ASSESSING THE PHYSICAL FITNESS LEVEL OF CHILDREN WITH INTELLECTUAL DISABILITY IN THE GRAHAMSTOWN REGION OF THE EASTERN CAPE, AND SUBSEQUENTLY DESIGNING, IMPLEMENTING AND EVALUATING THE EFFICACY OF AN EXERCISE INTERVENTION.

BY

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THESIS

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ABSTRACT

Background: Extensive research has addressed physical fitness as an agent in promoting health and well-being; however, there is little research on this topic for special populations, such as individuals with intellectual disability and even less relating to the South African context. Children with intellectual disability attending special need schools in disadvantaged communities in the Eastern Cape have lacked the opportunity to participate in structured physical education programs. Implementing a solution to this problem was seen to be a challenge, due to the lack of informative research and available data.

Aims: The purpose of this research was two-fold; firstly, it aimed to identify the physical fitness levels of the intellectually disabled children in the Grahamstown region of the Eastern Cape province of South Africa; and secondly, it aimed to implement and evaluate the efficacy of an exercise intervention programme on physical fitness in a local school for children with intellectual disability.

Phase 1: The descriptive study compared basic anthropometric as well as physical fitness measures from a sample of participants with intellectual disability (n=29) with a comparable sample of typically developed children (n=25). There were 15 males and 14 females in the intellectually disabled sample group, with an average age of 10.69 ± 1.26 years, and the typically developed sample had 13 males and 12 females, with an average age of 10.51 ± 0.74 years. The anthropometric measures included stature and mass; while the health-related physical fitness components included cardiorespiratory endurance, muscular endurance, strength, body composition, and flexibility; and the skill-related physical fitness components were balance, agility, speed, power, coordination and reaction time. The results revealed that the children with intellectual disability were significantly shorter in stature and lighter in mass ($p < 0.001$) compared to their typically developed peers. Muscular endurance and strength, balance, speed, power, coordination and reaction time were poorer among those with intellectual disabilities ($p < 0.05$). Cardiorespiratory endurance, flexibility and agility were similar between groups. Results of the correlation analyses determined significant ($p < 0.05$) relationships between certain health-related and/or skill-related physical fitness components, which were instrumental for selecting measures for Phase 2. The physical fitness components that had the most significant

($p < 0.05$) correlations were speed with five significant correlations, both muscular endurance and balance with six, coordination with seven, and power with eight significant correlations of the eleven physical fitness components. The comparative results, in conjunction with the correlations, determined that the most suitable physical fitness components to be implemented in the exercise intervention for Phase 2 were muscular endurance, balance, and power.

Phase 2: The intervention study was a case-control study (intervention group: n = 16; control group: n = 15), whereby the intervention group was exposed to an 8-week multi-modal exercise intervention training muscular endurance, balance and power. Pre-and post-intervention measures were performed using the same eleven physical fitness tests as in Phase 1. The interaction effects and effect sizes were determined and the results showed significant improvements and large effect sizes for the intervention group's performance of muscular endurance ($p=0.026$; $d=0.617$) and power ($p<0.000$; $d=0.999$), whereas no significant changes were found for balance. Furthermore, the exercise intervention also impacted the overall level of physical fitness, as significant changes were found for cardiorespiratory endurance ($p<0.001$; $d=0.98$), strength ($p=0.021$; $d=0.654$) and flexibility ($p=0.032$; $d=586$). In conclusion, the exercise intervention was effective for improving the intellectually disabled participants' muscular endurance and power but not found effective for balance.

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CHAPTER I

INTRODUCTION

STUDY BACKGROUND

Disabled people are one of the most marginalized and vulnerable populations in society (Statistics South Africa, 2005; WHO, 2011). In 2010, the United Nations estimated that more than a billion people worldwide live with some form of disability (Statistics South Africa, 2005; Mont, 2007; WHO, 2011). According to the Global Burden of Disease 95 million children between the ages 0-14 years are ailed with disabilities, of which 13 million have "severe" disabilities (WHO, 2011). Furthermore, 975 million people of 15 years and older live with disabilities (WHO, 2011).

Developing countries have approximately 80% of the world's disabled population living with some form of disability (Statistics South Africa, 2005; WHO, 2011). More specifically, in South Africa a total of 2 255 982 people were reported to have some kind of disability, which constituted 5% of the total South African population (Soudien & Baxen, 2006; Statistics South Africa, 2015). The majority of the South African population living with a disability have a low income and no or low level of education; therefore, disability and poverty are intricately interlinked (Statistics South Africa, 2005; Mont, 2007). Poverty can cause or exacerbate disability with its associated malnutrition, poor health services and sanitation, and unsafe living and working conditions (Mont, 2007). The World Health Organization (2011) reported that only 26 – 55% of disabled people received the medical attention they needed, and 5 – 24% received the required welfare services in Southern African countries (WHO, 2011). Conversely, the presence of a disability can trap people in a life of poverty because of the barriers disabled people face in taking part in education, employment, social activities, and indeed all aspects of life (Guthrie et al., 2001; Mont, 2007; Bodde & Seo, 2009; WHO, 2011). South Africa has begun to recognise the necessity for rehabilitation and civil rights of people with disabilities who are predisposed to activity limitations, participation restrictions, and furthermore the resulting disadvantage they experience on national indicators of health, education and economic prosperity (Statistics South Africa, 2005).

The Eastern Cape of South Africa has the third highest prevalence of disability in the country with 462 179 people (Soudien & Baxen, 2006; Statistics South Africa, 2015). In addition, the Eastern Cape has the second highest prevalence of 41 432 intellectually disabled people (Soudien & Baxen, 2006). The report prepared by Soudien and Baxen (2006) indicates that while the Eastern Cape accounts for 17.39% of disabled people in South Africa, the province only has 41 special needs schools. In contrast, these authors point out that the Western Cape has 5.47 % of the disabled population but has 82 special needs schools. Therefore, disabled children in the Eastern Cape are more likely to be overlooked or excluded from educational opportunities, as the regular schooling environment does not facilitate integration (Statistics South Africa, 2005).

Intellectual disability is the most prevalent of all developmental disabilities (Pastula et al., 2012). An intellectual disability is a disability characterized by significant limitations both in cognitive functioning and in adaptive behaviour, which covers conceptual, practical and social skills (Pastula et al., 2012). In addition to intellectual impairment, research by Waninge (2011) found that the intellectually disabled population, when compared to the general population, has twice the prevalence of health risks and co-morbidity. Therefore, people with intellectual disability are more likely to be obese, less likely to be physically active, and are at higher risk of developing a chronic disease such as cardiovascular disease, diabetes, osteoporosis and arthritis (Grund et al., 2000; Rice & Howell, 2000; Rimmer, 2001; Jansen et al., 2004; Haskell et al., 2007; Lin et al., 2010; Waninge, 2011; Barwick et al., 2012; Pastula et al., 2012). Individuals with mild intellectual disability have a mortality rate 1.7 times that of the general population, and those with severe disability 4.1 times the general rate (Beange et al., 1999; Waninge, 2011; Yanardag et al., 2013). Daily activities such as climbing stairs, getting in and out of bed and even walking become more challenging to perform as time and inactivity continue (Rimmer, 2001; Jansen et al., 2004). Recent literature has advocated that physical activity plays a key role for the management of chronic health conditions, as it not only reduces the risk for secondary health problems, but all levels of functioning can be influenced positively through physical activity (van der Ploeg et al., 2004; Ruiz et al., 2006; Santos & Mota, 2009; Calders et al., 2012; Stanish & Temple, 2012). If a minimal standard of physical fitness is met by an individual, regardless of disability status, they are more likely to live longer and suffer fewer restrictions in their daily activities as they age (Rimmer et al., 1996). Physical fitness can prevent the deterioration in physical function, increase autonomy and decrease dependence enforced by support needs (Davis et al., 2011; Hubbard et al., 2014). Furthermore, health and wellness are key factors that help people with disabilities to fully benefit from progress in education, employment, healthcare and community integration (Hubbard et al., 2014).

Despite the extensive research published in the field of exercise science concerning physical fitness and its importance in promoting health and preventing disease, there remains a lack of research regarding the efficacy of exercise interventions for children with intellectual disabilities (Rimmer et al., 1996; Golubović et al., 2012). Furthermore, there have been no studies on children with intellectual disability and their level of physical fitness in South Africa. Therefore, physical fitness as a healthcare intervention for intellectually disabled people in South Africa is a new yet under-developed field of research (Watermeyer et al., 2006).

STATEMENT OF THE PROBLEM

The children with intellectual disability attending special need schools in disadvantaged communities in the Eastern Cape have lacked the opportunity to participate in structured physical education programs. Implementing a solution to this problem was deemed to be a challenge, due to the lack of informative research and available data for intellectually disabled children's level of physical fitness in South Africa. Therefore, further research was needed to address the gap in the literature pertaining to intellectual disability and physical fitness in the South African context. Two problems needed to be addressed. Firstly, quantifying the level of physical fitness of intellectually disabled children in the Eastern Cape Province of South African and secondly, investigating the efficacy of an exercise intervention program in improving their level of health-related and skill-related physical fitness.

AIMS AND OBJECTIVES

In addressing the lack of research on intellectually disabled children's level of physical fitness in the Eastern Cape this study consisted of two phases (Figure 1). The first phase was a descriptive study, which aimed to identify the physical fitness levels of children with intellectual disability by measuring and assessing the eleven components of physical fitness of a sample group of intellectually disabled children and comparing their results to a sample of their typically developed peers. These results were then used, in conjunction with the literature, to subsequently inform and develop the design of the exercise intervention study - this constituted phase two of this study. The aim of phase 2 was to implement and evaluate the efficacy of an exercise intervention program, with the objective to improve intellectually disabled children’s level of physical fitness.

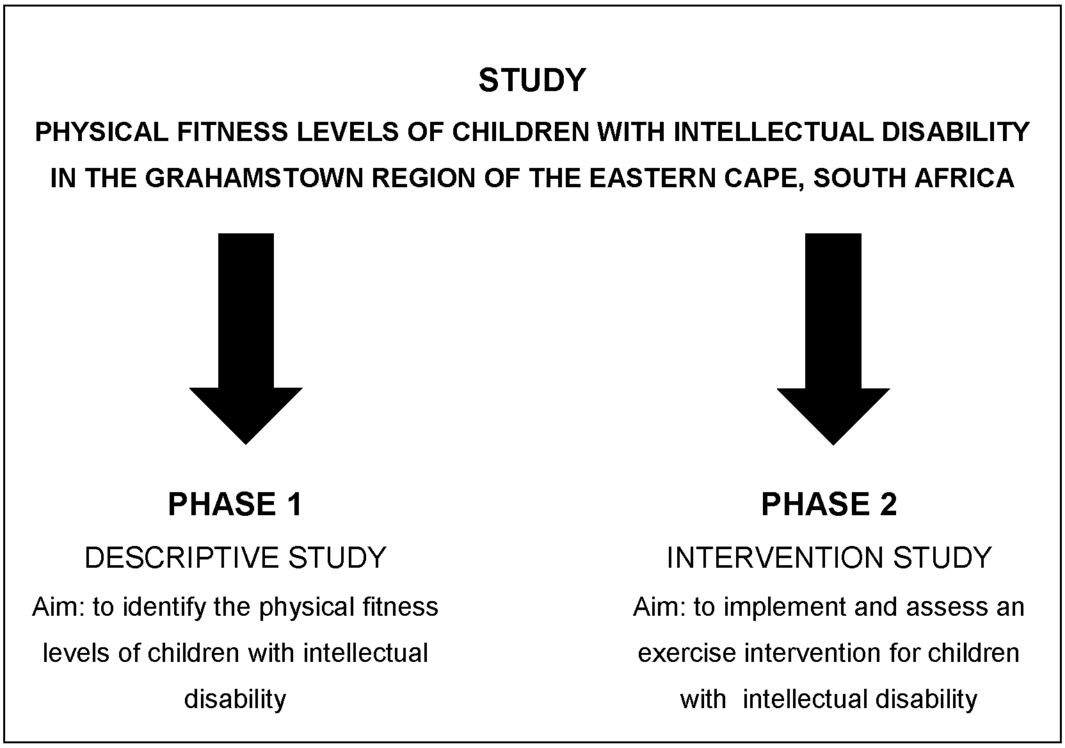


Figure 1: Flow diagram showing two-fold approach to the research study

CHAPTER II

REVIEW OF LITERATURE

The *Review of Literature* chapter has been separated into two parts: Part I is presented as a narrative review (pg. 6-31), while Part II is presented as a systematic review (pg. 32-44).

PART I: NARRATIVE REVIEW

Overview / History of Disability

Models of Disability

Intellectual Disability

Physical Activity

Physical Fitness

The South African Context

PART II: SYSTEMATIC REVIEW

The effect of an exercise intervention on the level of physical fitness for children with intellectual disability: a systematic review

The reason for this was that the narrative review would provide a broad understanding of intellectual disability and physical fitness, and the systematic review would provide clarity on the effectiveness of exercise interventions through the systematic analysis of evidence from previously related studies. From this evidence, the author would be able to identify the most appropriate and effective frequency, intensity and duration for an exercise intervention.

PART I: NARRATIVE REVIEW

OVERVIEW / HISTORY OF DISABILITY

The historic perspective of disability has been somewhat unclear and tumultuous. Scheerenberger (1983) stated that persons with intellectual disability have been a part of human civilization since the beginning of human history; however, the documentation has lacked clear evidence. The term used to describe individuals ailed with an intellectual disability have progressed from idiot, imbecile, moron, feeble-minded and retarded (Richards et al., 2015). If these terms were used in today's society to describe a person with intellectual disability it would be considered highly offensive. Historically however these terms were used by scholars of various time periods (Richards et al., 2015).

Intellectual disability was first legally defined in 1324 (Scheerenberger, 1983). Up until the 15th Century religion, superstition, and fear dominated society's beliefs (Kanner, 1964; Fait, 1978; Nehring, 2005; Richards et al., 2015). Persons with intellectual disability were often ostracized and tortured as a result, and the practice of infanticide for disabled children became widespread (Kanner, 1964; Fait, 1978; Nehring, 2005; Richards et al., 2015). Between the 16th and 19th century, a number of physicians, such as Paracelsus, Jacob Rodrigues Periere and Phillipe Pinel, were at the forefront of disability research that piqued interest into the field of intellectual disability (Scheerenberger, 1983; Stainton, 2004; Nehring, 2005; Richards et al., 2015). Furthermore, Jean Etienne Esquirol, a French psychiatrist, was one of the earliest physicians to actively identify that there were different levels/degrees of intellectual disability (Richards et al., 2015). Jean Marc Gaspard Itard was the first person to attempt to educate an individual with an intellectual disability in 1799 (Fait, 1978; Richards et al., 2015). Edouard Seguin was a renowned educationalist, specializing in intellectual disability, and founded, along with five other physicians, the Association of Medical Officers of American Institutions for Idiotic and Feebleminded Persons in 1876 (Fait, 1978; Richards et al., 2015). This organization is currently known as the American Association of Intellectual and Developmental Disability (Richards et al., 2015). However, in the last half of the 19th century, progress was stunted by the Civil War, the Great Depression and the Eugenics Movement (Fait, 1978; Owens et al., 2009; Barnes, 2012; Richards et al., 2015).

The early 20th century brought about affirmative transformation, due to a number of philosophical, educational, medical and legal influences that positively affected individuals with intellectual disability (Scheerenberger, 1983; Richards et al., 2015). The perceptions of intellectual disability changed moralistically and eugenics was de-emphasized (Scheerenberger, 1983; Richards et al., 2015). Educationally, individuals such as Edgar Doll began to have an impact, noting the importance of identifying and developing adaptive skills through legislations that supported special educational needs (Scheerenberger, 1983). During the second half of the 20th century a significant number of legislation acts were drawn up in support of individuals with intellectual disability (Richards et al., 2015). The acts contributed towards funding for health, research and education, which spiked an interest in the field of intellectual disability studies (Richards et al., 2015). The United Nations General Assembly, in 1948, implemented the Universal Declarations of Human Rights, upon which laid the foundation of the human right movements, but still lacked provisions concerning disability (Owens et al., 2009). In America in 1953 the "Educational Bill of Rights for the Retarded Child" was published, but this was not internationally adopted, as many countries still did not recognise education as a basic right for children with intellectual disability (Owens et al., 2009; Richards et al., 2015). It took nearly a quarter of a century before the United Nations began to adopt new declarations specifically focused on the rights of persons with disabilities, beginning with the Declaration on the Rights of Mentally Retarded Persons in 1971 (Owens et al., 2009). Canada was the first country in the world to incorporate federal, provincial, and territorial human rights legislations into their constitution, in which the principle that persons with disabilities are entitled to the same rights as the rest of the population was highlighted, and this began to make its way into statuses and common law in the 1970s and 1980s (Owens et al., 2009). These legislations marked a 'paradigm shift' in attitudes and approaches towards persons with disabilities, from viewing persons with disabilities as 'objects' of charity, medical treatment and social protection towards viewing persons with disabilities as 'subjects' with rights and who are capable of claiming those rights as well as being active members of society (Owens et al., 2009; Barnes, 2012). Interestingly enough, the second and third countries to follow suit were Germany and South Africa, two countries that had been among the most egregious violators of human rights in the 20th century (Owens et al., 2009). The latest and most significant milestone at international level was the adoption by the UN General Assembly of the

Convention on the Rights of Persons with Disability in December 2006 (Owens et al., 2009).

Despite an advanced legislation regarding rights for the disabled, South Africa has lacked the development and provision for disability progression, as the situation for disabled people has remained unchanged since the advent of democracy in 1994 (Guthrie et al., 2001; Adnams, 2010). In saying this, there were a few legislative changes made to the Bill of Rights concerning social security; however, these changes were fraught with problems at implementation level and the capacity of provincial and local organisations to plan and implement disability related programmes are limited, especially in the rural areas of South Africa (Guthrie et al., 2001; Watermeyer et al., 2006; Adnams, 2010; Foskett, 2014). At the same time persons with disabilities in South Africa continue to face poverty stricken circumstances and discrimination, despite the above protective measures (Guthrie et al., 2001; Watermeyer et al., 2006; Adnams, 2010). Therefore, key issues regarding health and disability have not been addressed and there is a serious lack of reliable information concerning the prevalence and nature of disability within South Africa (Guthrie et al., 2001; Adnams, 2010). This has resulted in little progress towards redressing the status of persons with disabilities in South Africa, in particular those living under severe socio-economic constraints (Guthrie et al., 2001; Adnams, 2010). Furthermore, there has been a lack of physical education in Government special needs schools in South Africa, which needs to be rectified, as the opportunity for structured physical activity is paramount for health related benefits as well as social integration.

MODELS OF DISABILITY

Disability is a complex phenomenon that has evolved throughout history as the definitions and models for disability have changed. The idea of a model for disability first came about when the concept of the norm came to be the ultimate social measure (Davis, 2006). The key to understanding the association between disability and ability requires an interrogation of the social meaning of normalcy (Wiart & Darrah, 2002; Davis, 2006). Persons with disability underwent scrutiny and had to conform to the standard of normalcy determined by individuals without disability (Wiart & Darrah, 2002; Davis, 2006). Hereafter, disabled individuals became objects of study for the biological and social sciences (Davis, 2006).

In many traditional cultures and religions, disability was first viewed via the moral model of disability (Vehmas, 2004). This model was based on moral flaws, for example, if a person was impaired later on in life, his/her impairment could have been explained by his/her own moral failures; or infants would inherit a disability as a result of their parents' moral offenses (Vehmas, 2004). As society moved towards a more scientific approach, the medical model of disability was adopted in the later part of the 1900s (Guthrie et al., 2001; Wiart & Darrah, 2002; Vehmas, 2004; Watermeyer et al., 2006; Iezzoni & Freedman, 2008). The general framework of the medical model emphasized clinical diagnosis, and acknowledged disability to be a direct product of genetics, disease, trauma or other health conditions, which predisposes practitioners to think of disability as a 'condition', which needs appropriate 'treatment' (Llewellyn & Hogan, 2000; Iezzoni & Freedman, 2008). Therefore, according to the medical model, disability was entirely a problem or deficit within an individual's physiological or mental capacity, which lead to a partial and inhibiting view of disability, with little to no consideration of society's role in the construction of disability (Brisenden, 1986; Llewellyn & Hogan, 2000; Guthrie et al., 2001; Wiart & Darrah, 2002; Vehmas, 2004; Watermeyer et al., 2006; Mont, 2007; Iezzoni & Freedman, 2008; Shakespeare, 2013). The more complex social model approach to disability argued that numerous factors, such as health conditions, impairments, discrimination, systematic exclusion and environmental factors combined elucidate disability (Watermeyer et al., 2006; Mont, 2007). The social model, therefore, enforces the fundamental differences between impairment, which is the pathological condition of the body, and disability, which is the construct of society that inhibits the participation of persons with impairments to achieve their full potential (Oliver, 1995; Hughes, 2004; Watermeyer et al., 2006; Mont, 2007; Shakespeare, 2013). This distinction had the effect of removing impairment and body from disability discourse and undermining the credibility of the medical model (Hughes, 2004). However, in the 1990s, the social model was criticized for not adequately addressing how one can identify individual truth, perceptions and belief about disability (Llewellyn & Hogan, 2000; Hughes, 2004). Therefore, disability must be recognised as a complex phenomenon, requiring different levels of analysis and intervention, ranging from the medical to the socio-political (Shakespeare, 2013).

The medical model and the social model are often presented as dichotomous, but disability should be viewed neither as purely medical nor as purely social (WHO, 2011). A more balanced approach was needed, giving appropriate weight to the different aspects of disability (WHO, 2011). In 1980, the World Health Organisation published the International Classification of Impairments, Disabilities and Handicaps, which suggested conceptual distinctions among three level of performance; impairment at the organ level, disability at the person level, and handicap at the societal level (Whiteneck, 2006). However, this sparked controversy by labelling the societal level as 'handicap' and by failing to incorporate environmental factors (Whiteneck, 2006). In 2001, the World Health Organisation released a revised International Classification of Functioning, Disability and Health (ICF), which recognised the importance of environmental factors within the new categorization system and replaced the three domains with more appropriate labels, namely body functions and structures at the organ level, activity at the person level, and participation at the social level (Whiteneck, 2006). The ICF is referred to as the bio-psycho-social model of disability, in which disability can no longer be seen as a static homogenous feature but rather as a dynamic and changing experience determined by the changing nature of the environment (Watermeyer et al., 2006; WHO, 2007). Therefore, this theoretical model draws upon both the medical model and the social model of disability. Disability in the ICF is not an "all or nothing" concept (Mont, 2007; WHO, 2007). Disabilities are classified according to a detailed description of their functioning within various domains, as shown in Figure 2 (Mont, 2007). Firstly, "body functions and structures" is the most closely related to the medical model, as it refers to the physiological and psychological functions of body systems (Watermeyer et al., 2006; Mont, 2007). Secondly, "activities" refers to a range of deliberate actions performed by an individual to accomplish a task, such as getting dressed or feeding oneself (Watermeyer et al., 2006; Mont, 2007). Thirdly, "participation" expands on the activities that are fundamental to social and economic life, such as being able to attend school or hold a job (Watermeyer et al., 2006; Mont, 2007). Moreover, the ICF incorporates the social model by including information on how a person's ability to function is affected by the environment they face (Mont, 2007). For example, a given level of impairment in the body function domain will not necessarily translate into an activity or participation limitation if the environment accommodates a person's different functional status (Mont, 2007).

The ICF serves as the global standard for defining and documenting disability and has shown to be an essential tool for identifying and measuring efficacy and effectiveness of rehabilitation services, both through functional profiling and intervention targeting (Simeonsson et al., 2003; Üstün et al., 2003). In short, the ICF offers an international, scientific tool for understanding human functioning and disability for clinical, research, policy development and a range of other public health uses (Üstün et al., 2003).

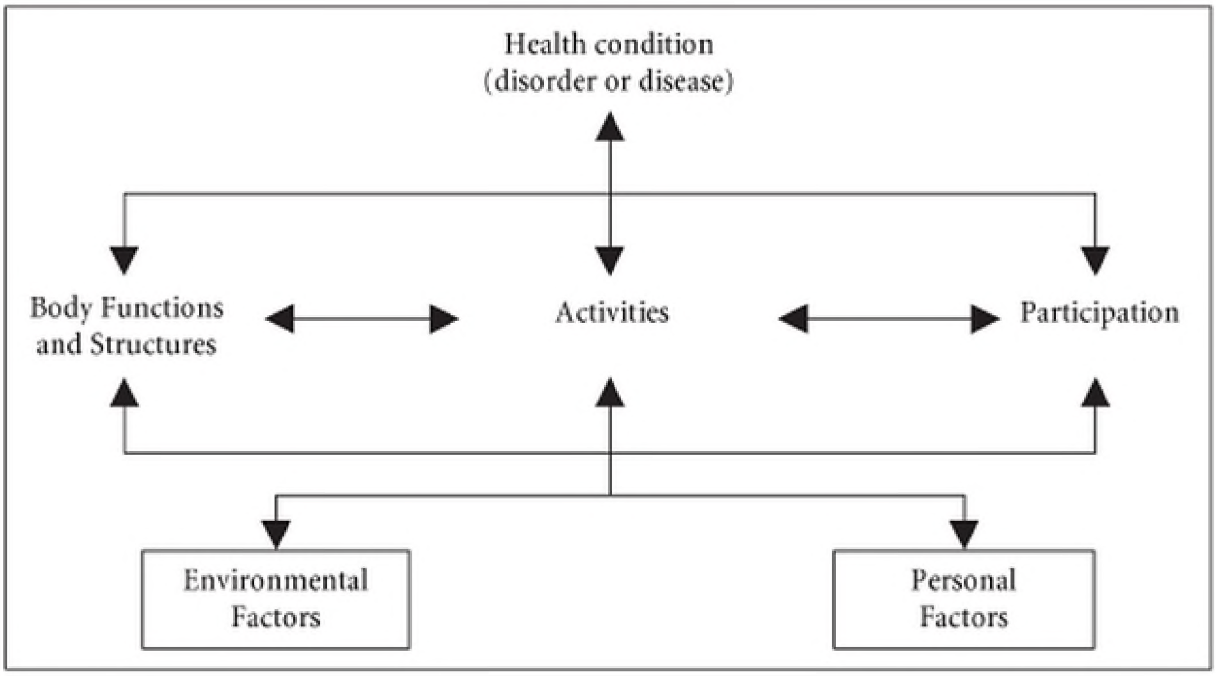


Figure 2: Interactions between the components of ICF (Whiteneck, 2006)

INTELLECTUAL DISABILITY

Intellectual disability has been defined as significant limitations both in intellectual functioning and in adaptive behaviour as expressed in conceptual, social and practical adaptive skills, whose onset is during the developmental period (Christianson et al., 2002; Colmar et al., 2006; Harris, 2006; Silverman et al., 2010; Maulik et al., 2011; Winnick & Short, 2014). Therefore, it is a developmental, intellectual and cognitive disability (Harris, 2006). The specific types of intellectual disabilities have specific educational, rehabilitation and movement needs as both physical and motor developments of children with intellectual disability are often delayed when compared to their peers of higher intellectual standard (Bryl et al., 2013). Furthermore, individuals with intellectual disability also find it difficult to focus their attention, have disturbed planning and disorganized movements and experience some problems with proprioceptive mechanisms, which additionally decrease the participation in physical activity and can hinder their level of physical fitness (Mikolajczyk & Jankowicz-Szymanska, 2015). All the above difficulties have a negative influence on performing complex activities and lead to certain limitations in everyday functioning, and therefore can delay or disturb intellectually disabled children's physical development, as well as have adverse ramifications on health-related quality of life in years to come (Bryl et al., 2013; Mikolajczyk & Jankowicz-Szymanska, 2015).

There is no single cause, mechanism, clinical course, or prognosis for the general category "intellectual disability" (Harris, 2006). Intellectual disability is not a static disorder, but rather a dynamic condition with a variable course that depends on its aetiology and the available environmental support (Harris, 2006). Multiple aetiologies result in intellectual disability, and these must be considered in treatment planning (Harris, 2006). In intellectual disability, thinking is not characteristically disordered and perception is not distorted unless there is another concurrent developmental or mental disorder (Harris, 2006). Intellectual disability includes a heterogeneous group of conditions that range from genetic and metabolic disorders to functional changes in cognition following trauma to the nervous system at birth or trauma to the brain occurring later in the developmental period (Harris, 2006; Maulik et al., 2011). Because of its diagnostic heterogeneity, each person with an intellectual disability must be considered individually according to whether or not they have a supplementary condition, such as an associated syndrome, for example, Down syndrome, or an associated aetiology, for example, head trauma (Harris, 2006). For classification purposes, Intelligence Quotient (IQ) levels, special education categories, environmental assessments, levels of adaptive behaviour, mental health measures, and intensity of support skills are important (Harris, 2006).

While considerable debate has focused on characterization of adaptive deficits and associated criteria defining "substantial" impairment, there has been a longstanding consensus regarding best practice for the assessment of intellectual impairment (Silverman et al., 2010). The gold standard has been a broadly focused and individually administered IQ test that provides a comprehensive measure of overall intelligence and allows educators to know whether a child was completing work at age level or was lagging behind (i.e. mental age) – so how far behind or ahead a child might be (Silverman et al., 2010; Keith & Keith, 2013). According to the International Classification of Functioning, Disability and Health there are four distinguished levels of intellectual disability; mild (IQ 50-69), moderate (IQ 35-49), severe (IQ 20-34) or profound (IQ under 20) (Fait, 1978; Wuang & Su, 2009; Waninge, 2011; Hilgenkamp et al., 2013). Adults with severe intellectual disability have an intellectual age from 3 to 6 years, which is likely to result in a continuous need for support (Waninge, 2011). Adults with profound intellectual disability have an intellectual age below 3 years, which results in serious limitations in self-care, continence, communication and mobility (Waninge, 2011). An individual with an IQ of 71–80 is considered to be borderline intellectually disabled (Christianson et al., 2002; Hilgenkamp et al., 2013). However, given the socio-economic and educational circumstances, in rural and urban South Africa, borderline intellectual functioning will usually predispose a child to school failure, which represents a significant limitation in adaptive capability (Christianson et al., 2002).

Intellectual disability places a heavy burden on affected individuals, as it is a serious and lifelong disability with associated secondary health issues, as well as to their families, society and the healthcare system (Christianson et al., 2002; Pastula et al., 2012). The prevalence of intellectual disability and associated epidemiological factors has been well documented in developed countries; whereas, only limited information, with regards to health and motor performance, is available from developing nations, such as South Africa (Christianson et al., 2002).

PHYSICAL ACTIVITY AND INTELLECTUAL DISABILITY

Physical activity, exercise, and physical fitness are terms that describe different concepts (Caspersen et al., 1985). However, they are often confused with one another and used synonymously (Caspersen et al., 1985; Grund et al., 2000). Physical activity is a behaviour while physical fitness is a set of attributes (Grund et al., 2000). Physical activity is defined as any bodily movement produced by skeletal muscles that results in energy expenditure (Caspersen et al., 1985; Calders et al., 2012; Winnick & Short, 2014). Physical activity in daily life can be categorized into occupational, sports, conditioning, household, or other activities (Caspersen et al., 1985; Calders et al., 2012). The primary role of physical activity is the conditioning benefit it provides in developing health-related physical fitness (Winnick & Short, 2014). Exercise is a subset of physical activity that is planned, structured, and repetitive and has as a final or an intermediate objective, namely the improvement or maintenance of physical fitness (Caspersen et al., 1985).

Physical activity is not only a fundamental human psychomotor development stimulator, but also a determinant of physical fitness, healthy lifestyle factor and indicator of the proper functioning of the body (Rice & Howell, 2000; Bryl et al., 2013; Ślężyńska et al., 2013). Regular physical activity and physical fitness are key factors in health and well-being of all individuals, as there is strong evidence that engaging in regular physical activity and physical fitness improves cardiorespiratory and muscular fitness, positively affects body composition, cardiovascular and metabolic health biomarkers and reduces the symptoms of anxiety and depression (Caspersen et al., 1985; Ruiz et al., 2006; Calders et al., 2012; Ortega, Ruiz et al., 2008; Santos & Mota, 2009; Salaun & Berthouze-Aranda, 2011; Stanish & Temple, 2012).

The American College of Sports Medicine (ACSM) recommends that, to endorse and maintain a healthy lifestyle, adults need moderate-intensity aerobic physical activity for a minimum of 30 minutes on five days each week, or vigorous-intensity aerobic activity for a minimum of 20 minutes on three days each week (Haskell et al., 2007; Garber et al., 2011; American College of Sports Medicine, 2014). Furthermore, recommendations for children state that an accumulation of a minimum of 60 minutes of moderate-vigorous physical activity should occur daily as part of transportation, physical education, sport, free play and planned exercise to maximize health and well-being (American College of Sports Medicine, 2014). However, nowadays environmental factors and inherent laziness frequently discourage physical activity and promote overeating, thus supporting an increase in the prevalence of sedentary lifestyles (Grund et al., 2000). Therefore, physical inactivity has inevitably become a pressing public health issue (Haskell et al., 2007).

Research has shown that persons with intellectual disability are substantially less physically active, as it has been reported that only approximately 35% of people with intellectual disability are physically active, compared to 75% for the general population, thus fostering a sedentary lifestyle, which contributes to secondary health problems, such as heart and lung disease, pressure sores, obesity, osteoporosis, joint pain, and arthritis (Grund et al., 2000; Rice & Howell, 2000; Rimmer, 2001; Haskell et al., 2007; Lin et al., 2010; Lante et al., 2011; Stanish & Temple, 2012; Bryl et al., 2013; Lante et al., 2014; Ogg-Groenendaal et al., 2014; Blick et al., 2015; Einarssona et al., 2016). Furthermore, these secondary health issues increase morbidity and mortality rates, diminish functional status and quality of life (Beange et al., 1999; Grund et al., 2000; Rice & Howell, 2000; Rimmer, 2001; Lin et al., 2010; Bryl et al., 2013; Ślężyńska et al., 2013; Blick et al., 2015). These rates of morbidity incur a lower life expectancy for persons with intellectual disability compared to those without intellectual disability (Glover & Ayub, 2010; Blick et al., 2015). Studies have suggested that persons with intellectual disability live, on average, 15 years less than the general population (Tyrer & McGrother, 2009; Glover & Ayub, 2010; Blick et al., 2015). Blick et al. (2015) showed that only a mere 5% of individuals with intellectual disability described themselves as having an excellent health status, far less than that reported by 30% of persons without disabilities. Failing to address these issues places an increased burden on families and carers, as well as on disability services and health systems (Christianson et al., 2002; Lante et al, 2011; Pastula et al., 2012). Such preventable health problems can increase dependency, add to absenteeism from disability employment and result in premature withdrawal from the workforce and greater healthcare utilisation (Lante et al., 2011).

A systematic review by Hinckson and Curtis (2013) found that children with intellectual disability are significantly less physically active compared to their typically developed peers (Hinckson & Curtis, 2013). Opportunities for children to be physically active predominantly take place during school hours, as well as after school, and on the weekend (Foley et al., 2008). In the school setting, there are two distinct time periods where physical activity takes place, which are during break time and physical education. Break is a period of unstructured play and this is where children make their own choices on ways to be active, whereas physical education provides an opportunity to participate in structured physical activity, as well as to improve related skills and knowledge (Foley et al., 2008). The importance for structured physical activity at school, which is lacking in the South African context can be highlighted again here. Furthermore, there is limited and inconclusive research pertaining to physical activity of children with intellectual disability in the school environment and, in particular, on how their physical activity levels compare to their typically developed peers during break time and physical education (Foley et al., 2008). A study by Faison-Hodge and Porretta (2004) showed that during break and physical education classes children with intellectual disability had physical activity levels similar to that of their typically developed peers with low fitness levels and had significantly lower physical activity levels than children who had high fitness levels.

There are several limiting factors that must be taken into consideration when discussing intellectual disability and physical activity (Bryl et al., 2013). Firstly, accurate assessment of behavioural patterns for physical activity, such as heart rate monitors and accelerometers, is necessary in determining levels of physical activity in children living with intellectual disability and assessing effectiveness of intervention programmes (Hinckson & Curtis, 2013). However, Hinckson and Curtis (2013) found a lack of studies addressing the validity and reliability of tools used to quantify physical activity in children with intellectual disability, as factors such as refusal to wear instruments, movement limitations and positioning of devices were found to be common issues that affected the outcomes of these studies. Secondly, the issue of physical activity analysed in the context of disability takes on another dimension, as there are a number of overlapping factors hindering or even excluding physical activity. Consequently, not only the physical disability, but also the intellectual disability, can affect physical activity and its intensity (Bryl et al., 2013). Thirdly, despite the emphasis on physical activity in children, numerous questions remain regarding the type, frequency, duration, and intensity of physical activity needed to achieve health benefits for children with intellectual disability (Rice & Howell, 2000; Frey, Stanish, & Temple, 2008). This will be discussed and elaborated further in Part II (systematic review) of this literature review. Fourthly, the lack of initiation and maintenance of physical activity of children with intellectual disability has not been extensively studied. A study by Bryl et al. (2013) highlighted two factors that may affect physical activity participation, which were persons with intellectual disabilities acquire an insufficient motivation to perform physical activity and consider themselves as inadequate during motor attempts, and consequently believe that the development and improvement of their current physical efficiency is pointless. These psychosocial factors need to be studied more in depth with regards to children with intellectual disability, as these factors are important parts of health promoting efforts to address physical inactivity.

