The Six-Minute Walk Test in adults with intellectual disability: A study of validity and reliability

by

Gabriella Nasuti
Hons.B.Sc., University of Toronto, 2006

A Thesis Submitted in Partial Fulfillment
of the Requirements for the Degree of

MASTER OF SCIENCE

in the School of Exercise Science, Physical and Health Education,
at the University of Victoria, BC

Supervisory Committee

The Six-Minute Walk Test in Adults with Intellectual Disability:
A Study of Validity and Reliability

by

Gabriella Nasuti
Hons.B.Sc., University of Toronto, 2006

Supervisory Committee

Dr. Viviene A. Temple, (School of Exercise Science, Physical and Health Education)
Supervisor

Dr. Lynneth Stuart-Hill, (School of Exercise Science, Physical and Health Education)
Departmental Member

Abstract

Supervisory Committee
Dr. Viviene A. Temple, (School of Exercise Science, Physical and Health Education)
Supervisor
Dr. Lynneth Stuart-Hill, (School of Exercise Science, Physical and Health Education)
Departmental Member

The aim of this study was to determine whether a modified version of the Six-Minute Walk Test (6MWT) (American Thoracic Society, 2002) could be used to assess aerobic power in adults with intellectual disability. Thirteen adults (7M, 6F), four with Down syndrome; between the ages of 18-44 years, with mild or moderate intellectual disability participated in the study. Each participant performed the following: (1) the modified 6MWT twice, with a pacer, along a straight 30-m course in a gymnasium; (2) the graded maximal treadmill test; and (3) flexion and extension of the leg using a Cybex dynamometer. Cronbach's reliability coefficient between the two 6MWTs was $\alpha = 0.98$. Stepwise linear regression analysis showed that the furthest 6MWT distance was predictive of peak oxygen consumption ($R^2 = 0.67$). Peak torque during extension of the leg and BMI were significantly correlated with 6MWT distance. The modified 6MWT can be used with minimal time and space, to assess aerobic power in adults with ID.

Table of Contents

Supervisory Committee ii

Abstract iii

Table of Contents iv

List of Tables vii

List of Figures viii

Acknowledgments ix

Dedication x

Chapter 1: Introduction 1

Chapter 2: Method 6

Participants 6

Apparatus 6

Anthropometric Measurements 6

The Supports Intensity Scale 7

The Six Minute Walk Test 7

The Graded Maximal Treadmill Test 8

Leg Strength 9

Protocol 10

Statistical Analyses 13

Chapter 3: Results 14

Chapter 4: Discussion 18

References 24

Appendix 38

Appendix A Review of Literature 38

Intellectual Disability 38

Physical Activity and Health 39

Fitness Testing for Individuals with ID 42

Appendix B Recruitment Email to Organizations 54

Appendix C Recruitment Flyer 55

Appendix D Consent Form – Participants 56

Appendix E Assent Form – Participants 59

Appendix F Consent Form – Parents/Guardians 62

Appendix G Medical Clearance Form 66

Appendix H Protocols 68

The Six-Minute Walk Test 68

The Graded Oxygen Consumption Test on the Treadmill 70

Leg Strength 71

Appendix I Data Recording Sheets 72

Participant Overview 72

6MWT 73

Treadmill Test 74

Leg Strength 75

Appendix J Raw Data 76

Appendix K Participant Bookings 2009 77

Appendix L Booklet for Participants 78

Appendix M Fitness Test Results for Participants 82

Appendix N Supports Intensity Scale 83

List of Tables

Table 1 Participant Visits for Familiarization and Testing 10

Table 2 Descriptive Statistics of Participant Characteristics and Variables Measured 15

Table 3 Regression Analysis 17

Table 4 Tests to Assess Aerobic Power in Adults with ID 45

List of Figures

Figure 1 Bland Altman plot of agreement. 16

Figure 2 Relationship between VO_2 peak and 6MWD. 16

Acknowledgments

A number of people have aided in the preparation and completion of this thesis. The first person who should be recognized is my thesis supervisor Dr. Viviene Temple. Thank you for your insight, guidance, support, dependability, confidence in my abilities, and most importantly in helping to make this an enjoyable and enlightening experience, with respect to this thesis, and in other facets of my graduate journey. Should I continue to pursue a career in academia, please know that a lot of it has to do with the role you have played in my academic life these past few years.

