PHYSICAL EDUCATION THROUGH HUMAN MOVEMENT FOR INDIVIDUALS LIVING WITH INTELLECTUAL DISABILITY: A RANDOMISED CONTROLLED TRIAL

By

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A complete dissertation submitted in fulfilment of the requirements for the degree of

Master of Education

in the Faculty of Education

at the Cape Peninsula University of Technology

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Wellington Campus
15 September 2023

DECLARATION

I, Elaine Steyn, declare that the contents of this dissertation represent my own unaided work and that the dissertation has not been submitted previously for academic examination towards any qualification. Furthermore, it represents my own opinions and not necessarily those of the Cape Peninsula University of Technology.

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ABSTRACT

Introduction and problem statement: Intellectual disability (ID) is defined by the Diagnostic Criteria for Intellectual Disabilities (DSM-5) as: "A disorder with onset during the developmental period that includes both intellectual and adaptive functioning deficits in conceptual, social, and practical domains" (American Psychiatric Association, 2013:33). Individuals living with ID have a shorter life expectancy than the general population (Kinnear et al., 2018). Although the life expectancy of individuals living with ID has increased in recent times, most individuals with ID are still inactive and live a sedentary lifestyle (Hsieh et al., 2017). A sedentary lifestyle and obesity may lead to other noncommunicable diseases in this population (De Winter et al., 2012). In order for individuals living with ID to live independent and healthy lives, their functional fitness levels need to improve so that they can execute daily activities safely and independently without undue fatigue and age in a healthy manner (Blick et al., 2015). Participation in physical activities is important to improve functional fitness and promote independence throughout adulthood. However, barriers such as lack of interest, supervision, finance, transportation, and accessibility make participation in physical activities difficult for adults living with ID. Walking is an inexpensive exercise that can easily be applied in daily life. Moreover, dancing and following exercise videos along with the use of household objects for resistance training is enjoyable and easy to perform at home. A combination of walking, dancing and resistance training has seldom been implemented before on individuals living with ID . **Purpose:** Consequently, the purpose of this study was to determine whether an adapted exercise intervention with activities which are simple, fun, accessible, convenient and primed for socializing in a group would elicit significant improvements in various parameters associated with functional fitness for adults living with ID. **Methods:** The study used quantitative research to conduct a randomised control study. The study incorporated a pre- and post-test intervention design. A total of 42 willing adults living with ID (44.5±11.5 years), between the ages of 18 and 50, were randomly placed in an experimental (n=19) or control group (n=23). The supervised program consisted of walking, dancing and resistance training exercises and was implemented, three times a week for six weeks. **Results:** Significant improvements ($p<0.05$) were reported for body mass, hip circumference, aerobic capacity, functional ability, muscular strength, balance and flexibility with varying degrees of effect sizes. **Conclusion:** The combined exercise training program showed a significant positive impact on various parameters associated with functional fitness for adults living with ID.

Keywords:
Adults, dancing, exercise intervention, functional fitness, ,
health education, inclusive education people with ID, physical activity, , resistance training, walking.

ACKNOWLEDGEMENTS

I wish to thank:

- My supervisors but especially my principal supervisor Professor P.H. Boer. He has been with me every step of the way. He inspired me to do my research on individuals living with an intellectual disability. I will always be thankful for his encouragement, guidance, and knowledge.

- Sincere thanks to my family. I would like to convey my gratitude for their support, inspiration, and tolerance over the past years.

- The care facility and the house parents for welcoming me with open arms and supporting me throughout the study.

- Supervisors that helped me during the pre- and post-tests and throughout the study.

TABLE OF CONTENTS

CHAPTER THREE: ARTICLE FORMAT

The effect of a walking, dancing and strength training program on the functional fitness of adults with intellectual disability: a randomised controlled trial

CHAPTER FOUR: FINDINGS AND RECOMMENDATIONS

LIST OF TABLES

LIST OF FIGURES

APPENDICES

GLOSSARY

Terms/Acronyms/Abbreviations	Definition/Explanation
6MWT	six-minute walking test
AAIDD	American Association on Intellectual and Developmental Disabilities
ACSM	American College of Sports Medicine
BMI	body mass index
CI	confidence interval
DSM-5	Diagnostic and Statistical Manual of Mental Disorders, fifth edition
ES	effect size
FMR1	Fragile X Messenger Ribonucleoprotein 1
GHS	General Household Survey
HC	hip circumference
ID	intellectual disability
ICF	International Classification of Functioning, Disability and Health
IQ	intelligence quotient
LeDer	Learning Disability Mortality Review Programme
SAHRC	South African Human Rights Commission
TUG	timed up and go test
VO_2Max	maximum rate of oxygen consumption
WC	waist circumference
WHO	World Health Organization
WHR	waist-to-hip ratio

CHAPTER ONE

INTRODUCTION AND OVERVIEW

1.1 Introduction

Human Movement Science is a field of study focused on the understanding of human movement and involves disciplines such as: exercise physiology; biomechanics; anatomy; nutrition; exercise psychology; health; physical fitness; functional fitness; exercise for the athlete, the elderly and those with disabilities. Functional fitness as one of the disciplines in the field of Human Movement Science is an important concept to study. Adequate functional fitness ensures that an individual lives with adequate balance, flexibility, muscular strength and aerobic capacity throughout life and especially when he/she ages (Rikli & Jones, 2013).

Unfortunately, the functional fitness of those living with intellectual disabilities (ID) is poor compared to the general population and many of these individuals age prematurely and live functionally dependent lives after the age of 50 years (Baynard, Pitetti, Guerra, Unnithan & Fernhall, 2008). Applying the principles of exercise prescription as taught in Exercise Physiology classes and understanding the anatomy and functionality of muscles is of paramount importance for persons living with ID. Individuals living with disabilities and particularly individuals living with ID, form part of inclusive education. Yet, research related to the functional fitness of these individuals is limited.

Intellectual disability is defined by the Diagnostic and Statistical Manual of Mental Disorders, fifth edition (DSM-5) as “a disorder with onset during the developmental period that includes both intellectual and adaptive functioning deficits in conceptual, social and practical domains” (American Psychiatric Association, 2013:33). Individuals living with ID have significant limitations in intellectual functioning (reasoning, scheduling, problem solving and reasoning) and adaptive skills (independence, communication, social participation and academic functioning) that are required for daily living, such as conceptual, social and practical skills (American Psychiatric Association, 2013). An intelligence quotient (IQ) score of 70 or below indicates a limitation in intellectual functioning (Shree & Shukla, 2016). It is estimated that 1% of people worldwide live with ID (Harris, 2006).

In South Africa, the latest national census survey implemented in 2001 revealed a prevalence of 5% overall disability of which 0.5% was ID (Njenga, 2009). Individuals living with ID have a shorter life expectancy than the general population (Kinnear, Morrison, Allan, Henderson, Smiley & Cooper, 2018). However, it has been reported that the life expectancy of individuals living with ID has increased due to improved medical care (O'Leary, Cooper & Hughes-McCormack, 2018). Although the life expectancy of individuals living with ID has increased during recent times, most individuals living with ID are still inactive and live sedentary lifestyles (Hsieh, Hilgenkamp, Murthy, Heller & Rimmer, 2017; Coats, Coxon, Temple, Butler & Stuart-Hill, 2023). A sedentary lifestyle enhances health-related problems and mortality in this population.

For individuals with ID to live independent and healthy lives, their functional fitness levels need to improve to enable them to execute daily activities safely and independently without undue fatigue as well as to age in a healthy manner (Blick, Saad, Goreczny, Roman & Sorensen, 2015). Exercise improves the daily functioning of individuals living with ID by facilitating basic tasks such as washing/bathing, dressing, walking and carrying objects. In previous studies, researchers demonstrated that interventions with physical activities improve the functional fitness of adults living with ID (Jo, Rossow-Kimball & Lee, 2018; Reina, Adams, Allison, Mueller, Crowe, Van Puymbroeck & Schmid, 2020; Obrusnikova, Firkin, Cavalier & Suminski, 2021). However, barriers to exercise participation such as a lack of finances and interest, transportation problems and a lack of educated physical activity professionals make it difficult for this population (Mahy, Shields, Taylor & Dodd, 2010; Burns, Carter, Draper & Foad, 2022; Ascondo, Martín-López, Iturricastillo, Granados, Garate, Romaratezabala, Martínez-Aldama, Romero & Yanci, 2023).

A combination of walking, dancing and resistance training has seldom been implemented before on individuals living with ID. These exercises can be implemented easily at home or in care facilities. These training interventions performed in isolation often provide improvements in some functional fitness parameters, but not in all of them. For example, studies have shown that a walking intervention improves aerobic capacity and functional ability in individuals living with ID but may not improve body composition (Bergström, Hagströmer, Hagberg & Elinder, 2013; Son, Jeon & Kim, 2016). Dancing has been shown to be an excellent exercise modality for individuals living with ID and has shown improvement in some of the parameters associated with functional fitness (Cluphf, O'Connor & Vanin, 2001; Martínez-Aldao, Martínez-Lemos, Bouzas-Rico & Ayán-Pérez, 2019; Kong, Sze, Yu, Loprinzi, Xiao, Yeung, Li, Zhang & Zou, 2019; DiPasquale & Kelberman, 2020).

Regarding an improvement in daily life functioning, two studies have reported significant improvements with a dancing intervention (Hwang & Braun, 2015; Martínez-Aldao et al., 2019). Furthermore, it has been demonstrated that individuals living with ID enjoy music and dancing and this exercise modality could help with exercise motivation (Barr & Shields, 2011). Resistance training interventions also have shown significant improvements in muscular strength and physical ability for individuals living with ID (Shields, Taylor & Dodd, 2008; Obrusnikova et al., 2021; Obrusnikova, Firkin & Farquhar, 2022; Gutiérrez-Cruz, Roman-Espinaco, Muñoz-López, Ruiz-Perálvarez & García-Ramos, 2023). However, various studies that have investigated the effect of functional exercise interventions on anthropometrical variables, have found no significant improvements (Mendonca, Pereira & Fernhall, 2011; Calders, Elmahgoub, Roman de Mettelinge, Vandenbroech, Dewandele, Rombaut, Vandevelde & Cambier, 2011; Mendonca, Pereira & Fernhall, 2013) and limited improvement in muscular strength (Shields & Taylor, 2010; Shields, Taylor, Wee, Wollersheim, O'Shea & Fernhall, 2013).

Walking, dancing and resistance training interventions performed in isolation have demonstrated significant improvements in various aspects related to functional fitness (Mendonca et al., 2013; Bergström et al., 2013; Son et al., 2016; Kong et al., 2019; Martínez-Aldao et al., 2019; DiPasquale & Kelbermans, 2020) . Combining fun, accessible and easy exercises (walking, dancing and resistance exercise) could improve more parameters associated with functional fitness. Such a diverse combined programme which includes team exercise and music, could increase enthusiasm towards physical activity by this population. Such a combined programme could be implemented habitually in their daily lives.

Information gained from this study will contribute to the knowledge taught in Exercise Physiology classes, teacher education in an inclusive environment, exercise prescription for those living with ID and adapted physical exercise interventions in the Bachelor of Education degrees (undergraduate and honours). Many Education students will teach at special schools as well as ID residential care facilities. Three months of the honours course presented by the Cape Peninsula University of Technology is taught at Sunfield Homes in Wellington which is an ID adult residential care facility. Content knowledge gained from this investigation in the field of Human Movement Science will help to drive teacher and student education in inclusive education environments and add disciplinary knowledge to the field of Exercise Physiology.

1.2 Problem statement

A combined intervention comprising of walking, dancing and resistance training has never been performed in a population of individuals living with ID. These activities are simple, inexpensive, convenient, enjoyable and can be adapted for socialising in a group. For example, studies have shown that walking improves aerobic capacity and functional ability but may not improve body composition (Bergström et al., 2013; Son et al., 2016).

Combining these exercises (walking, dancing and resistance exercise) could improve more parameters involved in human movement (body composition, muscle strength and endurance, cardiopulmonary endurance, functional ability, balance and flexibility) for individuals living with ID. Furthermore, a diverse combined programme could increase the motivation shown towards physical activity by this population. It has been shown previously that individuals living with ID enjoy music and dancing and, therefore, these elements could increase exercise motivation (Barr & Shields, 2011).

It is also important to improve the functional fitness of these individuals as many are overweight and live sedentary lifestyles (Winter, Bastiaanse, Hilgenkamp, Evenhuis & Echteld, 2012; Hsieh et al., 2017). A sedentary lifestyle and obesity may lead to other risk factors such as diabetes, cardiovascular heart disease, hypertension and high cholesterol. Fortunately, physical exercise appears to be an essential component to improve functional fitness, lowering chronic disease risk factors and increasing the age of mortality Oppewal & Hilgenkamp, 2019; Boer, 2021; Hsu, Chou, Pan, Y.H., Ju, Tsai & Pan, 2021; Højberg, Helge, Pingel & Wienecke, 2022; De Leeuw, Oppewal, Elbers, Hilgenkamp, Bindels & Maes-Festen, 2023)

This research will assess the effectiveness of a walking, dancing and resistance training on the functional fitness of individuals living with ID. The knowledge gained from the investigation will contribute to Human Movement Sciences in an inclusive education setting. This information can be taught in Human Movement classes such as exercise physiology, exercise prescription, exercise for those living with ID and working with norm- and criterion referenced tables. A study by Koh (2018) revealed that adapted physical education courses and practical classes taught at universities have a significant effect on the pre-service teachers' self-efficacy towards teaching learners living with ID. Similarly, a peer-tutored adapted physical education programme was reported to be beneficial for individuals living with ID, particularly for those in an overweight condition (Gobbi, Greguol & Carraro, 2018). The enjoyment of adapted physical education programmes compared to traditional physical education programmes may encourage exercise participation by learners living with ID (Gobbi et al., 2018).

1.3 Research questions

The following research question will be answered:
What parameters related to human movement will improve with a combined and adapted training programme for individuals living with ID?

The following research sub-questions will be answered:

- Will the adapted training programme improve parameters associated with body composition?
- Will the adapted training programme improve muscular strength, flexibility and balance?
- Will the adapted training programme improve aerobic capacity and functional ability?

1.4 The aim

The primary aim of the study was to determine how a six-week walking, dancing and resistance training programme will impact the functional fitness of individuals living with ID.
The objectives of this study were to:

- Determine the effect of an adapted exercise programme on parameters associated with body composition;
- Determine the effect of an adapted exercise programme on parameters associated with muscular strength, flexibility, and balance; and
- Determine the effect of an adapted exercise programme on aerobic capacity and functional ability.

CHAPTER TWO

LITERATURE REVIEW

2.1 Intellectual disability: overview and background

Intellectual disability refers to the limitation of intellectual functioning and adaptive behaviour. Different terms exist, but “intellectual disability” is predominantly used. The term “intellectual disability” has also been known as “mental retardation” (Shree & Shukla, 2016). However, “mental retardation” is not used anymore and is classified as a negative stereotype towards individuals living with ID. The term “intellectual disability” is used internationally with the purpose that it expounds the transformation theory of disability defined by the World Health Organization (WHO) and American Association on Intellectual and Developmental Disabilities (AAIDD) (Shree & Shukla, 2016; Shea, 2012).

Kleintjes, McKenzie, Abrahams and Adnams (2020) mention that “abusive” terminology like “mental handicap”, “moron”, “idiot”, “imbecile” and “mental retardation” also have been replaced in South African law with “intellectual disability”. The South African Human Rights Commission (SAHRC) (2017) added terms that also are not considered to be acceptable. These terms include “crippled”, “deformed”, “brain damaged”, “learning disabled”, “slow learner” and “mongo or mongoloid”. The term “mental retardation” was used to label this population. However, in 1986 this term was changed to mental handicap and in the year 2000 it was changed to the term “intellectual disability”. The SAHRC (2017) states that the general rule is that the individual comes first and not the disability. Therefore, the individual should be addressed and not the disability. The United Nations Office of the High Commissioner for Human Rights have presented terminology to address these individuals that are acceptable (SAHRC, 2017):

- Refer to “person” and not to “victim”;
- Refer to “person with” instead as “afflicted by”; and
- Refer to “person who has…” rather than “suffering from”.

The censuses of 1996 and 2001 as well as the community survey that collected the statistics of South Africa used similar questions to measure the disability based on the 1980 World Health Organisation International Classifications of Impairments, Disabilities and Handicaps that define whether the person is living with physical or mental disability (Statistics South Africa, 2014). The definition regarding disability was changed in the Census 2011 taking the Washington Group method into consideration. The reason for the change was that some people would not identify themselves as disabled. Therefore, the term “disabled” has been replaced with “difficulty”. This new definition assesses the difficulties in functioning of body impairments and limitation to daily activities. The questions focused on the difficulties of six functional domains: communication, hearing, seeing, walking, remembering, concentrating and self-care (Statistics South Africa, 2014).

In the censuses before the year 2000, the definition would refer to the type of disability as “mental” whereas the Census 2001, 2007 and 2011 refers to the type of disability as “intellectual” which corresponds to development in terminology and classifications made over the years for ID (Statistics South Africa, 2014).

The terms “developmental disability” and “developmentally delayed” are receiving more recognition. The word “development” includes a wider context of adaptive and social behaviours along with performance on intelligence tests (Sutherland, Couch & Iacono, 2002). “Developmental disability” is a broad term that is used to define a series of conditions that affect various developmental aspects such as speech, vision, hearing, mental and physical functioning. It is an umbrella term for a group of conditions which include disabilities such as Autism, Alzheimer’s, Aspergers disorder, Cerebral palsy, Down syndrome, foetal alcohol syndrome and ID (Steadward, Wheeler & Watkinson, 2003; Reichow, Volkmar & Bloch, 2013).

The term “developmental disability” is used to describe a wide range of conditions whereas ID focuses on the cognitive and adaptive functioning. The term "global developmental delay" is typically used for younger children (often younger than five years of age), whereas the term ID is usually designated for older children whenever IQ testing is accurate and trustworthy (Shapiro & Batshaw, 2013; Moeschler, Shevell, Saul, Chen, Freedenberg, Hamid, Jones & Stoler, 2014). The major differences between the terms “developmental disability” and ID are the age of onset, the severity of limitation and that the definition of “developmental disability” does not refer to an IQ responsibility. The characteristics of these two terms are presented in Table 2.1.

Table 2.1 Characteristics of intellectual disability and developmental disability

Characteristics	Intellectual disability	Developmental disability
Scope	Limitation in intellectual (IQ of 70 or lower) and/or adaptive functioning.	Includes a broad spectrum of impairments with varying developmental aspects.
Age of onset	Before 18 years of age.	Before 22 years of age.
Classification	According to severity: mild, moderate, severe and profound.	According to specific diagnosis.

2.2 Classifications of intellectual disability

Terms have been established to classify the severity of the condition of an individual living with ID. These terms include “mild”, “moderate”, “severe” and “profound”. Patel, Apple, Kanungo and Akkal (2018) mention that the classification of severity of an individual living with ID should be based on their cognitive and adaptive functioning and not only based on standardised testing.

2.2.1 Mild to moderate intellectual disability

Individuals living with mild ID have an IQ between 50 and 69 (Shree & Shukla, 2016). The majority of ID cases are classified as mild and involve mostly disability in cognitive development as well as social and daily functional skills. However, these individuals have basic independent job skills and are able to perform basic self-care and home activities. Individuals living with mild ID are less likely to be recognised to have ID before the age of six (Shree & Shukla, 2016; Shapiro & Batshaw, 2013). These individuals also require minimal support and only require occasional or short-term support. Individuals living with mild ID have an IQ comparable to children aged nine to 11 years (Carr & O’Reilly, 2016; Patel et al., 2018; Patel, Cabral, Ho & Merrick, 2020). Individuals living with moderate ID have an IQ between 35 and 54 and their IQ can be compared to children aged six to eight years (Patel et al., 2020). Some individuals living with moderate ID can master basic self-care and home activities but require an intermediate level of support to take care of themselves once they have learned the skills necessary for daily living (Boat & Wu, 2015; Patel et al., 2018).

2.2.2 Severe intellectual disability

Individuals living with severe ID have an IQ between 25 and 40 and are limited with regard to language and the ability for gaining academic skills (Boat & Wu, 2015; Patel et al., 2018). These individuals have the mental awareness similar to a child aged three to six years (Carr & O'Reilly, 2016; Patel et al. 2020). Severe ID may require forceful training on self-care skills and may entail lifetime supervision for labour, school and home activities. Therefore, families are often the primary caregivers and often rely on external facilities for additional support (Boat & Wu, 2015; Patel et al., 2018).

2.2.3 Profound intellectual disability

Individuals living with profound ID have an IQ of 25 and lower which can be compared to the mentality of a three-year-old child (Carr & O'Reilly, 2016; Patel et al. 2020). These individuals cannot live independently and require permanent caretakers to keep close supervision and aid in self-care activities. Individuals living with profound ID are likely to have physical limitations and are limited in their ability to communicate (Boat & Wu, 2015; Patel et al., 2018).

2.3 Causes of intellectual disability

A third to a half of the reasons or causes of ID cannot be identified during childhood (Daily, Ardinger & Holmes, 2014). Intellectual disability can be caused by genetic, non-genetic, or environmental factors as indicated in Figure 2.1 (Huang, Zhu, Qu & Mu, 2016). Genetic causes include up to 45% of ID cases with Down syndrome as the most common (Kaufman, Ayub & Vincent, 2010; Karam, Riegel, Segal, Félix, Barros, Santos, Matijasevich, Giugliani & Black, 2015b; Huang et al., 2016). Genetic causes include chromosome abnormalities, metabolic disorders and metabolic infections. Non-genetic causes comprise of prenatal, perinatal and postnatal causes (Huang et al., 2016). An example of an environmental cause of ID that is prenatal in nature is foetal alcohol spectrum disorder (Tyler, White-Scott, Ekvall & Abulafia, 2008; Chokroborty-Hoque, Alberry & Singh, 2014). Community prevalence studies were carried out in 17 municipalities across three of South Africa's provinces with rates varying from 29 to 290 per 1000 newborns. This prevalence of foetal alcohol spectrum disorder in South Africa is considered to be the highest in the world (Olivier, Viljoen & Curfs, 2016).