With this being said, it has been found that the measurement of behavioural patterns for physical activity of children with intellectual disability has been difficult to accurately quantify (Caspersen et al, 1985; Grund et al., 2000; Hinckson & Curtis, 2013).

However, previous research has found alternative methods, such as assessing a set of physical fitness attributes , that has been found to conclusively identify health issues or problems (Caspersen et al, 1985; Grund et al., 2000).

PHYSICAL FITNESS

Physical fitness is a set of attributes that people have or achieve and is focussed on two goals; optimum health and performance (Caspersen et al., 1985; Rice & Howell, 2000; Ruiz et al., 2006; Santos & Mota, 2009; Calders et al., 2012). Physical fitness has been defined as the physiologic state of well-being that enables a person to carry out daily tasks with vigour and alertness, without undue fatigue, with ample energy to enjoy leisure-time pursuits, and to meet unforeseen emergencies (Caspersen et al., 1985; Ortega, Ruiz, et al., 2008; Santos & Mota, 2009; Salaun & Berthouze-Aranda, 2011; Calders et al., 2012). Although the definition may be conceptually sound, things such as vigour, alertness, fatigue, and enjoyment are not easily measured (Caspersen et al., 1985). However, with this being said, physical fitness has also been described as a scientific construct that is multifaceted and there are a number of measurable components that contribute to physical fitness (Caspersen et al., 1985). These components have been divided into two subgroups of physical fitness, namely health-related and skill-related physical fitness, each of which have their own supplementary components, as seen in Figure 3 (Caspersen et al., 1985; Rice & Howell, 2000). A certain level of physical fitness is achieved by the competency of the combined physical fitness components. It would be simple to measure each component and come to a conclusion based of the scores, however physical fitness is multifactorial (Pate, 1988). All physical fitness components are distinguished theoretically, but are intertwined in their functioning practically (Hilgenkamp et al., 2010).

Levels of physical fitness can be influenced by sex, age, and level of intellectual disability (Golubović et al., 2012). Lower cognitive functioning, associated with intellectual disability, may negatively affect executive function, which includes motor planning and movement patterns, sensory information processing, such as delayed visual and proprioceptive information, and neuromuscular control, which could hinder physical fitness performance (Golubović et al., 2012; Giagazoglou, Kokaridas, et al., 2013; Memisevic & Sinanovic, 2014; Mikolajczyk & Jankowicz-Szymanska, 2015; Kachouri et al., 2016). Children with intellectual disability often have delayed development and/or maturation, which can impact their level of physical fitness for their age, which can further predispose this population to early development of serious health problems (Jones et al., 2000; Ozmen et al., 2007; Schalock et al., 2007; Lejčarová, 2008; Kachouri et al., 2016). It has been demonstrated that anthropometric measures, such as stature and mass, can help identify delayed maturation (Kemper et al., 1987; Beunen et al., 1997; Jones et al., 2000; Schalock et al., 2007; Zhang et al., 2009; Illingworth, 2012). It has been reported that stature is lower for intellectually disabled children when compared to their typically developed peers (Graham & Reid, 2000; Zhang et al., 2009; Zafeiridis et al., 2010). Furthermore, regardless of age and/or the measurement procedures, the fitness levels of intellectually disabled people are generally lower in comparison to their peers from general population, which may lead to an increased risk of prematurely developing hypokinetic disease and health problems associated with inactivity at all ages, such as hypertension, coronary artery disease, depression, obesity, colon and reproductive cancers (Caspersen et al., 1985; Frey & Chow, 2006; Fowler et al., 2007; Ortega, Ruiz et al., 2008; Lotan et al., 2009; Santos & Mota, 2009; Salaun & Berthouze-Aranda, 2011; Calders et al., 2012; Golubović et al., 2012).

There is evidence indicating that the precursors of hypokinetic disease have their origin in childhood and adolescence (Santos & Mota, 2009). Therefore, the assessment of health-related fitness at childhood and adolescence is of public health and clinical interest (Santos & Mota, 2009). However, with that being said, physical activity and physical fitness relationships have not been thoroughly investigated in youth with intellectual disability (Frey & Chow, 2006; Calders et al., 2012). Numerous studies have been conducted on physical fitness, to investigate the importance and benefits of singular components on overall health and performance (Chaniaset al., 1998; Ozmen et al., 2007; Lotan et al., 2009; Carmeli, Bachar et al., 2008; Yildirim et al., 2010; Golubović et al., 2012; Stanish & Temple, 2012). However, there have been no studies, as far as the researcher is aware, that have addressed all eleven components, as indicated in Figure 3, henceforth there is a gap in the literature pertaining to the holistic nature of physical fitness and performance.

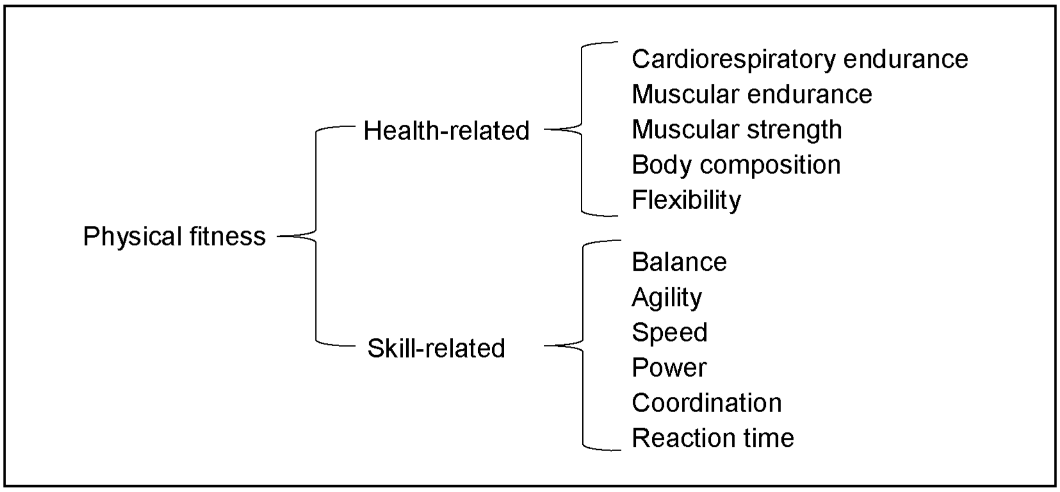


Figure 3: Components of physical fitness

Health-related fitness

Health-related physical fitness refers to the health and wellness of individuals, which can be affected by functional capacity, habitual physical activity and related health status (Ortega, Ruiz, et al., 2008; Winnick & Short, 2014). The health-related components include cardiorespiratory endurance, muscular endurance, muscular strength, body composition and flexibility (Caspersen et al., 1985; Suni et al., 1998; Rice & Howell, 2000; Calders et al., 2012; Ortega, Ruiz, et al., 2008; Santos & Mota, 2009; Winnick & Short, 2014). Numerous researchers have reported lower performance on standard health-related fitness tests for the assessment of persons with intellectual disability (Caspersen et al., 1985; Suni et al., 1998; Rice & Howell, 2000; Santos & Mota, 2009; Calders et al., 2012; Golubović et al., 2012; Winnick & Short, 2014).

Cardiorespiratory endurance

Cardiorespiratory fitness is one of the most important components of health-related physical fitness, as it is central to both functional and physiological aspects of health (Graham & Reid, 2000; Ruiz et al., 2006; Ozmen et al., 2007; Winnick & Sort, 2014). This component depends primarily on the efficiency or development of the cardiovascular and respiratory system and the musculoskeletal metabolic function, thus directly reflecting the overall physiological capacity and the ability to carry out prolonged strenuous activities (Graham & Reid, 2000; Ruiz et al., 2006; Ozmen et al., 2007; Winnick & Short, 2014). Cardiorespiratory fitness, cardiovascular fitness, cardiorespiratory endurance, aerobic fitness, aerobic capacity, aerobic power, maximal aerobic power, aerobic work capacity, physical work capacity and maximal oxygen consumption (VO_{2max}) all refer to a closely related concept that have been used interchangeably in the literature (Ruiz et al., 2006).

A number of longitudinal studies have suggested that low levels of cardiorespiratory fitness during childhood and adolescence are associated with early onset and high incidence of cardiovascular and other chronic diseases, such as hyperlipidemia, hypertension, obesity, some forms of cancer, Type II diabetes, osteoporosis, stroke, and coronary heart disease (Ruiz et al., 2006; Ozmen et al., 2007; Calders et al., 2011; Lante et al., 2011; van Schijndel-Speet et al., 2013; Oviedo et al., 2014). Research has indicated that individuals with intellectual disability exhibit lower levels of cardiovascular fitness than their peers without intellectual disability (Ozmen et al., 2007; Calders et al., 2011; Lante et al., 2011; Yanardag et al., 2013; van Schijndel-Speet et al., 2013; Oviedo et al., 2014). Research has focussed less on intellectually disabled children; however, the few studies that have, found similar trends of low cardiorespiratory fitness (Fernhall et al., 1988; Gillespie, 2003; Faison-Hodge & Porretta, 2004; Ozmen et al., 2007; Davis et al., 2010). This is of great concern, as it has been reported that poor health habits may occur/be adopted early on in an individual's youth, and therefore must be remedied in a proactive approach during childhood, rather than a reactive approach during adulthood (Gillespie, 2003; Santos & Mota, 2009).

Muscular endurance

A distinction between muscular strength and muscular endurance must be made before describing these two components of physical fitness (Graham & Reid, 2000). Muscular endurance is the ability of a muscle group to execute repeated contractions over time or to maintain a maximal voluntary contraction for a prolonged period of time (Caspersen et al., 1985; Graham & Reid, 2000; Ruiz et al., 2006). Muscular strength, on the other hand, is defined as the degree to which the muscular system can exert force in a single contraction (Graham & Reid, 2000). It has been suggested that a relationship exists between muscular strength and muscular endurance, so if muscular strength decreases then consequently, muscular endurance will also decrease (Graham & Reid, 2000).

It has been shown that muscular endurance, along with cardiorespiratory endurance, may have a combined and accumulative effect on the improvement of cardiovascular health in young people (Ortega, Ruiz, et al., 2008). Therefore, this association has determined that muscular endurance can be a health marker for cardiovascular health status (Ortega, Ruiz, et al., 2008). Furthermore, it has been reported that poor muscular endurance is a significant predictor for a decline in mobility, back function and pain and activity of daily living (Suni et al., 1998; Ortega, Ruiz, et al., 2008; Oppewal et al., 2015).

Research has shown a muscular endurance performance discrepancy of 25 – 50% between youngsters with an intellectual disability and those without (Graham & Reid, 2000; Zhang et al., 2009; Guidetti et al., 2010; Salaun & Berthouze-Aranda, 2011; Winnick & Short, 2014). Possible explanations that address the performance gap of muscular endurance for intellectually disabled people include lack of motivation, fewer opportunities to train, fewer opportunities to participate in physical activities, poor instruction, and physiological factors to be limiting constraints (Winnick & Short, 2014).

Muscular strength

Muscular strength relates to the amount of external force a muscle can exert (Caspersen et al., 1985; Graham & Reid, 2000; Ruiz et al., 2006). Persons with intellectual disability have been reported to have muscular strength decrements that reduce motor capacity, therefore affecting the performance of daily activities (Giagazoglou et al., 2012; Terblanche & Boer, 2013; Wuang et al., 2013). There is evidence that individuals with intellectual disability may have disturbed central and peripheral muscular processing components, thus hindering motor-neuron recruitment and movement control during sustained effort (Zafeiridis et al., 2010). Therefore, this muscle weakness and hypotonia can impair intellectually disabled people's gait movements and patterns (Wuang et al., 2013). The ramifications of this, along with poor balance, are factors underlying mobility deficiencies for intellectually disabled people, thus contributing to the increased prevalence of falls resulting in injuries in this population (Van Hanegem et al., 2013).

Recent studies have suggested that young people with intellectual disability may benefit from strength-training programs to develop and maintain metabolically active lean muscle mass, therefore resulting in improved glucose metabolism and reduced risks of falling, osteoporosis, osteopenia and bone fracture (Haskell et al., 2007; Lin & Wuang, 2012).

Body composition

Body composition is the component of health-related physical fitness that involves the body's degree of leanness or fatness and has implications for both functional and physiological health (Caspersen et al., 1985; Monyeki et al., 2005; Waninge, 2011; Winnick & Short, 2014). Cardiorespiratory fitness and body composition are considered the two major components of health-related fitness because of their apparent relation to health (Verschuren et al., 2009). Obesity in children is one of the most significant public health challenges internationally (Tokmakidis et al., 2006). When fat levels in the body are too high, a person's ability to lift or move the body is negatively affected (Winnick & Short, 2014). Therefore, it has been shown that overweight children have lower physical fitness levels than peers of normal weight, thus limiting their fitness performance and potentially influencing their gross motor capacity (Tokmakidis et al., 2006; Verschuren et al., 2009; Winnick & Short, 2014).

Individuals with intellectual disability may be more obese than individuals without intellectual disability (Ozmen et al., 2007; Casey & Rasmussen, 2013). Studies have reported that greater focus should be placed on the metabolic health of individuals with intellectual disability, since youths with intellectual disability who are overweight or obese also present an elevated number of obesity-related secondary conditions, such as asthma, high blood pressure, high blood cholesterol, diabetes, and depression, which later on in life increases risk of coronary heart disease, arthritis, various forms of cancer, and all-cause mortality (Suni et al., 1998; Winnick & Short, 2014). Understanding the causes and effects of obesity remains essential when monitoring the health of individuals with intellectual disability (Casey & Rasmussen, 2013).

Flexibility

Flexibility relates to the ability of a specific muscle or muscle group to move freely through the range of motion at the level of the joint (Ruiz et al., 2006; Winnick & Short, 2014). Flexibility is enhanced and maintained by physical activity; therefore, low flexibility levels can suggest a lack of sufficient activity (Carmeli et al., 2002; Salaun &

Berthouze-Aranda, 2011). It has been reported that children with intellectual disability have poor flexibility measures; however, the literature does not adequately address these poor levels of flexibility and the associative implications for the intellectually disabled (Carmeli et al., 2002; Skowroński et al., 2009; Salaun & Berthouze-Aranda, 2011). There is growing evidence for the associated benefits of flexibility, including improved range of motion, musculoskeletal integrity, functional performance, and athletic ability, and reduced risk of injury and orthopaedic complications later on in life (Haskell et al., 1983; Ruiz et al., 2006). Therefore, flexibility is very important from a public health perspective, as good flexibility improves functional abilities to carry out the activities of daily living, such as reaching, bending and stooping; and variety of athletic performances (Ruiz et al., 2006).

Skill-related fitness

Studies that have investigated the relationship between physical fitness and health, primarily focus on health-related fitness and less attention has been given to the influence of skill-related fitness on health (Twisk et al., 2000). Although there is some evidence that skill-related fitness is beneficial for cardiovascular health, skill-related fitness is more associated with daily activities and athletic abilities (Caspersen et al., 1985). The components of skill-related physical fitness include agility, balance, coordination, speed, power, and reaction time (Caspersen et al., 1985; Ortega, Artero, et al., 2008; Rice & Howell, 2000).

Balance

Balance relates to the maintenance of an individual's equilibrium while stationary or moving (Caspersen et al., 1985). Balance and motor impairments are common amongst intellectually disabled individuals and this adversely impacts postural control, gait quality, increases risk of accidental falls, and limits autonomy in activities of daily living (Carmeli, Bar-Yossef et al., 2008; Giagazoglou et al., 2012 Giagazoglou, Kokaridas, et al., 2013; Oviedo et al., 2014; Van Hanegem et al., 2013; Mikolajczyk & Jankowicz-Szymanska, 2015). It has been demonstrated in previous studies that individuals with intellectual disability have larger sway amplitudes with a greater degree of variability than individuals without intellectual disability during balance tasks (Giagazoglou et al., 2012; Oviedo et al., 2014; Mikolajczyk & Jankowicz-Szymanska, 2015). Previous studies have demonstrated that balance performance in persons with intellectual disability could be significantly improved following various intervention programs (Carmeli et al., 2005; Giagazoglou et al., 2012).

Agility

Agility is the ability to move, change direction and position the body quickly and effectively while under control, and requires the integration of isolated movement skills using a combination of balance, coordination, speed, strength, and endurance (Caspersen et al., 1985; Ruiz et al., 2006; Wuang et al., 2013). Agility helps performance in daily activities that require change of direction quickly (Wuang et al., 2013). There is a gap in the literature regarding intellectually disabled individuals' agility performance. A study by Carmeli, Bar-Yossef et al. (2008) and Wuang et al. (2013) showed that individuals with intellectual disability are deficient in carrying out tasks requiring agility, thus impacting their motor performance. It has been reported that lower-limb muscle strength, particularly of the hip and knee muscles, is positively linked with the agility performance in individuals with intellectual disability (Wuang et al., 2013). Agility can be improved by using a variety of muscle strengthening activities with emphasis on these muscle groups (Lin & Wuang, 2012). A study by Wuang et al. (2013) reported that agility training can improve neuromuscular control and might increase knee stability, strength, and function, which will be beneficial for performance of daily activities and decrease prevalence of falls in persons with intellectual disability.

Speed

Speed is determined by the contraction of a muscle or muscle group allowing an individual to cover a certain distance over a period of time (Caspersen et al., 1985; Ruiz et al., 2006). Physically active people tend to have a and higher speed in executing activities of daily living while still perceiving this as comfortable; therefore, speed has been deemed a necessity for daily living, and so has power (Hilgenkamp et al., 2010). Once again, there are only a few studies that have assessed speed in persons with intellectual disability. These studies found that children with intellectual disabilities consistently scored lower than their typically developed peers on measures of walking/running speed; however, it must be noted that the intellectually disabled tend to have difficulty grasping concepts of running speed and maximal effort

(Connolly & Michael, 1986; Skowroński et al., 2009; Salaun & Berthouze-Aranda, 2011; Hilgenkamp et al., 2014).

Power

Power has been defined to be the rate of exerting muscular force so that one can perform work (Caspersen et al., 1985; Ruiz et al., 2006). There is evidence suggesting that power has a positive relationship with speed and agility (Sekulic et al., 2012). Power has been included, along with muscular strength and endurance, with muscular fitness, which in turn has been associated with risk factors for cardiovascular disease (Ortega, Artero, et al., 2008). Many daily childhood activities consist of short bursts of high intensity activity; therefore, muscular power has been thought to be an important indicator of gross motor capacity (Verschuren et al., 2009). Poor levels of muscular power means that certain activities cannot be performed at the same pace as that of healthy children, or cannot be performed at all (Verschuren et al., 2009). Studies have shown that muscular power has been noted to be deficient to a certain extent for children with intellectual disability; however, these findings were not shown to be significant (Horvat et al., 1997; Golubović et al., 2012).

Coordination

Coordination refers to the ability to integrate the use of senses, such as sight, hearing and proprioception, together with body parts in performing motor tasks smoothly and accurately (Caspersen et al., 1985). Manual coordination includes speed, dexterity, and coordination of upper extremities, whilst body coordination infers balance and motor skills required for successful participation in physical activity (Wuang et al., 2013). The key role in developing motor skills in children with intellectual disability is ascribed to the ability of maintaining balance and ensuring coordination (Giagazoglou, Kokaridas, et al., 2013; Mikolajczyk & Jankowicz-Szymanska, 2015). Numerous studies have reported lower levels of performance for coordination for intellectually disabled individuals (Graham & Reid, 2000; Carmeli, Bar-Yossef et al., 2008; Wuang et al., 2008; Guidetti et al., 2010; Golubović et al., 2012). In accordance with balance, poor coordination may infer mobility problems for intellectually disabled individuals' gait capacities; therefore, coordination can be identified as a risk factor for the prevalence of fallings (Van Hanegem et al., 2013).

Reaction Time

Reaction time is a cognitive process and is an index of sensory-motor performance that reflects the time between application of a stimulus and response to the stimulus, during which perception, decision-making processes, and motor planning occur (Caspersen et al., 1985; Giagazoglou, Kokaridas, et al., 2013). A shorter reaction time indicates that individuals are more aware of their surroundings and therefore react faster to movements/actions in the environment, such as in the case of an emergency or danger people may react and protect themselves if deemed necessary (Giagazoglou, Kokaridas, et al., 2013).

Most research pertaining to persons with intellectual disability and their level of physical fitness has focused on cardiorespiratory endurance, muscle strength, muscle endurance and to some minor extent, flexibility, whereas information about performance or skills-related fitness components, such as manual dexterity, reaction time and balance, is scarce (Hilgenkamp et al., 2014). However, these few studies have shown that longer reaction times do occur in individuals with intellectual disability, although the underlying mechanisms for these findings have not been extensively studied (Horvat et al., 2003; Skowroński et al., 2009; Rigoldi et al., 2011; Giagazoglou, Kokaridas, et al., 2013; Wuang et al., 2013). One of the possible reasons is that stimuli, such as visual and vestibular information, are not processed effectively by individuals with intellectual disability (Giagazoglou, Kokaridas, et al., 2013). It has also been suggested that muscle activation and electromyographical variability could be a possible reason for movement delays observed in this population (Giagazoglou, Kokaridas, et al., 2013). However, these findings are not consistent with the findings of Horvat et al. (2003) who found that there were similar patterns of consistency across trials in motor unit recruitment and muscle activation for individuals with and without intellectual disability.

Test batteries

There are several well-known, physical fitness batteries to assess fitness in all its dimensions in young people (Ruiz et al., 2006). For example, popular in Europe is the ALPHA-FIT Test battery, a project coordinated by Dr. Michael Sjöström from the Karolinska Institute, as well as the EUROFIT battery, which was developed in 1993 by the Committee of Experts on Sports Research EUROFIT, while in the USA are the

FITNESSGRAM battery developed by the Cooper Institute for Aerobics Research in 1999 and revised in 2013 and the American Alliance for Health, Physical Education, Recreation & Dance (AAHPERD) Functional Fitness Test (Suni et al., 1996; Winnick, 2005; Ruiz et al., 2006; Ruiz et al., 2011; Winnick & Short, 2014). Youngsters with mild to severe intellectual disability have limitations that need extensive or pervasive support related to physical fitness (Winnick &+ Short, 2014). These tests acknowledge the need for modifications and accommodations for youngsters with disabilities in their test administration information; however, none provide specific criterion-referenced standards for youngsters with disabilities (Winnick, 2005; Davis et al., 2010).

The original EUROFIT test battery had been applied to the disabled population; however, many of the test items were not adaptable to this population because of difficulties in completing specific test items (Skowroński & Ziemilska, 1996; MacDonncha et al., 1999; Skowroński et al., 2009; Golubović et al., 2012). This necessitated a revision that was subsequently developed for individuals with intellectual disabilities, known as EUROFIT Special (Skowroński & Ziemilska, 1996). A study by MacDonncha et al. (1999) found that the EUROFIT test battery was a reliable tool for assessing physical fitness for adolescent males (mean age 15.5 ± 1.2 years) with and without intellectual disabilities. These findings by MacDonncha et al. (1999) have been cited by numerous studies as to why EUROFIT is a reliable test battery to be applied to methodological procedures. However, these studies, which had different sample characteristics, such as younger or older, female and/or male participants, have cited MacDonncha et al. (1999) as their only source of reliability for the EUROFIT test battery (even though the study was only found reliable for male adolescents), therefore assuming/generalizing the reliability across different sample characteristics, which could bring into question the validity of these studies using the EUROFIT battery to test the fitness levels of intellectually disabled individuals (MacDonncha et al., 1999; Skowroński et al., 2009; Salaun & Berthouze-Aranda, 2011; Giagazoglou, Kokaridas, et al., 2013). It has further been reported that, despite special attention taken to adapt the test items, intellectually disabled individuals still found it difficult to complete some test items, which showed limits for the use of the EUROFIT Special battery for adolescents with intellectual disabilities (Salaun & Berthouze-Aranda, 2011). Conversely, other studies have found the EUROFIT Special test battery to be easy to administer and a valid physical fitness assessment tool for individuals with intellectual disability (Skowroński et al., 2009; Golubović et al., 2012). However, there are no criterion-referenced standards and, when compared with other tests measuring the physical fitness of individuals with disabilities, there is limited research on the discriminatory ability of the EUROFIT Special and its applicability as a research and diagnostic tool (Skowroński et al., 2009).

To address these issues, the College at Brockport, State University of New York, developed a health-related, criterion-referenced physical fitness tests for young people between the ages 10 to 17 years with disability, known as the Brockport Physical Fitness Test (BPFT) battery (Davis et al., 2010; Winnick & Short, 2014). The populations targeted in this project included youth with intellectual disability, spinal cord injury, cerebral palsy, blindness, congenital anomaly, or amputation (Winnick & Short, 2014). The Brockport Physical Fitness Test battery recognizes the individualized nature of fitness testing and encourages a personalized approach based on health-related needs and a desired fitness profile (Winnick, 2005; Davis et al., 2010; Winnick & Short, 2014).

FITNESSGRAM was used as an important reference in developing the Brockport Physical Fitness Test for youth with disabilities (Winnick, 2005; Davis et al., 2010). This relationship with FITNESSGRAM would enhance inclusionary practices at the practitioner level (Winnick, 2005). The selection of test items and standards for the Brockport Physical Fitness Test battery was influenced by years of previous research in adapted physical activity, data collected on 1,542 youngsters, and the opinions of a panel of experts in the areas of health, fitness, and adapted physical activity (Winnick, 2005). The final product represents an initial attempt to apply a health-related, criterion-referenced fitness approach to youngsters with disability, which has been since reported to be valid and reliable for future research (Winnick, 2005; Zhang et al., 2009; Davis et al., 2010; Terblanche & Boer, 2013; Winnick & Short, 2014).

According to the Brockport Physical Fitness Test manual there are three levels of health-related physical fitness (Winnick & Short, 2014). The lowest level is classified as 'needs improvement' (NI), which means that the individual is in dire need of improvement in the specific area of fitness and if not improved then could increase the risk for health issues in the future (Winnick & Short, 2014). The second level, known as an adapted fitness zone (AFZ), were based on specific standards, which has been adjusted for the effects of disability and are target measures for youngsters with a specific disability (Winnick & Short, 2014). The adapted fitness zone can range from 'a minimum acceptable level of health-related physical fitness adjusted for the effects of disability' to 'attainable level of physical fitness leading to a healthy fitness zone' (Winnick & Short, 2014). The third level, designated to as a healthy fitness zone (HFZ), is considered to be an acceptable level of health-related physical fitness that is associated with the general population and is not adjusted for disability (Winnick & Short, 2014). The healthy fitness zone is based on general standards, which are target measures for the general population (Winnick & Short, 2014). One of the questions that needs to be addressed is whether one can apply American and/or European standards to a South African context? This will be discussed in chapter iii, as the data from the descriptive study (phase 1) will be compared to that of the literature reporting these standards.

THE SOUTH AFRICAN CONTEXT

Some of the suggested health-related fitness tests for intellectually disabled adults have been performed in Canada (Graham & Reid, 2000), United States (Zhang et al., 2009), Israel (Carmeli, Bar-Yossef, et al., 2008), Taiwan (Wu et al., 2010), Netherlands (Hilgenkamp et al., 2013; Hilgenkamp et al., 2014; Van Hanegem et al., 2013; van Schijndel-Speet et al., 2013), South Africa (Terblanche & Boer, 2013), Australia (Lante et al., 2014) and Spain (Oviedo et al., 2014). Here, it can be seen that very little research has been conducted in developing countries. The study by Terblanche and Boer (2013) was conducted on Down Synrome adults with intellectual disability between the ages of 18 and 66 years. This was the first study to report on the overall functional fitness of Down Syndrome adults exclusively, using a comprehensive test battery of flexibility, balance, coordination, aerobic capacity, muscular strength and endurance items, as well as a functional task (Terblanche & Boer, 2013). However, this study was on intellectually disabled adults, not children, and only compared age and sex differences within the Down Syndrome sample population itself; therefore, no comparison were made to criterion-referenced physical fitness standards or to the general population without disability.

Furthermore, there is a lack of research concerning physical fitness and intellectually disabled children. Studies have been conducted in Israel (Lotan et al., 2004), Turkey

(Ozmen et al., 2007), Czech Republic (Lejčarová, 2008), Taiwan (Wuang et al., 2008), Poland (Skowroński et al., 2009), Netherlands (Verschuren et al., 2009; Vuijk et al., 2010), Serbia (Golubović et al., 2012), and Greece (Giagazoglou, Kokaridas, et al., 2013). In contrast, in developing countries such as South Africa little is known about the relationship between intellectual disability and physical fitness in children and adolescents. Studies conducted in developed countries cannot be applied in South Africa, due to the supplementary conditions associated with the socio-economic deprived status of South Africa (Foskett, 2014).

Most disabled people in South Africa are resident in the rural or peri-urban areas (Guthrie et al., 2001; Christianson et al., 2002; DSD et al., 2012). Therefore, the majority of people with disabilities are unable to access primary health care, due to financial barriers, inadequate transport, constrained provisions of services and almost non-existent health care facilities in close proximity to rural areas in South Africa (Guthrie et al., 2001; DSD et al., 2012; Foskett, 2014). Consequently, additional risk factors associated with low socio-economic status must be taken into consideration when assessing intellectual disability and physical fitness outcomes, such as poor living conditions, lack of health care facilities, malnutrition, unclean water, lack of sanitation and endemic diseases (e.g. HIV/AIDS) (Guthrie et al., 2001; Christianson et al., 2002; DSD et al., 2012; Foskett, 2014; Azadeh et al., 2015). It has been reported that one in three children in South Africa experience hunger or are at risk for hunger (DSD et al., 2012). Malnourished children lack protein in their diets and have micronutrient deficiencies, such as lack of minerals and vitamins, which can result in children being underweight for age, stunting of somatic growth, and mobility and cognitive deficits (DSD et al., 2012).

A study by Monyeki et al. (2005) compared body composition and physical fitness of undernourished South African rural primary school children to the EUROFIT and AAHPERD reference data, as well as data from studies in developed countries, and found that the South African children performed poorly in the physical fitness tasks (Monyeki et al., 2005). Therefore, Monyeki et al. (2005) advocate that factors associated with poor socio-economic circumstances must be taken into consideration and be acknowledged as confounding variables. These confounding variables must be controlled as best as possible; therefore, reference data must be recorded contextually to reduce variance, and physical fitness of intellectually disabled children in South Africa must be compared to their typically developed peer group of the same socio-economic standards. However, there is no relevant reference-criterion data available to assess the physical fitness detriments of intellectually disabled children in South Africa.

PART II: SYSTEMATIC REVIEW

BACKGROUND

Children with intellectual disability are often considered to be poorer in health status, as their physical fitness levels are substantially lower compared to that of their typically developed peers, which may cause secondary health problems (Grund et al., 2000; Haskell et al., 2007; Lin et al., 2010; Stanish & Temple, 2012; Bryl et al., 2013; Lante et al., 2014; Ogg-Groenendaal et al., 2014; Blick et al., 2015; Einarssona et al., 2016). Physical activity and/or physical fitness training plays a crucial role in the management of secondary health conditions and quality of life (van der Ploeg et al., 2004). The majority of studies related to this topic have reported on test validations and described physical fitness levels (Frey et al., 2008). Little research has however addressed the appropriate physical activity or exercise guidelines for individuals with intellectual disability (Frey et al., 2008).

Exercise prescription and the frequency, intensity, nature and duration (FIND) principles for the general population have been scientifically defined and are evidence-based (Haskell et al., 2007; Garber et al., 2011; American College of Sports Medicine, 2014). The basic guidelines for exercise prescription for the general population can be used as a starting point when prescribing exercise for the intellectually disabled (Frey et al., 2008; American College of Sports Medicine, 2014). However, there is a lack of research documenting whether youth with intellectual disability are meeting these established exercise guidelines (Frey et al., 2008). Furthermore, research has emphasized that the application of the FIND principles needs to be modified based on the individual and the disability, as not only do intellectually disabled people have to maintain their health, which potentially is already lagging behind the general population due to social barriers, lack of understanding of health benefits and lack of compliance/motivation for physical activity/exercise, but also to improve their lower levels of physical fitness, more so than their typically developed peers, to try attain better functional performance for the future and to delay premature aging (Winnick, 2005; Frey et al., 2008; Davis et al., 2010). Therefore, people with intellectual disability would need an adapted and/or outcome specific FIND principles to meet their needs and to try attain physical fitness levels as relatively viable to their typically developed peers. No clear, evidence-based and scientifically proven recommendations have been made for the exercise guidelines and the FIND principle that best suits children with intellectual disability.

The purpose of this systematic review was to evaluate the FIND principles used in previous exercise interventions for intellectually disabled children. The findings of this review aim to identify evidence based recommendations to inform the study design for the exercise intervention that was implemented in Phase 2 of this Master's research project.

METHOD

The 'Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) Statement', which was obtained from the EQUATOR Network (www.equator-network.org/), was used as a guideline whilst developing the protocol for this systematic review.

Search and Selection Procedure

The search strategy made use of six online multidisciplinary databases to locate and retrieve journal articles, which were BioMed, EBSCO Host, Scopus, Science Direct, PubMed, and Web of Science. These databases were searched from May 2015 to August 2016 with no publication date restriction. The following query terms were used for the 'advanced search' within the databases: 'intellectual disability', 'mental retardation', 'intellectual impairment', 'intelligence quotient', 'exercise intervention', 'exercise program', 'training program', and 'physical fitness'. The English and American spelling and singular and plural were used. All terms were combined with no search limits. Additionally, a manual search was conducted of all the articles' reference lists for any relevant articles that were directly related to the query terms.

Potential articles underwent a three-phase screening process. The initial phase of screening was performed on the title, which was followed by the screening of the abstract, and finally the full text was examined for compliance of eligibility criteria and screened for selection. The eligibility of studies to be included for review underwent a selection process which followed a specific inclusion/exclusion guideline. Studies were included if (i) the effect of an exercise intervention on intellectually disabled level of physical fitness had been studied, (ii) the study included male and/or female participants, and (iii) all participants were 21 years or younger. Excluded were (i) studies that were not published in English, (ii) books, magazine articles, review articles, theses, and editorials, (iii) studies not specifically focussed on intellectual disability and/or multiple disabilities, in other words, cerebral palsy, Down Syndrome, autism, Attention deficit hyperactivity disorder (ADHD), and other developmental disorders, (iv) participant age was older than 21 years, (v) investigations did not include an independent exercise intervention, i.e. articles that subsequently used drugs, therapy, and dietary changes, (vi) articles that were not fully accessible, and (vii) articles with no clear protocols.

There were numerous literature search challenges and limitations. Firstly, a systematic review is normally conducted by two or more authors that all perform the same searches and assessments, and if their results are similar then this would infer reliability and validity for their systematic review. However, this systematic review was only conducted by one researcher, which may increase error probability for the search and assessment results. Secondly, database bias was an influential factor to be considered whilst conducting this systematic review, since no single database was likely to contain all published studies on the given subject. Henceforth, several databases were searched and multiple query terms were used to try minimize this bias. Similarly, publication bias was also taken into consideration, as articles that show statistical significance and positive treatment of effects could be published ahead of articles that do not show effects. The researcher was also made aware of English language bias and accessibility of articles. Therefore, the articles included in this systematic review potentially could not represent the full spectrum of articles assessing exercise interventions for children with intellectual disability.

Quality Assessment and Reporting Guidelines

To ensure a clear and complete report of this study's design, conduct and findings, several quality and reporting assessment tools were consulted and used as guidelines in order to assess the quality of the methodology and reporting within each study (Downs & Black, 1998; von Elm et al., 2007; Higgins & Green, 2009; Liberati et al., 2009; da Costa et al., 2011). It is important to note that 'methodological quality' and 'reporting quality' are not interchangeable terms, as is commonly implemented in practice (da Costa et al., 2011).

The reporting quality assessment tool determined whether key aspects of the study were reported transparently throughout the article (von Elm et al., 2007; da Costa et al., 2011). The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) Statement was consulted for guidance as to what a high quality study should adhere to; however, it has been emphasized that the STROBE checklist was not developed as a tool for assessing the quality of published research (von Elm et al., 2007; da Costa et al., 2011). Therefore, the Downs and Black 'checklist for measuring study quality' was used, in conjunction with the Quality Assessment Tool for Quantitative Studies, to establish a reporting quality assessment tool, as seen in Appendix 1A (Downs & Black, 1998; Sanderson et al., 2007). Studies scoring more than 11/15 (73.3%) for the reporting quality were considered to be of high quality.

Methodological quality or study quality typically focus on "risk of bias," i.e., the degree to which the design, conduct, and analysis of a study could potentially compromise confidence in its results by introducing systematic error in the magnitude or direction of the results (Samuel et al., 2016). The methodological quality assessment tool used to appraise the methodological quality of studies was a domain-based evaluation tool, that had been modified from the Downs and Black 'checklist for measuring study quality' and the Cochrane Collaboration Handbook (http://handbook.cochrane.org/) 'criteria for judging risk of bias assessment tool', which can be seen in Appendix 1B (Downs & Black, 1998; Higgins & Green, 2009). The assessment tool performed to appraise the risk of bias within each study, by taking into account; sequence generation, allocation concealment, blinding of personnel and outcome assessors, statistics, power, incomplete data, selective reporting and other potential threats to validity. Studies scoring more than 6/8 (75%) for the domain-based evaluation criteria were considered to be of high quality. Because it is impossible to know the extent of bias (or even the true risk of bias) in a given study, the possibility of validating any proposed tool is limited (Higgins & Green, 2009). The most realistic assessment of the validity of a study may involve subjectivity, which in itself leans towards the scrutiny of bias (Higgins & Green, 2009).