Dr. Lynneth Stuart-Hill, thank you for your input and expertise in exercise physiology; Greg Mulligan, Holly Murray, and Dona Tomlin for always being readily willing to help with your practical laboratory expertise; Dr. Ryan Rhodes, Dr. Paul Zehr, Dr. P. J. Naylor, and Stefan Scott for opportunities of professional growth and development.

I am indebted to Special Olympics BC, Victoria Local; in particular to Chantal Brodeur and all the coaches who were extremely helpful and accommodating throughout the recruitment process. A special thank you to the participants who came to the University for testing on many occasions and who were always ready and excited to put forth their best effort.

Graduate students who have assisted me with data collection: Geoff de Ruiter, Leanne Dickau, Janine Drummond, Emily George, Lindsay Grainger, Lizette Greyling, Marc Jacobson, Christine Kormos, and Leila Pfaeffli. Thank you to my family, friends, and peers for moral support throughout the process.

Dedication

This thesis is dedicated to those who work towards making activities of daily living accessible for all populations; and in particular, to those who work towards a healthier and more integrated future for people with intellectual disability.

Chapter 1: Introduction

Physical fitness comprises of a set of attributes that are either health- or skill-related that enable one to perform physical activity (Caspersen, Powell, & Christenson, 1985), and the extent to which someone is able to participate in physical activity depends on their level of physical fitness. The cardiorespiratory component of physical fitness (Astrand, 1967; Caspersen et al., 1985; Powers & Howley, 2007) can be measured via laboratory testing utilizing either the treadmill (Gibson, Harrison, & Wellicome, 1979; Taylor, Buskirk, & Henschel, 1955) or the cycle ergometer (Astrand & Saltin, 1961; Saltin & Astrand, 1967). Field tests that are reliable and that have been validated against laboratory tests to measure aerobic power can be more convenient and less costly to carry out. Examples of field tests include walk or run tests that require a maximal effort within a specified time or for a specified distance. Protocols for these tests are often modified when used with individuals with intellectual disability (ID) because the individuals may be unaccustomed to strenuous exercise (Rintala, McCubbin, & Dunn, 1995); instructions may need to be continuously reinforced and modified for purposes of comprehension; and mastery of the protocol is necessary in order to assure high motivation to put forth a maximal effort (Harris, 2006). Practice tests prior to the testing day; familiarization with the protocol, equipment, environment, and staff; verbal encouragement; and pacers are essential in ensuring validity and reliability of test performance (Fernhall et al., 1996; Guyatt et al., 1984; Guyatt et al., 1985; Kunde & Rimmer, 2000; Pitetti & Fernhall, 2005; Pitetti, Rimmer, & Fernhall, 1993; Reid, Dunn, & McClements, 1993).

Five field tests have been validated to assess aerobic power in adults with ID. They are the modified Canadian Step Test (Montgomery, Reid, & Koziris, 1992), the bicycle ergometer test using the Schwinn “Air-Dyne” (Pitetti, Fernandez, Pizarro, & Stubbs, 1988), the modified

