by managing dyspnoea, preventing secondary infection and maintaining bronchial hygiene (Potterton and Van Aswegen, 2006). Therefore, the role of the physiotherapist in children with HIV has a vital role in optimising exercise endurance and functional ability.

2.5 Antiretroviral Therapy and HIV

Before ART became accessible to the South African population, an estimated 50% of the admissions into the medical wards at public hospitals were due to HIV-related

illnesses (Burch and Benatar, 2006). The number of deaths that were related to HIV between 2001 and 2013 had decreased by 35%. This decline was mostly accredited to the improved availability of ART (Lumsden and Bloomfield, 2016). ART is used to prolong life span, improve health and drastically reduce the occurrence of HIV transmission (Johnson, 2012). Violari et al. conducted a large study in 2008 and found that when ARVs are initiated in infants this played a role in reducing mortality and disease progression (Violari et al., 2008). A reduction in mortality in HIV infected children results in an improvement in life expectancy (Kapogiannis et al., 2011). As a result of long life expectancy, patients on ART are often at a higher risk of developing diseases which are chronic and non-communicable (De Socio et al., 2017).

There was limited access to ART in SA once introduced in 2004 (Klug, 2012). In 2016 SA was receiving the greatest distribution of ART (UNAIDS, 2017). In this year ART was available to 3736 different health facilities around SA to people who met the $CD4^+$-T count criteria (Meintjes et al., 2015). According to the guidelines set out by the WHO in 2016, in children five years and older, it is highly recommended that ART should be initiated immediately if the child is diagnosed with WHO clinical stage 3 or 4, or has a $CD4^+$-T cell count of $\leq$ 350cells/mm^3 (World Health Organization, 2016b). Improved access to ART for pregnant women played a role in a 32% decrease of new infections in children living in SSA (Gall et al., 2017).

Although commonly used drugs are well tolerated, many of the ARVs have short term side effects and have the potential of causing more long term problems (Volberding and Deeks, 2010). Some of the side effects caused by ART include; metabolic dysfunction, hypertension, dyslipidemia, gastrointestinal dysfunction and insulin resistance (Palios et al., 2011). Resistance to medication used for HIV can occur and will result in a decrease in efficacy to reduce viral replication and improve immune function (Riordan and Bugembe, 2009). Persons infected with HIV using ART present with a variety of associated lung diseases as a result of the ART. Long-term exposure to ART can cause clinically significant organ damage and metabolic imbalances (Deeks et al., 2013).

There are a number of studies that have indicated that the use of ART in children has saved lives; this was seen in Africa and other regions around the world (Hassan et al., 2012, Nicol et al., 2011). A decrease in hospital admissions and the incidence of opportunistic infections were found with the introduction of ART into the public sector (Cotton et al., 2013). This proves that early initiation of ART had been favourable in HIV-infected children (de Jose et al., 2013). From 1993-2007, the Paediatric Clinical Trials Group followed up children with HIV. It was found that the incidences of cardiomyopathy were recorded six times less since ART had been introduced, when compared to the era before ART (Patel et al., 2012). In SSA, cross sectional studies done in the pre-ART era found an incidence of cardiomyopathy in almost 57% of patients who were hospitalised (Ntsekhe and Mayosi, 2009). A decrease in viral load as well as an increase in $CD4^+$-T cell count was also noted in children infected with HIV using ART (Bacha et al., 2012, Isaakidis et al., 2010).

Improvements in growth parameters had been noted in children infected with HIV that were on ART. It was found that before the initiation of ART, the weight-for-age was significantly lower than the normal average (Sutcliffe et al., 2008). However, even with good tolerability of ART seen in children infected with HIV in low to middle income countries, some of these children still present with stunted growth and are underweight (Arpadi et al., 2013). Some children don't improve their $CD4^+$-T cell count or viral loads after being on treatment for several years (Mutwa et al., 2014).

There are limited ARVs available for use in children and HIV treatment for children is often more costly than adult HIV treatment. Children are 30% less likely to receive HIV treatment compared to adults (Bekker et al., 2015). There are also fewer health facilities (including laboratories and clinics) available that address the needs of paediatric patients (Bekker et al., 2015). There can be multiple challenges in diagnosing children and retaining them in care due to their dependence on a caregiver (Isaakidis et al., 2010). Patients defaulting on treatment is one of the major concerns, with retention being particularly difficult for children who are in HIV care but are not receiving their ART (Braitstein et al., 2011).

The effective use of ART will have a positive impact on the exercise endurance of HIV infected individuals, as it positively impacts the pulmonary and cardiovascular systems (Scevola et al., 2003). Ultimately ART slows down the progression of the disease, prevents opportunistic infections and decreases mortality (Riordan and Bugembe, 2009). Despite the negative side effects of ART, the benefits of using this treatment in children outweighs the harmful effects (Hassan et al., 2012). Great progress has been made throughout the world and especially in SSA in an effort to reduce the number of new HIV infections, increase the distribution of ART and improve the PMTCT (Whitehead et al., 2014).

2.6 Nominal Group Techniques

Nominal Groups serve the purpose of getting group members to interact in order to generate data (Corner et al., 2007). This is a useful method of collecting data without having a dominant participant controlling the group discussion. All participants are given the opportunity to raise their opinions and views in a manner that prevents them from being rejected by other participants (Wellings et al., 2000). Nominal Groups generally involve participants generating ideas individually before sharing, listing and discussing these ideas as a group and lasting ranking ideas independently. The researcher needs to avoid leading questions, promoting discussion and influencing decision making in order to retrieve a high quality of data (Wright et al., 2006),

Various health research studies have successfully applied the NGT (Corner et al., 2007). A study conducted by Bissell et al. in 2000 aimed at developing criteria to measure the appropriateness of the advice given in pharmacies within a community. The study used the NGT to develop a set of criteria for assessing the appropriateness of advice given. This study concluded that valuable data was collected from the NGT and used to create guidelines and protocols regarding advice given on sales of medication and minor ailments (Bissell et al., 2000). Another study conducted by Corner et al., in 2007 used the NGT to determine the research priorities from the perspective of cancer patients. The NGT was carried out with 105

patients. The study concluded that there was a discrepancy between the current research portfolio and the research priorities identified by the participants (Corner et al., 2007).

A review carried out by Campbell and Cantrill in 2001 was aimed at describing consensus techniques, focusing on its value and limitations to prescribing research (Campbell and Cantrill, 2001). The study describes the NGT as being able to yield a larger number of ideas when compared to unstructured group meetings. It also discusses the lack of constraints of freedom to express ideas as compared to normal groups. The study highlights the fact that the NGT requires extensive pre-planning and preparation. The NGT has previously been criticised for its lack of evidence regarding validity and reliability (Ward et al., 2000). The NGT is also said to have minimal agreement within a group and between different groups held. It is also been mentioned that the group may be a generalised presentation of the actual population of interest. The NGT has however been commended on its ability to provide adequate opportunity to develop and assess the evidence base of components in health care where high levels of evidence are lacking (Campbell and Cantrill, 2001).

2.7 Endurance tests and the 6MWT

Response to exercise is a vital tool in assessing patients clinically. This provides a measure of assessment for their cardiac, metabolic and respiratory systems. Using walking as an assessment objective is not time or resource consuming and measures a number of different components (Li et al., 2005). Functional walk tests, measure a person's functional status, their ability to perform ADLs and provide a measure of response to treatment (Solway et al., 2001).

There are a variety of different tests that objectively evaluate functional exercise capacity. Some of these tests are more comprehensive in their assessment of bodily systems that are involved in exercise performance than other tests. The test that will be used should be based on what it is expected to test and the resources available (Weisman, 2003). Some of the most well-known exercise tests in order of increasing

complexity are; stair climbing, 6MWT, shuttle walk test, cardiac stress test and the cardiopulmonary exercise test (Eaton *et al.*, 2005). Recently there has been more interest shown in simple exercise tests that require little to no use of technology and are more focused on linking exercise testing to daily activities (Hakestad et al., 2015).

Walking tests were introduced in the 1960s and have been used as part of clinical practice ever since (Enright, 2003). In 1963, Balke developed a straightforward test to assess the functional capacity of an individual by measuring the distance that was walked over a certain period of time (Li et al., 2005). Another test, the shuttle walk test, demands persons to meet multiple targets that correlate with beeps from an audio player. The shuttle walk test is good to use to determine the correspondence between peak oxygen uptake and aerobic exercise (Enright, 2003).

Amongst the most popular walking tests is the 12 minute walk test. This test was modified in order to be used in patients with respiratory disease; this was then known as the 6MWT. Once tested, it was found that the 6MWT yielded similar results to the 12 minute walk test (Enright, 2003). The 6MWT is easy to administer and shows an accurate reflection of the exercise endurance that is required to conduct ADLs (Solway et al., 2001). The six minute walk distance (6MWD) - which is the distance that the participant has walked in six minutes- is the primary measurement that is recorded. The 6MWT has previously been used as an outcome measure to determine how successful treatment for moderate to severe cardiopulmonary diseases has been. This is done by measuring the 6MWD before and after treatment (Solway et al., 2001). In patients with cardiopulmonary diseases the 6MWT has accurately predicted both morbidity and mortality (Enright, 2003). Since HIV has detrimental effects on the cardiovascular and pulmonary systems this is the test that was used to measure endurance as part of this study.

A study was done by Li et al. in 2005 to determine the reliability and validity of the 6MWT in healthy children. 52 participants were used for the test-retest reliability. The intraclass correlation was calculated as 0.9, with a confidence interval of 95%. Investigators also demonstrated a high degree of repeatability. The study concluded that the 6MWT is both valid and reliable as a functional test to assess exercise

endurance in healthy children (Li et al., 2005). Currently there are no studies published on the reliability and validity of this test in children infected with HIV.

Obtaining an appropriate reference value for the 6MWT in paediatrics is challenging as a result of developmental age and stage. There are different reference values used for the 6MWT which are individualised for persons based on nationality and age (Mylius et al., 2016). A review of literature by Cacao et al., 2016, was done to compare existing reference values and equations for the 6MWT in healthy children and adolescents. A total of 12 articles were reviewed. The main finding of the study was a difference of 159 meters in the 6MWT reference values. The study concluded that the 6MWT reference values varied greatly between the different studies reviewed and was dependent on the country (Cacau et al., 2016).

The most appropriate reference value that was found to use in this study was set out by Saad et al. (2009). In the study conducted by Saad et al. children between the ages of six and 16 years in North Africa, Tunisia participated. The following equation was developed: 6MWD (m) =
4.63 x height (cm) - 3.53 x weight (kg) + 10.42 x age (years) + 56.32 (Saad et al., 2009).

The participant's oxygen saturation (SpO_2), BP and HR are also recorded as part of administering the test (Solway et al., 2001). A study done by Li et al., 2005 showed that a change in HR before and after the 6MWT was related to the 6MWD and these changes were a reflection of the amount of effort the participant put into the test. Participants with a lower than average resting HR, such as athletes, had a larger difference in their HR before and after the 6MWT. Resting HR was found to be inversely proportional to the 6MWD (Li et al., 2005). Height has been shown to be one of the anthropometric measurements that relate to the 6MWD, in that taller people have larger stride lengths resulting in further walking distances (Li et al., 2007). Research shows that people of shorter heights, older age and those with a larger body weight had the lowest performance in the 6MWT (Solway et al., 2001).

A study carried out in Switzerland showed that among the anthropometric data recorded for the 6MWT namely the participant's age, height, weight and HR - age

was the greatest predictor and had the biggest impact on the 6MWD. The study also advised that using reference calculations to predict 6MWD would be helpful in better assessing and comparing outcomes in younger participants who had respiratory or cardiovascular disease (Ulrich et al., 2013).

A study done to test the effectiveness of the pulse oximeter has shown that motion causes large discrepancies in the accuracy of these readings, but have proven to be reliable before and after the 6MWT (Enright, 2003). The pace of this test is determined by the participant therefore the participant is not likely to over exert him/herself (Enright, 2003).

2.8 Conclusion

Mother to child transmission is the most common way in which children become infected with HIV (Goga et al., 2012). Although there are strategies in place to prevent this transmission, children continue to become infected perinatally, during labour or while breastfeeding (Bekker et al., 2015). Children often progress faster from HIV to AIDS as compared to adults (Moreira-Silva et al., 2013). It has been proven that children with HIV have decreased exercise endurance when compared to uninfected children (Walker, 2015).

Childhood infections occur more frequently in children infected with HIV when compared to uninfected children (Moreira-Silva et al., 2013). The major infectious causes of death in all children under the age of five are pneumonia and diarrhoea (Walker et al., 2013). Dysfunction of the pulmonary, cardiovascular and neuromuscular systems in children results in exercise intolerance (Owens and Gutin, 2000).

Although HIV cannot be cured, ART is used to slow down the disease progression (Zar, 2008). Physical activity done at a moderate level has a positive impact on a child's immune system (Steele et al., 2008).

Therapies that work on nutrition and physical activity can complement medical management in an HIV-infected individual (Somarriba et al., 2010). Physiotherapists play a vital role in the management and diagnosis of physical dysfunction that is present in patients infected with HIV (Bopp et al., 2003, Lima et al., 2007). The aim of this literature review was to describe the scope of the childhood HIV epidemic and highlight complications arising from HIV infection which may impact the exercise endurance of children.

The methodology used in this study is presented in the next chapter.

CHAPTER 3: METHODOLOGY

This chapter details the methodology used in this study.

This study was divided into two phases:

Phase I - The development and validation of a HEP.

Phase II - The investigation of the outcomes of a HEP on the exercise endurance levels in children infected with HIV.

3.1 Phase I

3.1.1 Research Design

A mixed method design was selected for this phase of the study. Both quantitative and qualitative data was collected. This phase of the study was two- fold. The first aspect is the review of literature leading to the design of the HEP. Quantitative data was collected to determine the parameters used when constructing an exercise programme. Qualitative data was collected to determine the strengths and weaknesses of previous HEPs carried out. The second aspect is the validation of the HEP. Quantitative data was collected to prioritise suggestions from the Nominal Group. Qualitative data was collected to analyse and comment on the structure of the programme through the Nominal Group.

3.1.2 Location of Study

Health care professionals from the following hospitals were invited to participate in this study; Charlotte Maxeke Johannesburg Academic Hospital, Tambo Memorial Hospital, Rahima Moosa Mother and Child Hospital (RMMCH) and Chris Hani Baragwanath Hospital. The group meeting took place in the physiotherapy department at RMMCH, Johannesburg.

3.1.3 Participants

In calculating a sample size, it was found that face to face meetings are most beneficial with a sample of not more than 12 participants. This assists with group discussion and prevents rowdiness in the group (Campbell and Cantrill, 2001).The number of groups held was determined by the number of health professionals that were willing to participate. Participants were invited based on expertise in the area of paediatric HIV and their availability to attend the group meeting. Experts in paediatric HIV were chosen as the sample for this study as this would provide ideas on the best possible treatment for children with HIV considering their abilities and limitations.

Inclusion Criteria

- Health professionals working in the field of paediatric HIV for a minimum of five years including; doctors, nurses, physiotherapists and occupational therapists.
- Sufficient command of the English language. Participants had to understand the purpose of their participation when presented to them in English. Participants had to provide input in English.

Exclusion Criteria

- Health professionals who did not consent to be part of the study.

3.1.4 Procedure

- Literature Review

A literature review of both national and international studies was carried out to investigate the average duration of exercise programmes, types of exercises, frequency of exercise per week and time spent per day exercising. CINAHL and Medline were the electronic data bases that were used to source articles. Articles were accessed if they were dated from 2000-2018. Articles were included if they had details of an exercise programme utilised to improve any bodily outcome in children with chronic disease. Articles were excluded if participants were over the age of 18 years and/or presented with physical disability. Key words used to search articles

included; exercises and HIV, children, home exercise programmes, fitness and endurance. A review of abstracts was done to ensure that articles met the inclusion criteria.

- Designing the HEP

The HEP was drawn up (appendix II i) based on previous exercise programmes that were created and proven to be beneficial to children with chronic disease. The average length, frequency and duration of programmes were used to create the HEP used in this study. Literature on the advantages and disadvantages of different exercises were considered when choosing the types of exercises used in the HEP.

- Nominal Group

Recruitment Strategy

Health professionals were sourced by investigating which staff members worked in the paediatric department of the hospitals listed above. This was done by telephonically contacting these departments. The study was briefly explained to each health professional. If the health professional showed an interest in the study a formal invitation to participate in the Nominal Group was then sent out via email (appendix II a). Once a health professional confirmed that s/he would be attending, a confirmation letter and consent form was emailed to him/her (appendix II b, II c and II d). The rough draft of the HEP (appendix II i) was also emailed to participants that confirmed their attendance for the NGT. All participants signed the consent form prior to commencement of the NGT meeting.

- Nominal Group Meeting

The participants attending the Nominal Group meeting were given a hard copy of the rough draft of the HEP (appendix II i) before the formalities of the meeting started. A guideline (appendix II e) and the five steps for the NGT (appendix II f) were used to plan and conduct the group. An agenda was followed for the group with time allocations for each section (appendix II g). The Nominal Group is made up of 5 standard steps (Detailed in appendix II f). Step 1: Silent generation of ideas in writing. Step 2: Round Robin recording of ideas. Step 3: Serial discussion for clarification. Step 4: Preliminary vote of item-importance and final voting and step 5:

Analysis. In step 4 each participant selected the five most important domains from the list and ranked the five domains. This was done by allocating a score from 5-1 points to each of the five most important domains from first to fifth priority. Appendix II h, shows the emails that were sent out to each participant explaining how to rank the domains. Once ranking was received by the all participants, the suggestions were then ranked overall by the investigator as part of step 5. The overall ranking was done by adding up the scores for each domain allocated by each participant to get an overall score. The domains were ranked from highest to lowest score and represented highest to lowest priority. The final ranking was sent to the participants. The necessary changes were made to the HEP based on the suggestions made. The HEP was then finalised and implemented as part of phase II of this study.

3.1.5 Ethical Consideration

Ethical clearance to conduct the study was obtained from the WITS Human Research Ethics Committee (Medical) prior to commencement of the study – clearance certificate number M170648 (appendix I). Permission was obtained from the chief executive officer and medical superintendent of RMMCH (Mrs S Jordaan and Mr E Hank, respectively). Permission was also attained from the clinical heads of the Empilweni Clinic (Dr K Technau and Sr. L Rose) through the hospital's online application system. Written consent to participate in the Nominal Group (appendix II c) and to voice record the discussion (appendix II d) was required before participants attended the group.

3.1.6 Data Analysis

Findings from the literature review were tabulated and quantitative data was collected based on the similarities seen in each study. Qualitative data was collected from research based on exercise programmes.

The NGT was used to prioritise suggestions using quantitative values that were calculated from the ranking of suggestions by participants that attended the group. To categorise common themes from the group discussion, thematic analysis was

used. Key elements were taken from each participant and categorised according to existing categories or into a new category if it did not fit into any existing category (Joffe and Yardley, 2004).

3.2 Phase II

3.2.1 Research Design

A randomised control trial design was used for this phase of the study as elimination of any form of bias was necessary in order to receive accurate results. There were some bias factors, such as no blinding of the investigator. This was due to financial constraints where blinding was not possible. Quantitative data was collected as part of this phase using the results from the 6MWT. Qualitative data was collected in the form of written and verbal feedback after participants had completed the HEP.

3.2.2 Location of Study

The target population consisted of patients currently attending the Empilweni Treatment Clinic at RMMCH (HIV clinic), in Coronationville, Johannesburg. Most patients live in the surrounding areas such as Mayfair, Newclare, Westbury and Coronationville. Some patients come from further areas such as Soweto, Diepsloot and Orange farm.