Data Extraction and Analysis

Collected data included study characteristics, sample demographics and outcome data. A review-specific data extraction log/sheet was used to keep track of the outcome measures. Therefore, the outcome measures of the studies were evaluated and compared. 'Strong evidence' was defined as consistent findings among multiple high-quality studies. 'Moderate evidence' was described as consistent findings among multiple low-quality studies, or one high-quality study. 'Limited evidence' consists of findings from one low-quality study and 'conflicting evidence' defined as inconsistent findings among multiple studies.

RESULTS

Screening Process

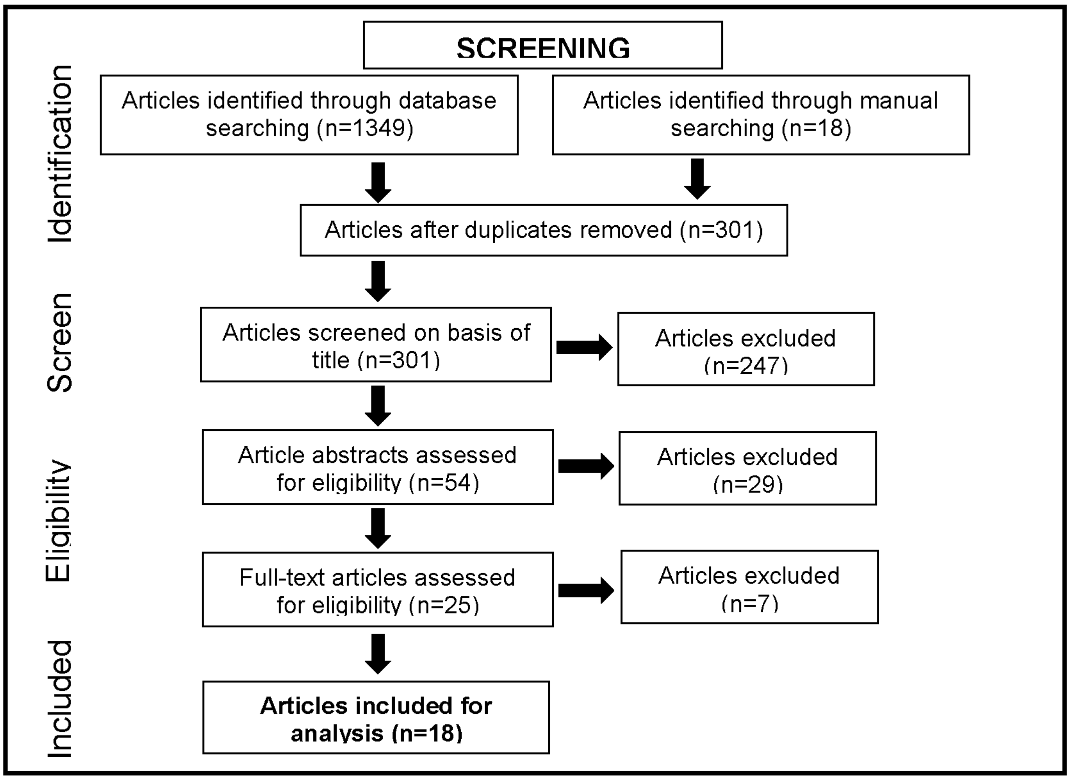


Figure 4: The screening process of journal articles for study selection

Study Characteristics

The studies included in this systematic review varied in study design from repeated measures to Randomized Controlled Trials (RCT) and Non-Randomized Controlled Trials (Non-RCT) (Table 1). The type of study design effects the validity of the study, which will be further discussed in the methodological quality section. The participants varied in intellectual disability, which ranged from borderline to profound, with the majority of the studies assessing mild to moderate intellectual disability (Table 1). In total, 348 intellectually disabled children, between the ages of 5 and 21 years, participated in an exercise intervention study, which met the inclusion criteria for this systematic review (Table 1). The study by Golubović et al. (2012) had 45 typically developed children participating as a control and the study by Mikolajkzyk and Jankowicz-Szymmanska in 2015 was a continuation of their 2014 study which was also included in this systematic review, so the same participants were involved for both studies. Smail and Horvat (2005) noted that their participants were students at a Special Education High School but never reported the age range of the study. Furthermore, majority of the studies included both male and female participants and some assessed males only. Three studies never reported the sex of their participants (Smail & Horvat, 2005; Giagazoglou et al., 2012; Tsimaras et al., 2012).

Table 1: Study characteristics summary

No#	Study	Study Design	Disability (IQ Severity)	Participation	Sex	Age
1	Lotan et al., 2004	Repeated measure	Moderate - Profound	n=15	male / female	5 - 10 years
2	Smail & Horvat, 2005	Repeated measure	Mild	n=10	-	(High School)
3	Ozmen et al., 2007	RCT	Mild - Moderate	Exercise (n=16) Control (n=14)	male	8-15 years
4	Yilmaz et al., 2009	Repeated measure	Mild - Moderate	n=16	male	11-15 years
5	Yildirim et al., 2010	RCT	Mild	Exercise (n=25) Control (n=25)	males / female	11-18 years
6	Kubilay et al., 2011	RCT	Mild	Exercise (n=14) Control (n=14)	male / female	9-21 years
7	Ahmadi et al., 2012	RCT	Mild	Exercise (n=17) Control (n=14)	male	8-14 years
8	Giagazoglou et al., 2012	Non- RCT	Moderate	Exercise (n=10) Control (n =9)	-	15.3 ± 2.1 years
9	Golubović et al., 2012	Non- RCT	Borderline - Mild Typically Developed	ID Exercise (n=21) ID Control (n=21) TD Control (n=45)	male / female	6.5-12 years
10	Tsimaras et al., 2012	Non- RCT	Mild - Moderate	Exercise (n=10) Control (n=7)	-	16-20 years
11	Giagazoglou, Arabatzi et al., 2013	Non- RCT	Moderate	Exercise (n=10) Control (n =9)	male	15.3 years (± 2.1)
12	Giagazoglou, Kokaridas et al., 2013	RCT	Moderate	Exercise (n=9) Control (n =9)	male / female	10.3 years (± 1.6)
13	Mikolajkzyk & Jankowicz-Szymmanska, 2014	RCT	Moderate	Exercise (n=17) Control (n=17)	male / female	14-16 years
14	Azadeh et al., 2015	Non- RCT	-	Exercise (n=15) Control (n=15)	female	12-19 years
15	Dehghani & Gunay, 2015	RCT	Mild	Exercise (n=11) Control (n=11)	male / female	8-13 years
16	Mikolajkzyk & Jankowicz-Szymmanska, 2015	RCT	Moderate	Exercise (n=17) Control (n=17)	male / female	14-16 years
17	Srinivasan & Giridharan, 2015	RCT	Mild	Exercise(n=15) Control (n=15)	male	14-21 years
18	Kachouri et al., 2016	Non- RCT	Mild	Exercise (n=10) Control (n=10)	male	9-13 years

Where: RCT = Randomized Control Trial; ID = intellectually disabled; TD = typically developed

Reporting & Methodological Quality

Table 2: Summative table of the FIND principle, Reporting and Methodological Quality (higher scores reflect better quality)

No#	Study	Frequencey	Intensity	Nature	Duration	Reporting Quality	Methodological Quality
1	Lotan et al., 2004	(20-30 mins) 7 x week	Low	Cardiorespiratory endurance	8 weeks	**6/15**	**3/8**
2	Smail & Horvat, 2005	(30mins) 3 x week	Low	Balance	12 weeks	**6/15**	**2/8**
3	Ozmen et al., 2007	(60mins) 3 x week	Moderate - High	Cardiorespiratory endurance	10 weeks	**8/15**	**4/8**
4	Yilmaz et al., 2009	(40mins) 2 x week	Moderate	Cardiorespiratory & muscular endurance	10 weeks	**11/15**	**3/8**
5	Yildirim et al., 2010	(30-60mins) 3 x week	Moderate - High	Reaction time	12 weeks	**11/15**	**4/8**
6	Ahmadi et al., 2012	(- mins) 3 or 4 x week	Low - Moderate	Balance & strength	6 weeks	**6/15**	**2/8**
7	Kubilay et al., 2011	(30mins) 3 x week	Low - Moderate	Balance	8 weeks	**9/15**	**4/8**
8	Giagazoglou et al., 2012	(30mins) 2 x week	Low - Moderate	Balance & strength	10 weeks	**9/15**	**4/8**
9	Golubović et al., 2012	(45mins) 3 x week	-	Cardiorespiratory, muscular endurance, balance & strength	24 weeks	**13/15**	**5/8**
10	Tsimaras et al., 2012	(45mins) 3 x week	Moderate	Balance	16 week	**11/15**	**3/8**
11	Giagazoglou, Arabatzi et al., 2013	(30mins) 2 x week	Low	Reaction time & muscle activation	14 weeks	**9/15**	**4/8**
12	Giagazoglou, Kokaridas et al., 2013	(20mins) 7x week	Low - Moderate	Balance & muscular endurance	12 weeks	**11/15**	**5/8**
13	Azadeh et al., 2015	(60mins) 3 x week	Low	Balance	8 weeks	**5/15**	**3/8**
14	Dehghani & Gunay, 2015	(40mins) 2 x week	Low	Balance	10 weeks	**10/15**	**3/8**
15	Mikolajkzyk & Jankowicz-Szymmanska, 2014	(45mins) 3 x week	Low	Static balance	12 weeks	**8/15**	**5/8**
16	Mikolajkzyk & Jankowicz-Szymmanska, 2015	(45mins) 3 x week	Low	Static balance	24 weeks	**10/15**	**5/8**
17	Srinivasan & Giridharan, 2015	(60mins) 3 x week	Low	Coordination & reaction time	6 weeks	**4/15**	**2/8**
18	Kachouri et al., 2016	(45-60mins) 3 x week	Moderate - High	Balance & strength	8 weeks	**12/15**	**4/8**

According to the reporting quality assessment, as seen in Table 2, only six of the eighteen studies included in this systematic review were considered to be of high reporting quality (11/15 or higher). This was a disappointing result, as fundamental reporting entities, such as reporting of setting, location, periods of recruitment, participants lost and/or follow-up due to poor adherence, limitations, and generalizability were not met or addressed in the other twelve articles. This brought into question the reliability and validity of some of the articles' reporting. The study by Golubović et al. (2012) scored the highest with 13/15 and Kachouri et al. (2016) scored the second highest with 12/15, which meant that the majority of the reporting entities for these two articles were addressed respectively. Seven of eighteen articles had moderate reporting quality between 7/15 and 10/15 (refer to Table 2). Lower reporting quality assessment were found for; Lotan et al. (2004), Smail and Horvat (2005), and Ahmadi et al. (2012) scoring 6/15; Azadeh et al. (2015) scoring 5/15; and Srinivasan and Giridharan (2016) scoring the lowest score of 4/15.

Not one study was considered to have been of high methodological quality, as all the articles scored lower than 6/8 (75%), as seen in Table 2. Golubović et al. (2012), Giagazoglou, Kokaridas, et al. (2013), Mikołajczyk and Jankowicz-Szyma (2014), and Mikolajczyk and Jankowicz-Szymanska (2015) scored 5/8, while Ozmen et al. (2007), Yildirim et al. (2010), Kubilay et al. (2011), Giagazoglou et al. (2012), Giagazoglou, Arabatzi, et al. (2013) and Kachouri et al. (2016) scored 4/8, which was considered to have been moderate methodological quality. None of the studies reported the sequence generation, nor allocation concealment in their methodologies, therefore there was insufficient information regarding the methods of randomization/allocation concealment, which lead to all articles having high risk of bias for these two methodological quality components. It was alarming that not one of the studies reported that they had attempted to blind those measuring the main outcomes of the intervention. This could have been achieved if the research assistants/administrators of the exercise intervention were not involved in the pre-and-post measurement procedures. The results of the methodological quality assessment, summarized in Table 2, determined that all the articles included in this systematic review were at high risk of bias, which makes the internal validity and the reliability of the results of these studies questionable.

The results of this systematic review found conflicting and moderate evidence for the FIND principle. There was moderate evidence found for frequency for exercise intervention, which varied from 20 minutes seven times a week to 60 minutes two, three or seven times a week. The most commonly reported frequency was three times a week used by twelve out of the eighteen articles; however, the time of each exercise session ranged from 30 to 60 minutes. The article by Ahmadi et al. (2012) was unclear, as discrepancies for the frequency were found in the article, as they reported the frequency to be both three times and four times a week. Three of the twelve articles were considered to be amongst the top three results for reporting and methodological quality, which were Golubović et al. (2012), Giagazoglou, Kokaridas et al. (2013) and Kachouri et al. (2016).

Conflicting evidence was also found for intensity in this review. The majority of the exercise intensity implemented in the studies were low and/or moderate; however, three studies reported moderate to high intensity. Two of the three studies that used moderate to high intensity were of poor quality (Ozmen et al., 2007; Yildirim et al., 2010). The study by Kachouri et al. (2016) was of moderate study quality and used moderate to high intensity.

The nature of the intervention was determined by identifying the aim of the intervention, evaluating the exercises used to achieve the aim, and looking at the main outcomes of the study. The natures of the interventions varied from balance exercises, to hippotherapy, to trampoline training and Greek traditional dance. However, the physical fitness component that was most studied and included as a variable of the exercise interventions was balance, with twelve of the eighteen articles reporting on it (refer to Table 2). The next most reported variables were cardiorespiratory endurance and muscular strength, which were both implemented in four studies, and muscular endurance which was implemented in three studies.

Once again, conflicting evidence was found for duration of exercise intervention, with the most reported durations for exercise interventions being eight, ten and twelve weeks; however, some interventions had a less common duration, such as six, fourteen, sixteen and twenty four weeks. Four of the eighteen articles implemented an 8 week duration intervention, of which one (Kachouri et al., 2016) was of high reporting quality and moderate methodological quality. The other three articles had low reporting and methodological quality (Lotan et al., 2004; Kubilay et al., 2011; Azadeh et al., 2015). A further four articles had a 10 week duration, all of which were found to have low quality (Ozmen et al., 2007; Yılmaz et al., 2009; Giagazoglou et al., 2012; Dehghani & Gunay, 2015). A 12 week exercise intervention duration was found in four articles, but only one (Giagazoglou, Kokaridas, et al., 2013) of the four was found to be of high reporting quality and moderate methodological quality, a second article (Mikołajczyk & Jankowicz-Szyma, 2014) was found to be of moderate reporting and methodological quality. It must be noted that the article by Mikołajczyk and Jankowicz-Szyma (2014) was a preliminary study and was continued for a further twelve weeks, which resulted in the Mikolajczyk and Jankowicz-Szymanska (2015) study with a duration of 24 weeks.

DISCUSSION

The physiological response to exercise is dependent on the intensity, duration and frequency of exercise (Shin & Park, 2012). Although several studies have reported an effect of exercise programs on individuals with intellectual disability, these studies did not report estimates of the effects related to the mode of exercise, minimum time, duration, and frequency needed to obtain meaningful outcomes (Chanias et al., 1998; Shin & Park, 2012). Henceforth, this systematic review provides evidence for the most appropriate and effective FIND principles for exercise prescription and intervention design for children with intellectual disability. Therefore, the results of this systematic review found that exercise interventions of at least eight weeks and preferably ten weeks or more in duration, a frequency of three times per week or more, exercise sessions lasting between 30 to 60 minutes, and a low to moderate exercise intensity, were more effective.

A previous systematic review by Bartlo and Klein (2011) found that a physical activity programme with a duration ranging from six to twelve weeks can be beneficial in improving physical fitness levels for intellectually disabled individuals, which was similar to the findings of this systematic review. However, the articles in the previous systematic review by Bartlo and Klein (2011) included adults of 18 years and older and participants with Down syndrome. Both Giagazoglou, Kokaridas, et al. (2013) and Mikołajczyk and Jankowicz-Szyma (2014) reported that a exercise intervention duration of 12 weeks was found to be effective; whereas Giagazoglou et al. (2012) and Yilmaz et al. (2009) found 10 weeks to be effective. However, these two articles were poorer in quality compared to those by Giagazoglou, Kokaridas, et al. (2013) and Mikołajczyk and Jankowicz-Szyma (2014). Furthermore, exercise programmes of shorter duration of 8 weeks were also found to be effective and sufficient to produce both neural and muscular adaptations (Kubilay et al., 2011; Kachouri et al., 2016). However, Kachouri et al. (2016) emphasized that this duration was the minimum time period to ensure effective outcomes and stated that it would be better if this time intervention was longer to get better improvements. A meta-analysis by Shin and Park (2012) found that the moderating effect of an exercise duration of 10 weeks was effective in affecting exercise outcomes and a meta-analysis by Chanias et al. (1998) indicated that longer exercise programs of more than 9 weeks have a significantly larger effect size than shorter programs of less than 8 weeks for intellectually disabled adults. The difference in results indicates that further studies should be performed to determine the effect of exercise according to duration, as well as specifying effect on children with intellectual disability.

The findings of this systematic review found that exercise sessions ranging from 30-60 minutes and a frequency of three times a week were most effective (Ozmen et al., 2007; Kubilay et al., 2011; Yildirim et al., 2010; Golubović et al., 2012; Kachouri et al., 2016). Similarly, previous meta-analyses stated that an exercise session length of more than 30 minutes had a larger effect size than exercise sessions below 30 minutes, and that exercise sessions of 31 to 60 minutes were found to be effective (Chanias et al., 1998; Shin & Park, 2012). In addition, Chanias et al. (1998) and Shin and Park (2012) also determined that higher-frequency exercise had a larger effect size than lower-frequency exercise, and an exercise frequency of 4 times per week was more effective than a frequency of 3 times per week.

The relationship between exercise intensity and effectiveness is a critical issue. A low to moderate exercise intensity for children with intellectual disability was found to be effective (Kubilay et al., 2011; Giagazoglou et al., 2012; Giagazoglou, Kokaridas, et al., 2013; Mikołajczyk & Jankowicz-Szyma, 2014). It must be noted that 12 of the 18 studies focussed on balance as the primary outcome, but the interventions themselves focussed on exercises that would be most beneficial, such as strength, neuromotor and proprioceptive training (nature of exercises), to improve balance. Therefore, the exercise intensities of these studies are still valid due to the nature of the intervention, which will be discussed later. Furthermore, these studies also provide information regarding the relationship between exercise intensity and adherence/ compliance of the intellectually disabled children to engage in exercise activities. The study by Kachouri et al. (2016) suggested that the intensity of exercises should be increased progressively throughout the exercise programme (Kachouri et al., 2016). Yildirim et al. (2010) implemented a progressive exercise programme that advanced from moderate to higher intensity, which enhanced the majority of the physical fitness components incorporated into the study. However, concerns arose with regards to the adherence and feasibility of such a high exercise intensity and it was suggested that future research should also assess whether exercise programs of lower intensity could result in similar improvements (Yildirim et al., 2010). It has been suggested that intellectually disabled individuals are more likely to adopt and maintain physical activity or exercise habits when they are introduced to a program of low to moderate intensity (Pastula et al., 2012). Furthermore, low to moderate exercise elicits greater levels of satisfaction and enjoyment in being able to engage and complete the exercises, whereas high intensity exercise may be difficult to maintain and complete without the intellectually disabled children loosing motivation and perseverance (Giagazoglou, Arabatzi et al., 2012; Giagazoglou, Kokaridas, et al., 2013; Stanish & Temple, 2012).

The most consistent findings for this systematic review was the nature of the exercise interventions, as twelve of the eighteen articles implemented balance-specific exercises. Persons with intellectual disability have delayed maturation for balance ability when compared to the general population (Giagazoglou, Kokaridas, et al., 2013). Previous studies have shown that individuals with intellectual disability have deficits in their sensory information processing, and therefore have disturbed planning and disorganized movements in response to visual and proprioceptive information, resulting in disabling balance maintenance, poor postural control, decreased quality of gait and increased risk of accidental falls (Golubović et al., 2012; Giagazoglou, Kokaridas, et al., 2013; Mikolajczyk & Jankowicz-Szymanska, 2015; Kachouri et al., 2016). Furthermore, intellectually disabled individuals experience premature aging, due to a sedentary lifestyle and lack of physical fitness, which adversely accelerates deconditioning and decreases coordination, which further increases the prevalence of falls resulting in injury (Bartlo & Klein, 2011; Giagazoglou, Kokaridas, et al., 2013). Exercise interventions have been considered to be one of the most effective ways to improve balance deficits and prevent falling injuries, as previous studies have reported a large effect size and significant improvements of 9-25% for proprioceptive integration following balance training (Zech et al., 2010; Bartlo & Klein, 2011; Shin & Park, 2012; Giagazoglou, Kokaridas, et al., 2013; Mikołajczyk & Jankowicz-Szyma, 2014; Kachouri et al., 2016). Therefore, there was an urgent need to identify effective balance-specific exercise interventions and research must continue as to produce higher quality studies that provide information regarding the most effective balance-specific exercise specifically for children with intellectual disability.

Strength training programs have also been widely reported to improve balance capacities in individuals with intellectual disability (Bartlo & Klein, 2011; Kachouri et al., 2016). Three of the twelve balance-specific interventions were combined with strength training (Ahmadi et al., 2012; Giagazoglou et al., 2012; Kachouri et al., 2016).

Generally, strength exercises have been found to improve proprioceptive integration, as the sensitivity and activation of the muscle afferent pathways that innervate the muscle spindle as well as muscle and tendon receptors are enhanced with strength training (Kachouri et al., 2016). A systematic review by Bartlo and Klein (2011) found strength training to be highly beneficial for intellectually disabled adults; however, it was suggested that low intensity strength exercises would suffice to improve functional abilities. Previous studies on intellectually disabled individuals have reported a 10% to 29% increase in strength after the completion of strength training programme (Bartlo & Klein, 2011). Meta-analyses reported a moderate effect size for strength improvements for intellectually disabled adults, whereas larger effect sizes were found for muscular endurance and cardiorespiratory endurance (Chanias et al., 1998; Shin & Park, 2012). However, it has been widely demonstrated that cardiorespiratory endurance, muscular endurance and strength have all been shown to be highly improvable in children with intellectual disability after participating (Golubović et al., 2012; Shin & Park, 2012).

CONCLUSION

The results showed low to moderate quality assessments for articles included in this systematic review, with conflicting evidence regarding the implementation of the frequency, intensity, nature and duration for exercise interventions for children with intellectual disability. With this being said, some conclusions could be drawn for the development of the current intervention study. The above findings had some similarities to the recommendations for typically developed children's physical activity; however, some of the FIND principles differed slightly, such as intensity and duration. This systematic review provided a more evidence-based guideline pertaining to an exercise programme intervening with intellectually disabled children, which should have the following characteristics: a duration of at least eight weeks and preferably ten weeks or more, a higher rather than a lower frequency, exercise sessions lasting between 30 to 60 minutes, and a low to moderate exercise intensity.

CHAPTER III

DESCRIPTIVE STUDY

INTRODUCTION

Research Aim

The purpose of the first phase of this Masters study was to acquire a better understanding of the level of physical fitness of children with intellectual disability in the Grahamstown region, South Africa. Therefore, the descriptive study aimed to identify the level of physical fitness of the intellectually disabled children by measuring and assessing eleven components of physical fitness of a sample group of intellectually disabled children and compare their results to those from a sample of typically developed children. Thereby, these results would determine which physical fitness components would be in need of improvement and be most applicable to improve their overall level of physical fitness. The objective was to use these results in conjunction with the literature to subsequently inform the development of an exercise intervention study, which formed the second phase of this Masters study (Chapter IV).

Scope of Study

The sample populations for this study focussed primarily on children with intellectual disability and secondarily on typically developed children as a comparative sample. Both groups were matched for age, sex and socio-economic status. Both populations were from a previously disadvantaged background with a low socio-economic status and recruited from government schools based in the Grahamstown region. Both female and male children, between the ages of 9 to 12 years, were included in this study. Participants were excluded if they had a physical disability and if they did not manage to complete the test battery.

METHODOLOGY

HYPOTHESES

Research Hypothesis

The research hypothesis proposed that the results obtained from the descriptive study would show a lower level of physical fitness for children with intellectual disability compared to typically developed children.

Statistical Hypothesis

The null hypothesis stated that there would be no significant difference between the levels of physical fitness between intellectually disabled and typically developed children.

H_O: $\mu PF_{ID} = \mu PF_{TD}$

The alternative hypothesis stated that there would be a significant difference between the levels of physical fitness between intellectually disabled and abled children.

H_A: $\mu PF_{ID} \neq \mu PF_{TD}$

Where:

PF: Physical fitness
ID: Intellectually disabled
TD: Typically developed

EXPERIMENTAL DESIGN

This study adhered to a non-repeated experimental and exploratory design. Basic descriptive statistics were used to provide measures of central tendency and of variability of the physical fitness components. A parametric independent t-test was administered to determine if the children with intellectual disability showed statistically significant decrements in their physical capabilities compared to their typically developed peers, while the exploratory design determined the inter-relationships of the physical fitness components.

Independent Variable

Disability status – Did the child live with or without an intellectual disability? Intellectual disability includes a predecessor of having a significantly subaverage intellectual functioning of an IQ of 70 or below (Silverman et al., 2010).

Dependant Variables

The following variables were recorded during the first phase of the testing sessions for the comparative descriptive study. The justifications of why these dependant variables were chosen have been discussed in the review of literature.

1. Stature and mass
2. Cardiorespiratory endurance
3. Muscular endurance
4. Muscular strength
5. Body composition
6. Flexibility
7. Balance
8. Agility
9. Speed
10. Power
11. Coordination
12. Reaction time

PARTICIPANT CHARACTERISTICS

Participant recruitment followed a non-probable sampling method of convenience. Government special needs schools within close proximity to Grahamstown, such as Port Elizabeth, were contacted via email and asked if they would be interested to participate in this Master's study. Two population groups, namely the intellectually disabled (ID) group and the typically developed (TD) group, were recruited to participate in the descriptive study. Both of the groups were recruited and met the inclusion criteria of; between the ages of 9-12 years, similar ratios of males to females, and similar socio-economic backgrounds. The intellectually disabled participants were in the middle level class of the local special needs school selected for this study. According to Cora van Vuuren (personal communications, 9th of June 2015), the educational psychologist who worked with the special needs school, the children were classified with mild intellectual disability, with an IQ ranging from 50 to 70. Thirty-six participants were recruited from the special needs school; however, one participants had a physical disability and six participants did not complete all the tests, therefore the intellectually disabled sample group had 29 participants (n = 29). There were 15 males and 14 females in the intellectually disabled sample group and the average age sample group was 10.69 ± 1.26 years. The second sample group (n = 25) was recruited form a government primary school in Grahamstown and was used as the comparative group that represented the typically developed peers of the intellectually disabled participants. The typically developed sample has an average age of 10.51 ± 0.74 years and consisted of 13 males and 12 females.

INSTRUMENTATION AND MEASUREMENT OF VARIABLES

The process developed for selecting test items and standards for intellectually disabled children incorporated the personalized approach (Davis et al., 2011; Winnick & Short, 2014). This approach facilitated selecting test items on the basis of meeting the criteria required to assess children with intellectual disability in a reliable and valid manner. Thus, test items were selected to meet the wide variations in needs and abilities of children with intellectual disability, rather than the children having to conform to generalized test items that are not appropriately designed and would hinder their capabilities (Winnick & Short, 2014). Therefore, extensive research of the literature was undertaken and stringent selection criterion facilitated the selection of the test items for the study. The primary criteria for selection of the test items corresponded to Winnick and Short (2014) criteria, which were validity, reliability and the extent to which test items could be used for different categories of disability and age (Winnick & Short, 2014). Therefore, preference was given to feasible test items that could be administered to both male and female children between 10 to 12 years of age, and to young people with and without intellectual disability (Hilgenkamp et al., 2010; Winnick & Short, 2014). The second criteria for the test items selection was that the tests had to be easily administered in field situations, as well as economical in terms of time and expense, as to adhere with the socio-economic context and sustainability of the project (Winnick & Short, 2014).

Anthropometric Measures

Stature

Stature was measured according to the International Society for the Advancements of Kinanthropometry (ISAK) measurement technique 'against the wall' (Stewart et al., 2011). This technique consists of a tape measure (TR-13W Tailor's Tape) being attached to a wall and used to measure the participant's stature (Stewart et al., 2011). Each participant was instructed to remove shoes and/or headwear before having their measurement taken. Participants were asked to stand in an upright position, with feet together and pressed against the base of the wall, with hands to their side (Stewart et al., 2011). The participant's buttocks and upper part of the back should also be touching the wall (Stewart et al., 2011). The participant's head was positioned in the Frankfurt plane, which is the position of the skull when the lower margins of the orbit and the upper margins of the ear canals lie in the same horizontal plane (Stewart et al., 2011). The measurement was taken during inspiration (inhalation), at the highest point of the participant's head (Stewart et al., 2011).

Body Mass

Each participant's mass was recorded using a digital bathroom scale (Safeway Electronic Scale) technique, which is accurate to the nearest 50g (Stewart et al., 2011). Each participant was instructed to remove any footwear, headwear and/or unnecessary clothing before stepping onto the digital scale (Stewart et al., 2011).The researcher checked that the scale was zeroed, after which the participant stood in the centre of the scale without support and weight distributed evenly on both feet (Stewart et al., 2011). Once on the scale, participants were instructed to remain as still as possible, while the scale measured their body mass to the nearest 0.1 kg.

Health-Related Physical Fitness

Cardiorespiratory endurance

The PACER test item, also known as the Multistage 20m Shuttle Run, is the most widely used performance test item to assess cardiorespiratory endurance, as it has been used in numerous studies and has been proven to be a reliable and valid field-based test to assess cardiorespiratory endurance for the intellectually disabled

(Fernhall et al., 2000; Faison-Hodge & Porretta, 2004; Ruiz et al., 2006; Ozmen et al., 2007; Ortega, Artero, et al., 2008; Santos & Mota, 2009; Zhang et al., 2009; Davis et al., 2011; Waninge, 2011; Calders et al., 2012; Golubović et al., 2012; Winnick & Short, 2014). The 20-meter PACER test, however, had also been adapted to the 15-meter PACER test, as to accommodate for the needs of children with intellectual disability from 10-12 years of age (Winnick & Short, 2014). Given this study's sample age group, the modified 15-meter PACER test was selected.

The 15-meter PACER test required the participants to have listened to the audio recording and have completed two familiarization sessions, so that they were fully aware of what the test involved and knew what to expect (Short & Winnick, 2014). During the two familiarization sessions and the test trial, an adult ran alongside the participants to orient the children with intellectual disability to the procedures of the test and to give verbal motivation cues (Davis et al., 2011; Short & Winnick, 2014). On the test day only one test trial was given (Short & Winnick, 2014). The modified 15-meter PACER test was performed on a flat non-slip surface and the distance of 15-meter was measured using a measuring tape and marked by cones and tape lines (Davis et al., 2011; Ortega, Artero, et al., 2008; Winnick & Short, 2014). An audio player, with adequate volume, was set up and the PACER audio recording was used in order to keep the incremental lap speed. For the first minute of the test the participants had 6.75 seconds to run each 15-meter distance; thereafter, the lap time decreased by half a second at each successive level. Single beeps indicated the end of a lap. Triple beeps at the end of each minute indicated the next level had begun with an increase in speed.

The participants were required to run the 15-meter distance to the marked line by the time of beep (Ruiz et al., 2006). At the sound of the beep, they turned around and ran back to the other end (Ruiz et al., 2006) (Figure 5). If a participant reached the line before the beep, he or she waited for the next beep before running in the other direction (Short & Winnick, 2014). Participants continued in this manner until they could no longer reach the cone/line before the beep sounds (Short & Winnick, 2014). The test was terminated once the participant has failed to reach the end lines concurrent with the audio signals on two consecutive occasions (Ruiz et al., 2006; Short & Winnick, 2014). Upon completing the test, participants walked from the testing area to a designated cool-down area, and were careful not to interfere with others who were still running, and continued to walk and stretch in the cool-down area facilitated by a research assistant (Short & Winnick, 2014).

The modified PACER test used an adapted formula for estimating VO_{2max}. The number of 15 meter laps were converted to an equivalent number of 20 meter laps. A lap conversion chart was used, which had been provided in the Brockport Physical Fitness Test Manual (Winnick & Short, 2014). The formula is as follows: VO_{2max} = 45.619 + (0.353 x 20-meter PACER laps) – (1.121 x age).

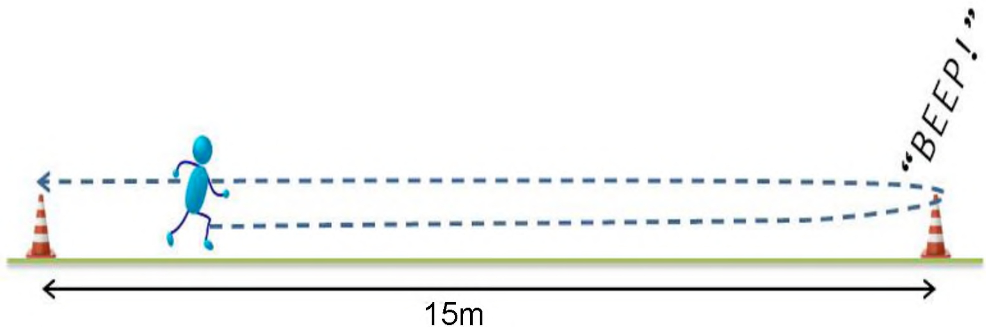


Figure 5: Illustration of the modified 15m PACER test (image taken from http://www.5-a-side.com/fitness/the-beep-test-a-comprehensive-guide/)

Muscular endurance

The modified curl-up test assessed abdominal muscular endurance, which measured the abdominal muscle groups capability to execute repeated contractions over time (Ruiz et al., 2006; Zhang et al., 2009; Davis et al., 2011; Stanish & Temple, 2012; Terblanche & Boer, 2013; Short & Winnick, 2014). The Brockport Physical Fitness Test recommended the modified curl-up to be used to test muscular endurance over other test items, as it had been found to be the most appropriate, reliable and valid test to measure muscular endurance for children with intellectual disability (Ruiz et al., 2006; Zhang et al., 2009; Davis et al., 2011; Stanish & Temple, 2012; Short & Winnick, 2014).

The modified curl-up test item required the participants to complete as many curl-up repetitions as possible in one minute (Ruiz et al., 2006; Davis et al., 2011; Short & Winnick, 2014). The participants began the test on a floor mat in the supine position, with both knees bent at an angle of approximately 140 degrees, legs slightly apart, feet flat on the floor, and hands placed on their thighs (Ruiz et al., 2006; Davis et al., 2011; Terblanche & Boer, 2013; Short & Winnick, 2014). The movement of the curl-up entailed lifting the shoulders off the floor, and their hands to slide up their thighs until their fingertips reach their patellae (Ruiz et al., 2006; Davis et al., 2011; Short & Winnick, 2014) (Figure 6). Research assistants placed their hands on the participants kneecaps to provide a more tangible target for the individuals' reach (Short & Winnick, 2014). Furthermore, the assistants encouraged a slow curling of the upper spine, and a steady, controlled and continuous movement during the curl-up (Short & Winnick, 2014).

Prior to the test, the participants had two practice trials of the modified curl-up during the familiarization sessions, as to make sure the curl-up was performed correctly (Short & Winnick, 2014). Only one test was administered and each participant's score recorded as the number of curl-ups performed correctly (Ruiz et al., 2006; Davis et al., 2011; Short & Winnick, 2014). One curl-up was counted for every return to the supine position on the mat (Ruiz et al., 2006; Davis et al., 2011; Terblanche & Boer, 2013; Short & Winnick, 2014). Curl-ups were not counted if the feet left the floor at any time during the movement, the participant did not reach the patella, did not return to the start position, or performed the curl-up in any other incorrect manner (Davis et al., 2011; Short & Winnick, 2014).

Figure 6: Illustration of the modified curl-up test (image taken from http://www.goodshepherdrehab.org/blog/improved-balance-through-core-stability)

Muscular strength

The dominant hand's grip strength was selected to assess upper body isometric strength, as it has been a valid and widely used test to measure intellectually disabled children's muscular strength (Caspersen et al., 1985; Proper et al., 2003; Frey & Chow, 2006; Ruiz et al., 2006; Fowler et al., 2007; Ortega, Artero, et al., 2008; Santos

& Mota, 2009; Terblanche & Boer, 2013; Waung et al., 2013; Short & Winnick, 2014). The test required the participant to be seated on a straight-back, armless chair, with the arm of the hand grasping the dynamometer to be bent at 90°, and feet flat on the floor, as seen in Figure 7 (Short & Winnick, 2014). Before the test began, the research assistant adjusted the handle of the dynamometer to fit the dominant hand of the participant; the second phalanx should rest on the adjustable handle when squeezed (Short & Winnick, 2014). Once the dynamometer had been adjusted correctly, the participant was instructed to squeeze the handle as hard as possible for at least 2 seconds (Ortega, Artero, et al., 2008; Short & Winnick, 2014). This test required three trials to be administered (Short & Winnick, 2014). The researcher recorded each score to the nearest 100 grams and there was a 30 second interval between each of the trials (Short & Winnick, 2014). The mean score of the three trials served as the final result (Short & Winnick, 2014). It was imperative that the particpants were familiarized with the equipment, as well as taught the concept of squeezing with as much force as possible (Short & Winnick, 2014).