Leger and Lambert (1982) shuttle run (Montgomery et al., 1992), the 1 mile (1.6 km) walk test (Rockport Fitness Walking Test) (Rintala, Dunn, McCubbin, & Quinn, 1992; McCubbin, Rintala, & Frey, 1997), and the 1.5-mile (2.4 km) walk/run test (Ferhall & Tymeson, 1988). A few items should be noted regarding these tests. For the modified Canadian Step Test (Montgomery et al., 1992), the investigators reported difficulty in teaching the participants the desired tempo, and the protocol overestimated peak oxygen consumption (VO_2 peak) by 21%. The bicycle ergometer test using the Schwinn "Air-Dyne" (Pitetti et al., 1988) was not valid for adults with Down syndrome because the prediction equation incorporated heart rate, and many people with Down sydrome have peak heart rates lower than their age-matched peers without Down syndrome (Pitetti, Climstein, Campbell, Barrett, & Jackson, 1992). The modified shuttle run (Montgomery et al., 1992) was not ecologically valid because most participants finished the test prematurely, in that they did not continue until physical exhaustion. This resulted in a predicted VO_2 peak that was 28% lower than the measured VO_2 peak. Since 1992 when Rintala et al. first validated the 1 mile walk test, two studies have sought to cross-validate the test. One study found that the predicted VO_2 overestimated the measured VO_2 peak, as revealed by a dependent *t*-test (df = 24, $p < 0.02$) (Kittredge, Rimmer, & Looney, 1994); conversely, the second study found that the prediction equation underestimated VO_2 peak in 74%-79% of the participants (df = 18, $p < 0.02$) (Rintala, McCubbin, Downs, & Fox, 1997). The 1.5 mile run/walk was found to be valid, but reliability has not yet been established. Furthermore, when given the option to walk or run, pacing can be more difficult than when one is simply required to walk.

Walking is the most popular activity among adults with ID, more-so than any other type of activity of mild-moderate intensity or greater (Draheim, Williams, & McCubbin, 2002b;

Temple, Anderson, & Walkley, 2000; Temple & Walkley, 2003); regardless of whether the intensity is sufficient enough to meet the minimum recommendations required to achieve health benefits (Stanish, Temple, & Frey, 2006). In a study conducted by Stanish and Draheim (2005a) the majority of the 103 participants with ID did not accumulate the recommended daily amount of steps, but they did accumulate step counts similar to those reported for the general American population. As such, when undergoing fitness testing, it would be appropriate to use an activity mode that most adults with ID would be comfortable and confident performing.

The American Thoracic Society [ATS] (2002) recently developed a protocol for conducting the Six Minute Walk Test (6MWT) which has gained wide acceptance and has been employed in many studies. The 6MWT has been investigated for use as a predictor of morbidity and mortality, for pre-operative and post-operative evaluation (Alahdab, Mansour, Napan, & Stamos, 2009; ATS, 2002); to measure exercise capacity and functional rehabilitation in adults (Guyatt et al., 1985; Lipkin et al., 1986; Spencer et al., 2008) and children (Nixon et al., 1996) with moderate to severe heart and lung disorders; as a measure of functional ability in children (Maher et al., 2008) and adults with cerebral palsy (Andersson et al., 2006), Parkinson's disease (Falvo & Earhart, 2009), Alzheimer disease (Ries, Echternach, Nof, & Gagnon Blodgett, 2009), and with a transtibial amputation (Lin & Bose, 2008); as a measure of aerobic power in adults with rheumatoid arthritis (Karlsson & Opava, 2008); in obese adults (Beriault et al., 2009; Evers Larsson & Reynisdottir, 2008); and in healthy older adult (Gremeaux et al., 2008; Troosters et al., 1999), adult (Enright & Sherrill, 1998; Gibbons et al., 2001; Jenkins et al., 2009; Rikli & Jones, 1998; Troosters et al., 1999), and child (Geiger et al., 2006; Li et al., 2005) populations.