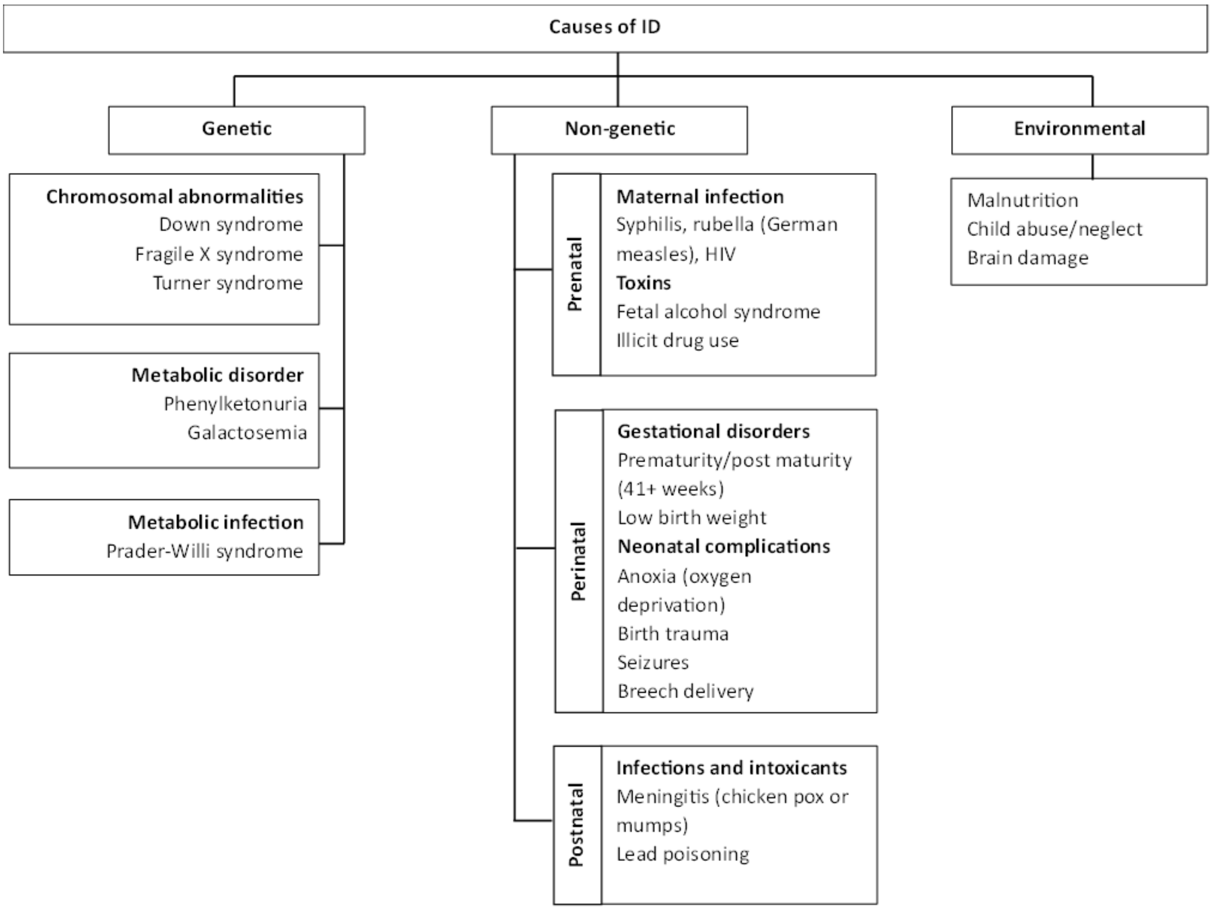

Figure 2.1: Causes of intellectual disability: genetic, non-genetic and environmental (Adapted from Shree and Shukla [2016] and Ilyas, Mir, Efthymiou and Houlden [2020])

2.3.1 Prenatal complications

The prenatal environment within the mother's womb is critical for the development of the child. Any deformity or abnormality in the 40 weeks prior to the birth of the newborn can result in prenatal problems which lead to ID (Santosh & Kumar, 2021). Factors pointed out by van Dommelen, De Gunst, Van Der Vaart and Boomsma (2004) such as maternal infection in the uterus, smoking, high blood pressure, diabetes, or liver problems can cause premature births. In addition, drinking alcohol puts the baby at risk for foetal alcohol syndrome.

2.3.2 Perinatal complications

Prematurely born babies or babies with a low birth weight are more likely to develop health-related complications and, in some cases, ID (Kessenich, 2003). Premature births are more common among low-income mothers, adolescent pregnancies and women who abuse medications and illicit substances (Wong, Twynstra, Gilliland, Cook & Seabrook, 2020). Additionally, birth traumas and temporary oxygen deprivation can result in ID and disorders such as Cerebral palsy (Rosenbaum, Paneth, Leviton, Goldstein, Bax, Damiano, Dan & Jacobsson, 2007; Shree & Shukla, 2016).

2.3.3 Postnatal complications

Postnatal complications such as disease or injury after birth can also result in ID. An example of an infectious and intoxicant illness is meningitis which causes damage to the brain's covering (the meninges) (Shree & Shukla, 2016). This illness can be caused by childhood chicken pox or mumps. Other disorders, such as lead poisoning, can result in seizures, neurological dysfunction and damage to the brain (Bedford, de Louvois, Halket, Peckham, Hurley & Harvey, 2001; Kirsh, Stergiou-Kita, Gewurtz, Dawson, Krupa, Lysaght & Shaw, 2009; Shree & Shukla, 2016).

2.3.4 Foetal alcohol syndrome, Down syndrome and Fragile X Syndrome.

Down syndrome is the most prevalent chromosomal disorder, Fragile X syndrome the most prevalent genetic cause and foetal alcohol syndrome the most prevalent environmental cause of intellectual impairment (Lee, Cascella & Marwaha, 2022). Of all three common causes of ID, the most prevalent birth abnormality in South Africa is foetal alcohol spectrum disorder (Williams, 2011). Foetal alcohol syndrome is an intellectual impairment developed from prenatal alcohol exposure (Chokroborty-Hoque et al., 2014). Women who use alcohol while pregnant put their newborn babies at risk for this disability. The degree of the disability is determined by the child's level of alcohol exposure during pregnancy, with women who consume significant amounts of alcohol during pregnancy increasing the chance of severe symptoms in their children's future (Dejong, Olyaei & Lo, 2019).

It is believed that at least one million South Africans suffer from foetal alcohol syndrome, with another five million suffering from partial foetal alcohol syndrome and foetal alcohol spectrum diseases (Williams, 2011). The Western Cape province in South Africa has an exceptionally high incidence of foetal alcohol spectrum diseases. This is supported by research conducted in Aurora, Western Cape, which found a 10% prevalence of foetal alcohol syndrome (Olivier, Urban, Chersich, Temmerman & Viljoen, 2013).

Down syndrome is an ID caused by an absence or duplicate of chromosome 21 in the deoxyribonucleic acid (DNA) (Barr & Shields, 2011; Parihar, Koshy & Srivastava, 2013). One in every 700 babies have Down syndrome (Parker, Mai, Canfield, Rickard, Wang, Meyer Anderson, Mason, Collins, Kirby & Correa, 2010). It is the most common genetic cause of children's mild to severe intellectual impairment (Parker et al., 2010). Down syndrome has an impact on the development of a child and these individuals suffer from low muscle tone which makes it more difficult for them to master basic motions like rolling over, walking, standing and sitting (Priosti, Blascovi-Assis, Cymrot, Vianna & Caromano, 2013). Huang et al. (2016) state that a mother over 35 years of age has a significant risk of having a child with ID and is 54% more likely to have a child with Down syndrome. This was confirmed by the Centers for Disease Control and Prevention (2023a).

Fragile X syndrome is also known as Martin-Bell syndrome. A person living with Fragile X Syndrome typically has an IQ of 70 and lower (Schneider, Hagerman & Hessl, 2009). Fragile X syndrome is caused by a mutation in a single gene on the X chromosome called Fragile X Messenger Ribonucleoprotein 1 (FMR1) (Williams, 2011). This is the most common type of hereditary developmental and intellectual disability as it occurs in one in every 5000 males (Coffee, Keith, Albizua, Malone, Mowrey, Sherman & Warren, 2009). Fragile X syndrome affects both males and females. A female carrier has a 50% chance of passing on the mutation to each of her children. A male carrier will pass on the gene to all of his daughters but none of his sons (Rajaratnam, Shergill, Salcedo-Arellano, Saldarriaga, Duan & Hagerman, 2017).

2.4 Prevalence of adults living with intellectual disability

Daily et al. (2014), Karam, Barros, Matijasevich, Dos Santos Anselmi, Barros, Leistner-Segal, Félix, Riegel, Maluf, Giugliani and Black (2015a), Melville, Mitchell, Stalker, Matthews, McConnachie, Murray, Melling and Mutrie (2015) and Pestana, Barbieri, Vitório, Figueiredo and Mauerberg de Castro (2018) mention that 2% to 3% of people in the world live with ID. The prevalence of ID is 10.4 in every 1000 people. A meta-analysis of 52 global studies revealed that ID prevalence was significantly greater in men as compared to women, with a difference ranging from 0.7% to 0.9% (Maulik, Mascarenhas, Mathers, Dua & Saxena, 2011; Boat & Wu, 2015). Maulik et al. (2011) reported a lower prevalence (4.9 in 1000) for studies with adult-only cohorts.

Hence, it was suggested that adults living with ID are less likely to be diagnosed as there are fewer opportunities outside the educational system for adults to exhibit the symptoms (Bourke, de Klerk, Nick, Smith & Leonard, 2016).

In South Africa, regular censuses and surveys have been executed. However, there are contradictions regarding definitions and modifications to the terminology and classifications made over the years. Therefore, there is no certainty regarding the number of people in South Africa living with ID (Statistics South Africa, 2014). In the developed regions of South Africa, the prevalence of ID has been found to be between 2% and 3%, while rural regions of South Africa have a prevalence rate of 3.6% (Pillay, 2018). KwaZulu-Natal was indicated to have the highest number of people living with ID by census statistics collected in 1996, 2001 and 2007.

Table 2.2 provides the number and percentage of people living with ID in South Africa according to the censuses held in 1996, 2001 and 2007. The results indicate that the ID percentage declined throughout the three periods (Statistics South Africa, 2014).

Table 2.2 Number and percentage of persons living with intellectual disability in South Africa

	Census 1996	Census 2001	Census 2007
Number of people	192 553	206 451	128 841
Percent of disabled persons (%)	0.5	0.5	0.3

South Africa also conducted a Community Survey in 2007 on 274 348 households and found 128 841 individuals with mental disabilities (conducted on a population of 48 502 064). Since changes have been made in the approach of asking disability-related questions in the census of 2011, the data could not be compared to censuses held in the previous years. The results of the census conducted in 2011 indicated that persons aged five years and older had difficulties in the following: visual (11%), hearing (3.6%), cognitive (remembering or concentrating) (4.5%) and communication, walking and self-care difficulties (2%) (SAHRC, 2017).

The General Household Survey (GHS) 2011 reveals a substantial percentage of children classified as severely disabled due to difficulty in all general health and functioning areas. However, statistics regarding children living with disabilities under the age of five are untrustworthy as a six-month-old child is unable to walk, communicate, or provide for itself (Statistics South Africa, 2014).

2.5 Health and physical fitness of individuals living with intellectual disability

2.5.1 Overview of the health and physical fitness requirements for individuals living with intellectual disability

The WHO recommends that adults living with ID (aged 18 to 64 years) perform 150 to 300 minutes of moderate-intensity exercise or 75 to 150 minutes of vigorous-intensity exercise per week for health benefits (World Health Organization, 2020). An example of moderate-intensity aerobic activity is a brisk walk or visible increase in the heart rate. An example of vigorous-intensity activity is jogging or activities with rapid breathing plus an extensive increase in heart rate (Haskell, Lee, Pate, Powell, Blair, Franklin, Macera, Heath, Thompson & Bauman, 2007). Furthermore, for additional health benefits, it is recommended to train muscular strength twice a week for all major muscle groups (World Health Organization, 2020). The systematic review by Dairo, Collett, Dawes and Oskrochi (2016) found that 91% of individuals living with ID do not meet these requirements.

2.5.2 Sedentary lifestyle amongst individuals living with intellectual disability

There are concerns amongst health professionals since 85% of elderly people living with ID live sedentary lifestyles which affect their health and increase premature mortality and morbidity (Melville, Hamilton, Hankey, Miller & Boyle, 2007; Hilgenkamp, Reis, van Wijck, & Evenhuis, 2012a; Hsieh et al., 2017; Oppewal, Maes-Festen & Hilgenkamp, 2020). Moreover, people living with ID are more sedentary than their peers living without ID (Doody & Doody, 2012; Lynch, McCarron, Eustace-Cook, Burke & McCallion, 2022; Coats et al., 2023). The research investigation by Boucher, McIntyre and Larocci (2022) support these findings and report that ten of the 14 children living with ID (ages eight to 16) in their study admitted to playing video games, watching television and looking forward to the weekends to spend time on the computer. A cross-sectional study by Melville, McGarty, Harris, Hughes-McCormack, Baltzer, McArthur, Morrison, Allan and Cooper (2018) found that 50% of their 725 study participants were spending four or more hours on screen time per day. Moreover, they reported that adults living with ID, despite their age or gender, are sedentary and most do not engage in physical activity.

2.5.3 Overweight and obesity levels of individuals living with intellectual disability

A large percentage of individuals living with ID are overweight or obese (Melville et al., 2007). According to Krahn, Hammond and Turner (2006), persons living in residential care facilities are more likely to have a personal doctor and are less likely to be overweight than those living on their own or with family. However, researchers such as Hsieh et al. (2017) and Hilgenkamp, Van Wijck and Evenhuis (2012b) evaluated the health of persons living with ID in residential care facilities and discovered that many were overweight or obese. A cross-sectional study of De Winter et al. (2012) implemented on 945 adults with borderline to profound ID reported that the body mass index (BMI) score revealed a greater prevalence of obesity (26%) than the standard Dutch older population.

Another cross-sectional study by Ryan, McCallion, McCarron, Luus and Burke (2021) was conducted on 572 Irish adults living with ID aged 40 years and older. This Irish longitudinal study on ageing found that 69% of the participants were overweight or obese. Furthermore, being overweight was more prevalent in those who were 50 years of age or younger (72.5%) than in those aged 51 to 64 years (70%) and 65 years and older (61.4%).

Considering adults with Down syndrome, a large cross-sectional study reported that 46.7% of the men and 61.6% of the women were obese (Terblanche & Boer, 2013). A cross-sectional survey by Krause, Ware, McPherson, Lennox and O'Callaghan (2016) found that obesity was more prevalent among adolescents with Down syndrome than among the other participants with an odds ratio of 3.21 (95% CI: 1.41-7.30). Additionally, results of the study compared to Australian standards indicated that 22.5% (95% CI: 17.8 to 28.0%) of adolescents were obese and 23.8% (95% CI: 19.0 to 29.4%) were overweight.

The prevalence of being overweight and obesity in African people living with and without ID has more than doubled in the last 30 years (De Onis & Blössner, 2000). Overall, childhood obesity is one of the major health concerns as it is hard to overcome and it frequently continues into adulthood (De Onis, Blössner & Borghi, 2010). Youth living with ID are more likely to have a high weight status, which is a main risk factor for a higher prevalence of morbidity and death in adults living with ID (Grondhuis & Aman, 2014). Childhood obesity is associated with excessive sedentary behaviour, which raises the risk for various chronic conditions and it also has a negative impact on mental health by contributing to low self-esteem (Marks, 2017).

2.5.4 Morbidities for individuals living with intellectual disability

The WHO defines health as a condition of whole physical, social and mental wellbeing (Lee, 2008). Psychological disorders such as depression, obsessive compulsive disorder and post-traumatic stress disorder are some of the common diseases observed in individuals living with ID (Cooper, Smiley, Morrison, Williamson & Allan, 2007; Emerson, 2011; Kendrick & Pilling, 2012). The negative side effects of medication promote an increase in appetite and/or diminished desire for exercise which lead to a rise in sedentary behaviour. Physical inactivity has been associated with an increase in the risk of chronic diseases such as cardiovascular disease, metabolic syndrome, hypertension, stroke, type 2 diabetes and obesity for individuals living with ID (Miller & Chan 2008; Newcomer & Hennekens, 2007; De Leeuw et al., 2023). Therefore, regular exercise is recommended for this population to prevent chronic complications associated with obesity and a sedentary lifestyle.

Being overweight is a risk factor for diabetes as excess belly fat is associated with resistance to insulin and type 2 diabetes (Misu, 2019). Childhood obesity and being overweight can cause short- and long-term complications. These include the significant risk of developing cardiovascular disorders, high blood pressure, or cholesterol, as well as pre-diabetes which can result in the development of diabetes in adulthood (Obrusnikova et al., 2022). There is also a significant probability of developing bone and joint issues, sleep apnoea and asthma (Janssen & LeBlanc, 2010; Grondhuis & Aman, 2014). The long-term outcome of becoming an obese or overweight adult places the individual at risk for additional health issues including cardiovascular disease, type 2 diabetes, stroke, various forms of cancer and severe arthritis (Obrusnikova et al., 2022). Other difficulties that arise include restricted movement or fall injuries as a result of the excess lipid stores that affect the body's ability to function properly (Heller & Sorensen, 2013; Dunkley, Tyrer, Gray, Bhaumik, Spong, Chudasama, Cooper, Ganghadaran, Davies & Khunti, 2017; Dwivedi, Dubey, Cistola & Reddy, 2020; Parra-Soto, Tumblety, Ho, Pell & Celis-Morales, 2022). Even a slight weight reduction can improve glucose and blood pressure control, reduce cholesterol levels and minimise the risk of a heart attack or stroke (Taylor, 2014; Kim, Choi & Park, 2018).

2.6 Mortality of intellectual disability

In general, adults living with ID have higher levels of sedentary behaviour than the general population, which place them at risk for cardiovascular diseases. In comparison to individuals living without ID, cardiovascular diseases are three times more prevalent in people living with ID (Prasher & Janicki, 2002). According to the WHO, cardiovascular disease accounts for 31% of all deaths in the United States, with stroke or coronary heart disease being the two primary causes of death (Gillespie, Wigington & Hong, 2013).

In terms of risk factors closely associated with mortality for individuals living with ID, the data is mostly congruent. The Learning Disability Mortality Review Programme (LeDer) that was conducted in England summarised the death of children and adults living with ID and found that almost half of them had seven to ten chronic health conditions (LeDer, 2021). The three leading causes of mortality for persons living with ID were identified as cancer, heart disease and cardiovascular disease (Parra-Soto et al., 2022).

A study on older adults living with ID by Oppewal and Hilgenkamp (2019) showed that physical fitness is related to survival as significant improvements were found in various physical components that are predictive for survival. A systematic review of O'Leary et al. (2018) found that individuals living with ID died roughly 20 years earlier than those living without ID, whereas this gap is greater in magnitude for individuals living with Down syndrome and those individuals living with severe ID (28 years).

The physical environment is another risk factor that contributes to premature mortality. Older individuals living with ID face multiple challenges in accessing health care such as: insufficient support, communication difficulties and prejudice (Bauer, Taggart, Rasmussen, Hatton, Owen & Knapp, 2019). Moreover, families from rural areas have financial difficulties in covering additional expenses such as hospital visits, equipment and aids (Office of the Deputy President, 1997). These barriers can enhance premature mortality.

2.7 Barriers to physical activity for individuals living with intellectual disability

2.7.1 Overview

Many barriers to physical activity have been identified for this population when it comes to meeting the health requirements set by the WHO. A combination of both individual (internal) and environment (external) factors seems to influence the level of physical activity.

2.7.2 Internal barriers

The abilities of individuals living with ID and their level of capability are factors influencing participation in physical activity (Barr & Shields, 2011; Bossink, Van der Putten & Vlaskamp, 2017; Ascondo et al., 2023). Bossink et al. (2017) report that the fear of experiencing injury, physical discomfort, or not being fit enough prevent individuals living with ID from participating. The study by Ascondo, Martín-López, Iturricastillo, Granados, Garate, Romaratezabala, Martínez-Aldama, Romero and Yanci (2023) reports that persons living with ID are more likely to refuse physical activity as they do not enjoy it. Additionally, Caton, Chadwick, Chapman, Turnbull, Mitchell and Stansfield (2012) reveal that adults living with ID have inadequate knowledge of the benefits of physical fitness and the associated effects of living a functionally healthy life. Making beneficial decisions about one's health, such as selecting appropriate foods and engaging in healthy exercise habits, remains an obstacle for individuals living with ID (Wehmeyer, Buntinx, Lachapelle, Luckasson, Schalock, Verdugo, Borthwick-Duffy, Bradley, Craig, Coulter & Gomez, 2008).

2.7.3 External barriers

Barriers such as the lack of finance and transportation prevent adults from meeting the health requirements (Mahy et al., 2010; Burns et al., 2022). Financial circumstances can be a major contributor to participation in physical activity. Adults living with ID are more likely to live in poverty which prevents them from paying for sport equipment, gymnasium memberships and associated travel fees (Bowers, Corby, Lambert, Staines, McVeigh, McKeon, Hoey, Belton, Meegan, Walsh & Trépel, 2016; Bossink et al., 2017; Burk & Sharaievska, 2017).

Additionally, the location of a person living with ID has an impact on his/her health (Prasher & Janicki, 2002). Those who live in dangerous neighbourhoods or poverty are less likely to participate in sport (Robertson & Emerson, 2010). According to the SAHRC (2017), the 2017-2018 Equality Report found that the government policy is failing individuals living with disabilities by not guaranteeing accessibility to universal services, equipment and facilities and by failing to accommodate people living with disabilities.

Another external barrier is the lack of educated instructors (Mahy et al., 2010; Burns et al., 2022). Frequently cited barriers to physical activities for this population are the lack of knowledge and lack of skilled and experienced staff to implement physical activity programmes (Cartwright, Reid, Hammersley & Walley, 2017; Bowers et al., 2016; Bossink et al., 2017). In a study conducted on adults living with ID in England, it was reported that 59% of participants did not participate in sports in the month prior to the experimental study and over a third of this group said that they would prefer not participating (Robertson & Emerson, 2010). Although some persons living with ID would like to participate in structured physical activity events, there are limited programmes for them. According to Taliaferro and Hammond (2016), adolescents living with ID who reach adulthood are no longer eligible for school-aged programmes. Carers also note the absence of assistance from secondary educational institutions once the individual living with ID graduates (Taliaferro & Hammond, 2016),

Ko and Boswell (2013) note the lack of experience of physical educators in educating learners living with disabilities in inclusive physical activity curricula and that it is a key barrier known to affect inclusive physical education. In addition, inclusive physical education programmes are limited for this population, which can lead to further disinterest (Cartwright et al., 2017). It was reported by Bowers et al. (2016) that parents and caregivers of individuals living with ID have little understanding of how sporting or fitness clubs operate, where they are situated, who is entitled to attend and how to sign up. Finding inclusive activities or an adapted physical activity programme can promote physical participation for this population.