Figure 7: Hand grip dynamometer (image taken from http://ispub.com/IJS/5/2/5127)

Body composition

The sum of the triceps and calf skinfold technique was used, as it had been reported to have a high level of reliability and validity for assessing body composition for children with intellectual disability (Winnick & Short, 2005; Frey & Chow, 2006; Zhang et al., 2009; Winnick & Short, 2014). Only two skinfold sites were measured, as it was less invasive and deemed a more appropriate test to assess intellectually disabled children's body composition (Frey & Chow, 2006; Zhang et al., 2009).

A skinfold calliper was used to measure the thickness of skinfolds at the triceps and calf (Zhang et al., 2009) (Figure 8). The triceps skinfold site was located over the triceps muscle, midway between the acromion process of the shoulder and olecranon of the elbow (Santos & Mota, 2009; Zhang et al., 2009). The calf skinfold site was measured on the medial side of the lower leg at the level of maximal calf girth (Zhang et al., 2009). The calf leg that was measured was non-weight bearing, as it rested on a raised box with the foot placed flat and with the knee flexed at an angle of 90 degrees (Zhang et al., 2009; Winnick & Short, 2014). The triceps and calf skinfold sites were marked and taken on the dominant side of the body to minimise location errors for repeated measures (Mei et al., 2002; Santos & Mota, 2009; Short & Winnick, 2014). The research assistant grasped the skinfold firmly between the thumb and forefinger and pulled it slightly from the body to raise a double layer of skin and the underlying adipose tissue, but not the muscle (Santos & Mota, 2009; Short & Winnick, 2005). The callipers were then applied 1 cm above the fingers that grasped the skinfold and at a right angle to the pinch (Santos & Mota, 2009; Zhang et al., 2009; Short & Winnick, 2014). The calliper's jaws held the skinfold for two seconds before recording the thickness of the fold to the nearest millimetre (Santos & Mota, 2009; Zhang et al., 2009; Short & Winnick, 2014). A total of three measurements were taken on each site and the mean of the three trials were used as the score for that site (Zhang et al., 2009; Santos & Mota, 2009; Short & Winnick, 2014). The final body composition score was the sum of the mean scores of the triceps and the calf.

Figure 8: Photographs showing the triceps and calf skinfold measurements (image taken from http://webpages.shepherd.edu/mmcintos/Grad%20599%20Exercise%20Prescription/Obesity.htm)

Flexibility

The back-saver sit-and-reach test had been reported as a suitable, reliable, valid and feasible technique to measure flexibility for children with and without intellectual disability (Frey & Chow, 2006; Ruiz et al., 2006; Ortega, Artero, et al., 2008; Zhang et al., 2009; Hilgenkamp et al., 2010; Davis et al., 2011; Hilgenkamp et al., 2014; Short & Winnick, 2014). This test item measured flexibility of the hamstring muscles (Short & Winnick, 2014). The participant was required to take off his or her shoes and was seated on the floor near the "sit-and-reach box". The participant's one leg was fully extended with the foot flat against the end of the sit and reach box, whilst the other leg was flexed with the sole of the foot pressed against the extended leg. The arms were both extended forward with the palms facing down on top of one another, resting on the edge of the sit-and-reach box. The sit-and-reach box contained a movable bar and a measurement scale. The objective was to push the bar forward with the fingertips; this was achieved by flexing the trunk to gain as much reach, whilst keeping the fully extended knee extended (Monyeki et al., 2005; Frey & Chow, 2006; Ortega, Artero, et al., 2008; Short & Winnick, 2014) (Figure 9). The farthest position of the bar reached by each leg was recorded in centimetres and the average of the distances reached by both legs was the final score (Ortega, Artero, et al., 2008).

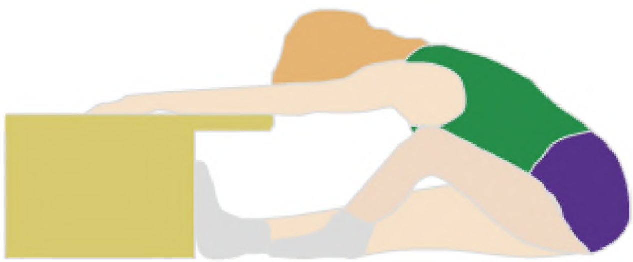


Figure 9: Illustration showing the back-saver sit-and-reach test (image taken from http://www.topendsports.com/testing/tests/sit-and-reach-backsaver.htm)

Skills-Related Physical Fitness

Balance

Balance was assessed using the single leg stance test (Giagazoglou et al., 2012; Jankowicz-Szymanska et al., 2012; Enkelaar et al., 2013; Giagazoglou, Kokaridas, et al., 2013; Terblanche & Boer, 2013; Oviedo et al., 2014). The single leg stance test required the participant to stand on one leg with their foot pointing straight, whilst the non-supporting leg was flexed 90° at the hip and knee joints, as seen in Figure 10 (Giagazoglou, Kokaridas, et al., 2013; Terblanche & Boer, 2013; Oviedo et al., 2014). The participant was instructed to stand as still as possible, with his or her hands on the hips, and look straight ahead at a point on a wall 65 cm away (Giagazoglou et al., 2012; Terblanche & Boer, 2013). The test was terminated if the participant reached the maximum standard of 30 seconds, or once the hands moved off the hips and/or if there was a loss of stability, as seen by too much body sway (Terblanche & Boer, 2013). The test was performed once with each leg and the best time was used as the final score (Terblanche & Boer, 2013; Oviedo et al., 2014).

Figure 10: Photograph showing the single leg stance test (image taken from http://www.ptonthenet.com/articles/assessing-your-client-for-the-loss-of-stability-744)

Agility

The 505 agility test was a simple and direct measure of agility, as the test isolated the ability to change direction and accelerate, independent of running speed capacity and this represented a valid measure of agility performance (Sheppard & Young, 2006; Gabbett et al., 2008; Stewart et al., 2014). A distance of a 15m shuttle was used for the 505 agility. At the 10m mark two timing gates were set up, while at the 15m mark cones and tape illustrated the turning point of the test. Each participant was instructed to accelerate as quickly as possible through the timing gates (at the 10m mark), pivot 180° behind the 15m line, and returned as quickly as possible through the timing gates, as depicted in Figure 11 (Sheppard & Young, 2006; Gabbett et al., 2008; Buchan et al., 2012; Stewart et al., 2014; Tomáš et al., 2014). Three trials were administered, with 5 minutes rest between each trial, and the fastest trial was recorded as the final score (Gabbett et al., 2008).

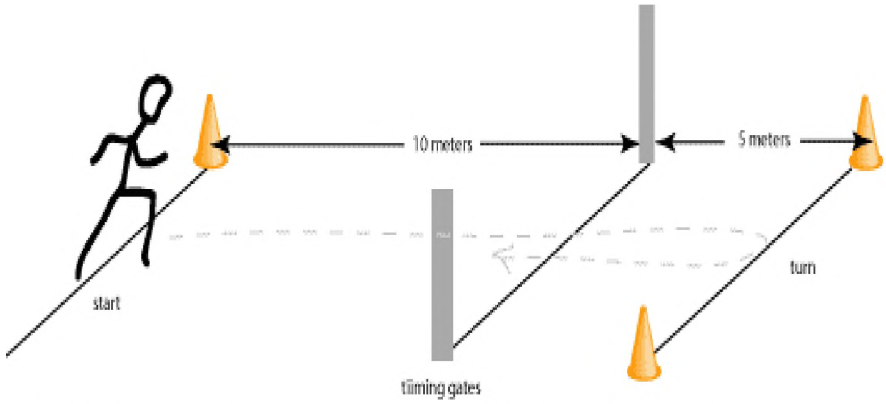


Figure 11: Schematic diagram of the 505 agility test (image taken from http://www.topendsports.com/testing/tests/505.htm)

Speed

The 50m sprint was a reliable and feasible test, which involved running a 50 m distance as fast as possible (Monyeki et al., 2005; Partavi, 2013; Ghosh, 2014). The test was setup on a level grass field and the starting and finishing point were marked by cones. The participants stood behind the starting line, in a stationary position with one foot in front of the other, ready to sprint, and waited for the instructions “ready”, “set” ten “go” (Ghosh, 2014) (Figure 12). The participant were encouraged to not slow down before crossing the finish line (Ghosh, 2014).

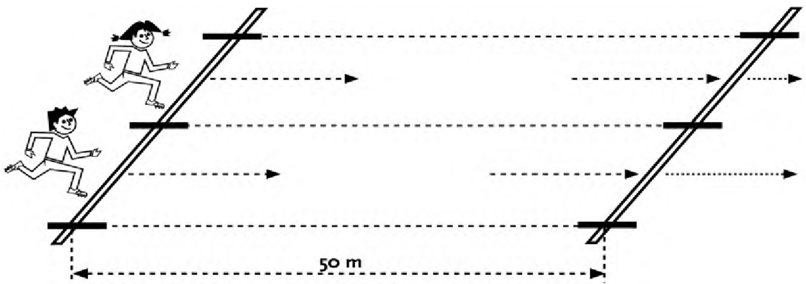


Figure 12: Illustration of a 50m sprint test (image take from http://www.bundesjugendspiele.de/wai2/showcontent.asp?themaid=4770)

Power

The standing broad jump was a reliable test to measure explosive power (Monyeki et al., 2005; Ruiz et al., 2006; Lejčarová, 2008; Ortega, Artero, et al., 2008; Santos & Mota, 2009; Fjørtoft et al., 2011; Golubović et al., 2012; Sekulic et al., 2012; Giagazoglou et al., 2013; Ghosh, 2014). A non-slip hard surface, chalk and a tape measure were used to perform the test (Ortega, Artero, et al., 2008). The participant stood behind a marked line with his/her feet approximately shoulder width apart (Ruiz et al., 2006; Ortega, Artero, et al., 2008). The participant was instructed to bend his/her knees and vigorously push-off on both feet, whilst swinging the arms, with the objective to try jump as far forward as possible and landing on both feet together, as seen in Figure 13 (Ruiz et al., 2006; Ortega, Artero, et al., 2008). The distance was measured from the take-off line to the participant's heel of where he/she had landed (Ruiz et al., 2006). Three trials were administered and the average, measured in centimetres, used as the final score.

Figure 13: Illustration of the standing broad jump test (image taken from *http://fitnessareus.weebly.com/drills-and-activites-muscular-power.html*)

Coordination

The Block and Box test was used to evaluate hand-eye coordination (Carmeli, Bar-Yossef, et al., 2008; Mathiowetz & Bass-Haugen, 2008; Hilgenkamp et al., 2010; Hilgenkamp et al., 2014). The Block and Box test required a specially designed box to be placed in the centre of a standard table (Carmeli, Bar-Yossef, et al., 2008; Mathiowetz & Bass-Haugen, 2008). The box had specific dimensions of 62 cm in length, 54 cm in width and a wall height of 9 cm (Carmeli, Bar-Yossef, et al., 2008). The box was divided into two equal compartments, which were separated using a 15 cm high dividing panel (Carmeli, Bar-Yossef, et al., 2008). 150 small blocks were placed in one of the compartments of the test box, in accordance to the participant's dominant side (Carmeli, Bar-Yossef, et al., 2008; Mathiowetz & Bass-Haugen, 2008). The participant sat at the table with the box test in front of him/her, with each hand on either side of the box. The participant was instructed to use the dominant hand only to transfer one block from one side of the box, over the dividing panel, and drop the small block into the other compartment, as seen in Figure 14 (Mathiowetz & Bass-Haugen, 2008). Once the participant had undestood the instructions and was ready, the research assistant said “go” and and the participant began to transfer the blocks as quickly as possible (Mathiowetz & Bass-Haugen, 2008). The score recorded was the number of blocks transferred in 1 minute (Mathiowetz & Bass-Haugen, 2008). The participant’s fingertips had to cross the dividing panel before the block was dropped, otherwise the transfer did not count (Mathiowetz & Bass-Haugen, 2008). If the participant picked up two blocks at a time, it was only counted as one, and if the participant dropped a block on the floor or table once it had been transferred across it was still counted, as to not waste time by the participant trying to pick it up (Mathiowetz & Bass-Haugen, 2008). The Block and Box test was administered again on the non-dominant hand, using the same procedures and the average of the two trials was recorded as the final score.

Figure 14: Photograph showing the Block and Box test (image take from https://www.thieme.de/de/ergo therapie/box-and-block-test-58066.htm)

Reaction time

The Fitts’ computer based task was used to measure simple reaction time. The design of the task was simple enough to be performed by an intellectually disabled person (Smits-Engelsman et al., 2007; Hilgenkamp et al., 2010). The Fitts’ task entailed the participant responding to a stimulus (green dot with a diameter of 150mm) presented on the computer screen, by clicking the space bar as quickly as possible (Hilgenkamp et al., 2010). The time interval between the presentation of the stimulus and the response of the participant was measured and the outcome was the median reaction time for 10 trials/stimuli, in milliseconds (Hilgenkamp et al., 2010). The stimulus presentation varied from 1000 and 2000ms.

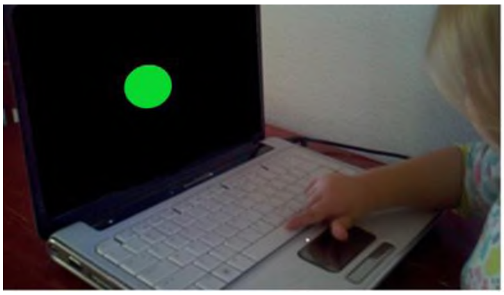


Figure 15: Photograph showing the Fitts' computer based test

ETHICAL CONSIDERATIONS

Prior to recruitment habituation and testing, an ethical standards application was submitted and approved by the Rhodes University Ethical Standards Committee (Appendix 2A.1, pg. 143). This application addressed ethical concerns with regards to scientific experiments conducted on human subjects and included a rationale for conducting this study, the risks and benefits associated with it, issues of informed consent, voluntary participation, anonymity, privacy and confidentiality as well as feedback. Approval was also be granted from the Eastern Cape Department of Education (Appendix 2A.2, pg. 144).

EXPERIMENTAL PROTOCOL

For the first phase of this Master's project participants were recruited from a government special needs school and a government primary school, both based in Grahamstown, South Africa. This was achieved through liaison with the head mistresses of both the schools. A meeting with the head mistress, together with the teachers was undertaken, to fully disclose the aims and purpose of the overall study and to discuss the project timeline. Each parent/guardian received an information sheet (Appendix 2A.5, pg. 150) along with a Children Physical Activity Readiness Questionnaire and Consent Form (Appendix 2A.6, pg. 153), which had to be read, filled out and signed. Once consent from the school and parents had been given, further assent from the children were required verbally. Once this was complete, familiarization and testing sessions commenced.

The participants recruited from the special needs school and the control group recruited from the 'mainstream' primary school were tested separately. However, both sample groups followed the exact same experimental protocol.

There were six sessions in total for each of the schools. The first two sessions consisted of the health-related physical fitness component familiarization sessions, which were essential for the participants to fully understand and become accustomed with the different test items. The third session entailed testing the health-related physical fitness components. The fourth and fifth sessions were the familiarization sessions for the skill-related physical fitness test. Once again, these sessions facilitated the learning and practice of the skill-related test items. The sixth session tested the skill-related physical fitness components.

A stretch and warm up was mandatory before every session to help prevent injury, enhance performance and to mentally prepare the participants for the upcoming sessions. The warm-up was facilitated by the research assistants.

The testing sessions entailed the participants to be split up into three groups. Each group was assigned to a station. Once the groups had completed their stations they rotated to the next station, until all stations had been completed. Each test item was administered by a research assistant. All testing was done on a one-on-one basis, so that each participant was tested individually. The exception to this was the PACER test, where a group of six performed the test together.

STATISTICAL ANALYSIS

The computer software, StatSoft® STATISTICA version 12, was used for statistical analysis. Descriptive statistics analyzed the dependent variables, which included the mean, standard deviation and coefficient of variation. An independent t-test was used to determine any statistical differences in the results between the two sample groups. In addition to descriptive statistics, the dependent variables were analyzed using two lists Pearson product-moment correlation matrices to determine whether any significant relationships existed between the different components of physical fitness. A 95% confidence interval was selected and significant differences were identified at $p<0.05$.

RESULTS

DESCRIPTIVE ANALYSIS

Anthropometry

Table 3: Summary of the participants' characteristics

	Intellectually Disabled	Typically Developed	p value
Age (years)	10.69 ± 1.26	10.51 ± 0.74	0.549
Sex	Male (n = 15) Female (n = 14)	Male (n = 13) Female (n = 12)	-
Stature (cm)	138.72 ± 5.94	146.56 ± 6	**p < 0.001**
Mass (kg)	37.23 ± 5.65	45.47 ± 7.57	**p < 0.001**

The intellectually disabled sample's mean stature (138.72 ± 5.94cm) was significantly ($p<0.001$) shorter than that of the typically developed sample (146.56 ± 6cm) (refer to Table 3). Similarly, the mean mass of the intellectually disabled participants (37.23 ± 5.65kg) was also found to be significantly ($p<0.001$) less compared to their typically developed peers (45.47 ± 7.57kg).

Health-Related Physical Fitness

Table 4: Summary of the health-related physical fitness tests for the intellectually disabled and the typically developed sample groups

	Intellectually Disabled	Typically Developed	p value
Cardiorespiratory endurance PACER (# 15m laps)	19.76 ± 12.42 (62.84%)	26.76 ± 16.07 (60.05%)	0.826
Muscular endurance Modified Curl-Ups (# completed)	18.79 ± 7.13 (37.95%)	39.54 ± 10.24 (25.89%)	**< 0.001**
Muscular strength Grip Strength (kg)	13.71 ± 5.93 (43.24%)	21.53 ± 6.77 (31.45%)	**< 0.001**
Body composition Triceps and Calf Skinfold (mm)	18.18 ± 8.04 (44.25%)	27.61 ± 12.69 (45.96%)	**0.001**
Flexibility Sit-and-Reach (cm)	24.11 ± 5.8 (24.06%)	24.89 ± 6.13 (24.61%)	0.594

Values expressed as "mean ± standard deviation"; CV = Coefficient of Variation presented in brackets; [bold] font highlights significant difference at p < 0.05

The intellectually disabled participant's health-related physical fitness components were significantly lower for muscular endurance (p<0.001), strength (p<0.001) and body composition (p=0.001), when compared to their typically developed peers, as seen in Table 4. Cardiorespiratory endurance was on average lower for the intellectually disabled participants compared to the typically developed sample groups, however not significantly different. The sit-and-reach test mean scores for both sample groups were very similar. The coefficient of variation (CV) for the health-related physical fitness components between the intellectually disabled and typically developed sample groups were fairly similar for the various tests. The PACER test had the highest CV of 62.84% for the intellectually disabled and 60.05% for the typically developed sample group, thereby showing a more heterogeneous variance for both sample groups.

Skill-Related Physical Fitness

Table 5: Summary of the skill-related physical fitness tests for the intellectually disabled and the typically developed sample groups

	Intellectually Disabled	**Typically Developed**	p value
Balance Single Leg Stance (sec)	17.41 ± 10.27 (59.01%)	27.29 ± 5.23 (19.16%)	**< 0.001**
Agility 505 Agility (sec)	3.8 ± 0.65 (17.08%)	3.56 ± 0.59 (16.44%)	0.149
Speed 50m Sprint (sec)	12.21 ± 2.4 (19.62%)	9.29 ± 1.48 (15.92%)	**< 0.001**
Power Standing Broad Jump (cm)	83.73 ± 39.04 (46.63%)	135.02 ± 27.03 (20.02%)	**< 0.001**
Coordination Block and Box (# transfer)	35.44 ± 9.59 (27.06%)	48.69 ± 4.61 (9.43%)	**< 0.001**
Reaction Time Fitts' Task (sec)	0.49 ± 0.18 (37.1%)	0.33 ± 0.06 (16.97%)	**< 0.001**

Values expressed as "mean ± standard deviation"; CV = Coefficient of Variation presented in brackets; [bold] font highlights significant difference at p < 0.05

Five of the six skill-related physical fitness components were significantly different ($p<0.001$), namely balance, speed, power, coordination and reaction time (Table 5). Agility, however, was the only skill-related component that was not significantly different ($p= 0.149$) between the intellectually disabled sample and the typically developed participants. The coefficient of variation was similar for two of the six skill-related physical fitness components, which were agility and speed. Therefore, these two sample groups were deemed homogenous in terms of agility and speed. However, discrepancies between the two sample's coefficients of variations were found for balance, power, coordination and reaction time (Table 5). The large inter-individual variation for these skill-related components showed that the intellectually disabled sample was considered less homogenous compared to the typically developed sample.

CORRELATION ANALYSIS

The coefficient of variation measures the relative variability of the data set on a ratio scale (Field & Hole, 2003). As the homogeneity of a group increases, the variance decreases and the magnitude of the correlation coefficient tends toward zero (Goodwin & Leech, 2006). It is thus imperative to ensure enough heterogeneity (variation) so that a relationship can manifest itself (Kemper & van Mechelen, 1996; Goodwin & Leech, 2006). Therefore, the two sample groups of the current descriptive study were combined for the correlation analysis of the eleven physical fitness components.

The correlation analysis, seen in Table 6 below, showed that there were several significant correlations between the different variables of physical fitness. Health-related components did not correlate significantly with one another, except for the relationship between muscular endurance and strength. More significant correlations were found for health-related with skill-related components, especially for muscular endurance that correlated with four of the skill-related components. Conversely, all the skill-related components correlated with one another, with exception of speed and agility, and speed and reaction time.

The component with the most correlations was power with eight significant correlations, followed by coordination with seven, balance with six and muscular endurance and reaction time with five significant correlations.

Table 6: Coefficient correlation analysis of the physical fitness components of both the intellectually disabled and the typically developed groups combined and the coefficient of variation for the combined sample

		Health-related					Skill-related					
		Cardio-respiratory endurance	**Muscular endurance**	**Muscular strength**	**Body composition**	**Flexibility**	**Balance**	**Agility**	**Speed**	**Power**	**Coordination**	**Reaction time**
Health-related	**Cardiorespiratory endurance** CV = 64%		r = 0.231 p = 0.093	r = 0.179 p = 0.195	r = 0.079 p = 0.570	r = 0.177 p = 0.200	r = 0.170 p = 0.218	r = 0.120 p = 0.931	r = 0.375 p = 0.005	r = 0.462 **p < 0.001**	r = 0.239 p = 0.081	r = 0.214 p = 0.121
	Muscular endurance CV = 47%	r = 0.231 p = 0.093		r = 0.375 **p = 0.005**	r = 0.114 p = 0.406	r = 0.016 p = 0.909	r = 0.564 **p < 0.001**	r = 0.164 p = 0.233	r = 0.463 **p < 0.001**	r = 0.584 **p < 0.001**	r = 0.615 **p < 0.001**	r = 0.375 **p = 0.004**
	Muscular strength CV = 43%	r = 0.179 p = 0.195	r = 0.375 **p = 0.005**		r = 0.198 p = 0.134	r = 0.074 p = 0.588	r = 0.111 p = 0.406	r = 0.199 p = 0.129	r = 0.205 p = 0.120	r = 0.328 **p = 0.011**	r = 0.385 **p = 0.003**	r = 0.206 p = 0.117
	Body composition CV = 51%	r = 0.079 p = 0.570	r = 0.114 p = 0.406	r = 0.198 p = 0.134		r = 0.077 p = 0.573	r = 0.113 p = 0.397	r = 0.045 p = 0.733	r = 0.144 p = 0.281	r = 0.045 p = 0.740	r = 0.171 p = 0.200	r = .122 p = 0.361
	Flexibility CV = 14%	r = 0.177 p = 0.200	r = 0.016 p = 0.909	r = 0.074 p = 0.588	r = 0.077 p = 0.573		r = 0.055 p = 0.685	r = 0.148 p = 0.275	r = 0.081 p = 0.554	r = 0.183 p = 0.178	r = 0.029 p = 0.826	r = 0.064 p = 0.638
Skill-related	**Balance** CV = 45%	r = 0.170 p = 0.218	r = 0.564 **p < 0.001**	r = 0.111 p = 0.406	r = 0.113 p = 0.397	r = 0.055 p = 0.685		r = 0.291 **p = 0.027**	r = 0.541 **p < 0.001**	r = 0.545 **p < 0.001**	r = 0.543 **p < 0.001**	r = 0.286 **p = 0.029**
	Agility CV = 17%	r = 0.120 p = 0.931	r = 0.164 p = 0.233	r = 0.199 p = 0.129	r = 0.045 p = 0.733	r = 0.148 p = 0.275	r = 0.291 **p = 0.027**		r = 0.004 p = 0.978	r = 0.408 **p = 0.001**	r = 0.291 **p = 0.022**	r = 0.262 **p = 0.042**
	Speed CV = 23%	r = 0.375 **p = 0.005**	r = 0.463 **p < 0.001**	r = 0.205 p = 0.120	r = 0.144 p = 0.281	r = 0.081 p = 0.554	r = 0.541 **p < 0.001**	r = 0.004 p = 0.978		r = 0.473 **p < 0.001**	r = 0.325 **p = 0.011**	r = 0.191 p = 0.143
	Power CV = 40%	r = 0.462 **p < 0.001**	r = 0.584 **p < 0.001**	r = 0.328 **p = 0.011**	r = 0.045 p = 0.740	r = 0.183 p = 0.178	r = 0.545 **p < 0.001**	r = 0.408 **p = 0.001**	r = 0.473 **p < 0.001**		r = 0.389 **p = 0.002**	r = 0.455 **p < 0.001**
	Coordination CV = 26%	r = 0.239 p = 0.081	r = 0.615 **p < 0.001**	r = 0.385 **p = 0.003**	r = 0.171 p = 0.200	r = 0.029 p = 0.826	r = 0.543 **p < 0.001**	r = 0.291 **p = 0.022**	r = 0.325 **p = 0.011**	r = 0.389 **p = 0.002**		r = 0.343 **p = 0.007**
	Reaction time CV = 39%	r = 0.214 p = 0.121	r = 0.375 **p = 0.004**	r = 0.206 p = 0.117	r = .122 p = 0.361	r = 0.064 p = 0.638	r = 0.286 **p = 0.029**	r = 0.262 **p = 0.042**	r = 0.191 p = 0.143	r = 0.455 **p < 0.001**	r = 0.343 **p = 0.007**	

Where: CV = coefficient of variation for combined group (%); r = correlation coefficient; [bold] font highlights significance at p < 0.05

DISCUSSION

ANTHROPOMETRY

When discussing physical fitness for children with intellectual disability, one must take into account the delayed development and/or biological maturity (Beunen et al., 1997; Jones et al., 2000; Guidetti et al., 2010; Bryl et al., 2013; Mikolajczyk & Jankowicz-Szymanska, 2015). In this descriptive study it was shown that the intellectually disabled children were significantly shorter in stature and weighed less when compared to their typically developed peers, which is similar to previous research (Pitetti et al., 2000; Zhang et al., 2009; Zafeiridis et al., 2010; Pastula et al., 2012). A short stature, as an indicator for delayed maturation for persons with intellectual disability, has a negative influence on overall physical fitness outcomes, which must be kept in mind when further discussing this current study's intellectually disabled children's health-related and skill-related physical fitness components (Beunen et al., 1997; Jones et al., 2000; Guidetti et al., 2010; Bryl et al., 2013; Mikolajczyk & Jankowicz-Szymanska, 2015). Studies have shown a direct link between short body stature and cardiorespiratory endurance, as well as muscular strength (Zhang et al., 2009; Hogrel et al., 2012; Wuang et al., 2013). According to Hogrel et al. (2012) the capacity of muscles to generate strength is one of the main features of maturation during child growth. Delayed maturation, therefore, plays a critical role in the delayed acquirement of physical fitness of children with intellectual disability, which can immediately put them on the back burner health-wise compared to their typically developed peers. This further indicates the need and importance of a structured physical fitness program at a young age for children with intellectual disability, to ensure a proactive approach for reconciling these delayed maturation's impact on physical fitness and related health predicament.

HEALTH-RELATED PHYSICAL FITNESS

Cardiorespiratory endurance

Cardiorespiratory endurance for the intellectually disabled sample was on average lower when compared to the typically developed sample, although not significantly. The 15m- laps were converted to the 20m-laps, using the lap conversion chart provided in the Brockport Physical Fitness Test Manual, to provide data that could be compared to the literature, as well as to use in the formula to estimate VO_{2max} for the respective samples (Winnick & Short, 2014). However, these are estimations and represent the relative level of cardiorespiratory endurance of the participants, but can provide a broad indication of the approximate level to be compared with the literature. The typically developed sample had a healthy fitness zone (more than 17 20m-laps), as a mean of 21 20m-laps were completed (Winnick & Short, 2014). Furthermore, the estimated mean VO_{2max} of 41.24 $ml.kg^{-1}.min^{-1}$ was also found to be an appropriate approximation for aerobic capacity, as the literature has shown that a VO_{2max} of more than 40.2 $ml.kg^{-1}.min^{-1}$ is considered to be healthy fitness zone for children aged ten to eleven (Dencker et al., 2008; Winnick & Short, 2014).

The intellectually disabled sample completed a mean of 15 20m-laps (estimated VO_{2max} 38.94 $ml.kg^{-1}.min$), which falls into the adjusted fitness zone range (5-16 laps) (Winnick & Short, 2014). Similar levels of cardiorespiratory endurance for intellectually developed children have been reported in previous studies. Zhang et al. (2009) found the intellectually disabled participants had a significantly lower level of cardiorespiratory endurance compared to the study's typically developed participants. It must be noted that Zhang et al. (2009) study's participants had an average age of 21.79 years for the intellectually disabled participants and 21.88 years for the typically developed participants. Therefore, Zhang et al. (2009) study results cannot be directly compared to this current study's results. Research by Davis et al. (2010) on twenty-six male and female elementary school children with mild to moderate intellectually disabled and an average age of 10 years, from Virginia in the United States, completed a mean 11.23 20m-laps, which was found to be lower than the current study's findings of 15 20m-laps. Yoshizawa et al. (1975) reported a 33 – 42 $ml.kg^{-1}.min^{-1}$ aerobic capcity for 12 to 15 year old male and female students, which was a similar range to this study's findings. Furthermore, studies have also reported persons with intellectual disability to have VO_{2max} of 41 $ml.kg^{-1}.min^{-1}$ (Teo-Koh & McCubbin, 1999), 33.8 $ml.kg^{-1}.min^{-1}$ (Fernhall et al., 2001), 32 $ml.kg^{-1}.min^{-1}$ (Guerra et al. 2003), 25.5 $ml.kg^{-1}.min^{-1}$ (Pitetti, 2003), a range of 17 to 42 $ml.kg^{-1}.min^{-1}$ (Elmahgoub et al., 2011) and a range of 36.94 to 40.17 $ml.kg^{-1}.min^{-1}$ (Salaun & Berthouze-Aranda, 2011). These studies have varied aerobic capacity results, but when assessing these findings it must be taken into account that different factors may contribute towards the variance, such as the socio-economic status of the individuals, sedentary behavior and were they involved in physical therapy and/or prescribed exercise programs prior to their involvement in the particular studies. However, these findings do contribute to the body of knowledge by providing evidence that a VO_{2max} of 38.94 $ml.kg^{-1}.min^{-1}$ reflects at least a minimally acceptable level of cardiorespiratory endurance (adjusted for the effects of disability), or an attainable performance level of physical fitness leading to a healthy fitness zone (Winnick & Short, 2014).

Persons with intellectual disability, regardless of age, possess cardiorespiratory endurance levels 20-40% below those of their typically developed peers (Fernhall et al., 1988; Fernhall et al., 2001; Pitetti, 2003; Wu et al., 2010). It has been hypothesized that this is due to inactivity, but there still is the possibility of a cognitive-dependent physiological difference (Fernhall et al., 1988). Previous studies have reported that there is a poor trend for cardiorespiratory endurance among older individuals with intellectual disability, which has also been found to be evident early in childhood (Gillespie, 2003).

The existing viewpoint regarding children with intellectual disability is that their levels of fitness and overall functioning is lower because they are less active during school time and they have fewer opportunities for physical activity participation as compared to their typically developed peers (Gillespie, 2003). However, this viewpoint slightly differs with regards to this study's findings of no significant differences between the children with intellectual disability and their typically developed peer's PACER scores. This may be attributed to several factors, such as the possibility that the typically developed peers also may have had less opportunity to participate in exercise and/or sport (due to the low economic-status of the school) and which would stimulate the necessary cardiorespiratory response for age-related referenced aerobic capacity. Participants may also not have been fully familiarized with the PACER test procedures, or may have lacked motivation to complete the test to their best of their abilities, as may be suggested by the large variance within the two data sets, as the CV was 62.84% for the intellectually disabled sample and 60.05% for the typically developed sample. Research has shown similar results with regards to large inter-individual variance of performance, due to intellectual disability being a heterogeneous group of conditions that vary in severity and aetiology; therefore, each person with an intellectual disability must be considered individually (Harris, 2006; Maulik et al., 2011). Nevertheless, it must be emphasized that issues of low exercise capacity and cardiorespiratory endurance of children with intellectual disability need to be attended to by both school districts and agencies dealing with individuals with intellectual disability (Pitetti et al., 2001). It has been noted that individuals with intellectual disability typically lead a more sedentary lifestyle, without external support and encouragement from individuals such as family members, group home workers, and educators (Gillespie, 2003). It must further be mentioned that sedentary lifestyles become more common with increasing age; therefore, it stands to reason that if young children with intellectual disability exhibit poor levels of cardiorespiratory endurance in comparison to their typically developed peers, the gap between groups is likely to increase with age (Gillespie, 2003). The trend toward progressively decreased levels of activity as individuals get older has led to high incidences of obesity and cardiovascular disease among adults with intellectual disability, as well as early onset of old age for these individuals (Gillespie, 2003).

Muscular endurance

A significant difference was found between the number of modified push-ups completed by the intellectually disabled sample and the typically developed sample. The typically developed children were considered to have a good level of muscular endurance, as they completed 39.55 curl-ups in one minute, and according to the Brockport Physical fitness manual, this falls into the healthy fitness zone (Winnick & Short, 2014). The intellectually disabled sample group however had a significantly lower level of muscular endurance, which was found to be a minimal to moderate standard for children with intellectual disability, as they only completed a mean of 18.79 modified curl-ups (Stanish & Temple, 2012; Winnick & Short, 2014). These results for muscular endurance support previous evidence of muscular endurance detriments for intellectually disabled children and reflect a true difference in performance, as a learning effect was minimized by having two familiarization sessions prior to final testing, during which the children were constantly encouraged to performed to the best of their abilities by the research assistants providing positive feedback and words of encouragement. A study by Zhang et al. (2009) also found a significant difference between persons with intellectual disability (13.24 modified curl-ups completed) and their peers from the general population (48.63 modified curl-ups completed). Furthermore, a study by Stanish and Temple (2012) found similar results, as adolescents with an average age of 17.8 years with mild to moderate intellectual disability completed 15.3 modified curl-ups and their typically developed peers completed 47.8 modified curl-ups. According to the literature, persons with an intellectual disability perform 25 – 50% below the general population standard for muscular endurance (Graham, 1996; Zhang et al., 2009; Guidetti et al., 2010; Salaun & Berthouze-Aranda, 2011; Winnick & Short, 2014). Poor muscular endurance has been described as a significant predictor for a decline in cardiovascular health, mobility, back function and pain and activity of daily living (Suni et al., 1998; Ortega, Ruiz, et al., 2008; Oppewal et al., 2015). Therefore, this reiterated the importance of improving the level of muscular endurance for the intellectually disabled participants in this study.

Muscular strength

According to the Brockport Physical Fitness Test manual, the typically developed participants were considered to have a healthy fitness zone, with a mean grip strength of 21.53kg (Winnick & Short, 2014). The ALPHA Health-Related Fitness Test Battery for Children and Adolescents reported that a low standard for grip strength for boys was 21.4 kg and girls 19.9 kg (Santos & Mota, 2009). However, the limitation of these standards were they were only applicable for 13 year olds and older. The intellectually disabled participants had a significantly lower mean grip strength of 13.71kg, which was classified as falling into the adjusted fitness zone of between 11-17kg (Winnick & Short, 2014). This means that the intellectually disabled participants in this study meet the minimal standard for muscular strength; however, the participants should pursue standards for the healthy fitness zone of 18kg or more to be considered to have a healthy level of muscular strength (Winnick & Short, 2014). A study by Stanish and Temple (2012) found similar results in adolescents, 15 to 21 years of age, with the intellectual disability sample having a lower mean grip strength (23.3kg) compared to their typically developed peers (33.9kg). Previous research has shown a detriment of 35-40% lower muscular strength levels of intellectually disabled individuals compared to their typically developed peers (Stanish & Temple, 2012; Abdullah et al., 2014). Such detriments can reduce motor capacity, and gait movements/patterns (Giagazoglou, Arabatzi, et al., 2012; Terblanche & Boer, 2013; Wuang et al., 2013). This in turn may affect the performance of daily activities and, along with poor balance, may cause underlying mobility deficiencies for intellectually disabled people later on in life, thus contributing to the increased prevalence of falls, resulting in injuries in this population group (Van Hanegem et al., 2013).

