

Effect of a long-term physical activity intervention on the functional capacity of persons with intellectual disability: A Potchefstroom cohort



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*“I can do all things through Him who strengthens me” **Philippians 4:13***

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*“Keep your dreams alive. Understand to achieve anything requires faith and belief in yourself, vision, hard work, determination, and dedication. Remember all things are possible for those who believe.” **Gali Devers.***

With sincere appreciation

The author

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DECLARATION

The co-author of the two articles, Prof. S.J. Moss (supervisor) hereby gives permission to Miss. T. Veldsman to include the two articles as part of the Masters dissertation. The contribution of the co-author was kept within limits in help with the planning and execution of the study, as well as supervising and guidance in completing the dissertation. The dissertation, therefore serves as fulfillment of the requirements for the M.Sc. Degree in Biokinetics. Further to be declared that Me. T. Veldsman had a great enough input to be the primary author of the articles.

Prof. S.J. Moss

Supervisor and co-author

ABSTRACT

Effect of a long-term physical activity intervention on functional capacity of persons with intellectual disability: A Potchefstroom cohort

Physical inactivity, a modifiable risk factor for coronary heart disease (CHD) both in persons with intellectual disability (ID) and non-ID, is considered the fourth leading cause of death in the world. Long-term regular participation in physical activity is associated with a reduced risk for CHD. Literature currently lacks evidence on the effect of long-term physical activity on the functional capacity and risk factors for developing CHD in persons with ID. The purpose of this study was firstly, to determine the effect of a long-term physical activity intervention on the risk factors associated with developing CHD and secondly the effect of a combined aerobic and resistance physical activity intervention on the functional capacity of persons with ID.

A cohort of seventy-four (74) participants living in a care facility in Potchefstroom, South Africa, participated in this study, a seven-year follow-up physical activity intervention study. To determine the effect of a seven-year combined aerobic and resistance exercise intervention programme, data was collected in 2006 and in 2013. At baseline (2006) and end (2013), a CHD risk profile was determined by means of a questionnaire and physical assessment. The physical assessment included resting blood pressure, peripheral glucose and cholesterol measurements, and body composition by means of body mass index (BMI), waist-to-hip ratio (WHR) and body fat percentage derived from skinfold measurements. Cardiorespiratory fitness was assessed by means of the adapted sub-maximal YMCA bicycle ergometer protocol from which a physical work capacity (PWC) was calculated. The participants followed a structured physical activity intervention two days per week for at least 45 minutes for a seven year period. The exercise intervention consists of cardiorespiratory exercises, muscle stretches and muscle endurance exercises.

All data analyses were performed with SPSS 22.0 (IBM SPSS Statistics, Armonk, NY) statistical analysis software programme. The descriptive statistics (mean and standard deviations) as well as frequencies were calculated to describe the characteristics of the participants and the point prevalence of the CHD risk factors. General Linier Model analyses were applied to determine the significant changes in CHD risk factors measured from baseline to end with adjustment for

baseline measurements. McNemar exact test indicated significant changes in the point prevalence of the CHD risk factors from baseline to end. The relationship between the changes in the cardiorespiratory fitness and the measured risk factors were performed with a partial correlation analysis adjusting for age in 2013. The level of significance was set at $p \leq 0.05$.

The results indicate that the prevalence of inactivity decreased with 50% after the seven-year intervention program. Prevalence of age as a risk factor for developing CHD increased significantly post-intervention from 10% to 18%. Body mass decreased significantly in men (1.25 ± 5.43 kg) and increased significantly in women (0.15 ± 6.83 kg). BMI changes reflect changes in body mass of the participants. Body fat percentages increased both in men (2.98%) and in women (0.95%). A significant increase in systolic blood pressure (6.2 ± 10.1 mmHg) for men and diastolic blood pressure (6.35 ± 10.42 mmHg) for women was found. Physical work capacity in both male (1.90 ± 0.73 watt/kg) and female (1.55 ± 0.43 watt/kg) participants decreased to 1.43 ± 0.45 watt/kg and 1.14 ± 0.46 watt/kg respectively during the intervention period. Although a correlation between changes in PWC and the risk factors for CHD was found, none of the correlations was significant when adjusted for age in 2013.

The conclusion drawn from this study is that a long-term physical activity intervention in a population with ID reduced the point prevalence for physical inactivity and overweight and obesity, in spite of a decrease in cardiorespiratory fitness. The changes in cardiorespiratory fitness did not relate to the changes observed in the risk factors of CHD.

Keywords: physical activity, physical intervention, intellectually disabled, functional capacity, long-term effect

OPSOMMING

Effek van langtermyn fisieke-aktiwiteitsintervensie op funksionele kapasiteit van persone met intellektuele gestremdheid: 'n Potchefstroom kohort

Fisieke onaktiwiteit, 'n veranderbare risikofaktor vir koronêre hartsiekte (KHS) beide in persone met intellektuele gestremdheid (IG) en nie-intellektuele gestremdheid, word beskou as die vierde vernaamste oorsaak van sterftes in die wêreld. Langtermyn gereelde deelname aan fisieke aktiwiteit word geassosieer met 'n afname in risiko vir KHS. Tans bestaan daar 'n gebrek in die literatuur aan bewyse van langtermyn fisieke aktiwiteit in persone met IG. Die doel van hierdie studie was eerstens, om die effek van 'n langtermyn fisieke-aktiwiteitsintervensie op die risikofaktore wat met die ontwikkeling van KHS geassosieer word en tweedens, om die effek van 'n gekombineerde aerobiese en weerstand oefenintervensie op die funksionele kapasiteit van persone met IG te bepaal.

'n Kohort van vier en sewentig (74) deelnemers wat in versorgingsoord in Potchefstroom, Suid-Afrika, woon, het aan hierdie studie deelgeneem, wat 'n sewe-jaar opvolg- oefen-intervensiestudie is. Om die effek van 'n sewe-jaar opvolg oefen-intervensieprogram te bepaal is data in 2006 en in 2013 ingesamel. Op basislyn (2006) en eindpunt (2013) is 'n KHS-risikoprofiel aan die hand van 'n vraelys en fisieke assessering bepaal. Die fisieke assessering het rustende bloeddruk, perifere glukose- en cholesterolmetings, en liggaamsamestelling deur middel van liggaamsmassa-indeks (LMI), middel-tot-heup-ratio (MHR) en liggaamsvet-persentasie deur middel van velvoumetings, ingesluit. Kardiorespiratoriese fiksheid is met die aangepaste submaksimale YMCA fiets ergometerprotokol bepaal waarvan 'n fisieke werk-verrigting(FWV) bereken is. Die deelnemers het twee dae per week minstens 45 minute lank oor die sewe jaar heen 'n gestruktureerde fisieke-aktiwiteitintervensie gevolg. Die oefen-intervensie het kardiorespiratoriese oefeninge, soepelheid en spieruithouvermoë behels.

Alle data-onledings is met die *SPSS 22.0 (IBM SPSS Statistics, Armonk, NY)* statistiese analise sagtewareprogram uitgevoer. Die beskrywende statistiek (gemiddelde en standaardafwykings) asook frekwensies is bereken om die eienskappe van die deelnemers en die voorkoms van die KHS risikofaktore te bepaal. Algemene Liniêre Model-ontledings is toegepas om die betekenisvolle veranderinge in KHS risikofaktore van basislyn tot eindpunt, met aanpassing vir

basislyn-metings te bepaal. *McNemar* eksakte toets het betekenisvolle veranderinge in die persentasie voorkoms van die KHS risikofaktore aangedui vanaf basislyn tot eindpunt. Die verband tussen die veranderinge in die kardiorespiratoriese fiksheid en die gemete risikofaktore is met 'n partiële korrelasie uitgevoer met aanpassing vir ouderdom in 2013. Die vlak van betekenisvolheid was op $p \leq 0.05$ gestel.

Die resultate dui aan dat die voorkoms van onaktiwiteit met 50% afgeneem het na die sewe-jaar intervensieprogram. Voorkoms van ouderdom as 'n risikofaktor vir die ontwikkeling van KHS het ná intervensie betekenisvol van 10% na 18% toegeneem. Liggaamsmassa het betekenisvol by mans (1.25 ± 5.43 kg) afgeneem en by vroue betekenisvol toegeneem (0.15 ± 6.83 kg). Liggaamsmassa-indeks- (LMI) veranderinge weerspieël veranderinge in die liggaamsmassa van die deelnemers. Liggaamsvet-persentasies het beide in mans (2.98%) en in vroue (0.95%) toegeneem. 'n Betekenisvolle toename in sistoliese bloeddruk (6.2 ± 10.1 mmHg) is gevind vir mans en diastoliese bloeddruk (6.35 ± 10.42 mmHg) vir vroue. Fisieke werkskapasiteit het na die intervensieperiode beide by manlike (1.90 ± 0.73 watt/kg) en vroulike (1.55 ± 0.43 watt/kg) deelnemers na 1.43 ± 0.45 watt/kg en 1.14 ± 0.46 watt/kg onderskeidelik afgeneem. Hoewel 'n korrelasie tussen veranderinge in FWV en die risikofaktore vir KHS gevind is, was geeneen van die korrelasies betekenisvol toe daar vir ouderdom in 2013 gekorrigeer is nie.

Die gevolgtrekking waarby hierdie studie gekom het, is dat 'n langtermyn- fisieke-aktiwiteitsintervensie in 'n populasie met IG die voorkoms van fisieke onaktiwiteit asook oorgewig en obesiteit verlaag het, ten spyte van 'n afname in kardiorespiratoriese fiksheid. Die veranderinge in kardiorespiratoriese fiksheid het nie verband gehou met die veranderinge wat in die bepaald KHS risikofaktore gemeet is nie.

Sleutelwoorde: fisieke aktiwiteit, fisieke intervensie, intellektueel gestremd, funksionele kapasiteit, langtermynneffek.

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LIST OF ABBREVIATIONS

AAIDD	American Association on Intellectual and Developmental Disorders
ACSM	American College of Sports Medicine
ADHD	Attention deficit hyper disorder
AND	Australian Network on Disability
BMI	Body Mass Index
CA	Chronological age
CDC	Centres for Disease Control and Prevention
CETP	Cholesterol ester transfer protein
CHD	Coronary heart disease
cm	Centimetre
DBP	Diastolic blood pressure
DEXA	Dual energy X-ray Absorptiometry
DSM-IV	Diagnostic and Statistical Manual of Mental Disorders
ECG	Electrocardiograph
EPS	Electronic pressure scanning
FAS	Foetal alcohol syndrome
HDL	High-density lipoproteins
HDL-C	High-density lipoprotein cholesterol
ID	Intellectual disability
IQ	Intelligence coefficient
kCal	kilocalories
kg	Kilogram
LCAT	Lecithin cholesterol acyltransferase
LDL	Low-density lipoproteins
m	meter

min	minutes
mmHg	millimetre of mercury
NCD	Non-communicable diseases
NIDD	National Intellectual Disability Database
PA	Physical activity
PWC	Physical work capacity
Reps	repetition
SBP	Systolic blood pressure
SBP	Systolic blood pressure
SD	standard deviation
Sec	seconds
StatsSA	Statistics South Africa
T-Chol	Total cholesterol
UK	United Kingdom
US	United States
VLDL	Very-low density lipoproteins
VO ₂	Measurement of oxygen consumption
WHF	World Health Federation
WHO	World Health Organisation
WHR	Waist-to-hip ratio
YMCA	Young Men's Christian Association

CHAPTER 1

INTRODUCTION

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1.1 Introduction

Persons with intellectual disability (ID) are prone to a sedentary lifestyle, which is considered a risk factor for developing coronary heart disease later in life (Moss, 2009:740). Physical inactivity contributes to other lifestyle diseases such as obesity, hypertension, dyslipidaemia and diabetes mellitus Type 2 (WHO, 2009:10). Impaired fitness is associated with several factors such as a sedentary lifestyle, possible lack of motivation and task understanding (Oviedo *et al.*, 2014:3624). Persons with ID have limited resources and knowledge concerning participation in regular physical activity and have often been neglected in the past when health benefits of regular physical activity were promoted (Stanish *et al.*, 2006:18). High levels of physical inactivity are related to increased morbidity and mortality in persons with ID to the same extent as in persons without ID.

This dissertation will state the problem associated with physical inactivity in persons with ID. The current knowledge with regard to the effect of exercise interventions for persons with ID will be explored and presented in order to identify the knowledge that is lacking. Based on the gaps in the current literature, a research question will be derived of which the results will be presented in the form of two research articles. A summary of the research findings together with a conclusion will finally be presented along with the limitations experienced with this study and recommendations for future research.

1.2 Problem statement

Physical inactivity in persons with intellectual disability (ID) is very common (Heath & Fentem, 1997:195) and is considered a major risk factor for coronary heart disease (CHD), similar to it being the case in non-ID persons (Smith, 2009:39; van der Ploeg *et al.*, 2004:640). CHD risk factors include a sedentary lifestyle, age, smoking, dyslipidaemia, hyperglycaemia, a family history of CHD, obesity and hypertension (Allen *et al.*, 2009:28). These risk factors constitute a substantial morbidity risk (de Winter *et al.*, 2012:1722). Hypertension, dyslipidaemia, and diabetes mellitus are directly related to CHD and are in themselves major risk factors for death worldwide (WHO, 2009:10).

Persons with ID may be obstructed from participating in daily activities due to a wide range of mental impairments. The World Health Organisation (WHO, 2010) defines ID as a disorder characterised by the presence of incomplete mental development, which is categorised according to the degree of deterioration of all functions that contribute to an individual's intelligence, such as cognitive, language and motor skills and socialisation functions. Synonyms for ID include cognitive disability, global developmental delay, mental retardation and learning disability.

Individuals with ID encounter several challenges when it comes to engaging in physical activity due to cognitive delays that may interfere with the ability to understand certain constructs, to engage in reflective thought, and/or to engage in constructive self-expression (Stanish *et al.*, 2006:18). Challenges linked to engaging in physical activity include the incomplete mental development of cognitive, social, motor, and behavioural factors in persons with ID (Frey *et al.*, 2008:110). External barriers to engaging in physical activity in persons with ID include the level of activity dictated by support systems, where one can site the example of an overprotective caregiver, agency structures and the lack of opportunities provided for physical activity among ID individuals (Stanish *et al.*, 2006:19). Internal barriers that limit persons with ID to attend and perform a regular physical activity programme include muscle weakness, hypotonia, increased heart defects and circulatory and respiratory anomalies (Dodd & Shields, 2005:2056).

The mortality rate in people with ID is reported to be similar to that of the general population (Carter & Jancar, 1983:154). A systematic review conducted by Hinckson and Curtis (2013:82) found agreement amongst studies that children with ID were significantly less active than children without disabilities. Results from a South African cohort regarding persons with ID reported physical inactivity and being overweight as the two leading CHD risk factors in this

particular population (Moss, 2009:741). Improvement in body fat percentage and reduced physical inactivity was observed with an increase in cardio-respiratory fitness after a 12-week walking intervention (Moss, 2009:742). Regular physical activity for persons with ID hold added health benefits (Jansen & Le Blanc, 2010:53) such as improved weight management (Wu *et al.*, 2010:716), improved muscular fitness, reduced CHD risk factors (Moss, 2009:742), and reduced symptoms of anxiety and depression (Carmeli *et al.*, 2009:82). Anxiety and depression may reduce a person's quality of life and is a disabling condition that is associated with the progression of disability, functional decline, and cognitive and psychological impairment (Carmeli *et al.*, 2009:78), conditions common in persons with ID (Carraro & Gobbi, 2012:1221).

Participation in regular physical activity can decrease the risk of developing chronic lifestyle diseases such as CHD, type 2 diabetes, cancer, and osteoporosis later in life (Jansen & Le Blanc, 2010:54). The above-mentioned diseases are reported to have a higher prevalence in persons with ID than those without ID (van der Ploeg, 2004:640). In order to reduce the risk of lifestyle diseases such as hypertension, CHD, stroke, diabetes, breast- and colon cancer, depression and the risk of falls, bone- and functional health, as well as maintain an energy balance (which leads to weight control) regular, long-term and adequate physical activity at the correct intensity is needed in a population with ID similar as those without ID (WHO, 2013).

Various studies have investigated the prevalence of CHD risk factors in persons with ID. A study on the prevalence of lifestyle-related risk factors in persons with ID reported a high prevalence of obesity (Moss, 2009:735). Physical inactivity was also considerably higher in persons with ID than in the general population (Robertson *et al.*, 2000:474). De Winter *et al.* (2012:1727) found that people with ID are at a higher risk of having hypertension, while other researchers reported a high prevalence of obesity (Chang *et al.*, 2012:1708; Moss, 2009:735) in individuals with ID. Levels of smoking and alcohol abuse were considerably lower in individuals with ID than those of the general population (Moss, 2009:735; Robertson *et al.*, 2000:478). People with less severe ID were more at risk of having diabetes than people with causes of ID other than Down syndrome (de Winter *et al.*, 2012:1727). Elevated or abnormal fasting plasma glucose, triglyceride and high-density lipoprotein cholesterol (HDL-C) concentrations were reported in persons with ID (Chang *et al.*, 2012:1704), as well as their proneness to develop metabolic diseases (de Winter, 2012:1727). A limited number of studies have investigated the effect of a physical activity intervention on the risk factors for CHD in persons with ID (Oviedo *et al.*, 2014:2624; Calders *et al.*, 2011:1099; Moss, 2009:737).

One of the first studies to determine the effect of a physical activity intervention for persons with ID reported that physical inactivity was reduced with 50% during a 12-week walking intervention, with a significant reduction in the percentage of body fat (Moss, 2009:742). A 15-week exercise intervention programme for individuals with ID found several improvements in aerobic fitness and abdominal muscular endurance, while a significant increase in the walking distance was reported for the 6-minute walk test (Stanish & Temple, 2012:321). The individualised exercise programme intervention according to fitness levels presented to 20 participants included 20 minutes of aerobic exercising, 20 minutes of weight training and 20 minutes of core strengthening and flexibility exercises (Stanish & Temple, 2012:322).