3.2.3 Participants

- The sample size calculations were based on the 6MWT data collected from research done at RMMCH (Muscle Strength and Endurance Study) (ESRU., 2014). The study used 76 HIV positive and 84 HIV negative children. A sample of 31 children per group was then calculated for this study to detect an effect size of 20 metres (m) assuming a standard deviation (SD) of 25m. This gave 90% power and allowed for a dropout rate of 20%. Confidence interval: ±7.14 for the average distance.

Inclusion Criteria

- HIV-infected children aged between seven (and 0 months) through nine years (and 11 months) old, who are receiving care at the Empilweni Clinic at RMMCH.
- Children who had been on ART for a period of at least 12 months and who were virally suppressed (previous two successive viral load results < 1000 copies/mL, six months apart).

Exclusion Criteria

- Children whose legal guardian did not provide informed consent. Children with sufficient mental capacity to provide assent, but did not provide assent.
- Children who were ill when presenting to the clinic i.e. had a pyrexia of >38°C, or a respiratory rate >24 breaths/minute, or SpO_2 level <90%.
- Children who were unable to walk unaided.
- Children with physical disability.
- Children who were unable to competently complete each of the exercises as part of the exercise programme.

3.2.4 Outcome Measures

- Six Minute Walk Test

A quiet corridor outside of the Empilweni clinic was used to conduct the 6MWT; the surface of this corridor was hard and flat. A 30m stretch was clearly marked using two orange cones. It was explained to participants that the aim of the test was to walk as many times as possible between the two cones within a timed period of six minutes. The guidelines set out by the American Thoracic Society (ATS) 2002 (appendix V) were used to conduct the 6MWT (Travis et al., 2002). SpO_2, BP and HR pre- and post-test were measured by the investigator. BP and HR were recorded using a digital electronic sphygmomanometer (Omron Professional Blood Pressure Monitor, model: HBP-1300). A pulse oximeter (Folee, Pulse Oximeter, model: FXY-A01) was used to measure SpO_2. Baseline and 12 week follow-up measurements were recorded on the participant's data collection sheet (appendix

IV). The test was timed using a cell phone timer (Samsung J5 Prime). A standard measuring tape was used to measure the remaining distanced walked between the two cones once the 6MWT was completed and the test was stopped.

- Anthropometric Measurements

As discussed with the head of the Empilweni Clinic, the participant's weight and height were recorded on the participant's data collection sheet (appendix IV) from the participant's clinic file. BMI was then calculated using the participants weight in kilograms and dividing it by the square of their height in meters (Bae et al., 2008). BMI was calculated at the baseline and follow- up visit. This was recorded at both visits in order to see if the HEP had an influence on BMI over the 12 week period.

- Immunology and Virology

The two consecutive measures of $CD4^{+}$-T cell count and viral load were obtained from the participant's clinic file and recorded on the data collection sheet (appendix IV) for each participant. 13 participants were excluded from the study as their HIV viral load results were above 1000 copies/ml.

3.2.5 Procedure

- **Consent**

Study procedures were carried out on a Tuesday and Thursday - the days on which the target age group were at the Empilweni clinic. Patients generally visited every three or six months depending on the doctor's discretion. Patients have their height and weight measured, blood results taken (to track changes in immunology) and general check up with the doctors and renewal of medical prescriptions done at these visits. All patients that attended the clinic on those days were given an opportunity to participate in the study.

The study was explained by the investigator to a group of parents/legal guardians and children present at the Empilweni Clinic waiting area and a request for participation was made. Once parents/legal guardians expressed interest in the study and had given verbal consent to allow their child to participate in the study, the parents/legal guardians were each given a consent form to read (appendix III a). The study was then discussed with individual parents/legal guardians and the consent form was signed together with the investigator. Screening was done to see if the child met the inclusion criteria. The parents were asked if the child was able to successfully complete each of the exercises in the programme- if the parent was unsure, the child was asked to demonstrate the exercise. If the child met the inclusion criteria s/he was given an assent form which was explained and signed together with the child, if the child was over the age of eight years (appendix III b). Once consent and assent had been obtained, the child and the parent/ legal guardian were taken to the prepared testing area to begin testing.

- **Immunology, Virology and Anthropometric Data**

Data was recorded from the patient's file before they were taken to the testing area. Blood tests are done for patients at their first visit to the Empilweni clinic. Follow-up tests are conducted according to the National Department of Health HIV Management Guidelines (Benson et al., 2009), or at the doctor's discretion. $CD4^{+}$-T cell count, viral load, height and weight values were all recorded prior to testing the participant.

- **Vital Signs**

Once taken to the testing area, the participant was asked to sit in a chair and wait for five minutes before baseline vitals were taken. It was required that jackets/jerseys be removed by the participant before testing. The BP cuff was placed on the participant's left upper arm and the pulse oximeter was placed on the participant's right index finger. A reading book was given to the participant to read through while waiting for time to lapse between testing time points. These measurements were repeated immediately after the 6MWT and five minutes post-test. This was done at

the baseline and 12 week follow-up assessment. Two separate data collection sheets were used.

- **Six Minute Walk Test**

. The walk test was demonstrated by the investigator depicting how the participant needed to turn around when reaching the cone. Only standard phrases were used to encourage the participant. Each completed lap (walking from the starting position to the opposite cone and back to the starting position) was marked on the data collection sheet (appendix IV).

- **Allocation**

The participants were then randomly divided into an intervention and control group using the random number table method, with a random number table downloaded from Google (Transtutor, 2015). Participants picked a small piece of paper with a number on it from an envelope which was then matched to the random number on the table to determine the group they would be allocated to.

- **Exercise Intervention**

After baseline data had been collected, each exercise of the HEP was demonstrated to the participants in the intervention group. This was done by the investigator in the same corridor where the 6MWT took place. A small gym mat (1m x 1m) was used to demonstrate and carry out the floor exercise. Each participant was asked to do each of the exercises as they would be doing it at home to ensure that the participant was doing the exercise correctly. The number of repetitions done was the same as during the first week of the HEP. Exercise progression increased weekly by two repetitions per exercise as validated by the Nominal Group. The number of repetitions that needed to be done per exercise was clearly stipulated in the exercise booklet, above the weekly exercise checklists. The parent/legal guardian was asked to monitor the child while doing the exercises.

Exercise checklists (appendix VI) and an information sheet (appendix VII) was explained and given to the parent/legal guardian and their child. The exercise checklists were pasted into an A5 booklet which was covered in appealing colourful paper (appendix VIII). The time when exercises were to be done, possible alternative times to do the exercises (if necessary), how often exercises were to be done and how many repetitions of each exercise were to be done, were documented in the booklet and clarified. The booklet allowed participants to comment on whether they took breaks or not and if they were unable to do exercises for the day (appendix VIII).

Keeping a health diary can decrease bias by allowing the individual to report mood, symptoms and health behaviours as they happen (Baigis et al., 2002). Based on this literature, the participants were asked to write comments on how they felt about the exercise programme at the back of the exercise booklet. When participants came for their follow- up appointments they were asked together with their caregiver what they thought about the exercise programme. A standard question was asked to all the participants and their caregivers in the intervention group; 'what did you think about the exercise programme?' The feedback was voice recorded and transcribed verbatim.

Participants in the control group were asked to continue with their usual lifestyle and make no new additional changes within the 12 week period. The next follow-up date with the doctor at the Empilweni Clinic was recorded for participants in both groups. All the parents/legal guardians and participants were told that they would be seen again on this date by the investigator. If participants were unable to return to the hospital on this follow-up date or if they phoned the clinic to reschedule their date, a new date was set with the participant. The participant's caregiver was reimbursed for their travelling costs.

The length of the programme was indicated to the parent/legal guardian (12 weeks). Within the set interval the investigator contacted each of the participant's parent/legal guardian in the intervention group via a phone call (if the investigator was unable to

get through via phone calls an SMS was sent). The parent/ legal guardian was contacted to remind them to follow the HEP with their child. Parents/legal guardians of participants in the control group were contacted every week for the last three weeks of the programme to remind them about their follow- up date. Phone calls/ SMS's were sent out on every Monday afternoon within the 12 week period. At the follow-up date, the procedures carried out for the 6MWT were the same as those conducted at the baseline visit.

The HEP (appendix VII) which was given to the participants in the intervention group was named 'The Super Lion Programme'. The programme included elements of pretend play where the participant pretended to be a lion while doing each exercise. The programme consisted of five different exercises, one strengthening and four cardiovascular exercises. All exercises needed to be done three times a week. Each participant in the intervention group was given a 20cm soft ball and a 2m long skipping rope to use for their exercises.

3.2.6 Ethical Consideration

Written informed consent from the parent/legal guardian was required for the child to be included in the study (appendix III a). An assent form attached to the information sheet was given to each child with the sufficient mental capacity to provide assent. Assent needed to be signed before the child became a participant in the study (appendix III b).Participants allocated to the control group were informed that they would be given a copy of the HEP at the end of the study if it was shown to increase exercise endurance.

3.2.7 Data Analysis

Data was analysed using an intention to treat analysis. Baseline results were carried forward to compensate for missing data from participants who did not arrive for their follow-up appointment. Participants who were enrolled into the study and randomly allocated to a group were included in the analysis and were analysed in the group to

which they were randomised. All participants who were enrolled as part of this study were analysed regardless of whether the participant completed their involvement in the study or not.

Statisticians from the Health Sciences Research Unit at the University of the Witwatersrand were consulted. Data was analysed and presented using Microsoft excel 2010 and SPSS (version 25). A similar study looking at the difference in endurance between two groups, HIV uninfected and infected school children, was sourced as an example to present data in this current study (Walker, 2015).

- Demographic information was analysed using descriptive statistics, mean, standard deviation, percentage and range,
- Anthropometric data was analysed using descriptive statistics, mean and standard deviation. The two groups were compared using an independent sample t-test.
- Immunological and virological data was presented using descriptive statistics, mean and range.
- Cardiovascular data was analysed using descriptive statistics, mean and standard deviation. The two groups were compared using an independent sample t-test.
- A multivariate analysis of variance (MANOVA) test was used to determine differences between groups, different time points and gender against different variables- BP, HR and SpO_2.
- A univariate analysis was performed to test differences in 6MWD measurements based on the dependent variables of group and gender.
- Descriptive statistics were used to analyse 6MWD at baseline and again at follow- up, including mean, maximum, minimum and SD values.
- An independent sample t-test was used to compare the baseline and follow-up 6MWD for each group.
- A Line graph was used to depict data for the 6MWD between groups at baseline and follow-up.

- An independent sample t-test were used to compare the 6MWD between the two groups at baseline and again at follow- up.
- The level of significance for all statistical tests was set at 0.05.
- Adherence to the HEP was analysed using descriptive statistics such as numbers and percentages.
- Qualitative data regarding feedback from the HEP was analysed by transcribing recorded discussions to provide contextual data on the components of the HEP that were important to the caregivers and participants in the intervention group. This was carried out in a similar manner as a study conducted by (Corner et al., 2007).

Reference ranges used to analyse data are presented below;

- Body Mass Index (BMI) - A graph was used to determine the expected normal BMI showing ranges from underweight to obese. This graph was taken from: https://kidshealth.org/en/parents/bmi-charts.html. Using the average age of all participants (8.5years), the average BMI was 15.45. See CHAPTER 4: RESULTS, page 57 for graph.

- HR - normal values for children between six through 12 years for resting HR ranges from 60-95 beats per minute (bpm) (appendix III c).

- Maximum HR - calculated using 208 — 0.7(age) equation (Mahon et al., 2010). See CHAPTER 5: DISCUSSION, page 84 for the explanation on calculating maximum HR.

- BP - normal values for children between the ages of seven through nine are different for males and females and are dependent on age and height (www.nhlbi.nih.gov). The average age of all participants (eight years) and height (1.27m) were used. The normal values for BP in males (the average BP is given by the 50th centile for height and age) are 99-123 mmHg for

systolic BP and 59-86 mmHg for diastolic BP. In females the normal values (on the 50th centile for height and age) for BP are 98- 122 mmHg for systolic BP and 58- 83 mmHg for diastolic BP. These values were taken from: (https://www.nhlbi.nih.gov/files/docs/guidelines/child_tbl.pdf). See appendix III d for the full BP chart.

- SpO_2 - this value is altitude dependent and also dependent on the time of day when measured (Fouzas et al., 2011). High altitude is often reported to start at 2400m above sea level (Gharib et al., 2014). Lower than 1000m above sea level is considered a low altitude (https://en.wikipedia.org/wiki/List_of_elevation_extremes_by_country). Johannesburg with an altitude of 1753m is considered to have a moderate altitude (Abiye et al., 2011). See chart in CHAPTER 4: RESULTS, page 64 showing that the expected $Sp0_2$ of a child living in Johannesburg during the day should range from 94-96%.

- 6MWD (m) - was the main outcome which was measured. A reference value was calculated using the following equation;

  6MWD (m) = 4.63 x height (cm) - 3.53 x weight (kg) + 10.42 x age (years) + 56.32 (Saad et al., 2009).

CHAPTER 4: RESULTS

This chapter presents the results of this study.

4.1 Phase I

4.1.1 Literature Review: Exercise Programmes

A scoping review of literature was done in order to determine the specific details of exercise programmes that have been used in studies previously. A broad age range was used to detect differences in exercise programmes for different age groups. 52 articles were reviewed for eligibility. 43 articles did not meet the inclusion criteria. Studies were done on the adult population (12), studies were done on children with disability (2), no details of exercise intervention included (13) and articles were a review of literature (16). Nine articles met the inclusion criteria. Only one appropriate study was found including children with HIV. The main findings from the articles were summarised to include; title of the article, author, year of publication, country, sample size, age of participants, details of programme and the outcome of the exercise intervention. Articles have been arranged in chronological order. Table 4.1 presents a summary of different exercise programmes that have been successfully carried out.

Table 4.1 The details and results of different exercise programmes.

Title of Article	Author	Year of Publication	Country	Sample Size	Age of participants	Details of the programme	Outcome
Improvement of Early Vascular Changes and Cardiovascular Risk Factors in Obese Children After a Six-Month Exercise Program	Meyer et al.	2006	America	67	12-16 years	Six months long. Exercises done for one hour, three times a week.	Restored endothelial function and improved cardiovascular risk profile.
Impact of a School-Based Physical Activity Intervention on Fitness and Bone in Adolescent Females.	Schneider et al.	2007	Los Angeles	122	16-18 years	12 weeks long. Exercises were done three times a week for 60 minutes per session.	Increased physical activity, (VO2peak). Improvements in cardiovascular fitness. Increased bone mineral content.
Feasibility and Effectiveness of anaerobic Exercise	Stephens et al.	2008	Canada	30	8-18 years	12 weeks long.	Increased physical function and QoL.

Program in children with fibromyalgia: results of a randomised controlled pilot trial.						Exercise done three times a week.	Decreased pain.
Effects of a 12 week training programme on aerobic fitness, body composition, blood lipids and c-reactive protein in adolescents with obesity.	Wong et al.	2008	Singapore	24	13-14 years	12 weeks long. Exercise done twice a week.	Improved endurance. Improved QoL.
Effect of Increased Exercise in School Children on Physical Fitness and Endothelial Progenitor Cells A Prospective Randomized Trial	Walther	2009	Germany	182	10-12 years	12 months long. Physical activity done for 45 minutes per day for five days a week, of which 15 minutes was endurance training.	Increased physical fitness (VO_2max). Increase in circulating progenitor cells, Improved BMI measurement. Improved motor ability
A 12 week aerobic exercise program reduces hepatic fat accumulation and insulin resistance in	Heijden et al.	2010	United Stes of America	29	15 years	12 weeks long. Exercise done four times a	Decreased hepatic and visceral fat accumulation.

obese, Hispanic adolescence.						week.	Decreased insulin resistance.
The Effects of an Exercise Program on Anthropometric, Metabolic, and Cardiovascular Parameters in Obese Children.	Lee et al.	2010	Korea	54	12-14 years	10 weeks long. Exercise was done three times a week for 60 minutes per session.	Low density lipoprotein-cholesterol, waist circumference, and systolic BP decreased significantly in the aerobic exercise group compared to the control group.
The Effect of a Structured Exercise Program on Nutrition and Fitness Outcomes in Human Immunodeficiency Virus-Infected Children	Miller et al.	2010	Miami	12	6-18 years	Six weeks long Exercises were done four times a week. Each session was one and a half hours long. Each session consisted of warm-up and stretching (15 min), aerobic exercises (25 min), resistance training (25 min), and	Increased muscle endurance, relative peak VO2, and lean body mass.

						cool- down and stretching (10 min).	
Study protocol: a randomized controlled trial study ón the effect of a game-based exercise training program on promoting physical fitness and mental health in children with autism spectrum disorder	Yu et al.	2018	Hong Kong	112	4-6 years	16 weeks long. Two sessions were done per week. Each session was one hour long. Six to eight stations were set up and children were instructed to finish the exercises in all stations one after another in a fixed order.	Improved engagement in sport activities. Improved relationship between mental and physical health.

Table 4.1 shows that most studies used a 12 week long programme. The frequency of exercise per week ranged from twice a week to five times a week with three times a week being the average. The American College of Sports and Medicine in 2013 recommended that exercise be done at least three times a week to be effective. However, for patients with acute or chronic infectious diseases, exercise is often contra-indicated until the condition is stable. The risk-benefit ratio will need to be evaluated before exercise can commence (American College of Sports Medicine, 2013). Extra care and attention should be taken with the assessment and treatment of patients with chronic diseases. For example; a patient who has cardiovascular disease needs to be carefully monitored during physiological testing. The side effects of the medication being taken need to be considered when looking at the response to exercise (Warburton et al., 2006).

Programmes that are developed with the aim of sharing knowledge and skills with mothers of children infected with HIV, in an attempt to promote the child's development within resource constrained families, have been proven to be effective (Engle et al., 2007). A well-structured exercise programme should be utilised as medical treatment in patients with HIV. These exercise programmes will be most effective if they are individualised and based on the functional capacity and symptoms of each patient (Spierer et al., 2007). It is crucial for the physiotherapist to monitor patients with HIV while carrying out an exercise programme as it is important to monitor alterations in the patient's health status. Adverse events during exercise could occur especially in patients with an advanced stage of immunosuppression (Castellani et al., 2006). The research above was used to form the basic structure of the HEP (appendix II i) that was reviewed by the Nominal Group participants.

- Development of the HEP

Using the design of previous studies and literature reviewed the HEP was designed. A 12 week programme done three times a week was chosen as this was found to be the most frequently occurring length and frequency of an exercise programme. Therefore this exercise programme consisted of 36 exercise sessions. As modified basketball, soccer, running activities, stair climbing and walking exercises were most

commonly used in exercise programmes the following exercises were chosen to make up the exercise programme used in this study- throwing a ball against the wall, skipping and jumping jacks. Since strengthening exercise is also known to improve exercise endurance sit-ups and wall squats were also added. Skipping can also be considered a strengthening exercise (Carter et al., 2003). Since equipment such as bicycle ergometers or treadmills result in a lack of motivation from children, a ball and a skipping was chosen as equipment to be used in the HEP. The exercise programme would be expected to take 20 minutes long to complete- from week one. This was decided as the length of exercise programmes ranged from 15-60 minutes long.

4.1.2 Nominal Group: Loss to follow-up

All participants who had committed to participating in the Nominal Group attended the scheduled session. All participants completed step 4 of the NGT via email.

4.1.3 Nominal Group: Demographic Data

Of the 25 health care professionals that were sourced out, 16 could be reached telephonically. Nine of the 16 health care professionals agreed verbally to partake in the Nominal Group session and were formally invited. Four could not attend due to unavailability. Demographic data was recorded from a form that each participant completed on the day of the group meeting. Only one Nominal Group Meeting was held. Table 4.2 provides demographic information of the participants that attended the Nominal Group Meeting.