Body composition

According to the Brockport Physical Fitness Test manual's criterion-reference standards, the typically developed sample with a mean sum of skinfolds of 27.61mm, was categorized into the healthy fitness zone for their age group (Winnick & Short, 2014). Likewise, the intellectually disabled group (18.18mm) also fell into the healthy fitness zone, which ranges from 11-29mm for intellectually disabled boys and 11-32mm for intellectually disabled girls (Winnick & Short, 2014). The sum of the triceps and calf skinfolds of the typically developed sample was significantly higher than the intellectually disabled sample's skinfolds, which is contrary to previous studies in the literature (Ozmen et al., 2007; Davis et al., 2010; Salaun & Berthouze-Aranda, 2011),

A study conducted by Zhang et al. (2009) found the mean sum of the triceps and calf skinfolds of persons without intellectual disability to be 35.7mm and that of persons with intellectual disability to be 37.88mm. There were no significant differences of triceps and calf skinfolds found between the two groups in the Zhang et al. (2009) study, implying that young adults with intellectual disability have similar body composition to those without disabilities. However, the findings by Zhang et al. (2009) implied that the two samples in this study had abnormal body composition, as both young adults with and without intellectual disability were found to be overweight or obese (Zhang et al., 2009). Furthermore, Zhang et al. (2009) study's participants were older compared to this current study, as the mean age of the intellectually disabled sample was 21.79 years and 21.88 years for the typically developed sample. Therefore, the findings in Zhang et al. (2009) study could not be directly compared to the results of this study.

The Brockport Physical Fitness Test manual provided the Fitnessgram Body Composition Conversion Chart, which was used to estimate the mean body fat percentages using the sum of triceps and calf skinfolds for both samples, so that these estimations could be compared to the literature (Winnick & Short, 2014). The males in the intellectually disabled sample had a body fat percentage of 14.2% and the females 16.1% (Winnick & Short, 2014). A study by Salaun and Berthouze-Aranda (2011) found body fat percentages for intellectually disabled adolescents, between the ages 12 to 17 years, had 20.3% for boys and for the girls 23.5%. Furthermore, a study done by Ozmen et al. (2007) on intellectually disabled boys found similar results, to Salaun and Berthouze-Aranda (2011), ranging from 20.5-24.3% body fat. Both of these studies had a slightly older sample group; however, according to the Brockport Physical Fitness Test manual, these values do not differ much between the ages of 10 to 13 years (Winnick & Short, 2014). Davis et al. (2010) reported that intellectually disabled elementary school children with a mean age of 10 years had body mass index values close to the heavier end of the healthy fitness zone based on the Fitnessgram standard and borderline of the needing improvement (NI) fitness zone of the Brockport Physical Fitness Test standards.

These studies by Zhang et al. (2009), Salaun and Berthouze-Aranda (2011), Ozmen et al. (2007), and Davis et al. (2010), all show higher results for body fat. All these studies took place in developed countries, which have, in the last decade, published numerous studies regarding information about the relationships between body composition and physical fitness in children, of which the literature has shown that persons with intellectual disability have the tendency to be more overweight and/or obese compared to the general population, which can inversely affect their motor proficiency (Suni et al., 1998; Monyeki et al., 2005; Tokmakidis et al., 2006; Verschuren et al., 2009; Rivilis et al., 2011; Casey & Rasmussen, 2013; Winnick & Short, 2014). In contrast with developed countries, little is known about the relationship between body composition and physical fitness in children and adolescents of developing countries like South Africa. A study by Monyeki et al. (2005) investigated body composition and physical fitness in undernourished South African rural primary school children. The findings of Monyeki et al. (2005) showed that children in the rural areas had a low body fat percentages for boys 12.2% and 15.6% for girls, which were comparable to the current study's intellectually disabled children's body fat percentages, of 14.2% for males and 16.1% for females. Therefore, the socio-economic status of the participants must be taken into consideration, as the participants attended a government special needs school located in a low socio-economic area in Grahamstown. This relationship is relevant for public health because in developing countries low fatness can be seen as a result of undernutrition, and undernutrition likely is an important risk factor for general health outcomes (Monyeki et al., 2005). Furthermore, factors associated with developing countries, such as income, education and malnutrition, can also exacerbate the effects of delayed intellectual development and its effect on physical fitness (Brown & Pollitt, 1996). From a public health perspective, improvement of both nutritional status and physical fitness can be seen as an important tool for the improvement of the well-being of children and for the prevention of diseases (Monyeki et al., 2005).

Flexibility

There was no significant difference between the flexibility of the typically developed children (24.89 cm) and the intellectually disabled children (24.11 cm). Both samples were considered to have acceptable levels of flexibility, as the Brockport Physical Fitness Test standards for a healthy fitness zone, for both typically developed and intellectually disabled samples, ranged from 20.32 – 25.40 cm for boys and girls (Winnick & Short, 2014). Literature has shown flexibility of the general population to have been 20 cm for boys and 25 cm for girls (Salaun & Berthouze-Aranda, 2011). Research by Ortega, Artero, et al. (2008) showed similar results for typically developed adolescent females who had a flexibility range of 24.8-26.2 cm and males 18.8-19.1 cm. However, it must be noted that detrimental difference of flexibility become more prevalent in the older populations with intellectual disability, as Zhang et al. (2009) found a significant difference for flexibility between young adults with intellectual disability (19.38 cm) and their typically developed peers (25.89 cm), as well as Stanish and Temple (2012) in older adults of 18-45 years. Furthermore, research on intellectual disability adults (18-45 years) showed a decreased range for flexibility of 18.4-19.1 cm (Guidetti et al., 2010). Therefore, flexibility may be more of interest for the older intellectually disabled population but should be taken into consideration at a younger age to prevent detriments in posture and range of motion later on in life.

SKILL-RELATED PHYSICAL FITNESS

Balance

A significant ($p < 0.001$) difference was found for balance between the intellectually disabled sample, which performed the single leg stance for a mean of 17.41 sec, whereas the general population sample that had a mean of 27.29 sec. These results are in accordance with the literature, as it has been previously stated that adolescents with an intellectual disability in general had significantly lower scores in balance when compared to their typically developed peers (Enkelaar et al., 2012; Blomqvist et al., 2013). A study conducted by Oviedo et al. (2014) found that an older sample (20-60 years) with intellectual disability had a mean time of 11.99 sec for the single leg stance test. It must be noted that research has highlighted the rapid deterioration with age of balance performance of intellectually disabled people (Barbara et al., 2007; Giagazoglou, Kokaridas, et al., 2013; Oviedo et al., 2014). Previous findings showed similar results to the current study's typically developed children's balance, as literature has shown the general population to have single leg stance test mean scores of 29.8 sec (Barbara et al., 2007) and 29.8 sec (Brito et al., 1998).

The results of the current study have shown that persons with intellectual disability have poor balance performance. A possible reason for this poor performance could be associated with an intellectually disabled person's inability to react adequately to visual and proprioceptive information, thus disabling appropriate balance maintenance and good posture (Golubović et al., 2012). The ramifications of this could impact persons with intellectual disability autonomy in activities of daily living and increase the risk of accidental falls (Giagazoglou et al., 2012; Oviedo et al., 2014; Mikolajczyk & Jankowicz-Szymanska, 2015). It has been suggested that balance can be trainable in persons with intellectual disability with an intellectually disabled-specific adjusted exercise intervention (Enkelaar et al., 2012; Giagazoglou, Kokaridas, et al., 2013).

Agility

There was no significant difference between mean scores for the 505 agility test of the intellectually disabled sample (3.8 sec) and typically developed sample (3.56 sec). A study conducted by Stewart et al. (2014) showed results of healthy adolescent participants to range from 2.51 to 2.58 sec for the 505 agility test. There was a lack of literature attaining to intellectually disabled people and their performance level for agility (Verschuren et al., 2009). Previous research stated that individuals with intellectual disability are deficient in carrying out tasks requiring agility (Lin & Wuang, 2012; Wuang et al., 2013). Some research pointed out that testing agility as a separate component is less relevant, as agility requires the integration of isolated movement skills using a combination of balance, coordination, speed, strength and muscular endurance (Verschuren et al., 2009; Hilgenkamp et al., 2010; Lin & Wuang, 2012). With that being said, all the above mentioned components were seen to be significantly poorer for the intellectually disabled participants when compared with the typically developed participants. This could possibly mean that the 505 agility test could not detect the small differences between the two samples adequately or the participants in the typically developed sample also performed poorly in the agility test. Previous studies have suggested that agility training might increase knee stability, strength, and function, which in turn could help minimize the risk of falling for older persons with ID (Giagazoglou et al., 2012; Wuang et al., 2013; Oviedo et al., 2014).

Speed

The results showed that there was a significant difference for the 50m sprint between the intellectually disabled sample (12.21 sec) and the typically developed sample (9.29 sec). The typically developed group completed the 50m sprint in an acceptable time, as it has been previously reported that children of the same age have a range of 8.42 to 9.5 sec (Partavi, 2013) and 9.3 to 9.8 sec (Monyeki et al., 2005) for the 50m sprint. This, therefore, reiterates that the intellectually disabled sample performed poorly in the speed component of physical fitness, and this component is thus in need of improvement, which was in accordance with the literature (Connolly & Michael, 1986; Skowroński et al., 2009; Salaun & Berthouze-Aranda, 2011). Speed is highly correlated with anaerobic capacity, as well as muscular strength and power, which were both significantly poorer for the intellectually disabled sample (Partavi, 2013). Furthermore, a limiting factor for the results and interpretation for the 50m sprint is that it has been reported that intellectually disabled tend to have difficulty grasping concepts of running speed and maximal effort (Connolly & Michael, 1986; Skowroński et al., 2009; Salaun & Berthouze-Aranda, 2011; Hilgenkamp et al., 2014).

Power

The current study showed that the power component was significantly lower for the intellectually disabled sample, as the mean score of the standing broad jump was 83.73cm, compared to the mean 135.02 cm score of the typically developed sample. This decrement in performance has been found in previous studies; however, the intellectually disabled sample's mean score has shown to be lower than previously stated in the literature, whereas the typically developed population seem to have a normal range for the standing broad jump (Tokmakidis et al., 2006; Lejčarová, 2008; Salaun & Berthouze-Aranda, 2011; Golubović et al., 2012; Ghosh, 2014). Tokmakidis et al. (2006) found that typically developed boys and girls, with the mean age of

9 years, have a standing broad jump range of 115.7 to 129 cm, which were slightly lower compared to the current study's typically developed sample; however, Tokmakidis et al. (2006) study's participants were on average one year younger than the current study's participants. Gontarev et al. (2014) found a standing broad jump range of 121.2 to 136.87 cm for males and females of the general population aged 10 year old, which were similar to the current study's results. Ghosh (2014) had a slightly older sample group of 12-20 year olds who produced a mean score for the standing broad jump of 151cm. Therefore, it was determined that the typically developed participants' mean score of 135.02 cm was found to be an acceptable level for power performance, whereas, the current study's intellectually disabled sample have shown lower values compared to findings in previous studies. Golubović et al. (2012) found a standing broad jump range of 96.25 to 109.91 cm for 9 year old children with mild to borderline intellectual disability, which is substantially greater than the 83.73 cm found in the current study for intellectual disability, even though the participants of Golubović et al. (2012) study were one year younger. A study by Lejčarová (2008) found intellectually disabled children with a mean age of 10 years to have a range of 120.97 to 129.66 cm for the standing broad jump test. Furthermore, Salaun and Berthouze-Aranda (2011) found a mean score of 140.72 cm for 12 to 17 year olds with mild intellectual disability, which was an older sample group; however, it still puts into perspective the poor performance of the intellectually disabled sample in the current study. The intellectually disabled sample in the current study showed a significant decrement in power compared to the typically developed sample and compared to previous studies investigating power for intellectually disabled individuals. Therefore, it is evident that this physical fitness component, power, was in need of considerable improvement.

Coordination

Children with intellectual disability have shown to have some form of central nervous system dysfunction that leads to problems with coordination and motor proficiency (Connolly & Michael, 1986). The literature has shown a decrement in performance for coordination of persons with intellectual disability compared to typically developed individuals, which is similar to the current study's findings for coordination (Connolly & Michael, 1986; Carmeli, Bar-Yossef, et al., 2008; Wuang et al., 2008; Vuijk et al., 2010; Salaun & Berthouze-Aranda, 2011; Hilgenkamp et al., 2014). Research conducted by

Johnson and Ethridge (2012) found intellectually disbled male and female adults between the ages 21 to 60 years to have on average a lower block and box test score, of 40 blocks transferred in one minute, compared to the general population who transferred 75.4 to 76.9 blocks per minute. A study by Oppewal et al. (2015) on the other hand found intellectually disabled adults to have a lower mean score of 28.8 blocks transfers for the box and block test for older adults with an IQ ranging from 20 to 70. These two studies' differences in results could be because of the different ratios of severity of intellectual disability; the Johnson and Ethridge (2012) study's particpants had a mean IQ of 49.1 and the participants in the Oppewal et al. (2015) study had an IQ range of 20 to 70. The current study's children with intellectual disability transferred on average 35.44 blocks in one minute, which was an acceptable score for the block and box test. However, the typically developed group's standard score were found to be lower than previously stated. A study by Mathiowetz et al. (1985) showed that typically developed boys and girls between the ages of 10 to 11 years had a mean range of 65.9 to 70 blocks transferred per minute for the block and box test, which is higher than the current study's typically developed children's block and box test average score of 48.96 blocks transfers.

Reaction Time

The mean simple reaction time for the intellectually disabled participants (0.49ms) was significantly longer compared to that of the typically developed participants (0.33ms), which concurs with what previous studies have reported (Connolly & Michael, 1986; Anson & Mawston, 2000; Horvat et al., 2003; Lejčarová, 2008; Skowroński et al., 2009; Giagazoglou, Arabatzi, et al., 2013). Nevertheless, the underlying mechanisms for these differences between individuals with intellectual disability and the general population have not been extensively studied (Giagazoglou, Arabatzi, et al., 2013; Hilgenkamp et al., 2014). However, one of the few studies that exist, such as that by Horvat et al. (2003) stated that inter-individual variations of reaction time for individuals with intellectual disability may be associated with disturbances of information processing of the central and peripheral components, as well as structural alterations within the central nervous system.

INTEGRATED DISCUSSION AND RATIONALE FOR PHASE 2

Muscular endurance, balance and power were the physical fitness components found to be most appropriate to include for the exercise intervention for phase 2 of the current study. These three components were found to be significantly poorer for children with intellectual disability when compared to typically developed children in this study. The reason why these three components were chosen over the other significantly lower physical fitness components was because these three components were shown to be essential and in need of improvement when compared to previous studies that had assessed intellectually disabled individuals physical fitness, whereas the other components were on par with the norms of intellectually disabled children. Furthermore, the rationale for the selective inclusion of muscular endurance, balance and power training was that they are the components that have been extensively studied and have been demonstrated to have positive effects on health outcomes when prescribed in isolation (Baker et al., 2007).

The most noticeable physical fitness decrement for the intellectually disabled sample was power, which was assessed using the standing broad jump. This significantly poorer performance of the intellectually disabled compared to the typically developed samples has been found in previous studies. The typically developed participants' mean score for the standing broad jump was similar to what had previously been reported; however, the intellectually disabled sample's mean score was found to be lower than previously stated results for intellectually disabled children in the literature (Tokmakidis et al., 2006; Lejčarová, 2008; Salaun & Berthouze-Aranda, 2011; Golubović et al., 2012; Ghosh, 2014). The standing broad jump requires explosive strength, speed, coordination and jumping skill (Ruiz et al., 2006; Lejčarová, 2008). Therefore, significant decrements were found for strength ($p < 0.001$), speed ($p < 0.001$) and coordination ($p < 0.001$) in this study for the intellectually disabled sample, which could have hindered the intellectually disabled participants' performance of power. Furthermore, according to Table 6, the standing broad jump was found to significantly correlate with 8 physical fitness components. Therefore, if power could increase, it might be possible that these correlated components could also improve, thus theoretically improving the overall level of physical fitness. Furthermore, two out of the eight significant correlations (muscular endurance and balance) were found to have an r-value greater than 0.5 and can therefore be seen to have a moderate to strong relationship, whereas all the remaining correlations were found to have a moderate to weak correlation (Field & Hole, 2003). Furthermore, literature has shown that the standing broad jump has been correlated with certain health decrements in adolecents, such as obesity and high cholesterol; therefore, the improvement of power would be deemed necessary for the intellectually disabled sample in this study (Ruiz et al., 2006).

Balance was also found to be significantly poorer for the intellectually disabled compared to the typically developed sample. These results are in accordance with the literature, as it has been previously stated that adolescents with an intellectual disability in general had significantly lower scores in balance when compared to their typically developed peers (Enkelaar et al., 2012; Blomqvist et al., 2013). Maturation of balance ability does occur in persons with intellectual disability although it may not reach the same level of maturation as persons without intellectual disability (Giagazoglou, Kokaridas, et al., 2013). In fact, previous studies have found that balance performance could be significantly improved, following various intervention programs, in intellectual disabled individuals (Giagazoglou, Kokaridas, et al., 2013). Thus, there is a need to identify effective exercise interventions for individuals with intellectual disability (Giagazoglou, Kokaridas, et al., 2013). Furthermore, balance was found to significantly correlate with six other physical fitness components, of which four of these correlations had an r-value greater than 0.5. Therefore, the improvement in balance could possibly also affect muscular endurance, agility, speed, power, coordination, and reaction time.

The intellectually disabled sample's muscular endurance was found to have been a moderate standard for children with intellectual disability (Stanish & Temple, 2012; Winnick & Short, 2014). According to the literature, persons with an intellectual disability perform 25 – 50% below the general population standard for muscular endurance (Graham, 1996; Zhang et al., 2009; Guidetti et al., 2010; Salaun & Berthouze-Aranda, 2011; Winnick & Short, 2014). Poor muscular endurance has been described as a significant predictor for a decline in cardiovascular health, mobility, back function and pain and activity of daily living, thus reiterating the importance of improving the level of muscular endurance for the intellectually disabled participants in this study (Suni et al., 1998; Ortega Ruiz et al., 2008; Oppewal et al., 2015).

One might argue that muscular strength should be the variable chosen to include in a training programme instead of muscular endurance, as muscular strength was found to have a greater performance decrement compared to muscular endurance, when assessed against previous findings in the literature. However, muscular strength only significantly correlated to 3 other variables, all of which were found to be weak correlations, whereas muscular endurance significantly correlated with six of the physical fitness components, of which four were found to have strong correlations. In addition, Doymaz and Cavlak (2007) found a positive and significant relationship between muscular endurance and strength, similar to the results in the current study with a significant ($p = 0.005$) correlation for muscular endurance and strength. Therefore, improving muscular endurance would have a greater benefit for the overall level of physical fitness, which would advertently include muscular strength to improve.

Decrements of power, balance, muscular endurance and strength can reduce motor capacity, and gait movements/patterns for persons who are intellectually disabled (Rivilis et al., 2011; Giagazoglou, Arabatzi, et al., 2012; Terblanche & Boer, 2013; Wuang et al., 2013). This could impact intellectually disabled persons' autonomy in activities of daily living and increase the risk of accidental falls (Giagazoglou, Arabatzi, et al., 2012; Van Hanegem et al., 2013; Oviedo et al., 2014; Mikolajczyk & Jankowicz-Szymanska, 2015). People with intellectual disabilities experience similar rates of falls as older adults in the wider population, but at a younger age (Crockett et al., 2015). Falls are a dominant cause of serious injury for individuals with intellectual disability and the rate of hospitalization because of fall injury is twice as high in persons with intellectual disability compared to the general population (Enkelaar et al., 2012; Shin & Park, 2012; Van Hanegem et al., 2013; Crockett et al., 2015). It has been reported that 25 to 40% of adults with intellectual disabilities who live in the community experience at least one fall in a 12-month period (Enkelaar et al., 2012; Crockett et al., 2015). Furthermore, 70% of the intellectually disabled population experienced a fall over a 5-year period, of which almost 30% fell multiple times (Enkelaar et al., 2012; Crockett et al., 2015).

Balance and gait deficiency are well-established risk factors for falling, as the correlation between balance and falls is reported to be high (Suni et al., 1998; Enkelaar et al., 2012; Shin & Park, 2012; Van Hanegem, Enkelaar et al., 2013; Crockett et al., 2015). There are several mechanisms that might contribute to limitations in balance and gait capacities in persons with intellectual disability (Enkelaar et al., 2012). First, intellectual disability is a condition of arrest or incomplete development of the mind, which does not only affect cognitive functions, but motor functions as well (WHO, 2007). A second mechanism that might contribute to balance and gait problems in persons with intellectual disability is premature aging. Compared to the general population, age-related problems in persons with intellectual disability are, to a great extent, similar but seem to occur more frequently and at a younger age (Enkelaar et al., 2012). With age, there is an increased malfunction of the sensory system, which in turn deteriorates ones sense of balance (Crocket et al., 2015). If there are additional problems with motor control and function, such as weakened muscular strength and endurance, the ability to recover properly from imbalance is disturbed, therefore raising the risk of falling and injury (Enkelaar et al., 2012; Crocket et al., 2015). A third mechanism potentially contributing to balance and gait problems is related to the lifestyle of persons with intellectual disability. Persons with intellectual disability are generally less active, with the result that their physical capacities like muscular endurance, balance and strength are trained less compared to their peers in the general population (Enkelaar et al., 2012). This in turn may lead to lower levels of physical functioning (Enkelaar et al., 2012).

A good understanding of the nature of balance and gait problems and their role in the causation of falling in persons with intellectual disability may help to develop intervention strategies to prevent falls and injuries (Enkelaar et al., 2012). According to the literature, exercise programs are the most effective single intervention to prevent falls (Baker et al., 2007; Enkelaar et al., 2012; Shin & Park, 2012; Giagazoglou, Kokaridas, et al., 2013; Van Hanegem et al., 2013). Furthermore, it has been demonstrated that exercise programs can improve balance, gait, muscular endurance and strength in persons with intellectual disability (Enkelaar et al., 2012; Shin & Park, 2012). In persons with intellectual disability, no studies have directly investigated the effect of exercise interventions on the reduction of falls, but several interventions were successful in improving physical fitness components to promote gait in children with intellectual disability (Enkelaar et al., 2012; Shin & Park, 2012). Therefore, a multi-modal intervention would be considered most effective if at least two of the following training modalities are included, namely balance, flexibility, muscular strength and endurance (Baker et al., 2007; Enkelaar et al., 2012; Giagazoglou, Kokaridas, et al., 2013).

It must be highlighted that the results of the children with intellectual disability may have been affected by performance variability on the day of testing, more so than those of their typically developed peers. Possible causes for the performance variability that occurred for the children with intellectual disability could have been the levels of arousal and mood on the day of testing, as well as social, family and environmental conditions that could have impacted the participant's level of attention and motivation at the time of data collection. One of the most important factors to have taken into consideration would have been that the children with intellectual disability could have lacked the understanding to perform the tests to maximal capacity. However, structures were put into place to try minimize this possibility by having familiarization sessions before testing took place, so that the participants could learn and practice the different test protocols and completed trial tests in these sessions. Furthermore, the teachers accompanied the research assistants in order to help explain the test protocols in the participant's first spoken language (isiXhosa or Afrikaans) and to answer any questions with regards to confusion or if instructions need to be made clearer.

CONCLUSION

To address the hypotheses of the first phase of this research project, the null hypothesis was rejected, as the intellectually disabled sample was found to have significantly different anthropometric measures and significant physical fitness decrements when compared to their typically developed peers for all components, with exception of cardiorespiratory endurance, flexibility and agility. The physical fitness components, namely muscular endurance, balance and power, were considered to have been the three modalities most appropriate to be included for a multi-modal exercise program to be developed and assessed in Phase 2 of this Master's project. Research has shown that it is imperative that a proactive approach be taken to improve these components and prevent the risk of health-related problems in the future.

CHAPTER IV

INTERVENTION STUDY

INTRODUCTION

Research Aim

The aim of the intervention study was to determine the efficacy of a multi-modal exercise intervention developed for children with intellectual disability following the outcomes of Phase 1 of this study. The exercise intervention's primary objective was to improve three key modalities of physical fitness, namely muscular endurance, power and balance, as identified in the descriptive study as being the main components in greatest need of improvement, while also being able to have positive spin-offs on other components. The second objective was to assess and evaluate the impact of the improvements of these three components on the overall physical fitness capacity of intellectually disabled children.

Scope of Study

The sample population for this study were children with intellectual disability from a previously disadvantaged background with a low socio-economic status recruited from a government special needs school based in the Grahamstown region. Both female and male children, between the ages of 9 to 12 years, were included in this study. Participants were excluded if they had a physical disability and if they did not complete testing. The study was field-based, as the test items and exercise program had to be economical in terms of time and expense, and easily administered in a school environment.

METHODOLOGY

HYPOTHESES

Research Hypothesis

The research hypothesis proposed that the results obtained from the intervention study would show an improvement in muscular endurance, power and balance, over time in the intervention group, but not in the control group. Specifically, it was hypothesised that the improvement of these three components, as a result of training, would improve overall health-related and skill-related physical fitness components, due to the correlations found in the descriptive study between certain components of physical fitness.

Statistical Hypotheses

Hypotheses 1:

The first null hypothesis (1a) stated that no change would occur in the health-related physical fitness levels over time (i.e. pre- vs. post-intervention), while the second null hypothesis (1b) stated that there would be no change in the skill-related physical fitness levels over time (i.e. pre- vs. post-intervention).

a) Ho: $\mu\text{Health-related}_{pre} = \mu\text{Health-related}_{post}$
b) Ho: $\mu\text{Skill-related}_{pre} = \mu\text{Skill-related}_{post}$

Conversely to the null hypotheses, the alternative hypotheses stated that changes in health- and skill-related parameters would occur over time.

a) Ho: $\mu\text{Health-related}_{pre} \neq \mu\text{Health-related}_{post}$
b) Ho: $\mu\text{Skill-related}_{pre} \neq \mu\text{Skill-related}_{post}$

Hypotheses 2:

Null hypothesis 2a stated that there would be no difference in the health-related physical fitness post-intervention levels for the exercise intervention group when compared to the control group, while null hypothesis 2b stated there would be no differences in the skill-related physical fitness post-intervention levels between the two experimental groups.

a) H_O: $\mu\text{Health-related}_{Ex} = \mu\text{Health-related}_{Con}$

b) H_O: $\mu\text{Skill-related}_{Ex} = \mu\text{Skill-related}_{Con}$

The alternative hypothesis stated that there would be a difference in the health-related and skill-related physical fitness post-intervention levels between the exercise intervention group and the control group.

a) H_A: $\mu\text{Health-related}_{Ex} \neq \mu\text{Health-related}_{Con}$

b) H_A: $\mu\text{Skill-related}_{Ex} \neq \mu\text{Skill-related}_{Con}$

Where:

Pre: Pre-intervention measures

Post: Post-intervention measures

Ex: Exercise intervention group

Con: Control group

Health-related measures include: cardiorespiratory endurance, muscular endurance, strength, body composition and flexibility.

Skill-related measures include: balance, agility, speed, power, coordination and reaction time.

EXPERIMENTAL DESIGN

This study adhered to a partially repeated two-factorial experimental design. A case-control design was implemented for this study whereby participants were assigned to either an intervention group or a control group, while ensuring that both groups' participants were matched as best as possible by age and sex. Both groups' physical fitness measures were recorded pre-and post-intervention, in order to assess the efficacy of the eight week exercise intervention (see Table 7). The process will be further elaborated under the experimental protocol section of the methodology.

Table 7: Design matrix

	PRE - Intervention	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	POST - Intervention
Intervention Group	**PF Measures**	Exercise (40mins) 4 x week	Exercise (40mins) 4 x week	Exercise (40mins) 4 x week	Exercise (40mins) 4 x week	Exercise (40mins) 4 x week	Exercise (40mins) 4 x week	Exercise (40mins) 4 x week	Exercise (40mins) 4 x week	**PF Measures**
Control Group	**PF Measures**	-	-	-		-	-	-	-	**PF Measures**

Where: PF Measures = health-related and skills-related physical fitness tests

Independent Variables

Exercise Intervention – Was the intellectually disabled child exposed to the exercise intervention or allocated to the non-exercising control group.

Time – What physical fitness adaptations occurred over time (pre vs. post exercise programme).

Dependant Variables

The following health- and skills-related variables were recorded before the intervention as baseline measures, and then again once the intervention was completed: cardiorespiratory endurance, muscular endurance, muscular strength, body composition, flexibility, agility, balance, coordination, speed, power and reaction time. The justification of why these dependant variables were chosen has been discussed in Chapter II.

PARTICIPANT CHARACTERISTICS

The children with intellectual disability who participated in the descriptive study were also recruited to participate in the intervention study. Therefore, the 36 moderately intellectually disabled children between the ages 9 to 12 years were recruited from the special needs school in the Grahamstown region. The sample was divided into two groups, which were matched by age and sex, an intervention group (n=19; 10 males and 9 females) and a control group (n = 17; 9 males and 8 females). The intellectually disabled children with physical disabilities were excluded from the study; however, they joined the control group's 'class time fun' sessions, as to not be socially excluded.

INSTRUMENTATION AND MEASUREMENT OF VARIABLES

The instrumentation and measurement of the physical fitness variables for the pre- and post-intervention measures have been replicated from the descriptive study in Chapter III.

EXERCISE INTERVENTION

A detailed review for the FIND principle of this intervention's exercise programme can be found in the systematic review in Chapter II.

Frequency and Duration

The exercise intervention consisted of an 8-week exercise programme, since literature has shown that this length had significantly greater outcome measures and a larger effect size when compared to shorter interventions (Shin & Park, 2012; Pastula et al., 2012). However, it must be noted that the school term, during which this intervention took place, only had 10 weeks in it. This served as a limitation, since two of the weeks were designated for testing the pre- and post-intervention measures, resulting in eight weeks left for the intervention to take place. Therefore, the duration of the intervention was chosen based on the length of the school's term, and hence why a longer intervention had not been found compatible for this study.

The frequency of the exercise program was four exercise sessions per week, as it was found that higher-frequency exercise training was more effective than lower-frequency exercise; therefore, it was determined that exercising four times per week had a better effect than exercising three times per week (Shin & Park, 2012).

The duration of this study was 40 minutes per session. According to Shin and Park (2012) short-duration exercise had a better effect than long-duration exercise, as to attain concentration and interest of the exercise for intellectually disabled children. Furthermore, it was reported that an exercise session length of more than 30 minutes was more effective than a session below 30 minutes, and the most effective exercise duration was between 31 – 60 minutes (Shin & Park, 2012).

Nature and Intensity

Balance, power and muscular training was the focus of this exercise programme. Each 40-minute session had a 5-min warm-up and a 5-min warm-down period, which allowed a 30-minute period for the exercise to take place. The 30 minutes were equally divided into three 10-minute slots, so that each component was allocated 10 minutes to solely work on exercises pertaining to that respective component. Each physical fitness component had its own specific set of exercises while other exercises integrated all three components. During the first four weeks, simple exercises were used to improve the performance of the specific components, whereas weeks five to eight incorporated more intense and integrated exercises. This is further discussed in the breakdown of the exercise intervention below.

Breakdown of Exercise Intervention

The exercise program was designed with four different stages that focussed on different training outcomes, as seen in Table 8. The first stage formed the foundation by training all three components with basic fundamental movements. The second and third stages focussed on more progressive, intense and dynamic exercises. The fourth stage aim was to integrate balance, muscular endurance and power into more complexed dynamic movements to improve joint stability, range of motion and neuromuscular efficiency (Clark, 2008). Furthermore, the exercise intervention utilized the Optimum Performance Training (OPT) model, seen in Figure 16, which included three levels. The first level was stabilization, which was trained using the balance exercises, depicted in Table 9. The exercises chosen for balance stabilization training involved little joint motion and were designed to improve reflexive joint stabilization contractions to increase joint stability (Clark, 2008). The second level was strength; however, the descriptive study in Phase 1 of this research emphasized the importance of muscular endurance which was phase two of the second level of the OPT model. Therefore, this intervention focused more on muscular endurance, which was the foundation for hypertrophy and strength. According to Phase 1 of this project, muscular endurance significantly correlated with strength; therefore, by improving muscular endurance it should also increase muscular strength. The muscular endurance exercises were more dynamic eccentric and concentric movements, refer to Table 10. These exercises were designed to improve the neuromuscular efficiency of the entire kinetic chain (Clark, 2008). The third level was power, which was trained by the exercises shown in Table 11. For power training, exercises were used to develop high levels of eccentric strength, dynamic neuromuscular efficiency, and reactive joint stabilization (Clark, 2008). Furthermore, exercises that integrated two or all of the muscular endurance, balance and power components were also included in this intervention, shown in Table 12. Appropriate exercises were chosen in accordance with the abilities of the children with intellectual disability. Furthermore, exercises had to be fun to keep the participants interested and motivated to continue the exercise.

Figure 16: Optimum Performance Training (OPT) model (image taken from Clark, 2008).

Table 8: Breakdown of exercise program

Integrated Exercise Training Program				
Stages	**Weeks**	**Exercises**		**Sets / Reps**
1: Foundation	1-2	Balance:	Toe & heel raises	3 x 10
			Side leg raises	12 x 10 sec
			One leg stand	12 x 10 sec
			Leg swing	3 x 10
		ME:	Static Lunges	4 x 10
			Quadruped alt.	3 x 10
			Supermans	10 x 5 sec
			Bridging	10 x 5 sec
		Power:	Squat Jumps	3 x 10
			Power Skipping	3 x 10
			Repeated long jump	3 x 10
			Diagonal obstacle jumps	3 x 10
2: Progressive	3-4	Balance:	Tandem walking	3 x 1 length
			One leg stand ball toss	12 x 10 sec
			One leg step-ups	3 x 10
			One leg foot tapping	1 x 16
		ME:	Dynamic lunges	3 x 10
			Plank	3 x 10 sec
			Sit ups ball catches	3 x 10
			Flexed arm hang	3 x 10 sec
		Power:	Box jumps	3 x 5
			Tuck jumps	3 x 5
			Diagonal obstacle jumps	3 x 10
			Single leg hop	3 x 10
3: Progressive	5-6	Balance:	Tandem walking	3 x 2 lengths
			One leg step-ups	3 x 10
			One leg foot tapping	1 x 24
			Bosu ball twist	1 x 10
		ME:	Plank	3 x 20 sec
			Sit ups ball catches	3 x 15
			Monkey bars	3 x 6
			Wheelbarow	2 x 1 length
		Power:	Box jumps	3 x 8
			Power skipping	3 x 8
			Tuck jumps	3 x 8
			Repeated long jump	3 x 8
		Integrated:	Burpees	3 x 5
			Hopscotch	1 x 1
4: Integrated	7-8	Balance:	One leg stand ball toss	8 x 15 sec
			One leg foot tapping	1 x 32
		ME:	Sit ups ball catches	3 x 20
			Monkey bars	3 x 12
		Integrated:	Burpees	3 x 8
			Bosu ball squat	3 x 8
			Bosu ball dynamic plank	3 x 8
			Hopscotch	2 x 1
			Leapfrog	2 x 1 length
			Jump rope	2 x 10

Table 9: Balance exercises

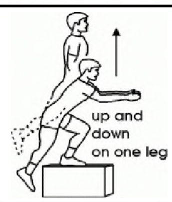
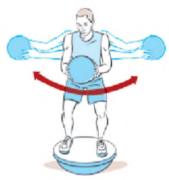
Heel & Toe Raises	For toe raises, lift your toes while your heels remain firmly planted on the floor. To raise your heel, stand on your toes as tall as you can comfortably extend. Both exercises start with added support and as the child improves balance use less and less added support.	
Side Leg Raises	Stand upright with feet slightly apart. Slowly abduct leg. Keep the lifted leg straight and toes facing forward. The weight bearing leg should be slightly bent. Hold position for 1 second. Alternate between legs.	
Heel-to-Toe Walk	The child must find and focus on a spot ahead of them to keep them steady whilst walking. Take a step by placing the heel in front of the other foot's toes, almost touching each other. Repeat for 20 steps.	
Tandem Walk (x3 variations)	Make a 3m straight line on the floor with tape. Have the children walk over it and watch their feet to check if they stay on the line. Useful tasks for their balance: have them walk the line with a beanbag on their head, backwards, and hopping on one foot.	
One Leg Stand / Ball Toss	Stand upright with arms crossed against your chest. Raise your leg by flexing the knee. Once the single leg stance has improved, progress balance by adding a catch and through component to the exercise.	
One Leg - Step Ups	Stand facing a raised platform of 30cm. Place the sole of your right foot on the platform. Push your right foot firmly into the platform, thereby raising body upward by extending your right knee and hip. Repeat on left leg.	
One leg Foot Tapping	Stand with feet together on the centre dot. The four surrounding dots will be different colours (similar to the game twister). When a colour is called out, lift leg and tap that coloured dot with your toes and then return to centre dot with feet together.	
Leg Swing	Stand with feet together and hands on hips. Slightly flex the knee, so it lifts of the ground. Slowly extend the hip (leg swings backwards), and then flex the hip (swings forward). Repeat on alternative leg. Increase range of motion and speed of swing as balance improves.	
Bosu Ball Twist	Stand on the bosu ball with feet apart, knees slightly flexed and arms held straight up in front of you holding a ball. Once balanced, twist the torso so that the ball moves from one side to the next.	