In a 6-month intervention study (Golubović et al., 2012:610) which evaluated physical fitness in individuals with ID, a carefully designed physical activity programme significantly increased physical fitness in children with ID aged between 6.5 years and 12 years. However, this study did not measure functional capacity or CHD risk factors in the children with ID. Wu *et al.* (2010:716) found that a 6-month intervention resulted in a statistically significant decrease in body weight, body-mass index (BMI), and a positive improvement in the sit-and-reach test. Wu *et al.* (2010:716) state that persons with ID exhibit fatigue profiles during intermittent exercising that differ from that of people without ID. The above studies all investigated the influence of physical activity interventions for 6 months or less, while the true value of physical activity for the improvement of health lies in the long-term compliance to regular physical activity (WHO, 2013). Limited information is available on long-term physical activity interventions for persons with ID. One study evaluating a long-term physical activity programme consisted of only one male and one female participant (N=2) (Lante *et al.*, 2011:201). The results indicated that participation in the programme improved physical and psychosocial benefits for both participants. Accelerometer measurements indicated an improvement of 65 steps over a period of one year. A lack of information on the influence of long-term (> 12 months) physical activity interventions in persons with ID is evident.

Therefore the question to be answered through this study is: What is the long-term effect of a health improvement physical activity intervention programme on the functional capacity and CHD risk factors of persons with intellectual disability? The results of this study will indicate whether long-term physical activity intervention programmes will improve the functional capacity and risk factors for CHD in persons with ID more than changes observed in 12-24 weeks. Improvements in functional capacity and CHD risk factors in persons with ID due to a

long-term physical activity intervention may assist in influencing government policies to implement regular participation in physical activity at care facilities across South Africa. The implementation of physical activity programmes at care-giving facilities for persons with ID will also hold physiological, psychological and social benefits for the participants (Carmeli *et al.*, 2009:84). The amount of care needed for persons with ID will also be reduced when functional capacity remains high for a longer part of their life-time.

1.3 Objectives

The objectives set for this study are to:

- Determine the change in coronary heart disease risk factors with a long-term physical activity intervention in adults with intellectual disability.
- Determine the changes in the cardiorespiratory capacity with a long-term physical activity intervention in adults with intellectual disability.

1.4 Hypotheses

This study is based on the following hypotheses:

- A long-term physical activity intervention will significantly reduce the coronary heart disease risk factors of adults with intellectual disability.
- A long-term physical activity intervention will significantly improve the cardiorespiratory capacity of adults with an intellectual disability.

1.5 Structure of the dissertation

This dissertation will be in article format as approved by the senate of the North-West University. The introduction of the dissertation is presented in Chapter one. The problem statement as well as the research objectives and hypotheses of the study are also presented in Chapter one. The referencing of Chapter one will be written according to the Harvard style prescribed by the NWU.

Chapter one will be followed by a literature review, Chapter two, with the title: “Physical activity as modifier of cardiorespiratory fitness and coronary heart disease risk in persons with intellectual disability”. The literature review will be followed by two research manuscripts prepared for publication in a peer-reviewed research journal as Chapters three and four. Chapter three, article one will report on “Effect of a long-term physical activity intervention on the risk

factors for coronary heart disease for adults with intellectual disability”. The article will be presented to the *Journal of intellectual disability research*. Chapter four, article , will report on “Effect of a long-term physical activity intervention on cardiorespiratory capacity of persons with intellectual disability”. This article will be presented to the *Journal of intellectual disability research*

The final chapter of the dissertation, Chapter five, will present a summary of the study. This final chapter will include the conclusions drawn from the research based on the objectives set for the research. Any limitations experienced during the study and within the design of the study will be presented in Chapter five. Recommendations for future studies regarding coronary heart disease and functional capacity and related exercise interventions in persons with intellectual disability will be presented in Chapter five.

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CHAPTER 2

LITERATURE REVIEW: PHYSICAL ACTIVITY AS MODIFIER OF CARDIORESPIRATORY FITNESS AND CORONARY HEART DISEASE RISK IN PERSONS WITH INTELLECTUAL DISABILITY

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2.1 Introduction

People that have intellectual disability (ID) have lower levels of cardiovascular fitness as opposed to persons without ID (Fernhall & Pitetti, 2001:178) and do not participate in regular physical activity (Heath & Fentem, 1997:195). Regular physical activity contributes to a decrease in risks of developing coronary heart disease (CHD) (WHO, 2013b) and increases physical fitness in persons with ID (Shin & Park, 2012:1944). Risk factors for developing CHD include: a family history of CHD, age, obesity, hyperlycaemia, dyslipidaemia, hypertension, sedentary lifestyle and tobacco smoking (Allen *et al.*, 2009:28).

There are several causes, pre- and postnatal; where ID can develop. Examples are brain injury, medical causes, psychiatric disorders and genetic mutations (Reynolds *et al.*, 2014). In this chapter, ID will be discussed together with the role physical activity plays in cardiorespiratory fitness and the risk of developing CHD among persons with ID.

Subsequently causes and consequences of ID will be discussed as well as the influence physical activity interventions can have on the long-term health outcomes among persons with ID, both on the short and long-term.

2.2 Intellectual disability

The term intellectual disability (ID) has been accepted by the American Association on Intellectual and Developmental Disorders (AAIDD) as a disorder that is defined by the presence of incomplete mental development (AAIDD, 2013). The lack of complete mental development is categorised by the deterioration of all functions that contribute to an individual's intelligence, such as cognitive, language, motor and socialisation functions (WHO, 2010). ID is also defined as limitations in both intellectual functioning and adaptive behaviour, which includes several social and practical skills (Hourcade, 2002:2). People with ID are less efficient at learning and have limited memory, attention or language skills (Hourcade, 2002:3). Synonyms for ID include cognitive disability, global development delay and learning disability. Previously accepted terms for individuals with ID in scientific literature were mental retardation, idiot, imbecile, feeble-minded, mentally subnormal, moron and mentally deficient. Although the terms were previously accepted, it is now seen as abusive and stigmatising (Parmenter, 2011:303) and therefore no longer used.

Intellectual disability is characterised by the limitations in intellectual functioning and adaptive behaviour and is usually first noticed during the developmental period (Schalock, 2011:224). Another characteristic of individuals with ID is the limit in learning skills which is consistent with the overall intelligence coefficient (IQ) level (Hourcade, 2002:4), remembering and concentrating (Ewing *et al.*, 2004:77). Deficits in memory, attention or language are also affected in more severe ID caused by brain damage and can be associated with physical disabilities as cerebral palsy and epilepsy (Hourcade, 2002:8). Anxiety and depression is a common characteristic in persons with an ID as well as in individuals with a physical disability (Esbensen *et al.*, 2003:627; Carmeli *et al.*, 2009:79).

Carmeli *et al.* (2012:183) reported data in older adults with ID that the loss of muscle mass and loss of muscle strength is associated with an early onset of physical ability decline in active daily living and functions. These results support the concept that low muscle mass and low muscle strength contribute to the phenomenon of adults with ID reporting low levels of physical activity, resulting in early onset of functional decline (Carmeli *et al.*, 2012:183).

2.2.1 Classification of intellectual disability

The classification of persons with an intellectual disability is based on intellectual functioning as measured by an IQ test (Schalock, 2011:225). Most IQ tests are structured and a score of 100

being considered average (Hourcade, 2002:2). An IQ score below 70 is considered to be the cut-off score for being classified with ID (Hourcade, 2002:2). IQ tests alone cannot be used to diagnose individuals with an ID; a low IQ must be associated with limitations in adaptive behaviour (social and practical skills in daily lives) (Hourcade, 2002:2). ID can be categorised in five general categories: borderline, mild, moderate, severe and profound (Hourcade, 2002:3; Daily *et al.*, 2000). Daily *et al.* (2000) adopted a table from Pelegano and Healy (1992) with developmental characteristics related to the level of ID (Table 2.1). The developmental characteristics related to the level of mental retardation are easily described according to mild, moderate, severe and profound retardation. Differences in IQ vary from 50-70, 35-49, 20-34 and less than 20 for the different categories of ID.

Table 2.1: Classification of persons with intellectual disability (DSM-IV Criteria) adapted from Daily *et al.*, 2000

	Mild retardation	Moderate retardation	Severe retardation	Profound retardation
Percentage of cases	75% to 90%	~10% to 25%	~10% to 25%	~10% to 25%
Function	1/2 - 2/3 of CA	1/3 -1/2 of CA	1/5 -1/3 of CA	< 1/5 of CA
IQ	50 to 70	35 to 49	20 to 34	< 20
Delays	Slow in all areas of daily functioning	Noticeable especially in speech	Obvious delays	Delays in all areas
Physical signs	No unusual physical signs	Some unusual physical signs	Little communication skills	Congenital abnormalities present
Lifestyle skills	Practical skills	Simple communication	Can teach daily routines and repetitive activities	Needs close supervision
Academic skills	Reading and mathematical skills up to grades 3 to 6.	Can learn elementary health and safety habits	May be trained in simple self-care	Often need attendant care
Social skills	Can conform socially	Can participate in simple activities and self-care	Need direction and supervision	May respond to regular physical activity and social stimulation
Self-care	Can acquire vocational skills for self-maintenance	Can perform tasks in sheltered conditions	—	Not capable of self-care
Acceptance	Integrated into general society	Can travel alone to familiar places	—	—

DSM IV = Diagnostic and Statistical Manual of Mental Disorders, 4th ed.; CA = chronological age; IQ = intelligence quotient; ID = Intellectual disability (Daily *et al.* 2000).

A meta-analysis on population-based prevalence of intellectual disability estimated that approximately 1% of the global population consists of persons with an intellectual disability (Maulik *et al.*, 2011:431). During the 2001 South-African census, 5% of the total population reported some kind of disability (StatsSa, 2005:14). The percentage of disabled persons by type of disability is summarised in Figure 1 (StatsSa, 2005:14). The 2011 census results are not comparable with those of previous censuses, since changes occurred in the approaching questioning about disability (StatsSa, 2012:45). In the 2011 census, disability was defined as difficulties encountered in functioning due to physical impairments or limitations in activity with or without the use of assistive devices (StatsSa, 2012:44). These difficulties are vision, hearing, communicating, walking or climbing stairs, remembering or concentrating and self-care. No distinction was drawn between intellectual disability and functional/physical disability (StatsSa, 2012:46). The percentages reported for the population aged 5 years and older that had difficulty in remembering and concentrating were 3.3% of the population reporting some difficulty, 0.9% a lot of difficulty and 0.2% cannot do it at all (StatsSa, 2012:46). The results do not classify the type of disability as in 2001 census data. Therefore the 2001 Census data are presented.

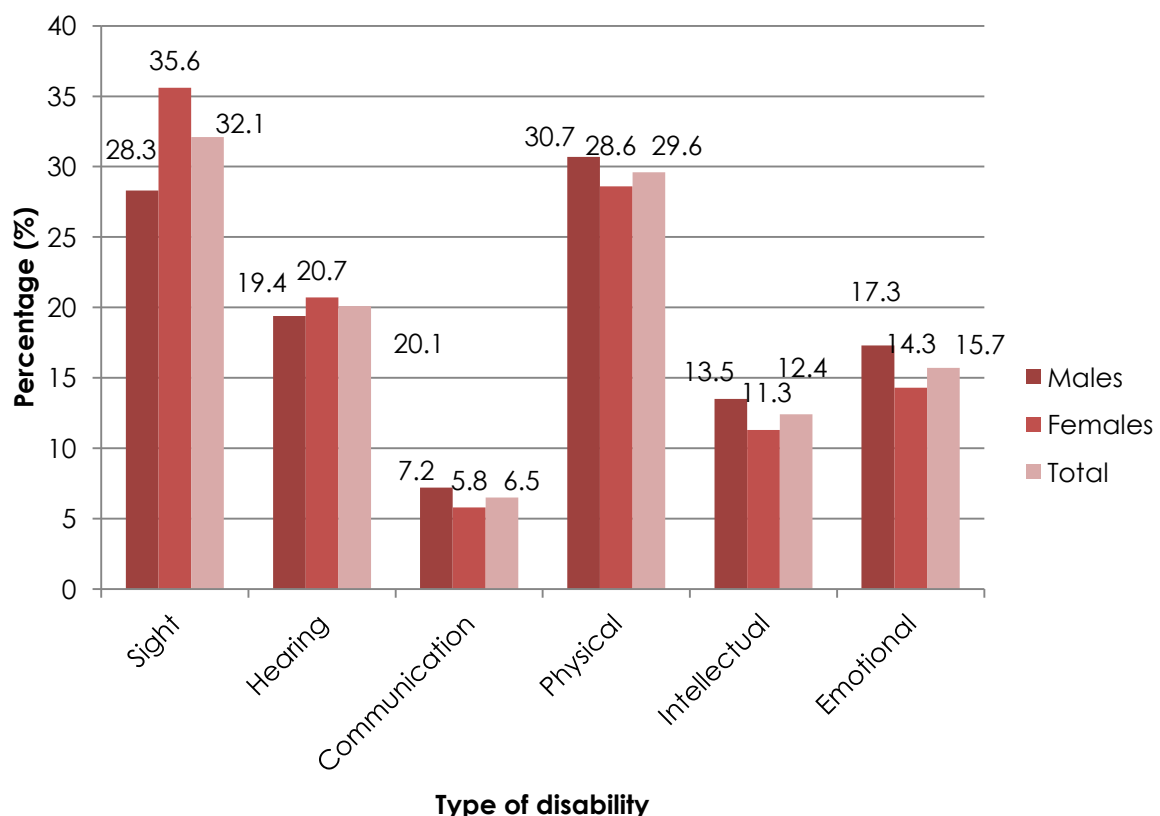


Figure 2.1: Percentage of disabled persons in South Africa by type of disability (StatsSa, 2005:15)

The statistical data of South Africa (Figure 2.1) based on the 2001 census information indicates that 12.4% of the total SA population with disabilities are classified as persons with intellectual disability, of which 13.5% and 11.3% of the persons with ID are male and female respectively (StatsSa, 2005:14). In Ireland there were 27 691 people registered on the National Intellectual Disability Database (NIDD) at the end of December 2013 (Kelly & O'Donohoe, 2013:14). In the United States approximately 1 in 6 children had developmental disabilities in 2006–2008 (CDC, 2011), 668 100 individuals have intellectual and/or developmental disorders in Australia (AND, 2014). There is an estimate of 200 million people with ID in the world, it has been estimated that persons with intellectual disability vary from 1-3% of the population (Special Olympics, 2009). The wide range of functionality observed in persons with ID necessitates caregiving. Although public and private caregiving facilities are available in many countries, information regarding the availability of care facilities in South-Africa is limited and information is not easily accessible. In future it would strengthen the level of care of persons with ID if databases of facilities were available and the quality of care available, be reported, in particular with regards to sport and recreational facilities,

2.2.2 Causes and consequences of intellectual disability

Individuals with mild ID do not always have a specific physical or medical cause for developing ID (Hourcade, 2002:4). Figure 2.2 is a summary of different causes of ID, which can be due to many medical (Reynolds *et al.*, 2014) and environmental, genetic, psychiatric factors (Reynolds *et al.*, 2014) or a combination of factors (Hourcade, 2002:2; Daily *et al.*, 2000). Although some persons have a genetic abnormality of the brain, other persons become ID due to brain damage pre- or postnatal (Daily *et al.*, 2000). Medical conditions causing ID may be experienced by a pre- or postnatal exposure to excess alcohol, drugs, toxins and certain viral and bacterial infections (Reynolds *et al.*, 2014). Examples of environmental factors causing ID are explained by exposure to toxins. Psychiatric causes of ID include Autism (Reynolds *et al.*, 2014). Examples of prenatal risk factors that result in the development of intellectual disability are chromosomal disorders, metabolic disorders, viral or bacterial infections, delayed or retarded brain development, maternal malnutrition, domestic violence, lack of prenatal care, parental disability, lack of education and drug abuse by the mother during pregnancy (Daily *et al.*, 2000). Abnormal use of alcohol during pregnancy may lead to foetal alcohol syndrome (FAS) as well as attention deficit hyperactivity disorder (ADHD) (Hourcade, 2002:2). Perinatal risk factors for developing ID include prematurity, injury during delivery and neonatal disorders. Postnatal risk

factors include traumatic brain injuries, malnutrition, and poverty, lack of stimulation, violence, degenerative seizure and disorders (Schalock, 2011:226). In more severe ID, chromosomal abnormalities such as Down syndrome and Fragile X occur (Hourcade, 2002:8). Down syndrome, which is the result of the presence of an extra chromosome on chromosome 21, is a major cause of ID and heart disease (Korenberg *et al.*, 1990:236). The abnormalities on the chromosome can lead to modified mitochondrial function, development of diseases of the nervous system, growth disorders, physiological malfunction and abnormal physical development (Fernhall *et al.*, 2013:138).