2.8 Inclusive physical education in a school context

The right to basic education in South Africa was established under Section 29(1) of the Constitution (Murungi, 2015). Individuals living with disabilities have the right to inclusive education at all levels according to Article 24(1) of the Convention on the Rights of Persons with Disabilities. Inclusive education must focus on the complete development of the integrity, self-worth and potential of persons living with disabilities (De Beco, 2014). Participation in physical activities is a fundamental childhood experience, yet inactivity is a global public health problem (Lamarre & Pratt, 2006).

According to physical education teachers, one of the disabilities that provide the most challenges when pursuing inclusion in their classroom is ID (Hodge & Jansma, 2000; Hutzler, 2003). One of the foundations of successful inclusion in physical education is teachers' adapted physical activity knowledge and experience which enable them to modify tasks, equipment, environmental conditions and game rules (Hutzler, Zach & Gafni, 2005).

Queralt, Vicente-Ortiz and Molina-García (2016) highlight that children living with ID accumulate only half their daily physical activity requirements as set by the WHO. The WHO states that children and teenagers should engage in at least 60 minutes of physical activity each day, which could come from free play, physical education, sports and other activities (Everhart, Dimon, Stone, Desmond & Casilio, 2012; Bull, Al-Ansari, Biddle, Borodulin, Buman, Cardon, Carty, Chaput, Chastin, Chou & Dempsey, 2020). The exercises should be a combination of moderate and vigorous intensity. Additionally, the WHO recommends two or three days of resistance training per week for children and teenagers (Bull et al., 2020). Climbing, leaping, tumbling, gymnastics and a range of games are some examples of activities for young children. However, in terms of health-related guidelines for physical activity, 56.9% of those surveyed said that they had been unaware of the most recent WHO physical activity guidelines (Bull et al., 2020).

A study conducted by Howie and Pate (2012) found that children and young people living with ID do not exercise enough, participate in sports, or have access to extracurricular activities. This prevents them from meeting the physical activity requirements. A recent cross-sectional study conducted in the Netherlands on 128 children living with ID demonstrated that 71% to 91% of the children scored below the age-related and gender-based standards of health-related physical fitness which comprises of cardiovascular endurance and muscular fitness (Wouters, Evenhuis & Hilgenkamp, 2020). Furthermore, Einarsson, Jóhannsson, Daly and Arngrímsson (2016) state that children living with ID have been observed to be less likely than children living without ID to participate in two or more hours of weekly organised sport after school. They also stipulate that if the child does engage in physical activity, the majority thereof is low-intensity activity.

Reasons for children to take part in physical activities should be enjoyment, recreation and general wellbeing (Shikako-Thomas, Dahan-Oliel, Shevell, Law, Birnbaum, Rosenbaum, Poulin & Majnemer, 2012). Additionally, regular participation in physical activities promotes self-esteem, social interaction and friendships (Darcy & Dowse, 2013; Boddy, Murphy, Cunningham, Breslin, Foweather, Gobbi, Graves, Hopkins, Auth & Stratton, 2014; Bota, Teodorescu & Stoica, 2017). Participating in physical activities during childhood can have a positive effect on schoolwork and mental health as well (Fedewa & Ahn, 2011; Everhart et al., 2012). Van Dusen, Kelder, Kohl, Ranjit and Perry (2011) state that there is a strong link between the cardiovascular health and the academic achievement of children. When compared to other aspects of physical health, such as flexibility or muscle strength, children with good levels of cardiovascular fitness had the greatest ability to think (Van Dusen et al., 2011). The advantages of sport have been established well and they typically include improved health and physical fitness as well as a reduction in associated diseases and conditions (Philpott, Houghton & Luke, 2010; De Leeuw et al., 2023).

Children and adolescents living with ID spend a large amount of time in school and, hence, it is crucial that schools play a significant role in promoting physical activity, especially during physical education, recess, or organised extracurricular sport (Van Dusen et al., 2011).

2.9 Functional fitness of individuals living with intellectual disability

Functional fitness is the ability to perform daily activities and tasks independently without undue fatigue, such as walking over a long distance, dressing, cleaning, preparing meals and lifting objects (Delgado-Lobete, Montes-Montes, Freire & Ferradás, 2021). Physical parameters predictive of functional fitness comprise of cardiorespiratory endurance, body composition, muscle strength and endurance, balance, flexibility and functional capacity (Hilgenkamp, Van Wijck & Evenhuis, 2011). Delgado-Lobete et al. (2021) further state that these physical components of functional fitness are necessary for independent living and to improve the individual's functional ability for daily activities.

Motor development limitations of individuals living with ID result in multiple impairments in various spheres of functioning and poorer levels of physical fitness at all phases of adulthood (Frey & Chow, 2006; Van de Vliet, Rintala, Fröjd, Verellen, Van Houtte, Daly & Vanlandewijck, 2006). The study by Pitetti, Yamer and Fernhall (2001) shows that youth living with ID have low cardiovascular and muscle fitness compared to those living without ID and this was reported in adults living with ID as well (Baynard et al., 2008).

Functional skills are an important component for individuals living with ID as these skills are being used for occupational activities at home, school and the residential care facility (if applicable). However, Melville, Cooper, Morrison, Allan, Smiley and Williamson (2008) state that the need for caretaking increases as the age of individuals living with ID increases and the functional fitness decreases. Delgado-Lobete et al. (2021) also observe that individuals living with ID need more assistance with functional activities such as washing, grooming and dressing since these types of activities require more muscular strength than simpler activities such as eating. Dijkhuizen, Douma, Krijnen, Van der Schans and Waninge (2018) report that muscle strength in the lower limbs for individuals living with ID is essential for functional activities such as walking at a suitable pace, standing, sitting and getting up from a chair and walking up and down a set of steps.

Individuals living with ID struggle to balance, separate and link their body movements. Their walking pace is substantially slower than typically developing children, which limits their physical or environmental movement and results in little or no physical activity (Frey, Stanish & Temple, 2008).

2.10 The effect of aerobic endurance and muscle strength training on the functional fitness of individuals living with intellectual disability

Few studies have focused on the associations between physical fitness and functional fitness in individuals living with ID. To perform activities of daily living, individuals living with ID need the necessary muscle strength and endurance, balance, agility and cardiopulmonary endurance. Studies have reported positive results in functional skills and ability after different training interventions such as resistance training, aerobic endurance training and combined interventions (Martínez-Aldao et al., 2019; Kong et al., 2019; DiPasquale & Kelberman, 2020; Aslan, Tonak, Kavlak & Ergin, 2023). Therefore, it is essential for individuals living with ID to be more active and to increase their physical fitness as it is important for improving the functionality of daily tasks.

According to the American College of Sports Medicine (ACSM), adults living with ID should take part in moderate-intensity physical activity for 30 minutes on five days per week or intense aerobic physical activity for 20 to 25 minutes on three days per week (Pescatello, Riebe & Thompson, 2014). However, studies such as Elmahgoub, Calders, Lambers, Stegen, Van Laethem and Cambier (2011) and Richardson, Duncan, Jimenez, Juris and Clarke (2019) prove that short-term training twice weekly for 30 minutes is necessary to reach the physical fitness requirements and health benefits. The solicitude is that adults living with ID are not motivated towards physical fitness and spend most of their time watching television or just sitting during occupational work (Harris, McGarty, Hilgenkamp, Mitchell & Melville, 2018). If someone enjoys an activity, it is most likely that they will continue participating in that activity for a longer period of time. Therefore, exercises for individuals living with ID should be fun, simple and adapted to their age. Group exercises will promote social interaction and this may be motivating for the participants (Stanish, Curtin, Must, Phillips, Maslin & Bandini, 2016). Group activities can be implemented as aerobic endurance or muscle strength training interventions.

Walking, dancing and resistance exercises are well-known aerobic endurance and muscle strength training exercises and these activities have shown an improvement in functional fitness and various physical fitness components for individuals living with ID (Melville et al., 2015; Weterings, Oppewal, Eeden & Hilgenkamp, 2018; Martínez-Aldao et al., 2019; Richardson et al., 2019; Aslan et al., 2023). It is recommended that combined training interventions for this population be used in future intervention studies (Pestana et al., 2018; Obrusnikova et al., 2021).

2.10.1 Aerobic endurance training

Aerobic endurance involves exercises of the large muscle groups and is essential in order to increase cardiorespiratory fitness. The maintenance of optimal cardiorespiratory fitness is important as it decreases with age and is considered a key cardiometabolic risk factor closely related to the survival age for older adults living with ID (Pitetti & Yarmer, 2002; Oppewal & Hilgenkamp, 2019).

2.10.1.1 Walk training interventions

Walking is the most commonly proposed physical exercise for adults living with ID, because it involves minimal joint impact and fall risk (Hsu et al., 2021). Walking as a physical activity can easily be integrated into daily activities. It requires no cost, is accessible and has shown health and fitness improvement. According to the ACSM, the minimum steps per day needed for adults living with ID to be physically active is 10 000 moderate to intense steps (Pescatello et al., 2014). Walking interventions are essential to increase the number of steps per day and improve functional capability (Bergström et al., 2013). Hagner-Derengowska, Kałużny, Hagner, Kochański, Plaskiewicz, Borkowska, Bronisz and Budzyński (2015) state that 90% of the body muscles are being used when walking. A walking intervention study supported these findings and reported a significant reduction in BMI and waist circumference (WC), as well as an increase in flexibility and muscle strength in adults living with ID (Son et al., 2016).

Even though the walking interventions by Bergström et al. (2013) and Melville et al. (2015) for individuals living with ID showed no improvement in physical fitness, other studies observed a significant reduction in anthropometric measures (BMI, body mass, WC) and an increase in flexibility and upper and lower muscle strength (Hagner-Derengowska et al., 2015; Son et al., 2016). In a walking programme study conducted by McDermott, Whitner, Thomas-Koger, Mann, Clarkson, Barnes, Bao and Meriwether (2012), the Step to your Health programme revealed no significant improvement in BMI after nine weeks, six months and twelve months of intervention on adults living with ID. Melville et al. (2015) support these findings after examining the effect of a Walk Well programme on the physical fitness of adults living with ID as their study revealed a negative outcome on improving steps per day and changes in sedentary time, BMI and well-being after 12 weeks of intervention. In contrast to the findings presented by Melville et al. (2015) and Bergström et al. (2013) report an increase of 1608 steps per day after their 12 to 16 months intervention. However, BMI and WC also showed no significant improvements.

Few studies have been conducted on treadmill walking for adults living with ID because in most cases it is financially inaccessible. A 32-week treadmill walking programme for older individuals living with ID demonstrated no improvement in lower limb muscle strength although a significant decrease in BMI was found (Merrick, Bachar, Carmeli & Kodesh, 2013). In contrast, another study with a 25-week treadmill walking programme showed a significant improvement on lower limb muscle strength (Carmeli, Kessel, Coleman & Ayalon, 2002). Furthermore, the study revealed an improvement in balance and functional capacity. The contrasting results of the two studies could possibly be explained by the number of participants or the intensity of the walking intervention. The study by Westrop, Melville, Muirhead and McGarty (2019) demonstrates that women living with ID are more inactive than men which may be a cause for the contrasting findings: the study by Merrick et al. (2013) was conducted on elderly women living with ID only.

2.10.1.2 Dance training interventions

Various dances such as Zumba, contemporary, Tai Chi and traditional dances have shown positive effects on the physical fitness components of individuals living with ID. This different style of aerobic endurance intervention has showed a significant improvement in BMI, muscle strength and endurance, flexibility and mobility for individuals living with ID (Cluphf et al., 2001; Tsimaras, Giamouridou, Kokaridas, Sidiropoulou & Patsiaouras, 2012; Martínez-Aldao et al., 2019; Kong et al., 2019; DiPasquale & Kelberman, 2020; Ladwig, Broeckelmann, Sibley, Ripat & Glazebrook, 2023). Music is an effective motivational tool for this population and shown to influence physical fitness positively when performing physical activity (Owlia, French, Ben-Ezra & Silliman, 1995). This study showed video recordings with music while doing stationary cycling and a significant improvement in various performance parameters were reported for adolescents living with ID (Owlia, French, Ben-Ezra & Silliman, 1995).

In a study incorporating s low-impact dance programme, Cluphf et al. (2001) examined whether their programme would improve the cardiovascular fitness of adults living with ID. The programme was implemented three times a week and after 12 weeks a significant improvement in the experimental group's cardiovascular endurance was found. Similarly, a study by Martínez-

Aldao et al. (2019) conducted on 30 adults living with ID, demonstrated a significant improvement in cardiovascular fitness and muscle strength and a decrease in BMI after ten weeks of training.

Dance studies conducted on adolescents living with ID found similar physical fitness results. A contemporary dancing intervention conducted by DiPasquale and Kelberman (2020) was implemented on 11 adolescents living with ID, for 12 weeks, twice a week and for 60 minutes and found an improvement in balance, muscle strength and flexibility. Another 12-week dancing intervention study using Tai Chi conducted by Kong et al. (2019) on 10-year-old to 18-year-old adolescents living with ID demonstrated significant results. After exercising twice a week for 60 minutes, significant improvement was found in the sit ups test and the six-minute walking test (6MWT), with a decrease in BMI (Kong et al., 2019). Both dancing intervention studies reported a significant improvement in various physical fitness parameters using bi-weekly training of 60 minutes in duration for a period of 12 weeks. Lin, Lin, Lin, Chang, Wu and Wu (2010) propose that individuals living with ID be physically active for at least three times per week for 30 minutes at a moderate level to enhance their quality of life.

2.10.2 Muscle strength training interventions

According to Dijkhuizen et al. (2018), muscle strength of the lower limbs is crucial for daily activities such as walking up and down stairs, standing, lifting and walking in individuals living with ID. In addition, it is fundamental to improve lower body strength as it is closely related to balance (Jeng, Chang, Liu, Hou & Lin, 2017). Improvement of abdominal and upper body strength in this population is crucial for posture, stabilisation of the body and execution of daily tasks (Poncumhak, Saengsuwan, Kamruecha & Amatachaya, 2013; Delgado-Lobete et al., 2021). Furthermore, the lower extremity muscle strength of individuals living with ID is directly correlated to bone mineral density (Pitetti & Yarmer, 2002). Thus, several resistance training programmes have proven to increase muscle strength and endurance for individuals living with ID (Shields et al. 2008; Shields & Taylor, 2010; Rosety-Rodriguez, Camacho, Rosety, Fornieles, Rosety, Diaz, Rosety & Ordonez, 2013; Obrusnikova et al., 2021; Gutiérrez-Cruz et al., 2023). For resistance training to be beneficial, the guidelines of ACSM require adults to perform resistance exercise two to three times per week using two to four sets with eight to 12 repetitions per set and a resting period of two to three minutes between sets (Pescatello et al., 2014).

It is critical to enhance lower and upper body strength since each muscle group contributes to independence in everyday tasks for individuals living with ID (Diz, Gomes & Santos, 2021). Previous studies have shown that resistance training programmes can improve the strength of different muscle groups for individuals living with ID. For example, Zetts, Horvat and Langone

(1995) report positive effects of resistance training on all body muscles while Obrusnikova et al. (2021) found significant improvements in abdominal, upper and lower body muscle strength after a 13-week intervention on adults living with ID (aged 18 to 44 years). However, some studies have reported inconsistent results depending on the population and the intervention. Shields et al. (2008) observed an increase in upper limb muscle strength but not lower body strength after a 10-week resistance training programme on adults living with Down syndrome in Oceania. In contrast, Shields and Taylor (2010) and Shields et al. (2013) found significant improvements in both lower and upper body muscle strength after implementing the same programme on adolescents living with Down syndrome with mild to moderate ID. The intervention consisted of six exercises performed at 60% to 80% of maximum repetition using 12 repetitions and three sets once a week for 90 minutes at a community gymnasium for ten weeks.

The effects of cross-circuit fitness training on overweight and obese Taiwanese adolescents living with ID were investigated by Wu, Yang, Chu, Hsu, Tsai and Liang (2017). The study involved 28 overweight learners living with ID who participated in a 12-week intervention which consisted of 50-minute sessions on five days a week. The participants performed exercises such as bicep curls, triceps expansion, chest press and handgrip tension using rubber bands, weight discs, dumbbells, medicine balls and ankle weights. The results showed that the circuit training improved the participants' dynamic balance, vertical leap, abdominal muscular endurance, cardiovascular fitness and reduced their weight, BMI and fat mass (Wu et al., 2017).

Falls are the leading cause of injury and death among older adults (65+) as reported by the Centers for Disease Control and Prevention (2023b). Muscle strengthening exercise can have a significant positive effect on balance and posture. Several studies have demonstrated the benefits of strength exercises without equipment on balance and muscular strength of children and adolescents living with ID (Ghaeeni, Bahari and Khazaei, 2015; Kachouri, Borji, Baccouch, Laatar, Rebai and Sahli, 2016) . For instance, Kachouri et al. (2016) found that an eight-week programme of combined strength and proprioceptive training improved static balance with closed and opened eyes, as well as abdominal and lower body muscular strength in boys living with ID. Ghaeeni et al. (2015) report significant improvements in static balance measured by the Stork stand test after an eight-week programme of abdominal workout consisting of three to four exercises per session, three to six sets and to 20 repetitions on children living with Down Syndrome. Kachouri et al. (2016) also observed a significant improvement in postural balance after a strength training programme that included exercises such as air squats, jumping squats, straight sit ups, flutter kicks, standing long jump, single-leg hop, running up the stairs with one foot and double-leg hops. Each exercise was performed with 15 to 20 repetitions in sets ranging from three to five.

2.10.3 Combined aerobic endurance and muscle strength training

A systematic review by Pestana et al. (2018) revealed that functional and health outcomes such as mobility, blood pressure and lower and upper body muscle strength for individuals living with ID were improved more by combined aerobic and resistance exercises than by aerobic exercise alone. Other studies also have reported significant improvements in various physical parameters for individuals living with ID after combined aerobic and resistance training programmes or multi-component interventions. For example, Jo et al. (2018) implemented a 90-minute, twice-weekly intervention of aerobic and strength training and observed a significant increase in abdominal muscle endurance, but not in BMI, flexibility and aerobic capacity.

A similar 12-week intervention of combined aerobic and resistance training on adults living with ID was conducted by Salomon, Bellamy, Evans, Reid, Hsu, Teasdale and Trollor (2023) and resulted in significant improvements in BMI, lower and upper limb muscle strength and cardiovascular fitness. Significant improvements in body mass, BMI, abdominal and lower body strength, flexibility and cardiovascular endurance were demonstrated by Asonitou, Mpampoulis, Irakleous-Paleologou and Koutsouki (2018) after performing a multi-component exercise intervention that consisted of one-hour sessions done twice a week for 16 weeks.

A 20-week, three times a week, 60-minute combined aerobic and strength programme in Belgium resulted in significant improvement in handgrip strength, sit-to-stand (lower limb strength) and abdominal muscular strength for 15 adults living with moderate ID (Calders et al., 2011). A shorter 14-week combined training programme, three days weekly and 60 minutes per session for individuals living with ID was carried out in Spain and yielded similar findings for handgrip and lower limb strength (Oviedo, Guerra-Balic, Baynard & Javierre, 2014). The same study also reported significant improvements in balance, cardiovascular fitness and a reduction in BMI and weight. The study involved 37 individuals living with mild to moderate ID with a mean age of 41. Possible explanations for why the shorter training programme of Oviedo et al. (2014) found more significant results than Calders et al. (2011) could be due to the difference in exercise intensity. Oviedo et al. (2014) reported that their programme consisted of high-intensity interval training and Calders et al. (2011) did not specify the intensity of their programme. Another reason could be the difference in the age and severity of ID of the participants since the Oviedo et al. (2014) individuals had mild to moderate ID with a mean age of 41 and Calders et al. (2011) had individuals living with moderate ID with a mean age of 50.

Another combined training programme study in Belgium conducted by Elmahgoub et al. (2011) was implemented to assess the effect of training frequency on adolescents living with ID (aged 14 to 22 years). A total of 15 overweight adolescents living with ID were trained twice weekly for 50 minutes. The training group was subjected to 30 training sessions which lasted for 15 weeks, but those who exercised three times a week trained for ten weeks. Elmahgoub et al. (2011) reported significant improvements in both combined exercise training groups compared to the control group after 30 sessions. Significant improvements were shown for body mass, BMI, WC, cardiovascular fitness, lower and upper limb strength. Comparing the two training groups, exercising three times a week has shown to be significantly better than training twice a week in the lower body muscle strength. Considering these findings, Elmahgoub et al. (2011) suggest that exercising twice a week is more realistic and practical for participation.

Similar findings were found in children living with ID after participating in combined training programmes. A 12-week combined aerobic and strength training intervention performed in China by Wang, Bu, Yu, Sun, Wang, Lee, Baker and Gao (2022) was carried out twice a week for 60 minutes. Fifteen overweight and obese children living with ID, aged between 12 and 18 years, were assigned to take part in 12 aerobic games established by the Jockey Club Keep Fit Formular for Children Programme. Each session for the exercise group included a 10-minute warm-up, a 45-minute main activity (which included two 15-minute cardiovascular games followed by 15-minute weight training) and a 5-minute cool-down. After 12 weeks of moderate to vigorous training, they reported significant improvements in cardiovascular fitness, muscular strength endurance, handgrip strength and BMI.

To summarise, combined aerobic and resistance training significantly improved lower and upper limb muscle strength and cardiovascular fitness in the studies by Oviedo et al. (2014), Calders et al. (2011) and Elmahgoub et al. (2011). They used aerobic exercises such as jogging, walking, running, stepping, cycling and aerobic dancing and combined these with resistance training. Wang et al. (2022) used a different approach for their combined exercise programme which involved aerobic games with weight training. This was suitable for their school-based physical activity intervention for children living with ID. These studies showed that combined exercise programmes can benefit children, adolescents and adults living with ID regardless of age. Oviedo, Javierre, Font-Farré, Tamulevicius, Carbó-Carreté, Figueroa, Pérez-Testor, Cabedo-Sanromá, Moss, Massó-Ortigosa and Guerra-Balic (2020), Elmahgoub et al. (2011) and Wang et al. (2022) report significant improvements in weight, BMI, lower limb strength and cardiovascular fitness after the interventions.