Table 10: Muscular endurance exercises

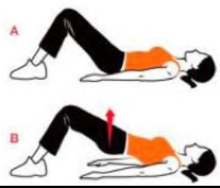
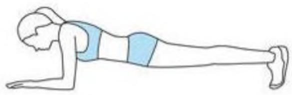
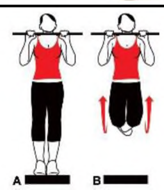
Exercise	Description	Illustration
Lunges (Static/Dynamic)	*Static*: Stand with feet together. Take step forward and go into the lunge position. Hold lunge for 2 seconds then return to original stance. Repeat on alternative leg. *Dynamic*: Moving forward by alternating lunges continuously.	
Quadruped Alternating Arms & Legs	On hands and knees, hold spine stable and straight. Alternate lifting and straightening the opposite arm and leg while holding spine and pelvis stable.	
Prone Extensions / Supermans	Lay on stomach with arms overhead. Lift arms and legs so upper chest and upper thighs lift off surface, engaging spinal extensors. Arms and legs should be straight.	
Bridging	Lay on back with knees bent and feet flat on floor. Push through heels and lift buttocks off surface. Hold position and focus on keeping pelvis and shoulders level. Engage lumbar stabilizers and gluteals.	
Plank	Get into a press up position. Bend your elbows and rest your weight onto your forearms and heels of your feet. Your body should form a straight line from shoulders to ankles. Engage your core by sucking your belly button into your spine.	
Sit ups Ball Catches	Lay supine with knees bent and feet on floor. Lift head and shoulders off surface. Breathe out as you lift and in as you lower. Play catch with the ball as the child lifts and lowers.	
Flexed Arm Hangs	Grasp the overhead bar using an overhand grip (palms facing away from body). Using a chair, position body with the armed flexed and the chin clearing the bar. To begin exercise take chair away and allow the child to 'hang' and hold the position for a prescribe period.	
Monkey Bars	Start with a dead hang. One hand releases the bar and is placed on the next bar in front. Then bring the other hand to the same bar. This is repeated until all money bars are completed.	
Wheelbarrow	In pairs: One child will presume the top of a push up position. The other child will stand behind and then pick up his/her partners legs. Once in the correct position, move forward by one partner walking on their hands and the other on their legs.	

Table 11: Power exercises

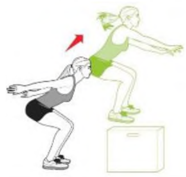
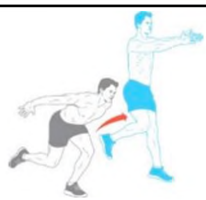
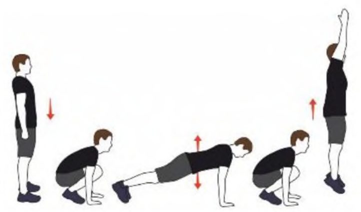
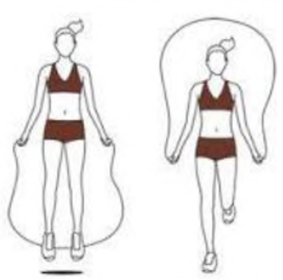
Exercise	Description	Illustration
Box Jumps	Stand with feet together and hands at your side. Lower body into jumping position by bending knees and hips. Explosively jump from crouched position, whilst swinging the arms, onto the platform of 30cm. Stand tall then jump down.	
Squat Jumps	Stand with feet together and hands at your side. Lower body into the squat position then explosively push against the ground and swing arms up. Try jump as high as possible.	
Power Skipping	Leading with right knee, skip as high as possible by raising your right knee to hip height and swinging your left arm up. The left leg should remain straight and your right elbow should be slightly bent at your side. Land on the ball of your left foot.	
Repeated Tuck Jumps	Standing with your feet together. Bend knees and go into the squat position then immediately explode upward. Jump as high as possible and raising knees up and towards chest.	
Repeated Long Jumps	Standing with your feet together, lower body into the squat position and immediately jump forward by pushing off the ground with both legs and swinging your arms up. Try jump as far as possible. Land on both legs and repeat movement.	
Diagonal Obstacle Jumps	Stand next to a 3m line with feet together and elbows bent. Jump diagonally with both feet and land on the other side of the line. Repeat movement until the end of the line.	
Single Leg Hops	Start in the single leg stance for the left leg with arms at your side. Presume jumping position by bending left knee and swing arms back. Jump as high and far as possible. Land on the same leg. Repeat movement on the right leg.	

Table 12: Integrated exercise

Exercise	Description	Illustration
Burpees	Begin in a standing position. Drop into a squat position with your hands on the ground. Kick feet back, while keeping arms extended. Immediately return your feet into the squat position. From the squat position, push of the ground with both feet and explosively jump as high as possible whilst reaching with your arms above your head.	
Bosu Ball Squat	Stand on the bosu ball with feet apart and arms out in front of body. Find your balance. Once balanced, lower your body into the squat position and hold position for a prescribed amount of time.	
Bosu Ball Dynamic Plank	Get into the push up position with arms straight, hands on the bosu ball and feet slightly apart (A). Once stabilized, bend left elbow (B) then subsequently bend right elbow, so you are bearing weight on your forearms, not hands anymore (C). Once stabilized in this position, reverse movement sequence (C, B, A).	
Hopscotch	Begin in the standing position. Hop into square 1 with right leg. Hop into blocks 2 and 3, each leg in a block, so you land on both legs. Continue this process until the semi-circle numbered 10. Hop into the semi-circle landing on both legs. Jump and rotate 180 degrees and land on both feet. Then start the process back with the left leg single hop.	
Leapfrog	In pairs. Person A kneels down on the ground, then bends over knees and places hands on the ground whilst keeping arms straight. Person B stands behinds person A and places their hands on their back and using their hands as leverage, jump over person A, landing on two feet in front of them. Person B then kneels and Person A will replicate person B's previous movements.	
Jump Rope	Start in the standing position. Hold the jump ropes handles in each hand. Slightly abduct and extend arms, so that they are at a 45 degree angle. This will create a larger arc to jump through. Start with the rope behind you. Use hands and wrists to swing the rope over head. When the rope is coming towards your feet, hop over it by standing on your toes and pushing off the balls of your feet.	

Setting and location

The exercise sessions took place at the special needs school. The design of the intervention incorporated school resources and facilities, so that the exercises sessions could take place with minimal disruption to the school day, as well as the exercises learnt during the intervention could also easily be administered by the teachers once the intervention was completed. Therefore, the exercises incorporated into the intervention were low-cost and economical, to comply with the school's low socio-economic status. The school's facilities included a small playground and, in case of bad weather, the school hall was made available. All sessions were supervised by the principal researcher and facilitated by research assistants. It had been previously recorded that supervised, centrally located exercise sessions, for persons between the ages of 40-65 years, had a 16% better compliance rate (an average of 90% attendance at sessions) compared to home-based, unsupervised programmes (where attendance rates of 75% can be expected) (Cox et al., 2003). It was assumed that better compliance rates would also be achieved for school children by conducting centrally located exercises.

ETHICAL CONSIDERATIONS

An ethical standards application was submitted and approved by the Rhodes University Ethical Standards Committee (Appendix 3A.1, pg.158). This application addressed ethical concerns with regards to scientific experiments conducted on human subjects and included a rationale for conducting this study, the risks and benefits associated with it, issues of informed consent, voluntary participation, anonymity, privacy and confidentiality as well as feedback. Requiring the participants in the control group to not participate in the exercise intervention was viewed as ethically questionable. As such, in order to remediate the 8-week period of inactivity, the control participants were offered the opportunity to participate in activity once the intervention period was completed.

EXPERIMENTAL PROTOCOL

Informed consent & pre-screening questionnaire

A meeting with the headmistress of the special needs school took place, whereby she was given an information sheet (Appendix 3A.2, pg.159) and a consent form

(Appendix 3A.3, pg.162), followed by discussions regarding the purpose and procedures involved for the research. Thereafter, an information sheet (Appendix 3A.4, pg. 163) and a Children PAR Q questionnaire and ethical consent form (Appendix 3A.5, pg. 166) were distributed to each participant's parents prior to the commencement of the intervention period. This ensured that all the participants were of good physical health and their parents were willing for their children to participate in the intervention. Furthermore, a briefing session occurred where the exercise programme was explained to the children and each child was asked for their assent, in the presence of an adult, confirming that they were willing to participate in the intervention.

Participant allocation and outcome blinding

The school had three middle level classes for the children with intellectual disability between the ages 10 to 12 years of age. The school had assigned the children to a class based on their first language preference, which were isiXhosa, Afrikaans, and a bilingual class that could speak English and Afrikaans or isiXhosa. Therefore, one class was allocated to the intervention group, as well as half of the participants from the second class (n=19). The other half of the participants from second class were part of the control group and the third class also formed part of the control group (n=17). Some teachers were more interested in being involved and help supervise and translate for the participants in the exercise sessions than other teachers; therefore, their classes were chosen due to practicality and to minimize disruption to the teachers' schedules and their relationships with their learners.

The research assistants who helped with the pre-and-post intervention tests were different to the research assistants who helped facilitate the exercise sessions. This was to try minimize risk of bias within the data collection procedures. During testing, each participant was allocated a number that had been assigned to them on a code sheet. The code sheet stated whether the participants were in the intervention group or the control group. The numbers were randomly assigned to the participants. Only the principal researcher had access to the code sheet. Therefore, when the participants were being tested prior to and after the exercise programme, the research assistants were blinded to which participants had been allocated to the intervention and control groups.

Pre-and post-exercise intervention tests

Although the intervention focussed and trained muscular endurance, balance and power, all the physical fitness components were tested pre- and post- exercise intervention. The evaluation measures used to determine changes in physical fitness parameters over time for the control and intervention group were the same as the descriptive study's protocol for the physical fitness measures. The physical fitness tests took place in the Human Kinetics and Ergonomics Department at Rhodes University. The physical fitness components were all measured within one week, which included four sessions. Therefore, the health-related physical fitness components were familiarized in session 1 and measured in session 2, while skills-related physical fitness tests were familiarized in session 3 and measured in session 4. The health-related sessions 1 and 2 were tested on Monday and Tuesday, then the skill-related sessions 3 and 4 were tested on the Thursday and Friday, to minimize fatigue and allow for suitable recovery time for the participants between the health-related and skills-related fitness component sessions. There was only one session of familiarization prior to each testing session, as the participants were familiar with the tests due to their participation in the descriptive study. However, it was still deemed necessary to have familiarization sessions as to allow the participants to recall the tests and to once again ensure they fully understood the test protocols. A stretch and warm-up was mandatory before every session, to help prevent injury, enhance performance and to mentally prepare the participant for the upcoming sessions. The warm-up was facilitated by the research assistants.

The testing sessions entailed randomly splitting up the total sample into four smaller groups, consisting of both the intervention group and control group. Each group was assigned to a station. Each station assessed one of the physical fitness components. Once the groups had completed one station they rotated to the next station, until all stations had been completed for that session. Each test item was administered by a research assistant. All tests were done on a one-on-one basis, so that each participant was tested individually. The exception to this was the PACER test, where the group performed the test together.

STATISTICAL ANALYSIS

If the intervention group's participants did not attend 80% of the exercise sessions, their data were excluded from the study, to minimize skewing of the data due to the lack of adherence. The computer software, StatSoft® STATISTICA version 12, was used for statistical analysis. Basic descriptive statistics were used to provide measures of central tendency and of variability of the physical fitness components. A two-factorial analysis of variance was administered to determine whether there was a significant effect of time, group or an interaction effect. A 95% confidence interval was selected and significant differences were identified at $p<0.05$. A Tukey HSD post-hoc test was used for the significant results to determine between which conditions significant differences had occurred. A repeated measures Analysis of Variance with effect size and powers was conducted.

RESULTS

The approach to the results sections was to report on the primary and secondary aims for Phase 2 of this Master's project. The primary objective was to assess the impact of the exercise intervention on the three physical fitness components targeted with the intervention, which were muscular endurance, power and balance, by comparing the results of the exercise intervention group and the control group. The second objective was to evaluate the impact of the improvements of these three components on the overall physical fitness capacity of children with intellectual disability.

Participant adherence/retention

Participant adherence of the intervention group for the exercise sessions was high, with a 91.4% attendance rate. Of the 19 participants in the intervention group, two participants' data were excluded, as they did not fulfil the 80% attendance rate of the exercise sessions. Furthermore, one of the intervention group's participant did not attend the post intervention testing session, therefore making this participant's data set inadmissible. Henceforth, 16 participants' data were included for the intervention group (9 males/ 7 females). The control group had one participant with supplementary physical disabilities and one participant who did not attend the post intervention testing sessions; therefore, these two participants' data were also excluded from the intervention study, resulting in a sample size of 15 participants in the control group (8 males/ 7 females).

Muscular endurance

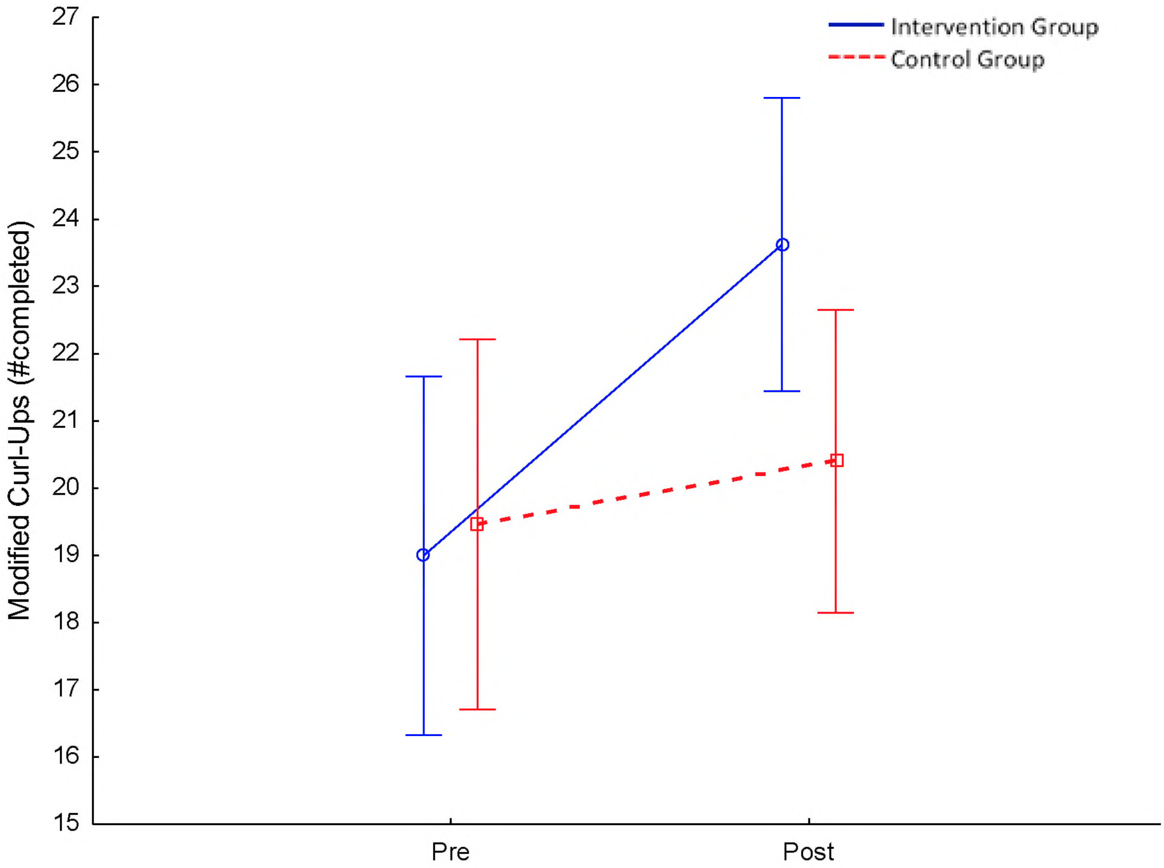


Figure 17: Modified curl-up results obtained pre-and-post intervention of the intervention and control groups

The pre-intervention measures for the modified curl-ups were similar, as there was no significant ($p = 0.993$) difference between the intervention and control group (Table 14). The intervention group's pre-intervention modified curl-up changed over time, as the post-intervention modified curl-up significantly ($p = 0.001$) improved (Table 14). The control group, however, showed no significant change over time ($p = 0.844$). Therefore, a statistically significant interaction effect ($p = 0.026$) was identified for muscular endurance in response to the exercise intervention, depicted in Figure 17. A significant effect size ($d = 0.617$) was found for this interaction effect, while inter-individual variability decreased for both groups from the pre-to post-intervention for the modified curl-up test (Table 13).

Balance

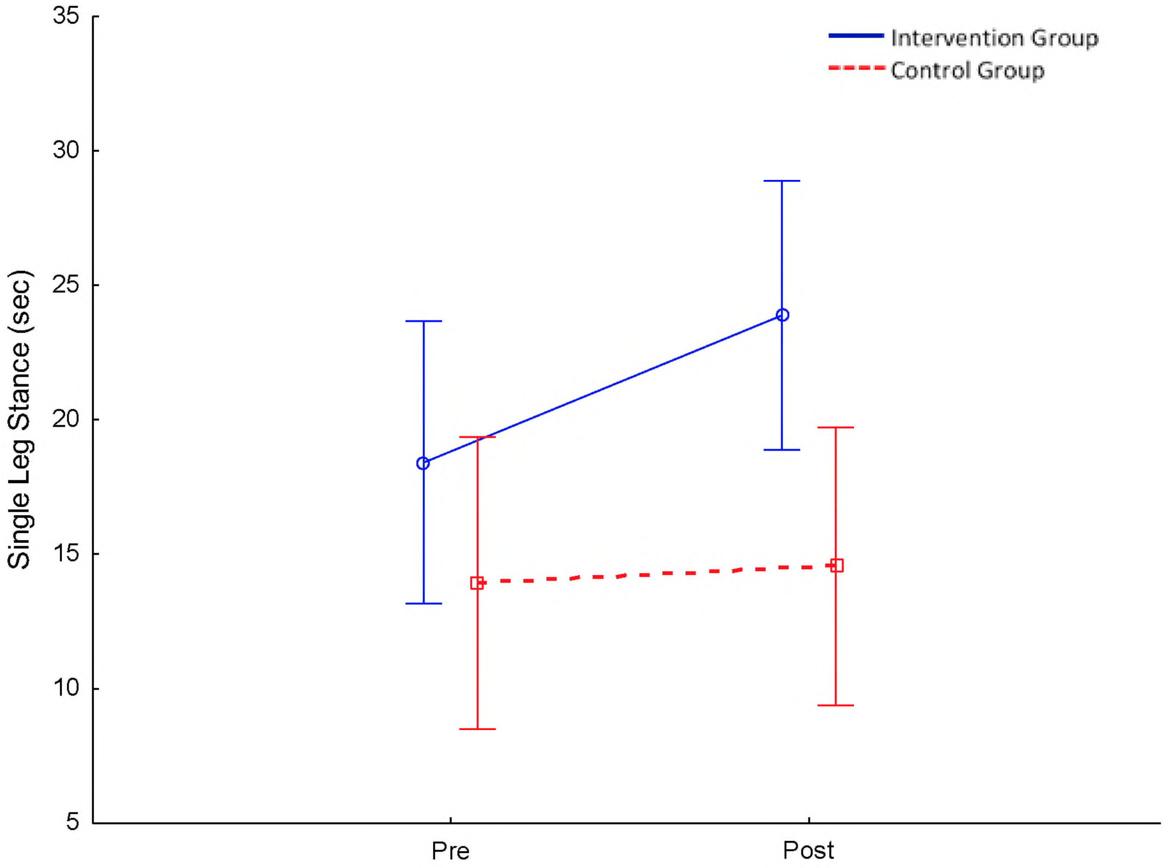


Figure 18: Single leg stance pre-and-post intervention measures for the intervention and control groups

The pre-intervention values for the single leg stance between the groups were not significantly ($p = 0.603$) different. The intervention group's post-intervention scores did not significantly ($p = 0.06$) improve from the pre-intervention scores, nor did they for the control group ($p = 0.991$). There was no statistical significant ($p = 0.114$) interaction effect and a small effect size ($d = 0.35$) for balance in the intervention study (refer to Table 13). The pre-intervention inter-individual variability for the single leg stance had a large coefficient for both the intervention (60.22%) and control (60.89%) groups, as seen in Table 14. Inter-individual variability for the control group's post-measure for single leg stance were similar (68.46%). However, the intervention group's post-intervention measure's coefficient of variation decreased to 37.43%, thereby decreasing the level of dispersion around the mean and improving the homogeneity of the intervention group's performance for single leg stance.

Power

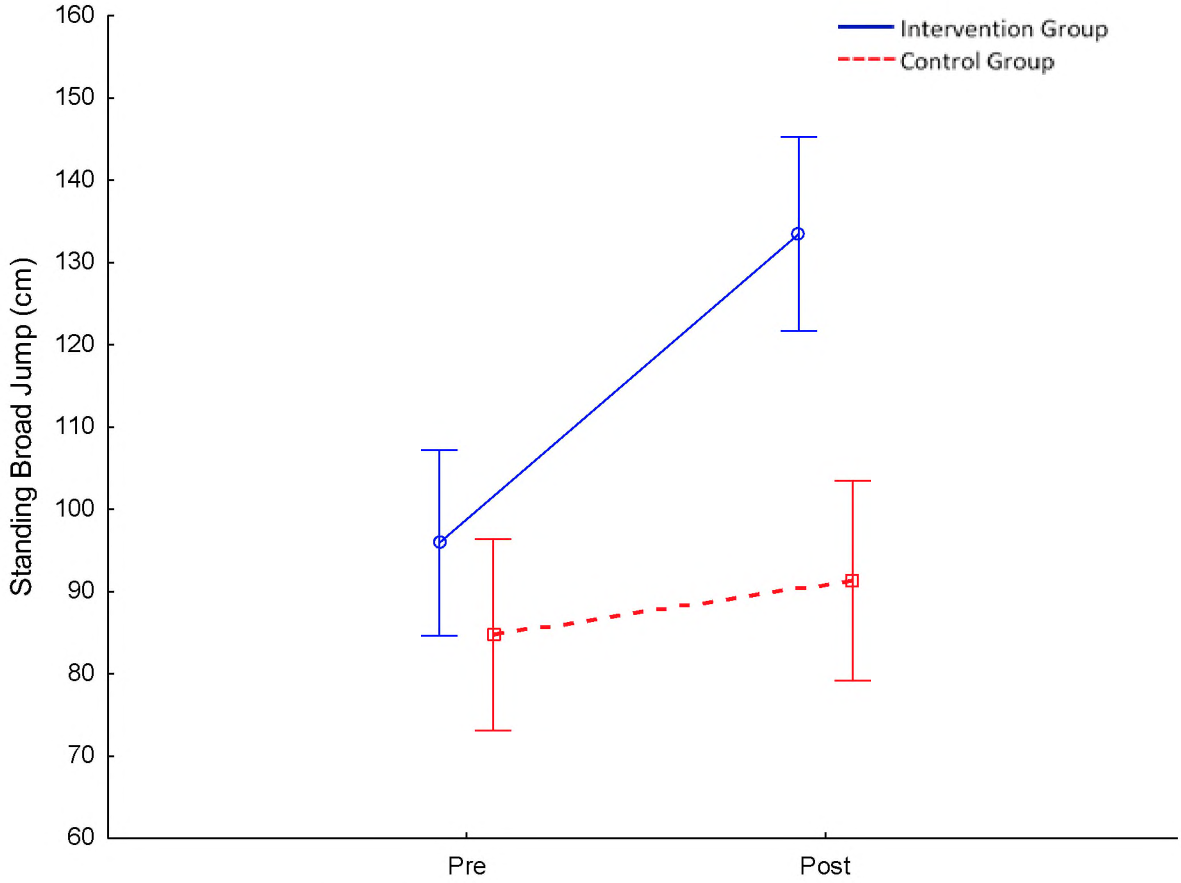


Figure 19: Standing broad jump pre-and-post intervention measures for the intervention and control groups

There was no significant ($p = 0.52$) difference between the intervention and control group's pre-intervention standing broad jump; however, a significant ($p < 0.001$) difference was found between the two groups' post-intervention jumps (Table 14). The intervention group significantly ($p < 0.001$) improved their standing broad jump after completing the 8-week exercise programme, whereas no significant ($p = 0.226$) changes occurred for the control group. Therefore, a significant ($p <0.001$) interaction effect was found for power in the intervention study, with a large and significant effect size ($d =0.999$), as seen in Table 13. The intervention group's pre-intervention standing broad jump had a coefficient of variation of 19.59% and became even more homogenous of 13.21% for the post-intervention measure. The coefficients of variation for the control group were similar for the pre-intervention (27.98%) and post-intervention (28.78%); however, they were less homogenous when compared to the intervention group.

Overall physical fitness

Table 13: The pre-and post-intervention measures for the physical fitness tests (mean, SD and CV), and the interaction effect (group x time) and effect size

		Intervention Group		**Control Group**		Group x Time (p-value)	Effect Size (d-value)
		Pre	Post	Pre	Post		
Health-related	**Cardiorespiratory endurance** PACER (# 15m laps)	19.31 ± 9.39 (48.63%)	26.88 ± 15.49 (57.63%)	15.47 ± 7.96 (51.45%)	13.40 ± 6.99 (52.19%)	**p < 0.001**	**0.984**
	Muscular endurance Modified Curl-Ups (# completed)	19 ± 4.49 (23.61%)	23.63 ± 4.15 (17.57%)	19.47 ± 5.57 (28.62%)	20.40 ± 4.1 (20.08%)	**0.026**	**0.617**
	Muscular strength Grip Strength (kg)	12.3 ± 3.41 (27.74%)	15.24 ± 3.9 (25.6%)	13.49 ± 4.14 (30.68%)	14.05 ± 5.07 (36.11%)	**0.021**	**0.654**
	Body composition Triceps and Calf Skinfold (mm)	19.83 ± 7.08 (35.72%)	18.69 ± 7.33 (39.23)	15.03 ± 3.73 (24.85%)	15.97 ± 4.94 (30.97%)	0.156	0.292
	Flexibility Sit-and-Reach (cm)	18.84 ± 7.69 (40.78%)	22.02 ± 7.49 (34.03%)	18.6 ± 6.53 (6.53%)	18.64 ± 6.62 (35.5%)	**0.032**	**0.586**
Skill-related	**Balance** Single Leg Stance (sec)	18.42 ± 11.09 (60.22%)	23.89 ± 8.94 (37.43%)	13.94 ± 8.49 (60.89%)	14.56 ± 9.97 (68.46%)	0.114	0.35
	Agility 505 Agility (sec)	4.59 ± 0.79 (17.14%)	3.62 ± 0.46 (12.83%)	4.37 ± 0.84 (19.29%)	3.87 ± 0.61 (15.84%)	0.127	0.33
	Speed 50m Sprint (sec)	13.3 ± 5.79 (43.52%)	10.32 ± 1.35 (13.04%)	12.12 ± 2.03 (16.76%)	11.08 ± 1.91 (17.27%)	0.247	0.208
	Power Standing Broad Jump (cm)	95.97 ± 18.8 (19.59%)	133.52 ± 17.64 (13.21%)	84.79 ± 23.73 (27.98%)	91.4 ± 26.31 (28.78%)	**p < 0.001**	**0.999**
	Coordination Block and Box (# transfer)	35 ± 8.9 (25.43%)	39.69 ± 8.42 (21.21%)	32.2 ± 10.21 (31.72%)	35.8 ± 8.9 (24.86%)	0.724	0.064
	Reaction Time Fitts' Task (sec)	0.46 ± 0.15 (32.88%)	0.41 ± 0.09 (20.93%)	0.45 ± 0.12 (26.69%)	0.45 ± 0.12 (26.82%)	0.257	0.201

Values expressed as "mean ± standard deviation"; CV = Coefficient of Variation presented in brackets; Statistical significance = p-value; Practical significance = d-value; [bold] font highlights significant difference at p < 0.05

Table 14: The post-hoc Tukey HSD test for the components with significant results highlighted in Table 13, as well as for balance

	Int. Pre vs Post	$Int._{Pre}$ vs $Con._{Pre}$	$Int._{Post}$ vs $Con._{Post}$	Con. Pre vs Post
Cardiorespiratory endurance PACER	**p < 0.001**	0.762	**0.008**	0.592
Muscular endurance Modified Curl-Ups	**0.001**	0.993	0.249	0.844
Muscular strength Grip Strength	**p < 0.001**	0.868	0.869	0.851
Flexibility Sit-and-Reach	**0.014**	0.999	0.583	0.999
Balance Single Leg Stance	0.06	0.603	0.061	0.991
Power Standing Broad Jump	**p < 0.001**	0.52	**p < 0.001**	0.226

Where: Int. is 'intervention group'; Con is 'control group'; pre is 'pre-measures' and post is 'post-measures'

Table 14 highlights that, prior to the intervention, the two groups were not significantly different in their physical fitness from one another. Over time, the control group showed no positive changes in performance from the pre- to post-intervention physical fitness measures, whereas the intervention group did positively improve their physical fitness performance for cardiorespiratory endurance, muscular endurance, muscular strength, flexibility and power (Table 13 & 14). The balance post-intervention test scores for the single leg stance improved for the intervention group, but not significantly.

Despite the significant increases over time for the intervention group, but not the control group, the differences between the groups recorded post intervention were only significant for cardiorespiratory endurance and power. To reduce the effect that inter-individual variability may have had on these results, the post-intervention performance results for the overall physical fitness levels were normalized to the baseline (pre-intervention) results for the intervention and control groups (Figure 20). Normalized, three components were found to be significantly different between the intervention and control group, namely cardiorespiratory endurance ($p < 0.001$), muscular strength ($p = 0.01$) and balance ($p = < 0.001$). However, the relative changes in performance for balance were significant (see Figure 20), whereas the absolute changes in balance performance (see Table 13 & 14) were not significant. Furthermore, the normalized muscular endurance, flexibility and power were not significantly different, which is contradictory to for the findings of the absolute changes of performance for these three components.

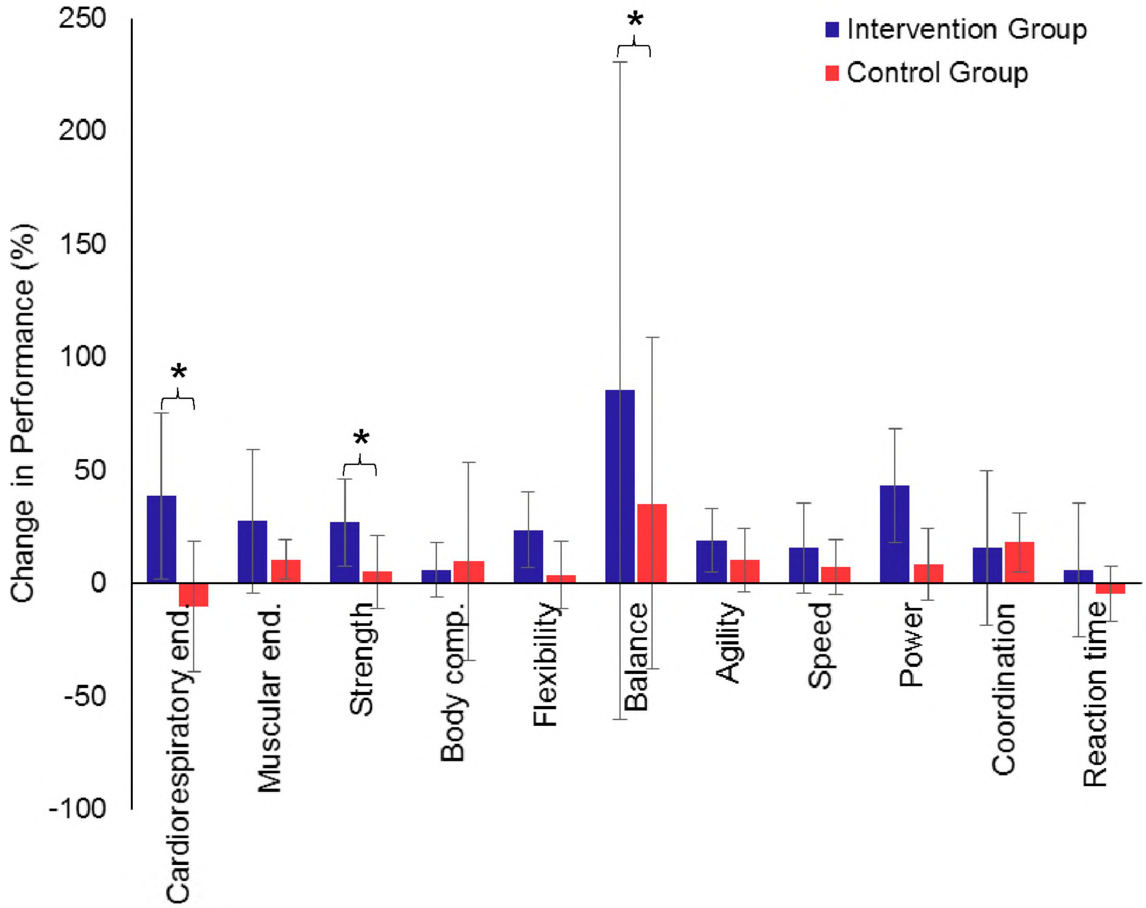


Figure 20: The intervention and control groups' changes in performance (post-intervention results shown as a percentage of the pre-intervention results). Components indicated with an asterisks (*) show a statistical significance ($p < 0.05$) difference between the two experimental groups.

DISCUSSION

The results of the intervention study indicate that muscular endurance and power performance in the children with intellectual disability improved significantly after an 8-week exercise programme when compared to the non-exercising control group. The observed effect size for these two components were in the moderate to large range, especially in the improvement of power. However, balance was not found to be significantly different and had a small effect size. Secondary findings show that the overall level of physical fitness had been affected, as cardiorespiratory endurance, muscular strength and flexibility had also significantly improved for the intervention group, despite not having been specifically trained.

The significant interaction effects signified that the physical fitness improvements recorded in the intervention group are most likely attributed to the exercise programme, as opposed to physical maturation or learning effects, since the control group did not show the same changes for their pre- and post-intervention measures. This intervention study, therefore, found that the exercise programme's muscular endurance and power training probably induced neuromuscular adaptations for the intervention group, which subsequently impacted cardiorespiratory endurance, strength and flexibility (Bonacci et al., 2009). Furthermore, these findings are in accordance with the correlation analysis in Phase 1 of the current Master's project, as power significantly correlated with cardiorespiratory endurance, muscular endurance, strength, all of which significantly improved, and as well as balance, agility, speed, coordination and reaction time, which also improved but not significantly. Muscular endurance was also shown to significantly correlate with strength, balance, speed, power, coordination and reaction time. Similar findings in previous studies were reported for the practical significance of the improved physical fitness components, as a large effect size was reported for cardiorespiratory and muscular endurance, moderate effects for muscular strength, and small effects for flexibility (Chanias et al., 1998; Shin & Park, 2012). However, it must be taken into account that heterogeneous data, such as the cardiorespiratory endurance data, with a coefficient of variation ranging from 48.63% to 57.63%, may have higher incidence for error probability, thus making any possible effects of the intervention for cardiorespiratory endurance likely biased (Nakagawa & Cuthill, 2007). This must therefore be taken into account when interpreting the assessment of cardiorespiratory endurance in this intervention study.

The results showed that cardiorespiratory endurance, muscular endurance, strength, flexibility and power are all highly trainable for children with intellectual disability, which is similar to previous studies' findings (Golubovic et al., 2012; Kubilay et al., 2011; Giagazoglou, Kokaridas, et al., 2013). Similar trends were found for the intervention group's improvement of cardiorespiratory endurance, muscular endurance, power and flexibility. The pre-intervention measures for these four components were considered to have been of moderate standards for intellectually disabled children and the mean scores fell into the adapted fitness zone (AFZ), which lies between the minimum acceptable level and the attainable level of fitness leading to a healthy fitness zone (Stanish & Temple, 2012; Winnick & Short, 2014). The significant improvements of the post-intervention measures for these three components resulted in the intervention group being considered to have a healthy fitness standard for intellectually disabled children (Tokmakidis et al., 2006; Lejčarová, 2008; Salaun & Berthouze-Aranda, 2011; Golubović et al., 2012; Ghosh, 2014). These findings must be highlighted, as they can have a great impact on the intellectually disabled children's physical cababilities in everyday life and are beneficial for health predispositions in the future. The significant improvement of strength did not however alter the fitness zone classification, as the pre-to-post intervention grip strength measurements both fell within the range of the adapted fitness zone, according to the classification of Winnick and Short (2014), and did not improve to a healthy fitness zone. Furthermore, this intervention study revealed that the children with intellectual disability who were involved in the exercise program and who had improved certain components' of physical fitness, did not reach the level of physical fitness of typically developed children. This finding is also consitent with findings from previous research (Golubović et al., 2012; Winnick & Short, 2014).