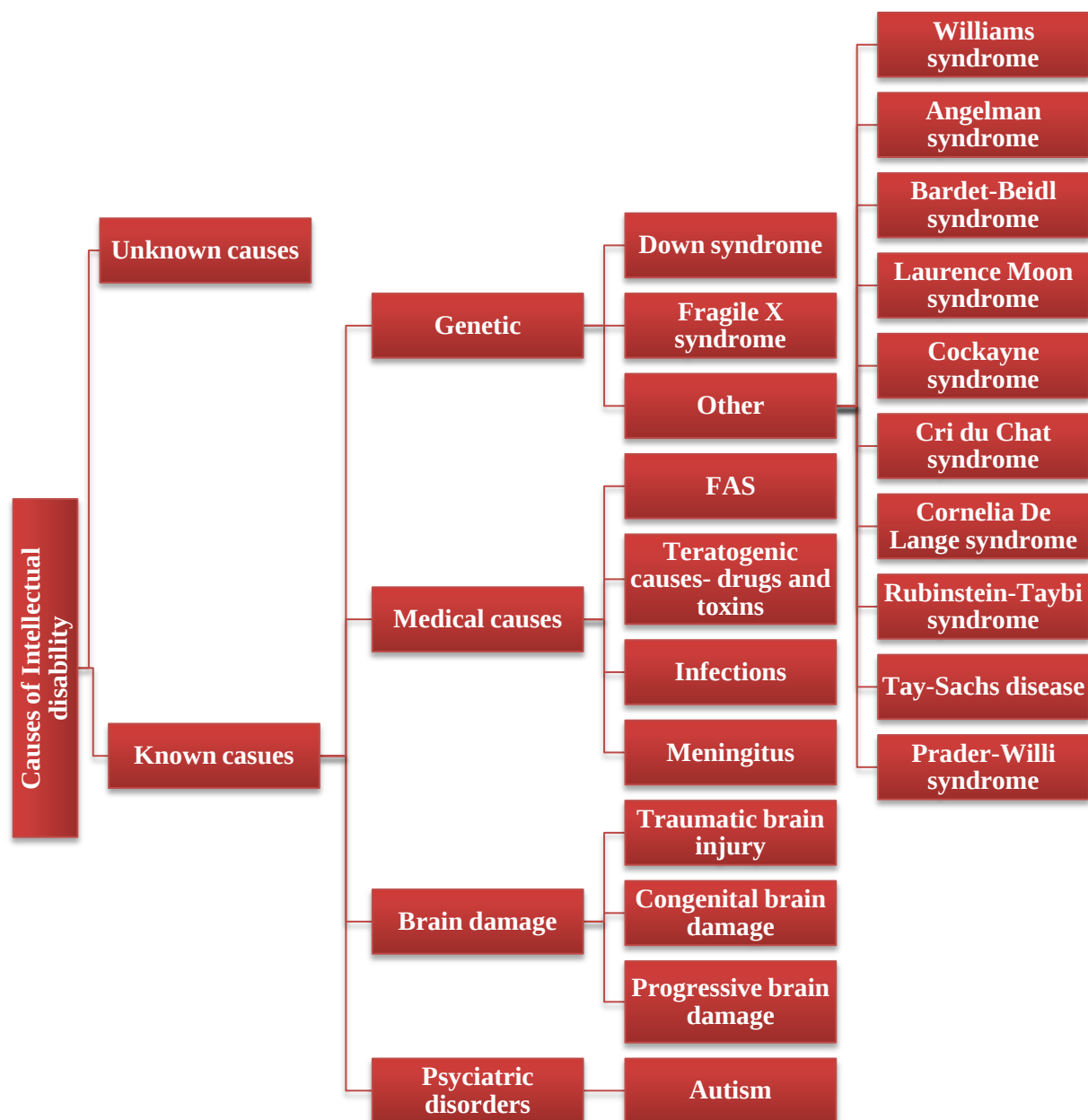


Figure 2.2: Causes of intellectual disability compiled from research conducted by Reynolds *et al.*, 2014

People with ID have lower levels of cardiovascular fitness than persons without ID (Fernhall & Pitetti, 2001:176). Contributing factors to poor levels in physical work capacity are a lack of motivation and of task understanding (Fernhall & Pitetti, 2001:176), lack of physical activity (Hinckson & Curtis, 2013:83; Hilgenkamp *et al.*, 2012:480; Phillips & Holland, 2011:5; Melville *et al.*, 2007:226; Fernhall & Pitetti, 2001:176, Heath & Fentem, 1997:203), leg strength and reduced heart rate response to exercise (Fernhall & Pitetti, 2001:180) in individuals with an ID. A sedentary lifestyle can contribute to the low levels of cardiovascular fitness (Dodd & Shields, 2005:2056). Persons with ID have low levels of relative peak VO₂ while individuals with Down syndrome have even lower relative peak VO₂ than persons with ID, which is consistent with low levels of cardiovascular fitness (Fernhall *et al.*, 2013:138). The low levels of cardiovascular fitness can be as a result of the sedentary lifestyle of people with Down syndrome (Dodd & Shields, 2005:2056). Fernhall *et al.* (2013:145) explain that young individuals with Down syndrome have the same physical work capacity as an older normal person without an ID. A sedentary lifestyle has been found to be related to several health problems, including the occurrence of coronary heart disease risk factors.

Individuals with ID experience an early onset of ageing. In a survey querying the institutional manager's perception and service preparation on early onset of ageing in people with ID in Taiwan (n =54), 90 % of the respondents agreed with the early onset of ageing characteristics in this population (Lin *et al.*, 2011:191). Another study focusing on prevalence of sarcopenia in older adults (age 50 and above) with ID found 14.3% prevalence of sarcopenia in the participants (Bastiaanse *et al.*, 2012:2007), with inclusion of functional persons with walking speed of at least 3.2 km/h. Emerson *et al.* (2010:231) found that families that support children with an intellectual disability or other disabilities are more likely to be living in hardship, which shows that parents of persons with ID may face several financial constraints.

2.3 Risk factors for coronary heart disease in persons with ID

Risk factors for coronary heart disease have been indicated to be related to mortality and morbidity in both non-ID persons and persons with ID (de Winter *et al.*, 2012:1722). The traditional risk factors associated with coronary heart disease are: a family history of coronary revascularisation, myocardial infarction or sudden cardiac death in direct male or female relatives, age (males >45 years; females >55 years), obesity, hyperglycaemia, dyslipidaemia, hypertension, sedentary lifestyle and tobacco smoking (Allen *et al.*, 2009:28).

Cardiovascular diseases account for most mortalities due to non-communicable diseases (NCD) – 17.3 million people annually (WHO, 2013b). Cardiovascular diseases, cancers (7.6 million), respiratory diseases (4.2 million) and diabetes (1.3 million) cause 80 % of all NCD deaths and are also the four main types of chronic diseases (WHO, 2013b). In a large cross-sectional study investigating the prevalence of CHD risk factors in 2150 individuals with ID, a high prevalence of hypertension (N=815, 53.0% prevalence), hypercholesterolemia (N=724, 23.1% prevalence), diabetes (N=724, 13.7% prevalence) and metabolic syndrome (N=584, 44.7% prevalence) was reported (de Winter *et al.*, 2012:1729). The age of the participants varied between 50-93 years (mean age 61.5 years), which in itself is a risk factor for developing CHD. The study reported that an additional risk for CHD was present due to the clustering of hypertension, diabetes, and hypercholesterolemia with abdominal adiposity to constitute the metabolic syndrome (Alberti *et al.*, 2009:1640). The presence of the risk factors adds a substantial morbidity risk to participants with ID (de Winter *et al.*, 2012:1722).

CHD is a major cause of death in older persons with an ID compared to that in persons without an ID. The mortality rate due to CHD risk factors can be managed through changes in lifestyle-related risk factors, particularly by increasing physical activity (Chang *et al.*, 2012:1704; de Winter *et al.* 2012:1723). Modifiable risk factors in developing CHD include hypertension, obesity, dyslipidaemia and hyperglycaemia.

Regular moderate physical activity is important in managing blood pressure, and a decrease in systolic blood pressure (SBP) with approximately 4-9 mmHg has been reported in the normal population (Chobanian *et al.*, 2003:1217). The mechanism by which blood pressure is lowered is largely unknown. However, reduced levels of norepinephrine in blood levels occur with regular physical activity. Epinephrine and norepinephrine are both vasoconstrictors in the arteries and with regular physical activity the levels of norepinephrine is reduced and allows a slight reduction in peripheral resistance to blood pressure (Ehrman *et al.*, 2009:240).

The role of regular physical activity in lowering glucose levels starts with an increase in insulin-dependent and insulin-independent glucose transport to the active muscles (Ehrman *et al.*, 2009:207). Exercise improves insulin sensitivity through several mechanisms; including change in body composition, muscle mass, capillary density and glucose transporters in muscles (Sigal *et al.*, 2004:2520). The positive effect of exercise on insulin control is lost within a few days; therefore it is important to continuously take part in daily moderate physical activity (Ehrman *et al.*, 2009:207).

Regular physical activity together with a healthy diet is important components in improving lipid profile (Ehrman *et al.*, 2009:258). Many of the changes to the lipid profile as a result of regular exercise may occur due to changes in the circulating enzymes involved in the degradation and transport of cholesterol, of which the mechanisms are not fully understood (Ehrman *et al.*, 2009:258). Lipoprotein lipase contributes to hydrolysis of triglyceride-rich lipoprotein particles, such as very low density lipoproteins (VLDL) and chylomicrons (Ehrman *et al.*, 2009:258). Regular and acute exercise bouts increase the activity of lipoprotein lipase; this contributes to a direct lowering of plasma triglyceride concentrations (Ehrman *et al.*, 2009:258). After the lipid hydrolysis, the remaining particles may be transformed to high density lipoproteins (HDL) or accepted by HDL (Ehrman *et al.*, 2009:258). HDL is important in the reverse cholesterol transport mechanism and serves a protective mechanism for developing hypercholesterolemia (Ehrman *et al.*, 2009:248). Individuals that are physically active have higher levels of lecithin cholesterol acyltransferase (LCAT) activity (LCAT is responsible for maturation of HDL through cholesterol esterification) (Ehrman *et al.*, 2009:258). After exercise training cholesterol ester transfer protein (CETP) decreases and also contributes to HDL maturation (Ehrman *et al.*, 2009:258). CETP removes esterified cholesterol from HDL and low density lipoproteins (LDL) and transforms to VLDL and chylomicrons. A decrease occurs in hepatic triglycerides lipase after physical activity and contributes to decreased catabolism of HDL in the liver (Ehrman *et al.*, 2009:258). Together with a lack of exercise, dietary intake of fats also contributes to the development of CHD (Ehrman *et al.*, 2009:258).

In order to improve and maintain weight loss with physical activity, energy expenditure needs to be 1000-2000 kCal per week for general health benefits (Ehrman *et al.*, 2009:225). Therefore to lose weight, an expenditure of 2000-2800 kCal per week is recommended for persons that are obese or overweight (Ehrman *et al.*, 2009:225).

Globally abdominal obesity and hypertension have a higher prevalence in persons with ID than in persons without an ID (Chang *et al.*, 2012:1704). Results from a study involving persons with ID, participants with a higher physical activity level did not have lower blood pressure or healthier body compositions than persons with a lower physical activity level (Stanish & Draheim, 2007:187). Women with ID are at greater risk of being overweight and obese than is the risk in men with ID, which is similar to the findings from the general population (Melville *et al.*, 2007:225, Robertson 2000:483). The CHD risk factors of life style, smoking and alcohol use are reported to have a low prevalence in a South African cohort with ID (Moss, 2009:741), while

Robertson *et al.* (2000:483) found lifestyle risk factors of a cohort from England to be considerably lower than that of the general population. A considerably higher prevalence of physical inactivity was found in men and women with ID than in the general population (Robertson *et al.*, 2000:483). A sedentary lifestyle is a significant factor in the reduced level of physical fitness and general health among a population with ID (Shin & Park 2012:1944). Increased levels of physical fitness is related to less chronic conditions related to CHD, type 2 diabetes and stroke (Shin & Park, 2012:1944). Fitness in general is related to regular exercise with the purpose of improving functional capacity. Therefore in order to improve fitness or in more broader terms, functional capacity, regular bouts of exercise are required in order to improve cardiorespiratory efficiency, muscle strength and endurance as well as flexibility. Regular bouts of exercise result in conditioning of the physiological processes with an evidence-based lowering in the risk factors for CHD.

A study by Ewing *et al.* (2004:79) applied an inexpensive group intervention programme to determine whether persons with ID would improve their CHD risk factors by applying a programme similar to that for persons without ID (Ewing *et al.*, 2004:84). The intervention consisted of eight classes focused on targeted issues in each session, such as nutritional choices, benefits of exercise, stress reduction and behaviours, ensuring successful lifestyle choices, medical reasoning to adhere to the lifestyle choices and relapse prevention (Ewing *et al.*, 2004:79). The intervention which determined BMI, weight, fruit and vegetable intake, knowledge and exercise status, did not result in significant changes in the BMI values of the participants. The reason for the lack of change was given as physical activity, stress reduction and nutritional intake that did not change with the intervention (Ewing *et al.*, 2004:84).

2.4 Physical inactivity in persons with an ID

Physical inactivity in persons with intellectual disability (ID) is very common (Heath & Fentem 1997:195) and is considered a major risk factor for CHD in persons with ID, as is the case with non-ID persons (Smith, 2009:39; Van der Ploeg *et al.*, 2004:640). Physical inactivity has been identified as the fourth leading risk factor for global mortality and causes an estimated 3.2 million deaths globally (WHO; 2013a). In a literature review of the prevalence and determinants of obesity in adults with ID, 8-16% of adults with ID met the criteria of being physically active, compared to 30-47% of the general population (Melville *et al.*, 2007:226). The findings of Melville *et al.* (2007:224) upon reviewing data from Australia, UK, Irish adults, US and Norwegian adults, indicate that physical activity for health changes are very low in persons with

ID. Individuals with ID present several challenges when it comes to engaging in physical activity due to cognitive delays that may interfere with the ability to understand certain constructs, to engage in reflective thought, and/or to engage in constructive self-expression (Stanish *et al.*, 2006:18).

Persons with ID experience additional barriers to developing a regular physical activity programme due to internal as well as external barriers (Stanish *et al.*, 2006:17). External barriers to engage in physical activity include the level of activity dictated by support systems, where one can cite the example of an overprotective caregiver, agency structures and the lack of opportunities provided for physical activity among ID individuals (Stanish *et al.*, 2006:19). Internal barriers that limit persons with an ID to achieve a regular physical activity programme include muscle weakness, hypotonia, increased heart defects and circulatory and respiratory anomalies (Dodd & Shields, 2005:2056), as well as difficulty understanding their own health problems and a lack of basic health knowledge. The results of a South African study on the CHD risk factors prior to a 12-week walking intervention, found physical inactivity to be a major risk factor for CHD in persons with an ID living in a care facility (Moss, 2009:740).

2.5 Physical activity interventions for persons with ID

Knowledge of the protective role physical activity plays in the prevention of risk factors for CHD, particularly in the non-ID population, is important but it is as important to understand whether the same holds true for persons with ID. Regular physical activity can reduce the risk of developing CHD, breast cancer, and depression (WHO, 2013b). Little is known about physical activity in this targeted population with ID. In order to understand the effect of physical activity on the risk factors of CHD in persons with ID, a systematic search of the current literature was performed. Physical activity is defined as being any bodily movement that is produced by skeletal muscles to increase energy expenditure (WHO, 2013a) and exercise improves the physical fitness in persons with ID (Shin & Park, 2012:1944).

In order to understand the evidence for the effect of a physical activity intervention health outcome of persons with ID, the following search engines were consulted: Ebscohost, ScienceDirect, Google Scholar and Sabinet. Databases that were included in the search were: Academic Search Premier, ERIC, MEDLINE, SPORTDiscus, Health Source-Consumer Edition and Health Source-Nursing/Academic edition. Electronically published theses and dissertations were included in the search, as well as cross references. The following keywords were used to

search for relevant articles: ‘physical activity’, ‘intellectually disabled’, ‘mental retardation’, ‘physical intervention’. Articles and research published were included in the summary table (Table 2.2) when the findings were related to persons with ID, physical activity intervention programme, interventions stretching across more than four weeks and focusing on physical activity, functional capacity, cardiorespiratory fitness of individuals, and reporting CHD risk factors.

Research findings of 10 studies ranging from January 2000 to October 2014 were traced and summarised. The majority of the outcome variables were on physical fitness in persons with ID and did not focus on the effect of exercise on CHD risk factors. The lack of research indicates the need for randomised controlled trials on the effect of physical activity on the prevalence of risk factors for CHD in persons with ID.

One of the earliest studies reporting on a physical activity intervention programme and the benefits thereof in persons with ID was conducted in Potchefstroom, South Africa. The results of the walking intervention indicated a significant reduction in body fat percentage over a 12-week period (Moss, 2009:742). The meta-analyses by Shin and Park (2012:1944) found that regular physical activity in persons with ID improved physical fitness, weight management, less maladaptive behaviours and improved adaptive behaviours, positive attitudes towards exercise and improved life satisfaction.

Table 2.2: A summary of physical activity interventions on physical fitness and CHD risk factors in persons with ID

Reference	Objective	Participants	Intervention	Measurements	Results	Conclusion
Oviedo <i>et al</i> (2014:264–263)	To investigate the effect of a combined physical activity programme on cardiovascular fitness, strength, balance and functional measures.	37 adults from an Occupational Day Centre (Spain) for people with ID, aged between 20 and 60 years participated in the intervention programme. Mean age 41±11 years.	Duration: 14 weeks Frequency: 3x/week, 1 hour sessions. Exercise focused on endurance, strength and balance training.	BMI, Cardiovascular fitness, strength, flexibility and balance.	Significant results were found in weight 70.1±13.5 to 68.1±13.1 kg, BMI 27.4±5.0 to 26.6±4.8 kg/m ² , VO ₂ peak 2.02±0.5 from 1.85±0.4 l/min, VO ₂ peak 26.8±6.8 to 29.3±7.5 ml/kg/min Peak workload from 161.9±38.3Watt to 170.1±38.4 Watt SBP lowered with 6±14 mmHg DBP 78±9 to 71±10 mmHg, 6 min walk test increased from 461.5±89.3 m to 519.0±96.5 m, Strength test showed improvements in right and	The combined physical activity programme improved aerobic fitness, muscle strength and balance in people with an ID.

					left hand grip tests and leg strength test. Flexibility significantly improved and balance significantly improved.	
Giagazoglou <i>et al.</i> (2013:2701–2707)	To investigate the effect of a 12-week trampoline exercise intervention programme on motor and balance ability of school-aged children with ID.	N=18 (mean age 10.3 ± 1.6 years) with moderate ID, recruited randomly from special primary school unit of 32 Greek students.	The intervention was applied to the experiment group. Duration: 12 weeks. Frequency: daily Sessions: 20 minutes Exercises: focused on functional movement patterns.	Standing long jump test 12.89±6.25cm Vertical jump test 73.33±30.84cm Sit and reach test 13.11±7.27 cm Balance testing (EPS pressure platform)	Statistical significant effect in vertical jump (Post-test 19.11±6.45cm), broad jump (Post-test 103.44±32.94cm) and sit-and-reach (Post-test - 7.00±6.52 cm). No significant differences were found between the two groups or in the control group.	Improvements were found in balance and motor-skills by the children whom participated in the 12 week intervention and trampoline training can be used to improve functional outcomes.
Rahmat & Hasan (2013:2058–2062)	To investigate the effects of core stability exercises on physical fitness of children with	31 male students with ID in two groups (control N=14 and experimental N=17).	The control group did not receive the core stability training Duration: 6	22.86 m dash: 5.27±0.53sec Bent arm hang: 20.47±10.18 sec Leg lift:	Results showed that children with ID significantly improved physical fitness levels after the intervention.	6 weeks CST intervention has viable effects on the participants' physical fitness

	ID.	Mean age 11.07 ± 3.02 years). Iran	weeks. Frequency: 4 x/week Exercises: CST consisted of 5 core-related exercises performed.	13.17±3.94 number of leg lifts/ 20 sec Thrusts: 7.29±3.36 number of thrusts n 20 seconds Static balance test: 7.82±4.59 seconds 274.32 m run-walk: 93.72±10.29 seconds	Before training time to finish the 274.32 run-walk test were 94.92 seconds for the control group and 93.72 seconds for the training group. The training group time after intervention was 86.05 seconds.	levels.
Casey <i>et al.</i> (2012:221–229)	Investigating the effects of a 13-week moderate to vigorous aquatic exercise and nutritional education intervention on body fat percentage using Dual-energy X-ray Absorptiometry (DEXA).	8 adults (males N=6; females N=2) with ID aged 41.0 ± 13.7 years of varying body fat percentages (15%-39%) from two group homes. Canada	Duration: 13-week moderate to vigorous aquatic exercise programme intervention Frequency: 3 x/week one-hour sessions held in a 25 m pool Exercises: aqua jogging, water polo and lap swimming to 60-	Weight: 74.9±15.6 kg Body fat percentage (DEXA): 28.7±9.0% BMI calculated: 29.7±5.9 kg/m ²	Mean body fat percentage decreased to 28.0%, BMI decreased from 29.7 to 29.2 kg/m ² which was not statistical significant	The aquatic exercise and nutrition intervention proved ineffective at decreasing body fat percentage and BMI among adults with ID.