The 6MWT has recently been used with an adult population of individuals with Down syndrome (Vis et al., 2009). Of the 81 participants, 29 did not have cardiac disease and 52 had severe cardiac disease categorized by cardiac echocardiography. The distance walked during the 6MWT (6MWD) was not significantly different between groups; but older age, female sex, and level of intellectual disability were found to be independently and significantly correlated with lower 6MWD. In particular, level of intellectual functioning accounted for 29% of the variation in distance walked by the participants. The coefficient of variation between the first and second 6MWD was 11%, indicating high reproducibility. Although highly reproducible, the test was used without validation of its actual purpose; assessing aerobic power in adults with Down syndrome.

A number of participant characteristics might influence the distance walked during a field test. The distance an individual can walk during a fitness test is reduced by diseases such as lung disease, heart failure, arthritis, and neuromuscular disease (Butland et al., 1982; Cooper, 1968); as well as by genetically-caused physical conditions such as Down syndrome. In healthy adults, age, body mass, and height have been independently associated with distance walked (Enright & Sherrill, 1998). Leg strength (measured by isokinetic leg extension and flexion) has been shown to be significantly correlated with VO_2 peak, relative to body weight, for adults with ID (r = .61) (Pitetti & Boneh, 1995) and children with ID (Pitetti & Fernhall, 1997). This relationship has been found to be even more substantial for adults with Down syndrome (Cowley et al., 2010; Fernhall et al., 2007; Pitetti & Boneh, 1995). Furthermore, there was a significant relationship between distance covered during the 20-m shuttle run and 600m walk/run in children with ID (Fernhall & Pitetti, 2000).

The 6MWT is easy to administer and requires minimal equipment; it is inexpensive, safe, and better tolerated by various populations compared to other field tests (Lipkin et al., 1986; Solway, Brooks, Lacasse, & Thomas, 2001), yet has never been explored as a test to gauge aerobic power in adults with ID. The aim of this study was to determine whether a modified version of the 6MWT (American Thoracic Society, 2002) could be used to assess aerobic power in adults with ID by establishing its test-retest reliability and concurrent validity with the Graded Maximal Treadmill Test (GXTT). The influences of age, height, body mass, BMI, resting heart rate, leg length, and leg strength on 6MWD were also explored.

Chapter 2: Method

Participants

Participants were recruited from Special Olympics Victoria and other organizations in the Victoria area that offer services to individuals with ID. Participants were eligible to participate if they were between the ages of 18 and 50 years old, had mild or moderate intellectual disability, could walk without assistance, were able to come to the testing site at least four times, and had obtained medical clearance. Medical exclusion criteria were the following: congenital heart defects; taking medications that could affect normal physiological responses to exercise; orthopaedic or motor impairments that would prevent them from walking, jogging, or running; or other medical contraindications to strenuous exercise.

Twenty-one adults contacted the researchers for information on the study, viewed the familiarization video, and were given a medical clearance form to be completed by their physician. Eight of these adults chose to not take part in the study. No participants were excluded due to lack of medical clearance. One participant had a congenital heart defect and two participants had asthma, but their physicians deemed them suitable to engage in vigorous physical activity and participate in the study. All participants who began the study continued until completion (zero attrition). Thirteen adults participated in the study.

Apparatus

Anthropometric Measurements

Height (to the nearest 0.5cm) and body mass (to the nearest 0.1kg) were measured on a standard physician scale (Congenital Scale Corporation, Bridgeview, IL). Body mass index

(BMI) was determined using the formula: BMI = body weight/height^2 (kg/m^2). Leg length was measured from the greater trochanter of the femur bone to the floor, using a measuring tape (measured to the nearest cm).

The Supports Intensity Scale

The Supports Intensity Scale (SIS) (Thompson et al., 2004) was created by the AAMR and focuses on the supports (frequency, intensity, and type) needed for an individual to succeed in life activities. These activities are grouped under the categories: home living, community living, lifelong learning, employment, health and safety, and social activities. This measure provides a more global perspective on the individual, compared to tests that solely measure IQ or specific adaptive skills. The scale is completed (via interview) by persons who are close to the individual; such as a parent, care provider, or coach. The individual with ID can also partake in providing answers alongside the person being interviewed. The test-retest reliability for the total SIS score was $r = 0.79$ when completed twice by the same interviewer, and $r = 0.997$ when the test was completed for the same individual by two different interviewers. Content validity, criterion-related validity, and construct validity with tests of intelligence and adaptive behaviour have been established (Thompson et al., 2004).