Table 4.2 Demographics of participants attending the Nominal Group Session.

Participant Number	Gender	Age (Years)	Professional	Years of experience
1	Female	39	Physiotherapist	17
2	Female	36	Physiotherapist	14
3	Female	31	Occupational Therapist	8
4	Female	50	Paediatric Neurologist	15
5	Female	29	Enrolled Nurse	5

Table 4.2 shows that all participants were female between the ages 29-50 years. Four different health professions were represented. The number of years of experience working with paediatrics that the participants had since qualifying ranged from 5-17years.

4.1.4 Nominal Group Technique Analysis

In steps 1-3 a number of different suggestions were mentioned by participants during the group meeting and these were categorised into nine common themes. The themes were; age range, exclusion criteria, involving family, strength versus endurance exercise, repetitions, appeal to children, combination of exercise, including weekends and exercise as ADLs.

Table 4.3 presents the five most important suggestions as a result of the Nominal Group evaluation (Step 5) in order of priority:

Table 4.3 Ranking of suggestions from the Nominal Group evaluation.

Ranking Order	Suggestion	Score
1	Children at the age of five will not be able to do the exercises that a nine year old would be able to do. Rather use ages seven through nine.	24
2	Add in exclusion criteria - children who are unable to perform the exercise.	17
3	Let the parents involve the siblings in the exercises to improve patient compliance to the HEP.	9
4	The HEP should be given a trendy name and a theme to appeal to children.	7
5	Repetitions should be as few as possible. Start with ten repetitions and increase.	6

The above table shows the five most important areas as suggested by the participants attending the Nominal Group, in order of priority. The highest priority was the age range and the lowest priority was the repetitions.

4.1.5 Thematic Analysis

The most commonly occurring theme was; 'age range'. Other themes that emerged were; exercise complexity, compliance to the programme and appeal to children.

- Theme 1: Age Range

It was suggested that the age range was too wide (five through nine years). All participants agreed that the exercises would be too difficult for five year olds to do. For example; skipping, wall squats and sit-ups. It was suggested that the exercises were more appropriate for children between the ages of seven through nine years old. '*You should just keep it between seven to nine otherwise it becomes two separate studies with two different groups*,' from participant 3. '*The compliance will*

be better with a seven to nine year old and will be more motivated,' was also mentioned by participant 3.

- Theme 2: Exercise Complexity

'*Children with HIV may present with gross motor developmental delayed and struggle with coordination, resulting in exercises not being done properly and this would be an incorrect representation of their endurance levels'*, was mentioned by participant 1. However, the group decided that skipping should remain part of the exercise programme as it is an efficient endurance exercise. It was suggested that the repetitions should be kept to a minimum, starting in the first week with ten repetitions and then progressing. Progression is vital in improving muscular endurance (Kisner et al., 2017). Due to space limitations in the patient's home environment, the group agreed that jogging on the spot would be more appropriate than running laps - to replace wall squats. *'The wall squats are more like strengthening and not cardio,'* came from Participant 2. It was suggested that the order in which the exercises are done should be changed so that the strengthening exercises are performed in between the cardiovascular exercises. Strengthening exercises were; sit- ups and skipping.

- Theme 3: Compliance to programme

Some of the important suggestions that were related to compliance with the HEP were; involving siblings in the study, including weekends as days in which exercises should be done and making exercises part of ADLs.

'*I just think also, umm I know that it's not part of your programme to include siblings but also the child might ask but why do I have to do it and they* (siblings) *don't have to do it? Others might say but why can't I also do it? It's not, it's not really involving it but I think if they do want to be involved, is it gonna change your programme?*' said by participant 5. *'Including weekends as well, coz I'm just trying to think maybe it'll be more time with the other two days 'cause on the weekend like imagine now a child goes to school and say my kid finishes school at like five, I fetch them at, half past five from after care, we get home and it's bathing and it's eating, it's homework and by the time they are done that it's around eight*' from Participant 1.

- Theme 4: Appeal to Children

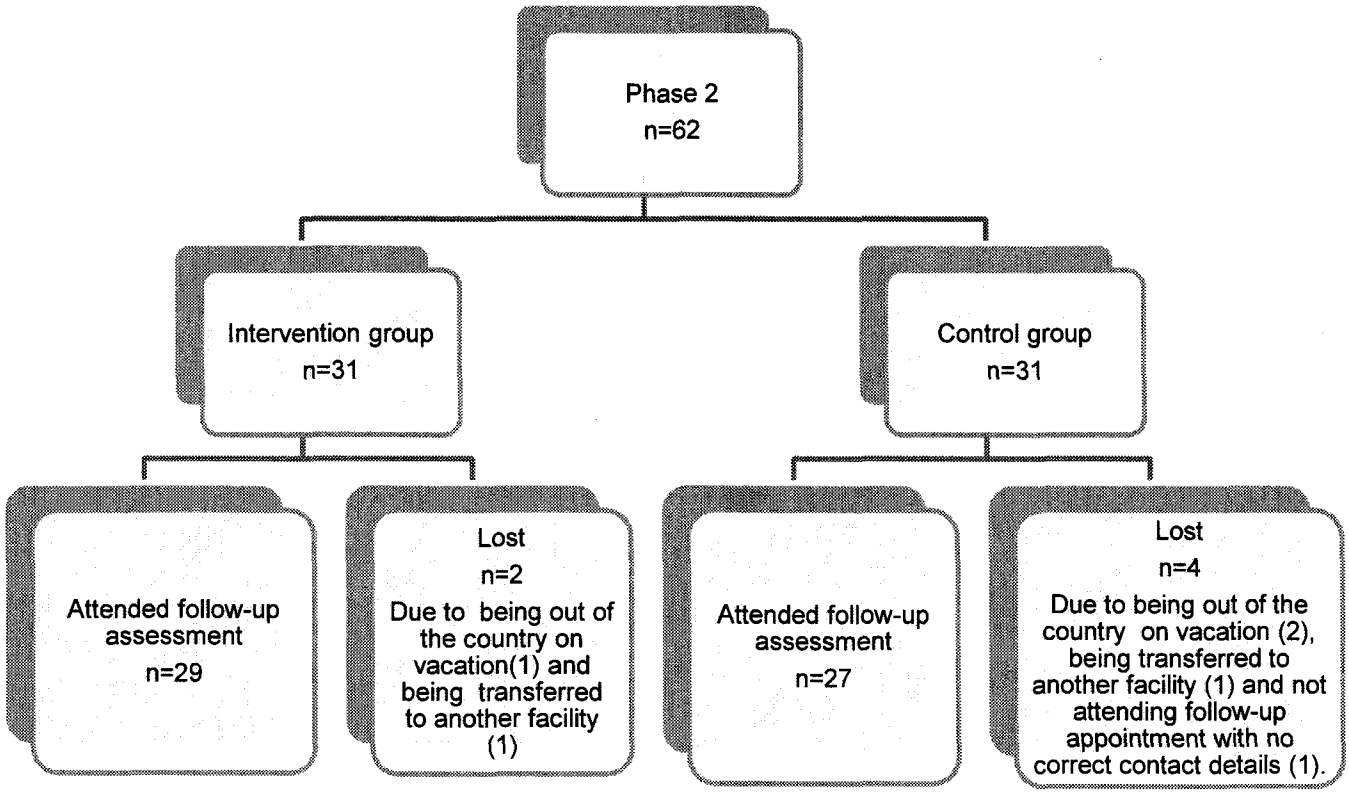
Participant 3 suggested *'I think you may need to add in an element of pretend play. Why do they have to do a sit- up? What's the point?'* It was suggested that the programme should be given a trendy name and a theme. *'The other thing is, your whole study, does it have a funky name? You can give it a cute name that the participants enjoy'* mentioned by Participant 4. *'Strong me, stronger me, super me, whatever,'* comment made by Participant 4.

It is was brought up whether skipping was appropriate for girls and boys, the group concluded that skipping is appropriate for both genders as the gym culture promotes skipping for both male and female sport groups. The group was happy with the length of the programme (12 weeks) and the frequency of the exercises (three times a week).

4.2 Phase II

4.2.1 Loss to follow-up

In phase II, 62 participants between the ages of seven through nine years were recruited. Of these participants, 31 were randomised to the intervention group and 31 to the control group. 6 participants (9.7%) were lost to follow-up. Figure 4.1 shows the attrition in each group.



Total loss to follow-up

N=6

Due to:

- Out of the country on vacation (3)
- Transferred to another facility (2)
- Not attending follow-up appoint and no contact details (1)

Figure 4.1 Flow diagram showing study attrition.

Three participants were unable to attend the follow-up date as their families were still out of the country on vacation at the time of follow-up. Their clinic appointments were rescheduled to a later stage (after the 12 week period) and therefore could not be followed up as part of this study. Two participants were referred to a facility closer to their home and were unable to come back to RMMCH for a follow-up appointment, even with transport cost reimbursement. One participant missed their follow-up appointment and could not be contacted as the caregiver's phone number provided did not work. There was also no response to SMS, and this participant did not return to the Empilweni clinic during the follow-up period. More of the participants that missed their follow-up appointment were in the control group.

4.2.2 Demographic Data

Demographic data in phase II of this study was collected from the participant's clinic file and was recorded on the day of their visit. Data is represented using numbers, means, SD or percentages for parametric data. The age and gender are discussed below.

- Age

The mean age of participants in the control group was 8 years and 4 months, SD= 9.91 months. The mean age of participants in the intervention group was 8 years and 9 months, SD= 8.2 months. There was an equal age distribution between the two groups. No significant difference in mean age between groups was found ($p>0.05$).

- Gender

There were 26 (42%) males and 36 (58%) females in the total sample. The intervention group consisted of 13 (42%) males and 18 (58%) females, this was the same for the control group. Therefore, the two groups were equally matched in terms of gender.

4.2.3 Anthropometric Data

Anthropometric data was measured at baseline and at the 12 week follow-up visit. This was recorded from the participant's clinic file and was recorded on the day of their visit. Descriptive statistics were used to analyse data- mean and standard deviation. An independent sample t-test was used to compare the two groups. This data is presented in the tables 4.4 (baseline and follow- up). Data is represented using mean and SD.

Table 4.4 Comparison of Anthropometric data at baseline and follow- up.

Baseline				
	Variable	Group	Mean (SD)	p-value
	Height (m)	Control (N= 31)	1.25 (0.07)	0.12
		Intervention (N= 31)	1.27 (0.07)	
	Weight (kg)	Control	23.95(4.26)	0.49
		Intervention	24.81 (5.35)	
	BMI	Control	15.44 (2)	0.99
		Intervention	15.43 (2.48)	
Follow-Up				
	Height (m)	Control (N=31)	1.28 (0.07)	0.24
		Intervention (N=31)	1.26 (0.07)	
	Weight (kg)	Control	25.24 (5.32)	0.826
		Intervention	24.90 (6.23)	
	BMI	Control	15.46 (1.88)	0.986
		Intervention	15.46 (2.78)	

The data in table 4.4 above shows that there were no significant differences in height, weight or BMI between the control and intervention group (p-value > 0.05 for all values) at baseline.

The data in table 4.4 shows that there were no significant differences in height, weight or BMI between the control and intervention group (p-value > 0.05 for all values) at the 12 week follow-up visit. When the baseline and follow- up data are

compared, it can be seen that the control group did have an increase in mean weight of 1.29kg over the 12 week period while the intervention group showed a mean increase of 0.09kg over the same time period.

Figure 4.2, below shows the expected BMI range for individuals between the ages of two through 20 years. The star that has been added to the figure represents the average BMI for the average age of all participants and represents the average for baseline and follow-up measurements.

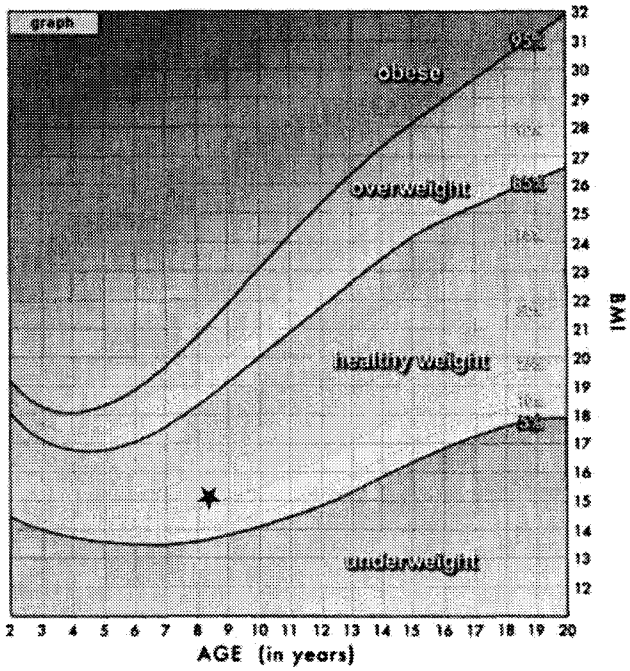


Figure 4.2 The ranges of BMI*

Average Age: 8.5years, BMI 15.45

(*Reference: https://kidshealth.org/en/parents/bmi-charts.html)

The average BMI for age at baseline and follow-up was within a healthy weight range according to figure 4.2.

4.2.4 Immunological and Virological Data

$CD4^+$T-cell count and viral load measurements were only recorded at baseline. These measurements were taken at varied times and not all participants had a recent

blood count taken before follow-up. The average $CD4^{+}$T-cell count of all participants at baseline was 1417/mm^3 and ranged from 592/mm^3 to 3138/mm^3.

The average viral load was 86 copies/ml and ranged from 20 copies/ml to 944 copies/ml.

4.2.5 Cardiovascular data

Cardiovascular data was measured at baseline and at the 12 week follow-up visit.

Cardiovascular data was recorded at three different intervals (pre-test, immediately post-test and five minutes post-test) relating to the 6MWT. Descriptive statistics were used to analyse data- mean and standard deviation. An independent sample t-test was used to compare the two groups. This data is presented in the tables below.

Table 4.5 HR data during the 6MWT at baseline and follow- up.

Baseline				
Testing point	Variable	Intervention Group n=31	Control Group n=31	p-value
		Mean (SD)	**Mean (SD)**	
Pre-test				
	HR (Bpm)	84 (13.58)	84 (14.81)	0.749
	Male	81 (9.01)	82 (15.89)	0.607
	Female	86 (16.72)	86 (14.24)	0.656
Immediate Post-test				
	HR (Bpm)	93 (15.02)	90 (13)	0.565
	Male	91 (10.23)	87 (14.66)	0.869
	Female	95 (17.86)	92 (11.51)	0.456
5 minutes Post-test				
	HR (Bpm)	91 (19.4)	93 (15.8)	0.422
	Male	86 (14.29)	85 (16.08)	0.420

	Female	93 (22.89)	89 (15.98)	0.719
Follow- Up				
Pre-test				
	HR (bpm)	88 (11.86)	85 (13.68)	0.450
	Male	86 (11.39)	85 (11.24)	0.671
	Female	87 (15.58)	89 (14.92)	0.473
Immediate Post-test				
	HR (bpm)	93 (9.92)	93 (18.03)	0.962
	Male	91(15.74)	92 (15.85)	0.656
	Female	99 (7.38)	93 (18.39)	0.264
5 minutes Post-test				
	HR (bpm)	88 (14.95)	84 (15.38)	0.195
	Male	82 (15.62)	81 (18.04)	0.64
	Female	87 (11.64)	87 (14.12)	0.97

The normal range of resting HR for children between the ages of seven through 12 years is 60 - 95 bpm (Santillanes, 2008). The baseline resting HR measurements of all participants (pre-test point) was within the normal range. The average resting HR of all participants five minutes post-test was also within the normal range. At baseline, the average HR increased from the pre-test time point to the immediate post-test time point in both groups. It can also be seen that the average HR then dropped from the immediate post-test time point to the five minute post-test time point in both groups, but did not return to pre-test values. There were no statistically significant differences between the two groups' HR at all three time points. The HR values immediately post-test for baseline seen in table 4.5 will be discussed in the next chapter of this study, page 84.

At the 12 week follow-up visit, the average resting HR at the pre-test interval of all participants was within the normal range. The average HR five minutes post-test was also within the normal range for all participants. Females' HR was higher than males' HR over all three intervals, seen in table 4.5. At follow-up the average HR increased between the pre-test point and immediate post-test point in both groups. It can also

be seen that the average HR then dropped between immediate post-test and five minutes post-test in both groups. There were no statistically significant differences between the two groups' HR at all three time points. The HR values immediately post-test for follow-up seen in table 4.5 will be discussed in the next chapter of this study, page 84.

Table 4.6 Blood Pressure data during the 6MWT at baseline and follow- up.

Baseline				
Testing point	Variable	Intervention Group n=31	Control Group n=31	p-value
		Mean (SD)	**Mean (SD)**	
Pre- test				
	BP (mmHg)			
	Systolic	116.39 (19.35)	117.39 (18.54)	0.905
	Male	122 (25.36)	117 (14.72)	0.748
	Female	114 (13.3)	116.94 (19.74)	0.282
	Diastolic	78.84 (24.38)	75.09 (15.44)	0.299
	Male	80.15 (26.36)	81.5 (20.96)	0.935
	Female	76.21 (20.36)	72.12 (14.31)	0.246
Immediate Post- test				
	Systolic	115 (13.31)	119 (16.1)	0.409
	Male	114.15 (17.6)	113.5 (17.52)	0.853
	Female	116.5 (9.54)	123.53 (14.38)	0.112
	Diastolic	75.16 (10.57)	82.4 (13.75)	0.571
	Male	75.77 (12.04)	76 (9.17)	0.589
	Female	74.86 (9.73)	86.59 (15.31)	0.174
	Systolic	115 (13.31)	119 (16.1)	0.409
	Male	114.15 (17.6)	113.5 (17.52)	0.853
	Female	116.5 (9.54)	123.53 (14.38)	0.112
	Diastolic	75.16 (10.57)	82.4 (13.75)	0.571

	Male	75.77 (12.04)	76 (9.17)	0.589
	Female	74.86 (9.73)	86.59 (15.31)	0.174
Five minutes post- test				
	Systolic	115.21 (18.75)	109.73 (13.67)	0.648
	Male	115.92 (20.4)	111.75 (13.02)	**0.008**
	Female	114.85 (18.39)	107.35 (14.23)	**0.01**
	Diastolic	78.21 (17.25)	76.87 (13.24)	0.083
	Male	75.09 (17.3)	75.67 (15.43)	0.977
	Female	80.74 (16.66)	77 (11.6)	0.381
Follow- Up				
Pre-test				
	Systolic	112.96 (14.59)	113.93 (14.55)	0.645
	Male	114 (9.84)	115.09 (13.38)	0.883
	Female	109.72 (13.04)	111.67 (15.41)	0.232
	Diastolic	74.18 (12.91)	73.82 (12.37)	0.643
	Male	72.73 (16.02)	78 (16.96)	0.083
	Female	76.28 (11.67)	68.67 (5.23)	0.064
Immediate Post- Test				
	Systolic	113.37 (12.90)	115.41 (15.53)	0.531
	Male	115.91 (11.51)	114.89 (15.89)	0.786
	Female	111 (14.31)	115.27 (16.16)	0.218
	Diastolic	76.79 (10.58)	76.14 (9.53)	0.406
	Male	82.45 (17.62)	75.91 (10.82)	**0.03**
	Female	73.84 (8.64)	77.26 (8.78)	**0.02**
Five Minutes Post- Test				
	Systolic	107.27 (12.64)	111.35 (13.69)	0.578
	Male	109.18 (9.7)	112.79 (11.79)	0.6
	Female	105.35 (14.17)	109.33 (14.85)	**0.01**
	Diastolic	74.17 (8.1)	73.31 (12.28)	0.645
	Male	73 (7.92)	72.09 (10.61)	0.56
	Female	75.02 (10.61)	75.45 (14.47)	0.87

- Systolic Blood Pressure

The normal values for children between the ages of seven through nine are different for males and females and dependent on age and height (www.nhlbi.nih.gov). Using the average age of all participants (eight years) and height (1.27m), the normal values for systolic BP in males (the average BP is given by the 50th centile for height and age) are between 99 -123 mmHg. In females the normal values (on the 50th centile for height and age) for systolic BP are between 98 - 122 mmHg. (https://www.nhlbi.nih.gov/files/docs/guidelines/child_tbl.pdf). Data in table 4.6 shows that at baseline all systolic BP values for males and females over the three time points are within the normal range. An exception to this is seen in females in the control group who had a slightly increased systolic BP at the immediate post-test time point (mean 123.53 mmHg, SD 14.38). Table 4.6 also shows a statistically significant difference in systolic BP between males in the control and the intervention group at the five minutes post-test point at baseline (p=0.008). Males in the intervention group had a higher systolic BP at this time point. A statistically significant difference was also found between females in the control and the intervention group at the same time point (p=0.01). Females in the intervention group had a higher systolic BP at the five-minute post-test time point.