The positive training adaptations could infer a learning effect, as the intellectually disabled children who participated in the exercise programme could have learnt to produce specific patterns of muscle recruitment that are associated with optimal performance for these physical fitness components (Bonacci et al., 2009). This, therefore, suggests that these components are highly trainable for children with intellectual disability, which is similar to the reporting of previous studies (Chanias et al., 1998; Lin & Wuang, 2012; Shin & Park, 2012; Stanish & Temple, 2012). Furthermore, it could also be suggested that during the exercise intervention the children with intellectual disability experienced a learning effect about their own physical and mental capabilities, as they could have come to the realization that they could push themselves to a greater extent and sustain higher efforts for longer. The improvement of cardiorespiratory endurance, muscular endurance, strength, power and flexibility may have a combined and accumulative effect on health in young people, as it may improve the health markers for cardiovascular health and hypokinetic diseases, as well as improve activity of daily living, recreational activities, quality of life and decrease the risk of falling (Suni et al., 1998; Ortega, Ruiz, et al., 2008; Yanardag et al., 2013; Oppewal et al., 2015).

One of the more unexpected findings was for balance; the intervention group's balance did not significantly improve after the completion of the exercise programme, which is in contrast to previous research findings (Kubilay et al., 2011; Giagazoglou et al., 2012; Golubović et al., 2012; Mikołajczyk & Jankowicz-Szyma, 2014; Kachouri et al., 2016). It must be noted that the coefficient of variation for balance was very high (60.22% to 68%) for the intervention and control group's pre-intervention measures and post-intervention for the control group, which could have potentially masked any significant effects for balance in response to the exercise programme. The large inter-individual variability for balance could be attributed to the participants' range of IQ (50-70), which could cause variations within the sensory information processing deficits, and therefore the participants could have different levels of motor planning and movement disturbances, due to delayed visual and proprioceptive information (Golubović et al., 2012; Giagazoglou, Kokaridas, et al., 2013; Mikolajczyk & Jankowicz-Szymanska, 2015; Kachouri et al., 2016). Another potential factor that could have influenced the inter-individual variability was the lack of understanding and/or motivation to perform the single leg stance test to the best of their abilities. The control group's post-intervention coefficient of variation increased slightly to 68%, whereas the intervention group's coefficient of variation decreased to 37.43%. Therefore, the intervention group's performance became more homogeneous, possibly as a result of the exercise programme and thus a better understanding of the concept.

One of the most interesting findings was the discrepancies between the absolute findings and relative findings for the change in balance performance between the intervention and the control group. Sometimes absolute values can be taken at face value and/or be overlooked; therefore, the relative value provides a direct insight into the true scale of differences between the intervention and control groups. The absolute values for balance showed no significant change in performance; however, the relative value was found to significantly differ for balance performance between the intervention and control group. It must be noted that the results showed that the pre-intervention inter-individual variability for the single leg stance had a large coefficient for both the intervention (60.22%) and control (60.89%) groups. Inter-individual variability for the control group's post-measure for single leg stance (68.46%) did not differ substantially from pre-protocol measures, whereas the intervention group's post-intervention measure's coefficient of variation decreased to 37.43%. Therefore, if the influence of the inter-individual variability was disregarded then potentially an interaction effect for balance and the intervention study could be unmasked, resulting in the exercise programme eliciting significantly positive balance improvements.

Furthermore, previous research on adults with intellectual disability found a large effect size for balance improvements following an exercise programme, whereas the current study, which focussed on children with intellectual disability, found a small effect size (Chanias et al., 1998; Shin & Park, 2012). According to a systematic review by Zech et al. (2010), a balance training duration of a minimum of six weeks was required to improve sensorimotor adaptation; however, the studies included in the systematic review had a healthy and physically active adolescent population sample and did not systematically examine the influence of balance training dosage; therefore, this assumption remains speculative (Zech et al., 2010). There is a lack of research reporting the effect size for balance improvements in children with intellectual disability following an exercise program. Studies on intellectually disabled children found that balance training programmes of eight to twelve weeks showed improvements to their balance performance (Smail & Horvat, 2005; Kubilay et al., 2011; Mikołajczyk & Jankowicz-Szyma, 2014; Azadeh et al., 2015; Dehghani & Gunay, 2015; Kachouri et al., 2016). However, all these studies' exercise programs were balance-specific and utilized all designated time for balance training, whereas the current intervention study had three physical fitness components, thus only a third of the training time was allocated for balance exercises. The balance training dosage of this intervention study may therefore not have elicited the necessary sensorimotor adaptations of the proprioceptor pathways to improve balance significantly (Yaggie & Campbell, 2006; Bonacci et al., 2009; Kachouri et al., 2016).

The only health-related physical fitness component that did not significantly improve after the exercise program for the intervention group was body composition, while the majority of the skill-related components did not improve, namely agility, speed, coordination and reaction time. Body composition remained fairly similar after the completion of the exercise programme in both the experimental groups; the intervention group slightly decreased their sum of skinfolds, while the control group's body composition slightly increased. Both groups however remained within the healthy fitness zone for body composition (Winnick & Short, 2014).

Both coordination and reaction time require sensory information processing, similar to balance, and the cognitive impairment and possible motor disturbance could be attributed to the poor performance (Piek et al., 2004; Carmeli, Bar-Yossef et al., 2008). Agility requires motor planning and the integration of movement skills using a combination of balance, coordination, speed, strength, and endurance (Caspersen et al., 1985; Ruiz et al., 2006; Wuang et al., 2013). Therefore, the lack of improved agility performance for the intellectually disabled children in the intervention group could have been attributed to the delay of motor planning and/or the lack of improvement for balance, coordination and speed, since previous research stated that children with intellectual disability tend to have difficulty grasping concepts of running speed and maximal effort, which could have limited the intellectually disabled children's performance in speed (Salaun & Berthouze-Aranda, 2011).

CONCLUSION

The exercise intervention resulted in an increase in physical fitness parameters over time, but only for the intervention group's cardiorespiratory endurance, muscular endurance, strength, flexibility and power. Therefore, four of the five health-related physical fitness components significantly improved over time, thereby rejecting the null hypothesis; however, the null hypothesis was accepted for the skill-related changes, as only power improved and the remaining five skill-related components did not significantly change over time. While the two experimental groups' pre-intervention scores were similar to one another, significant differences between groups for post-intervention measures were only found for cardiorespiratory endurance and power. Therefore, the null hypotheses, which stated that there would be no change in the health-related and skill-related physical fitness levels, were rejected for cardiorespiratory endurance and power. This indicates that the exercise programme developed for the children with intellectual disability had a positive effect on health-related fitness parameters, but not on skill-related fitness parameters.

CHAPTER V

CONCLUSION

SUMMARY

Extensive research has addressed physical fitness as an agent in promoting health and well-being; however, there is little research on this topic for intellectually disabled people and even less relating to the South African context. Children with intellectual disability attending special need schools in disadvantaged communities in the Eastern Cape have lacked the opportunity to participate in structured physical education programs. Implementing a solution to this problem was seen to be a challenge, due to the lack of informative research and available data.

The purpose of Phase 1 of the current Master's project was to assess the level of physical fitness of children with intellectual disability in the Grahamstown region, by comparing basic anthropometric measures, as well as eleven physical fitness components of a sample of intellectually disabled children to those from a sample of typically developed children. The results revealed a significant difference for the anthropometric measures and for eight of the eleven components of physical fitness for the intellectually disabled participants compared to their typically developed peers; therefore, the null hypothesis was rejected, with exception of cardiorespiratory endurance, flexibility and agility. Children with intellectual disability have delayed maturation, indicated by a short stature, that can negatively affect overall physical fitness outcomes, which can further cause associated health issues (Beunen et al., 1997; Jones et al., 2000; Guidetti et al., 2010; Bryl et al., 2013). This reiterates the importance of a structured physical fitness program at a young age for children with intellectual disability, to ensure a proactive approach for reconciling these delayed maturation's impact on physical fitness and the related health predicaments. Furthermore, decrements of power, balance, muscular endurance and strength were found to be associated with reduced motor capacity, and gait movements/patterns for persons who are intellectually disabled, which could further impact their autonomy in activities of daily living and increase the risk of accidental falls in the future (Rivilis et al., 2011; Giagazoglou, Arabatzi, et al., 2012; Terblanche & Boer, 2013; Wuang et al., 2013; Van Hanegem et al., 2013; Oviedo et al., 2014). Henceforth, muscular endurance, balance and power were considered to have been the three physical fitness components most appropriate to be included for a multi-modal exercise program, based on significant correlations with other fitness parameters.

The purpose of Phase 2 was to determine the efficacy of an exercise intervention for children with intellectual disability. The exercise intervention's primary objective was to improve muscular endurance, balance and power, while the second objective was to assess and evaluate the impact of the changes of these three components on the overall physical fitness capacity of intellectually disabled children. The intervention study was a case-control study (intervention group: n = 16; control group: n = 15), whereby the intervention group was exposed to an 8-week exercise programme training muscular endurance, balance and power. Pre-and post-intervention measures were performed using the same eleven physical fitness tests as in Phase 1. The results showed significant improvements for four of the health-related physical fitness components over time for only the exercise intervention group, namely cardiorespiratory endurance, muscular endurance, strength and flexibility; therefore, rejecting the null hypothesis for four of the five health-related physical fitness components. Power was the only skill-related physical fitness component to significantly improve after the completion of the exercise programme for only the intervention group, therefore the remaining five skill-related components accepted the null hypothesis. The significant interaction effects signified that the physical fitness improvements recorded in the intervention group are most likely attributed to the exercise programme, as opposed to physical maturation or learning effects, since the control group did not show the same changes for their pre- and post-intervention measures. Therefore, the results showed that cardiorespiratory endurance, muscular endurance, strength, flexibility and power are all highly trainable for children with intellectual disability, which is similar to previous studies' findings (Golubovic et al., 2012; Kubilay et al., 2011; Giagazoglou, Kokaridas, et al., 2013). In conclusion, the exercise intervention implemented in the current study had a positive effect on the health-related parameters, but was not found effective for the skill-related parameters, with the exception of power.

LIMITATIONS

There were a number of challenges which transpired throughout the duration of this research project. These complications were mostly unanticipated, resulting in minor alterations to the intervention design and consequently the interpretation of the data.

Sampling technique

The non-probability sample was not a product of randomized selection process, as the schools were approached on the basis of their accessibility to the researcher. Thereby, an unknown portion of the children with intellectual disability living in the Eastern Cape were not included in this Master's study, which could entail that the sample may or may not have represented the population accurately. Therefore, the results of the research cannot be used in generalizations pertaining to the entire population of children with intellectual disability living in South Africa.

Sample size

A larger sample size would have been more preferable for a stronger statistical power and to minimize the margin of error. However, due to the lack of accessibility of suitable participants for the current Master's project this was not possible.

Phase 1: The descriptive study consisted of 29 intellectually disabled participants and 25 participants for the typically developed sample. A sample of 36 participants or more per sample group would have been preferable.

Phase 2: The intervention study recruited 36 participants from the special needs school, of which five were excluded, as one participant had a physical disability, two participants did not attend the post-intervention testing sessions, and two participants in the intervention group did not attend 80% of the exercise sessions. As a result, the size of the sample group decreased to 31 participants in total, with 16 participants in the intervention group ($n = 16$) and 15 in the control group ($n = 15$). Participant recruitment from more special needs school in the Eastern Cape would have been preferable, to increase the number of participants included in this study.

Anthropometry

Comparing performance results of children with different statures and masses was acknowledged to be a limitation. Unfortunately, no such data exist for South African children, hence such an analysis is not feasible.

Performance variability

The following tests were only measured once during the descriptive study and once for the intervention study's pre-and-post intervention measures; PACER test, Block and box test, and the modified curl-up test, which introduced the possibility of fluctuations in performance. On the other hand, three trials were administered for; the dominant grip strength test, skinfold technique, back-saver sit-and-reach test, single leg stance, agility, speed and power; and 10 trials for the Fitts' simple reaction time test. Furthermore, performance variability could have possibly been accounted for by the intellectually disabled participants' levels of arousal on the day of testing, as well as social, family and environmental conditions that could have impacted the participant's level of motivation at the time of data collection. Furthermore, the children with intellectual disability could have lacked the understanding to perform the test to the best of their capabilities. This factor was minimized by having familiarization sessions before testing took place. As such, participants' scores for the descriptive and intervention studies' tests may, or may not, have been a true reflection of their level of physical fitness.

Intervention length

Phase 2: The length of the school term was a limiting factor. The term during which the intervention took place was only 10 weeks long, followed by a vacation. As participants were required to perform the pre- and post-intervention tests in the first and last week of the term respectively, only eight weeks of intervention training were possible. The systematic review, in Chapter II, found that a duration for an exercise programme of ten or more weeks was more preferable than eight weeks; however, with that being said an 8-week duration was still considered acceptable.

Intervention sessions

Phase 2: The intervention design had 32 exercise sessions scheduled for the exercise programme. The sessions were reduced to 30 sessions, as one session was cancelled due to a public holiday and the other session was cancelled by the school, as the school busses could not collect the students in the morning for school. Furthermore, three of the 30 exercise sessions were compromised, due to bad weather conditions, and the testing sessions took place in the small school hall, necessitating the exercise sessions to be slightly altered.

RECOMMENDATIONS

Future studies should continue to investigate the physical fitness profiles of children with intellectual disability in South Africa and build-up a database that includes data on intellectually disabled children living in different provinces of South Africa. Therefore, including more data of intellectually disabled children’s physical fitness components could entail having a larger sample size that may represent the population more accurately and provide criterion-reference data and generalizations specific to the South African context.

It is recommended that physical activity profiles of intellectually disabled children in South Africa should be assessed, to determine possible sedentary behavioural patterns, which may have a significant impact on the level of physical fitness for intellectually disabled children in South Africa.

A longer duration exercise programme should be implemented in future studies, to assess if this would result in more significant improvements in physical fitness levels of intellectually disabled children.

A balance-specific and/or strength training exercise intervention programme should be implemented in future studies and assessed for efficacy. Furthermore, an exercise intervention study that specifically looks at improving skill-related physical fitness components for intellectually disabled children should be undertaken in the future.

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APPENDIX

Appendix 1: Systematic Review

1A. Reporting Quality Assessment Tool

1. Is the hypothesis/aim/objective of the study clearly described?

Yes	1
No	0

2. Has the scientific background and rationale for the investigation been reported?

Yes	1
No	0

3. Have the key elements of study design been presented early in the paper?

Yes	1
No	0

4. Are the main outcomes to be measured clearly described in the Introduction or Methods section? If the main outcomes are first mentioned in the Results section, the question should be answered no.

Yes	1
No	0

5. Are the characteristics of the participant included in the study clearly described?

Yes	1
No	0

6. Are the interventions of interest clearly described?

Yes	1
No	0

7. Are the distributions of principal confounders in each group of subjects to be compared clearly described?

Yes	1
No	0

8. Has the setting, locations and relevant dates, including periods of recruitment, exposure, follow-up and data collection been described?

Yes	1
No	0

9. Have the main findings of the study clearly described? Simple outcome data should be reported for all major findings so that the reader can check the major analyses and conclusions. (This question does not cover statistical tests which are considered below).

Yes	1
No	0

10. Does the study provide estimates of the random variability in the data for the main outcomes? In non-normally distributed data the inter-quartile range of results should be reported. In normally distributed data the standard error, standard deviation or confidence intervals should be reported. If the distribution of the data is not described, it must be assumed that the estimates used were appropriate and the question should be answered yes.

Yes	1
No	0

11. Have all important adverse events that may be a consequence of the intervention and/or

limitations, taking into account sources of potential bias or imprecision, been addressed?

Yes	1
No	0

12. Have the characteristics of participants lost to follow-up been described? This should be answered yes where there were no losses to follow-up or where losses to follow-up were so small that findings would be unaffected by their inclusion. This should be answered no, where a study does not report the number of patients lost to follow-up.

Yes	1
No	0

13. Have actual probability values been reported (e.g.0.035 rather than <0.05) for the main outcomes except where the probability value is less than 0.001?

Yes	1
No	0

14. Has an overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence been reported?

Yes	1
No	0

15. Has the generalizability (external validity) of the study been discussed?

Yes	1
No	0

1B. Methodological Quality Assessment Tool

Sequence Generation:

Was the allocation sequence adequately generated? So were study participants adequately randomised to intervention groups? Studies which state that participants were randomised should be answered yes, such as using a computer random number generator, referring to a random number table, or pulling participants' names out of an envelope? Where method of randomisation would not ensure random allocation, such as sequence generated by some rule based on date or day of admission to the study, allocation the availability of the intervention, or alternate allocation would score no because it is predictable. Insufficient information about the sequence generation process to permit judgement of yes or no would be unable to determine.

Yes	1
No	0
Unable to determine	0

Allocation concealment:

Was the randomised intervention assignment concealed from both participant personnel until recruitment was complete and irrevocable? Was randomized intervention assignment adequately concealed? Yes if participants and investigators enrolling participants could not foresee assignment because of the following, or an equivalent method, was used to conceal allocation, such as sequentially numbered, opaque, sealed envelopes. No if participants or investigators enrolling participants could possibly foresee assignments and thus introduce selection bias, such as allocation based on; date of birth; case record number; or any other explicitly unconcealed procedure. Unable to determine is usually the case if the method of concealment was not described or not described in sufficient detail to allow a definite judgement.

Yes	1
No	0
Unable to determine	0

Blinding of personnel and/or outcome assessors:

Was an attempt made to blind those measuring the main outcomes of the intervention, then answer yes. However, yes was also answered if no blinding occurred, but the review authors judge that the outcome and the outcome measurement are not likely to be influenced by lack of blinding, or either participants or some key study personnel were not blinded, but outcome assessment was blinded and the non-blinding of others unlikely to introduce bias. Answered no if no blinding or incomplete blinding occurred, and the outcome or outcome measurement was likely to be influenced by lack of blinding. Unable to determine if insufficient information permit judgement for yes or no, or the study did not address this outcome.

Yes	1
No	0
Unable to determine	0

Statistics:

Were the statistical tests used to assess the main outcomes appropriate? The statistical techniques used must be appropriate to the data.

Yes	1
No	0
Unable to determine	0

Power:

Did the study have sufficient power to detect a clinically important effect where the probability value for a difference being due to chance is less than 5%?

Yes	1
No	0
Unable to determine	0

Incomplete Outcome Data:

Were the main outcome measures used accurate (valid and reliable)? For studies where the outcome measures were clearly described, the question should be answered yes. For studies which referred to other work or that demonstrated the outcome measures were accurate, the question should be answered as yes. Answer no if outcome data was missing and reason for missing outcome data likely to be related to true outcome, with either imbalance in numbers or reasons for missing data across intervention groups. Unable to determine if insufficient reporting of attrition/exclusions to permit judgement of yes or no (e.g. number randomized not stated, no reasons for missing data provided) or the study did not address this outcome.

Yes	1
No	0
Unable to determine	0

Selective Outcome Reporting:

Are reports of the study free of suggestion of selective outcome reporting? Yes if the study protocol was available and all of the study's pre-specified (primary and secondary) outcomes that were of interest in the review have been reported in the pre-specified way; or the study protocol was not available but it was clear that the published reports included all expected outcomes, including those that were pre-specified (convincing text of this nature may be uncommon). No if one or more reported primary outcomes were not pre-specified (unless clear justification for their reporting is provided, such as an unexpected adverse effect), or the study report failed to include results for a key outcome that would be expected to have been reported for such a study. Unable to determine if insufficient information to permit judgement of yes or no. It is likely that the majority of studies will fall into this category.

Yes	1
No	0
Unable to determine	0

Other Potential Threats to Validity:

Was the study apparently free of other problems that could put it at a risk of bias? Yes if the study appears to be free of other source of bias. No if there is at least one important risk of bias. For example, the study had a potential source of bias related to the specific study design used; or stopped early due to some data-dependent process (including a formal-stopping rule); or had extreme baseline imbalance; or has been claimed to have been fraudulent; or had some other problem. Unable to determine if there may be a risk of bias, due to insufficient information to assess whether an important risk of bias exists; or insufficient rationale or evidence that an identified problem will introduce bias.

Yes	1
No	0
Unable to determine	0

Appendix 2: Descriptive Study

2A. Ethics Documents

2A.1. Rhodes Ethical Clearance

RHODES UNIVERSITY
Where leaders learn

Rhodes University Ethical Standards Committee, Rhodes University, P O Box 94, Grahamstown, 6140
Tel: +27 46 603 7366 • Fax: +27 46 603 8934 • Email: ethics-committee@ru.ac.za

15-Jul-2016

Dear Samantha Parsons

Ethics Clearance: Assessing the level of physical fitness of intellectually disabled children in the Grahamstown region.

Principal Investigator: Samantha Parsons

This letter confirms that a research proposal with tracking number: RU-HSD-15-09-0003 and title: **Assessing the level of physical fitness of intellectually disabled children in the Grahamstown region.** was given ethics clearance by the Rhodes University Ethical Standards Committee.

Please ensure that the ethical standards committee is notified should any substantive change(s) be made, for whatever reason, during the research process. This includes changes in investigators. Please also ensure that a brief report is submitted to the ethics committee on completion of the research. The purpose of this report is to indicate whether or not the research was conducted successfully, if any aspects could not be completed, or if any problems arose that the ethical standards committee should be aware of. If a thesis or dissertation arising from this research is submitted to the library's electronic theses and dissertations (ETD) repository, please notify the committee of the date of submission and/or any reference or cataloguing number allocated.

Yours Sincerely,

Dr J. Marx: Chairperson RUESC.

Note:
1. This clearance is valid from the date on this letter to the time of completion of data collection.
2. The ethics committee cannot grant retrospective ethics clearance.
3. Progress reports should be submitted annually unless otherwise specified.

2.A.2. Department of Education Ethical Clearance

Province of the
EASTERN CAPE
EDUCATION

STRATEGIC PLANNING POLICY RESEARCH AND SECRETARIAT SERVICES
Steve Vukile Tshwete Complex • Zone 6 • Zwelitsha • Eastern Cape
Private Bag X0032 • Bhisho • 5605 • REPUBLIC OF SOUTH AFRICA
Tel: +27 (0)40 [illegible] • Fax: +27 (0)40 [illegible] • Website: [illegible]

Enquiries: NY Kanjana Email: nykanjana@live.co.za Date: 05 February 2016

Ms. Samantha Lee Parsons

Department of Human Kinetics and Ergonomics

Rhodes University

Grahamstown

6139

Dear Ms. Parsons

PERMISSION TO UNDERTAKE A MASTERS THESIS: ASSESSING THE PHYSICAL FITNESS DETRIMENTS OF INTELLECTUALLY DISABLED CHILDREN IN SOUTH AFRICA AND SUBSEQUENTLY DESIGNING AND EVALUATING THE EFFICACY OF AN EXERCISE INTERVENTION

1. Thank you for your application to conduct research.
2. Your application to conduct the above mentioned research in two selected schools under the jurisdiction of Grahamstown District of the Eastern Cape Department of Education (ECDoE) is hereby approved based on the following conditions:
   a. there will be no financial implications for the Department;
   b. institutions and respondents must not be identifiable in any way from the results of the investigation;
   c. you present a copy of the written approval letter of the Eastern Cape Department of Education (ECDoE) to the Cluster and District Directors before any research is undertaken at any institutions within that particular district;
   d. you will make all the arrangements concerning your research;
   e. the research may not be conducted during official contact time, as educators' programmes should not be interrupted.

building bricks for growth

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PGDP

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

g. the research may not be conducted during the fourth school term, except in cases where a special well motivated request is received;

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

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

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

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

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

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

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

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

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

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

NY KANJANA
DIRECTOR: STRATEGIC PLANNING POLICY RESEARCH & SECRETARIAT SERVICES

FOR SUPERINTENDENT-GENERAL: EDUCATION

2.A.3. Information to Schools

Dear [name of headmistress],

Thank you for showing interest for the Masters Research study titled: **Assessing the physical fitness detriments of intellectually disabled children in the Grahamstown region.** This letter will inform you of the purpose of the study, the protocol and equipment to be used as well as any benefits and/or risks that a child in your school may be exposed to. Please ensure that you read everything carefully before signing.

Purpose of study

The overall purpose of my Masters study is to develop and assess a physical exercise programme for children with intellectual disabilities. In order to do so I need to determine where these children's strengths and limitations lie. Since there is currently no research or data available for the level of physical fitness of intellectually disabled children in South Africa, this first phase of the study is aimed at acquiring a better understanding of the level of physical fitness of intellectually disabled children. This will be achieved by measuring and assessing eleven components of health- and skills-related physical fitness in a sample group of intellectually disabled children and compare their results to those from a sample of able-bodied children. The objective is be to use these results in conjunction with the literature to subsequently inform the development of an exercise intervention programme, which will form the second phase of this Masters study.

Protocol:

Eleven physical fitness components will be tested in this study. Physical fitness can be divided into two sub-classes, which are health-related and skill-related physical fitness. The health-related physical fitness components consist of cardiorespiratory endurance, muscular endurance, muscular strength, body composition and flexibility. The skills-related components are balance, agility, speed, power, coordination and reaction time (Caspersen, Powell, & Christenson, 1985; Rice & Howell, 2000). All of the tests that have been chosen to test these components are the most suitable, reliable and feasible test items to assess children of 10-12 years of age living with and without intellectual disability (Davis et al., 2011; Winnick & Short, 2014). The following tests will be administered:

1. 15m PACER test to test cardio-respiratory endurance
2. Modified curl-up test to test muscular endurance
3. Dominant grip strength test to test muscular strength
4. Sum of skinfold (Triceps and Calf) to test body fat
5. Back saver sit and reach test to test flexibility
6. Single leg stance test to test balance
7. 505 agility test to test agility
8. 50m sprint test to test speed
9. Standing broad jump to test power
10. Block and box test to test coordination
11. Fitts' simple reaction time computer based test to test reaction time

Risk and Benefits

There are several benefits to the first phase of this Masters project. Firstly, there are community based benefits, which include the feedback provided to the department of education, the school and parents/guardians. The results will help identify areas of weakness and strength in your students' level of physical fitness. These results will then be used to design a fun and effective physical fitness program for the intellectually disabled children, which will be implemented next year at a Special Needs School to improve the children with intellectually disability's level of fitness. Secondly, the individual benefits of the study will be the student's experience of participating in physical fitness activities. Your students will gain a better understanding of what physical fitness is and why it is so important. There will be learning outside the class room, which is always a fun and positive experience.

There are, however, also risks associated with this study which are physical and emotional in nature. The risks your students will be exposed however do not exceed the day-to-day risks of playing outside. There is risk of injury whilst performing the certain tests, which could include muscle strain, falling, grazing, possible sprain or fracture of the wrist or ankle. There is also the risk of Delayed Onset of Muscle Soreness (DOMS), which manifests itself as feeling of 'stiffness' and 'soreness' for 3-4 days after unaccustomed exercise, as well as just general feelings of fatigue while performing the tests which will pass quickly. These risks have been minimized through rigid test selection criteria and most adverse events to that may occur are reversible. The Children Physical Activity Readiness Questionnaire will be used to screen the participants and exclude any participants with any health detriments, who would be at an increased risk due to certain health issues. Participants that have had the flu in the week before testing, who have asthma, or who have suffered from an injury will be excluded from this study, as they are at greater risk. The researcher is a certified Level 1 first aider and will be able to deal with minor injuries, but a doctor will be on call in the unlikely event of a more serious emergency.

Privacy, Anonymity and Confidentiality

Be assured that your student's privacy and anonymity will be protected at all times. This is achieved through the use of participant codes and data published will only include the summary results of the group and not individual results. You will have the option to withdraw your students' participation at any time. Furthermore, your students will also have the right to not partake or pull out of the study, without any negative consequences.

Thank you again for your time and willingness for your students to participate in this study. If you require any additional information feel free to contact me.

Yours sincerely,

Samantha Lee Parsons

(Master student at the Human Kinetics and Ergonomics Department)

Samantha.parsons55@yahoo.com

Tel: 0844263823

2.A.4. School Consent

I, …………………………………………… (Headmistress) have been fully informed of the research project entitled; **Assessing the physical fitness detriments of intellectually disabled children in the Grahamstown region.**

I am fully aware of the nature of the research and procedures involved as well as the potential risks and benefits attendant to my students' participation as explained to me verbally and in writing. I am aware that I may withdraw my consent and may withdraw my students from participation in the research at any time without negative consequences. The researcher may / may not (circle applicable) use school grounds if necessary for familiarization and testing sessions. I am aware that my student's anonymity will be protected at all times, as well as the schools' anonymity. I have read the information sheet accompanying this form and understand it. Any questions which may have occurred to me have been answered to my satisfaction.

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

HEADMISTRESS PROVIDING CONSENT:

____________________	____________________	____________________
(Print Name)	(Signed)	(Date)

WITNESS:

____________________	____________________	____________________
(Print Name)	(Signed)	(Date)

PRINCIPAL RESEARCHER:

____________________	____________________	____________________
(Print Name)	(Signed)	(Date)

2.A.5. Information to Parents

Dear Parent/Guardian

Thank you for showing interest for the Masters Research study titled: **Assessing the physical fitness detriments of intellectually disabled children in the Grahamstown region.** This letter will inform you of the purpose of the study, the protocol and equipment to be used as well as any benefits and/or risks that your child may be exposed to. Also attached to this document is the Children Physical Activity Readiness Questionnaire and Health Screening Consent Form, which will have to be signed prior to commencing with testing. Please ensure that you read everything carefully before signing.

Purpose of study

The overall purpose of my Masters study is to develop and assess a physical exercise programme for children with intellectual disabilities. In order to do so I need to determine where these children's strengths and limitations lie. Since there is currently no research or data available for the level of physical fitness of intellectually disabled children in South Africa, this first phase of the study is aimed at acquiring a better understanding of the level of physical fitness of intellectually disabled children. This will be achieved by measuring and assessing eleven components of health- and skills-related physical fitness in a sample group of intellectually disabled children and compare their results to those from a sample of able-bodied children. The objective is be to use these results in conjunction with the literature to subsequently inform the development of an exercise intervention programme, which will form the second phase of this Masters study.

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1. 15m PACER test to test cardio-respiratory endurance
2. Modified curl-up test to test muscular endurance
3. Dominant grip strength test to test muscular strength
4. Sum of skinfold (Triceps and Calf) to test body fat
5. Back saver sit and reach test to test flexibility
6. Single leg stance test to test balance
7. 505 agility test to test agility
8. 50m sprint test to test speed
9. Standing broad jump to test power
10. Block and box test to test coordination
11. Fitts' simple reaction time computer based test to test reaction time

Risk and Benefits

There are several benefits to the first phase of this Masters project. Firstly, there are community based benefits, which include the feedback provided to the department of health, the school and you as parents/guardians. The results will help identify areas of weakness and strength in your child's level of physical fitness. These results will then be used to design a fun and effective physical fitness program for the intellectually disabled children, which will be implemented next year at Kuyasa Special Needs School to improve your child's level of fitness. Secondly, the individual benefits of the study will be the child's experience of participating in physical fitness activities. Your child will gain a better understanding of what physical fitness is and why it is so important. There will be learning outside the class room, which is always a fun and positive experience.

There are, however, also risks associated with this study which are physical and emotional in nature. The risks your children will be exposed to however do not exceed the day-to-day risks of playing outside. There is risk of injury whilst performing the certain tests, which could include muscle strain, falling, grazing, possible sprain or fracture of the wrist or ankle. There is also the risk of Delayed Onset of Muscle Soreness (DOMS), which manifests itself as feeling of 'stiffness' and 'soreness' for 3-

4 days after unaccustomed exercise, as well as just general feelings of fatigue while performing the tests which will pass quickly. These risks have been minimized through rigid test selection criteria and most adverse events to that may occur are reversible. The Children Physical Activity Readiness Questionnaire will be used to screen the participants and exclude any participants with any health detriments, who would be at an increased risk due to certain health issues. Participants that have had the flu in the week before testing, who have asthma, or who have suffered from an injury will be excluded from this study, as they are at greater risk. The researcher is a certified Level 1 first aider and will be able to deal with minor injuries, but a doctor will be on call in the unlikely event of a more serious emergency.

Privacy, Anonymity and Confidentiality

Be assured that your child's privacy and anonymity will be protected at all times. This is achieved through the use of participant codes and data published will only include the summary results of the group and not individual results. You will have the option to withdraw your child's participation at any time. Furthermore, your child will also have the right to not partake or pull out of the study, without any negative consequences. With your consent, photographs may be taken of your child, purely to use for illustrative purposes in the thesis, but all identifying features will be obscured to ensure anonymity.

Thank you again for your time and willingness for your child to participate in this study. If you require any additional information feel free to contact me.

Yours sincerely,

Samantha Lee Parsons

(Master student at the Human Kinetics and Ergonomics Department)

Samantha.parsons55@yahoo.com

Tel: 0844263823

2.A.6. Children PAR Q & Consent Form

The purpose of this questionnaire is to ensure that we provide every participant with the highest level of care, since there are a small number of children who may be at increased risk when participating in an exercise / physical activity session. This questionnaire was adapted from the American College of Sports and Medicine (2006) Standards and Guidelines. Completion of this questionnaire is mandatory and your child cannot participate in any of the studies testing sessions until it has been submitted.

Child's name:	**Child's date of birth:**
Child's sex: Female / Male	**Current age of child:**
Emergency contact details:	
Parent/Guardian's name:	
Tel work:	**Tel mobile:**

Health Questionnaire

Does your child have or has he or she ever experienced any of the following? Please circle correct answer.

High or Low blood pressure	Yes	No
Elevated blood cholesterol	Yes	No
Diabetes	Yes	No
Chest pains brought on by physical exertion	Yes	No
Childhood epilepsy	Yes	No
Dizziness or fainting	Yes	No
A bone, joint or muscular problems	Yes	No
Asthma or respiratory problems	Yes	No
Any sustained injuries or illness	Yes	No
Any allergies	Yes	No
Is your child taking any medication	Yes	No
Has your doctor ever advised your child to exercise	Yes	No
Is there any reason not mentioned above why physical activity may not be suitable for your child	Yes	No

If the answer is ‘YES’ to any of the above questions please give full details here:

Is there anything else we should know about your child that has not yet been addressed in the health questionnaire?

If your child has allergies, has the instructor in charge of the sessions been made aware of medication the child is taking and if necessary where to find it?

In the absence of a parent / guardian, I understand that my child will be monitored by the researcher and/or research assistants throughout any activity, and should any unusual symptoms occur, the child will be asked to ease participation.

In the event that medical clearance must be obtained before my child’s participation in an exercise session, I agree to contact the GP and obtain written permission prior to the commencement of the exercise session, and the permission will be given to the instructor.

I understand that if my child behaves in a manner that is a risk to him/herself or any of the other children, then my child may not continue and could be suspended from that particular activity.

Human Kinetics and Ergonomics Department

INFORMED CONSENT AND INDEMNITY

For research involving human participants

I, …………………………………………… (Parent/Guardian) have been fully informed of the research project entitled; **Assessing the physical fitness detriments of intellectually disabled children in the Grahamstown region.**

I am fully aware of the nature of the research and procedures involved as well as the potential risks and benefits attendant to my child's participation as explained to me verbally and in writing. By consenting to my child's participation in this research I accept joint responsibility together with the Human Kinetics and Ergonomics Department, should the injury sustained be as a result of the experimental protocol. The Department will, however, waiver any legal recourse against the researcher or Rhodes University in the event the injury is self-inflicted, due to negligence or non-compliance of the participant with the researcher's instructions, or is in any other way not related directly to the study itself.

I am aware that I may withdraw my consent and may withdraw my child from participation in the research at any time without negative consequences. The researcher may / may not (circle applicable) take photographs of my child for illustrative purposes for her thesis. I am however aware that my child's anonymity will be protected at all times, and agree that the information collected may be used and published for statistical or scientific purposes.

I have read the information sheet accompanying this form and understand it. Any questions which may have occurred to me have been answered to my satisfaction.