			80% of their theoretical maximal heart rate Weekly educating sessions in regards to portion size and food nutrition.			
Golubović <i>et al.</i> (2012:608–614)	The effect of a physical exercise program on the development of physical fitness in children with ID.	42 children with ID enrolled in special schools. Age groups 6.5-12 years.	Duration: 6 month programme, 3 x/week 45 minute sessions. Exercises were done to develop specific physical fitness	Balance Standing broad jump Bent arm hang Endurance of abdominal muscles Cardiorespiratory endurance	Balance: 21.095 in 60 seconds Standing broad jump: 118.429 cm Bent arm hang: 27.720 seconds Endurance of abdominal muscles: 13.190 in 30 seconds Cardiorespiratory endurance 140.095 seconds	Significant lower performance in initial fitness assessment of children with ID than typically developing children.
Stanišić <i>et al.</i> (2012:89–93)	To determine the differences in	12 adolescents (6 male and 6 female	Adapted basketball	Maximum sprint over 20 meters (s):	The 8 week training programme did not result	The study improved tested

	physical fitness and specific motor skills after 8 weeks of a specially adapted basketball training programme.	participants) with ID partook in the study in Serbia. All participants resided at home. Mean age (15.1± years)	training programme Duration: 8 weeks Frequency: 4 x/ week 30 minute sessions. Exercises included ball handling and receiving, passing, shooting and playing basketball.	mean 4.77±1.05 Standing long jump test (cm): mean 104.38 ±48.12 Bent arm hang test (s): mean 10.99±15.17 Sit up test: mean 11.38±5.43 Sit and reach test (cm): mean 13.35 ±9.64 Motor skills	in significant improvements in the adolescent participants. Maximum sprint over 20 meters (s): mean 4.59±0.84 Standing long jump test (cm): mean 111.31 ±34.98 Bent arm hang test (s): mean 14.06±18.07 Sit up test: mean 13.15±5.78 Sit and reach test (cm): mean 12.9 ±10.7	motor skills for all adolescents but no changes in the physical fitness of the participants.
Calders <i>et al.</i> (2011:1097–1108)	Investigating the effect of a combined aerobic and strength training programme on metabolic and physical fitness in adults with	45 adults with ID. Mean age 42, mean BMI 24, mean IQ 56. Belgium	3 Groups: Duration: 20 weeks, 2x/week Group1: (n=15) Combined exercise training Group 2: (n =15) endurance exercise training	Lipid profile Physical fitness Blood pressure Body composition	Group 1: Relative peak VO ₂ : 27.7 to 30.3 ml/kg/min in Peak power: 124 to 138 Watt 6-minute walk distance: 502 to 557 m Maximal upper and lower body strength	Combined exercise training in adults with ID has more beneficial effects than aerobic exercise training or no training group.

	intellectual disabilities compared to endurance training and no training.		(n=15) Group 3: (n15) control group		Abdominal muscles and sit-to stand Changed significantly.	
Stanish & Temple (2011:319–328).	To examine the effects of a peer guided exercise programme for increasing health related physical fitness among adolescents with ID.	N=20, 10 male and 10 female participants with mild and moderate ID who resided at home with a parent/guardian. Situated in the United States Mean age 17.8±1.6 years	The study was based on team up for fitness with support of peer partner. Duration: 15 weeks 2 x/ week for 1 hour after school. Exercises: combined aerobic and strength training programme	Sit and reach (in): 9.3±4.6 Grip strength (kg): 23.3±6.9 Curl ups (reps): 15.3±11.6 6 min walk (m): 448.9±11.6 BMI (kg/m ²): 25.3±4.4	Significant changes were found in curl-ups 23.2±7.7 and 6-min walk test 588.6±63.8	The intervention may have the potential to promote semi-independent participation to exercise for individuals with ID to increase physical fitness components.
Wu <i>et al.</i> (2010:713–717)	To provide information of examining the effectiveness of a healthy physical	146 participants who lived in an institution partook in the study. Ages varied 19-67 years	Physical fitness programme Duration: 6 month (24 weeks), 40 min healthy	Height: 158.82±10.37 Weight: 61.89±13.73 BMI: 24.70±5.46 Physical fitness	During the 6 month intervention the mild disability level group lost 4.98 kg in average and the severe level ID lost 1.83	Appropriate regular physical activity will improve health behaviours and efficacy of weight

	fitness programme on persons with an ID.	Taiwan	physical fitness activities 4x/week.	status: V-shape sit-and-reach: 14.29±14.60 Sit up 30s: 5.49±4.38 Sit up 60s: 9.99±8.31 Shuttle run: 241.78±98.70	and 1.94 kg.	management in persons with an ID
Moss (2009:735–744)	To investigate the changes in CHD risk disease profile of adults with ID following a 12 week walking intervention.	100 men and women between the ages of 21 and 73 years with ID living in a care facility in North-West. Average age: men 39.2±8.9, women 37.5±10.1	Duration:12 week, 3 days/week, progression every 4 weeks by increasing the time from 20 min to 30 min per session ,walking intervention	A CHD risk profile, physical activity assessment, resting blood pressure, BMI, non-fasting glucose and cholesterol and cardiorespiratory fitness	Physical inactivity decreased to 50%, body fat percentage significantly decreased (-8.03% for men and -18.69% for women. PWC significantly changed with 12.38 and 23.66 for men and women respectively.	The two major risk factors for persons with ID living in the care facility were inactive and overweight. The physical activity intervention decreased physical inactivity with 50 %.

2.5.1 Physical activity and coronary heart disease risk factors

In the non-ID population, regular physical activity has been indicated to reduce the risk for CHD later in life (Thompson *et al.*, 2003:3109). Results from intervention studies in persons with ID indicate similar findings. Regular physical activity by means of a walking intervention resulted in a decrease in systolic and diastolic blood pressure (Moss, 2009:742). The findings correspond with those of a 12-week walking intervention regarding postmenopausal women which found that blood pressure had reduced even more with an additional 12-week intervention (Moreau *et al.*, 2001:1828). The changes in blood pressure were not related to changes in body mass, adiposity, diet or fasting insulin level (Moreau *et al.*, 2001:1828). Eight weeks of accumulating daily physical activity by use of a pedometer was effective at improving glucose tolerance in previously inactive, overweight women who were at risk of developing type 2 diabetes (Swartz *et al.*, 2003:359). The study also found a significant decrease in systolic and diastolic blood pressure during the walking intervention, and at last resulting in an 85% increase in daily physical activity in overweight, previously inactive women (Swartz *et al.*, 2003:359). In a six-month physical activity and dietary uptake intervention in men and women with impaired glucose tolerance, positive changes were found in dietary fat intake, physical activity body mass, systolic blood pressure and insulin sensitivity. The physical activity intervention consisted of 20-30 minutes cardiovascular exercising (Oldroyd *et al.*, 2001:40).

The studies with participants with ID as (Table 2.2) focused on muscle endurance and physical fitness. Studies determining the risk of CHD are limited to the studies by Moss (2009:735) and Calders *et al.* (2011:1097). Moss (2009:735) focused on the effect of a 12-week walking intervention on the CHD risk profile and physical fitness of 100 participants with ID (mean age men: 39.2 years and women: 37 years in South-Africa. Calders *et al.* (2011:1097) focused on lipid profile, blood pressure, physical fitness and body composition in 45 participants (mean age 42 years) following a combined exercise training programme for 20 weeks. Although both studies reported significant improvements in the health outcomes, the combinations of an aerobic intervention combined with a resistance programme reported additional improvements in the determined health variables.

Although there are limited studies on physical activity interventions for persons with ID, certain components are influenced by physical activity interventions resulting in positive health and quality of life outcomes.

2.5.2 Cardiorespiratory fitness/ Functional capacity

Cardiorespiratory fitness, also indicated as functional capacity, is determined by means of indirect respiratory gas exchange methods such as the relative VO₂ max or Physical Work Capacity test (PWC) as calculated from the YMCA bicycle ergometer test (Allen *et al.*, 2009:81). The limited number of physical activity interventions investigating outcome on physical fitness, ranged from 6 weeks (Rahmat & Hasan, 2013:2058) to a 6-month intervention period (Golubović *et al.*, 2012:608; Wu *et al.*, 2010:713). The studies applied interventions such as core stability training (Rahmat & Hasan, 2013:2058), basketball training (Stanišić *et al.*, 2012:89), combined exercise training (Oveido *et al.*, 2014:3264) and walking (Moss, 2009:735) to improve physical fitness in persons with ID. The findings indicate that core stability interventions improved the distance walked in a group of persons with ID (Rahmat & Hasan, 2013:2058); as did the distance walked after 12 weeks of walking intervention, improve in persons with ID (Moss, 2009:735). The relative VO₂ peak improved in individuals with ID after a 14-week combined exercise training programme (Oveido *et al.*, 2014:3264), which indicates an improvement in physical cardiorespiratory fitness in individuals with ID. After a 20-week combined exercise intervention, a significant positive change was found in aerobic capacity of individuals with ID (Calders *et al.*, 2011:1097). In a six-month physical fitness intervention the time in the shuttle run decreased significantly. A peer-guided 15-week physical activity intervention improved distance walked in a 6-min walk test (Stanish & Temple, 2011:324). However, the basketball intervention (Stanišić *et al.*, 2012:89) or a 6-month physical activity intervention did not result in significant changes. The reason for these findings might be that the basketball intervention gave attention to detail in developing basic functional technique that might have reduced the intensity of the exercise programme and did not improve physical fitness in persons with ID (Stanišić *et al.*, 2012:892), and factors that could affect the exercise programme itself (Golubović *et al.*, 2012:613). Only 2 studies included adult participants; most of the study participants were children and adolescents (Calders *et al.*, 2011:1098 and Moss, 2009:736).

2.5.3 Muscle strength and muscular endurance

Muscular strength and muscular endurance form part of the health-related physical fitness components. Muscular strength is defined as the ability of a muscle to exert force, and muscular endurance is the ability of muscles to perform without fatigue (Allen *et al.*, 2009:3). Physical activity interventions show positive attributes to muscle strength and muscular endurance.

Studies focusing on muscular strength and endurance of persons with ID ranged from 6 weeks (Rahmat & Hasan, 2013:2058) to a 6-month intervention period (Golubović *et al.*, 2012:608; Wu *et al.*, 2010:713). The majority of studies include children and adolescents. Only Calders *et al.* (2011:1097) included adults with ID. Interventions varied from core stability training (Rahmat & Hasan, 2013:2058), basketball training (Stanišić *et al.*, 2012:89), combined exercise training (Oveido *et al.*, 2014:3264; Calders *et al.*, 2011:1097), functional exercise trampoline training (Giagazoglou *et al.*, 2013:2701) physical exercise training (Golubović *et al.*, 2012:613) to peer guided exercise programmes (Stanish & Temple, 2011:324). The findings indicate that several studies found significant positive effects in the muscle endurance of participants with ID. The 15-week peer-guided exercise intervention (Stanish & Temple, 2011:324), 20-week combined exercise training intervention (Calders *et al.*, 2011:1101) and 6-month physical activity intervention programme (Wu *et al.*, 2011:715) improved abdominal muscle endurance. Leg strength significantly improved after a 14-week combined exercise programme intervention (Oveido *et al.*, 2014:2629). A significant improvement occurred in hand grip strength after both combined exercise programme interventions (Oveido *et al.*, 2014:2629; Calders *et al.*, 2011:1101). The trampoline intervention programme significantly improved the vertical and broad jump measures in the experimental group (Giagazoglou *et al.*, 2013:2704). Core stability training significantly improved upper body and leg strength (Rahmat & Hasan, 2013:2060).

No significant differences were found in bent arm hang test; standing long jump and sit up test after a basketball intervention although the participants' specific motor skills increased significantly (Stanišić *et al.*, 2012:91). A 6-month physical exercise programme did not have significant positive changes in groups regarding muscle endurance but the group that took part in exercises showed the most improvement (Golubović *et al.*, 2012:610).

2.5.4 Flexibility

Flexibility, another health-related physical fitness component, is defined as the range of motion available at a joint (Allen *et al.*, 2009:3). Only 4 studies included tests for flexibility. There was a significant improvement in the flexibility of the individuals with ID after the combined exercise programme intervention (Oveido *et al.*, 2014:2629) and trampoline exercise intervention (Giagazoglou *et al.*, 2013:2704). However, no significant results were found after a peer guided exercise intervention (Stanish & Temple, 2011:324). The reason for this finding might be the lack of control to measure the fitness changes (Stanish & Temple, 2011:326). The result of an 8-week basketball specific intervention programme proved to show statistically significant difference in the pre- and post-intervention flexibility test (Stanišić *et al.*, 2012:91). Stanišić *et al.* (2012:90) did not focus on stretching in the particular study – exercises focused on motor skills used in basketball.

2.5.5 Quality of life

Regular physical activities have been indicated to improve general quality of life. Quality of life can be altered by mood disorders such as depression and anxiety (Carmeli *et al.*, 2009:77) that restricts social life and reduces independence. Anxiety is reported to be common among persons with an ID and a physical disability (Carmeli *et al.*, 2009:79; Esbensen *et al.*, 2003:627). Aerobic physical activity intervention programmes (Carmeli *et al.*, 2009:82) and exercise sessions by movements of large muscle groups and using balls, balloons, bands, sticks, bean bags and scarves for general activities (Carraro & Gobbi, 2012:1224) proved to be beneficial in reducing the level of anxiety experienced by persons with an ID.

2.6 Summary

Physical activity is considered a modifier of lifestyle with the purpose of reducing the risk of developing CHD, and improving physical fitness in persons without ID. Physical activity decreases the risk of developing CHD, breast cancer, and depression (WHO, 2013b). Regular physical activity also improves physical fitness, muscle endurance, flexibility and quality of life in persons with ID.

Persons with ID present to be less physically active than persons without ID, which contributes to health risks such as obesity, dyslipidaemia and hyperglycaemia. A limited number of studies

that focus on physical activity interventions have been published. From the current published literature, the benefits of physical activity interventions between 4 and 20 weeks have proven to be yield positive results. The large improvement observed with interventions in children and adolescents may be due to the low levels of functional capacity prior to the interventions. The intervention studies also mainly focussed on children and adolescents with only 2 studies on adults and the risk factors of CHD. A lack of information on the influence of long-term (> 12 months) physical activity interventions in persons with ID is evident. Therefore future research should investigate the long-term effect of health improvement physical activity intervention programmes on the functional capacity and CHD risk factors of persons with intellectual disability. Findings from studies on long-term exercise interventions may inform caregivers and health practitioners on the importance of habitual exercise programmes for persons with ID. The ageing effect observed within persons with ID may be slowed down through the implementation of regular physical activity. Improvements in functional capacity and CHD risk factors in persons with an ID due to a long-term physical activity intervention may assist in influencing government to design policies in the interest of implementing regular participation in physical activity at caregiving facilities across South Africa. The implementation of physical activity programmes at caregiving facilities for persons with ID will also hold physiological, psychological and social benefits for the participants (Carmeli *et al.*, 2009:84).

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CHAPTER 3

Effect of a long-term physical activity intervention on risk factors for coronary heart disease in adults with intellectual disability

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Abstract

Background: Physical inactivity is a major risk factor for developing coronary heart disease (CHD). People with an intellectual disability (ID) are prone to physical inactivity, leading to a high prevalence of overweight and obesity. Longevity of individuals with an ID can be ameliorated by decreasing the risk for CHD. Limited research is available on long-term physical activity intervention in persons with ID therefore; the aim of this study is to determine the effect of a long-term physical activity intervention programme on risk factors for CHD. Our findings may contribute to a new approach in the management of CHD risk factors in persons with an ID.

Methods: A cohort of 74 participants living in a care facility in Potchefstroom, North West Province of South Africa, gave consent for participation in this seven-year follow-up study. The participants aged chronologically between 25 and 76 years were intellectually aged between 4 and 12 years. The CHD risk factors were determined by means of questionnaire and physical assessment that included resting blood pressure measurements, body mass index (BMI), fat percentage and non-fasting glucose and cholesterol measurements. The long-term physical activity intervention included twice weekly supervised physical activity. The exercise programmes consisted of aerobic training, strength and resistance training of large muscle groups for health improvement. Dependent *t*-tests were performed as well as the McNemar exact test for pre- to post-intervention changes in risk factor variables and point prevalence of risk factors.

Results: The point prevalence of inactivity in the participation decreased from 50% to 24%. Total cholesterol prevalence risk factor increased from 23% to 45%. Prevalence of age as a risk for developing CHD increased significantly in the seven-year follow-up study from a 10% prevalence to 28%. Body mass decreased significantly in men (1.25 ± 5.43 kg) and increased significantly in women (0.15 ± 6.83 kg). BMI reflected the changes in body mass for men and women respectively. Body fat percentages in men (2.98%) and in women (0.95%) increased. A significant increase in systolic blood pressure (SBP) for men (6.2 ± 18.1 mmHg) and diastolic blood pressure (DBP) for women (6.35 ± 10.42 mmHg) was determined. In women Total cholesterol increased significantly (0.53 ± 0.41 mmol/L).

Conclusion: A long-term physical activity intervention in a population with ID reduced the point prevalence of inactivity, while Total cholesterol increased.

Introduction

Risk factors for coronary heart disease (CHD) are related to mortality and morbidity both in persons with an intellectual disability (ID) and persons without an intellectual disability (ID) (de Winter *et al.*, 2012). The term intellectual disability (ID) has been accepted by the American Association on Intellectual and Developmental Disorders (AAIDD) as a disorder which is defined by the presence of incomplete mental development (AAIDD, 2014). In the population of persons with ID and Down's syndrome, ageing tends to progress at a faster rate than in persons without ID (Carmeli *et al.*, 2012). Carmeli *et al.* (2012) suggest that low muscle mass and low muscle strength may explain the early onset of ageing in individuals with ID. Together with age, tobacco smoking, hyperglycaemia, dyslipidemia, family history of coronary heart disease, hypertension, obesity and a sedentary lifestyle (Allen *et al.*, 2009) are associated with the development of CHD in adults with ID and Down's syndrome.