All systolic BP values for males and females over the three time points are within the normal range at follow- up. A statistically significant difference was seen in systolic BP between females in the control and the intervention group at the five minutes post-test point (p= 0.01) at follow-up, shown in table 4.6. Females in the control group had a significantly higher systolic BP at this time point.

- Diastolic BP

The normal values for children between the ages of seven through nine are different for males and females and are dependent on age and height (www.nhlbi.nih.gov). Using the average age of all participants (eight years) and height (1.27 m), the normal values for diastolic BP in males (the average BP is given by the 50th centile for height and age) 59 - 86 mmHg. In females the normal values (on the 50th centile for height and age) for diastolic BP are 58 - 83 mmHg. All diastolic BP values for

males and females over all three time points are within the normal range at baseline. An exception to this is seen in females of the control group at the immediate post-test point who had a higher than normal value at baseline. When the control and intervention group were compared at baseline, there were no statistically significant differences seen.

All diastolic BP values for males and females over all three time points are within the normal range at follow- up. When the control and intervention group were compared at follow-up, there was a statistically significant difference between males (p= 0.03) and females (P= 0.02) at the immediate post-test point. Males in the intervention group and females in the control group had the higher diastolic BP.

Table 4.7 Oxygen Saturation data during the 6MWT at baseline and follow- up.

Baseline				
Testing point	Variable	Intervention Group n=31	Control Group n=31	p-value
		Mean (SD)	**Mean (SD)**	
Pre- test				
	SATS (%)	95.13 (6.41)	97.23 (1.38)	0.538
Immediate Post- test				
	SATS (%)	95.45 (5.42)	96.87 (1.34)	0.611
Five minutes post- test				
	SATS (%)	95.43 (5.67)	96.97 (2.52)	0.692
Follow- Up				
Pre-test				
	SATS (%)	96.97 (1.27)	96.69 (1.44)	0.581
Immediate Post- Test				
	SATS (%)	98.82 (1.63)	97.43 (1.5)	0.56
Five Minutes Post- Test				
	SATS (%)	97.42 (1.26)	97.47 (1.39)	0.379

The peripheral capillary SpO_2 is an altitude and time dependent variable (Fouzas et al., 2011). High altitude is often reported to start at 2 400m above sea level (Gharib et al., 2014). Lower than 1000 m above sea level is considered a low altitude (https://en.wikipedia.org/wiki/List_of_elevation_extremes_by_country). Johannesburg with an altitude of 1753 m is considered to have a moderate altitude (Abiye et al., 2011). The figure 4.3 below shows the average normal values for SpO_2 in children living at different altitudes. The normal range of SpO2 for children living in Johannesburg during the daytime (participants were always assessed during the daytime) is between 94-96 %, which is highlighted with the bold line.

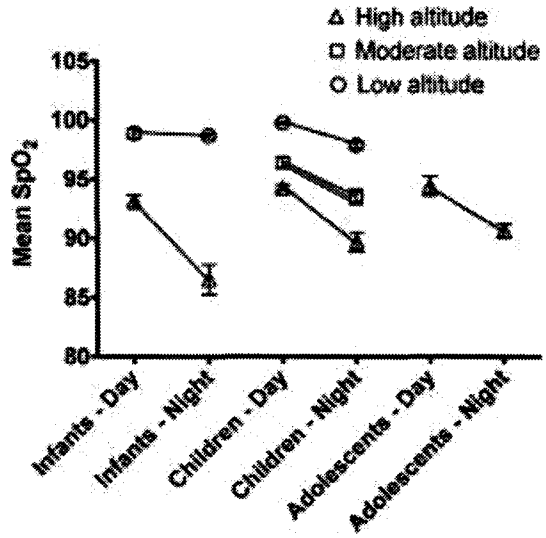


Figure 4.3. Normal ranges of SpO2 at different altitudes.

(Reference: https://academic.oup.com/sleep/article/39/5/1001/2454007)

The average SpO_2 over the three time points for participants in the intervention at baseline was within the normal expected range, seen in table 4.6. The average SpO_2 for participants in the control group at all three time points was above 96 % and ranged from 96, (87 %) to 97, (23 %). When the control and intervention group were compared at baseline, there were no statistically significant differences seen. The average SpO_2 increased between the pre-test and the immediate post-test interval at baseline, in the intervention group and decreased in the control group. Between the immediate post- test interval and five minutes post- test at baseline, the average SpO_2 decreased slightly in the intervention group and increased in the control group.

At follow-up visit, the average SpO_2 for all participants over the three time points was higher than the expected normal range, seen in table 4.7. These values ranged from 96.69% to 98.82%. When the control and intervention group were compared at follow-up, there were no statistically significant differences seen. Between the pre-test to the immediate post-test interval the average SpO_2 increased in the intervention and control group. Between the immediate post-test and five minutes post-test interval the average SpO_2 decreased in the intervention group and increased slightly in the control group, seen in table 4.7.

A MANOVA test was used to determine any statistical significance between groups, different time points and gender against the different variables that were tested relating to the 6MWT (BP, HR and SpO_2). This data is displayed in tables 4.8

Table 4.8 Differences in cardiovascular data at baseline and follow- up

Baseline		
Source	**Dependent Variable**	**p-value**
Group	Systolic BP (mmHg)	0.527
	Diastolic BP (mmHg)	0.854
	HR (bpm)	0.618
	SpO_2 (%)	**0.018**
Time	Systolic BP (mmHg)	0.289
	Diastolic BP (mmHg)	0.939
	HR (bpm)	**0.01**
	SpO_2 (%)	0.965
Gender	Systolic BP (mmHg)	0.787
	Diastolic BP (mmHg)	0.840
	HR (bpm)	0.182
	SpO_2 (%)	0.181

Follow- Up		
Source	**Dependent Variable**	**Significance**
Group	Systolic BP (mmHg)	0.378
	Diastolic BP (mmHg)	0.804
	HR (bpm)	0.680
	SpO_2 (%)	0.668
Time	Systolic BP (mmHg)	0.309
	Diastolic BP (mmHg)	0.464
	HR (bpm)	**0.024**
	SpO_2 (%)	0.148
Gender	Systolic BP (mmHg)	0.567
	Diastolic BP (mmHg)	0.734
	HR (bpm)	**0.003**
	SpO_2	0.720

Each source is commented on separately below from table 4.8 :

Group differences

Table 4.8 shows that when measures of systolic and diastolic BP, as well as HR between the two groups were compared at baseline (regardless of the time points) no statistical differences were found. However a statistical difference was found for $Sp0_2$ between the two groups at baseline ($p = 0.018$). The control group had a significantly higher average SpO_2 score compared to the intervention group at baseline, this can be seen in the data presented in table 4.7.

Table 4.8 shows that when measures of systolic and diastolic BP, as well as HR and SpO_2 between the two groups were compared at follow- up (regardless of the time points) no statistical differences were found.

Time point differences

Table 4.8 also shows that when measures of systolic and diastolic BP, as well as HR and SpO2 were measured at baseline (over all values for all participants regardless of group) and compared between the three different testing points it was found that the only statistical significance was found for HR changes over time (p= 0.01). Looking at the data in table 4.5, HR was significantly higher at the immediate post-test point than at any of the other two time points at baseline.

Table 4.8 also shows that measures of systolic and diastolic BP, as well as HR and SpO2 were compared at follow- up (over all values for all participants regardless of group). The result of the comparison between the three different testing points found that the only statistical significance was seen for HR changes over time (p=0.024). Looking at the data in table 4.5, HR was significantly higher at the immediate post-test point than at the pre-test and five minutes post-test point.

Gender differences

Table 4.8 also shows that measures of systolic and diastolic BP, as well as HR and SpO2 were compared at baseline (over all values for all participants regardless of group or time points). The comparison showed that between genders, no statistically significant differences were found.

Table 4.8 also shows that measures of systolic and diastolic BP, as well as HR and SpO2 were compared at follow- up (over all values for all participants regardless of group or time points). The comparison between genders, found that there was a statistically significant differences between the HR of the different genders (p=0.003). Females had a significantly higher HR compared to males, which can be seen when looking at data presented in table 4.5.

4.2.5.3. Baseline vs. Follow-up Cardiovascular Data

A multivariate analysis was used to determine the average measurements over the three time points between the baseline and 12 week follow-up visit, for both groups. Measurements at baseline and follow-up were compared in order to find significant differences. These outcomes are displayed in the table 4.9 below:

Table 4.9 A comparison of baseline and follow-up Cardiovascular Data.

Source	Dependent Variable	Significance
Baseline vs follow-up measurements	Systolic	0.116
	Diastolic	**0.038**
	HR	**0.049**
	SpO_2	**0.040**

Table 4.9 shows statistically significant differences in average diastolic BP, HR and SpO_2 measurements were found when baseline and follow-up measurements were compared ($p<0.05$). No statistically significant difference was found between the baseline and follow-up systolic BP measurements ($p>0.05$). The average HR was higher at baseline than at follow-up, seen in table 4.5. The average diastolic BP was higher at baseline, seen in table 4.6. The average SpO_2 measurements were higher at follow-up, seen in table 4.7.

4.2.6 Six Minute Walk Test

This was measured at baseline and at the 12 week follow-up visit. 6MWD was analysed using sample t-tests to find differences between the groups. A univariate analysis was performed to test differences in 6MWD measurements based on the dependent variables of group and gender. This data is presented in the tables 4.10 and 4.11 for baseline and 4.12 and 4.13 for the 12 week follow-up. Data is represented as means and SD. A Line graph was used to depict data for the 6MWD between groups at baseline and follow-up (figure 4.4).

The reference equation set out by Saad et al. (2009) was used to calculate the expected average 6MWD for all participants: 6MWD (m) = 4.63 x height (cm) - 3.53 x weight (kg) + 10.42 x age (years) + 56.32.

The average demographic results of all participants were used;

- Height= 127 cm
- Weight= 25.07 kg
- Age= 8.5 years

The expected average 6MWD was calculated as follows: 4.63 x 127 – 3.53 x 25.07 x 8.5 + 56.32 = 644.4 m.

All participants completed the 6MWT at baseline and at follow-up. Six participants took a break at baseline; to have their height and weight measurements recorded (3) and to sit down as they were feeling tired (3). Two participants took a break at the follow-up visit to sit down as they expressed that they felt tired.

Table 4.10 below shows the descriptive statistics for participants in both groups and gender at baseline.

Table 4.10 Descriptive Statistics of 6MWD at baseline.

Group	Gender		Minimum	Maximum	Mean	SD
Control	Male	6MWD (m)	365.0	555.3	442.38	57.17
	Female	6MWD (m)	283.5	498.7	415.92	56.29
Intervention	Male	6MWD (m)	280.0	580.0	455.91	94.28
	Female	6MWD (m)	271.3	528.1	409	69.74

From Table 4.10 and the reference equation for 6MWD above, it can be seen that the average distance walked by all participants at baseline was much lower than the expected distance (Range: 271.3 m – 580 m). Males in both groups walked further (mean=449.15 m, SD= 75.73) than females (mean=412.46 m, SD=63.02) in both groups at baseline.

Table 4.11 below represents the level of significant difference between different sources when 6MWD was compared at baseline.

Table 4.11 6MWD level of significant difference at baseline.

Source	p-value
Gender	**0.04**
Group	0.86
Gender * Group	0.57

Table 4.11 shows a statistically significant difference between gender (p=0.04). Males walked significantly further than females at baseline, which can be seen in table 4.10. Participants in the intervention group walked further than participants in the control group within the six minutes at baseline, seen in table 4.10. However, there was no statistically significant difference between the two groups at baseline (p>0.05), as seen in table 4.11.

Table 4.12 below shows the descriptive statistics for participants in both groups and gender at follow-up.

Table 4.12 Descriptive Statistics of 6MWD at follow-up.

Group	Gender		Minimum	Maximum	Mean	SD
Control	Male	6MWD (m)	384.6	660	464.33	74.64
	Female	6MWD (m)	325	495	421.84	54.11
Intervention	Male	6MWD (m)	328	540	456.71	69.28
	Female	6MWD (m)	377	595	447.09	60.45

At follow-up the average 6MWD from table 4.12 is still much lower than the expected 6MWD according to the reference equation seen above (Range: 325 m – 660 m).

Males (mean=460.52m, SD=71.96) in both group still walked further than females (mean=434.47, SD=57.28) at follow-up, seen in table 4.12.

Table 4.13 below represents the level of significant difference between different sources when 6MWD was compared at the 12 week follow-up visit.

Table 4.13 6MWD level of significant difference at 12 week follow-up visit.

Source	p-value
Gender	0.14
Group	0.61
Gender * Group	0.35

There were no statistically significant differences between the groups or gender ($p>0.05$) seen in table 4.13.

The table below compares the difference in distance walked at baseline and follow-up for each group.

Table 4.14 Comparison of Baseline and Follow- up 6MWD for each group.

Group	6MWD at baseline	6MWD at follow-up	Significance
Intervention	432.46	451.9	0.91
Control	429.15	443.09	0.23

Figure 4.4 below shows the average distance walked by participants in both groups from baseline to follow-up.

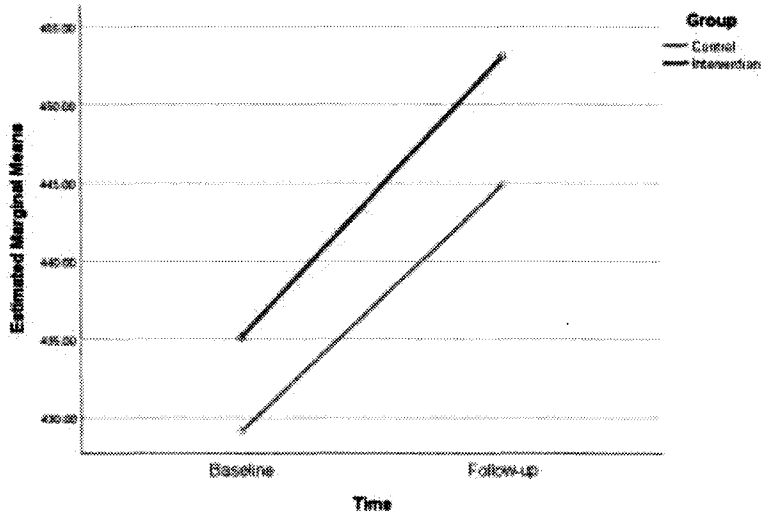


Figure 4.4 6MWD for both groups at baseline and follow-up.

There was no statistically significant difference found between the two groups from baseline to follow-up, this can be seen in figure 4.4 and table 4.14. However, the participants in the intervention group did improve their 6MWD from baseline to follow-up by an average of 11.2m more than the participants in the control group from baseline to follow-up. In the intervention group the average 6MWD increased by 38.89m (Range: 1.2 m – 60 m). In this group the males had an increase of 0.8m and the females had an increase of 38.1m. In the control group the average 6MWD increased by 27.87m (Range: 5.8 m – 48.6 m). In this group the males had an increase of 21.95m and females had an increase of 5.92m. This can be seen when table 4.10 and 4.12 were compared. It can also be seen from figure 4.4 and table 4.14 that participants in the intervention group walked further than participants in the control group at baseline and follow-up. The participants (in both groups) walked an average of 213.6m less at baseline and 196.91m less at follow-up, than the expected 6MWD for children between seven through nine years of age.

4.2.7 Home Exercise Programme

Patients were excluded from this study if they were unable to complete the exercises in the HEP. Ten patients were excluded from the study, eight of which had difficulty in skipping and two who were unable to perform sit-ups.

A total of 31 checklist booklets were given to participants in the intervention group during the baseline visit, 25 (80%) of these books were returned at the follow-up visit. As stated previously, two participants dropped out of this study and it was not possible to check if they had finished the programme or not. The four participants that did not bring their booklets to the follow-up visit had forgotten the booklet at home (n=3) or had lost the booklet (n=1). Figure 4.5 below shows the distribution and flow of booklets.

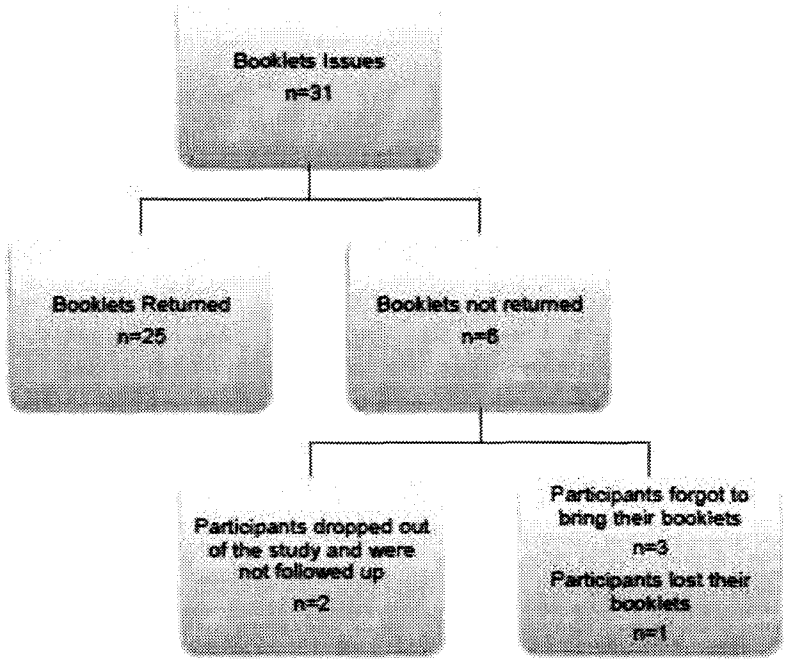


Figure 4.5 The distribution and flow of exercise booklets.

Below is a flow chart showing detail of the compliance to the HEP.