The Modified Six Minute Walk Test

The modified 6MWT was conducted in a gymnasium, along a straight 30-m path. The starting line and 30-m line were marked by orange cones, and the starting line and every two meters along the course was marked by red tape. Two standard stop-watches were used to time six minutes for the test. The 6MWT followed the guidelines recommended by the ATS (2002). As recommended, there was no warm-up. Throughout the test standard phrases of encouragement were said each minute, such as, “You are doing well. You have “x” minutes to go." Adaptations to the ATS's protocol for adults with ID were: a pacer (the same pacer for all testing) walking approximately one to three meters ahead of the participant, encouraging them to walk as quickly as possible; additional phrases of encouragement (e.g. "Great effort. Keep it up!") approximately every fifteen seconds; and one practice test prior to the testing day.

The number of laps completed and extra distance walked was recorded to the nearest 0.1 m. Heart rates were obtained using a Polar-electro heart rate monitor (Model S610, Polar Electro, Finland) and heart rate data was collected every 15 seconds. The equation used to predict maximal heart rate was: HR = 210 – 0.56 (age) – 15.5 (DS); where 1 = non-DS, and 2 = DS (Fernhall et al., 2001).

The Graded Maximal Treadmill Test

The Graded Maximal Treadmill Test (GXTT) was conducted on a Woodway treadmill (Model: DESMO-EVO, Waukesha, WI) with a grade range of 0-20%, which could be adjusted in 0.1% increments; and a speed range of 0-20 mph, which could be adjusted in 0.1mph increments. Gas exchange was analyzed using a TrueOne 2400 Parvo Medics Metabolic Measurement System (Model: MMS-2400, Sandy, UT), and OUSW computer software. The metabolic system was calibrated prior to each test. The oxygen and carbon dioxide analyzers were calibrated with gases of known concentration, and the pneumotach was calibrated with a syringe of known volume. Participants breathed into a Hans-Rudolph silicone mask attached to a two-way valve. Metabolic data and heart rates were collected and averaged every 15 seconds. Heart rates were obtained with Polar Electro heart rate monitors. Other physiologic responses collected and utilized in the analyses included: VO_2 peak and respiratory exchange ratio (RER). The highest VO_2 attained during the last stage completed was recorded as VO_2 peak. All measurements were taken in a room in which the temperature was between 20-26°C and the relative humidity between 24-54%.

The protocol for the GXTT was adapted from Fernhall and Tymeson (1987), and follows suggestions provided by Pitetti and Fernhall (2005). The test began at 0% grade for 2 minutes at a speed between 2.0 and 3.5 mph. The speed remained constant while the grade increased by 2.5% every two minutes, until a grade of 12.5% was reached. After two minutes at 12.5%, the speed was increased by 0.5 mph every minute until exhaustion.

Leg Strength

Measurement of isokinetic knee flexion and extension strength was performed on a Cybex 6000 dynamometer. The isokinetic strength measurements were peak torque (measured in Nm) and average power (measured in watts). Peak torque is defined as the rotary effect of a force (Hall, 2007). Average power is defined as the greatest average rate of torque production (Hall, 2007).

Measurements were taken for the dominant leg, determined by the leg the participant would use to kick a soccer ball. This protocol has been previously used to test leg strength for adults and adolescents with ID (Pitetti, 1990; Pitetti & Boneh, 1995; Pitetti, Climstein, Mays, & Barrett, 1992; Pitetti & Fernhall, 1997). Participants were tested in a seated position, with their hands gripping the handlebars located near their hips. The lever pad was placed on the distal anterior tibia, three inches above the lateral malleolus; and they were strapped in at the thigh, and across the chest and waist; with their non-dominant foot tucked behind a restraining bar. Practice involved ten repetitions of extension and flexion at a speed of 60° per second, immediately followed by two repetitions at the same speed at medium intensity, and two at vigorous intensity. Following a brief rest, participants performed two sets of three maximal efforts, with 30 seconds of rest between sets, at a speed of 60° per second.