The leading risk factors attributable to death in the general population are hypertension (13% of global deaths), followed by smoking tobacco (9%), hyperglycaemia (6%), physical inactivity (6%), overweight and obesity (5%) (WHF, 2012). Besides the early onset of ageing in persons with ID, low physical activity levels are consistently reported for persons with ID who live in a community-based setting and/or independently (Hinckson & Curtis, 2013; Hilgenkamp *et al.*, 2012; Phillips & Holland, 2011; Moss, 2009; Peterson *et al.*, 2008; Melville *et al.*, 2007; Heath & Fentem, 1997). Physical inactivity, a risk factor for developing CHD, also contributes to the development of several other risk factors of CHD in individuals with ID, as in non-ID persons (Smith, 2009; Van der Ploeg *et al.*, 2004). These risk factors include overweight and obesity in persons with ID (de Winter *et al.*, 2012; Moss, 2009). The low levels of physical activity combined with potential unhealthy dietary intake may contribute to the high prevalence of overweight and obesity in individuals with ID (Moss, 2009).

Coronary heart disease can become a major cause of death in older persons with ID due to inactivity and the high prevalence of obesity (Chang *et al.*, 2012; de Winter *et al.*, 2012; Moss, 2009). Physical inactivity has been identified as the fourth leading risk factor for global mortality, causing an estimated 3.2 million deaths globally (WHO, 2013). Regular physical activity is a leading health indicator that is directly associated with a reduction in chronic

diseases of lifestyle such as obesity and diabetes (Stanish *et al.*, 2006) and can reduce the risk of developing CHD, breast cancer, and depression (WHO, 2013).

Several challenges, such as cognitive delays, the ability to understand certain constructs, engage in reflective thought, and/or to engage in constructive self-expression, are present when individuals with ID are requested to engage in physical activity (Stanish *et al.*, 2006). Persons with ID also experience several barriers in adhering to regular physical activity programmes due to internal as well as external barriers (Stanish *et al.*, 2006). The external barriers include the level of activity dictated by support systems, where the example of an overprotective caregiver, agency structures and the lack of opportunities provided for physical activity among individuals with ID can be listed (Stanish *et al.*, 2006). Internal barriers limiting persons with ID from achieving a regular physical activity programme include muscle weakness, hypotonia, increased heart defects and circulatory and respiratory anomalies (Dodd & Shields, 2005), as well as difficulty understanding their own health problems and a lack of basic health knowledge.

Limited research is available on the effect of exercise intervention on the risk factors for CHD. A South African-based study investigating the CHD risk factors prior to a 12-week walking intervention reported physical inactivity as being a major risk factor in persons with an ID living in a care facility (Moss, 2009). A walking intervention resulted in a significant reduction in body fat percentage and physical inactivity (Moss, 2009). Although little is known of physical activity in this targeted population with ID and risk factors for CHD, findings from the limited number of studies that ranged between 6 weeks and 6 months indicate that physical activity is related to risk factors for CHD in persons with ID. In a 13-week moderate to vigorous aquatic exercise and nutritional education intervention, participants with ID reported a 0.8% decrease in body fat percentage and a 0.3 kg/m² decrease in BMI (Casey *et al.*, 2012). The effect of a 20-week combined aerobic and strength training programme in adults with ID showed that the combined exercise training programme found a positive effect on the participants' T-chol, aerobic capacity, muscle strength and resting systolic blood pressure (Calders *et al.*, 2011). Wu *et al.* (2010) found that a 6-month physical fitness intervention resulted in a statistically significant decrease in body weight and subsequently a decrease in BMI. The above studies all investigated the influence of physical activity interventions for a period of 6 months or less. The true value of physical activity for improving health is in the long-term compliance to regular physical activity (WHO, 2013) of 30 minutes on two days of the week (Allen *et al.*, 2009). Since

most of the current literature is limited to interventions of less than 6 months, limited information is available on long-term physical activity interventions on CHD risk factors for persons with ID. Information on the development of CHD risk in the presence of regular physical activity is currently also not available in the published literature. Therefore the purpose of this study is to determine the long-term effect of a health-based physical activity intervention programme on the CHD risk factors of persons with intellectual disability. The results of this study will indicate whether long-term physical activity intervention programmes will prevent or reduce the development of risk factors for CHD in persons with ID. A decrease in CHD risk factors in persons with ID due to a long-term physical activity intervention may assist in influencing government policies to implement regular participation in physical activity at care-giving facilities for persons with ID.

Methods

Setting and participants

All individuals living at a care facility for persons with ID in the North West Province of South Africa, that had participated in a similar study in 2006, was recruited to take part in this follow-up study (N=130). The facility accommodates residents in three-bedroom apartments with a full-time caregiver for each apartment. Informed consent was obtained from the legal guardian of the participants, as well as assent from each participant. Parents of the individuals in the care facility gave consent for the legal guardian to sign informed consent on their behalf. The participants were aged 25–76 years and intellectually aged between 4–12 years (Moss, 2009). The severity of the level of ID was determined before their acceptance in the care facility by means of standard evaluation criteria and obtained from the medical files of the participants. Exclusion criteria for participation were the presence of a physical disability rendering it impossible for the person to perform the assessment. The study has been independently reviewed and approved by the Ethics committee of the North-West University (NWU-00105-13-A1).

Procedure

All persons with ID that gave consent for participation in the study completed a coronary risk profile questionnaire (Björstrom & Alexiou, 1978) with the assistance of the full-time employed

registered nurse and the participants' medical files. The testing protocol was explained to the participants and caregivers of the facility to familiarise everybody with the procedure. Resting blood pressure (Baumanometer[®], W. Baum Co Inc., USA) was measured after the participants had been seated for 5 minutes. Two resting measurements, 5 minutes apart, were performed and the average of the two measurements was recorded as the resting blood pressure measurement. Resting heart rate was determined by means of a stethoscope (Sprague Rappaport Type Stethoscope, China). Body composition and cardiorespiratory fitness was then measured. Body mass was measured (Seca[®]700) to the nearest 0.1 kg and stature was measured with a stadiometer to the nearest 0.1 m. Fat percentage was calculated with the use of the seven skinfold equation (Jackson & Pollock, 1985) according to the guidelines of the International Society for the Advancement of Kinanthropometry (Stewart *et al.*, 2011). Skinfolts were measured by a level two accredited anthropometrist with a calibrated skinfold caliper (Harpندن[®], UK). Waist and hip circumference was measured according to the guidelines of the International Society for the Advancement of Kinanthropometry (Stewart *et al.*, 2011). The physical activity participation was determined with the assistance of the full-time caregiver, sport coach and Biokineticist (registered clinical exercise physiologist) on-site. After the body composition and questionnaires were completed, the glucose and cholesterol concentrations were determined by means of peripheral blood sampling (Accutrend[®] Roche Diagnostics, Germany). The participants had been familiarised with the testing protocol in advance. All participants were also familiar with the testing equipment, since testing was performed at the exercise facility of the care facility where the participants have been following a physical activity intervention during the last seven-years.

Physical activity intervention

Based on the findings of a 12-week aerobic walking intervention (Moss, 2009), a regular physical activity intervention programme was introduced to the participants at the care facility and was conducted by a registered Biokineticist familiar with exercise prescription for health outcomes in special populations. A structured physical activity intervention, two days per week, had been presented to the participants for the last seven years (2006–2013). Two days of exercise were the only number of days available for supervised exercise sessions due to the structured programs at the care facility. The exercise intervention consisted of cardio-respiratory exercises lasting at least 20 minutes, stretches to improve flexibility for 10 minutes and muscle

endurance exercises by means of resistance training for 30 minutes involving the large muscle groups. About 10 participants trained under the supervision of a registered exercise specialist at a time. Aerobic exercise comprised of treadmill walking and stationary biking with the intention to reach approximately 70% of age-predicted maximal heart rate during the 20-minute period. Attendance of the intervention programme was recorded by means of an attendance register and exercise training cards.

Statistical analyses

Statistical analyses were performed with SPSS 22.0 (IBM SPSS Statistics., Armonk, NY) statistical analysis software programme. Descriptive statistics was performed for all CHD risk factor variables at baseline (2006) and seven years post healthy exercise intervention (2013). Mean and standard deviations were determined. Frequencies were calculated for the prevalence of the CHD risk factors prior to and after the seven-year intervention period. General Linier Model analyses were applied to determine significant changes from baseline (2006) to end (2013) and adjusted for baseline values. Significant changes in the prevalence of CHD risk factors from 2006 to 2013 were determined by means of the McNemar exact test. The level of significance was set at $p \leq 0.05$.

Results

Only 74 participants that were tested in 2006 took part in the follow-up study (37 male and 37 female participants), five (5) participants passed away and sixteen (16) are not living in the care facility. The descriptive characteristics of the participants' before and after the seven-year intervention (Table 1) indicate that the participants were middle-aged. The male participants were significantly taller and heavier than the female participants, while the women became slightly heavier after the seven-year intervention period. Females had a higher BMI and body fat percentage than the males at both measurement points. The average BMI for both genders pre- (males = $28.32 \pm 8.72 \text{ kg/m}^2$, females = $29.33 \pm 6.64 \text{ kg/m}^2$) and post-intervention (males = $27.21 \pm 5.47 \text{ kg/m}^2$, females = $30.08 \pm 6.62 \text{ kg/m}^2$) were higher than the healthy norm of between $18.5\text{-}24.9 \text{ kg/m}^2$ as indicated by the American College of Sports Medicine's (ACSM) guidelines for a healthy weight (Allen *et al.*, 2009). The results show that women had more subcutaneous body fat than men. The participants' fat percentage increased during the seven-year follow-up period.

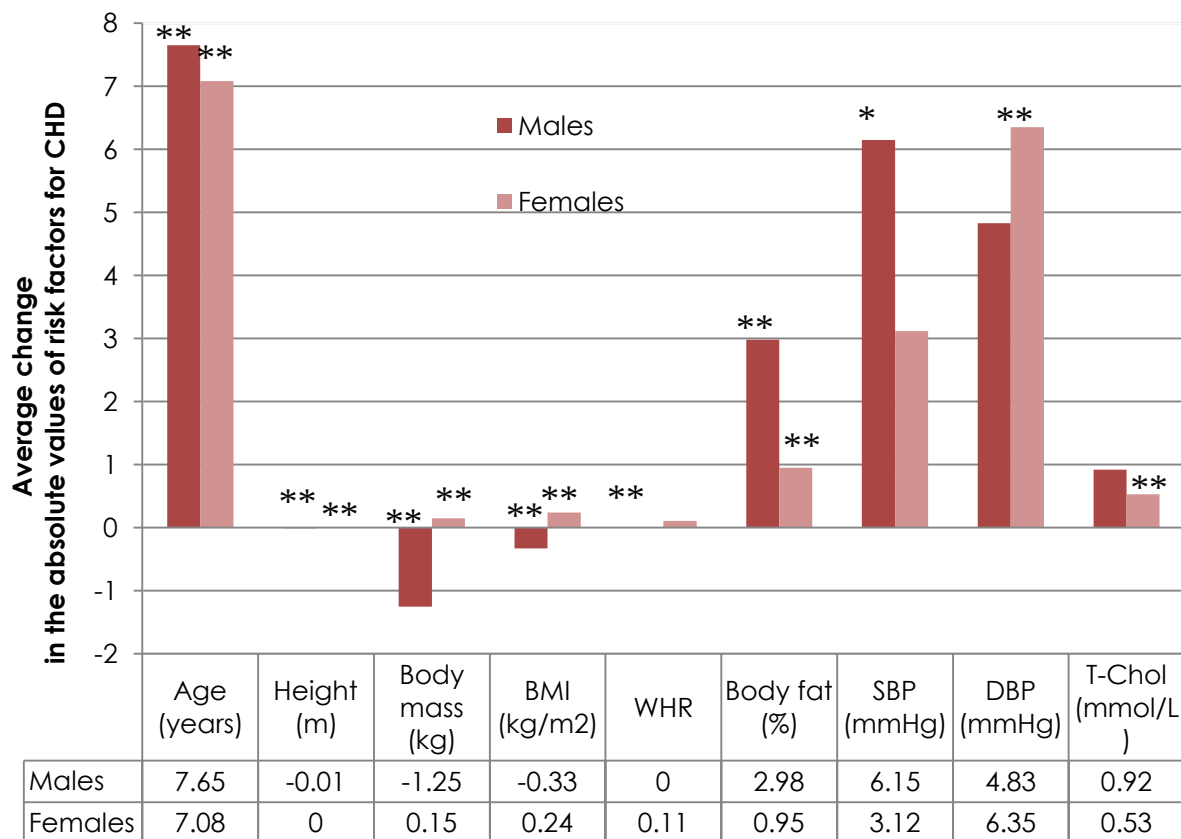
The average blood pressure of the participants was classified as normal (<120/<80 mmHg) according to the ACSM's guidelines for exercise testing and prescription (Allen *et al.*, 2009). The pre-test values for T-Chol and glucose, which are the post-test data of the 2006 12-week intervention, are not available due to participants declining the repeated peripheral blood sampling test. The base line testing in Moss (2009) indicated normal blood glucose (men: 4.6 ± 2.2 mmol/L; women: 4.9 ± 1.8 mmol/L) and T-Chol levels (men: 4.6 ± 0.8 mmol/L; women: 4.8 ± 0.9 mmol/L). The post seven-year intervention resulted in an average increase in T-Chol concentration in males and females and glucose levels increased in male participants. The percentage of participants attending moderate to vigorous physical activity under supervision for at least twice a week for the seven-year period was 70.2% for males and 81% for females respectively.

Table 1: Pre and post seven-year physical activity intervention descriptive characteristics for men and women with intellectual disability (mean $\pm$ SD)

Variables	Pre-test		Post-test	
	Men	Women	Men	Women
Age (years)	39.14 $\pm$ 8.91	37.47 $\pm$ 10.06	44.95 $\pm$ 7.38	44.24 $\pm$ 8.51
Height (m)	1.69 $\pm$ 0.13	1.59 $\pm$ 0.10	1.70 $\pm$ 0.11	1.58 $\pm$ 0.10
Body mass (kg)	81.23 $\pm$ 22.53	74.13 $\pm$ 17.14	78.85 $\pm$ 18.82	75.34 $\pm$ 16.47
BMI (kg/m²)	28.32 $\pm$ 8.72	29.33 $\pm$ 6.64	27.21 $\pm$ 5.47	30.08 $\pm$ 6.62
WHR	0.88 $\pm$ 0.07	0.79 $\pm$ 0.09	0.87 $\pm$ 0.06	0.78 $\pm$ 0.14
Body fat (%)	17.20 $\pm$ 6.52	23.53 $\pm$ 7.27	20.18 $\pm$ 6.85	25.07 $\pm$ 5.96
SBP (mmHg)	111.62 $\pm$ 13.73	110.98 $\pm$ 15.33	116.38 $\pm$ 17.83	115.41 $\pm$ 10.00
DBP (mmHg)	71.95 $\pm$ 11.28	70.43 $\pm$ 12.75	75.84 $\pm$ 12.64	76.05 $\pm$ 8.85
T-Chol (mmol/L)	5.13 $\pm$ 0.55	4.96 $\pm$ 1.41	4.98 $\pm$ 0.85	5.16 $\pm$ 1.01
Glucose (mmol/L)			4.71 $\pm$ 1.49	4.93 $\pm$ 1.52
PA (%)*	50%	50%	70.2%	81%

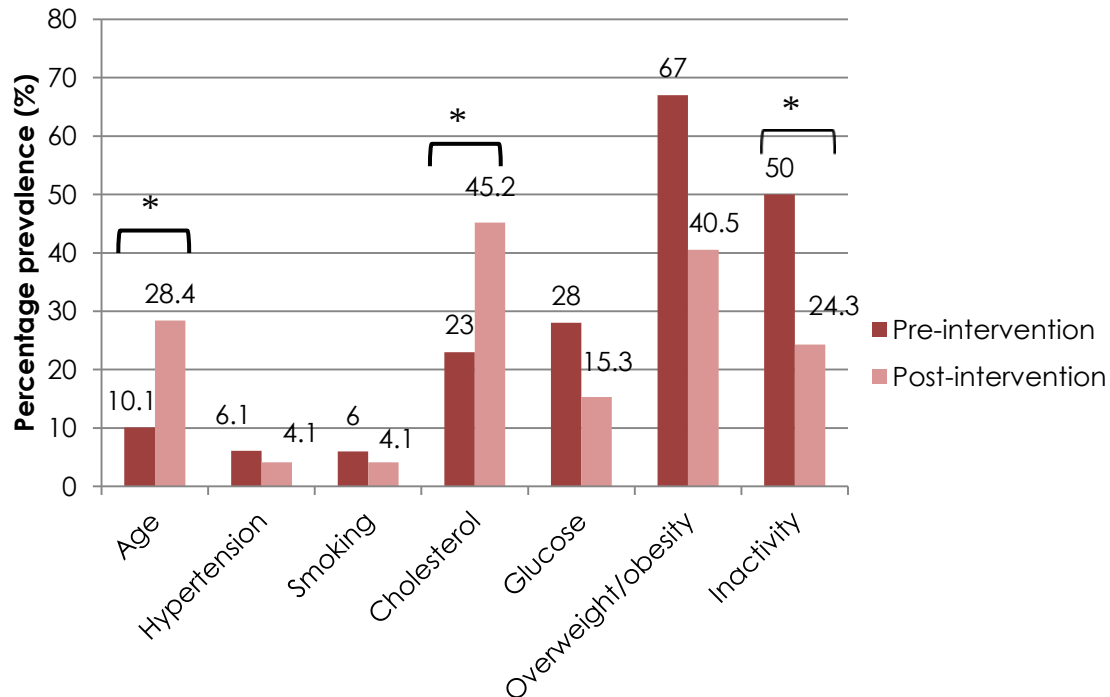
* The percentage participants engaging in moderate to vigorous physical activity at least twice per week. BMI = body mass index; WHR = waist-hip ratio; SBP = systolic blood pressure; DBP = diastolic blood pressure; PWC = physical work capacity; T-Chol = total cholesterol; SD = standard deviations

The results of the General Linier Model analyses, to determine the significant changes observed from the long-term intervention in the risk factor values, with adjustment for the baseline values, are presented in Figure 1. The male participants results show a statistical significant change in their fat percentage, where females show a statistical significant change in diastolic blood pressure values.