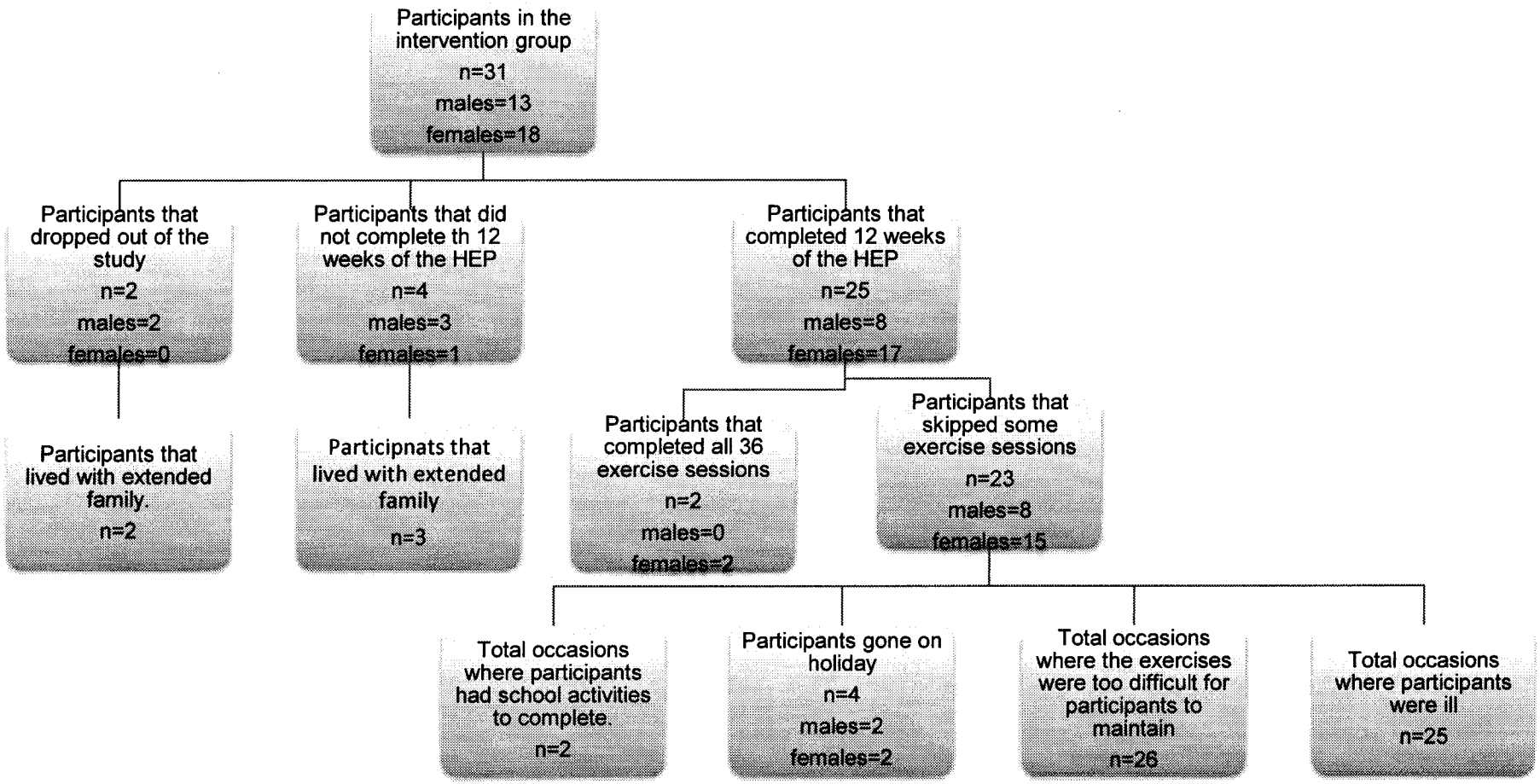


Figure 4.6 The details of compliance with the HEP

Most participants who completed the 12 weeks of the HEP left out a few days of the programme (81%). Some exercises were skipped, reasons for this were; the participant was tired and/or thirsty and participants were kept indoors and did not have space to do some of the exercises. Exercises were reportedly not done when the participants were feeling ill. Some of the most common illnesses reported were; 'flu', fevers, colds and tooth ache. Males took more breaks throughout the HEP and skipped more days of the HEP than females. See Appendix VIII for images of these comments from the exercise booklets.

- Feedback from Participants and Caregivers

When participants were asked what they thought of the exercise programme they responded positively. '*I like pretending that I am a lion!*' said participant 16. '*Catching the mouse was my favourite exercise*' said participant 5. '*Please can you give me more exercises to do*' responded participant 13. When caregivers and parents were asked what they thought of the exercise programme, they too responded positively. '*My child had fun doing these exercises*' said the caregiver of participant 10. '*I noticed that my daughter is now more responsible, she would remind me to do the exercises and wanted to tick the book herself*' said by the parent of participant 58. '*I can see that my child has bigger muscles (*in her arms*) after doing the exercises, her muscles grew bigger for sure*' responded the parent of participant 5. '*I am so happy that she (*participant*) can now walk from Florida to Mariasburg and she doesn't get so tired now, she even can help clean the house for a long time and she isn't getting tired like before*' reported the parent of participant 42. '*He walks far now to catch the taxi and he no more needs to take a break, already from week 6 of the exercises*' said the caregiver of participant 23. '*She was always ready to do the exercises, I didn't need to call her, it (the exercises) was like playing for her*' said the parent of participant 13. Two parents reported that their children were able to do the exercises more easily with more agility and increased speed by the end of the 12 weeks. Most caregivers reported that it was easy to supervise the programme as they were able to watch the participant doing the exercises while cooking or doing the washing. The caregivers also reported that having all the children in the house doing the exercises together meant that they didn't need to worry about where the other children were while supervising the participant. Participants wrote in their exercise booklets;

'Exercises are fun (Participant 8), 'I can be a lion (Participant 13)', 'I am stronger than my brother now (Participant 5)', 'I am getting good with skipping' (Participant 7). There was no negative feedback regarding the HEP from the participants and their parent/caregivers.

4.3 Summary of main findings

In phase I of this study, from the literature reviewed it was found that the average length of exercise programmes used in children was 12 weeks. The frequency of exercise per week ranged from twice a week to four times a week. The use of equipment such as bicycle ergometers or treadmills was found to be unnecessary. Running activities were proven to be better than cycling activities for exercise programmes (O Brien et al., 2004).

The outcome of the NGT was that the age range was the highest ranked suggestion. The other suggestions were ranked as follows: exclusion criteria that needed to be added to the study, sibling involvement, appeal to children and number of repetitions. The results of the thematic analysis showed that the most commonly occurring theme was also age range. Other themes included; exercise complexity, compliance to the programme and appeal to children.

The results from phase II of this study showed that the two groups were well matched in terms of age and gender. The weight and height of the participants at baseline and follow-up were also well matched as there was no statistically significance difference found between the two groups. There was however, a greater increase in weight in the control group (increase of 1.29kg) from baseline to follow-up than in the intervention group (increase of 0.09kg) within the same time period. The average BMI for age at baseline and follow-up was within a healthy range.

The analysis of cardiovascular data found that there was a statistically significant difference in HR over time. This was found at baseline and at the 12 week follow-up

visit, in both groups. There was also a significant difference seen in HR for the different genders. When baseline and follow-up data was compared the HR was significantly higher at baseline.

For systolic BP, at baseline a significant difference was found between males in the two groups. There was also a significant difference found between females in the two groups. At follow-up a statistically significant different was seen between females in the two groups. For the diastolic BP results, a statistically significant difference was seen only at follow-up. When baseline and follow-up results were compared, the diastolic BP was significantly higher at baseline. When baseline and follow-up measurements were compared it was also found that there was a statistically significant difference in SpO_2 results.

After analysing the results of the 6MWD it was found that there was no statistically significant difference between the two groups at baseline and follow-up. However a statistically significant difference was found between males and females at baseline, with males walking significantly further than females. No statistically significant difference was found at follow-up. When the baseline and follow-up results were compared, there was no statistically significant difference between the two groups, or gender between the two groups.

The results of the HEP showed that participants enjoyed the element of pretend play and the types of exercises in the HEP. Participants who had good family support completed the exercises programme as compared to participants living with siblings, grandparents or extended family. Females were more diligent in completing the programme. Caregivers noted positive changes in their child's muscle bulk, increased responsibility and increased endurance when doing ADLs. Most participants were unable to complete each session of the 12 week programme, as they had to skip some days or some exercises for various reasons. Towards the end of the programme participants often had to take breaks as they were unable to complete the number of repetitions without getting tired.

The results of this study are discussed in the next chapter.

CHAPTER 5: DISCUSSION

This chapter discusses in detail the results of this study and will include both phase I and phase II. Looking at phase II of the study; demographic, anthropometric and cardiovascular data as well as results of the 6MWT between the two groups will be compared and discussed. The effectiveness of the HEP will be explained and discussed. The limitations of this study will be discussed next. Recommendations for clinical practice and further research will also be given.

5.1 Study Design

This study investigated whether a HEP would have a positive impact on the exercise endurance of children infected with HIV. A literature review was done to help form the basic structure of the HEP. The NGT was used to validate the exercise programme as a wide range of ideas and suggestions were needed from a broad focus question (What can be done to improve this home exercise programme?). This study along with other research shows that Nominal Groups are effective in fulfilling these goals. The 6MWT was used as it is proven to be easy to administer and shows an accurate reflection of the exercise endurance that is required to conduct ADLs (Solway et al., 2001). Anthropometric and cardiovascular data collected was based on aspects that were known to have an effect on the 6MWD. Participant's BP, SpO_2 and HR were recorded as part of administering the test (Solway et al., 2001).

5.2 Loss to Follow-up

When calculating the sample size the attrition rate was estimated at 20%. During the data collection phase of this study a higher number of participants were anticipated to drop out due to this study being conducted over the December school holiday period. Follow- up appointments were scheduled by the Empilweni clinic between December 2017 to early January 2018. Most participants who had caregivers that were immigrants left the country during the holiday season to visit their home country. SA is known to be home to a large number of immigrants (Kalitanyi and Visser, 2010). These participants could not be contacted to remind them to do their exercises, if

they were in the intervention group. It was therefore assumed that these participants would not attend their follow-up appointments. However, most participants did return to SA before their follow-up appointment date. Two participants from the intervention group and four participants from the control group dropped out of the study. Reasons for drop out included; participants were out of the country on vacation (3), participants were transferred to another facility (2) and contact details were not valid (1). See CHAPTER 4: RESULTS, page 54 for flow diagram (figure 4.1) showing study attrition.

Every effort was made to follow-up with participants. All follow-up sessions were booked on the same day as the Empilweni clinic follow- up dates. Caregivers of participants were called once a week and reminded about their appointments over the 12 week period. Caregivers from the control group were called once a week for the last three weeks of the programme to remind them about their appointment. If they could not be reached telephonically an SMS was sent to them. If no reply was received, the clinic file was checked for an alternative contact number. South Africans frequently change mobile numbers for various reasons but mostly due to loss as a result of being a victim of crime (Müller et al., 2011). This could be a possible reason as to why some caregivers could not be reached during the 12 week period.

5.3 Phase I

5.3.1 Nominal Group

Participants who attended the Nominal Group had a vast knowledge of working with children- as they had a minimum of five years of experience. However, only two participants had experience with using and designing HEPs as part of their patient care. The other three participants had little to no experience on designing and implementing HEPs. Two participants based their suggestions on experiences they have had with their own children. A variety of health professionals attended the group; this was beneficial in getting varied perspectives. As previous studies using the NGT have shown; a number of problems were identified, solutions to these

problems were generated and each member's perspective was taken into consideration (Casteleijn and Graham, 2012). Although the aim of the NGT was to validate the HEP, when the study was explained to the participants, suggestions were made about the study criteria. The most valuable change made to this study, as a result of the Nominal Group, was the age range from between five through nine years to between seven through nine years. The gross motor expectations for children between these ages are known to be similar (Khudolii et al., 2015). Studies looking at gross motor function have analysed participants between the ages of seven through nine years in the same group. (Akbari et al., 2009, Khudolii et al., 2015, Malina, 2006, Penha et al., 2005, Walker, 2015). Therefore, the results of this study are expected to be a more accurate representation of exercise endurance with no age advantages impacting on exercise endurance. Age advantages may include coordination and muscle strength differences.

The results of the thematic analysis showed that the most commonly occurring theme was also age range. This proves that the age range was an important suggestion made in the Nominal Group. Other themes included; exercise complexity, compliance to the programme and appeal to children. Under these themes, suggestions such as; using a low number of repetitions, involving siblings, including a theme and pretend play were mentioned. These results prove that the aim of the Nominal Group was not properly explained to the participants or not properly understood by the participants, as feedback was not only related to the HEP but to the study as a whole. However, major changes were made to the HEP in terms of; layout, types of exercise and creativity as this was valuable feedback and added value to the study. The HEP was revised in order to be more individualised for the age group of the participants and less of an adult-based generic programme. Previous studies using exercise programmes for children often highlighted the types of exercises done but put little emphasis into the way these exercises were executed. Implementing changes to the HEP, suggested through the Nominal Group discussion, proved to have had a positive impact on the responsiveness of the participants to the HEP. These responses are further elaborated on in Phase II of this discussion (5.4.6 Effectiveness of the HEP).

5.4 Phase II

5.4.1 Demographics

In the total sample of phase II of this study there were more females than males. There were an equal number of males and females in each group. The groups were therefore well matched and gender was not a bias factor between the groups. Gender has been reported as a factor that can affect the 6MWD (Enright, 2003, Ulrich et al., 2013). Differences in 6MWD were seen in this study to be influenced by gender and are discussed further, later on in this discussion (5.4.5 6MWD).

The mean age between the groups only differed by 5 months. The minor SD in age was expected within the groups and between the two groups, due to the narrowed age range chosen for this study. Due to all participants being of a similar age, this was not a factor affecting the 6MWD. Age is also a factor reported to have an effect on 6MWD (Enright, 2003, Ulrich et al., 2013).

5.4.2 Anthropometric outcomes

The average BMI of participants in this study was within the normal healthy range (7 years: 13.8- 17.8, 8 years: 13.9- 18.1, 9 years: 14-19). Using the average age of all participants, the average BMI was found to be 15.45 kg/m^2. A close to normal BMI was expected as participants had been receiving ART for a minimum of twelve months. ART has been proven to have a positive effect on weight and height in children infected with HIV and is known to help maintain normal growth (Buonora et al., 2008, Guillén et al., 2007, Lee et al., 2010). BMI between both groups was similar with no statistically significant differences at baseline or follow- up. The SD in both groups at baseline and follow- up was also minimal. Having participants with an average healthy BMI was beneficial as weight therefore was not a factor influencing 6MWD and endurance. Weight is proven to have an inversely proportional relationship with walking distance (Enright, 2003, Ulrich et al., 2013). Obese children often present with hypertension and increased triglycerides, which have a negative impact on their exercise endurance (Lee et al., 2010).

The control group did have an average increased weight of 1.29kg over the 12 week period while the intervention group only had an average increased weight of 0.09kg over the same period. This difference in weight gain could be attributed to the exercise intervention done by participants in the intervention group. This may have resulted in participants in the intervention group gaining less weight than participants in the control group. Studies done to investigate the effects of a HEP on obesity found that doing cardiovascular exercise for 12 weeks resulted in a decreased amount of adipose tissue (Carrel et al., 2005, Davis and Cooper, 2011, Lee et al., 2010, Meyer et al., 2006, Savoye et al., 2007). However the reasoning for this difference in weight gains is only an assumption as no other investigations were done.

A SD of 0.07 m in height was found in both groups at baseline and follow- up. This shows that participants were of a similar height. Therefore, height was not a bias factor and there were no exceptionally tall participants in this study. It is known that taller people generally have a longer stride length resulting in a further 6MWD (Li et al., 2005).

5.4.3 Immunology and Virology Measures

It was difficult to accurately record the average immunological and virological measurements as viral loads and $CD4^+$ T-cell counts were often measured at different intervals for each child according to the National Department of Health HIV management guidelines, or at the doctor's discretion. Therefore the average viral load and $CD4^+$T-cell count calculated as part of this study is not a true reflection of the participants' current viral load and $CD4^+$T-cell count at the time of this study visit. As part of the inclusion criteria, participants were expected to be taking ART for a minimum of 12 months to be included in this study. When an individual initiates ART it can take between three to six months for the viral load to reach undetectable levels (Evans and Fox, 2013). To ensure children in this study were virally suppressed, only children taking ART for longer than 12 months were included.

All participants were asymptomatic at the time of assessment and therefore were within Stage 1 of the WHO clinical classification staging for HIV. Looking at the $CD4^+$T-cell count levels at baseline in relation to the severity of immunosuppression, the average participant had a $CD4^+$T-cell count of 1417/mm^3. This shows that there is no significant immunosuppresion (World Health Organization, 2007). Participants had an average viral load of 867 copies/ml. Participants showed viral suppression of previous two successive viral load results, as the average viral load of all participants at baseline was < 1000 copies/mL- six months apart. Viral suppression was an exclusion criterion as patients with a high viral load may not be as medically stable or have the same baseline cardiovascular fitness as patients with a lower viral load.

5.4.4 Cardiovascular Data

- **Heart Rate**

The average resting HR of all participants at baseline and follow-up was found to be within the normal expected resting HR range (60-95 bpm). The SD in the HR measurements for all participants was an expected spread in data. Resting HR measurements were expected to be lower than the normal healthy range due to the complications of HIV (Walker, 2015). A decreased HR in patients infected HIV can be caused by anaemia, cardiovascular and/or pulmonary dysfunction (Stringer, 2000). Variations in HR in persons with HIV have been investigated in various studies (Benseñor et al., 2011, Mittal et al., 2004, Neild et al., 2000, Sakhuja et al., 2007). Most of these studies show a decreased HR in persons with HIV when compared to the expected normal range of HR, similar findings are seen in patients with cardiomyopathy (Mittal et al., 2004, Neild et al., 2000, Sakhuja et al., 2007, Walker, 2015). A study by Benseñor et al., found that ART may have a positive effect on improving autonomic dysfunction (Benseñor et al., 2011).

A statistically significant difference was found in the HR changes over the different time intervals at baseline ($p=0.01$) and at follow-up (0.024). At baseline and follow-up, the HR was higher at the immediate post-test point than at the other two testing points. This is similar to findings seen in literature stating that exercise causes an increase in HR measures (Cade et al., 2002, Pedersen and Saltin, 2006). The rate of

increase in HR is directly proportional to the increasing exercise intensity (Meyer et al., 2006). It was seen in both groups that the HR did not return to pre-test values five minutes after the 6MWT at baseline. However the difference in HR for both groups was less than the expected 13 bpm and was therefore of no concern (Swigris et al., 2011). At follow- up, HR values for both groups did return to pre- test results when measured five minutes after the 6MWT.

Currently there is no research on the expected changes in HR during the 6MWT. However since all values were within normal ranges and HR is expected to increase with increased physical activity and decrease after physical activity (Carter et al., 2003, Jouven et al., 2005, Miyai et al., 2002), the changes in HR found in this study were accepted as normal. It was interesting to note that the average HR increased five minutes after the 6MWT in the control group at baseline. As the increase was minimal, this was not taken as a significant finding. In this study it was found that females had a significantly higher HR when compared to males at follow-up ($p=0.003$). This was seen especially at the pre-test and immediately post-test points. This concurs with findings in studies that reported on differences in HR and gender (Geiger et al., 2007, Li et al., 2005, Saad et al., 2009, Ulrich et al., 2013).

The maximum HR of all participants was measured at baseline and follow-up, immediately after the 6MWT. This measurement was analysed using the equation set out by Mahon et al. 2010. The study compared two reference equations with the measured maximal HR to determine which equation was most accurate in predicting maximal HR in children and adolescents. The equation: 208 — 0.7(age) was found to be more accurate when compared to 220- age, for children(Mahon et al., 2010).