2.11 Conceptual Framework

The conceptual outline for this study (Figure 2.2) is a combined framework of the model of Bouchard, Shephard and Stephens (1994) and the International Classification of Functioning, Disability and Health (ICF) model of McDougall, Wright and Rosenbaum (2010). Bouchard et al. (1994) highlighting the positive impacts of functional fitness on health and physical fitness suggests a direct link between targeted functional exercises and improved overall health outcomes, potentially serving as a practical approach to enhancing well-being. Additionally, the ICF model introduced by McDougall et al. (2010), emphasizing the intricate relationship between functioning, health, and disability, provides a comprehensive framework to assess how improvements in functional fitness may positively influence an individual's overall functioning and subsequently impact their health and disability status within the broader context of their environment and personal factors. Furthermore, a study conducted by Oviedo et al. (2020) demonstrates the positive influence of physical activity in senior adults living with ID on their independent functioning, mobility and performance in relation to ageing. The current study focuses on the association between physical activities, functional fitness and activities of daily living. Thus, the framework demonstrates the broader perception in which these conceptions intervene with each other (Figure 2.2). The illustrated conceptual framework (Figure 2.2) guided the analyses and methodology employed for this study. The chosen empirical research methodology used in this study was in alignment with the conceptual framework and research design.

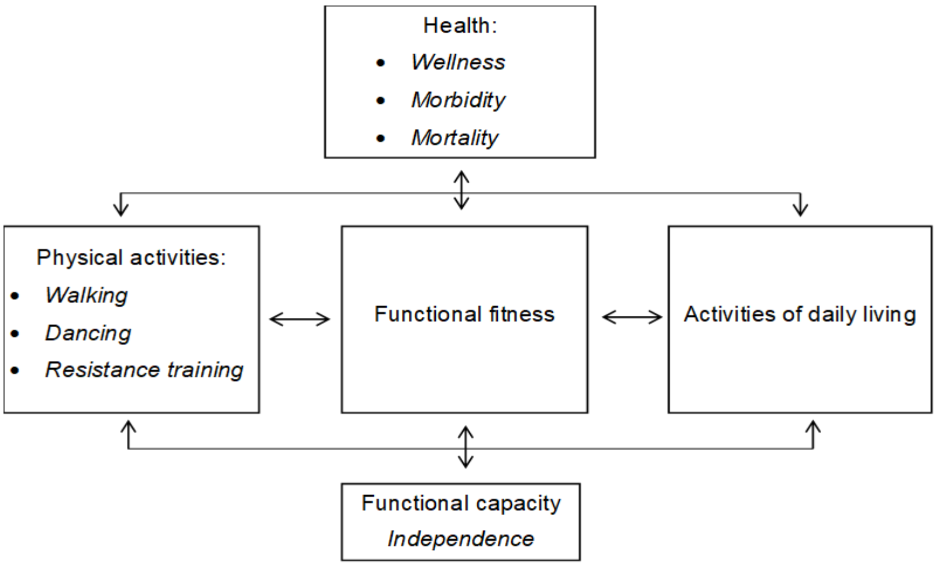

Figure 2.2: Combined framework of Bouchard et al. (1994) and the ICF-model of McDougall et al. (2010)

2.12 Conclusion

Individuals living with ID experience many health-related conditions and barriers to physical activity which lead to sedentary lifestyles and being overweight. Consequently, many of the individuals depend on others and age prematurely. Exercise has been shown to prevent or slow down the many conditions associated with a functionally debilitating lifestyle for this population. Most studies that used aerobic training as an intervention strategy in isolation demonstrated few to no improvements in various anthropometrical or functional fitness parameters. However, a few studies implemented combined training interventions and showed more promising results, although significant improvements in all functional fitness parameters were not shown.

CHAPTER THREE

The effect of a walking, dancing, and strength training programme on the functional fitness of adults with intellectual disability: a randomised trial

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The article is accepted for publication in the *Journal of Intellectual and Development Disability* (2023/09/06). Changes as requested by international reviewers have already been incorporated. See Appendix G for prove.

Written according to the guidelines of this Journal (Appendix A).

The effect of a walking, dancing and strength training program on the functional fitness of adults with intellectual disability: a randomised controlled trial

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Abstract

Background Many adults with intellectual disabilities live a sedentary lifestyle, have low levels of functional fitness and are overweight. The purpose of this study was to determine whether an exercise intervention with activities which are simple, fun, accessible, convenient and adapted for socialising in a group would elicit significant improvements in various parameters associated with functional fitness for adults with intellectual disabilities.

Methods Forty-two adults with intellectual disability (44.5±11.5 years) were randomly located to an exercise group (n=19) and control group (n=23). The program consisted of walking, dancing and resistance training exercises and was implemented, three times a week for six weeks.

Results Significant ameliorations (p<0.05) were reported for body mass, hip circumference, aerobic capacity, functional ability, muscular strength, balance and flexibility with varying degrees of effect sizes.

Conclusions The combined exercise training program showed a significant positive impact on various parameters associated with functional fitness for adults with intellectual disability.

Keywords: functional fitness, intellectual disability, adults, intervention, physical activity, randomised controlled trail.

Introduction

Intellectual disability is defined by the Diagnostic Criteria for Intellectual Disabilities (DSM-5) as: “A disorder with onset during the developmental period that includes both intellectual and adaptive functioning deficits in conceptual, social, and practical domains” (American Psychiatric Association, 2013:33). Individuals with intellectual disability have significant limitations in intellectual functioning (reasoning, scheduling and problem-solving**)** and adaptive skills (independence, communication, social participation and academic functioning) that are required for daily living, such as conceptual, social and practical skills (American Psychiatric Association, 2013). People with an intelligence quotient (IQ) score of 70 or below indicates a limitation in intellectual functioning. It is estimated that 1% of people worldwide live with intellectual disabilities (Harris, 2006). In South Africa, the latest national census survey implemented in 2001 revealed a prevalence of 5% overall disability of which 0.5% was intellectual disability (Njenga, 2009). Individuals with intellectual disability have a shorter life expectancy than the general population (Kinnear et al., 2018). However, it has been reported that the life expectancy of individuals with intellectual disability has increased due to improved medical care (O'Leary et al., 2018). Although the life expectancy of individuals with intellectual disability has increased in recent times, most individuals with intellectual disability are still inactive and live a sedentary lifestyle (Hsieh et al., 2017). A sedentary lifestyle and obesity may lead to other risk factors such as diabetes, cardiovascular heart disease, hypertension and high cholesterol in this population (De Winter et al., 2012).

In order for individuals with intellectual disability to live independent and healthy lives, their functional fitness levels need to improve so that they can execute daily activities safely and independently without undue fatigue and age in a healthy manner (Blick et al., 2015). Exercise for individuals with intellectual disability will improve their daily functioning which is needed for basic tasks, such as washing/bathing, dressing, walking, and carrying objects. In previous studies, researchers demonstrated that interventions with physical activities can improve the functional fitness of adults with intellectual disability (Jo et al., 2018; Obrusnikova et al., 2021). However, barriers to exercise participation have made it difficult for this population with a lack of finances and interest, transportation problems and a lack of educated physical activity professionals are reasons often cited (Burns et al., 2022; Mahy et al., 2010). A combined intervention comprising of fun, easy-to-do, inexpensive, accessible activities such as walking, dancing and resistance training has never been performed in a population of intellectual disability individuals. These exercises can easily be implemented at home or in care facilities. Often, these training interventions performed in isolation provide improvement in some functional fitness parameters, but not in all. For example, studies have shown that a walking intervention improves aerobic capacity and functional ability in individuals with intellectual disability but may not improve body composition and vice versa (Bergström et al., 2013; Son et al., 2016). Dancing has been shown to be an excellent exercise modality for individuals with intellectual disability and have shown improvement in some of the parameters associated with functional fitness (DiPasquale & Kelbermans, 2020; Kong et al., 2019; Martínez-Aldao et al., 2019). Regarding an improvement in daily life functioning, two studies have reported significant improvements with a dancing intervention (Hwang & Braun, 2015; Martínez-Aldao et al., 2019). Furthermore, it has been demonstrated that individuals with intellectual disability enjoy music and dancing and this exercise modality could thus help with exercise motivation (Barr & Shields, 2011). Resistance training interventions have also shown significant improvements in muscular strength and physical ability for individuals with intellectual disability (Obrusnikova et al., 2022; Obrusnikova et al., 2021; Shields et al., 2008) but no significant improvements in various anthropometrical variables (Calders et al., 2011; Mendonca et al., 2013; 2011) and limited improvement in muscular strength (Shields et al., 2013) .

It is clear that dancing, walking and resistance training modalities performed in isolation are beneficial for adults with intellectual disability but combining these fun, accessible and easy-to-do exercises could possibly improve more parameters associated with functional fitness (anthropometry, muscle strength and endurance, cardiopulmonary endurance, functional ability, balance and flexibility) for adults with intellectual disability.

Methods

Participants

A total of 45 willing adults with intellectual disability, between the ages of 18 and 65 formed part of this study. Participants that could not understand and comprehend test instructions and demonstrations or that suffered from congestive heart disease were not eligible for this study. The care centre for adults with intellectual disability has a population of 90 residents and all the residents and their parents or legal guardians who gave consent were selected for this study. The participant's parents or legal guardians had to provide consent and the participants themselves had also provided consent through an adapted and easier-to-understand consent form using a thumbprint for consent. Forty-five willing adults with intellectual disability that provided consent were randomly allocated to two groups (an exercise group (EG) and a non-exercising control group (CG)) (Figure 1). Three individuals in the EG dropped out during the first week of the intervention due to injury (not related to the baseline tests or intervention) or family crisis. The final sample consisted of 42 participants. The study was approved by the institutional human research ethical committee (CPUT/HWS-REC 2022/S12).

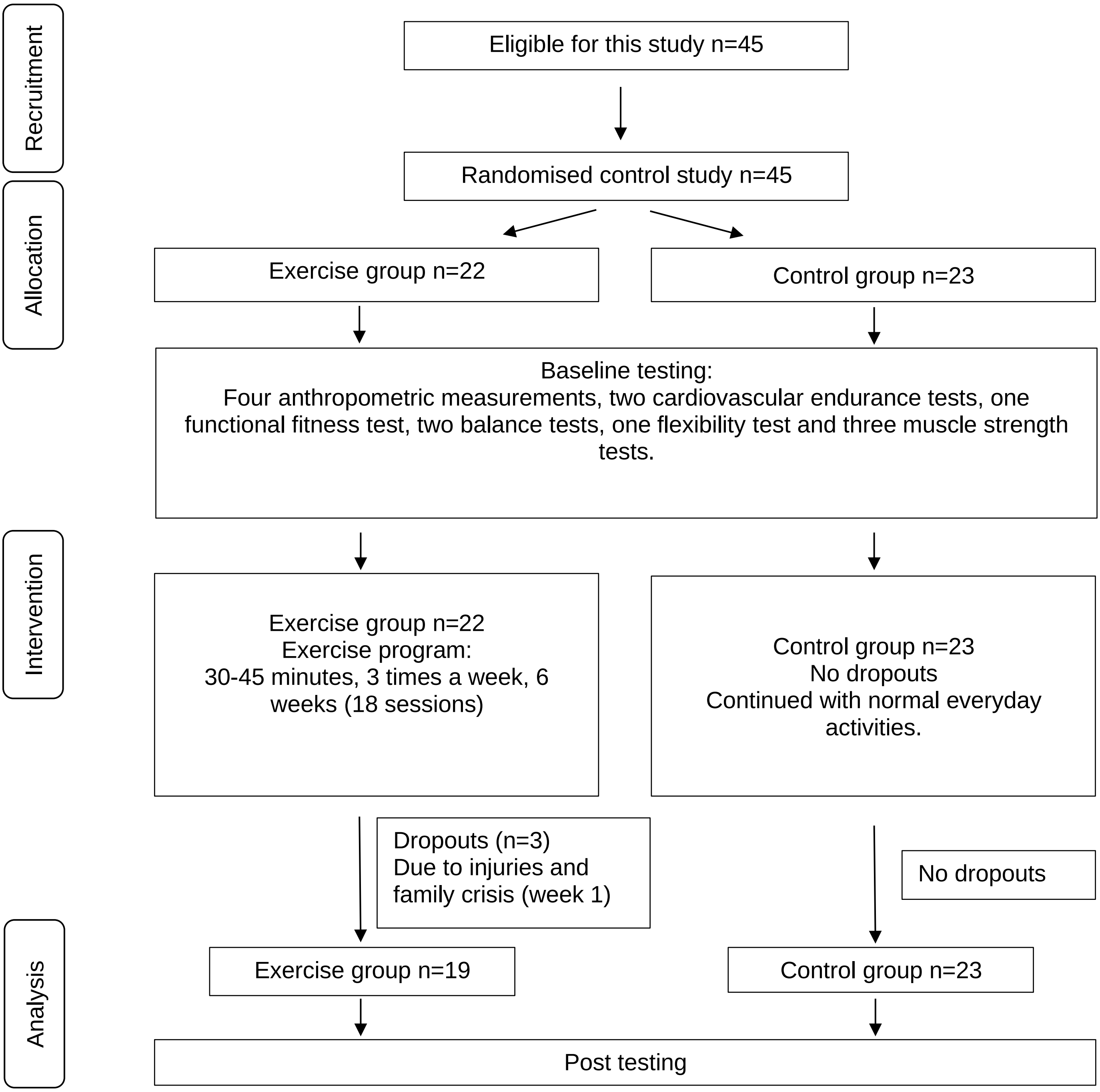

Figure 1. Intervention flow diagram

Procedures

All participants completed the 13 baseline tests. Participants were well familiarised with all tests and procedures on two separate occasions one week before the study commenced, as recommended by Boer (2021), Casey et al. (2012) and Fernhall et al. (1990). During these familiarisation sessions, the procedures and tests were physically demonstrated and participants were verbally instructed (concise, simple and clear communication), physically prompted and progressively guided. It also helped with pacing and gave a feel of the duration of the tests. For all of the tests (except the two cardiovascular endurance tests), familiarisation was again performed on testing day, prior to the test (see details in next section). All procedures were followed identically as outlined in Boer (2021). On the first assessment day all anthropometric measurements (body mass, height, waist and hip circumference), balance (static: standing on one leg and dynamic: walking on a balance beam) and flexibility (sit and reach) tests were completed. On the second day, the chair stand test, isometric push-up, and 6-minute walking distance test were performed. On the third and final day, the modified curl-up, eight-foot get up and go test and 16-meter PACER test were performed. These 13 tests were repeated after six weeks in the same order. The primary researcher, two social workers and two Human Movement Science students were present during all testing sessions (from here on referred to as ‘supervisors’). During the baseline and post testing period, the primary researcher (First Aid level 3), a registered nurse and a social worker were on the premises of testing. All testing accrued in a well-ventilated and spacious indoor venue free from noise and disturbance on a non-slippery floor.

Training programme/ sessions

All exercises performed in this training program had been adapted to the specific needs of individuals with intellectual disability. The final EG of 19 adults with intellectual disability participated in a structured six-week adapted exercise intervention program (Appendix A). The table in the Appendix (Appendix A) shows specific information that was performed during the six-weeks of training. The table is structured for Week 1 and 2, Week 3 and 4 and Week 5 and 6 and separately for resistance-, walk- and dance-training. All three sessions were structured and led by the primary researcher, who has experience in teaching physical activity for adults with intellectual disability.

The first session included resistance training. The participant performed a circuit of six exercises which involved two lower-limb muscle exercises, two upper-body exercises, one abdominal muscle exercise and one muscle endurance exercise. A study supervisor was present at each one of the six stations, and participants performed each station in a group of three to four participants. Registration and exercise familiarisation sessions were held ten minutes before the start of activity. Each repetition of resistance exercise was performed for 45-seconds and three to four sets were performed. The rest between repetitions was 30 seconds and between sets, one minute. All resistance training exercises were performed using the participants own body weight, except for 'bicep curls' which was performed using a 2- or 4-kg dumbbell weight. The resistance exercises described, were chosen due to their simplicity and because no special equipment was needed. Consequently, this training regimen could be repeated by other researchers, adapted physical activity specialists or the physical education specialists working at intellectually disabled care centres using these easy-to-do exercises and with no specialised equipment. The table as provided in the Appendix provides more specific information (Appendix A).

The second training modality involved moderate-intensity walking for 30 minutes (after two weeks, hills were added and after four weeks, exercise duration was increased to 45 minutes). Participants also completed this activity in a group of three to four individuals with a study supervisor based on their fitness level as assessed by the 16-meter PACER test (described in the next section). However, all participants walked at the same time of day.

The third session focused on dancing and comprised of various movements and lasted between 25 minutes (week 1 & 2) and 40 minutes (week 5 & 6) (Appendix A). Dancing was performed as a group in whole. The study supervisors were present to motivate and dance with the participants. Ten minutes before the dancing session, familiarisation with the session's dance moves and associated keywords were performed. The dancing moves/style were comparable to Zumba movements, which were simple to learn. To execute the movements, the instructor/researcher used terms like "hands", "knees", "legs", "crossover", "walk", "side to side", etc. Some dances, however, needed chairs, in which they had to open and close their legs, rise up and sit, lift their legs, stamp their feet, punch hands in the air, etc. A thorough description is also provided in the Appendix Table (Appendix A).

All three exercises modalities were performed with music. Dancing and walking exercise intensity was monitored subjectively using Borg's rating of perceived exertion (RPE) scale (Williams, 2017). For moderate intensity exercise, a RPE level of 12 to 14 is required. The supervisors (five supervisors: 19 participants) encouraged the participants to maintain their level of RPE. Participants were asked every five minutes at what level of RPE they were currently exercising (supervisors held a RPE table which was printed on an A3 laminated page in front of the participant who selected the appropriate current level of exercise intensity). Exercise intensity was then adapted to the necessary intensity level. For dancing, the music encouraged participants to maintain the required level of RPE. Music with an appropriate beat using hits from well-known local (Afrikaans songs) and international artists were preferred. Music was chosen ahead of time, and movements were designed to complement it. The music and additional support as provided by the supervisors motivated the adults to actively engage.

Testing session

Anthropometric measures

Body mass and height (Body mass index)

The body mass of each participant was measured with a calibrated electronic scale (Beurer, Germany) to the nearest 0.1kg. Participants wore light clothes with no shoes. Stature was determined with a sliding steel stadiometer to the nearest 0.1cm (Siber-Hegner GPM, Switzerland). The body mass (kg) and stature (m) were used to determine the BMI.

Waist and hip ratio (WHR)

Waist and hip measurements were conducted with a flexible steel tape (Lufkin, Cooper Tools, Apex, NC). Waist circumferences (WC) were measured at the umbilicus after a normal expiration. Hip circumferences (HC) were measured across the broadest part of the hips and recorded to the nearest cm. The waist and hip circumference were used to calculate the waist-to-hip ratio (WHR) using the formula: WHR = Waist circumference ÷ hip circumference.

Functional fitness test

Eight-foot get up and go test.

This functional fitness test was performed twice and the best time was recorded. On the researchers' signal, the participant got up from the edge of the chair, walked quickly around a marker 2.43 meter (8 feet) away and returned to a seated position. After one practise trial, two test trials were conducted and the best time is recorded in seconds (Boer, 2021). Test-retest reliability for eight-foot get up and go was conducted in an elderly population, with an ICC value of 0.95 (Rikli & Jones, 2013). Test-retest reliability was also done for adults with Down syndrome (ICC = 0.95) (Boer & Moss, 2016b).

Cardiovascular endurance

Six-minute walking time

The six-minute walking time test (6MWT) is a self-walking paced test, whereby the participant was required to walk as fast as he or she could for six minutes and attempt to finish as many laps as he or she is capable of. One lap equals a distance of 45.72 meters (50 yards). A practise trial was performed one week before the study (Casey et al., 2012). The test-retest reliability for individuals with intellectual disability is ICC 0.98 (Nasuti et al., 2013).

16-meter PACER *test*

Cardiorespiratory fitness was assessed with the 16-meter PACER test. At the tone sound of an audio tape recorder, the participant had to run between two lines 16 meters apart. Only one trial was provided, with the assistance of the researcher acting as a pacer for motivation. The number of shuttles that are completed on pace was recorded and documented. Test-retest reliability was measured in adolescents and children in intellectual disability with an ICC value of 0.98 (Winnick & Short, 1998). The 16-meter PACER test was shown by Boer and Moss (2016b) as a feasible and reliable functional test for adults with Down syndrome with an ICC value of 0.99.

Muscular strength and endurance

30 seconds chair stand

The 30 seconds chair stand test (30s CS) test assessed the lower body muscle strength of the participants. The participant sat in an upright position on a chair, feet flat and shoulder-width apart on the floor, with arms folded across the chest. On the command of the researcher, the participant rose to a full stand and back to a seated position. The total stands that the participant performed in 30 seconds was recorded. One practise trial was performed and two test trials (Boer, 2021) Test-retest reliability (ICC of 0.72) is good for individuals with intellectual disability (Hilgenkamp et al., 2012).

Modified curl-up.

The modified curl-up test examined the abdominal muscular strength and endurance of the body. The participant lay in a supine position on the mat, knees bent and feet flat on the floor, with their hand placed in front of his or her thighs. During the modified curl-up test, the participant had to slide his/her fingertips along his or her thighs until their fingertips reached his or her superior aspect of the patella and then return to the starting position. The participants only had one trial to perform as many curl-ups as achievable for as long as possible. The total correct curl-ups were recorded. For this test, only one test trial was conducted and a practise trial of less than three curl-ups was conducted (Boer, 2021). Test-retest reliability measured in adolescents with intellectual disability is good (ICC = 0.82) (Winnick & Short, 1998).

Isometric push-up

The isometric push-up test was used to examine the upper body strength and endurance of the body. The participant was requested to hold a push-up position (raised plank position) for as long as they possibly can. One attempt was provided to hold an isometric push-up position and the result time was taken to the nearest second. Time stopped as soon as the participants raised or sagged their back. For this test, a practise trial of three to five seconds was conducted to ensure proper posture and one test trial (Boer, 2021). Good test-retest reliability is shown in adolescents with intellectual disability (ICC = 0.98) (Winnick & Short, 1998).

Balance

Standing on one leg

The static balance of the left and right legs was evaluated by standing on one leg on a flat surface. The free foot had to be lifted 90 degrees backward with their hands on their thighs. The participants had to stand for as long as they could for a maximum of 10 seconds on each leg. The time started when the participants lifted their foot. Two practise trials and two test trials were given to the participant and the best score of each leg was recorded to the nearest 0.01 second (Boer, 2021). The test-retest reliability of the one-leg stand test for the elderly population has shown an ICC value of 0.88 (Rikli & Jones, 2013) and an excellent ICC value of 0.95 has been shown in adults with Down syndrome (Boer & Moss, 2016b).

Waking on the balance beam

The dynamic balance was measured by walking on a balance beam that was 3.05m long and 10.16cm wide. The participant was required to walk with their hand on the hips while preserving a normal stride. The total steps were recorded on the balance beam, with a maximum of six steps. After one practise trials, two test attempts were provided to each participant, whereby the best score was documented (Boer, 2021). The test has demonstrated excellent feasibility and test-retest reliability (ICC = 0.93) in individuals with Down syndrome (Boer & Moss, 2016b).