BMI = Body Mass Index, WHR =Waist to Hip Ratio, SBP = Systolic Blood Pressure, DBP = Diastolic Blood Pressure, T-Chol = Total cholesterol; * = indicate significant change $p \leq 0.05$; ** = indicate significant $p \leq 0.001$

Figure 1: Average change in the absolute values of risk factors for coronary heart disease over a seven-year follow-up period of a combined aerobic and resistance physical activity intervention



* = indicate significant change $p \leq 0.05$

Figure 2: Distribution of CHD risk factors of the total groups pre- and post- a combined aerobic and resistance physical activity intervention

The distribution of the CHD risk factors (Figure 2) shows a high prevalence of overweight/obesity at baseline (64%) which declined during the seven-year period of the physical activity intervention with 27%. The exact McNemar's test determined that there was a statistically significant difference in the proportion of persons with an ID pre and post-intervention for age ($p \leq 0.001$), T-Chol ($p = 0.001$), and physical inactivity ($p \leq 0.001$). Smoking and hypertension which was not of high prevalence in 2006 is even lower in the population in 2013. The percentage of individuals with elevated glucose concentrations as CHD risk factor decreased with 13%, while the percentage of participants with elevated T-Chol levels nearly doubled. In the seven-year follow-up age as a risk factor for CHD increased with 18%.

Discussion

This study examined the change in coronary heart disease risk factors after a long-term (seven years) physical activity intervention in persons with an intellectual disability living in a care facility in Potchefstroom, the North West Province of South-Africa. The major finding from this

study is that T-Chol as a risk factor for CHD increased significantly in the population, in particular the women. Results indicate that in this population's elevated T-Chol levels seem to be the most prevalent risk factor for developing CHD in future. Although glucose and cholesterol concentrations are not fasting values, 45% of participants reported T-Chol concentrations above the 5.18 mmol/L. Women with ID are generally prone to be prescribed contraceptive medication in prevention of pregnancy and to maintain problems with menstruation or behaviour. In a study performed in the Netherlands 48% of the women aged 15-59 years used contraception. Most of them used oral contraceptives (van Schroyen Lantman-de Valk *et al.*, 2011). Risks in using oral contraceptives include lipid changes and venous thromboembolism (Paransky & Zurawin, 2003) which may contribute to the elevated T-Chol levels observed in our study's female participants. Dietary intake of fat may have contributed to the high levels of cholesterol, but dietary intake was not determined in this study. The increase in age can contribute to the increase in cholesterol concentrations as was reported by Gertler *et al.* (1950) who found a steady and significant rise in the level of serum cholesterol with an increase in chronological years in a healthy group of males which was not the case in this population, where only females showed an increase in T-Chol levels..

Overweight and obesity were the second most prevalent risk factor in the study population, being present in 41% of the participants. Although this prevalence is lower than seven years ago, the observed decrease was not statistically significant. This finding is consistent with the high prevalence of overweight and obesity reported among persons with ID from various countries. Chang *et al.* (2012) found that 35.7% females and 23.3% males in a Taiwanese population with ID were obese. Our results from this study are similar to findings from studies performed in the UK, where it was found that the majority of a UK population of persons with ID living in care facilities are overweight or obese (Robertson *et al.*, 2000; Merriman *et al.*, 2005). In our study even after a seven-year physical activity intervention programme, a large percentage of female participants were still overweight and obese. This can be explained by Blaak (2001) who found females in the general population having higher fat percentages than males. Contraceptives have also been linked to weight retention in females.

The fact that this study investigated changes in risk factors and the prevalence of risk factors for CHD over a seven-year period, the time elapsed contributed to the number of risk factors reported, because the average age of male participants changed statistically significantly and was

44.95 years post the intervention period. In males 45 years of age and older, is considered a risk factor for developing CHD (Allen *et al.*, 2009). Both male and female participants migrated during the intervention period to become middle-aged leading to the increase in age as a risk factor. Although Moss (2009) was not able to analyse blood glucose and cholesterol concentrations post the 12-week intervention, the seven-year follow-up study data compared to 2006 baseline, resulted in higher values for cholesterol concentrations in male participants (Moss, 2009).

Physical inactivity as a risk factor for CHD was halved over the period of seven years. The long-term effect of a combined physical activity intervention resulted in a 50% reduction in the levels of inactivity in this population of persons with ID in a care facility. The participation in physical activities considered moderate to vigorous in intensity by the Ainsworth Compendium (Ainsworth *et al.*, 1993) on a weekly basis (one or more times per week) was categorized as active; therefore the inactivity of the participants decreased to less than one quarter of the participants being inactive. Reasons for still finding overweight and obesity in our study may be due to the guidelines posed by Allen *et al.* (2009) who states that participants should at least take part in 30 minutes moderate intensity physical activity three times per week to not be classified as living a sedentary lifestyle. High prevalence of physical inactivity in persons with ID have been reported by Moss (2009) and Heath and Fentem (1997). Moss (2009) found an initial decrease of 50% in the physical inactivity in the population in the 2006 12-week walking intervention study. Although the inactivity of the participants decreased there is still a high prevalence of overweight and obesity among adults with ID. The results seem to elude to the fact that participants attended the physical activity interventions, but the intensity of the activity in combination with possible unhealthy dietary intake, contributed to the overweight prevalence.

The prevalence of hypertension and blood pressure to develop a risk for CHD are low in persons with ID, this coincides with the results from Moss (2009) and Merriman *et al.* (2005), namely that these two mentioned studies both found 6.1% prevalence of hypertension in persons with ID. Although there was an increase in blood pressure, the values were still within the normal range of 120/80 mmHg (Allen, *et al.*, 2009), even though 40.5% of the individuals still are overweight or obese. In a research review Draheim (2006) noted that persons with Down syndrome have low systolic and diastolic blood pressure values, which contributes a lower prevalence of hypertension as a risk for developing CHD, contradictory to studies where

overweight and obesity is often associated with hypertension. The low blood pressure values in this population may be related to trisomy 21 (Morrison *et al.*, 1996). Reason for the low blood pressure values in spite of overweight and obesity prevalence may be participants have not made the complete transition from late adulthood to middle-age.

The prevalence of smoking was also low in this population (4%). This result differs from findings of Merriman *et al.* (2005) who found 53% of individuals smoking. Reasons for smoking being low may be as result of a positive influence from care-givers and availability of tobacco smoking to the participants in the care facility.

The changes in the risk of developing CHD after the seven-year physical activity intervention significantly changed the male participants' fat percentage and body mass – there is a decrease in BMI. In 2006, more than two thirds of the participants were overweight or obese after the 12-week walking intervention; this was further reduced by 27% during the long-term physical activity intervention. This can be explained by high rates of physical inactivity in the participants at baseline, where physical activity interventions are expected to decrease the rates of physical inactivity. After the 12-week walking intervention, Moss (2009) found a decrease in the BMI both of men and women and also a decrease in the fat percentage of the participants. After the 12-week walking intervention there was an initial decrease in the BMI and a further decrease in weight and BMI in the male participants, contradicting the results of the general population, indicating an increase in body weight of 0.1 kg per year in men and 0.7 kg in women (Donnelly *et al.*, 2009). The high rates of obesity are expected to decrease when obese persons partake in physical activity.

The glucose concentration has lowered during the long-term intervention as well as the risk for hyperglycaemia. Benefits of regular physical activity include improved glucose tolerance, reduced insulin needs and reduced resting blood pressure (Allen *et al.* 2009). The results show a slight increase in diastolic blood pressure of the female participants which is in contrast with the results of Calders *et al.* (2011), Moss (2009) and of Oviedo *et al.* (2014). This can be due to the intellectually disabled participants ageing at a faster rate than that the normal population (Carmeli *et al.*, 2012). Franklin *et al.* (1997) has explained that diastolic blood pressure increases in middle-aged individuals.

The increase in physical activity in the participants contributes to the lower rates of overweight and obesity. Regular physical activity contributes to better insulin sensitivity and may explain the lower risks in the glucose values of the participants. Even though the participants were physically active T-Chol increased in women but is still within normal range, T-Chol is influenced by unhealthy diet and/ or the prescribed contraceptive medication. Increase in T-Chol in women may also be explained by the intensity and more likely the frequency of the physical activity intervention not being sufficient.

Conclusion

The participation in this combined aerobic and resistance physical activity intervention programme for persons with ID significantly reduced the percentage of persons that were inactive. The significant increase in age was also associated with an increase in the average blood pressure and significant increase in T-Chol concentrations. In conclusion the data indicate that the physical activity intensity might have been too low to prevent the increase in T-Chol usually associated with an increase in age.

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CHAPTER 4

Effect of a long-term physical activity intervention on cardiorespiratory capacity of persons with intellectual disability

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Abstract

Background: Persons with intellectual disability (ID) have lower rates of cardiorespiratory fitness than persons without ID. Physical inactivity, lack of motivation and task understanding, leg strength and reduced heart rate response to exercise in individuals with ID contribute to the lower levels of cardiorespiratory fitness. Improvement of cardiorespiratory fitness is achieved with a long-term physical activity intervention. The purpose of the study is to determine the effect of a long-term physical activity intervention on cardiorespiratory fitness in persons with ID. Improvement in cardiorespiratory fitness in this population may influence the development of CHD risk factors in later years of life in persons with ID.

Methods: A physical activity intervention programme was presented for a seven-year period to a cohort of 120 participants living in a care facility for persons with an ID in Potchefstroom, South Africa. Seventy-four of the participants aged chronologically between 25 and 76 years and intellectually aged between 4 and 12 years gave consent for participation in this study. CHD risk factors were determined by means of a questionnaire and physical assessment that included resting blood pressure, body mass index, body fat percentage and non-fasting glucose and T-Chol measurements. The cardiorespiratory fitness was measured by means of a submaximal YMCA bicycle ergometer protocol from which a physical work capacity index was calculated. The physical activity intervention consisted of twice weekly supervised aerobic training combined with strength and resistance training of the large muscle groups. General Linear Model analyses performed to determine the significant change in cardiorespiratory fitness with adjustment for baseline (2006) and the McNemar exact test for pre- and post-test changes in risk factor variables and point prevalence of risk factors. A partial correlation analysis, adjusted for age in 2013, was applied to determine whether changes in functional capacity related to changes in CHD risk factor.

Results: Physical work capacity both in male (1.90 ± 0.73 watt/kg) and female (1.55 ± 0.43 watt/kg) participants decreased to 1.43 ± 0.45 watt/kg and 1.14 ± 0.46 watt/kg respectively over the seven-year intervention period. Physical activity participation decreased with 50%. There was no statistically significant correlation between the changes in physical work capacity and changes in risk factors for CHD adjusted for 2013 age.

Conclusion: Cardiorespiratory fitness over a seven-year period decreased in a population with ID in spite of the point prevalence of physical activity increasing. The change in cardiorespiratory fitness was not related to changes in CHD risk factors. The intensity of the intervention might

not have been adequate to ensure improvement in the fitness and CHD risk factors in this population with ID.

Introduction

People with intellectual disability (ID) have a lower rate of cardiorespiratory fitness than persons without ID (Fernhall & Pitetti, 2001). Persons with ID are consistently reported to be physically inactive and prone to be obese (Hinckson & Curtis, 2013; Hilgenkamp *et al.*, 2012; Phillips & Holland, 2011; Moss, 2009; Peterson *et al.*, 2009; Melville *et al.*, 2007; Heath & Fentem, 1997). A decreased quality of life is often reported in association with inactivity and obesity (Carmeli *et al.*, 2009, Esbensen *et al.*, 2003). A sedentary lifestyle causes several health concerns for individuals with and without ID. An estimated 3.2 million deaths globally are caused by inactivity, considered the fourth leading risk factor for global mortality (WHO, 2013).

Cardiorespiratory fitness can indirectly be determined by submaximal testing of cardiorespiratory fitness with a physical work capacity test (Allen *et al.*, 2009). Contributing factors to poor levels in physical work capacity in persons with ID are a lack of motivation and task understanding, lack of participation in physical activity (Dodd & Shields, 2005; Fernhall & Pitetti, 2001), leg strength and reduced heart rate response to exercise (Fernhall & Pitetti, 2001) in individuals with ID. Persons with ID report low levels of relative peak VO_2 while individuals with Down syndrome present with even lower relative peak VO_2 than persons with ID, which is consistent with low levels of cardiorespiratory fitness (Fernhall *et al.*, 2013). Fernhall *et al.* (2013) explain that young individuals with Down syndrome have the same physical work capacity (PWC) than that of an older person without ID. A sedentary lifestyle has been found to be related to several health problems, including the occurrence of coronary heart disease risk factors.

There is moderate to strong evidence that physical activity interventions positively influence physical fitness (Oviedo *et al.* 2014; Rahmat & Hasan 2013, Stanišić *et al.*, 2012), muscle strength (Giagazoglou *et al.*, 2013), flexibility (Giagazoglou *et al.*, 2013) and quality of life (Carraro & Gobbi, 2012; Carmeli *et al.*, 2009). Limited information is available on long-term physical activity interventions for persons with ID, and their effect on cardiorespiratory fitness. Intervention studies in the literature range from six-week to six-month exercise intervention periods. A single study found to evaluate a long-term physical activity programme consisted of only one male and one female participant (N=2) (Lante *et al.*, 2011). The results of the single study indicated that participation in the programme improved physical and psychosocial

variables for both participants. Accelerometer measurements of physical activity indicated an average increase of 65 steps per hour for the first participant and 280 steps per hour for the second participant over a period of one year. Risk factors for CHD and their changes over the years were, however, not explored.

The majority of studies reported applied interventions focusing on core stability training (Rahmat & Hasan, 2013), basketball training (Stanišić *et al.*, 2012), and combined exercise training (Oviedo *et al.*, 2014) as well as walking intervention (Moss, 2009) to improve physical fitness in persons with ID. Both the core stability interventions and the 12-week walking intervention improved the distance walked in a group of persons with ID (Rahmat & Hasan, 2013; Moss, 2009). A peer-guided 15-week physical activity intervention improved distance walked in the six-min walk test (Stanish & Temple, 2012).

The VO₂ peak improved in individuals with ID after a 14-week combined exercise training programme (Oveido *et al.*, 2014), indicating an improvement in cardiorespiratory fitness in individuals with ID. A significant positive change was found after a 20-week combined aerobic and resistance exercise intervention in aerobic capacity of individuals with ID (Calders *et al.*, 2011). However, neither the basketball intervention (Stanišić *et al.*, 2012) nor a 6-month physical activity intervention to improve coordination resulted in significant changes in cardiorespiratory fitness. The reason for these findings might be that the basketball intervention gave attention to detail in developing basic functional technique that might have reduced the intensity of the exercise programme and did not improve physical fitness in persons with ID (Stanišić *et al.*, 2012) and factors that could affect the exercise programme itself (Golubović *et al.*, 2012).

In the majority of the intervention studies, the participants were adolescents and the interventions were limited to a maximum of 20-weeks. The outcome of long-term (> 12-month) physical activity interventions in adult persons with ID is lacking. Therefore the aim of this study was to determine the effect of a long-term physical activity intervention on the cardiorespiratory fitness of persons with ID and how the changes in cardiorespiratory fitness relate to changes in risk factors for CHD. Information on long-term interventions will contribute to knowledge on the evidence for preventing accelerated ageing in adults with ID through regular physical activity programmes.

Methods

Setting and participants

The participants are all individuals living in a care facility for persons with ID in the North West Province of South Africa, that participated in a similar study in 2006 (N=130). The participants were aged 25–76 years and intellectually aged between 4–12 years (Moss, 2009). The residents all live in three-bedroom apartments with a full-time caregiver for each apartment. Each participant, as well as their legal guardian signed the informed consent. The participants' parents gave consent for the legal guardian to sign informed consent on their behalf. The severity of the level of ID was determined before their acceptance in the care facility by means of standard evaluations criteria and was obtained from the medical files. Exclusion criterion for participation was the presence of a physical disability rendering it impossible for the person to perform the assessment or to participate in the physical activity intervention programme. Ethical clearance was granted by the Ethics Committee of the North-West University (NWU-00105-13-A1).

Procedure

All persons with ID that gave consent for participation in the study completed a coronary heart disease risk profile questionnaire (Björstrom & Alexiou, 1978) with the assistance of the full-time employed registered nurse and the participants' medical file. The testing protocol was explained to the participants and caregivers of the facility to familiarise everybody with the procedure. Resting blood pressure (Baumanometer[®], W.A. Baum Co. Inc., USA) was measured after the participants had been seated for 5 minutes. Two resting blood pressure measurements were performed 5 minutes apart and the average of the two measurements was recorded as the resting blood pressure measurement. Resting heart rate was determined by means of a stethoscope (Sprague Rappaport Type Stethoscope, China).

Body mass was measured (Seca[®]700) to the nearest 0.1 kg and stature was measured with a stadiometer to the nearest 0.1 cm. Fat percentage was calculated with the use of the seven skinfold equation (Jackson & Pollock, 1985) in accordance with the guidelines of the International Society for the Advancement of Kinanthropometry (Stewart *et al.*, 2011). Skinfolts were measured by a level two accredited anthropometrist with a calibrated skinfold

caliper (Harpender®, UK). Waist and hip circumference was measured according to the guidelines of the International Society for the Advancement of Kinanthropometry (Stewart *et al.*, 2011). The physical activity participation was determined with the assistance of the full-time caregiver, sport coach and on-site Biokineticist. Finally, the sub-maximal adapted YMCA bicycle ergometer test for functional capacity was performed (Monark 828E, Sweden) on each participant to 70% of their age predicted maximal heart rate as determined by the Karvonen's formula (Allen *et al.*, 2009). The physical work capacity was calculated as maximal load in watt expressed in body mass. Physical work capacity was calculated by the PWC₁₇₀ formula. The participants had previously been familiarised with the testing protocol. All participants were also familiar with the equipment, since testing was performed previously at the facility. The physical activity intervention has been presented at the same facility during the last seven-years.

Participants with three or more risk factors for CHD were categorised as high risk according to the American College of Sport Medicine's guidelines (Allen *et al.*, 2009:23) for exercise testing and therefore an ECG (Schiller, Switzerland) recording was included during the sub-maximal testing procedure.