Using the average age of 8.5 years, the maximum HR was calculated as: 214.05 bpm. It was assumed that participants were exercising at less than 50% of their maximum HR. The average age of all participants was used and the predicted HR was: 105.75 bpm. The average HR for males and females in both groups at baseline (89.17 bpm, 42.16% of predicted maximum HR) and follow-up (92.82 bpm, 43.89% of predicted maximum HR) measured immediately after the 6MWT was below the

predicted HR. There was no statistical significance between the groups or between genders. Results were found to correlate well with the expectations of maximum HR for this study, participant's maximum HR was less than 50% of the age predicted HR. According to the American College of Sports Medicine, the guidelines for exercise testing and prescription state that less than 50% of maximum HR is considered very light intensity exercise (American College of Sports Medicine, 2013). Participants walked at a pace that they were comfortable with and were told that they were allowed to take a break if they were tired or out of breath.

Exercise capacity is often defined as 'the maximum amount of physical exertion that a patient can sustain' (American College of Sports Medicine, 2013). Assessment of exercise capacity through exercise testing is a helpful guide to exercise prescription (Bellet et al., 2011). Comparing a patient's prior performance to their current performance in the same exercise test will provide quantitative changes with therapy. Comparing a patient's performance to other patient's performance in the same exercise test can provide assessment of comparability within a population group (Bellet et al., 2011)

- **Blood Pressure**

Normal BP values for children between the ages of seven through nine are different for males and females and are dependent on age and height (www.nhlbi.nih.gov). It is known that BP is slightly higher in males than in females of the same age (Reckelhoff, 2001). However, this was not seen in this study and females had higher BP results than males at some testing points, this could be as a result of fluctuating BP.

At baseline, a statistically significant difference was seen between the two groups in the systolic BP at the 5 minutes post- test point. A statistically significant difference was seen between the two groups for the diastolic BP measurements at the immediate post- test point at follow- up. A statistically significant difference was also

seen in the systolic BP measurements at the 5 minutes post- test point at follow- up. This difference was only seen in females.

In both children and adults, systolic BP increases with exercise. The magnitude of which this systolic BP increases is dependent on the intensity of exercise done (Whelton et al., 2002). This increase is less in children than it is in adults. In this study the change in BP immediately post-test when compared to pre-test were inconsistent. This may be as a result of the 6MWT being of very light intensity (Whelton et al., 2002). There are no studies done in the paediatric population showing evidence of these changes with exercise intervention.

It can be seen that all systolic BP values for males and females over all 3 time points (at baseline and follow up) are within the normal range, except at baseline where females in the control group had a slightly increased systolic and diastolic BP at the immediate post-test point. In females the normal values (on the 50th centile for height and age) for BP are 98- 122 mmHg for systolic BP and 58- 83 mmHg for diastolic BP. The systolic BP in the females participating of this study is only increased by 1.53mmHg and the diastolic BP is only increased by 3.59 mmHg more than the expected normal value and is therefore not clinically significant as BP is known to fluctuate naturally.

Looking at the statistically significant differences, it was found than none of the differences were more than 15 mmHg for systolic values or more than 10 mmHg for diastolic values, in both genders. Therefore, it was concluded that there was no clinical significance in these differences. The differences in BP values were attributed to natural fluctuation and were expected. It was assumed that HIV infected individuals respond similarly to the uninfected population, as no literature was found on the fluctuation of BP in HIV infected individuals specifically. These changes can be a result of the time of day, changes in circadian rhythm, stress or food sensitivities (Ogedegbe and Pickering, 2010).

When baseline and follow-up results were compared the diastolic BP was significantly lower at follow-up, p=0.038. This was looked at in further detail. The difference in diastolic BP between baseline and follow- up results were; 2.36 mmHg in the intervention group and 3.7 mmHg in the control group. These findings were not expected, as participants in the intervention group were expected to have a greater difference in diastolic BP as a result of exercise reducing BP. Research shows that when exercise is done for more than 30 minutes at 70% of maximal oxygen uptake this will decrease resting BP. Exercise done for less than 30 minutes, low intensity, will have less of an effect on BP. Since the control group had a greater reduction in diastolic BP from baseline to follow- up and both differences were less than 10 mmHg, this difference was not clinically significant. This could be as a result of the HEP being done at low intensity rather than moderate intensity. Since exercise intensity was not measured as part of this study, this only an assumption.

- **Oxygen Saturation**

SpO_2 is the amount of oxygen bound to haemoglobin. Haemoglobin is a component found in blood that transports oxygen to the organs, cells and tissues around the body by binding to the oxygen (Stenson et al., 2013). Components influencing SpO_2 include: the amount of oxygen available in the atmosphere, the affinity of haemoglobin for oxygen and the amount of haemoglobin found in the red blood cells (Boas and Franceschini, 2011), There is a higher demand for oxygen during exercise, therefore the SpO_2 value increases during exercise (Van De Bruaene et al., 2013)

In this study it was found that the SpO_2 measurements were within the normal expected range for children between the ages of seven through nine years at baseline and follow-up, over all 3 time points (94- 96%), in the intervention group at baseline at all testing points. However, in the control group at baseline and both groups at follow-up the SpO_2 measurements were higher than the expected normal. The average SpO_2 over all intervals at follow-up was higher in the intervention group when compared to the control group but this difference was not statistically significant. Although no statistical significance was found, this increase in SpO_2

values occurred at all 3 intervals at follow-up in the intervention group. It is also interesting to note that the average SpO_2 measurements in the control group was higher than the measurements of the intervention group at baseline, seen at all three intervals. As this increase in SpO_2 results were consistent, it could be attributed to the HEP done by the intervention group. This conclusion is consistent with research showing that the long term effects of exercise are said to improve the resting SpO_2 values (Kriemler et al., 2016). As this was not further investigated, this was only an assumption.

At baseline a change in SpO_2 measurements were noticed between the pre-test and immediately post-test time point. In the intervention group an increase of 0.32% was seen and in the control a decrease of 0.36% was seen. At follow-up during the same time interval an increase was seen in both groups. In the intervention group an increase of 1.85% was seen and in the control group an increase of 0.74%. Between immediately post-test and five minutes post-test a decrease was seen in the intervention group and an increase was seen in the control group for SpO_2 measurements, this was seen at baseline and follow-up. Looking at the results between the pre- test and the immediately post- test point, only minor differences were noted for both groups. The changes in SpO_2 measurements between the immediately post- test and five minutes post- test points were unexpected. An increase in SpO_2 for both groups was expected as research shows that SpO_2 measurements increase post- exercise (Mayer et al., 2018). As the participants were walking for six uninterrupted minutes, this was considered short term cardiovascular exercise. A study done in Brazil on 24 healthy men found that short term resistance exercise improved the immediate post-exercise SpO_2 (Neto et al., 2016). A similar test done in Germany using cardiovascular exercise training found that SpO_2 increased immediately post-exercise in their participants (Kriemler et al., 2016). Oxygen uptake is expected to increase during exercise as the body has a greater demand for oxygen during this time (Mayer et al., 2018).

The overall SpO_2 measurements of all participants regardless of group or time interval were significantly higher at follow-up when compared to baseline, $p= 0.04$. A significantly higher overall SpO_2 measurement was expected at follow- up. The

exercise intervention could be attributed to this increase. This is only an assumption as no further investigation was done.

It is evident that this group of participants responded in predictable ways to submaximal exercise. Responses are close to the normal ranges set out for the healthy population. This may be an indication of little to no side effects caused by chronic diseases present in these patients (Evans and Fox, 2013).

5.4.5 Six Minute Walk Test

At baseline it was found that males walked significantly further than females regardless of the group (p= 0.04). Males walked further than the females at baseline and at follow-up, regardless of the group. It has been proven that male children have a greater exercise capacity and an increased muscle mass and therefore will perform better in the 6MWT as compared to female children (Li et al., 2005). Due to this male advantage some studies, aimed at identifying changes in body composition over time, used only one gender to avoid gender bias in the study (Griffin et al., 2011, Hyun et al., 2014, Korzeniowska-Kubacka et al., 2011, Owoeye et al., 2014, Rubley et al., 2011, Steffen et al., 2013).

Using the equation set out by Saad et al. 2009, it can be seen that participants from both groups, at baseline and follow- up, had lower 6MWD than what is expected of a healthy individual between the ages of seven through nine years. There was no common pattern seen in SD between the baseline and follow- up period, showing great improvements in walking distance of some participants over others. There are a number of different studies showing decreased endurance in HIV infected individuals.

The results in this study relate well to the results found in a similar study done in a South African setting to investigate the difference in exercise endurance between HIV infected and uninfected school aged children. The study used children between the ages of seven through ten years. The 6MWD was used as an indicator of endurance. A significant difference in distance walked between the infected and non-

infected participants was found in the study. HIV infected participants walked 57.86m less than non-infected participants. A statistically significant difference was found between males and females in the study, with males having walked a significantly further distance as compared to females (Walker, 2015). The results of the study are similar to the results in this current study, in that both studies found decreased endurance in HIV infected participants compared to the expected normal. Males walked significantly further than females in both studies.

Another study was done in Miami between 2005-2009, to investigate the cardiorespiratory fitness in children and adolescents. The study included both HIV infected and uninfected individuals ranging from seven through twenty years. Exercise endurance was tested using peak oxygen consumption levels. Results from the study showed that medically stable HIV infected participants had lower cardiorespiratory fitness when compared to the uninfected participants (Somarriba et al., 2013). These findings correlate with the results of this current study. In a study done to test endurance in adolescents using peak oxygen consumption as an outcome measure, it was found that participants infected with HIV had significantly lower peak oxygen consumption when compared to their age matched uninfected peers. This indicated substantial decreases in the aerobic capacity of the HIV infected individuals (Cade et al., 2002). Although different outcome measures were used in these studies when compared to this study, similar results were seen. HIV infected children and adolescents are proven to have decreased endurance levels when compared to the uninfected population.

Although there were no statistically significant differences between the baseline and follow-up results in both groups, the average participant in the intervention group did improve their 6MWD by 11.2 m more than the average participant in the control group. Participants in the control may have improved their 6MWD as they could have been more familiar with the testing procedure therefore more relaxed and able to perform better. Males in the control group improved their 6MWD by 21.95m and females in the same group improved their 6MWD by 5.92 m. Males in the intervention group improved their 6MWD by 0.8m and females in the same group improved their 6MWD by 38.1m. When investigating changes in endurance within a group of

participants, a mean increase in the 6MWD of statistical significance is generally less than an increase of clinical significant seen in individual participants (Travis et al., 2002). There were no clinical differences between the groups, gender or over the two time points. There are no other recorded studies that investigated the changes in endurance using the 6MWT after implementing a HEP. Therefore the follow- up results could not be compared with other literature.

5.4.6 Effectiveness of the Home Exercise Programme

In this study it was found that participants did present with developmental delay, this was assessed when participants were screened for eligibility. This was seen when some children that were screened had to be excluded from this study because they were unable to perform the exercises prescribed. Skipping seemed to be one of the most difficult exercises to do. Of the ten patients that were excluded from the study, eight were unable to skip. It was found that upper and lower limb coordination was the biggest delay in these children. This could be as a result of a lack of exposure to skipping or lack of co-ordination caused by a developmental delay. Research shows that fundamental skills will not naturally develop as an individual ages (Payne and Issacs, 2002).

Towards the end of the programme, when repetitions of exercises had compounded over the 12 weeks, the participants in the intervention group often struggled to complete the whole exercise programme without taking a break as they felt tired. Since only 25 booklets were returned, the completion of the other four booklets was reported by the caregivers.

In this study it was found that participants were more compliant with their HEP if they had good family support and motivation from a parent. Participants who were living with grandparents or extended family often were inconsistent with following the HEP or did not complete the 12 weeks of exercise. These findings are consistent with research that shows that environmental factors influence the fundamental movement abilities in children. Some of these factors include; encouragement, practice and instruction (Gallahue and Ozmon, 2006). Specifically, family care is known to be the

key element in ensuring that children learn, grow and socialise effectively (Richter et al., 2009).

Clinically, it was seen that the females in the intervention group of this study were more diligent with following the exercise programme. Caregivers of female participants in the intervention group reported that participants had completed their exercise diaries more thoroughly and were able to show the exercises more precisely. Caregivers of female participants reported more frequently that the participant was following the exercise programme diligently. Males took more breaks throughout the HEP and skipped more days of the HEP than females. This could be a possible reason for the greater improvement in 6MWD from baseline to follow-up in females when compared to males in this group. Unfortunately, no research on the gender differences with exercise compliance in children was found and this assumption could not be validated.

Exercises were not done when children were feeling ill, which was seen often within the 12 week period. Some of the most common sicknesses reported were; flu, fevers, colds and tooth ache. Participants were immunocompromised due to their underlying condition and at a higher risk of getting infectious diseases (Lawn et al., 2011, Tan et al., 2012). All participants in this study also came from a poor socio-economic background, which is another reason why they were more at risk of community acquired illnesses. These findings are also supported by literature which states that persons who have poor access to health care facilities often are at more risk of contracting opportunistic infections (Grubb et al., 2006).

Another reason why exercises were not done is that some children were kept indoors throughout the day and did not have enough space to do all the necessary exercises. A possible reason for keeping children indoors throughout the day would be due to the stigmatisation by the community, or that the outside environment was not safe for children to play in. Some children skipped days of the exercise programme as their caregiver was busy and unable to assist them or monitor them doing the exercises. Caregivers reported that they often had to work lengthy hours in order to support the

family. They did not have the time to monitor their child doing their exercises three times a week. This is also in line with literature that shows that the South African caregivers' main focus is economic survival and meeting these needs for themselves and their children presents as a major challenge. Most South African caregivers of children living with HIV find caregiving to be demanding and exhausting, this is exacerbated by lack of support, extreme poverty, responsibility of the other members of the household and stigma (Demmer, 2011).

- Feedback from Participants and Caregivers

Caregivers of participants in the intervention group reported positive changes in their children. These changes included increased muscle bulk, increased responsibility in remembering to do their exercises and filling in the checklist as well as increased endurance when walking to school or other places. One mother reported that her child was able to walk a further distance to get to the taxi rank without taking a break or getting tired, after six weeks of following the exercise programme. These parents often reported that their children improved in their ability to do the exercises given to them over the 12 period. These children were able to do the exercises more easily with more agility and increased speed by the end of the 12 weeks, as reported by their caregivers. This is consistent with research that shows that the early initiation of motor skill programmes has a positive impact on motor skill development in children (Apache, 2005, Fisher et al., 2005, Wong et al., 2008). Caregivers reported that it was easy to supervise the participant throughout the 12 week programme as sibling involvement and including weekends made it easier to include into their lifestyle.

All participants reported that the exercises were enjoyable and the pretend element motivated them to continue with the HEP. Caregivers of these participants reported that their children did not need to be forced to do the exercises. Caregivers also reported that their children were excited and treated the exercises as play more than a duty. Pretend play, known as a type of play which includes make-believe, fantasy and symbolism (Russ, 2003), was one of the key elements in the development of the HEP in order to captivate the interest of children and to motivate children to finish the 12 week programme. Pretend play is known to be a significant contributor to a

child's physical, social, cognitive and emotional development (Lillard et al., 2013). A study in Iraq showed that using games was more effective in improving developmental motor skills than ADLs, as games were pleasurable and diverse (Akbari et al., 2009).

Towards the end of the programme, when repetitions of exercises had compounded over the 12 weeks, the participants in the intervention group often struggled to complete the whole exercise programme without taking a break as they felt tired. These results were expected as part of this study as it is known that exercise endurance in children infected with HIV can influence disease-specific outcomes in a positive manner, however medical conditions may limit these children (Somarriba et al., 2013).

5.5 Limitations to the study

- No blinding of the investigator was used in this study due to financial constraints and lack of human resources. Therefore we were unable to have a different investigator conducting the follow- up 6MWT sessions or demonstrating the exercise programme to participants in the intervention group. No blinding meant that bias results were not eliminated in this study. The investigator had the opportunity to influence participant's performance.

- The 12 week period between baseline and follow-up sessions fell within the December 2017 school holiday period; this meant that participants were expected to carry out the HEP over the holiday period making it difficult for participants to stick to a routine during this time.

- HR was not monitored throughout the 6MWT therefore HR measured immediately after the 6MWT was not an accurate depiction of maximum HR. Due to lack of finance, a device measuring HR throughout the 6MWT could not be purchased.

- Respiratory rate was not taken as part of the 6MWT done in this study, as only the standard procedure and guidelines set out by the ATS were followed. This did not include the measuring of respiratory rate. Measuring respiratory rate when conducting the 6MWT in children infected with HIV is beneficial. Many of these children may present with respiratory conditions which may be complicated when carrying out this test and would need to be closely monitored.

- Despite valuable contribution from the participants attending the Nominal Group, the participants selected for this study may not have been the most appropriate health professionals as none of the participants had extensive knowledge on designing or implementing a HEP.

- Baseline fitness levels were not taken into consideration when prescribing an exercise programme, therefore the exercise intensity may not have been appropriate for all participants. It was assumed that all participants had the same baseline fitness level.

- Precautions related to HIV infection or side effects of ARVs and other medication were not considered when designing the HEP. Side effects such as; tachycardia, tachypnoea and dizziness may result in a higher risk of falling and injury during exercise.

5.6 Clinical recommendations

- Providing patients with a HEP allows individuals; to be responsible for their own health, is educational and empowering. Many patients with HIV living in SA often have a poor understanding of their condition, therapy required and medication needed. This may be as a result of a lack of education on the condition and treatment (Cobbing et al., 2014). Physiotherapists often spend an ample amount of time with their patients and this presents with many opportunities to provide education to them (Atwal and Caldwell, 2005).

- Allowing the patient to do the exercises in front of the therapist was proven to be beneficial in this study in order to correct posture and avoid compensatory movements which may have been missed by the caregiver when exercises were carried out at home. This was done when exercises were initially given to the participant at the baseline visit.

- When designing an exercise programme for children with HIV, it is recommended that the precautions for chronic diseases be considered along with the side effects of any medication the participant may be taking (Harvard Health Publishing, 2010). The parent should be advised to carefully monitor the participants when exercises are being carried out at home. Symptoms to be aware of include; tachycardia, tachypnoea and dizziness.

- The repetition of exercises should be progressed gradually. In this study each exercise was progressed by two repetitions each week. All the studies that were reviewed when drawing up the HEP described the exercise programmes used in the studies with regards to frequency and duration of exercises. Few studies described details of exercise progression and repetition of exercises. It will be beneficial to progress exercises more gradually based on changes in HR. Measuring parameters of exercise intensity will give a more accurate guide for progression of exercise.

5.7 Recommendations for further research

- Using different age groups with different exercise programmes will be beneficial to show the changes in exercise endurance across a wider age range. This will substantiate the effectiveness of a HEP further.

- Consulting with colleagues who have an interest in and knowledge of designing and implementing exercise programmes will greatly assist in the development of a HEP.

CHAPTER 6: CONCLUSION

The purpose of this study was to investigate the effects of a HEP on the exercise endurance of children infected with HIV. This included developing and validating a HEP, investigating the outcomes in terms of exercise endurance after completing the HEP and comparing the exercise endurance of participants receiving the HEP to participants not receiving the HEP. Evaluating the effectiveness of the HEP by investigating compliance to the programme and receiving feedback from the participants and their caregiver was also included in this study. Participants in this study were all patients of the Empilweni clinic (HIV clinic) at the RMMCH. Participants were well matched in terms of gender and age. The main conclusions of this study are listed below.