Protocol

Prior to agreeing to participate, participants viewed a 7-minute familiarization video depicting what would be involved in the study. Physician approval and informed consent or assent was obtained from participants and (if needed) consent was obtained from their legal guardian.

On the days of their visits, participants were asked to not eat a large meal for at least two hours prior, and to refrain from caffeinated beverages and vigorous physical activity. Familiarization and testing occurred over of four visits; see Table 1 for an outline of each visit.

Table 1

Participant Visits for Familiarization and Testing

Visit #1	Visit #2	Visit #3	Visit #4
Anthropometric measurements m6MWT familiarization Leg strength test #1	m6MWT #1 Leg strength test #2 GXTT familiarization (Phase 1)	m6MWT #2 GXTT familiarization (Phase 2)	GXTT (Phase 3)

Note. m6MWT = modified Six Minute Walk Test; GXTT = Graded Maximal Treadmill Test

For the modified 6MWT, participants underwent one familiarization session prior to data collection. During familiarization the protocol was explained and demonstrated to the participant, and they then practiced the test, with a pacer, while wearing a heart rate monitor. The modified 6MWT was then performed twice, on two different days, separated by 2 to 8 days. The primary investigator was the pacer for all modified 6MWTs.

The modified 6MWT served as a warm-up for leg strength testing. After approximately five minutes of rest during which time the leg strength protocol was demonstrated, the participant practiced extension and flexion of the leg, then was tested for leg strength. Leg strength testing was performed twice, separated by a minimum of 48 hours, and only the highest recorded value from either day was used for data analysis. Constant encouragement to perform at vigorous intensity was provided throughout the test and the same investigator tested all participants.

Familiarization and testing for the GXTT involved three phases, each of which occurred over a minimum of one visit, depending on the participant's comfort level at each phase. Each visit was separated by a minimum of 2 days and a maximum of 8 days.

Phase 1 involved familiarization of the laboratory, staff, and equipment. In order for the participant to advance from Phase 1 to Phase 2 the following had to occur: (a) A comfortable walking speed had to be established. The participant started walking on the treadmill at a speed of 2.0 mph. Once the participant had adjusted to the speed it was increased by 0.2 mph and the participant was given time to adapt to this speed before it was increased again by 0.2 mph. This was repeated until the participant experienced discomfort with the speed, to a maximum of 3.5 mph. Discomfort with speed was demonstrated by constantly holding onto the railings, trepidation, reaching out for a staff member standing near the treadmill to gain balance, or by verbalising their anxiety. Once one or more of these signs had been displayed, the treadmill speed was lowered to the previous level. This was the speed that would be used for testing. (b) The participant felt comfortable with changes in treadmill elevation while walking at the previously selected speed. Changes in treadmill grade occurred in incremental increases of 2.5%. (c) The participant felt comfortable breathing through the Hans-Rudolph mask.

Phase 2 involved confirmation of comfort with the walking speed selected during Phase 1; and further familiarization with the laboratory, equipment, and protocol. In order for the participant to advance from Phase 2 to Phase 3 the following had to occur: the participant felt comfortable wearing the mask and heart rate monitor while walking on the treadmill at the selected speed, while experiencing elevations in grade.

Data collection for the GXTT occurred during Phase 3. Prior to testing, the participant sat quietly for ten minutes and resting heart rate was obtained. This was followed by a 5-minute warm-up on the treadmill, at the testing speed; consistent with a protocol previously used with this population (Kittredge, Rimmer, & Looney, 1993). The GXTT was performed with two investigators conducting the test. Constant encouragement was provided throughout.