Flexibility

Sit and reach.

The participant sat on the edge of the chair, placed against a wall. Participants placed their two hands on top of each other. The tips of the middle finger were even. The distance was measured between the tip of the middle finger and the toes. If the tips touched the toes the result was zero. If they did not touch the toes, it was a negative score and if the fingertips moved past the toe, it was a positive score and the magnitude recorded. Two practise trials were allowed (Boer, 2021). Two trials were performed. The test-retest reliability of this test is excellent for older adults (ICC = 0.95) (Rikli & Jones, 2013) and adults with Down syndrome (ICC = 0.98) (Boer & Moss, 2016b).

Statistics

Data were analysed with the Statistical Package for the Social Sciences (SPSS 28.0, Chicago, IL, USA). Data were screened for normality and outliers by using descriptive statistics and the Shapiro-Wilk test statistic. Data are presented as mean and standard deviation and non-gaussian data as median and interquartile range. The results of participant data at baseline between the EG and CG was assessed using a one-way ANOVA. To evaluate differences between groups from pre to post a one-way ANOVA was used, controlling for differences at baseline. Data was screened to analyse whether one-way ANOVA assumptions were violated. If normality assumptions were violated the non-parametric Wilcoxon signed-rank test statistic was used. Cohen's D effect sizes (ES) is also provided to demonstrate the practical magnitude effects of improvement or deterioration. A conventional rule is to consider Cohen's d of 0.2 as small, 0.5 as medium, and 0.8 as large (Cohen, 1988). A significance level of $p < 0.05$ was used.

Results

The final sample of the study included 42 individuals. The sample consisted of 26 men and 16 women with mean age (44.5±11.5) and body mass index (BMI) (26.1±3.9). No serious or adverse events resulted due to the tests or training intervention from the current study. The intervention period was well attended, with only four individuals missing one session and catching that up the same or following week. Consequently all 19 EG participants completed all 18 exercise sessions.

Table 1 presents the mean and SDs of the functional fitness parameters for the total sample (n=42), EG (n=19) and CG (n=23). At baseline, there were no significant differences between the tests except for height, WHR and the eight-foot get up and go test (see # in Table 1). The results of body mass, standing on one leg, walking on the balance beam and sit & reach flexibility were not normally distributed and consequently the median and interquartile range values are also provided. Significance for these tests were tested with the non-parametric Wilcoxon signed-rank (See % in Table 1). After six weeks of physical training, the EG group showed a significant decrease in body mass and HC compared to the CG with negligible ES (Table 1 and 2). The EG had a statistically significant improvement in cardiovascular endurance, functional ability, muscular strength, balance and flexibility, compared to the CG (Table 1). Large ES were reported for muscle strength and endurance, dynamic balance and cardiovascular endurance (6MWT) and small ES for functional ability, 16-meter PACER and static balance (Table 2). Individual results as line graphs are also visually shown in Figure 2 for body mass, cardiovascular endurance, and leg strength (Figure 2).

Table 1. Mean, standard deviation and significance for the total sample, exercise and control group as pre and post values.

Variables	Total sample (n=42)		EG (n=19)		CG (n=23)	
	Mean Pre (SD)	Mean Post (SD)	Mean Pre (SD)	Mean Post (SD)	Mean Pre (SD)	Mean Post (SD)
General						
Age	44.5 (11.5)	44.9 (11.5)	47.2 (12.3)	47.6 (12.3)	42.3 (10.6)	42.6 (10.4)
Gender (male/female)	26/16	26/16	11/8	11/8	15/8	15/8
Anthropometry						
Body mass (kg)	72.4 (14.0)	71.5 (14.0)	75.5 (11.4)	73.7 (11.2)*	69.9 (15.7)	69.7 (15.9)
Body mass (median & IQR)	69.1 (17.9)	69.1 (16.8)	70.3 (17.9)	70.3 (16.6)%	68.5 (13.9)	68.1 (15.4)
Height (cm)	1.65 (0.1)	1.65 (0.1)	1.69 (0.09)#	1.69 (0.08)	1.62 (0.1)	1.62(0.1)
BMI (kg/m^2)	26.1 (3.9)	26.1 (4.4)	26.2 (3.2)	25.7 (3.1)	26.1 (4.5)	26.5 (5.2)
WC (cm)	89.9 (11.5)	89.8 (11.6)	89.9 (8.9)	89.5 (8.9)	89.9 (13.4)	90.1 (137)
HC (cm)	103.4(10.2)	102.6 (10.0)	106.8 (8.9)	105.3 (8.9)*	100.5 (10.5)	100.3 (10.4)
WHR (waist/hip)	0.87 (0.08)	0.87 (0.08)	0.84 (0.05)#	0.85 (0.05)	0.89 (0.09)	0.90 (0.08)
Static and dynamic balance						
SOOL (cm)	6.8 (3.4)	7.0 (3.4)	7.5 (3.3)	8.2 (2.9)	6.3 (3.5)	6.1 (3.5)
SOOL (median & IQR)	8.2 (6.5)	10.0 (6.5)	9.3 (4.9)	10.0 (1.8)%	6.2 (7.4)	6.7 (7.4)
WOBB	3.5 (2.0)	4.2 (2.2)	3.8 (1.6)	5.5 (1.1)$	3.2 (2.2)	3.2 (2.3)
WOBB (median & IQR)	3.0 (3.3)	5.5 (4.0)	4.0 (3.0)	6.0 (1.0)%	3.0 (5.0)	3.0 (5.0)
Flexibility						
Sit & reach (cm)	-2.6 (11.9)	-1.7 (11.8)	-4.0 (12.1)	-2.3 (11.4)	-1.4 (12.0)	-1.2 (12.4)
Sit & reach (median & IQR)	-2.5 (18.0)	-1.0 (17.3)	-3.0 (16.0)	-2.0 (13.0)%	-1.0 (20.0)	0.0 (19.0)
Muscular strength and endurance						
Modified curl-up (n)	37.8 (27.9)	50.0 (29.3)	43.4 (28.8)	65.6 (20.4)*	33.2 (26.8)	37.1 (29.7)
Isometric push-up (s)	43.5 (33.8)	51.8 (36.6)	40.6 (26.0)	67.9 (35.2)$	46.0 (39.6)	38.5 (32.7)
Chair stand (n)	11.0 (2.4)	13.3 (2.8)	10.7 (1.7)	14.9 (1.7)$	11.2 (2.9)	11.9 (2.7)
Cardiovascular endurance						
16-meter PACER (shuttles)	23.9 (20.2)	27.4 (21.7)	24.4 (17.8)	32.7 (20.9)$	23.5 (22.4)	23.0 (21.8)
6MWT (m)	530.7(120.0)	563.3 (119.6)	547.2 (79.8)	616.5 (90.2)$	517.1 (145.6)	519.3 (124.6)
Functional fitness test						
Eight-foot get up and go (s)	5.71 (1.3)	5.73 (1.3)	5.18 (0.9)#	4.90 (0.7)$	6.14 (1.3)	6.42 (1.3)

Values are presented as mean ± standard deviation except where otherwise indicated.
6MWT: Six-minute walking time; BMI: body mass index; CG: control group EC: exercise group; HC: hip circumference; IQR: interquartile range; SD: standard deviation; SOOL: standing on one leg; WC: waist circumference; WHR: waist-hip ratio, WOBB: walking on balance beam.
#: P<0.05 significant difference between exercise and control group at baseline
*: P<0.05 significant difference between exercise and control group from pre to post.
$: P<0.01 significant difference between exercise and control group from pre to post
%: Significant difference within groups using the non-parametric Wilcoxon signed-rank test statistic
Significance not assessed for total sample.

The figure (Figure 2) below demonstrates the individual results as line graphs for the 19 exercise participants between pre and post-test for (a) 16-meter PACER, (b) body mass, (c) 6MWT and (d) the chair stand test.

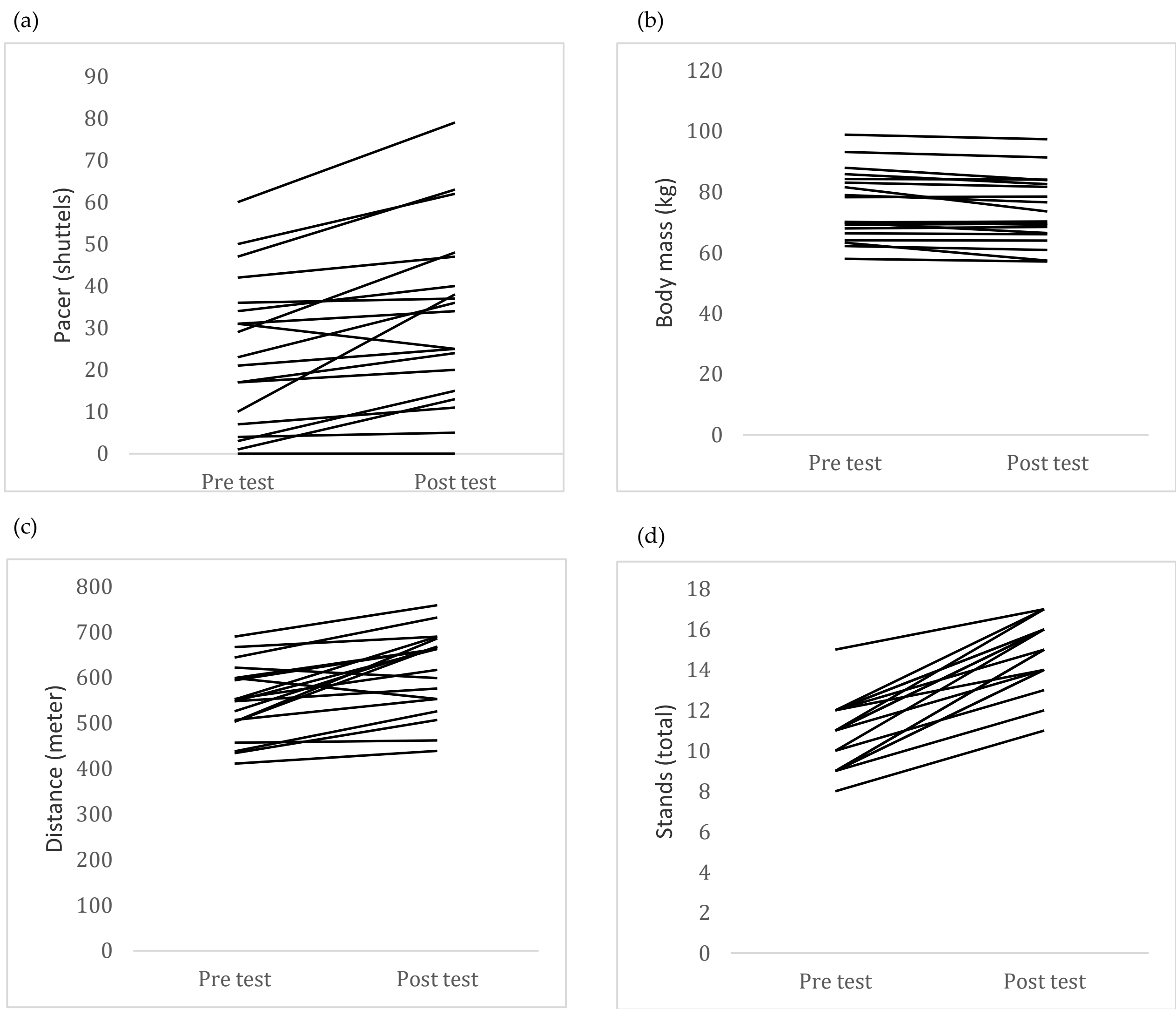

Figure 2. Individual representation of the pre- and post-test scores of the exercise group (n=19) for the (a) 16-meter PACER test; (b) body mass; (c) 6MWT; (d) chair stand test.

Table 2. Effect size for each functional fitness parameter

	EG (n=19)		CG (n=23)	
Variables	ES	Magnitude	ES	Magnitude
Anthropometry				
Body mass	-0.16	negligible	-0.01	negligible
BMI	-0.15	negligible	0.08	negligible
WC	0.03	negligible	0.01	negligible
HC	-0.16	negligible	-0.02	negligible
WHR	0.12	negligible	0.00	negligible
Static and dynamic balance				
SOOL	0.30	small	0.07	negligible
WOBB	1.16	large	0.00	negligible
Flexibility				
Sit & reach	0.14	negligible	0.02	negligible
Muscular strength and endurance				
Modified curl-up	0.89	large	0.14	negligible
Isometric push-up	0.88	large	-0.19	negligible
Chair stand	2.55	large	0.24	small
Cardiovascular endurance				
16-meter PACER	0.43	small	-0.02	negligible
6MWT	0.81	large	0.00	negligible
Functional fitness test				
Eight-foot get up and go	-0.34	small	0.21	small

6MWT: Six-minute walking time; BMI: body mass index, CG: control group EC: exercise group; ES: effect size; HC: hip circumference SOOL: standing on one leg; WC: waist circumference; WHR: waist to hip ratio; WOBB: walking on balance beam.

Discussion

The primary aim of the current study was to examine the effect of a walking, dancing and strength training program on the functional fitness of adults with intellectual disability. The key finding of this study is that this combined exercise program had a significant impact on most parameters associated with functional fitness. Body mass, HC, cardiorespiratory endurance, functional ability, muscular strength, balance and flexibility demonstrated significant improvements compared to the CG with ES ranging in magnitude.

Previous studies utilising combined exercise interventions reported significant improvements in some anthropometric profile of adults with intellectual disability (Asonitou et al., 2018; Elmahgoub et al., 2011; Harris et al., 2017; Oviedo et al., 2014; Salomon et al., 2023). Asonitou’s et al. (2018) 16 week (4 days/30 minutes) program and Oviedo’s et al.

(2014) 14 week (3 days/60 minutes) program showed a significant decrease in body mass and BMI. After six weeks of training, our study showed significant improvements in body mass and HC but not for WC and WHR. Twenty-six individuals out of a total sample of 42 (61.9%) were overweight or obese in the current study with a BMI > 24.9 (Bull et al., 2020). A study longer in duration than six weeks could possibly show larger ES as a systematic review by Mitic & Aleksandrovic (2021) stated that programs between 8 and 12 weeks, show significant anthropometrical results for adults with intellectual disability.

Regarding BMI, other studies also found no significant improvement in BMI after implementing a walking or dancing or combined aerobic and strength training program for individuals with intellectual disability (Bergström et al., 2013; Calders et al., 2011; Jo et al., 2018; Melville et al., 2015). On the other hand, some studies, did report significant improvements in BMI (Elmahgoub et al., 2011; Martínez-Aldao et al., 2019; Oviedo et al., 2014). The type of intervention, duration of study length, initial BMI level at baseline and age of participants differ in these studies and no clear reason emerges as to why some report significant improvement and others not. A possible reason for improved BMI could be related to exercise intensity as the study by Boer and Moss (2016a) reported significant improvements in BMI for the high intensity EG but no changes for the moderate intensity EG or CG in adults with Down syndrome.

No significant improvement was reported after six weeks for WC and WHR for the current study. An intervention in longer duration (24 weeks) comprising only one type of exercise also found no improvement in the WC of adults with intellectual disability (Melville et al., 2015). However, a 16-week walking study (100 minutes per session) reported significant improvements in WC for adults with intellectual disability (Son et al., 2016). Also, a multicomponent weight program and a combined exercise program have shown a significant decrease in WC after only 10-13 weeks for individuals with intellectual disability (Elmahgoub et al., 2011; Harris et al., 2017). Improving WC and WHR is important as these variables are associated with abdominal fatness which are related to risk factors such as diabetes mellitus, high blood pressure, coronary heart disease and a risk of hypertension (Kang & Dingwell, 2008). A program longer in length or higher in intensity may elicit more improvements for WC and WHR for adults with intellectual disability (Boer et al., 2014).

Cardiorespiratory fitness is considered a key cardiometabolic risk factor and indicative of 5-year survival for older adults with intellectual disability (Oppewal & Hilgenkamp, 2019). Tests associated with cardiorespiratory fitness and functional ability demonstrated significant improvements in the 16-meter PACER test, 6MWT and eight-foot get up and go with large and small ES (Table 1 & 2). The improvement of the PACER test and 6MWT could partially be a result of an improvement in the leg strength as reported by the chair stand test since aerobic capacity and quadriceps strength are correlated for individuals with intellectual disability (Pitetti & Boneh, 1995; Vaidya et al., 2017). As shown in Figure 2, a large majority of individuals in the EG demonstrated improvements in 16-meter PACER, 6MWT and the number in chair stands (leg strength test). The 6MWT significantly improved by a mean value of more than 50 meters. Elmahgoub et al. (2011) conducted a combined aerobic and resistance training study of 15 weeks and reported mean improvements of 50-80 meters in the 6MWT for adults with intellectual disability. Other studies also reported significant improvements in cardiorespiratory endurance as assessed with maximal oxygen consumption (VO_2 max) testing and the 6MWT for individuals with intellectual disability (Salomon et al., 2023; Sun et al., 2022). In contrast to the findings of the current study and other studies listed, a combined program of 12 weeks and a multicomponent program of 10 weeks showed no significant improvement in cardiorespiratory endurance (Jo et al., 2018; Kim's et al., 2020). Studies comprising only aerobic or strength training have also shown improvement with large ES on aerobic capacity for adolescents and adults with intellectual disability (Kong et al., 2019;

Martínez-Aldao et al., 2019; Obrusnikova et al., 2021). Poor cardiorespiratory endurance is considered a risk factor for cardiac diseases that can result in early mortality for adults with intellectual disability (De Winter et al., 2012; Højberg et al., 2022). Exercises that possibly could have contributed to the improvement of cardiovascular fitness in the current study were the moderate and continuous walking sessions, stair climbing activities, leg strength activities (squats and lunges) and moderate intensity dancing sessions (Appendix A).

Lower body, upper body and abdominal strength all improved significantly with large ES. It is important to improve muscular strength in a population with known low muscular strength as it is an essential requirement for activities of daily living and to function independently for adults with intellectual disability (Diz et al., 2021). Improving leg strength is an important factor that correlates with physical fitness for individuals with intellectual disability (Delgado-Lobete et al., 2021) as poor lower body strength of adults with intellectual disability has been associated with poor functioning in everyday living activities (Cuesta-Vargas et al., 2014). Interventions using resistance training in adults with intellectual disability have also revealed a significant increase in the upper body, lower body and abdominal strength after 12-13 weeks of exercises (Obrusnikova et al., 2021, Salomon et al., 2023).

Improving upper body strength is necessary to perform daily activities such as carrying groceries bags, vacuuming, and executing tasks that depend on upper body muscle strength (Delgado-Lobete et al., 2021). Other scientific investigations have also reported significant improvements in upper body strength after combined training interventions (measured by the push-up/chest press test, single arm push and handgrip test) for adults with intellectual disability (Calders et al., 2011; Obrusnikova et al., 2021; Oviedo et al., 2014; Salomon et al., 2023). Exercises that could have contributed to the improvement of muscular strength is the resistance exercises, and dancing movements. Walking could have also contributed to the improvement in abdominal strength as Son et al. (2016) showed significant improvement in the abdominal strength after a walking intervention study. Aerobic endurance or combined exercise interventions have also reported improved abdominal muscle endurance for individuals with intellectual disability after 12-16 weeks of training (Asonitou et al., 2018; Jo et al., 2018; Kong et al., 2016).

Jeng et al. (2017) further reiterated the importance of improving especially lower body strength as it is closely related to the balance of individuals with intellectual disability. This statement corresponds to the findings of the current study as static and dynamic balance improved significantly (Table 1) with small and large ES respectively (Table 2).

The improvement of static and dynamic balance is important for postural control and to prevent the risk of falling (Poncumhak et al. 2013). Balance ability can be improved with structured exercise training for individuals with intellectual disability (Balouchy, 2022; Haghighi et al., 2019; Kovačič, et al., 2020; Oviedo et al., 2014; Tsimaras et al., 2012; Wu et al., 2017). As an example, the study by Oviedo et al. (2014) demonstrated that aerobic, resistance and balance training performed three times a week for an hour in duration and for 14 continuous weeks, showed significant improvement in balance. Regarding an improvement in dynamic balance, exercises of various modalities (running, resistance training, walking and combined exercises) have demonstrated significant improvements for individuals with intellectual disability (DiPasquale & Kelbermans, 2020; Haghighi et al., 2019; Kovačič, et al., 2020; Martínez-Aldao et al., 2019; Tsimaras et al., 2012). A study with a similar intervention period and consisting of dancing exercises for individuals with intellectual disability (three times a week for 30 minutes, eight continuous weeks) also found significant improvements in dynamic balance (Haghighi et al., 2019). Both studies highlighted that shorter exercise programs can have a significant improvement in dynamic balance. The positive and significant effect of dancing on dynamic balance was also confirmed in other studies with longer interventions and longer training sessions for adults in the general population and adults with intellectual disability (DiPasquale & Kelbermans, 2020; Holmerová et al., 2010; Tsimaras et al., 2012).

Flexibility for adults with intellectual disability is also important as it contributes to postural control and improves joint reach for daily functionality (Carmeli et al., 2005). Adequate flexibility is considered a fundamental component of functional fitness as it is closely related with health development and injury prevention (Ferguson, 2014). Our study showed significant improvement in lower body flexibility but with negligible ES. It is possible that the type of exercises in the current study or the length of the study duration did not provide the needed stimulus for larger practical benefits. Perhaps the inclusion of stretching warm-up and stretching cool-down regime could have resulted in larger practical benefits. Asonitou et al. (2018) reported a significant increase in lower body flexibility for adults with intellectual disability, after implementing a multi-component exercise strategy for 16 weeks. Other studies using aerobic training (Kong et al., 2019; Sun et al., 2022; Son et al., 2019) and dancing (Hwang & Braun, 2015) also reported significant improvements with lower body flexibility but ES are not reported.

Conclusion

The current study demonstrated that most parameters associated with functional fitness improved significantly with varying ES with a combined training program consisting of walking, dancing and resistance training. Some anthropometric variables showed limited or no improvement and this may be a result of the short intervention period. These results demonstrate that this combined program may be of value to improve body mass, HC, cardiovascular endurance, functional ability, muscular strength, balance and flexibility for adults with intellectual disability. Since the length of the exercise program can affect the magnitude of improvement, it is recommended that future studies implement longer exercise programs. Another future study could request that the participants continue to exercise after the intervention period and then perform a three month follow up to determine whether the participants continued to exercise independently and maintained or improved functional fitness as these activities are easy to perform and with no additional equipment needed. A limitation of the current study is that the specific cause of intellectual disability is not known for the participants of the current study. Another limitation of the current study was that exercise intensity was not measured objectively using heart rate monitors although moderate exercise intensity was maintained using the ratings of perceived exertion scale.