PARENT/GUARDIAN PROVIDING CONSENT:

____________________	____________________	____________________
(Print Name)	(Signed)	(Date)

WITNESS:

______________________	____________________	_________________
(Print Name)	(Signed)	(Date)

PRINCIPAL RESEARCHER:

______________________	____________________	_________________
(Print Name)	(Signed)	(Date)

2B. Independent t-test results

Variable	T-tests; Grouping: Disability Status (Descriptive Study - Collective Data) Group 1: ID Group 2: TD									
	Mean ID	Mean TD	t-value	df	p	Valid N ID	Valid N TD	Std.Dev. ID	Std.Dev. TD	F-ratio Variances	p Variances
PACER (15m-laps)	19,75862	26,7600	-1,76966	52	0,082647	29	25	12,63684	16,40193	1,68466	0,185295
Modified Curl-Up (#completed)	18,79310	38,7200	-8,58223	52	0,000000	29	25	7,25741	9,76610	1,81084	0,132180
Grip Strength (kg)	13,78161	21,5867	-4,42630	52	0,000049	29	25	5,92163	7,03844	1,41277	0,377888
Triceps and Calf Skinfold (mm)	17,90897	27,8208	-3,35410	52	0,001492	29	25	8,32405	13,16039	2,49959	0,021210
Sit-and-Reach (cm)	42,05000	42,9532	-0,53631	52	0,594032	29	25	5,99582	6,36885	1,12830	0,753195
Single Leg Stance (sec)	17,07828	27,1824	-4,37737	52	0,000058	29	25	10,37994	5,41210	3,67839	0,001827
505 Agility (sec)	3,82552	3,5743	1,46126	52	0,149961	29	25	0,63965	0,61859	1,06922	0,874302
50m Sprint (sec)	11,61310	9,3400	4,85946	52	0,000011	29	25	1,86726	1,51566	1,51777	0,302501
Standing Board Jump (cm)	87,40402	134,1720	-5,01700	52	0,000006	29	25	39,19245	27,12481	2,08772	0,070852
Block and Box (#transfer)	35,75862	48,8600	-6,47919	52	0,000000	29	25	9,06290	4,80781	3,55337	0,002367
Fitts' Simple Reaction (sec)	0,48745	0,3312	3,83071	52	0,000346	29	25	0,19688	0,05635	12,20775	0,000000

Appendix 3: Intervention Study

3A. Ethics Documents

3A.1. Ethical Clearance

RHODES UNIVERSITY
Where leaders learn

Rhodes University Ethical Standards Committee, Rhodes University, P O Box 94, Grahamstown, 6140
Tel: +27 46 603 7366 • Fax: +27 46 603 8934 • Email: ethics-committee@ru.ac.za

17-Aug-2016

Dear Samantha Parsons

Ethics Clearance: Implementing and evaluating the efficacy of an exercise intervention for intellectually disabled children in South Africa.

Principal Investigator: Samantha Parsons

This letter confirms that a research proposal with tracking number: RU-HSD-16-05-0019 and title: **Implementing and evaluating the efficacy of an exercise intervention for intellectually disabled children in South Africa.** was given ethics clearance by the Rhodes University Ethical Standards Committee.

All stipulations have been met.

Please ensure that the ethical standards committee is notified should any substantive change(s) be made, for whatever reason, during the research process. This includes changes in investigators. Please also ensure that a brief report is submitted to the ethics committee on completion of the research. The purpose of this report is to indicate whether or not the research was conducted successfully, if any aspects could not be completed, or if any problems arose that the ethical standards committee should be aware of. If a thesis or dissertation arising from this research is submitted to the library's electronic theses and dissertations (ETD) repository, please notify the committee of the date of submission and/or any reference or cataloguing number allocated.

Yours Sincerely,

Dr J. Marx: Chairperson RUESC.

Note:
1. This clearance is valid from the date on this letter to the time of completion of data collection.
2. The ethics committee cannot grant retrospective ethics clearance.
3. Progress reports should be submitted annually unless otherwise specified.

3A.2. Information to School

Dear [name of headmistress],

Thank you for showing interest for the Masters Research study titled: **Implementing and evaluating the efficacy of an exercise intervention for Intellectually Disabled children in the Grahamstown region.** This letter will inform you of the purpose of the study, the protocol and equipment to be used as well as any benefits and/or risks that your students may be exposed to. Please ensure that you read everything carefully before signing.

Purpose of study

This study constitutes the second phase for my thesis, and will follow on from the study that was conducted earlier this year. The aim of this phase is to implement and evaluate an exercise intervention of eight weeks. This means that a selected group of children from your school will be exposed to fun exercises and games. The children participating in this study will need to be intellectually disabled and in the middle level class and range from ages 10 to 12 years old. Children with subsequent physical disabilities will not be allowed to participate in the exercise program but will be allowed to join in on the fun games and arts and crafts in the classrooms, as to not socially exclude them.

The exercise intervention will focus on improving three components of physical fitness, namely balance, muscular endurance and power. These components have emerged from the first phase of the overall project as being significantly poorer, compared to their typically developed peers and as also having significant correlations with other fitness components that were found to be significantly poorer amongst the intellectually disabled children.

Protocol:

The intervention will happen during the third term of school. Before the exercise intervention begins, the children will be allocated into groups: the exercise intervention group and the control group. Both of these groups will be evaluated for general physical fitness, before the exercise program begins. The eleven physical fitness components will be assessed, as they were in study 1, namely via the PACER test, modified curl-up test, dominant grip strength test, sum of skinfold, back-saver sit and reach test, single leg stance test, 505 agility test, 50m sprint test, standing broad jump test, block and box test, and the Fitts' simple reaction time computer based test.

Once these tests are complete, the exercise intervention group will undergo the exercise training program, while the control group will be in a classroom playing fun board games and arts and crafts activities. Having a control group that is not exposed to the exercise program is common practice in intervention studies and necessary to maintain the validity of this study. Upon completion of the study, the children in the control group will then be offered the same fun exercises of the training program, so that they too may gain the anticipated benefits of this training programme.

The exercise training program will entail four sessions a week, for 40 minutes per session. As the intervention progresses, the intensity or difficulty of the exercises will increase. After eight weeks of the intervention, all (both the control and intervention group) participants' physical fitness will be evaluated for the second time. The completion of the second measurements will mean the intervention has finished.

Risk and Benefits

There are several benefits to the Second phase of this Masters project. Firstly, there are community based benefits, which include the feedback provided to the Department of Health, the school and parents/guardians. The results will help identify if implementing this exercise program at a school level is effective and will benefit the children's level of physical fitness and health. Secondly, the individual benefits of the study will be the students' experience of participating in physical fitness activities. Your students will gain a better understanding of what physical fitness is and why it is so important. There will be learning outside the class room, which is a fun and positive experience and may even have a beneficial effect on learning activities in the classroom.

There are, however, also risks associated with this study which are physical and emotional in nature. The risks your students will be exposed however do not exceed the day-to-day risks of playing outside. There is risk of injury whilst performing the certain tests, which could include muscle strain, falling, grazing, possible sprain or fracture of the wrist or ankle. There is also the risk of Delayed Onset of Muscle

Soreness (DOMS), which manifests itself as feeling of ‘stiffness’ and ‘soreness’ for 3-4 days after unaccustomed exercise, as well as just general feelings of fatigue while performing the exercises/tests which will pass quickly. These risks have been minimized through rigid test selection criteria and most adverse events to that may occur are reversible. Experiences from the first phase of this project also confirm that the tests conducted are suitable for Children with Intellectual Disabilities. The Children Physical Activity Readiness Questionnaire will be used to screen the participants and exclude any participants with any health detriments, who would be at an increased risk due to certain health issues. Participants who have had the flu in the week before testing, who have asthma, or who have suffers from an injury will be excluded from this study, as they are at greater risk. The researcher is a certified Level 1 first aider and will be able to deal with minor injuries, but a doctor will be on call in the unlikely event of a more serious emergency.

Privacy, Anonymity and Confidentiality

Be assured that your school’s name will remain anonymous and that your learners’ privacy and anonymity will also be protected at all times. This is achieved through the use of participant codes, and data published will only include the summary results of the group and not individual results. You will have the option to withdraw your students’ participation at any time. Furthermore, your pupils will also have the right to not partake or pull out of the study, without any negative consequences.

Thank you again for your time and willingness for your students to participate in this study. If you require any additional information feel free to contact me.

Yours sincerely,

Samantha Lee Parsons

(Master student at the Human Kinetics and Ergonomics department)

Samantha.parsons55@yahoo.com

3A.3. School Consent

I, …………………………………………… (Headmistress) have been fully informed of the research project entitled; **Implementing and evaluating the efficacy of an exercise intervention for Intellectually Disabled children in the Grahamstown region.**

I am fully aware of the nature of the research and procedures involved as well as the potential risks and benefits attendant to my students' participation as explained to me verbally and in writing. I am aware that I may withdraw my consent and may withdraw my students from participation in the research at any time without negative consequences. The researcher may / may not (circle applicable) use school grounds if necessary for familiarization and testing sessions. I am aware that my student's anonymity will be protected at all times, as well as the schools' anonymity. I have read the information sheet accompanying this form and understand it. Any questions which may have occurred to me have been answered to my satisfaction.

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

HEADMISTRESS PROVIDING CONSENT:

____________________	____________________	____________________
(Print Name)	(Signed)	(Date)

WITNESS:

____________________	____________________	____________________
(Print Name)	(Signed)	(Date)

PRINCIPAL RESEARCHER:

____________________	____________________	____________________
(Print Name)	(Signed)	(Date)

3A.4. Information to Parents

Dear Parents/Guardians,

Thank you for showing interest for the Masters Research study titled: **Implementing and evaluating the efficacy of an exercise intervention for Intellectually Disabled children in the Grahamstown region.** This letter will inform you of the purpose of the study, the protocol and equipment to be used as well as any benefits and/or risks that your child may be exposed to. Please ensure that you read everything carefully before signing.

Purpose of study

This study constitutes the second phase for my thesis, and will follow on from the study that was conducted earlier this year. The aim of this phase is to implement and evaluate an exercise intervention of eight weeks. This means that a selected group of children from your child's school will be exposed to fun exercises and games. Children with physical disabilities will not participate in the exercise program but will be allowed to join in on the fun games and arts and crafts in the classrooms, as to not socially exclude them.

The exercise intervention will focus on improving three components of physical fitness, namely balance, muscular endurance and power. These components have emerged from the first phase of the overall project as being significantly poorer, compared to their typically developed peers and as also having significant correlations with other fitness components that were found to be significantly poorer amongst the intellectually disabled children.

Protocol:

The intervention will happen during the third term of school. Before the exercise intervention begins, the children will be allocated into groups: the exercise intervention group and the control group. Both of these groups will be evaluated for general physical fitness, before the exercise program begins. The eleven physical fitness components will be assessed, as they were in study 1, namely via the PACER test, modified curl-up test, dominant grip strength test, sum of skinfold, back-saver sit and reach test, single leg stance test, 505 agility test, 50m sprint test, standing broad jump test, block and box test, and the Fitts' simple reaction time computer based test.

Once these tests are complete, the exercise intervention group will undergo the exercise training program, while the control group will be in a classroom playing fun board games and arts and crafts activities. Having a control group that is not exposed to the exercise program is common practice in intervention studies and necessary to maintain the validity of this study. Upon completion of the study, the children in the control group will then be offered the same fun exercises of the training program, so that they too may gain the anticipated benefits of this training programme.

The exercise training program will entail four sessions a week, for 40 minutes per session. As the intervention progresses, the intensity or difficulty of the exercises will increase. After eight weeks of the intervention, all (both the control and intervention group) participants' physical fitness will be evaluated for the second time. The completion of the second measurements will mean the intervention has finished.

Risk and Benefits

There are several benefits to the Second phase of this Masters project. Firstly, there are community based benefits, which include the feedback provided to the Department of Health, the school and parents/guardians. The results will help identify if implementing this exercise program at a school level is effective and will benefit the children's level of physical fitness and health. Secondly, the individual benefits of the study will be the children's experience of participating in physical fitness activities. Your child will gain a better understanding of what physical fitness is and why it is so important. There will be learning outside the class room, which is a fun and positive experience and may even have a beneficial effect on learning activities in the classroom.

There are, however, also risks associated with this study which are physical and emotional in nature. The risks your child will be exposed however do not exceed the day-to-day risks of playing outside. There is risk of injury whilst performing the certain tests, which could include muscle strain, falling, grazing, possible sprain or fracture of the wrist or ankle. There is also the risk of Delayed Onset of Muscle Soreness (DOMS), which manifests itself as feeling of 'stiffness' and 'soreness' for 3-4 days after unaccustomed exercise, as well as just general feelings of fatigue while performing the exercises/tests which will pass quickly. These risks have been minimized through rigid test selection criteria and most adverse events to that may occur are reversible. Experiences from the first phase of this project also confirm that the tests conducted are suitable for Children with Intellectual Disabilities. The Children Physical Activity Readiness Questionnaire will be used to screen the participants and exclude any participants with any health detriments, who would be at an increased risk due to certain health issues. Participants who have had the flu in the week before testing, who have asthma, or who have suffers from an injury will be excluded from this study, as they are at greater risk. The researcher is a certified Level 1 first aider and will be able to deal with minor injuries, but a doctor will be on call in the unlikely event of a more serious emergency.

Privacy, Anonymity and Confidentiality

Be assured that your child's privacy and anonymity will be protected at all times. This is achieved through the use of participant codes, and data published will only include the summary results of the group and not individual results. You will have the option to withdraw your child's participation at any time. Furthermore, your child will also have the right to not partake or pull out of the study, without any negative consequences.

Thank you again for your time and willingness for your child to participate in this study. If you require any additional information feel free to contact me.

Yours sincerely,

Samantha Lee Parsons

(Master student at the Human Kinetics and Ergonomics department)

Samantha.parsons55@yahoo.com

Tel: 0844263823

3A.5. Children PAR Q & Consent Form

The purpose of this questionnaire is to ensure that we provide every participant with the highest level of care, since there are a small number of children who may be at increased risk when participating in an exercise / physical activity session. This questionnaire was adapted from the American College of Sports and Medicine (2006) Standards and Guideline. Completion of this questionnaire is mandatory and your child cannot participate in any of the studies testing sessions until it has been submitted.

Child's name:	**Child's date of birth:**
Child's sex: Female / Male	**Current age of child:**
Emergency contact details:	
Parent/Guardian's name:	
Tel work:	**Tel mobile:**

Health Questionnaire

Does your child have or has he or she ever experienced any of the following? Please circle correct answer.

High or Low blood pressure	Yes	No
Elevated blood cholesterol	Yes	No
Diabetes	Yes	No
Chest pains brought on by physical exertion	Yes	No
Childhood epilepsy	Yes	No
Dizziness or fainting	Yes	No
A bone, joint or muscular problems	Yes	No
Asthma or respiratory problems	Yes	No
Any sustained injuries or illness	Yes	No
Any allergies	Yes	No
Is your child taking any medication	Yes	No
Has your doctor ever advised your child to exercise	Yes	No
Is there any reason not mentioned above why physical activity may not be suitable for your child	Yes	No

If the answer is ‘YES’ to any of the above questions please give full details here:

Is there anything else we should know about your child that has not yet been addressed in the health questionnaire?

If your child has allergies, has the instructor in charge of the sessions been made aware of medication the child is taking and if necessary where to find it?

In the absence of a parent / guardian, I understand that my child will be monitored by the researcher and/or research assistants throughout any activity, and should any unusual symptoms occur, the child will be asked to ease participation.

In the event that medical clearance must be obtained before my child’s participation in an exercise session, I agree to contact the GP and obtain written permission prior to the commencement of the exercise session, and the permission is given to the instructor.

I understand that if my child behaves in a manner that is a risk to him/herself or any of the other children, then they may not continue and could be suspended from that particular activity.

Human Kinetics and Ergonomics Department

INFORMED CONSENT AND INDEMNITY

For research involving human participants

I, …………………………………………… (Parent/Guardian) have been fully informed of the research project entitled; **Implementing and evaluating the efficacy of an exercise intervention for Intellectually Disabled children in the Grahamstown region.**

I have read the information sheet and understand the testing procedure that will take place for my child. All testing procedures associated risks and the benefits from my child partaking in this study have been explained to me in writing. I have had ample opportunity to ask questions and to clarify any concerns or misunderstandings. I am satisfied that these have been answered satisfactorily. I understand that all data collected for publication purposes will be kept anonymous and all information gained in this regard will be treated confidentially. Furthermore, I consent to photographs of my child being taken, knowing that these will be altered to ensure my child's anonymity. I understand that I am able to withdraw my child's consent from the study at any point, irrespective of external influences placed on me by the researcher.

In agreeing to allow my child to participate in this research study I waive any legal recourse against the researchers from the Department of Human Kinetics and Ergonomics (HKE), Rhodes University, from claims resulting from personal injuries of my child sustained whilst participating in the above mentioned research. I am aware and fully understand that the Department of Human Kinetics and Ergonomics is not responsible for my child's injuries due my child's personal negligence and non-compliance with instructions. This waiver shall be binding upon my heirs and personal representatives.

I have read and understood the above information, as well as the information provided in the letter accompanying this form. I therefore consent that my child voluntarily can participate in this research project.

PARENT/GUARDIAN PROVIDING CONSENT:

____________________	__________________	________________
(Print Name)	(Signed)	(Date)

WITNESS:

____________________	__________________	________________
(Print Name)	(Signed)	(Date)

PRINCIPAL RESEARCHER:

____________________	__________________	________________
(Print Name)	(Signed)	(Date)

3B. Statistical Tables

3B.1. Repeated measure analysis of variance

PACER

Repeated Measures Analysis of Variance (Control & Intervention - Pre & Post)
Sigma-restricted parameterization
Effective hypothesis decomposition; Std. Error of Estimate: 14,7999

Effect	SS	Degr. of Freedom	MS	F	p
Intercept	21805,66	1	21805,66	99,55219	0,000000
Sample	1161,33	1	1161,33	5,30199	0,028671
Error	6352,09	29	219,04		
PRE-POST	116,92	1	116,92	5,84159	0,022170
PRE-POST*Sample	358,92	1	358,92	17,93251	0,000211
Error	580,44	29	20,02		

Modified curl-ups

Repeated Measures Analysis of Variance (Control & Intervention - Pre & Post)
Sigma-restricted parameterization
Effective hypothesis decomposition; Std. Error of Estimate: 5,9733

Effect	SS	Degr. of Freedom	MS	F	p
Intercept	26341,45	1	26341,45	738,2539	0,000000
Sample	29,45	1	29,45	0,8254	0,371087
Error	1034,74	29	35,68		
PRE-POST	119,59	1	119,59	12,3714	0,001457
PRE-POST*Sample	52,76	1	52,76	5,4573	0,026608
Error	280,34	29	9,67		

Dominant grip strength

Repeated Measures Analysis of Variance (Control & Intervention - Pre & Post)
Sigma-restricted parameterization
Effective hypothesis decomposition; Std. Error of Estimate: 5,7723

Effect	SS	Degr. of Freedom	MS	F	p
Intercept	11744,54	1	11744,54	352,4865	0,000000
Sample	0,00	1	0,00	0,0000	0,999288
Error	966,25	29	33,32		
PRE-POST	47,53	1	47,53	12,9182	0,001189
PRE-POST*Sample	21,84	1	21,84	5,9353	0,021215
Error	106,70	29	3,68		

Triceps & calf skinfolds

Repeated Measures Analysis of Variance (Control & Intervention - Pre & Post)
Sigma-restricted parameterization
Effective hypothesis decomposition; Std. Error of Estimate: 8,3268

Effect	SS	Degr. of Freedom	MS	F	p
Intercept	18703,17	1	18703,17	269,7460	0,000000
Sample	218,86	1	218,86	3,1564	0,086121
Error	2010,75	29	69,34		
PRE-POST	0,16	1	0,16	0,0201	0,888370
PRE-POST*Sample	16,71	1	16,71	2,1261	0,155557
Error	227,89	29	7,86		

Back-saver sit-and-reach

Repeated Measures Analysis of Variance (Control & Intervention - Pre & Post)
Sigma-restricted parameterization
Effective hypothesis decomposition; Std. Error of Estimate: 10,0363

Effect	SS	Degr. of Freedom	MS	F	p
Intercept	23609,00	1	23609,00	234,3867	0,000000
Sample	50,80	1	50,80	0,5044	0,483262
Error	2921,07	29	100,73		
PRE-POST	39,85	1	39,85	5,3141	0,028503
PRE-POST*Sample	38,05	1	38,05	5,0740	0,032026
Error	217,47	29	7,50		

Single leg stance

Repeated Measures Analysis of Variance (Control & Intervention - Pre & Post)
Sigma-restricted parameterization
Effective hypothesis decomposition; Std. Error of Estimate: 12,9005

Effect	SS	Degr. of Freedom	MS	F	p
Intercept	19412,84	1	19412,84	116,6479	0,000000
Sample	737,96	1	737,96	4,4342	0,043999
Error	4826,25	29	166,42		
PRE-POST	143,63	1	143,63	4,1889	0,049849
PRE-POST*Sample	90,96	1	90,96	2,6527	0,114194
Error	994,37	29	34,29		

505 agility

Repeated Measures Analysis of Variance (Control & Intervention - Pre & Post)
Sigma-restricted parameterization
Effective hypothesis decomposition; Std. Error of Estimate: 0,8273

Effect	SS	Degr. of Freedom	MS	F	p
Intercept	1047,729	1	1047,729	1530,815	0,000000
Sample	0,004	1	0,004	0,007	0,936240
Error	19,848	29	0,684		
PRE-POST	8,264	1	8,264	24,465	0,000029
PRE-POST*Sample	0,834	1	0,834	2,470	0,126893
Error	9,796	29	0,338		

50m sprint

Repeated Measures Analysis of Variance (Control & Intervention - Pre & Post)
Sigma-restricted parameterization
Effective hypothesis decomposition; Std. Error of Estimate: 3,6139

Effect	SS	Degr. of Freedom	MS	F	p
Intercept	8484,403	1	8484,403	649,6343	0,000000
Sample	0,689	1	0,689	0,0528	0,819885
Error	378,748	29	13,060		
PRE-POST	62,976	1	62,976	6,0199	0,020392
PRE-POST*Sample	14,611	1	14,611	1,3967	0,246884
Error	303,375	29	10,461		

Standing broad jump

Repeated Measures Analysis of Variance (Control & Intervention - Pre & Post)
Sigma-restricted parameterization
Effective hypothesis decomposition; Std. Error of Estimate: 30,5093

Effect	SS	Degr. of Freedom	MS	F	p
Intercept	637071,6	1	637071,6	684,4200	0,000000
Sample	10996,4	1	10996,4	11,8136	0,001798
Error	26993,8	29	930,8		
PRE-POST	7544,8	1	7544,8	88,6626	0,000000
PRE-POST*Sample	3705,4	1	3705,4	43,5447	0,000000
Error	2467,8	29	85,1		

Block and box

Repeated Measures Analysis of Variance (Control & Intervention - Pre & Post)
Sigma-restricted parameterization
Effective hypothesis decomposition; Std. Error of Estimate: 11,9004

Effect	SS	Degr. of Freedom	MS	F	p
Intercept	78811,83	1	78811,83	556,5036	0,000000
Sample	173,12	1	173,12	1,2224	0,277973
Error	4106,97	29	141,62		
PRE-POST	265,87	1	265,87	7,3587	0,011108
PRE-POST*Sample	4,58	1	4,58	0,1267	0,724445
Error	1047,77	29	36,13		

Fitts' simple reaction time

Repeated Measures Analysis of Variance (Control & Intervention - Pre & Post)
Sigma-restricted parameterization
Effective hypothesis decomposition; Std. Error of Estimate: 0,1535

Effect	SS	Degr. of Freedom	MS	F	p
Intercept	12,16844	1	12,16844	516,5910	0,000000
Sample	0,00418	1	0,00418	0,1776	0,676583
Error	0,68310	29	0,02356		
PRE-POST	0,00922	1	0,00922	1,1188	0,298915
PRE-POST*Sample	0,01101	1	0,01101	1,3363	0,257122
Error	0,23891	29	0,00824		

3B.2. Repeated measures analysis with effect size

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Repeated Measures Analysis of Variance with Effect Sizes and Powers (Control & Intervention - Pre & Post)
Sigma-restricted parameterization
Effective hypothesis decomposition

Effect	SS	Degr. of Freedom	MS	F	p	Partial eta-squared	Non-centrality	Observed power (alpha=0,05)
Intercept	21805,66	1	21805,66	99,55219	0,000000	0,774411	99,55219	1,000000
Sample	1161,33	1	1161,33	5,30199	0,028671	0,154568	5,30199	0,604877
Error	6352,09	29	219,04					
PRE-POST	116,92	1	116,92	5,84159	0,022170	0,167661	5,84159	0,646692
PRE-POST*Sample	358,92	1	358,92	17,93251	0,000211	0,382091	17,93251	0,983445
Error	580,44	29	20,02					

Modified curl-ups

Repeated Measures Analysis of Variance with Effect Sizes and Powers (Control & Intervention - Pre & Post)
Sigma-restricted parameterization
Effective hypothesis decomposition

Effect	SS	Degr. of Freedom	MS	F	p	Partial eta-squared	Non-centrality	Observed power (alpha=0,05)
Intercept	26341,45	1	26341,45	738,2539	0,000000	0,962203	738,2539	1,000000
Sample	29,45	1	29,45	0,8254	0,371087	0,027675	0,8254	0,142057
Error	1034,74	29	35,68					
PRE-POST	119,59	1	119,59	12,3714	0,001457	0,299033	12,3714	0,924877
PRE-POST*Sample	52,76	1	52,76	5,4573	0,026608	0,158378	5,4573	0,617270
Error	280,34	29	9,67					

Dominant grip strength

Repeated Measures Analysis of Variance with Effect Sizes and Powers (Control & Intervention - Pre & Post)
Sigma-restricted parameterization
Effective hypothesis decomposition

Effect	SS	Degr. of Freedom	MS	F	p	Partial eta-squared	Non-centrality	Observed power (alpha=0,05)
Intercept	11744,54	1	11744,54	352,4865	0,000000	0,923982	352,4865	1,000000
Sample	0,00	1	0,00	0,0000	0,999288	0,000000	0,0000	0,050000
Error	966,25	29	33,32					
PRE-POST	47,53	1	47,53	12,9182	0,001189	0,308177	12,9182	0,934842
PRE-POST*Sample	21,84	1	21,84	5,9353	0,021215	0,169895	5,9353	0,653601
Error	106,70	29	3,68					

Triceps & calf skinfolds

Repeated Measures Analysis of Variance with Effect Sizes and Powers (Control & Intervention - Pre & Post)
Sigma-restricted parameterization
Effective hypothesis decomposition

Effect	SS	Degr. of Freedom	MS	F	p	Partial eta-squared	Non-centrality	Observed power (alpha=0,05)
Intercept	18703,17	1	18703,17	269,7460	0,000000	0,902928	269,7460	1,000000
Sample	218,86	1	218,86	3,1564	0,086121	0,098159	3,1564	0,404445
Error	2010,75	29	69,34					
PRE-POST	0,16	1	0,16	0,0201	0,888370	0,000691	0,0201	0,052152
PRE-POST*Sample	16,71	1	16,71	2,1261	0,155557	0,068305	2,1261	0,291543
Error	227,89	29	7,86					

Back-saver sit-and-reach

Repeated Measures Analysis of Variance with Effect Sizes and Powers (Control & Intervention - Pre & Post)
Sigma-restricted parameterization
Effective hypothesis decomposition

Effect	SS	Degr. of Freedom	MS	F	p	Partial eta-squared	Non-centrality	Observed power (alpha=0,05)
Intercept	23609,00	1	23609,00	234,3867	0,000000	0,889896	234,3867	1,000000
Sample	50,80	1	50,80	0,5044	0,483262	0,017094	0,5044	0,105562
Error	2921,07	29	100,73					
PRE-POST	39,85	1	39,85	5,3141	0,028503	0,154867	5,3141	0,605856
PRE-POST*Sample	38,05	1	38,05	5,0740	0,032026	0,148911	5,0740	0,586150
Error	217,47	29	7,50					

Single leg stance

Repeated Measures Analysis of Variance with Effect Sizes and Powers (Control & Intervention - Pre & Post)
Sigma-restricted parameterization
Effective hypothesis decomposition

Effect	SS	Degr. of Freedom	MS	F	p	Partial eta-squared	Non-centrality	Observed power (alpha=0,05)
Intercept	19412,84	1	19412,84	116,6479	0,000000	0,800890	116,6479	1,000000
Sample	737,96	1	737,96	4,4342	0,043999	0,132626	4,4342	0,530251
Error	4826,25	29	166,42					
PRE-POST	143,63	1	143,63	4,1889	0,049849	0,126213	4,1889	0,507516
PRE-POST*Sample	90,96	1	90,96	2,6527	0,114194	0,083805	2,6527	0,350280
Error	994,37	29	34,29					

505 agility

Repeated Measures Analysis of Variance with Effect Sizes and Powers (Control & Intervention - Pre & Post)
Sigma-restricted parameterization
Effective hypothesis decomposition

Effect	SS	Degr. of Freedom	MS	F	p	Partial eta-squared	Non-centrality	Observed power (alpha=0,05)
Intercept	1047,729	1	1047,729	1530,815	0,000000	0,981408	1530,815	1,000000
Sample	0,004	1	0,004	0,007	0,936240	0,000224	0,007	0,050698
Error	19,848	29	0,684					
PRE-POST	8,264	1	8,264	24,465	0,000029	0,457587	24,465	0,997575
PRE-POST*Sample	0,834	1	0,834	2,470	0,126893	0,078485	2,470	0,330111
Error	9,796	29	0,338					

50m sprint

Repeated Measures Analysis of Variance with Effect Sizes and Powers (Control & Intervention - Pre & Post)
Sigma-restricted parameterization
Effective hypothesis decomposition

Effect	SS	Degr. of Freedom	MS	F	p	Partial eta-squared	Non-centrality	Observed power (alpha=0,05)
Intercept	8484,403	1	8484,403	649,6343	0,000000	0,957267	649,6343	1,000000
Sample	0,689	1	0,689	0,0528	0,819885	0,001817	0,0528	0,055678
Error	378,748	29	13,060					
PRE-POST	62,976	1	62,976	6,0199	0,020392	0,171901	6,0199	0,659745
PRE-POST*Sample	14,611	1	14,611	1,3967	0,246884	0,045948	1,3967	0,207907
Error	303,375	29	10,461					

Standing broad jump

Repeated Measures Analysis of Variance with Effect Sizes and Powers (Control & Intervention - Pre & Post)
Sigma-restricted parameterization
Effective hypothesis decomposition

Effect	SS	Degr. of Freedom	MS	F	p	Partial eta-squared	Non-centrality	Observed power (alpha=0,05)
Intercept	637071,6	1	637071,6	684,4200	0,000000	0,959351	684,4200	1,000000
Sample	10996,4	1	10996,4	11,8136	0,001798	0,289453	11,8136	0,913285
Error	26993,8	29	930,8					
PRE-POST	7544,8	1	7544,8	88,6626	0,000000	0,753533	88,6626	1,000000
PRE-POST*Sample	3705,4	1	3705,4	43,5447	0,000000	0,600247	43,5447	0,999995
Error	2467,8	29	85,1					

Block and box

Repeated Measures Analysis of Variance with Effect Sizes and Powers (Control & Intervention - Pre & Post)
Sigma-restricted parameterization
Effective hypothesis decomposition

Effect	SS	Degr. of Freedom	MS	F	p	Partial eta-squared	Non-centrality	Observed power (alpha=0,05)
Intercept	78811,83	1	78811,83	556,5036	0,000000	0,950470	556,5036	1,000000
Sample	173,12	1	173,12	1,2224	0,277973	0,040448	1,2224	0,187774
Error	4106,97	29	141,62					
PRE-POST	265,87	1	265,87	7,3587	0,011108	0,202391	7,3587	0,746010
PRE-POST*Sample	4,58	1	4,58	0,1267	0,724445	0,004350	0,1267	0,063690
Error	1047,77	29	36,13					

Fitts' simple reaction time

Repeated Measures Analysis of Variance with Effect Sizes and Powers (Control & Intervention - Pre & Post)
Sigma-restricted parameterization
Effective hypothesis decomposition

Effect	SS	Degr. of Freedom	MS	F	p	Partial eta-squared	Non-centrality	Observed power (alpha=0,05)
Intercept	12,16844	1	12,16844	516,5910	0,000000	0,946847	516,5910	1,000000
Sample	0,00418	1	0,00418	0,1776	0,676583	0,006086	0,1776	0,069241
Error	0,68310	29	0,02356					
PRE-POST	0,00922	1	0,00922	1,1188	0,298915	0,037145	1,1188	0,175804
PRE-POST*Sample	0,01101	1	0,01101	1,3363	0,257122	0,044050	1,3363	0,200933
Error	0,23891	29	0,00824					

3B.3. Tukey HSD post-hoc test

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Tukey HSD test; variable DV_1 (Control & Intervention - Pre & Post)
Approximate Probabilities for Post Hoc Tests
Error: Between; Within; Pooled MSE = 119,53, df = 34,256

Cell No.	Sample	PRE-POST	{1} 19,313	{2} 26,875	{3} 15,467	{4} 13,400
1	Intervention	Pacer Pre		0,000394	0,762410	0,445887
2	Intervention	Pacer Post	0,000394		0,031175	0,008368
3	Control	Pacer Pre	0,762410	0,031175		0,591847
4	Control	Pacer Post	0,445887	0,008368	0,591847	

Modified curl-ups

Tukey HSD test; variable DV_1 (Control & Intervention - Pre & Post)
Approximate Probabilities for Post Hoc Tests
Error: Between; Within; Pooled MSE = 22,674, df = 43,639

Cell No.	Sample	PRE-POST	{1} 19,000	{2} 23,625	{3} 19,467	{4} 20,400
1	Intervention	Curl Pre		0,001348	0,992879	0,845672
2	Intervention	Curl Post	0,001348		0,086388	0,249614
3	Control	Curl Pre	0,992879	0,086388		0,843608
4	Control	Curl Post	0,845672	0,249614	0,843608	

Dominant grip strength

Tukey HSD test; variable DV_1 (Control & Intervention - Pre & Post)
Approximate Probabilities for Post Hoc Tests
Error: Between; Within; Pooled MSE = 18,499, df = 35,327

Cell No.	Sample	PRE-POST	{1} 12,300	{2} 15,240	{3} 13,489	{4} 14,053
1	Intervention	Strength Pre		0,000996	0,867889	0,671245
2	Intervention	Strength Post	0,000996		0,672286	0,868635
3	Control	Strength Pre	0,867889	0,672286		0,851190
4	Control	Strength Post	0,671245	0,868635	0,851190	

Back-saver sit-and-reach

Tukey HSD test; variable DV_1 (Control & Intervention - Pre & Post)
Approximate Probabilities for Post Hoc Tests
Error: Between; Within; Pooled MSE = 54,113, df = 33,294

Cell No.	Sample	PRE-POST	{1} 18,844	{2} 22,016	{3} 18,600	{4} 18,637
1	Intervention	Sit & Reach Pre		0,013816	0,999745	0,999843
2	Intervention	Sit & Reach Post	0,013816		0,574442	0,583005
3	Control	Sit & Reach Pre	0,999745	0,574442		0,999984
4	Control	Sit & Reach Post	0,999843	0,583005	0,999984	

Single leg stance

Tukey HSD test; variable DV_1 (Control & Intervention - Pre & Post)
Approximate Probabilities for Post Hoc Tests
Error: Between; Within; Pooled MSE = 100,36, df = 40,463

Cell No.	Sample	PRE-POST	{1} 18,421	{2} 23,891	{3} 13,941	{4} 14,563
1	Intervention	SLS Pre		0,060042	0,602974	0,708675
2	Intervention	SLS Post	0,060042		0,041101	0,061383
3	Control	SLS Pre	0,602974	0,041101		0,991311
4	Control	SLS Post	0,708675	0,061383	0,991311	

Standing broad jump

Tukey HSD test; variable DV_1 (Control & Intervention - Pre & Post)
Approximate Probabilities for Post Hoc Tests
Error: Between; Within; Pooled MSE = 507,96, df = 34,258

Cell No.	Sample	PRE-POST	{1} 95,973	{2} 133,52	{3} 84,793	{4} 91,398
1	Intervention	Power Pre		0,000162	0,520060	0,941876
2	Intervention	Power Post	0,000162		0,000164	0,000204
3	Control	Power Pre	0,520060	0,000164		0,226123
4	Control	Power Post	0,941876	0,000204	0,226123	

3B.4. Independent t-test for change in performance

T-tests; Grouping: Sample (Spreadsheet2)
Group 1: Intervention
Group 2: Control

Variable	Mean Intervention	Mean Control	t-value	df	p	Valid N Intervention	Valid N Control	Std.Dev. Intervention	Std.Dev. Control	F-ratio Variances	p Variances
cardiorespiratory end.	38,5045	-10,3759	4,22747	28	0,000228	16	14	37,1865	23,5475	2,493916	0,105623
muscular end.	27,5093	10,5037	1,72660	29	0,094880	16	15	20,8954	32,9830	2,491597	0,090242
strength	26,6818	4,9897	2,74942	29	0,010169	16	15	24,1789	19,2840	1,572098	0,404055
body comp	-5,8753	9,5434	-1,39562	29	0,173423	16	15	15,5558	41,2082	7,017507	0,000567
flexibility	23,4892	3,5421	1,81687	29	0,079586	16	15	38,6733	18,1809	4,524709	0,007368
balance	85,1786	35,2933	0,99138	29	0,329699	16	15	120,8589	157,9715	1,708440	0,314891
agaility	-18,9201	-10,1829	-1,64602	29	0,110555	16	15	16,3287	12,8907	1,604541	0,383252
speed	-15,5095	-6,8247	-1,28367	29	0,209419	16	15	17,4728	20,1728	1,332941	0,586737
power	42,9173	8,3649	4,75382	29	0,000050	16	15	26,5813	9,4963	7,835085	0,000403
coordination	15,5624	18,0807	-0,24910	29	0,805039	16	15	17,7437	36,0792	4,134514	0,009851
reaction time	-5,8449	4,7087	-1,08285	29	0,287798	16	15	24,4771	29,6881	1,471102	0,466952