If a participant required extra familiarization with any of the tests, they came in for extra visits. Four participants required additional visits. One participant came in five times because on his first visit he forgot to bring the asthma medication that his doctor required him to take prior to exercise, and therefore only anthropometric measurements were taken during Visit 1. Two participants came in for an extra visit because they were not comfortable performing the GXTT after only three visits and required extra practice; and another participant came in for a fifth visit because the metabolic system used during the GXTT was malfunctioning during Visit 4.

At the end of each visit participants were led through stretches and were offered juice and a small token ($5 gift card to a coffee shop or movie theatre). Each visit was separated by a minimum of 2 days and a maximum of 8 days. After all testing was complete, the primary investigator met with the participant and their parent or legal guardian at a location of the participant's choice. The participant was given a family movie pass, the results from their

GXTT, and suggestions on how to improve their fitness. The SIS was administered at this time. All but three parents or legal guardians agreed to complete the SIS. This study was approved by the Human Research and Ethics Board at the University of Victoria.

Statistical Analyses

Means and standard deviations (SD) were calculated for all variables. Test-retest intraclass reliability coefficient was calculated for the distances on the two modified 6MWTs. 6MWDs were analyzed using a Bland Altman plot (Altman & Bland, 1983; Bland & Altman, 1996). Validity of the modified 6MWT was determined using stepwise linear regression analysis with VO_2 peak from the GXTT as the dependent variable. The furthest 6MWD from the two modified 6MWTs was used for 6MWD. The relationship between age, height, weight, BMI, resting heart rate, leg length, and leg strength variables on 6MWD was explored using Pearson Product Moment correlations. An alpha level of 0.05 was set for determining all statistical significance. Statistical Package for the Social Sciences (version 17.0; SPSS Inc, Chicago, IL) was used for the analyses.

Chapter 3: Results

Thirteen physically healthy adults (7 males and 6 females, ages 18 to 44 years) with ID (classified as either mild or moderate, as identified by their parents or caregivers, with values that ranged from less that 1% to 32% on the SIS) participated in the study. Of the 13 participants, four had Down syndrome (3 males, 1 female). Descriptive statistics are shown in Table 2. All participants had been actively involved with Special Olympics for at least three years. Special Olympics activities included swimming, gymnastics, curling, golf, track and field, skiing, softball, and soccer. Participants attended Special Olympics trainings and practices 1 to 6 times per week.

Ten participants achieved their furthest distance on the 6MWT the second time they performed the test, and all participants were able to walk the six minutes without stopping or needing to end the test prematurely. Reliability of the 6MWT after one practice session yielded a high test-retest reliability coefficient (95% confidence interval), at $\alpha = 0.98$. The Bland Altman plot (Figure 1) demonstrated a high degree of repeatability; the bias was -5.2 m and the limits of agreement (2 SD) were -54 and 43.6 m. Correlation analysis showed that VO_2 peak ($r = .84$) and peak torque during leg extension ($r = .65$) were significantly and positively correlated with 6MWD; and BMI ($r = -.62$) was significantly and negatively correlated with 6MWD. The linear relationship between VO_2 peak and 6MWD is shown in Figure 2.

The GXTT was continued until volitional exhaustion. Five participants reached an RER of at least 1.1. Twelve participants reached a heart rate within 15 bpm or 85% of their predicted maximal heart rate, and a plateau in VO_2 was seen in six participants during the GXTT. Aside from 6MWD, other variables that were significantly correlated with VO_2 peak include peak torque during leg extension ($r = .62$), height ($r = .56$), and percent of the maximal heart rate achieved during the 6MWT (r = - .58). When the variables that significantly correlated with VO_2 peak (6MWD, BMI, peak torque during leg extension, and % HR max achieved during the 6MWT) were entered into a stepwise linear regression analysis with VO_2 peak as the dependent variable, all variables except 6MWD were automatically excluded from the analysis (see Table 3).