Acknowledgements

None

Disclosure statement

The authors report no conflicts of interest.

Funding

No external funding was received for the research reported in the paper.

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APPENDIX

<table>
<tr><td colspan="7">Week 1 + 2</td></tr>
<tr><td colspan="7">10 minutes of registration, greetings and familiarisation of exercises</td></tr>
<tr><td colspan="7">±5 min Warmup and Cool down</td></tr>
<tr><td rowspan="2">Monday: Resistance exercises
Total session: 30-35 minutes
Length of repetition: 45 seconds
Rest between sets: 30 seconds
Rest between exercises: 1 minute.

Three sets in total</td><td>Squats x3 sets</td><td>Push-ups x3 sets. (Female participants were allowed to place knees on mat)</td><td>Climb up and down steps x3 sets</td><td>Sit-ups x3 sets</td><td>Palms facing up, arms straight. Move arms up and down x3 sets.</td><td>Forward lunges (walking forward with alternating legs) x3 sets</td></tr>
<tr><td colspan="6">Each station had a supervisor for motivation and assistance where needed (approximately 3-4 individuals per station)</td></tr>
<tr><td>Wednesday: Walking
30 minutes</td><td colspan="6">Walk 30 minutes (Moderate-intensity walking)
Supervisors walked with participants in groups of three to five so that an average moderate intensity training (RPE level: 12 to 14) was maintained for each participant. Participants were asked every five minutes at what level of RPE they were currently walking. Walking intensity was adapted to the necessary intensity level.</td></tr>
<tr><td rowspan="2">Thursday: Dancing
25 minutes</td><td colspan="2">30 seconds rest between each song. Familiarize moves in the resting period for the next dance.</td><td colspan="4">Dancing with chairs: open and close legs, rise-up and sit, lift legs, stamp feet on the ground, punch hands in the air, touch side to side, lift hands one by one in the air, walking around the chair, hold the chairs back and lift legs backwards up, calve raises and others.

Examples of some of the movements without a chair: Lift knees, jumping, walking on toes, step side to side, kick legs, squats, high fives in the air, jazz hands, clap hands above head, wave arms, walking on the spot, kick backwards, touch side to side, calf rises, lift legs backwards, tap feet or heel on the floor and many others.

Chair dancing was only done in week one and two.</td></tr>
<tr><td colspan="6">Dancing was performed as a group in whole, but supervisors danced with participants for motivation and to assess and control the necessary RPE level. Every 5 minutes each supervisor would ask a participant: “Point to the table to show, at what level of RPE are you exercising at the moment”. Exercise intensity was adapted if outside of the acceptable range (12-14).</td></tr>
</table>

<table>
<tr><th colspan="7">Week 3 + 4</th></tr>
<tr><td colspan="7">10 minutes registration, greetings and familiarisation of exercises</td></tr>
<tr><td colspan="7">±5 min Warmup and Cool down</td></tr>
<tr><td rowspan="2">Monday: Resistance exercises
Total session: 30-35 minutes
Length of repetition: 45 seconds
Rest between sets: 30 seconds
Rest between exercises: 1 minute.

Three sets in total (except Bicep curls)</td><td>Squats x3 sets</td><td>Push-ups x1 set
Tricep dips x2 sets</td><td>Climb up and down steps x3 sets</td><td>Alternating Backward lunges x3 sets</td><td>Toe-tap sit-ups x2 sets Bicycle sit-up x1 set</td><td>Bicep curls x 4 sets (with 2 or 4 kg weights)</td></tr>
<tr><td colspan="6">Each station had a supervisor for motivation and assistance where needed (approximately 3-4 individuals per station)</td></tr>
<tr><td>Wednesday: Walking
30 minutes</td><td colspan="6">Walk 30 minutes with steep hills (Moderate-intensity walking)
Supervisors walked with participants in groups of three to five so that an average moderate intensity training (RPE level: 12 to 14) was maintained for each participant. Participants were asked every five minutes at what level of RPE they were currently walking. Walking intensity was adapted to the necessary intensity level.</td></tr>
<tr><td rowspan="2">Thursday: Dancing
35 minutes</td><td>30 seconds rest between each song. Familiarize moves in the resting period for the next dance.</td><td colspan="5">Examples of some of the movements: Lift knees, jumping, walking on toes, step side to side, kick legs, squats, high fives in the air, jazz hands, clap hands above head, wave arms, walking on the spot, kick backwards, touch side to side, calf rises, lift legs backwards, tap feet or heel on the floor. (Fast movements – Moderate-intensity dancing)</td></tr>
<tr><td colspan="6">Dancing was performed as a group in whole, but supervisors danced with participants for motivation and to assess and control the necessary RPE level. Every 5 minutes each supervisor would ask a participant: “Point to the table to show, at what level of RPE are you exercising at the moment”. Exercise intensity was adapted if outside of the acceptable range (12-14).</td></tr>
</table>

<table>
<tr><th colspan="7">Week 5+6</th></tr>
<tr><th colspan="7">10 minutes of registration, greetings and familiarisation of exercises</th></tr>
<tr><th colspan="7">±5 min Warmup and Cool down</th></tr>
<tr><td rowspan="2">Monday: Resistance exercises
Total session: 35 - 40 minutes
Length of repetition: 45 seconds
Rest between sets: 30 seconds
Rest between exercises: 1 minute.

Four sets in total</td><td>Squats x4 sets</td><td>Push-ups x2 sets.
Dips x2 sets</td><td>Climb up and down steps x4 sets</td><td>Forward lunges x 4sets</td><td>Bicep curls x4 sets (with 2 or 4 kg weights)</td><td>Plank x1 set
Left side plank x1 set
Right side plank x1 set
Sit-ups x1 set</td></tr>
<tr><td colspan="6">Each station had a supervisor for motivation and assistance where needed (approximately 3 individuals per station)</td></tr>
<tr><td>Wednesday: Walking
45 minutes</td><td colspan="6">Walk 45 minutes with steep hills (Moderate-intensity walking)
Supervisors walked with participants in groups of three to five so that an average moderate intensity training (RPE level: 12 to 14) was maintained for each participant. Participants were asked every five minutes at what level of RPE they were currently walking. Walking intensity was adapted to the necessary intensity level.</td></tr>
<tr><td rowspan="2">Thursday: Dancing
40 minutes</td><td colspan="2">30 seconds rest between each song. Familiarise moves in the resting period for the next dance.</td><td colspan="4">Examples of some of the movements: Lift knees, jumping, walking on toes, step side to side, kick legs, squats, high fives in the air, jazz hands, clap hands above head, wave arms, walking on the spot, kick backwards, touch side to side, calf rises, lift legs backwards, tap feet or heel on the floor. (Moderate-intensity dancing)</td></tr>
<tr><td colspan="6">Dancing was performed as a group in whole, but supervisors danced with participants for motivation and to assess and control the necessary RPE level. Every 5 minutes each supervisor would ask a participant: “Point to the table to show, at what level of RPE are you exercising at the moment”. Exercise intensity was adapted if outside of the acceptable range (12-14).</td></tr>
</table>

CHAPTER FOUR

FINDINGS AND RECOMMENDATIONS

4.1 Introduction

The primary aim of the study was to determine whether a six-week walking, dancing and resistance training programme would improve the functional fitness of individuals living with ID.

The objectives of this study were to:

- Determine the effect of an adapted exercise programme on parameters associated with body composition;
- Determine the effect of an adapted exercise programme on parameters associated with muscular strength, flexibility, and balance; and
- Determine the effect of an adapted exercise programme on aerobic capacity and functional ability.

The main finding of this study is that the combined walking, dancing and strength training programme demonstrated significant improvements in body mass, hip circumference, cardiorespiratory endurance, functional ability, muscular strength, balance and flexibility, with effect sizes (Ess) varying in magnitude. Specific results (see Chapter 3) are summarised in section 4.3 according to the objectives of this study and individual improvements are shown as per Figure 1 (see Chapter 3).

4.2. Summary

A summary is provided according to the three specific objectives of the study.

4.2.1 Objective one: parameters associated with body composition

The present study showed significant improvements in body mass and HC but not for BMI, WC and WHR for individuals living with ID (Chapter 3: Table 1). Other studies that used a combination of exercises during their intervention studies also reported a significant reduction in body mass for children living with ID (Wang et al., 2022), adolescents living with ID (Wu, Lin, Hu, Yen, Yen, Chou & Wu, 2010; Elmahgoub et al., 2011) and adults living with ID (Oviedo et al., 2014; Harris, Hankey, Jones, Pert, Murray, Tobin, Boyle & Melville, 2017;

Asonitou et al., 2018). Not only did long-term combined physical activity intervention studies of six or more months by Wu et al. (2010) and Harris et al. (2017) report a significant decrease in body mass, short-term intervention studies achieved similar significant results in less time and fewer sessions (Oviedo et al., 2014; Asonitou et al., 2018). Oviedo et al. (2014) performed a 14-week programme (three days a week for 60 minutes) of aerobic, resistance and balance exercises on 37 adults living with ID and found a significant decrease in body mass and BMI. Similarly, Asonitou et al. (2018) demonstrated with a 16-week program (4 days a week for 30 minutes) using a multi-component intervention that consisted of aerobic, strength, flexibility and balance type exercises, a significant improvement in body mass and BMI for adults living with ID. Moreover, a recent study by Wang et al. (2022) demonstrated a significant improvement in body mass and BMI after applying a 12-week combined programme with aerobic games and resistance exercises for children living with ID.

A possible reason for the significant reduction in body mass and BMI in the short-term studies is that they incorporated a variety of aerobic exercises such as walking, jogging, mild running up and down stairs, cycling and swimming, as well as strength training and balance exercises, (Asonitou et al., 2018). Long-term studies of six or more months demonstrated significant reductions in body mass for adolescents living with ID (Harris et al., 2017) and adults living with ID (Wu et al., 2010) and incorporated exercises such as dancing, acrobatics, jogging, walking, cycling and swimming. In addition, intervention studies consisting of aerobic exercise only such as the walking intervention by Son et al. (2016) for 16 weeks (three days a week for 100 minutes) for adults living with ID and another by Kong et al. (2019) consisting of a dance intervention for children and adolescents living with ID also reported significant improvements in both body mass and BMI.

However, many other studies conducted on adults living with ID found no significant improvement in BMI after implementing a combined aerobic and strength training programme (Calders et al., 2011; Bergström et al., 2013; Melville et al., 2015; Jo et al. 2018; Salomon et al., 2023). For example, the study by Jo et al. (2018) was very similar to our study in that combined walking, dancing and resistance training exercises were performed (12 weeks: two days a week for 90 minutes) and no significant improvement in both BMI and body mass was reported. However, their resistance training programme was performed with Thera band exercises and the exercise intensity for all three modalities may have been insufficient to improve variables associated with body composition. The combined training programme by Salomon et al. (2023) that was implemented on adults living with ID for 12 weeks (two days a week for 60 minutes) also found no improvement in body mass and BMI. Their programme consisted of 40% aerobic exercises, 30% strength exercises and 20% balance exercises.

The factors that could explain this discrepancy between studies using combined exercise training for individuals living with ID (significant loss in body mass and BMI, significant loss in body mass only and no significant improvement in either body mass or BMI) is unclear, as the studies vary in their specific combined training intervention methods, duration of exercises, intensity of exercise, proportion of aerobic/resistance/balance/flexibility exercise, baseline BMI and age of participants. One possible factor could be the intensity of exercise as Elmahgoub et al. (2011) and Boer and Moss (2016a) found that only the high intensity group, but not the moderate intensity or control group, showed significant BMI and body mass improvement after the combined intervention period for individuals living with ID. The length of the intervention period is also an important factor to consider as the systematic review by Mitic and Aleksandrovic (2021) demonstrates that longer programmes reported larger improvements on indices associated with body composition for individuals living with ID. Consequently, a longer exercise period and/or higher exercise intensity may have resulted in significant improvements of BMI for the current study as well as ES larger in magnitude.

A significant improvement in HC was observed among the body composition parameters, but WC and waist-to-hip ratio (WHR) remained unchanged after six weeks of combined exercise training (Chapter 3: Table 1). A 20-week intervention study by Calders et al. (2011) on adults living with ID also found no significant improvement of WC in the aerobic or combined aerobic and resistance training group. A similar outcome (no significant change in WC) was reported by Elmahgoub et al. (2011) after a ten and 15-week intervention period with a combined aerobic and resistance training programme in adolescents living with ID. In contrast, a multicomponent training intervention programme conducted on adults living with ID resulted in a significant decrease in WC (Harris et al., 2017). The study suggested that the improvement of the WC after six and 12-months could be due to the dietary intervention combined with the physical activity. A combined programme by Salomon et al. (2023) also showed a significant improvement in WC after 12 weeks (two days a week for 60 minutes) of aerobic, strength and balance exercises. It appears that a longer or more intense exercise programme combined with a controlled nutritional intake may be needed for adults living with ID to achieve significant improvements in WC and WHR (Boer, Meeus, Terblanche, Rombaut, Wandele, Hermans, Gysel, Ruige & Calders, 2014).

4.2.2. Objective two: muscular strength, flexibility and balance

The present study found significant improvements in lower, upper and abdominal strength for the exercise group compared to the control group as assessed by the 30 seconds chair stand test, isometric push-up test and modified curl-up test (Chapter 3: Table 1). Since individuals living with ID have mobility problems due to reduced muscle and postural functioning (Pitetti & Yarmer, 2002), enhancing their lower body and upper body strength is crucial for their independent daily functioning (Cuesta-Vargas & Gine-Garriga, 2014; Diz et al., 2021). Different types of exercises, such as aerobic, resistance and combined aerobic and strength exercises also have revealed significant improvement in the upper body, lower body and abdominal muscle strength in adults living with ID (Wu et al., 2010; Calders et al., 2011; Oviedo et al., 2014; Son et al., 2016; Jo et al., 2018; Asonitou et al., 2018; Martínez-Aldao et al., 2019; Reina et al., 2020; Kim, Moon, Hong & Ho, 2020; DiPasquale & Kelberman, 2020; Obrusnikova et al., 2021; Diz et al., 2021; Salomon et al., 2023; Ladwig et al., 2023; Gutiérrez-Cruz et al., 2023) A systematic study by Pestana et al. (2018) suggests that exercise programmes using combined strength and aerobic exercises is more effective than those that only have aerobic exercises for improving lower and upper limb muscle strength. A 12-week study by Calders et al. (2011) confirms this finding by demonstrating a more significant improvement in the upper body and lower body muscle strength in the combined exercise group compared to the endurance training group.

4.2.2.1. Upper body strength

The current study demonstrated a significant improvement with a large ES in the isometric push-up which assess the strength and endurance of the upper body muscles (Chapter 3: Table 1 and 2). Upper body muscle strength is essential for doing everyday tasks that require upper body strength such as lifting bags of groceries and cleaning with a vacuum cleaner (Delgado-Lobete et al., 2021). The exercises that could have contributed to the improvement of upper body muscle strength are resistance training exercises and dance movements. According to a systematic review and meta-analysis conducted by Obrusnikova et al. (2021) on adults living with ID, resistance training had a large and positive effect on muscular strength regardless of the length, frequency, or amount of the training sessions. However, Jo et al. (2018) report that a 12-week combined programme of aerobic and resistance training did not improve upper body strength but did show significant improvement in abdominal muscle endurance for adults living with ID. It is possible that the type, intensity, or tension of the Thera band resistance exercises was not primed to improve muscular strength.

Other scientific investigations also have revealed a significant increase in upper body strength after a combined programme was implemented on adults living with ID, which was measured by the single arm test, push-up/chest press test and handgrip test (Calders et al., 2011; Oviedo et al., 2014; Asonitou et al., 2018; Kim et al., 2020; Obrusnikova et al., 2021; Salomon et al., 2023). For example, a 14-week combined aerobic, strength and balance programme demonstrated a significant improvement in the 30-second arm curl up and handgrip test

(Oviedo et al., 2014). Other studies that also reported a significant improvement in upper body muscle strength in adults living with ID were the 12-week combined aerobic, strength and balance programme implemented twice a week for 60 minutes of Salomon et al. (2023) and that of Asonitou et al. (2018) which consisted of a 16-week multi-component programme (four days a week for 30 minutes) of aerobic, strength, flexibility and balance exercises. Furthermore, sport-based exercise programmes by Pejčić, Kocić, Berić, Kozomara and Aleksandrović (2019) and Wang et al. (2022) improved the strength of the upper body muscles of children and adolescents living with ID after 12 weeks, which was measured by the single arm push and handgrip tests. Their programmes involved games such as soccer, badminton, basketball, table tennis and volleyball or school-based physical activities such as running, jumping, kicking, catching and throwing.

4.2.2.2. Abdominal strength

Mobility requires abdominal muscular strength (Balouchy, 2022). Improving abdominal and upper body strength for individuals living with ID is critical for posture, bodily stabilisation and execution of daily chores (Poncumhak et al., 2013; Delgado-Lobete et al., 2021). Our study demonstrated a significant increase in abdominal muscle endurance, which was measured by the modified curl-up test, with a large ES (Chapter 3: Table 1 and 2). This improvement possibly could be attributed to the walking, resistance and dancing sessions in our programme since a 16-week walking programme study by Son et al. (2016) revealed a significant improvement in the sit-up test, as well as a 12-week dancing programme by DiPasquale and Kelberman (2020) on adults living with ID. Moreover, a significant enhancement in abdominal muscle strength and endurance (measured by the sit-up test) was found in a multi-component programme on adults living with ID by Asonitou et al. (2018). In contrast to these studies and our study, Jo et al. (2018) and Wu et al. (2017) found no significant increase in abdominal muscle strength after their 12-week combined and circuit training programme. The lack of sufficient resistance training in the study by Jo et al. (2018) and the individual variability in physical characteristics, motivation and compliance in the study by Wu et al. (2017) might explain the non-significant results.

4.2.2.3. Lower body strength

According to Pitetti and Yarmer (2002), individuals living with ID have significantly lower limb muscle strength than those living without ID. Therefore, it is essential to focus on improving their lower limb muscular strength as leg strength is a key factor for physical fitness in individuals living with ID as it contributes to daily functioning such as walking, dressing, climbing stairs, bathing and toileting (Delgado-Lobete et al., 2021). Our study demonstrated a significant improvement in lower body muscle strength and endurance measured by the 30-

second sit-to-stand test and a large ES (Chapter 3: Table 1 and 2). Walking, dancing and lower leg resistance exercises such as lunges and squats targeting the lower body limb strength could have contributed to the significant improvement. Specific exercise with respect to repetitions, sets , duration, for the current study is well described in Appendix F.

Previous studies have shown that interventions such as seven and 10-week aerobic training on adults living with ID (Martínez-Aldao et al., 2019; Reina et al., 2020), a 12-week resistance training programme on adolescents living with ID (Wu et al., 2017) and a combined programme using the sit-to-stand/30-seconds chair stand test to assess lower body muscle strength on adults living with ID (Elmahgoub et al., 2011; Calders et al., 2011; Wang et al., 2022) have demonstrated significant increases in lower body strength. A combined programme by Salomon et al. (2023) and Oviedo et al. (2014) reported significant improvements in the 30-second sit-to-stand test in adults living with ID after combining aerobic, strength and balance exercises. Our study observed a larger improvement in the 30-second chair stand test (+4.2 stands compared to +2.93 stands) which may explain the significant results achieved in a shorter intervention duration compared to the 12-week programmes of Salomon et al (2023). However, it is important to note that the programmes and equipment used for strength training varied across the studies. A systematic review by Obrusnikova et al. (2022) reveals that resistance training on its own significantly improves the lower limb muscle strength of adults living with ID. By strengthening the lower body limbs, Jeng et al. (2017) state that due to a significant improvement in balance, improvements in lower leg strength may have contributed to this improvement. The current study agrees with this statement as both static and dynamic balance improved significantly with small to large ES respectively. However, a correlational or regression study design would need to be conducted to confirm this possible association. Additionally, an improvement in lower limb strength is important for adults living with ID as leg strength has been associated with improved aerobic and functional capacity for individuals living with ID and Down syndrome (Calders et al., 2011; Terblanche & Boer, 2013).

4.2.2.4. Balance

Static and dynamic balance is essential for maintaining posture and preventing falls for individuals living with ID (Poncumhak et al. 2013). Interventions with structured exercise for adults living with ID have demonstrated significant improvements in balance tests such as the Stork test, one leg stand test, flamingo balance test, timed up and go (TUG) test, standing long jump and standing board jump (Oviedo et al., 2014; Asonitou et al., 2018; Martínez-Aldao et al., 2019; Kovačič, Kovačič, Ovsenik & Zurc, 2020; Reina et al., 2020; DiPasquale & Kelberman, 2020; Diz et al., 2021; Bibro, Wódka, Smoła & Jankowicz-Szymańska, 2023). A significant increase in static and dynamic balance, as assessed by standing on one foot and walking on the balance beam, were revealed in the present study with small and large ESs respectively (Chapter 3: Table 1 and 2). These improvements possibly could be attributed to the abdominal and lower limb exercises in the resistance training exercises as well as the walking and dancing activities. A ten to 12-week dancing programme also demonstrated a significant improvement in static balance (flamingo balance test) for adults living with ID (Martínez-Aldao et al., 2019; DiPasquale & Kelberman, 2020). Furthermore, an eight-week core stability programme by Balouchy (2022) demonstrated a significant increase in static and dynamic balance as measured by the one leg stand test and TUG test after implementing the programme three times a week for 45 minutes for adolescents living with ID.

Interventions on adults living with ID that included balance exercises in their combined programme reported significant results regarding dynamic balance as measured by the standing board jump/standing long jump, heel-to-toe walk and Berg balance scale tests (Oviedo et al. 2014; Asonitou et al., 2018; Diz et al., 2021). Some of the balance exercises they used were standing on one leg or on a beam, walking in a line, stepping over obstacles and catching and throwing a ball. Other exercises such as jogging, strength training, walking and combined exercises have all demonstrated significant improvements in dynamic balance for individuals living with ID (Tsimaras et al., 2012; Martínez-Aldao et al., 2019; Haghighi, Mohammadtaghipoor, Hamedinia & Harati, 2019; DiPasquale & Kelberman, 2020; Bidaurrazaga-Letona, Ayán, Duñabeitia, Esain, Monasterio, Zulueta & Torres-Unda, 2023). A study that used a comparable intervention duration of Haghighi et al. (2019) and consisted of dance exercises for 13 to 17-year-old adolescents living with ID (three times a week for 30 minutes for eight weeks) demonstrated significant improvements in static and dynamic balance. Both studies demonstrated that training interventions of eight weeks can significantly improve static and dynamic balance.