In developing an exercise programme, we found that the programme should be structured over a 12 week period and exercises should be done three times a week. There are no other studies showing specific details for the development of a HEP in children with HIV. The use of HEPs has been proven to be a beneficial form of therapy (Gohar et al., 2011, Huang and Ness, 2011, Takken et al., 2009). On average patients are seen once a month at public hospitals, which will not effectively have an impact on the patient's condition. Therapy sessions at public hospitals may be held in an area with confined space which only allows for written communication and no physical therapy. Therefore issuing a HEP to these patients will help overcome these barriers and ensure carry through of therapy.

The NGT added a valuable contribution and many elements to improve compliance to an exercise programme were identified. However, the manner in which the NGT was run did not meet the requirements of a NGT, in that participants advised on subjects that were not meant to be discussed. The elements that were highlighted by the group These included; age range, pretend play, exercise progression, considering the home environment, combination of exercise, involving siblings, including weekends and appeal to children. Each element is elaborated on below.

The HEP needs to be specific for different age groups. Having a narrow age range to ensure similar gross motor abilities of children within a specific age group is vital. Pretend play motivates children to do their exercises as it is enjoyable, this was also noted with the positive feedback from participants. This is in line with studies which prove that there are positive outcomes with the use of pretend play. Exercises should be progressed gradually to ensure that participants are able to keep up with the exercises and to prevent burnout and fatigue. Exercises programmes need to be based on the individual's exercise capacity and monitor changes in HR to predict the exercise intensity in order to have an effective impact on exercise endurance. A limiting factor in this study is the time period in which the HEP was implemented, over the December 2017 school holidays. Implementing an exercise programme in the correct time period, i.e. a school term may improve compliance to the programme and yield a more favourable outcome.

The patient's home environment should be considered when choosing exercises, as patients living in the poorer areas of SA often have small home environments. Exercises should be mixed between strengthening and cardiovascular exercises to prevent fatigue during exercise routine. Involving siblings in the study allows the family to feel included and makes it easier for the caregiver to supervise. Including weekends as days in which exercises should be done allows for more availability of the caregiver to supervise the HEP. The HEP needs to appeal to children by having a theme and trendy name, this will make the programme more exciting. These changes made to the programme proved to be beneficial as participants reported that the programme was creative and enjoyable. Caregivers reported that it was easy to supervise the 12 week programme as it fit into their lifestyle.

A 12 week HEP can improve the distance walked in the 6MWT even though the change in distance from baseline was not statistically significant in this study. No decline was found in the 6MWD from baseline to 12 weeks follow-up. Participants in the intervention group also had a better improvement in their 6MWD when compared to participants in the control group. HIV infected children were found to walk a shorter distance in the 6MWT when compared to the expected calculated distance for the healthy population of the same age, set out by Saad et al., 2009. These results were

also seen in several other studies done. This implies the need to improve the exercise endurance in HIV infected children through exercise programmes.

South African studies done on the effects of exercise in children with HIV are limited. The majority of exercise programmes that have been developed to improve endurance are not South African based. Most studies done with the aim of improving endurance are carried out in developed countries using equipment and resources which are limited in SA. Therefore these exercise programmes will not be effective in a South African context. The majority of patients attending public hospitals have huge financial constraints which prevent them from attending regular hospital based therapy sessions. Children with HIV often suffer from a poor QoL, without access to adequate resources to improve this. Children attending HIV services have been shown to default follow-up treatment. It is vital to use home based therapy in a South African setting to improve factors such as endurance.

CHAPTER 7: REFERENCES

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APPENDIX I

R14/49 Ms Candice Noelle Naidoo

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)

CLEARANCE CERTIFICATE NO. M170648

NAME: [Principal Investigator]	Ms Candice Noelle Naidoo
DEPARTMENT:	Physiotherapy Rahima Moosa Mother and Child Hospital
PROJECT TITLE:	A Study Investigating the Effects of a Home Exercise Programme on Exercise Endurance in Children Infected with Human Immunodeficiency Virus
DATE CONSIDERED:	30/06/2017
DECISION:	Approved unconditionally
CONDITIONS:	
SUPERVISOR:	Natalie Benjamin and Dr Renate Srehlau
APPROVED BY:	Professor P. Cleaton-Jones Chairperson, HREC (Medical)
DATE OF APPROVAL:	21/08/2017

This clearance certificate is valid for 5 years from date of approval. Extension may be applied for.

DECLARATION OF INVESTIGATORS

To be completed in duplicate and **ONE COPY** returned to the Research Office Secretary in Room 10004, 10th floor, Senate House/3rd floor, Philip Tobias Building, Parktown, University of the Witwatersrand. I/We fully understand the conditions under which I am/we are authorised to carry out the above-mentioned research and I/we undertake to ensure compliance with these conditions. Should any departure be contemplated, from the research protocol as approved, I/we undertake to resubmit to the Committee. **I agree to submit a yearly progress report.** The date for annual re-certification will be one year after the date of convened meeting where the study was initially reviewed. In this case, the study was initially review June and will therefore be due in the month of June each year. Unreported changes to the application may invalidate the clearance given by the HREC (Medical)

Principal Investigator Signature Date 30/08/2017

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES

APPENDIX II a

To Whom It May Concern

My name is Candice Naidoo, I am a qualified physiotherapist working at Rahima Moosa Hospital. I am currently doing my Masters on the effects of a home exercise programme on the exercise endurance of children with HIV. This study will consist of a randomised control trial.

As part of my study I will use the six minute walk test (6MWT) to measure the baseline endurance of 62 participants between the ages of five- nine years. The participants will be randomly allocated into two groups- the control and intervention group. The intervention group will be given an exercise programme to complete at home for a certain period of time (based on the validation outcome of the programme). After this time, both the intervention and control groups will be followed-up and endurance will be tested once again using the 6MWT. If the exercise programme yields a positive impact on the exercise endurance in the intervention group then the control group will also be given a copy of the programme.

As part of my study I need to have the home exercise programme evaluated. I would like to validate my home exercise programme through the use of a NGT. The study and proposed home exercise programme will be further explained at the group. The group will consist of a maximum of eight members and attendance is only required once. The group will run according to the standard five steps as highlighted by Galinsky, 2014, which I have attached.

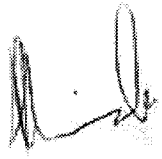
I would like to invite you to be a part of my group. The group will take at Rahima Moosa Hospital and will run between 45-90 minutes. I would like to start the group at 12:00. I have the following dates that I would like to propose, please let me know which day will suit you best: 14 September 2017, 16 September 2017 or the 18 September 2017.

An agenda will be sent to you upon confirmation of the meeting specifics.

This group will be voice recorded so I will require written consent to allow voice recording. Please note that I will also need written consent prior to your participation in this group and consent forms will be sent out once you confirm your availability or will be handed out on the day.

Please feel to RSVP via email or SMS: candicenoellenaidoo@gmail.com or 073 025 6337

Kind Regards



Candice Naidoo

APPENDIX II b

Nominal Group Confirmation Letter

Dear _____,

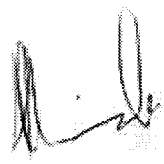
Thank you for your willingness to participate in my Nominal group. As discussed, I would like to hear your ideas and opinions about a paediatric home exercise programme in the public sector of Johannesburg.
You will be in a group with four to seven other health professionals working with paediatrics.

The date, time, and place are listed below. Please look for signs once you arrive directing you to the room where the group will be held.

Date: 18 September 2018
Time: 12:00
Venue: Rahima Moosa Hospital

Please RSVP before (11 September 2017)
Call Candice at 011 470 9075/6.

Kind Regards



Candice Naidoo

APPENDIX II c

Consent to Participate in a Nominal Group

You have been invited to participate in a Nominal group in the assistance of myself, Candice Naidoo, to validate a home exercise programme which forms part of my Masters dissertation. The purpose of this group is to approve the structure of the home exercise programme I have drawn up to improve the endurance of children infected with HIV.

You can choose whether or not to participate in the group and stop at any time. Although the group will be voice recorded, no names will be mentioned in the report. There are no right or wrong answers to the group questions. I want to hear different viewpoints from everyone in the group.

In respect for each other, I ask that only one individual speaks at a time in the group and that responses made by all participants be kept confidential.

I will try my best to keep all your personal information confidential. However we cannot guarantee that all your information will be kept absolutely confidential. Personal information will have to be shared if it is requested by law. Some organisations that may need to look at and use your information will be the research ethics committee and the medicines control council. Your information will only be used by them for study purposes. It may lead to individual identification if the results from studies are going to be published.

As the participant, I understand this information and agree to participate under the conditions stated above:

Name of participant: _____

Signature of participant: _____

Date: _____

APPENDIX II d

Consent to Voice Record in a Nominal Group

You have been invited to participate in a Nominal group in the assistance of myself, Candice Naidoo, to validate a home exercise programme which forms part of my Masters dissertation. The purpose of this group is to approve the structure of the home exercise programme I have drawn up to improve the endurance of children infected with HIV.

As part of your consent to participate in the Nominal group I would like your consent to voice record this group discussion in order to get an accurate record of what was said in the group. This voice recording will only be used for the purpose of data analysis as part of this study and will not be released to the media.

I will try my best to keep all your personal information confidential. However we cannot guarantee that all your information will be kept absolutely confidential. Personal information will have to be shared if it is requested by law. Some organisations that may need to look at and use your information will be the research ethics committee and the medicines control council. Your information will only be used by them for study purposes. It may lead to individual identification if the results from studies are going to be published.

Audiotapes will be kept for a period of two years after publication or six years if the study is not published.

As the participant, I understand this information and agree to allow the investigator to voice record this session under the conditions stated above:

Name of participant:_____

Signature of participant:_____

Date:_____

APPENDIX II e

Guidelines for Running a Nominal Group

- The group will need to be made up of multi professionals in order to get a wide range of views. This was applied to this study by inviting a number of different health care professionals including, allieds (Physiotherapists, Occupational therapists and Speech therapists), doctors and nurses.

- The group should run from 45- 90 minutes. This was applied to this study by allocating time limits to each step of the group meeting. Time restrictions were stipulated to the participants at the start of the meeting.
- This guide should be used to ensure that the same questions will be posed to all groups. Only one group was held so this did not apply to this study.

A time, date and venue should be proposed and health professionals should state whether they will be available to attend this meeting. In this study, this was carried out via email. On the day of the meeting the study should be explained in detail and then the focus question should be asked. This process was accurately followed in this study.

APPENDIX II f

Nominal Group Techniques

There are five steps that form part of the Nominal group technique as listed below;

The focal question	A focus question should be posed.
Step 1 : Silent generation of ideas in writing	Individual brainstorming: each participant will receive a small booklet of paper (8cm x 8cm) on which to write one suggestion per piece of paper with unlimited outcomes.
Step 2: Round Robin recording of ideas	Compiling a public list (on a flip chart) by a round robin collection of ideas, with no criticism of ideas posed.
Step 3 : Serial discussion for clarification	Discussion and clarification of outcomes on the public list. Duplications will be deleted and other domains will be renamed for clarity of understanding.
Step 4 (via e-mail): Preliminary vote of item-importance and final voting.	Compiling the final list of the outcomes and distributed via e-mail to all the participants. Each participant will select the five most important outcomes or domains from the list and rank the five domains from first to fifth priority (1st = Priority 1, 2nd = Priority 2, etc.).
Step 5: Analysis	Counting and weighting of domains: For e.g. assigning 5 to all 1st , 4 to all 2nd, etc.

(Wilcox & Zuber-Skerritt, 2003)

APPENDIX II g

Nominal Group Agenda

- Introduction
- Register
- Summary of the study
- Presentation of the home exercise programme – rough draft given to participants.
- Nominal Group Techniques:

The focal question	What can be done to improve this home exercise programme?
Step 1 (10min)	Individual brainstorming.
Step 2 (20 – 30 min)	Compiling a public list
Step 3 (30 – 45 min)	Discussion and clarification of outcomes on the public list.
Step 4 (via e-mail)	Compiling the final list of the outcomes and distributed to all the participants
Step 5- by the investigator	Counting and weighting of domains

APPENDIX II h

Good Morning

A big thank you for attending my Nominal group. I really appreciate all the valuable feedback.

I require one more thing from you please. Now that I have all the suggestions you have given me I need you to please rank these suggestions in order of priority. Please find the list below and rate the top five important suggestions. With 1 being the most valuable and 5 being the least valuable. Please write your score in front of the relevant suggestions.

- Children at the age of five won't be able to do the exercises that a nine year old would be able to do, therefore age gap is too large. For example skipping, wall squats and sit ups. It was suggested that I should just use seven-nine year olds.

- Add in exclusion criteria: children who are unable to perform the exercises. Children with HIV may be delayed and therefore struggle with coordination and may not be able to do the exercises properly and this will not be a correct representation of their endurance levels.

- Let the parents involve the siblings in the exercises so that the participant doesn't feel like they have to be the only one doing the exercises in the family- this will also help motivate the participant to be compliant with the exercise programme.

- Jogging on the spot as an exercise to replace wall squats as the wall squats involves too much strengthening and less endurance.

- Repetitions- the amount of repetitions should be kept minimal since there are a variety of exercises. Therefore to start in the first week with ten repetitions and then progress from there.

- The home exercise programme should be given a funky name such as the Tiger challenge or the Super Me workout so that it appeals more to children and the exercises could include an element of pretend in it. There could be a theme to the exercises. I.e. 'tiger movements' to incorporate the element of pretend.

- The exercises should be mixed up so that the strengthening exercises are in between the cardiovascular exercises.

- Weekends should be included as two of the days in which exercises should be done.

- Exercises can be made to be part of ADLs to increase compliance.

Thank You Kindly.



Candice Naidoo

APPENDIX II i

EXERCISE SHEET

This is a rough draft of what the exercise sheet will look like. This exercise sheet was designed based on previous studies that showed positive outcomes using an exercise programme.

Topics for research:

-An acceptable length of programme.

-Progression of exercise programme.

-The benefits of a combination of endurance and resistance exercises.

-Applicable design for the home exercise programme.

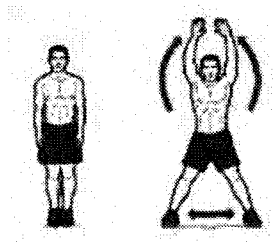
- **Jumping Jacks**

Start with your legs together and your arms at your side.

Jump and spread your arms and legs out at the same time to make a star.

Jump and bring your arms and legs back to the middle of your body.

Repeat the exercise



- **Skipping**

Using your skipping rope hold one handle in each of your hands.

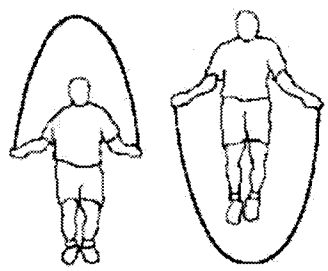
Let the rope lie behind your feet, using the handles flick the rope over the top of your head.

As the rope comes to the front of your feet jump over it (both feet in the air) so that the rope will be where it started.

You don't need to jump too high, just high enough to allow the rope to pass under your feet.

This will count as 1 skip.

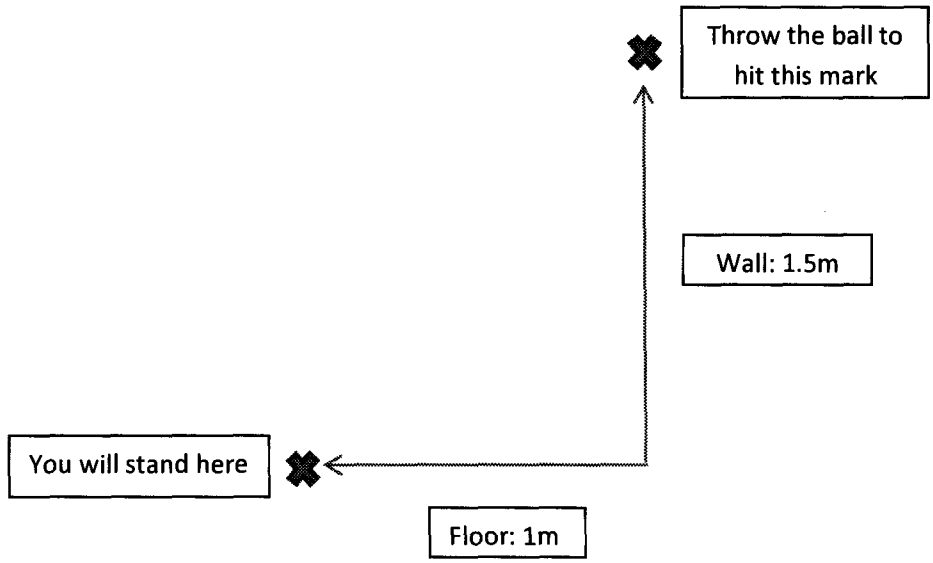
Repeat the exercise.



- **Throwing a ball against the wall**

Against a flat and smooth wall measure 1.5m high from the ground up and make a mark using any marker (You can use chalk so you can rub it off when you are done).

From the wall measure 1m on the floor away from the wall. This is where you will stand (See diagram below).



When you are standing in the correct spot with the ball in your hands bend both your knees and crouch down.

Straighten your legs and throw the ball up to hit the mark on the wall.

As the ball bounces off the wall and towards you, catch the ball.

This will count as 1.

Repeat the exercise.

- **Wall Squats**

Stand against a flat wall with your feet apart so that they line up with your shoulders.

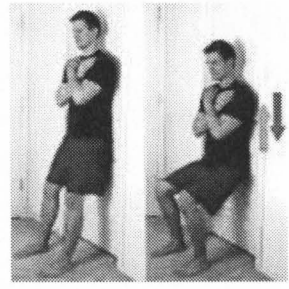
Cross your arms over your chest.

Slide down the wall making sure your knees bend and your back stays flat against the wall.

Slide down a little bit and then slide back up until your knees are straight again.

This will count as 1.

Repeat the exercise.



Please make sure that your knees don't come together and rather stay apart at all times. Please don't slide down too far.

- **Sit Ups**

Bend both your knees and ask someone to hold your feet down.

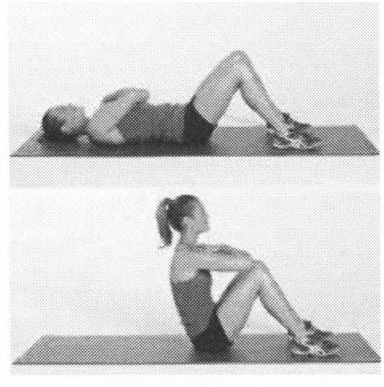
Cross your hands over your chest.

Squeeze in your tummy and lift your head and back up from the ground.

Slowly lower your body back down to the ground- make sure your lower back goes down gently first, then your upper back and lastly your head.

This will count as 1.

Repeat the exercise



Please ensure that you don't use your neck muscles to do this exercise.

APPENDIX III a

INFORMATION DOCUMENT

University of Witwatersrand

Informed Consent

Title: **A pilot study looking at the effects of a home exercise programme on the exercise endurance of HIV infected children.**

Addressing: Parent/ Legal Guardian of Child

Hello my name is Candice Naidoo. I am a physiotherapist working at Rahima Moosa Mother and Child Hospital. I am studying further now and would like to collect some information here at the hospital. In this study I want to learn if exercise will help children to do tasks that form part of their lives without getting tired as quickly, this is known as endurance.

I would like to ask if you will allow your child to take part in my study. With your permission, I would like to do some tests after your child has seen the doctor at the Empilweni department at the hospital. In this study I want to see how tired your child gets while walking for six minutes and then your child will be put into one of two groups to test if exercise will improve their endurance.

I will need him/her to walk from one cone to another; these cones will be ten meters apart, for six minutes. Important information that I will collect from her/him will include- heart rate, amount of oxygen in their body and blood pressure. This information will be collected before they start walking, immediately after they have walked and then five minutes after they have walked again. Once this is done your child will be randomly placed into one of two groups. One group will be given exercises to complete while the other group won't need to do anything new at home. Only one other visit will be required and each session of this test should take approximately 20 minutes. If your child is in the exercise group the first session will take approximately 30 minutes.