Physical activity intervention

Based on the findings of a 12-week aerobic walking intervention (Moss, 2009), a regular aerobic and muscle strength and endurance exercise intervention programme was introduced to the participants at the care facility. The intervention was conducted by a registered Biokineticist (Clinical Exercise Physiologist) familiar with exercise prescription for health outcomes in special populations. A structured physical activity intervention two days per week was presented to the participants for the last seven years (2006–2013). Exercise sessions were limited to two times per week due to limited time within participants daily schedule and availability of support staff. The physical activity intervention consisted of cardiorespiratory exercises lasting at least 20 minutes, stretches of the large muscle groups to improve flexibility for 10 minutes and muscle endurance exercises by means of resistance training for 30 minutes which included all the large muscle groups. Aerobic exercise was intended to reach approximately 70% of age-predicted maximal heart rate during the 20-minute period. Attendance of the intervention programme was recorded by means of an attendance register and exercise training cards.

Statistical analyses

Statistical analyses were performed with the SPSS 22.0 (IBM SPSS Statistics, Armonk, NY) statistical analysis software programme. Descriptive statistics were performed for all individual variables at baseline (2006) and seven years post- healthy exercise intervention (2013). General Linier Model analyses were performed to determine the significant change from baseline (2006) to end (2013) for cardiorespiratory fitness with adjustments made for baseline values (2006). The effect of the intervention programme on the percentage persons being physically active was determined by means of the McNemar exact test. A partial correlation analysis, adjusted for age in 2013, was applied to determine whether changes in functional capacity related to changes in CHD risk factors. The level of significance was set at $p \leq 0.05$.

Results

Only 74 participants of the initial 100 participants tested in 2006 took part in this follow-up study. Sixteen (16) participants are not living in the care facility anymore and five (5) had passed away. The descriptive characteristics of the participants' pre and post seven-year intervention (Table 1) show that the men reported a higher levels of cardiorespiratory fitness (1.90 ± 0.73 watt/kg) pre-long-term intervention compared to the females (1.43 ± 0.45 watt/kg). The average cardiorespiratory fitness of the total group decreased over the seven-year period both in the males and females. The BMI values for both genders were higher than the healthy norm of 18.5–24.9 kg/m² as stated in the American College of Sports Medicine's (ACSM) guidelines for healthy weight (Allen *et al.*, 2009). The results of the exact McNemar test indicate that of the 74 participants, 47 participants that were inactive in 2006 became active over the seven-year period as a result of the intervention ($p \leq 0.001$).

Table 1: Pre and post seven-year descriptive characteristics for men and women with intellectual disability (mean $\pm$ SD)

Variables	Pre-test		Post-test	
	Men	Women	Men	Women
Age (years)	39.14 $\pm$ 8.91	37.47 $\pm$ 10.06	44.95 $\pm$ 7.38	44.24 $\pm$ 8.51
Height (m)	1.69 $\pm$ 0.13	1.59 $\pm$ 0.10	1.70 $\pm$ 0.11	1.58 $\pm$ 0.10
Body mass (kg)	81.23 $\pm$ 22.53	74.13 $\pm$ 17.15	78.85 $\pm$ 18.82	75.34 $\pm$ 16.47
BMI (kg/m²)	28.32 $\pm$ 8.72	29.33 $\pm$ 6.64	27.21 $\pm$ 5.47	30.08 $\pm$ 6.62
WHR	0.88 $\pm$ 0.07	0.79 $\pm$ 0.09	0.87 $\pm$ 0.06	0.78 $\pm$ 0.14
Body fat (%)	17.20 $\pm$ 6.52	23.53 $\pm$ 7.27	20.18 $\pm$ 6.86	25.07 $\pm$ 5.96
SBP (mmHg)	111.62 $\pm$ 13.73	110.98 $\pm$ 15.33	116.38 $\pm$ 17.83	115.41 $\pm$ 10.00
DBP (mmHg)	71.95 $\pm$ 11.28	70.43 $\pm$ 12.75	75.84 $\pm$ 12.64	76.05 $\pm$ 8.85
PWC (watt/kg)	1.90 $\pm$ 0.73	1.55 $\pm$ 0.43	1.43 $\pm$ 0.45	1.14 $\pm$ 0.46
Total Watt	91.25 $\pm$ 36.49	79.73 $\pm$ 24.18	106.98 $\pm$ 33.33	79.73 $\pm$ 23.45
PA (%)*	50%	50%	70.2%	81%

BMI = body mass index; WHR = waist-hip ratio; SBP = systolic blood pressure; DBP = diastolic blood pressure; PWC = physical work capacity; PA = physical activity; SD = Standard deviation

* The percentage participants engaging in moderate to vigorous physical activity at least twice per week.

The absolute changes observed in the risk factors for CHD (Table 2) indicate a significant increase in age for men and women, increase in body mass in women and decrease in men. Changes in BMI reflect the changes in body mass of the participants. Body fat percentage increased significantly both in men and women. Waist-to-hip ratio significantly decreased in men. Resting systolic blood pressure increased significantly in men as well as diastolic blood pressure in women.

Table 2: Changes observed in the risk factors of CHD for individuals with ID during a long-term exercise intervention

Changes in variables	Men			Women		
	Average	SD	<i>p</i>	Average	SD	<i>p</i>
Age (years)	7.65	2.54	0.000	7.08	0.28	0.000
Height (m)	-0.01	0.01	0.000	0.00	0.13	0.000
Mass (kg)	-1.25	5.43	0.000	0.15	6.83	0.000
BMI (kg/m²)	-0.33	2.14	0.000	0.24	2.59	0.000
WHR	-0.00	0.64	0.001	0.01	0.10	0.121
Fat %	2.98	4.71	0.000	0.95	3.59	0.000
SBP (mmHg)	6.15	18.10	0.052	3.12	17.08	0.173
DBP (mmHg)	4.83	14.66	0.152	6.35	10.42	0.000
T-Chol (mmol/L)	0.92	1.04	0.187	0.53	0.41	0.002
PWC (watt/kg)	-0.50	0.78	0.309	-0.31	0.54	0.307

PWC = Physical work capacity index, BMI = Body Mass Index, WHR = Waist to Hip Ratio, SBP = Systolic Blood Pressure, DBP = Diastolic Blood Pressure, T-Chol = total cholesterol, SD = Standard deviation
Level of significant difference was set at: $p \leq 0.05$.

The mean blood pressure of the individuals was below 120/80 mmHg, considered healthy, according to the ACSM guidelines for exercise testing and prescription (Allen *et al.*, 2009). Body mass in the male participants was lower after the seven-year physical activity intervention, although the females gained some weight during the seven years. Waist-to-hip ratio was within the healthy range for males (0.9) and above the healthy norm for females (0.88) (Allen *et al.*, 2009). The physical work capacity of the participants was lower in 2013 than in 2006.

Results of the partial correlation with adjustment for age in 2013, between the changes in the cardiorespiratory fitness and risk factors for CHD (Table 3) indicate a weak negative linear correlation between BMI, Body fat percentage and systolic blood pressure. Changes in waist-to-hip ratio indicate a weak positive correlation with cardiorespiratory fitness. None of the correlations was statistically significant.

Table 3: Correlation between changes in physical work capacity and changes in risk factors for CHD adjusted for 2013 age after a long-term exercise intervention in persons with an ID

Change CHD risk factors	Change in Physical Work Capacity	
	<i>r</i>	<i>p</i>
BMI (kg/m²)	-0.13	0.41
WHR	0.02	0.92
Body fat (%)	-0.02	0.91
SBP (mmHg)	-0.11	0.49
DBP (mmHg)	-0.26	0.09

BMI = Body mass index, WHR = Waist to Hip Ratio, SBP = Systolic Blood Pressure, DBP = Diastolic Blood Pressure

Level of significant difference was set at $p \leq 0.05$.

Discussion

The study examined the change in functional capacity with a long-term physical activity intervention in persons with intellectual disability living in a care facility in Potchefstroom, South-Africa. The main finding of this study is that the participants of this study had similar cardiorespiratory fitness levels than persons without an ID. The cardiorespiratory fitness in general decreased over the seven-year period both in men and women. This finding is consistent with what Graham and Reid (2000) stated, namely that a decline in cardiovascular endurance is expected during middle age. The decline in fitness was observed in spite of the fact that the point prevalence for physical inactivity as a risk factor decreased. The number of participants being sedentary decreased, since 70% of men and 81% of women were physically active at least twice per week at the end of the seven-year intervention period. This trend is a continuation of the changes observed by Moss (2009) during the 12-week walking intervention in these same participants.

The suggested work rate for individuals based on gender and individual fitness status (Allen *et al.*, 2009), as stated in the ACSM (2009) are 100-150 watts in men and 75-100 watts in women

respectively for conditioned participants. In our study the work load increased during the seven-year period particularly for the males while the females reported no change in the work load performed. The participants in this study were able to produce an average total work output similar to that of conditioned individuals. The finding contradicts studies that found persons with ID to have lower levels of cardiorespiratory fitness than persons without ID (Fernhall & Pitetti, 2001). The lower work rate reported by the females may be due to the lack of leg strength during middle age, while the men increased their work output. Since the work capacity test was performed on a bicycle ergometer, leg strength plays an important role. The female participants have a lower functional capacity than the male participants; the reason may be due to cardiovascular efficiency being related to leg muscle strength (Graham & Reid, 2000), which can explain why men performed better in the physical work capacity test. Men also partake in sport; the care facility has sport facilities and athletic participation. The seven-year period of the intervention resulted in the participants migrating from late adulthood (38.25 ± 9.54 years) to middle age (45–65 years). The natural progress of ageing might have contributed to the lack of improvement in the cardiorespiratory fitness test. The lack of motivation in physical activity participation may also be a contributor to the decline in cardiorespiratory fitness levels. Although the intervention programme was intended to counter the known decrease in PWC with an increase in age, the intensity of the exercise intervention might have been inadequate to prevent the natural decrease in cardiorespiratory fitness. The fact that persons with ID age at a faster rate than the normal population, (Carmeli *et al.*, 2012) may be the explanation for these observations.

Regular physical activity increases cardio respiratory fitness when performed at least at 70% of heart rate reserve. Low level of cardiorespiratory fitness on the other hand has been associated with the presence of risk factors for CHD. In this population with ID, the decrease in cardiorespiratory fitness observed, was not related to the changes observed in the risk factors for CHD of the participants.

It can be interpreted that although the participants attended the intervention, weak correlation between PWC and risk factors to develop CHD may exist due the intensity at which the intervention was conducted was not high enough to result in an increase in cardiorespiratory fitness. The general prevalence of physical activity reported for the participants were, however higher than reported in other studies for persons with ID (Fernhall *et al.*, 2013).

Conclusion

Cardiorespiratory fitness over a seven-year period decreased in a population with ID and the changes in fitness did not relate to the changes observed in the determined risk factors. The intensity and frequency of the physical activity during the intervention might not have been adequate to improve the cardiorespiratory fitness in persons with ID. Intensity may have been influenced by a lack of motivation and frequency due to external barriers. Future studies should look into alternative intervention strategies to ensure long-term improvements of risk factors for CHD.

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CHAPTER 5

Summary, conclusion, limitations and recommendations

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5.1. Summary

Coronary heart disease (CHD) and the risk factors related to CHD prevail in persons with ID similar to what is present in persons without ID. Regular physical activity is known to modify risk for CHD. Limited information is available on the long-term effect of an exercise intervention on the risk for developing CHD and the role of physical activity in preventing CHD. The purpose of this study was to determine the effect of a long-term physical activity intervention programme on the functional capacity as determined by means of a cardiorespiratory fitness test and risk factors for CHD in individuals with ID. In this chapter a summary of the research findings will be presented as well as the conclusions that can be drawn from the results obtained. Conclusions will be presented based on the hypotheses set. Recommendations emanating from the study will be rendered in this chapter in pursuit of further research. Limitations of this study will also be highlighted.

Summary, conclusions, and recommendations emanating from the study will be discussed in this chapter. Recommendations will be made based on the findings. Limitations and implications for future research will be highlighted.

The background with regard to the research, Chapter 1, indicated that physical inactivity ranges high in persons with ID, as well as the prevalence of overweight and obesity. CHD is a concern for persons with ID, as also in the normal population, with rapid ageing observed in persons with

ID, contributing to the decline in wellness of persons with ID. Although regular physical activity is associated with improved wellness and health outcomes, as well as with reduced prevalence of CHD risk factors, limited research is available on the effect of physical activity intervention on the CHD risk profile of persons with ID. Research is also lacking with regard to the long-term physical activity interventions and their health outcomes. The research question that emerged and thus needed to be answered was: What is the long-term effect of a health improvement physical activity intervention programme on the functional capacity and CHD risk factors of persons with an intellectual disability? The objectives related to the research questions were presented with the hypotheses to be tested.

The review of the current literature, Chapter 2, titled “Physical activity as modifier of cardiorespiratory fitness and coronary heart disease risk in persons with intellectual disability” presented the current knowledge available on the topic. ID is defined as the presence of incomplete mental development. Persons with ID have lower levels of cardiovascular fitness than those without ID. Contributing factors to low levels of fitness include: lack of physical activity and leg strength and reduced heart rate response to exercise. In addition to low levels of fitness and functional capacity, persons with ID experience early onset of ageing, which contributes to an earlier reduction in functional capacity and an increase in mortality and morbidity.

Common risk factors for developing CHD in persons with ID have been identified as obesity and lack of participation in a regular physical activity programme. From the literature it is evident that risk factors such as tobacco smoking and hypertension are uncommon in persons with ID. The reason for tobacco smoking being low might be that care-givers set positive examples for the population or the availability of tobacco may be restricted financial means for purchasing tobacco are lacking. Hypertension as a risk factor for CHD has a high prevalence in the non-ID population, but persons with Down syndrome generally report lower blood pressure values than that which is considered normal according to guidelines. The sedentary lifestyle in this population contributes to a high prevalence of overweight and obesity, while regular exercise contributes to the necessary energy expenditure to limit excess weight gain, lower blood pressure, improve glucose sensitivity and improve blood lipid profile.

Persons with ID do not have the necessary understanding of the importance of a healthy lifestyle due to incomplete mental development. Physical activity is beneficial to the improvement of the functional capacity of persons with ID and can contribute to higher levels of self-care among this population, and to improving quality of life. Research on the positive effect of physical activity interventions on the risks for developing CHD for persons with ID is limited. However, studies have proven that physical activity interventions have positive attributes to muscle strength and endurance, cardiorespiratory fitness, CHD risk factors, flexibility and quality of life in this population.

From the literature studied, the length of the exercise interventions of studies has been short to medium, varying from six-weeks to six- months. Information on the effect of long-term physical activity interventions on risk factors for developing CHD and functional capacity outcomes in persons with ID is lacking. The true benefit of regular physical activity lies in the long-term compliance with the necessity to participate regularly in physical activity. Since the gap in the literature was identified as a lack of information on long-term exercise interventions, a long-term intervention study with a pre and a post-test was designed to address the research question posed. The methodological approach together with the results of this study were presented in the form of two articles prepared for publication, namely Chapter three, titled “Effect of a long-term physical activity intervention on risk factors for coronary heart disease in adults with intellectual disability” and Chapter four titled “Effect of a long-term physical activity intervention on cardiorespiratory capacity of persons with intellectual disability”. Chapter three describes the change in the CHD risk factors of individuals with ID in the follow-up study after a seven-year combined physical activity intervention. Chapter four describes the change in the cardiorespiratory capacity of persons with intellectual disability and how the changes in the cardiorespiratory fitness relate to the changes observed in the CHD risk factors determined.

5.2. Conclusions

The conclusions drawn from this research project are based on the hypotheses posed in Chapter one.

Hypothesis 1: *A long-term physical activity intervention will significantly reduce the coronary heart disease risk factors of adults with intellectual disability.*

A statistically significant difference was observed in the proportion of persons with ID pre- and post-intervention for age ($p \leq 0.001$), cholesterol ($p = 0.001$), and physical inactivity ($p \leq 0.001$). The point prevalence of physical inactivity in this study decreased with 50%. Prevalence of cholesterol as a risk factor in developing a CHD increased significantly from 23% to 45% after the seven-year follow-up intervention. Age as a risk factor increased after the intervention period. There is a clinically significant change in the prevalence of overweight and obesity with a 39.5% decrease. Body mass decreased significantly in men (1.25 ± 5.43 kg) and increased significantly in women (0.15 ± 6.83 kg). The changes in BMI reflect the changes found in the changes in body mass for men and women respectively. Body fat percentages in men (2.98%) and in women (0.95%) increased. A significant increase was found in systolic blood pressure for men (6.2 ± 18.1 mmHg) and diastolic blood pressure for women (6.35 ± 10.42 mmHg). In women total cholesterol increased significantly (0.53 ± 0.41 mmol/L). Therefore hypothesis 1 is partially accepted since physical inactivity significantly decreased while T-Chol as CHD risk factor increased.

Hypothesis 2: *A long-term physical activity intervention will significantly improve the cardiorespiratory capacity of adults with an intellectual disability.*

Physical work capacity (PWC) of the individuals decreased over the past seven years. Male participants' PWC decreased from 1.9 ± 0.73 watt/kg to 1.43 ± 0.45 watt/kg and the PWC of females decreased from 1.55 ± 0.73 watt/kg to 1.14 ± 0.46 watt/kg. Physical activity participation increased with 50%. There was no statistically significant change between PWC indexes from pre-intervention to post-intervention when adjusted for pre-intervention measurements. Consequently hypothesis 2 is rejected due to the decrease in the functional capacity of the participants as determined by means of the cardiorespiratory fitness assessment. .

In conclusion, persons suffering from ID are prone to follow a sedentary lifestyle. The percentage of persons in each of the risk factors indicates that physical inactivity among the participants decreased by 50% due to regular physical activity sessions daily at the care facility. The duration of the long-term physical activity intervention contributed to a higher percentage of participants being at risk for CHD based on increase in age as the time lapsed from baseline to end. It is stated in literature that persons with ID experience rapid ageing compared to person without ID, which should be taken into consideration when interpreting the results from this

study. Although most of the participants took part in the physical activity intervention study, the ageing effect on the physiology of the participants may have been the reason for the increase observed in the blood pressure measured and increased T-Chol levels of the participants. Although the blood pressure had increased, the values were still within the normal range. Cholesterol levels are influenced by the dietary intake of the participants and the use of oral contraceptive medication.