4.2.2.5. Flexibility

Adequate flexibility is a fundamental component of functional fitness as it is closely related to healthy development and injury prevention (Ferguson & Murphy, 2014). It is also important for adults living with ID as it contributes to postural control and improves joint reach for daily functionality (Carmeli, Zinger-Vaknin, Morad & Merrick, 2005). Lower body flexibility improved significantly in our study, but the ES was negligible. It is possible that the present study's activities or study period were unable to provide the necessary stimulation for greater practical benefits for adults living with ID who need flexibility for postural control and daily functionality (Carmeli et al., 2005).

Stretching for longer periods during warm-up and cool-down sessions could have increased the magnitude of the ES (Chapter 3: Table 2). Other combined training studies conducted on adults living with ID implemented a 10-minute warm-up and cool-down in their study which resulted in a significant improvement in flexibility (Wu et al., 2010; Asonitou et al., 2018; Diz et al., 2021; Sun, Yu, Wang, Chan, Ou, Zhang, Xie, Fong & Gao, 2022). Studies utilising aerobic programmes for individuals living with ID also reported a significant improvement in flexibility (Wu et al 2010; Son et al., 2016; DiPasquale & Kelberman, 2020), possibly because aerobic exercises enhanced blood flow and reduced arterial stiffness (Li, Lv, Su, You & Yu, 2022).

A 12-week cross circuit programme by Wu et al. (2017) was conducted five times a week for 50 minutes per session on adolescents living with ID and reported significant results in the sit-and-reach test. Their study included aerobic exercises, such as treadmill walking, stationary cycling, elliptical training and stair climbing, which possibly could have accounted for flexibility improvement. Moreover, their warm-up and cool-down periods with stretching exercises were also ten minutes in duration.

4.2.3 Objective three: functional ability and aerobic capacity

Our study showed significant improvements for both aerobic capacity and functional ability with small to large ESs (Chapter 3: Table 1 and 2). Improving cardiovascular fitness is important for this population which has low aerobic fitness as it is associated with cardiovascular diseases and early mortality (Baynard et al., 2008; De Winter et al., 2012; Oppewal & Hilgenkamp, 2019; Boer, 2021; Højberg et al., 2022; De Leeuw et al., 2023). The participants performed several exercises during the combined intervention period such as moderate-paced hill-walking, moderate intensity dancing and various resistance type activities such as jumping, lunges, squats and stepping which could have resulted in an improvement in aerobic capacity and functional ability. The exercises conducted in the current study are well described in Appendix F. Other intervention studies also have reported significant improvements in cardiorespiratory fitness for adults living with ID (Cluphf et al., 2001; Merrick et al., 2013; Oviedo et al., 2014; Asonitou et al., 2018; Boer & de Beer, 2019; Martínez-Aldao et al., 2019; Reina et al. 2020; Diz et al., 2021; Salomon et al., 2023; Ladwig et al., 2023). For example, a 12-week combined aerobic, strength and balance programme resulted in significant improvements in maximum rate of oxygen consumption (VO_2 max) measured by the cycle ergometer (Salomon et al., 2023). Moreover, the aerobic shuttle run test improved significantly after a 12-week multi component programme which consisted of aerobic, strength and balance games and activities for adults living with ID (Asonitou et al., 2018).

In contrast, a 10-week combined aerobic and strength training programme (one day a week for 60 minutes) found no significant improvement in cardiorespiratory fitness as measured by the six-minute walking test (Kim et al., 2020). A study with a similar combined training programme as our study reported no significant improvement in the three-minute step test. The programme lasted for 12 weeks and exercises were performed two days a week for 90 minutes. Moderate to vigorous intensity aerobic exercise was performed for 30 minutes and the Thera band exercises were executed to a maximum repetition of ten to 15 (Jo et al., 2018). The low frequency of sessions per week could explain why these studies did not observe any improvement in cardiorespiratory fitness compared to the present study. Additionally, it is not clear whether the three-minute step test is a standardised aerobic test indicative of cardiorespiratory fitness. Lastly, the improvements shown in aerobic fitness in the current study may be because of a significant increase in leg strength, as measured by the chair stand test, which has been shown to be associated with aerobic capacity in individuals with living ID and Down syndrome (Terblanche & Boer, 2013; Vaidya, Chambellan & De Bisschop, 2017).

The current study demonstrated a significant improvement in functional ability with a small ES (Chapter 3: Table 1 and 2). A possible reason for the significant improvement in functional ability could be the significant improvement in the lower body muscle strength as well an improvement in aerobic capacity (Calders et al., 2011; Terblanche & Boer, 2013; Boer & Moss, 2016c). Additionally, both the resistance and aerobic exercises may have played a role in the improvement as supported by the studies of DiPasquale and Kelberman (2020) who used a 12-week aerobic programme and observed improvement in the TUG functional test. Donoghue, Savva, Cronin, Kenny and Horgan (2014) found that there is a positive correlation between the TUG test and the risk of falls. As a result, improving the parameters of functional fitness such as cardiorespiratory endurance, body composition, muscle strength and endurance, balance and flexibility might help reduce falls and injuries in adults living with ID (Enkelaar, Smulders, van Schrojenstein Lantman-de Valk, Geurts & Weerdesteyn, 2012).

It is crucial to improve functional fitness in adults living with ID as it helps to strengthen the muscles required for daily activities such as walking long distances, getting up from a chair or bed, getting out of the bathtub, walking up and down stairs, carrying heavy objects and performing daily tasks such as grooming, cleaning and cooking (Dijkhuizen et al., 2018; Delgado-Lobete et al., 2021). A restriction in functional ability can cause limited capability to perform daily activities and tasks independently and lead to a sedentary lifestyle (Rikli & Jones, 2013; Oppewal & Hilgenkamp, 2019). Furthermore, a reduction in functional ability may lead to premature morbidity and mortality (Boer, 2021; Oppewal & Hilgenkamp, 2019; Hsu et al., 2021).

4.3 Conclusion

The conclusion of the current study is discussed in relation to the objectives.

4.3.1 Objective one

The first objective was to determine the outcome of an adapted exercise programme on parameters associated with body composition. Five parameters associated with body composition were assessed in the current study, namely, body mass, BMI, WC, HC and WHR. After six weeks of physical training, the exercise group showed a significant decrease ($p<0.05$) in body mass and HC compared to the control group with negligible ESs (Chapter 3: Table 1 and 2). Individual improvements are also represented in a line plot for body mass (Chapter 3: Figure 2). In conclusion, body mass and HC resulted in significant improvements after six weeks of exercise but not for BMI, WC and WHR.

4.3.2 Objective two

The second objective was to determine the outcome of an adapted exercise programme on parameters associated with muscular strength, flexibility and balance. Our study showed significant improvements ($p<0.05$) in muscle strength, flexibility and balance. Muscle strength revealed that the modified curl-up (mean and SD: 43.43 ± 28.8 to 65.6 ± 20.4 number of curl-ups), chair stand (mean and SD: 10.7 ± 1.7 to 14.9 ± 1.7 number of sit to stands) and isometric push-up (mean and SD: 40.6 ± 26.0 to 67.9 ± 35.2 s) were significantly improved with large ESs. The lower body flexibility improved significantly (median and IQR: -3.0 ± 16.0 to -2.0 ± 13.0 cm) but with negligible ESs. Both balance tests improved significantly ($p<0.05$) (Chapter 3: Table 1). The dynamic balance measured by the walking on balance beam test demonstrated a significant improvement (median and IQR: 4.0 ± 3.0 to 6.0 ± 1.0 steps) between the exercise and control group from pre to post ($p<0.05$) with a large ES (Chapter 3: Table 1 and 2). Static balance also demonstrated a significant improvement ($p<0.05$) using the non-parametric Wilcoxon signed-rank test statistic (median and IQR: 9.3 ± 4.9 to 10.0 ± 1.8 s), even though small ESs were reported (Chapter 3: Table 1 and 2).

4.3.3 Objective three

The third objective was to determine the outcome of an adapted exercise programme on aerobic capacity and functional ability. After six weeks of training, the exercise group improved significantly in aerobic capacity and functional ability with small to large ES ($p<0.01$) (Chapter

3: Table 1 and 2). The exercise group revealed a significant improvement in the 16-metre PACER test (mean improvement: +8.3 shuttles) and 6MWT (mean improvement: +69.3 m) compared to the control group. Small ESs were shown for the 16-metre PACER test and the 6MWT demonstrated a large ES (Chapter 3: Table 1 and 2). Individual improvements are also represented in a line plot for both variables (Chapter 3: Figure 2). The functional ability test also demonstrated a significant improvement between the exercise and control group from pre to post test ($p<0.01$) in the eight-foot TUG test (mean and SD: 5.18 ± 0.9 to 4.90 ± 0.7 s) with a small ES of 0.34 (Chapter 3: Table 1 and 2).

4.4 Limitations and recommendations

Firstly, the cause and level of ID was not known for all participants of the current study. However, it is important to note that ID is a complex condition and its causes and severity can vary widely among individuals.

Secondly, the study did not employ the use of heart rate monitors to objectively measure the exercise intensity of the participants. Although the researcher and assistants (five supervisors for 19 exercise participants) motivated the participants to maintain a moderate exercise intensity (Appendix F) and used the ratings of perceived exertion scale, objective measurement of exercise intensity would be more accurate. The use of up-beat music (during dancing and resistance training) as well as the use of hill training whilst walking contributed to a higher exercise intensity. Increasing the exercise intensity to vigorous or high intensity may provide more significant effects and ESs greater in magnitude as other comparison studies (moderate versus high intensity training) conducted on individuals living with ID and Down syndrome demonstrated (Boer et al., 2014; Boer & Moss, 2016a).

Thirdly, the programme's duration of six weeks is a limitation. Whilst significant improvement was noted for most functional fitness parameters, a training programme of longer length (up to 12 weeks) may provide more benefits (for example: a significant improvement in BMI and WC) and ES's larger in magnitude. Additionally, the effect of detraining after the intervention period may be restricted as reported in a study conducted on adults living with Down syndrome (Boer, 2018). It is also a limitation that the participants were not monitored after the intervention to determine whether a habitual physically active lifestyle was maintained.

Despite these limitations, the study provides valuable insights into the effectiveness of a combined physical fitness programme of moderate intensity for individuals living with ID in residential care institutions.

4.5 Future research

Future studies should make use of a larger and more diverse sample from different ethnic groups. This approach can help to identify any variations in the programme's effectiveness across different settings and population groups. The activities presented in the current study are easy to apply and do not require any additional equipment, which allows data collection from a larger and more diverse sample.

The study could be extended to investigate the impact of a longer exercise programme with one high-intensity session per week using a combined exercise training intervention. Additionally, participants could be requested to continue exercising after the intervention period and then undergo a three-month follow-up to determine if they maintained or improved their functional fitness levels. A further study could be conducted to determine the effect of a combined high-intensity training intervention with a combined moderate-intensity training intervention on functional fitness and various health-related markers such as blood glucose, cholesterol, blood pressure, body fat percentage and other variables. Since individuals with ID have a strong affinity towards music, further studies using various forms of dancing may provide exercise specialists and physical education teachers with more information regarding the use of this exercise modality.

A study altering the type, nature, number of repetitions, number of sets and intensity of resistance type exercises as well as the duration of resting periods may provide more instructive information regarding resistance exercise training for this population. A study conducted in a gymnasium using explosive resistance training could provide exercise professionals and physical education teachers working in the field of adapted physical activity with information regarding the viability and importance of using such programmes.

Lastly, the impact of the same study should be assessed on children living with ID and the use of the physical education class at schools to determine not only parameters associated with functional fitness but also mental wellbeing and cognitive ability. The researcher intends to conduct such an investigation in the future as part of her continued academic development.

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APPENDICES

APPENDIX A: GUIDELINES FOR AUTHORS FROM THE JOURNAL OF INTELLECTUAL & DEVELOPMENTAL DISABILITY

Instructions for authors

Thank you for choosing to submit your paper to us. These instructions will ensure we have everything required so your paper can move through peer review, production and publication smoothly. Please take the time to read and follow them as closely as possible, as doing so will ensure your paper matches the journal's requirements.

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APPENDIX B: CONSENT FORM.

Consent form for PARENT(S)/ LEGAL GUARDIAN

Department of Health and Wellness Science
Bellville, 7530
Cape Peninsula University of Technology
Phone: 021 808 2818
Email: SethN@cput.ac.za

CONSENT TO PARTICIPATE PARENT IN A RESEARCH STUDY

Category of Participants (tick as appropriate):

Principals		*Teachers*		*Parents*		*Lecturers*		*Students*	
Other (specify)		**Intellectual disabled adult**							

Your child is kindly invited to participate in a research study being conducted by Elaine Steyn from the Cape Peninsula University of Technology (CPUT). The findings of this study will contribute towards (tick as appropriate):

An undergraduate project		*A conference paper*	
An Honours project		*A published journal article*	***X***
A Masters/doctoral thesis	***X***	*A published report*	

Selection criteria
Your daughter/son was selected as a possible participant in this study because:

Your daughter/son complies with the requirements for this study. I would like to give an adult that is intellectually disabled the opportunity to be part of this study and help me to help you improve his/her functional fitness to do daily activities, such as walking, getting into and out of a vehicle, sitting and getting up from a chair or couch etc.

The information below provides details about the study and what you can suspect prior to, during and after this study before making your decision.

PLEASE INFORM RESEARCHER IF YOUR CHILD HAVE CARDIOVASCULAR DECEASES OR COMPLICATIONS THAT IS A CONTRAINDICATION TO PHYSICAL ACTIVITY.

Title of the research:

Physical Education through Human Movement for individuals with intellectual disability: a randomise controlled trial

A brief explanation of what the research involves:

We want to invite your daughter/son to be part of a combined training program that includes walking, dancing and resistance training January, February and March 2023. Ten functional fitness tests will be done before the six weeks of exercise training and then measured afterwards again, to see their development. The tests and training program will be explained below. The study is carried out at the

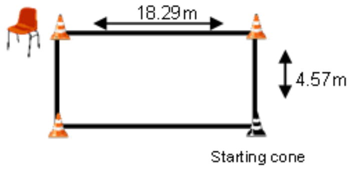
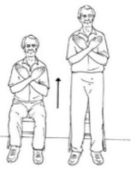
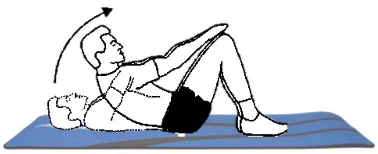
Intellectually Disabled Care Centre where your son/daughter lives. A social worker from the Intellectually Disabled Care Centre will be present along with the primary investigator of this study.

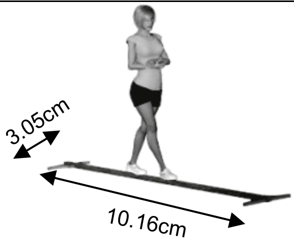
Procedures

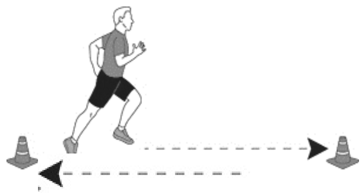
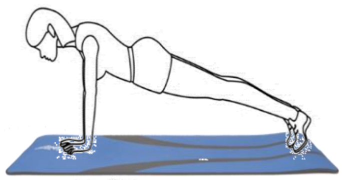
If your daughter/son volunteers to participate in this study, they will be asked to do the following:

Basic information will be collected from the participant such as age and gender. Measurements regarding body mass, body length, waist and hip measurements will also be collected. The researcher will perform a pre- and post-test that involves 8 standardised functional fitness tests. These tests include one functional fitness activity, two aerobic endurance activities, two balance tests and three muscular body strength and endurance activities.

The tests will be divided and performed on separate days. All tests will also be physically demonstrated before this consent form is signed or it can be sent as a video message so that parents are clear to test description. The test will be implemented on the following days in this exact order.

Day 1		
TEST	DEMONSTATION	DESCRIPTION
1. 6-minute walk test		Will only be done once. The participant will walk for 6-minutes in a rectangle form and try to cover as much distance as they can.
2. 30s chair stand test		The participant will sit on a chair, raise to a full stand and back to a seated position. The result will be the number of stands done in 30 seconds.
3. Modified curl-up test		This is almost like a sit-up but modified for individuals with intellectual disabilities
4. One Leg stand		Here the participant will stand on one leg for as long as possible up to a maximum of 10 seconds.

Day 2		
TEST	DEMONSTATION	DESCRIPTION
5. Balance beam test		The participant will walk on a balance beam that is 3.05 m by 10.16cm wide. The balance beam is only 5cm off the ground. The total steps will be recorded on the balance beam, with a maximum of six steps.

6. 16-meter PACER test		At the sound of a tape recorded beep, the participant will run between two lines 16-meters apart. The participant must get to the next line before the beep goes off. The time between each interval steadily decreases and it gets more difficult. The assistant will help set the pace for the participant.
7. Timed up and go test		The participant will sit on a chair and walk as fast as he or she can for 2.43 meters, around a beacon and return as quickly as he or she can to a seated position. They will perform this test twice
8. Isometric push-up test		isometric push-up test which means they will hold a push-up position with straight arms for as long as they can.

After the tests have been completed, the participant will be randomly allocated to the **experimental or control group**. The experimental group will partake in combined training that will take place over 6 weeks, 3 times a week for a duration of 30 minutes.

- **First session** will be walking, where the participant will walk for 25 minutes or do activities that include **walking**.
- The **second session** will be for **dancing**. Dancing will include different styles of dancing and include the use of props, such as ribbons.
- The **third session** will consist of **resistance training**, where muscular strength training will be performed. The participant will perform a full-body circuit training workout that involves lower- and upper-body workouts, core workout and one aerobic endurance workout (also attached as Appendix).

After the 6-weeks of the intervention program, the baseline functional fitness tests will be performed again. The control group must be tested again for statistical reasons. It is the experimental group that will be compared against the control group to ensure that if the fitness intervention helped, it was indeed so compared to a control group that will probably not improve. It also ensures the validity and reliability of the tests used to assess functional fitness. After the data has been analysed, a report of your son/daughter's findings will be presented to you. If you feel this study was helpful to your son/daughter, an exercise program specifically aimed at their capability can be provided to you.

Potential risks, discomforts or inconveniences

In the two aerobic endurance tests (6-minute walking test and 16-meter PACER test), the participant might get tired, causing a fast heartbeat and increased breathing. The participant can drop out at any time and the researcher (a qualified Level 3 First Aid) will be there to assist your child if physical injurie (falling) may happen. Staff from the Intellectually Disabled Care Centre will also be there to provide comfort and emotional assistance for any physiological/emotional distress that may occur. Stiffness and muscle pain may arise the next day after the functional tests have been done. All tests and training programs have been adapted to the needs of adults with ID. All tests have been standardised specifically for this population as shown by feasibility, reliability and validity analyses. **The participant can withdraw at any point if he or she wishes to do so. There will be no consequences if the participant wishes to do so.**

The participant name or any personal information will stay anonymous. All data and information of the participant that will be collected, will be stored in a locked cabinet in an office. Furthermore, computerised data gathered will be stored in a secured file with a locked password on the laptop. Under no circumstance will the researcher communicate and share any information with others apart from the researcher's supervisor. The data will be stored while the study is in process and kept for 5 years before executing all statistics.

You are invited to contact the researchers should you have any questions regarding the research before or during the study.

Kindly complete the table below before participating in the research.

Tick the appropriate column		
Statement	Yes	No
1. I understand the purpose of the research.		
2. Does your child have cardiovascular deceases or complications that is a contraindication to physical activity?		
3. I understand what the research requires of my son/daughter.		
4. I give my consent for my daughter/son to take part in the research.		
5. I know that the participant can withdraw at any time.		
6. I understand that there will not be any form of discrimination against the participant as a result of her/his participation or non-participation.		
7. Comment:		

Please sign the consent form. You will be given a copy of this form on request.

Signature of parent/ legal guardian	Date:

Researchers

	Name:	**Surname:**	**Contact details:**
1.	Elaine	Steyn	079 853 9255

Contact person: Miss. Elaine Steyn (Primary researcher)	
Contact number: 079 853 9255	**Email:** elaine.steyn01@gmail.com
Contact person: Dr.PH Boer (Supervisor)	
Contact number: 082 672 2729	**Email:** boerpi@cput.ac.za

APPENDIX C: CONSENT FORM (SIMPLER LANGUAGE)

Consent form for PARTICIPANT (simpler language)

Department of Health and Wellness Science
Bellville, 7530
Cape Peninsula University of Technology
Phone: 021 808 2818
Email: SethN@cput.ac.za

CONSENT TO PARTICIPATE IN A RESEARCH STUDY

Category of Participants (tick as appropriate):

Principals		*Teachers*		*Parents*		*Lecturers*		*Students*	
Other (specify)		**Intellectual disabled adult**							

You are kindly invited to participate in a research study being conducted by Elaine Steyn from the Cape Peninsula University of Technology. The findings of this study will contribute towards (tick as appropriate):

An undergraduate project		*A conference paper*	
An Honours project		*A published journal article*	***X***
A Masters/doctoral thesis	***X***	*A published report*	

Selection criteria
You were selected as a possible participant in this study because:

you meet the requirements for the study. I want you to be part of my study so that I can determine whether these exercises help individuals with ID

Title of the research:
Physical Education through Human Movement for individuals with intellectual disability: a randomise controlled trial.

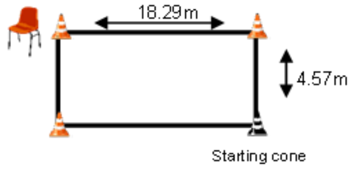
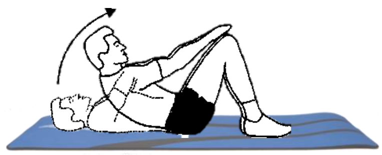
A brief explanation of what the research involves:

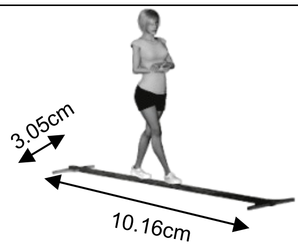
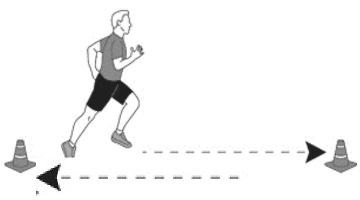
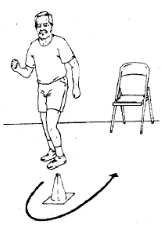
We want to invite you to be part of a fitness study. We want to do walking, dancing and muscle training at your care facility and see if this program can help make activities, such as walking, bending, lifting and carrying things easier for you. Let us explain what will happen in this study.