If your child is given exercises to complete at home, they will need to do a few simple exercises that will not take too long to complete. All children given exercises to complete at home will need to be supervised by an adult to ensure that the exercises are being done correctly. An exercise sheet will need to be completed to confirm whether exercises were done and any reasons why exercises could not be done.

After 12 weeks when you come for your follow-up visit with the doctors I will check your child's endurance by doing the same walking test and collecting the same important information-heart rate, blood pressure and amount of oxygen in the body. Children that are part of the control group will be given a copy of the exercise programme at the end of the study, if the exercise programme has been proven to improve the endurance of children in the exercise group.

Risks: It is possible that your child may get out of breath and tired while walking or while doing their exercises at home. If this does happen they can stop walking and start again when they feel less breathless. They are welcome to take a break at any time at home.

Benefits: The exercises done as a home exercise programme by children in the intervention group may or may not improve their endurance. Once all information has been collected and if the exercises are helping the children then I will create exercise pamphlets and all children will be given one to do at home.

Reimbursements: I will assist you with transportation costs if you are asked to come to the hospital on a different date to your doctor's follow-up visit to take part in the study.

Confidentiality: I will try my best to keep all your personal information confidential. However I cannot guarantee that all your information will be kept absolutely confidential. Personal information will have to be shared if it is requested by law. Some organisations that may need to look at and use your information will be the research ethics committee and the medicines control council. Your information will only be used by them for study purposes. It may lead to individual identification if the results from studies are going to be published.

Please note

It is your choice whether you want your child to be a part of this study or not. If you do not want to be a part of this study you will still receive all services, like all other patients, with no unfair treatment. You are also welcome to stop your child from taking part in this study at any time with no penalties or loss of benefits.

Contact details of researcher/s:

For any extra information / reporting of study related adverse events please feel free to contact: Candice 073 025 6337

Contact details of REC administrator and chair:

For reporting of complaints / problems.

Professor P Cleaton Jones: 011 717 1234

Consent:

I have carefully read the information document/ it has been explained to me in a language that I understand.

I understand what is expected of my child and what the goal of this study is.

I understand that at any time I may pull my child out of the study.

I understand that there are no monetary rewards for taking part in the study.

I hereby give permission for my child to participate in this study.

Name (in full) of child/participant: _____

Name (in full) of caregiver: _____

Signature of caregiver: _____

Relationship to child: _____

Name (in full) of witness: _____

Signature of witness: _____

Date: _____

APPENDIX III b

INFORMATION DOCUMENT

University of Witwatersrand

Informed Assent

Title: **A pilot study looking at the effects of a home exercise programme on the exercise endurance of HIV infected children.**

Addressing: Participants

Hello, my name is Candice and I am a physiotherapist doing a project to see how quickly children get tired while doing tasks in their day and then I am going to try and help you get through your day without getting as tired. I want to do a special test with you to first check how quickly you get tired.

I will need you to sit and relax in a chair while I check how fast your heart is beating and how your blood is flowing around your body by putting a band around your arm- this band will slowly get tighter but will not hurt you in any way. I will need to put a small machine on your index finger for a few minutes to measure the amount of oxygen in your blood.

Once we have done this we are going to start a walking test. What you have to do is walk for six minutes between two orange cones. You should try and walk as many times between the cones as possible. If at any point you are feeling tired or short of breath you are allowed to take a break and then carry on when you are ready. If you want to stop the test completely you can let me know. I will then like you to sit in the chair again so that I can check the same things I checked before you started walking.

You may also get some exercises that you will need to do at home. If you are given exercise to do at home you will need to do these exercises three times a week so we can test and see if these exercises are going to make you less tired in your day. I will show you how to do all these exercises before you go home and you will also get a chance to try them out to make sure that you can do them by yourself. The exercises will be given to you on paper in case you forget them. I will give you a ball and a skipping rope that you will use at home.

You are allowed to take breaks in between the exercises if you need to catch your breath and you can also take a break in the middle of completing an exercise if you need to. An adult will need to watch you doing your exercises and tick off as soon as you have done them. If you are unable to do your exercises please let an adult know so they can write it down. After some time you will need to come back to the hospital and I will ask you to walk and I'll do the same tests on you again.

Consent

- I know what I will have to do in this test.
- I know that I can stop and take a break if I get tired. I know that I can stop the test at any time I want to.
- I would like to take part in this study. YES NO

Name written by child (in full) : _____

Thumbprint of child (if necessary): _____

Witness signature_____

APPENDIX III c

Heart Rate and Respiratory Rate in Children

Age	Heart Rate (beats/min)	Respiratory Rate (breaths/min)
Premature	120-170	40-70‡
0-3 months	100-150	35-55
3-6 months	90-120	30-45
6-12 months	80-120	25-40
1-3 yr	70-110	20-30
3-6 yr	65-110	20-25
6-12 yr	60-95	14/22
12 ≥ yr	55-85	12-18

(Santillanes, 2008)

APPENDIX III d

Table showing the normal blood pressure for males between the ages of 7- 10 years.

Age	Percentile	Systolic BP (mmHg)							Diastolic BP (mmHg)						
		Percentile of height							Percentile of height						
7	50th	92	94	95	97	99	100	101	55	55	56	57	58	59	59
	90th	106	107	109	111	113	114	115	70	70	71	72	73	74	74
	95th	110	111	113	115	117	118	119	74	74	75	76	77	78	78
	99th	117	118	120	122	124	125	126	82	82	83	84	85	86	86
8	50th	94	95	97	99	100	102	102	56	57	58	59	60	60	61
	90th	107	109	110	112	114	115	116	71	72	72	73	74	75	76
	95th	111	112	114	116	118	119	120	75	76	77	78	79	79	80
	99th	119	120	122	123	125	127	127	83	84	85	86	87	87	88
9	50th	95	96	98	100	102	103	104	57	58	59	60	61	61	62
	90th	109	110	112	114	115	117	118	72	73	74	75	76	76	77
	95th	113	114	116	118	119	121	121	76	77	78	79	80	81	81
	99th	120	121	123	125	127	128	129	84	85	86	87	88	88	89
10	50th	97	98	100	102	103	105	106	58	59	60	61	61	62	63
	90th	111	112	114	115	117	119	119	73	73	74	75	76	77	78
	95th	115	116	117	119	121	122	123	77	78	79	80	81	81	82
	99th	122	123	125	127	128	130	130	85	86	86	88	88	89	90

Table showing the normal blood pressure for females between the ages of 7-10 years.

Age	Percentile	Systolic BP (mmHg)							Diastolic BP (mmHg)						
		Percentile of height							Percentile of height						
7	50th	93	93	95	96	97	99	99	55	56	56	57	58	58	59
	90th	106	107	108	109	111	112	113	69	70	70	71	72	72	73
	95th	110	111	112	113	115	116	116	73	74	74	75	76	76	77
	99th	117	118	119	120	122	123	124	81	81	82	82	83	84	84
8	50th	95	95	96	98	99	100	101	57	57	57	58	59	60	60
	90th	108	109	110	111	113	114	114	71	71	71	72	73	74	74
	95th	112	112	114	115	116	118	118	75	75	75	76	77	78	78
	99th	119	120	121	122	123	125	125	82	82	83	83	84	85	86
9	50th	96	97	98	100	101	102	103	58	58	58	59	60	61	61
	90th	110	110	112	113	114	116	116	72	72	72	73	74	75	75
	95th	114	114	115	117	118	119	120	76	76	76	77	78	79	79
	99th	121	121	123	124	125	127	127	83	83	84	84	85	86	87
10	50th	98	99	100	102	103	104	105	59	59	59	60	61	62	62
	90th	112	112	114	115	116	118	118	73	73	73	74	75	76	76
	95th	116	116	117	119	120	121	122	77	77	77	78	79	80	80
	99th	123	123	125	126	127	129	129	84	84	85	86	86	87	88

APPENDIX IV

Data Collection Sheet- All participants

Date: __ __ / __ __ __ / __ __ __ __

DD MMM YYYY

Interval at which data is being recorded: Baseline 12 week follow-up

Study Number:

Gender: M F

Age: _____ years _____ months

Height: _____ cm

Weight: _____ kg BMI: _____

CD4 count: _____ _____

Viral Load: _____

Six Minute Walk Test

1. Was measurement obtained? ☐ 1 = Yes ☐ 2 = No

If NO, reason: _____

2. Measurements:

	Pre test	Post test (immediate)	Post test (5 min)
BP			
HR			
Sats			

3. Lap counter: _____ _____ _____ _____ _____ _____ _____

_____ _____ _____ _____ _____ _____ _____ _____ _____

_____ _____ _____ _____ _____ _____ _____ _____ _____

_____ _____ _____ _____ _____

4. Total Distance: _____ m

5. Paused during test: ☐ 1 = Yes ☐ 2 = No If YES, reason:

_____

APPENDIX V

Testing guidelines to be used: As recommended by the American Thoracic Society (2002)

Indications and Limitations

- To measure the way a patient with moderate to severe lung or heart disease responds to a medical intervention.
- To predict the morbidity and mortality functional status in a patient.

Safety

- Testing should be done in a location where there is close access to emergency services if needed.
- The 6MWT needs to be stopped if the patient experiences; chest pain, dyspnea (which is intolerable), cramping in their legs or dizziness.

Technical Features

- The test must be performed indoors on a long, flat, straight 30m long corridor that has a hard surface and will not be crowded by people walking past during the test.

Equipment Needed

- Stop watch
- Lap counter
- Two small cones to mark the turnaround points
- A chair which can be moved around the room
- A source of oxygen
- Sphygomanometer

Patient Preparation

- Comfortable clothing and appropriate shoes for walking should be worn.
- The patient's usual medical regimen should be continued.
- A light meal is acceptable before early morning or early afternoon tests.

Measurements

1. When the test is repeated it should be performed at approximately the same time of day as the first test in order to minimise intraday variability.
2. A "warm-up" period before the test should not be performed.
3. Instruct the participant as follows:
   "The object of this test is to walk as far as possible for six minutes. You will walk back and forth in this hallway. Six minutes is a long time to walk, so you will be exerting yourself. You will probably get out of breath or become exhausted. You are permitted to slow down, to stop, and to rest as necessary. You may lean against the wall while resting, but resume walking as soon as you are able. You will be walking back and forth around the cones. You should pivot briskly around the cones and continue back the other way without hesitation. Now I'm going to show you. Please watch the way I turn without hesitation." Demonstrate by walking one lap yourself. Walk and pivot around a cone briskly. "Are you ready to do that? Remember that the object is to walk AS FAR AS POSSIBLE for six minutes, but don't run or jog. Start now, or whenever you are ready."
4. Position the participant at the starting line. You should also stand near the starting line during the test. Do not walk with the participant. As soon as the participant starts to walk, start the timer.
5. Do not talk to anyone during the walk. Use an even tone of voice when using the standard phrases of encouragement. Watch the participant. Do not get distracted and lose count of the laps. Each time the participant returns to the starting line, mark the lap on the worksheet. Let the participant see you do it.

After the first minute, tell the participant the following (in an even tone): "You are doing well. You have five minutes to go". When the timer shows four minutes remaining, tell the participant the following: "Keep up the good work. You have four minutes to go". When the timer shows three minutes remaining, tell the participant the following: "You are doing well. You are halfway done". When the timer shows two minutes remaining, tell the participant the following: "Keep up the good work. You have only two minutes left". When the timer shows only one minute remaining, tell the participant: "You are doing well. You have only one minute to go."

If the participant stops walking during the test and needs a rest, say this: "You can lean against the wall if you would like; then continue walking whenever you feel able." Do not stop the timer. If the participant stops before the six minutes are up and refuses to continue (or you decide that they should not continue), wheel the chair over for the participant to sit on, discontinue the walk, and note on the worksheet the distance, the time stopped, and the reason for stopping prematurely.

When the timer is 15 seconds from completion, say this: "In a moment I'm going to tell you to stop. When I do, just stop right where you are and I will come to you. "When the timer rings (or buzzes), say this: "Stop!" Walk over to the participant. Consider taking the chair if they look exhausted. Mark the spot where they stopped by placing a bean bag or a piece of tape on the floor.

6. If using a pulse oximeter, measure SpO2 and pulse rate from the oximeter and then remove the sensor.
7. Record the total number of laps from the tick marks on the worksheet.
8. Record the additional distance covered (the number of meters in the final partial lap) using the markers on the wall as distance guides. Calculate the total distance walked, rounding to the nearest meter, and record it on the worksheet.
9. Congratulate the participant on good effort and offer a drink of water.

A reading book will be given to the child to keep them busy while they are waiting for ten minutes to pass.

APPENDIX VI

Exercise Checklist

Please tick (if the exercise was done) or cross (if the exercise was not done) in the exercise columns and write a comment (if necessary) in the last two columns.

Please keep this checklist safe and bring it back to the hospital when you come for your check up in 12 weeks' time.

An example of how to fill in the table:

Week 1

Date	1.Sit Up and Catch the Mouse. x10	2.Help! A lion is chasing me. x10	3.Pouncing on Lion cubs. x15	4.Chasing a Cow. X20	5. Catch a bird. X10	**Any reasons why I could not do my exercise**	**Any reason why I had to take a break from doing my exercise**
22/08/2017	√	√	√	√	X	I was too tired to throw the ball 10 times so I threw the ball 8 times to my brother.	I took two breaks while doing my exercise because I was feeling tired, then I continued with my exercise.
25/08/2017	√	√	√	√	√	None	I only took one break today and then continued with my exercises.

I have chosen to do my exercises on: (Choose and circle three days)

Monday Tuesday Wednesday Thursday Friday Saturday Sunday

I will do my exercises in the: (Choose and circle one)

Morning Afternoon Evening

APPENDIX VII

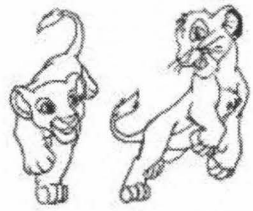
The Super Lion Programme



In this programme we will pretend that you are a Lion. When you do each exercise you must pretend that you are a lion doing it.

Your brothers and sisters are allowed to join you do the exercises as long as they don't help you.

Name of exercise	Instructions	Pretend	Picture
1.Sit Up and Catch the Mouse.	• Lie on your back and bend your knees. • Ask someone to hold your feet flat and hold a ball above your knees. If there is no one to help you, tuck your feet under a low bed or low table and place the ball between your knees. • With your hands stretched out come up and touch the ball in front of you. • Squeeze in your tummy and lift your head and back up from the floor. • Touch the ball and then slowly lower your body back down to the ground- make sure your lower back goes down gently first, then your upper back and lastly your head. • Remember not to squeeze your neck muscles.	You are a lion and the ball is the mouse that you are catching.	 

2.Help! A lion is chasing me	• Start standing up with your legs together and your arms at your side. • Jump and spread your arms and legs out at the same time to make a star. • Jump and bring your arms and legs back to the middle of your body. • Remember to lift your hands all the way up to your head.	A lion is chasing you and you are calling your friends for help.	 
3. Pouncing on Lion cubs.	• Using your skipping rope hold one handle in each of your hands. • Let the rope lie behind your feet, using the handles flick the rope over the top of your head. • As the rope comes to the front of your feet jump over it (both feet in the air) so that the rope will be where it started. You don't need to jump too high, just high enough to allow the rope to pass under your feet. • This will count as one skip.	You are playing with all the other lion cubs	 
4.Chasing a Cow	• Jogging on the spot. • Lift one foot up as high as you can. • And let your arms move with your legs as if you are running but just stay in one spot. • Remember to make sure that you are lifting your legs up high.	You are running after a cow that is trying to get away.	 

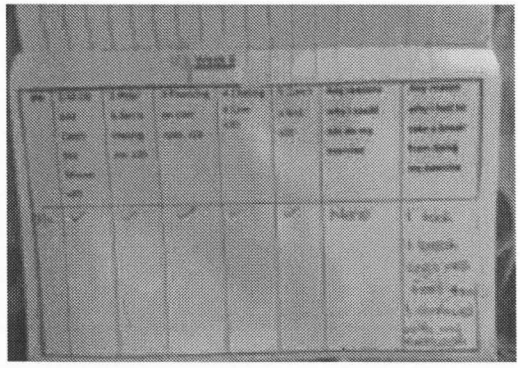
5. Catch a bird	• Make a space, one big step, between you and someone else. Take the ball and bounce it in the middle of you and someone else so the person catches the ball. That counts as one. • Let the other person throw and bounce the ball and you must catch the ball.	The ball is a bird that you are catching and throwing in the air.	

Appendix VIII

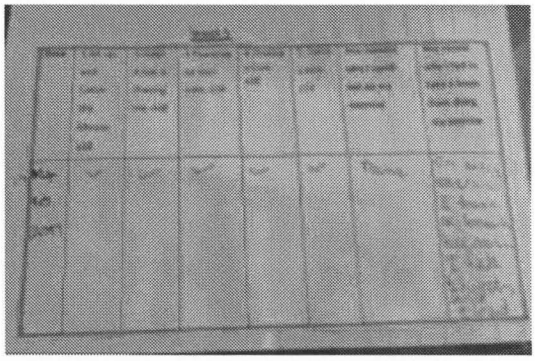
The following images were taken from the exercise booklets given to participants in the intervention group. These were given out at the baseline visit and returned at the follow-up visit.



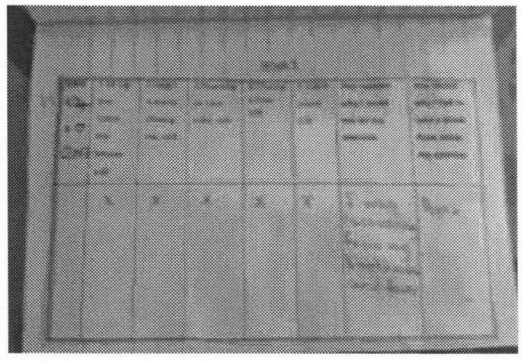
Decorated A5 checklist booklets



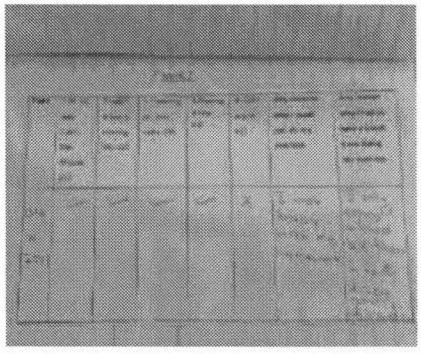
Comment in the booklet showing why participant took a break.



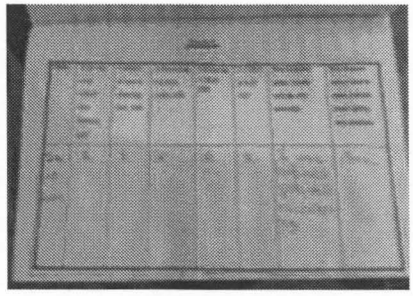
Comment in the booklet showing why participant took a break.

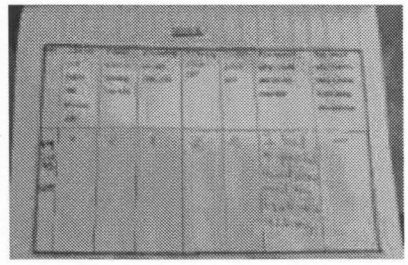


Comment in the booklet showing why exercises could not be done on that day.



Comment in the booklet showing why participant took a break.





Comment in the booklet showing why exercises could not be done on that day.

Appendix IX

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