The decline in the PWC-index and the absence of positive changes in the CHD risk factors of the participants over the seven-year intervention period could be caused by the frequency or intensity of the physical activity intervention not being adequate to ensure the physiologic changes expected from regular appropriate physical activity. It is known that persons with ID lack motivation to partake in physical activity and possess inadequate knowledge on the health benefits of regular physical activity. The lack of motivation could therefore have, in spite of the participants being present at the exercise sessions, contributed to them not partaking at the prescribed intensity. The insignificant correlation between the PWC index and CHD risk factors for people with ID may be as a result of the normal ageing process. The normal ageing process decreases cardiorespiratory fitness of persons and increases risk factors for CHD.

Hence, from the findings of the study, it is concluded that the particular long-term health improvement physical activity intervention programme did not improve the functional capacity in persons with ID, although the prevalence of physical inactivity as a risk factor decreased significantly. Together with a significant decrease in overweight and obesity point prevalence.

In the South African context, the study outcomes present a strong argument for the importance of regular physical activity for preventing persons with ID from being at risks of developing CHD. It is, however, important to understand the type and intensity of regular physical activity needed to improve health outcomes such as risk factors for CHD in persons suffering from ID. The appropriateness of exercise for this population is also important, since lack of motivation plays a central role in the intensity at which exercise is performed.

5.3. Limitations

The results found in this study should be interpreted against the background of the following limitations that were present in the study:

- The lack of measurement points on an annual basis during such a long intervention (seven years).
- The lack of motivation in persons with ID resulted in difficulties experienced with the physical work-capacity test.
- Participants' diet was not recorded during the study and could contribute to the risk factors for developing CHD.
- Supervision during the intervention period did not record the intensity level of the exercise based on heart rate achieved during exercise sessions.
- Implementation of a control group will indicate a comparison between the effect of early onset of ageing on participants with an ID.

5.4. Recommendations

The following recommendations are tendered with a view to improve future research.

- Participants should be measured on an annual basis in long-term follow-up studies to monitor changes longitudinally.
- Appropriate field tests should be used with measurements of persons with ID, which are simple to execute while still remaining reliable and safe.
- Dietary intake should be determined in conjunction with exercise interventions to understand the energy balance in persons with ID.
- Exercise intensity during interventions should be monitored in order to determine whether the appropriate intensity, to ensure physiological adaptations, has been reached.
- Control group to evaluate the effect of early onset of ageing.

APPENDIX A:

GUIDELINES FOR AUTHORS (JIDR)



Author guideline

The journal to which you are submitting your manuscript employs a plagiarism detection system. By submitting your manuscript to this journal you accept that your manuscript may be screened for plagiarism against previously published works.

3.1. Getting started

Content of author guidelines:

1. General
2. Ethical guidelines
3. Submission of manuscripts
4. Manuscript types accepted
5. Manuscript format and structure
6. After acceptance.

Relevant documents: colour work agreement form

Useful websites: submission site, articles published in the journal of intellectual disability research, author services, Blackwell publishing's ethical guidelines, guidelines for figures.

1. General

The Journal of Intellectual Disability Research is devoted exclusively to the scientific study of intellectual disability and publishes papers reporting original observations in this field. The subject matter is broad and includes, but is not restricted to, findings from biological,

educational, genetic, medical, psychiatric, psychological and sociological studies, and ethical, philosophical, and legal contributions that increase knowledge on the treatment and prevention of intellectual disability and of associated impairments and disabilities, and/or inform public policy and practice. Such reviews will normally be by invitation. The journal also publishes full reports, brief reports, letters to editor, and an 'hypothesis' papers. Submissions for book reviews and announcements are also welcomed.

The Journal of Intellectual Disability Research will feature four annotation articles each year covering a variety of topics of relevance to the main aims of the journal or topics. Senior researchers, academics and clinicians of recognized standing in their field will be invited to write an annotation for the journal covering an area that will be negotiated with the associate editor, prof. Chris Oliver, on behalf of the editorial team. Anyone expert in his/her particular field wishing to submit an uninvited review is advised to seek prior guidance from the associate editor.

All papers are assessed by expert referees.

Please read the instructions below carefully for details on the submission of manuscripts, the journal's requirements and standards as well as information concerning the procedure after a manuscript has been accepted for publication in *the Journal of Intellectual Disability Research*. Authors are encouraged to visit John Wiley & sons PTE LTD's author services for further information on the preparation and submission of articles and figures.

2. Ethical guidelines

The Journal of Intellectual Disability Research adheres to the ethical guidelines for publication and research summarized below.

2.1. Authorship and acknowledgements

Authorship: authors submitting a paper do so on the understanding that the manuscript has been read and approved by all authors and that all authors agree to the submission of the manuscript to the journal. All named authors must have made an active contribution to the conception and design and/or analysis and interpretation of the data and/or the drafting of the paper and all must

have critically reviewed its content and have approved the final version submitted for publication. Participation solely in the acquisition of funding or the collection of data does not justify authorship and, except in the case of complex large-scale or multi-centre research, the number of authors should not exceed six.

The Journal of Intellectual Disability Research adheres to the definition of authorship set up by the international committee of medical journal editors (icmje). According to the icmje authorship criteria should be based on 1) substantial contributions to conception and design of, or acquisition of data or analysis and interpretation of data, 2) drafting the article or revising it critically for important intellectual content and 3) final approval of the version to be published. Authors should meet conditions 1, 2 and 3.

It is a requirement that all authors have been accredited as appropriate upon submission of the manuscript. Contributors who do not qualify as authors should be mentioned under acknowledgements.

Acknowledgements: Under acknowledgements please specify contributors to the article other than the authors accredited. Please also include specifications of the source of funding for the study and any potential conflict of interests if appropriate. Suppliers of materials should be named and their location (town, state/county, country) included.

2.2. Ethical approvals

Experimental subjects: Experimentation involving human subjects will only be published if such research has been conducted in full accordance with ethical principles, including the world medical association declaration of Helsinki (version, 2002 www.wma.net/e/policy/b3.htm) and the additional requirements, if any, of the country where the research has been carried out. Manuscripts must be accompanied by a statement that the research was undertaken with the understanding and written consent of each participant and according to the above mentioned principles. A statement regarding the fact that the study has been independently reviewed and approved by an ethical board should also be included. Editors reserve the right to reject papers if there are doubts as to whether appropriate procedures have been used.

All studies using human participants or animal subjects should include an explicit statement in the material and methods section identifying the review and ethics committee approval for each study, if applicable. Editors reserve the right to reject papers if there is doubt as to whether appropriate procedures have been used.

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2.3 Clinical trials

Clinical trials should be reported using the consort guidelines available at www.consort-statement.org. A consort checklist should also be included in the submission material ([http://www.consort-statement.org/mod_product/uploads/consort 2001 checklist.doc](http://www.consort-statement.org/mod_product/uploads/consort%202001%20checklist.doc)).

Manuscripts reporting results from a clinical trial must provide the registration number and name of the clinical trial. Clinical trials can be registered in any of the following free, public clinical trials registries: www.clinicaltrials.gov, clinicaltrials-dev.ifpma.org/, isrctn.org/. The clinical trial registration number and name of the trial register will be published with the paper.

The Journal of Intellectual Disability Research encourages authors submitting manuscripts reporting from a clinical trial to register the trials in any of the following free, public clinical trials registries: www.clinicaltrials.gov, clinicaltrials-dev.ifpma.org/, isrctn.org/. The clinical trial registration number and name of the trial register will then be published with the paper.

2.4 Conflict of interest and source of funding

Conflict of interest: authors are required to disclose any possible conflict of interest. These include financial (for example patent, ownership, stock ownership, consultancies, speaker's fee). Author's conflict of interest (or information specifying the absence of conflicts of interest) will be published under a separate heading entitled 'conflict of interests'.

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The reference list should be in alphabetical order thus:

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- Moss T.J. & Austin G.E. (1980) preatherosclerotic lesions in Down's syndrome. *Journal of mental deficiency research* **24**, 137- 41.
- Seltzer m. M. & krauss m.w. (1994) aging parents with co-resident adult children: the impact of lifelong caregiving. In: *life course perspectives on adulthood and old age* (eds m. M. Seltzer, m.w. Krauss & m. P. Janicki), pp. 3–18. American association on mental retardation, washington, dc.

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www.refman.com/support/rmstyles.asp

5.4. Tables, figures

Tables: tables should include only essential data. Each table must be typewritten on a separate sheet and should be numbered consecutively with Arabic numerals, e.g. Table 1, table 2, etc., and give a short caption.

Figures: all graphs, drawings and photographs are considered figures and should be numbered in sequence with arabic numerals. All symbols and abbreviations should be clearly explained.

Tables and figures should be referred to in the text together with an indication of their approximate position recorded in the text margin.

Preparation of electronic figure for publication

Although low quality images are adequate for review purposes, print publication requires high quality images to prevent the final product being blurred or fuzzy. Submit eps (line art) or tiff (halftone/photographs) files only. Ms powerpoint and word graphics are unsuitable for printed pictures. Do not use pixel-oriented programmes. Scans (tiff only) should have a resolution of at least 300 dpi (halftone) or 600 to 1200 dpi (line drawings) in relation to the reproduction size (see below). Please submit the data for figures in black and white or submit a colour work agreement form (see colour charges below). Eps files should be saved with fonts embedded (and with a tiff preview if possible).

For scanned images, the scanning resolution (at final image size) should be as follows to ensure good reproduction: line art: >600 dpi; halftones (including gel photographs): >300 dpi; figures containing both halftone and line mages: >600 dpi.

Further information can be obtained at guidelines for figures:

<http://authorservices.wiley.com/bauthor/illustration.asp>

Check you electronic artwork before submitting it:

<http://authorservices.wiley.com/bauthor/eachecklist.asp>

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Figure legends: in the full-text online edition of the journal, figure

APPENDIX B:
CONSENT FORM AND MEASUREMENTS

Persoonlike inligting:

Naam: _____

Posadres: _____

Woonadres: _____

Tel: _____ **(H)** _____ **(W)**

Sel: _____ **Fax:** _____

Geboorte datum: ____ / ____ / ____ **Geslag** **M/V**

Geneesheer: _____

Rede vir besoek: _____

Mediesefonds: _____

Mediesefondsnummer: _____

Ingeligte toestemming:

Ek, die ondergetekende _____

Verklaar hierby dat ek die gedetailleerde inligting deurgelees het en dit ten volle verstaan. Ek het die geleentheid gehad om relevante vrae met betrekking tot die evaluasie te vra en die evaluasie op eie risiko is. Ek gee toestemming dat data vir navorsing gebruik mag word met dien verstande dat ek as individu nie identifiseer word nie.

Handtekening/Signature

Datum/ Date

Informed consent:

I, the undersigned _____

Declare that I have read the detailed information about the evaluation and understand it fully. I had the opportunity to discuss all relevant matters concerning the test with the Biokineticist. I participate in the evaluation at my own risk. I give permission that the information may be used for research purposes with understanding that I as individual will not be identified.

RISK SCREENING/ RISIKO BEPALING

1. Are you capable of walking 2 – 3 km without experiencing chest pains and/or becoming short of breath?

Kan u 2 - 3 km stap sonder om 'n pyn op die bors te ervaar of kort asem te word?

Yes/ Ja

No/ Nee

Uncertain/ Onseker

2. If No, state the problem

Indien Nee, gee die rede

3. Has your doctor indicated that you have a heart ailment?

Het u geneesheer al aangetoon dat u 'n hart problem het?

Yes/ Ja

No/ Nee

4. If Yes, state the problem

Indien Ja, noem die probleem

5. Do you suffer from high blood pressure?

Ly u aan hoë bloeddruk?

Yes/ Ja

No/ Nee

6. Are you taking medication on a daily basis?

Neem u enige medikasie op 'n gereelde basis?

Yes/ Ja

No/ Nee

7. If Yes, what medication and for what reason?

Indien Ja, watter medikasie en die rede vir gebruik?

8. Are you experiencing any pain in the lower back area?
 Het u enige las van lae rugpyn?

Yes/ Ja

No/ Nee

9. If Yes, please specify.
 Indien Ja, spesifiseer.

10. Are you troubled by any kind of hernia?
 Het u enige breuke?

Yes/ Ja

No/ Nee

11. If Yes, please specify.
 Indien Ja, spesifiseer.

12. Do you suffer from any of the following ailments? Y/J N
 Lei u aan enige van die volgende siektetoestande?

- | | | | |
|----|---|-----|---|
| a) | Exercise induced asma
Oefen geinduseerde asma | Y/J | N |
| b) | Regular headaches or migraine attacks
Gereelde hoofpyne of migraine aanvalle | Y/J | N |
| c) | Regular tiredness
Gereelde moegheid | Y/J | N |
| d) | Depression
Depressie | Y/J | N |
| e) | Kidney problems
Nier probleme | Y/J | N |
| f) | Cramps in the legs
Krampe in die bene | Y/J | N |

g)	Diabetes Mellitus Diabetes mellitus	Y/J	N
h)	Flu, cold or bronchitis Verkoue, griep of brongitis	Y/J	N
i)	Joint or skeletal problems Gewrig of skeletprobleme	Y/J	N
j)	Epilepsy Epilepsie	Y/J	N
k)	Varicose veins in the legs Spatare in die bene	Y/J	N
l)	Any pulmonary ailments Longsiektes	Y/J	N
m)	Dizziness or fainting Duiseligheid of floutes	Y/J	N
n)	Blood circulatory disorder Bloed sirkulasie problem	Y/J	N

13. Please mark the one condition most applicaple to you
Merk die mees gepaste stelling

Never ever tense/ nooit ooit gespanne	
Seldom tense/ Selde gespanne of angstig	
From time to time tense/ Soms gespanne	
Frequently tense and/ or anxious/ Dikwels gespanne of angstig	
Usually tense and/ or anxious/ Gewoonlik gespanne	
Exceedingly tense and anxious / Take medication/ Uitermatig gespanne/ Gebruik medikasie	

14. Has your doctor diagnosed any other medical problem or ailment, which seems necessary to be considered or might affect your exercise program? Het u geneesheer enige ander mediese problem gediagnoseer wat u oefenprogram mag beïnvloed?

Yes/ Ja

No/ Nee

15. If Yes, please specify.
Indien Ja, spesifiseer.

16. Are you a smoker?
Rook u?

Yes/ Ja

No/ Nee

17. If Yes, how many per day?
Indien Ja, aantal per dag ._____

18. If No, did you ever smoke and when did you stop?
Indien Nee, het u voorheen gerook en wanneer het u gestop?

19. Do you participate in sport? **Yes/ Ja** **Soort**_____.
Neem u aan enige sport deel? **No/ Nee**

Does any of your blood relatives suffer from any of the following conditions? Lei enige van u bloedverwante aan van die volgende siektes?

High cholesterol levels	
Coronary heart disease under 60	
Diabetes Mellitus	
Hypertension	
Overweight	
Stroke	

Ortopediese inligting:

Ledemaat: _____

Tipe besering: _____

Bloedtoetse:

	<u>Waarde</u> <u>(mmol/L)</u>
Glukose	
Totale cholesterol	

Evalueringsdatum: _____ / _____ / _____ Ouderdom: _____

Lengte: _____ m Massa: _____ kg BMI: _____

Middel: _____ cm Heup: _____ cm M/H ratio: _____

Opsitte: _____ per min Soepelheid: _____ cm

Velvoumetings: _____ Vet%: _____

Triceps			Biceps		
Subscapula			Mid-axilêr		
Supra-spinale			Ilio-cristale		
Para-umbilicus			Pectoralis		
Mid dy					
Medial kuit					

Fisieke werksvermoë: _____ FEV- indeks: _____

Weerstand	Hart tempo	SBD	DBD	Borg skaal
Rest/Rus				
1 min herstel				
3 min herstel				
5 min herstel				

THT: 60% _____ 70% _____ 80% _____ 90% _____

APPENDIX C

ETHICS APPROVAL OF PROJECT



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YUNIBESITHI YA BOKONE-BOPHIRIMA
NOORDWES-UNIVERSITEIT

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Ethics Committee
Tel +27 18 299 4852
Email Ethics@nwu.ac.za

ETHICS APPROVAL OF PROJECT

The North-West University Ethics Committee (NWU-EC) hereby approves your project as indicated below. This implies that the NWU-EC grants its permission that provided the special conditions specified below are met and pending any other authorisation that may be necessary, the project may be initiated, using the ethics number below.

Project title: Effect of a long-term physical activity intervention on the functional capacity of persons with intellectual disability: A Potchefstroom co-hort

Project Leader: Prof SJ Moss

Ethics number:

N	W	U	-	0	0	1	0	5	-	1	3	-	A	1
Institution			Project Number						Year		Status			

Status: S = Submission; R = Re-Submission; P = Provisional Authorisation; A = Authorisation

Approval date: 2013/09/09

Expiry date: 2018/09/08

Special conditions of the approval (if any): None

General conditions:

While this ethics approval is subject to all declarations, undertakings and agreements incorporated and signed in the application form, please note the following:

- The project leader (principal investigator) must report in the prescribed format to the NWU-EC:
 - annually (or as otherwise requested) on the progress of the project,
 - without any delay in case of any adverse event (or any matter that interrupts sound ethical principles) during the course of the project.
- The approval applies strictly to the protocol as stipulated in the application form. Would any changes to the protocol be deemed necessary during the course of the project, the project leader must apply for approval of these changes at the NWU-EC. Would there be deviation from the project protocol without the necessary approval of such changes, the ethics approval is immediately and automatically forfeited.
- The date of approval indicates the first date that the project may be started. Would the project have to continue after the expiry date, a new application must be made to the NWU-EC and new approval received before or on the expiry date.
- In the interest of ethical responsibility the NWU-EC retains the right to:
 - request access to any information or data at any time during the course or after completion of the project;
 - withdraw or postpone approval if:
 - any unethical principles or practices of the project are revealed or suspected,
 - it becomes apparent that any relevant information was withheld from the NWU-EC or that information has been false or misrepresented,
 - the required annual report and reporting of adverse events was not done timely and accurately,
 - new institutional rules, national legislation or international conventions deem it necessary.

The Ethics Committee would like to remain at your service as scientist and researcher, and wishes you well with your project. Please do not hesitate to contact the Ethics Committee for any further enquiries or requests for assistance.

Yours sincerely

Prof Amanda Lourens
(chair NWU Ethics Committee)

APPENDIX D

ACKNOWLEDGEMENT OF LANGUAGE EDITING



26 November 2014

I, Ms Cecilia van der Walt, hereby confirm that I took care of the editing of the dissertation of Ms Tamrin Veldsman titled *Effect of a long-term physical activity intervention on the functional capacity of persons with intellectual disability: A Potchefstroom cohort.*

MS CECILIA VAN DER WALT

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