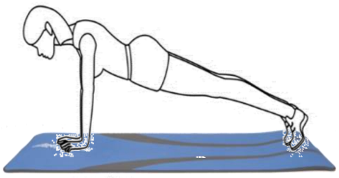
Procedures

If you volunteer to participate in this study, you will be asked to do the following things:

At the start of the study, we will take your body mass, height, waist and hip circumference. You will also do 8 tests to measure your functional fitness.
You will do the following tests:

Day 1		
TEST	DEMONSTATION	DESCRIPTION
1. 6-minute walk test		You will walk for 6-minutes in a rectangle.
2. 30s chair stand test		you will sit on a chair, then stand up and sit down back again for 30 seconds.
3. Modified curl-up test		You will do sit ups that has been made easier for you
4. One Leg stand		You will try and balance on one foot for 10 seconds (left and right foot).

Day 2		
TEST	DEMONSTATION	DESCRIPTION
5. Balance beam test		You will also walk on a balance wooden beam that is 10 cm long
6. 16-meter PACER test		You will slow jog between two lines,16 meters apart
7. Timed up and go test		You will sit on a chair, walk as fast as you can for 2 meters, around a cone and sit again on the chair.

8. Isometric push-up test		You will do push ups that has been made easier for you

After these tests, the researcher will randomly choose 20 people that will be placed in a group that will exercise for 6 weeks or in a group that will not do exercise and carry on will their daily routine. If you are in the exercise group, you will be doing the following:

You will exercise 3 days a week for only 30 minutes.

- The **first day** we will walk.
- On the **second day**, we will dance to music.
- On the **third day**, we will build some muscles in the arms, legs and tummy.

After 6 weeks of training, we will test both groups again and compare the results with each other to see if the program made them fit. The control group **must** be tested again for statistical reasons. The group that exercised while be compared to the group that did not exercise, to see if the exercises helped them improve their fitness. It also ensures the validity and reliability of the tests used to assess functional fitness. If you are in the exercise group, I will give feedback to your family and I can create your **own exercise program** of the exercises you have done over the past 6 weeks.

Potential risks, discomforts or inconveniences
If you are in the exercise group:

in two of the ten tests, you might get tired, causing a fast heartbeat and you will start breathing quickly. You can stop at any time if you are too tired and feel uncomfortable. There will always be a staff member that will help you. In the push up and sit up tests, it can cause stiffness and muscle pain the next day because your body is not used to do exercises. When we build muscles in the arms, legs and tummy, you can choose an exercise that is comfortable for you and easy to perform and that causes no pain. The exercise will be fun and help you get fit and be healthier. **This study is voluntary so you can withdraw at any point if you are uncomfortable, inconvenient or feel you are at potential risk during a session.**

You are invited to contact the researchers should you have any questions about the research before or during the study. You will be free to withdraw your participation at any time without having to give a reason. You can tell your caretaker if you don’t want to participate anymore. You have a whole week to think about it with your family. You do not have to sign it immediately.

Kindly complete the table below before participating in the research.

Tick the appropriate column with thumb print.		
Statement	Yes	No
1. I understand the purpose of the research.		
2. Have anyone told you that you can't do physical exercise?		
3. I understand what the research requires of me.		
4. I volunteer to take part in the research.		
5. I know that I can withdraw at any time.		
6. I understand that there will not be any form of discrimination against me as a result of my participation or non-participation.		
7. Comment:		

Please sign the consent form (Thumb print). You will be given a copy of this form on request.

	________________________
Thumb print of participant	Date

Researchers

	Name:	**Surname:**	**Contact details:**
1.	Elaine	Steyn	079 853 9255

Contact person: Miss. Elaine Steyn (Primary researcher)	
Contact number: 079 853 9255	**Contact number:** 079 853 9255
Contact person: Dr.PH Boer (Supervisor)	
Contact number: 082 672 2729	**Contact number:** 082 672 2729

APPENDIX D: PERMISSION FROM CARE FACILITY

INFORMED CONSENT – Care Centre PRINCIPAL

Intellectually Disabled Care Centre's address

Lake Farm Centre, Gqeberha

Eastern Cape, South Africa

To the Principal

RE: Permission to conduct research at your Intellectually Disabled Care Centre

Dear *Mr/Mrs/Dr/Prof Principal's Name:* Amelia Laubscher

I write to request your permission and assistance to conduct research at your Intellectually Disabled Care Centre.

I am a researcher from the Cape Peninsula University of Technology, Western Cape, South Africa, in which we are investigating the **effect of walking, dancing and resistance training on the functional fitness of adults with intellectual disabilities.**

The procedure of this study is:

All physical tests and training that will be done will be physically demonstrated and explained by myself at your Intellectually Disabled Care Centre. All tests and procedures will be explained and consent and assent forms will be handed out. All tests will be explained and demonstrated step by step. After a week has passed and on my second visit, after consent has been given, descriptive (basic) information regarding age and gender, body mass, body length, waist and hip measurements will be collected. Participants themselves will also be familiarised with all testing procedures and equipment.

On my third visit, testing will start. All testing is performed 1 to 1 with the participant. Someone from the Care Centre will also be there. The first test is the 6 minute walk test. During the 6 minute walk test, he/she will walk for 6 minutes in a rectangle to cover as much distance as possible. This test is only performed once. After a few minutes of rest, the 30s chair stand test will be performed. The participant will sit on a chair, raise to a full stand and back to a seated position. The result will be the number of stands done in 30 seconds. This test will be performed twice. After a period of rest, they will do the modified curl-up. This is almost like a sit-up but modified for individuals with intellectual disabilities. The last test of the day is the one-leg stand test. Here the participant will stand on one leg for as long as possible up to a maximum of 10 seconds. This will also be performed twice on each leg.

The 4th visit will continue two days later, the participant will walk on a balance beam that is 3.05 m by 10.16cm wide. The balance beam is only 5cm off the ground. The total steps will be recorded on the balance beam, with a maximum of six steps. When the participant is rested and fully recovered, he/she will do the timed up and go test. The participant will sit on a chair and walk as fast as he or she can for 2.43 meters, around a beacon and return as quickly as he or she can to a seated position. They will perform this test twice. In the last test, the participant will do an isometric push-up test which means they will hold a push-up position with straight arms for as long as they can.

On the fifth visit, the last test will be performed. The 16 meter shuttle run test will be performed. At the sound of a tape recorded beep (sound from a CD player), the participant runs from one line to the other 16 meters away. He/She must arrive at the second line prior to the next beep (initially a nine second interval; 1.8 m/s). The time between beeps gradually decreases over the length of the test, so participants find it increasingly difficult to keep up with the pace the longer the test goes on. The primary researcher (Elaine Steyn) runs alongside the participant for help or assistance. If he/she feels tired or scared he/she may stop the test at any time. There will be a professional person from the care facility where he/she stays to comfort him/her. The primary researcher will also be there.

The 6-week intervention period will start where he/she will be required to exercise for 30 minutes, three times a week. Allocation to the exercise group will be total random (pulling a number out of a hat) and the participant will have a 50% chance of landing up in this group. The non-exercise group will perform no structured training and will continue with their normal everyday activities as usual.
All of the above-mentioned tests (visit 3 to 5) will be repeated after the 6-week intervention by all participants (exercise and non-exercise group). The group that was not in the exercise group will be given the opportunity to partake in exercise after the study has been terminated.

We hereby request your permission to conduct this important research study at your Centre, and ask permission for your individuals with Intellectual Disability to participate. If permission is granted by yourself, the parents and the participant will also have to provide us with consent and assent respectively. Unfortunately neither you, nor the participants, will receive any payment for your participation. The participation of each individual with Intellectual Disability would be greatly appreciated. Be assured that every effort will be made to ensure minimal disruption of the participants' normal day-to- day curriculum during the course of the study.

Ethical clearance will be obtained from the Ethical Committee of the Faculty of Health and Wellness, Cape Peninsula University of Technology in the Western Cape, South Africa . You may contact Dr Dirk Bester (BESTERD@cput.ac.za) from the Ethical Committee for any information about the ethical permission of this study.. The primary investigator and Masters Student (Ms. Elaine Steyn: 079 853 9255; elaine.steyn01@gmail.com) or the study supervisor (Prof. PH Boer: 082 672 2729; boerpi@cput.ac.za) who has previously conducted research at your Work/Care Centre may also be contacted for further information.

Once I have completed the research and all the data have been analysed, we will publish the results of this study in a scientific Adapted Physical Activity Journals. No person's name or identity or the Centre's name will be revealed in the publication or any research reports The results of the study will also be written up in a Master thesis.

Please feel free to contact any of the researchers or ethical committee should you have any questions or concerns regarding this study.

Principal Consent Form

I have read and comprehended the information on the research that is being done on walking, dancing and resistance training on individuals with intellectual disability , between the ages of 18 to 50 years, who reside in the Eastern Cape.

I give the researchers permission to conduct this study at Lake Farm Centre - Adult Care **Intellectually Disabled Care Centre's name**.

[signature]
Signature of Principal

6.6.2022
Date

Or

I <u>**do not**</u> give the researchers permission to conduct this study at **the Intellectually Disabled Care Centre**.

____
Signature of Principal

____
Date

APPENDIX E: ETHICAL APPROVAL

Cape Peninsula
University of Technology

HEALTH AND WELLNESS SCIENCES RESEARCH ETHICS COMMITTEE (HWS-REC)
Registration Number NHREC: REC- 230408-014

P.O. Box 1906 • Bellville 7535 South Africa
Symphony Road Bellville 7535
Tel: +27 21 959 6917
Email: sethn@cput.ac.za

25 October 2022
REC Approval Reference No:
CPUT/HWS-REC 2022/S12

Faculty of Health and Wellness Sciences

Dear Elaine Steyn

Re: APPLICATION TO THE HWS-REC FOR ETHICS CLEARANCE

Approval was granted by the Health and Wellness Sciences-REC to **Ms Elaine Steyn** for ethical clearance. This approval is for research activities related to research for **Ms Elaine Steyn** at Cape Peninsula University of Technology.

TITLE: **Physical Education through Human Movement for individuals with intellectual disability: a randomized controlled trial**

Supervisor: Prof Pieter Boer

Comment:

Approval will not extend beyond 26 October 2023. An extension should be applied for 6 weeks before this expiry date should data collection and use/analysis of data, information and/or samples for this study continue beyond this date.

The investigator(s) should understand the ethical conditions under which they are authorized to carry out this study and they should be compliant to these conditions. It is required that the investigator(s) complete an **annual progress report** that should be submitted to the HWS-REC in December of that particular year, for the HWS-REC to be kept informed of the progress and of any problems you may have encountered.

Kind Regards

Ms Carolynn Lackay
Chairperson – Research Ethics Committee
Faculty of Health and Wellness Sciences

APPENDIX F: EXERCISE PROGRAMME

<table>
<tr><th colspan="7">Week 1 + 2</th></tr>
<tr><td colspan="7">10 minutes of registration, greetings and familiarizing of exercises</td></tr>
<tr><td colspan="7">±5 min Warmup and Cool down</td></tr>
<tr><td rowspan="2">Monday: Resistance exercises
Total session: 30-35 minutes
Length of repetition: 45 seconds
Rest between sets: 30 sec
Rest between exercises:
1 minute.

Three sets in total</td><td>Squats x3 sets</td><td>Push-ups x3 sets. (Female participants were allowed to place knees on mat)</td><td>Climb up and down steps x3 sets</td><td>Sit-ups x3 sets</td><td>Palms facing up, arms straight. Move arms up and down x3 sets.</td><td>Forward lunges (walking forward with alternating legs) x3 sets</td></tr>
<tr><td colspan="6">Each station had a supervisor for motivation and assistance where needed (approximately 3 individuals per station)</td></tr>
<tr><td>Wednesday: Walking
30 minutes</td><td colspan="6">Walk 30 minutes (Moderate-intensity walking)
Supervisors walked with participants in groups of three to five so that an average moderate intensity training (RPE level: 12 to 14) was maintained for each participant. Participants were asked every five minutes at what level of RPE they were currently walking. Walking intensity was adapted to the necessary intensity level.</td></tr>
<tr><td rowspan="2">Thursday: Dancing
25 minutes</td><td colspan="2">30 seconds rest between each song. Familiarize moves in the resting period for the next dance.</td><td colspan="4">Dancing with chairs: open and close legs, rise-up and sit, lift legs, stamp feet on the ground, punch hands in the air, touch side to side, lift hands one by one in the air, walking around the chair, hold the chairs back and lift legs backwards up, calve raises and others.

Examples of some of the movements without a chair: Lift knees, jumping, walking on toes, step side to side, kick legs, squats, high fives in the air, jazz hands, clap hands above head, wave arms, walking on the spot, kick backwards, touch side to side, calf rises, lift legs backwards, tap feet or heel on the floor and many others.

Chair dancing was only done in week one and two.</td></tr>
<tr><td colspan="6">Dancing was performed as a group in whole, but supervisors danced with participants for motivation and to assess and control the necessary RPE level. Every 5 minutes each supervisor would ask a participant: “Point to the table to show, at what level of RPE are you exercising at the moment”. Exercise intensity was adapted if outside of the acceptable range (12-14).</td></tr>
</table>

<table>
<tr><th colspan="7">Week 3 + 4</th></tr>
<tr><td colspan="7">10 minutes registration, greetings and familiarizing of exercises</td></tr>
<tr><td colspan="7">±5 min Warmup and Cool down</td></tr>
<tr><td rowspan="2">Monday: Resistance exercises
Total session: 30-35 minutes
Length of repetition: 45 seconds
Rest between sets: 30 sec
Rest between exercises:
1 minute.

Three sets in total (except Bicep curls)</td><td>Squats x3 sets</td><td>Push-ups x1 set Tricep dips x2 sets</td><td>Climb up and down steps x3 sets</td><td>Alternating Backward lunges x3 sets</td><td>Toe-tap sit-ups x2 sets Bicycle sit-up x1 set</td><td>Bicep curls x 4 sets (with 2 or 4 kg weights)</td></tr>
<tr><td colspan="6">Each station had a supervisor for motivation and assistance where needed (approximately 3 individuals per station)</td></tr>
<tr><td>Wednesday: Walking
30 minutes</td><td colspan="6">Walk 30 minutes with steep hills (Moderate-intensity walking)
Supervisors walked with participants in groups of three to five so that an average moderate intensity training (RPE level: 12 to 14) was maintained for each participant. Participants were asked every five minutes at what level of RPE they were currently walking. Walking intensity was adapted to the necessary intensity level.</td></tr>
<tr><td rowspan="2">Thursday: Dancing
35 minutes</td><td>30 seconds rest between each song. Familiarize moves in the resting period for the next dance.</td><td colspan="5">Examples of some of the movements: Lift knees, jumping, walking on toes, step side to side, kick legs, squats, high fives in the air, jazz hands, clap hands above head, wave arms, walking on the spot, kick backwards, touch side to side, calf rises, lift legs backwards, tap feet or heel on the floor. (Fast movements – Moderate-intensity dancing)</td></tr>
<tr><td colspan="6">Dancing was performed as a group in whole, but supervisors danced with participants for motivation and to assess and control the necessary RPE level. Every 5 minutes each supervisor would ask a participant: “Point to the table to show, at what level of RPE are you exercising at the moment”. Exercise intensity was adapted if outside of the acceptable range (12-14).</td></tr>
</table>

<table>
<tr><th colspan="7">Week 5+6</th></tr>
<tr><td colspan="7">10 minutes of registration, greetings and familiarizing of exercises</td></tr>
<tr><td colspan="7">±5 min Warmup and Cool down</td></tr>
<tr><td rowspan="2">Monday: Resistance exercises
Total session: 35 - 40 minutes
Length of repetition: 45 seconds
Rest between sets: 30 sec
Rest between exercises: 1 minute.

Four sets in total</td><td>Squats x4 sets</td><td>Push-ups x2 sets.
Dips x2 sets</td><td>Climb up and down steps x4 sets</td><td>Forward lunges x 4sets</td><td>Bicep curls x4 sets (with 2 or 4 kg weights)</td><td>Plank x1 set
Left side plank x1 set
Right side plank x1 set
Sit-ups x1 set</td></tr>
<tr><td colspan="6">Each station had a supervisor for motivation and assistance where needed (approximately 3 individuals per station)</td></tr>
<tr><td>Wednesday: Walking
45 minutes</td><td colspan="6">Walk 45 minutes with steep hills (Moderate-intensity walking)
Supervisors walked with participants in groups of three to five so that an average moderate intensity training (RPE level: 12 to 14) was maintained for each participant. Participants were asked every five minutes at what level of RPE they were currently walking. Walking intensity was adapted to the necessary intensity level.</td></tr>
<tr><td rowspan="2">Thursday: Dancing
40 minutes</td><td colspan="2">30 seconds rest between each song. Familiarise moves in the resting period for the next dance.</td><td colspan="4">Examples of some of the movements: Lift knees, jumping, walking on toes, step side to side, kick legs, squats, high fives in the air, jazz hands, clap hands above head, wave arms, walking on the spot, kick backwards, touch side to side, calf rises, lift legs backwards, tap feet or heel on the floor. (Moderate-intensity dancing)</td></tr>
<tr><td colspan="6">Dancing was performed as a group in whole, but supervisors danced with participants for motivation and to assess and control the necessary RPE level. Every 5 minutes each supervisor would ask a participant: “Point to the table to show, at what level of RPE are you exercising at the moment”. Exercise intensity was adapted if outside of the acceptable range (12-14).</td></tr>
</table>

APPENDIX G: ARTICLE ACCEPTANCE LETTER

FW: [EXTERNAL] Journal of Intellectual & Developmental Disability - Decision on Manuscript ID CJID-2023-0061.R2 Inbox ×

Pieter Boer <BoerPi@cput.ac.za> Fri, 15 Sept, 08:09
to me

-----Original Message-----
From: Journal of Intellectual & Developmental Disability <onbehalfof@manuscriptcentral.com>
Sent: Friday, September 15, 2023 8:05 AM
To: Pieter Boer <BoerPi@cput.ac.za>
Subject: [EXTERNAL] Journal of Intellectual & Developmental Disability - Decision on Manuscript ID CJID-2023-0061.R2

This message originated from outside your organization

15-Sep-2023

Dear Dr Boer,

Ref: The effect of a walking, dancing, and strength training program on the functional fitness of adults with intellectual disability: a randomised controlled trial

Thank you for submitting this revised manuscript to the Journal of Intellectual & Developmental Disability (JIDD). I have pleasure in confirming that this revised article has been accepted for publication.

Your paper will be published both online and in print. Once an article appears online, and a Digital Object Identifier (DOI) number is allocated, it is considered "published". The DOI number becomes the true and verified record of the article's publication.

The paper will then be allocated to a print issue of the journal. The manuscript's assignment to a particular issue will be dependent upon a number of factors, including the journal's backlog, available page budget, thematic groupings and the scheduling of special issues, so there may be several months before the article will be assigned to a print issue.

Please note that the production process to prepare your manuscript for publication involves a number of steps. The manuscript will be formatted in our editorial office and then sent to the publisher, Taylor & Francis, for copyediting and typesetting. Once the proofs have been prepared, you will be notified by the production editor, who will provide instructions on how you may access them through the Central Article Tracking System (CATS). The notification email will include a username and password to enable you to access CATS, your manuscript's assigned DOI, as well as instructions relating to the submission of corrections and transfer of copyright. As you will be requested to check and return your corrections promptly, it will be important to monitor your email address regularly. Once the publisher has received your corrections and Author Publishing Agreement, your article will be corrected and published online as soon as possible thereafter.

The journal only functions because authors also share their expertise by reviewing submissions from peers. We do hope that you will respond favourably to future invitations to review for JIDD.

Thank you for your contribution to the Journal of Intellectual & Developmental Disability. We look forward to receiving further submissions from you.

Sincerely,
Professor Rafat Hussain
Editor, Journal of Intellectual & Developmental Disability

Fwd: [EXTERNAL] Taylor & Francis author update: congratulations, your article is published! Inbox ×

Pieter Boer <BoerPi@cput.ac.za>
to me, George

23 Dec 2023, 12:01

Get Outlook for iOS

From: info@tandfonline.com <info@tandfonline.com>
Sent: Friday, December 22, 2023 4:47 PM
To: Pieter Boer <BoerPi@cput.ac.za>
Subject: [EXTERNAL] Taylor & Francis author update: congratulations, your article is published!

This message originated from outside your organization

The online platform for Taylor & Francis Group content

Author Services | **FAQ** | **Twitter** | **Facebook** | **LinkedIn**

Dear author,

Congratulations, we're delighted to let you know that your final published article (the Version of Record) is now on Taylor & Francis Online.

The effect of a walking, dancing, and strength training program on the functional fitness of adults with intellectual disability: A randomised controlled trial

Want to tell others you're published? Use your free eprints today
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Taylor & Francis

CJID2260582

Manuscript Title:	The effect of a walking, dancing, and strength training program on the functional fitness of adults with intellectual disability: a randomised controlled trial
Manuscript DOI:	10.3109/13668250.2023.2260582
Journal:	Journal of Intellectual & Developmental Disability

APPENDIX H: PROOF OF LANGUAGE EDITING

EDIT PRO

Postnet suite 248, P/bag X1, Melrose Arch, 2076
info@editpro.co.za
082 782 7376

EDITED

11 September 2023

CONFIRMATION OF TEXT EDITING SERVICES

To whom it may concern

Title: *Physical education through human movement for individuals living with intellectual disability: a randomised controlled trial*

Author: Ms. E. Steyn

I would like to confirm that I acted as Language Editor for the above-mentioned text (excluding the third chapter). In my capacity as an independent language practitioner, I reviewed the text to provide text editing and proofreading services in order to optimise the consistency, clarity, correctness, and presentation of the text. Please note that I merely recommend corrections and make suggestions regarding necessary changes – it is the author's choice and responsibility to implement those changes.

I am an Accredited Text Editor (ATE) and completed my accreditation through the Professional Editors' Guild (PEG) in South Africa. I am a qualified and experienced language practitioner and a copy of my CV as well as proof of my accreditation and/or qualifications can be provided on request.

Please contact me for further information.

Kind regards

Chirne van Wyk
Accredited Text Editor (English)
Professional Editors' Guild (PEG)

As a professional language practitioner, I follow a professional code of ethical standards which excludes plagiarism in any form. Please contact me for further information regarding ethical language practice and/or available services.

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