Table 2

Descriptive Statistics of Participant Characteristics and Variables Measured

Variable	Range	Mean (SD)
Age (years)	18 - 44	30.4 (7.6)
SIS score (%)	<1 – 32	n/a
Body mass (kg)	54.8 – 94.3	79.9 (13.5)
Height (m)	1.53 – 1.85	1.67 (0.10)
BMI (kg/m^2)	20.9 – 36.1	28.8 (4.9)
Leg length (m)	0.76 – 1.04	0.89 (0.08)
6MWD #1 (m)	523.9 – 838.7	655.8 (90.8)
6MWD #2 (m)	543.6 – 835.0	661.1 (82.8)
6MWD furthest (m)	543.6 – 838.7	667.7 (87.5)
HR during 6MWT (%max)	73 - 100	87.5 (10.3)
VO_2 peak (ml/kg/min)	14.20 – 53.70	32.87 (9.81)
Peak torque - flexion (Nm)	26 - 113	74.9 (26.4)
Average power - flexion (W)	18 – 73	53.5 (18.2)
Peak torque – extension (Nm)	65 – 180	107.2 (28.5)
Average power – extension (W)	39 - 98	63.6 (17.3)

Note. n = 13 for all variables, except SIS (n = 10); 6MWD = distance walked during the Six-Minute Walk Test; 6MWD furthest = the furthest of the two distances walked; HR = heart rate; VO_2 peak = peak oxygen uptake during the GXTT.

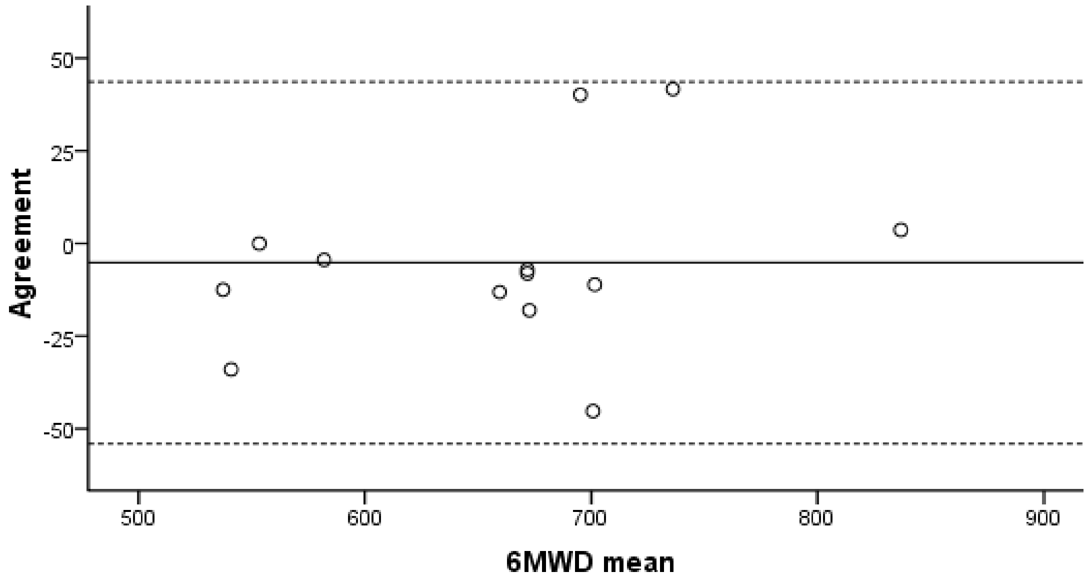

Figure 1. Bland Altman plot of agreement of 6MWD between two tests. The bias (mean difference between the two paired means) was -5.2 m (—–) and the limits of agreement (----) were between -54.0 m and 43.6 m.

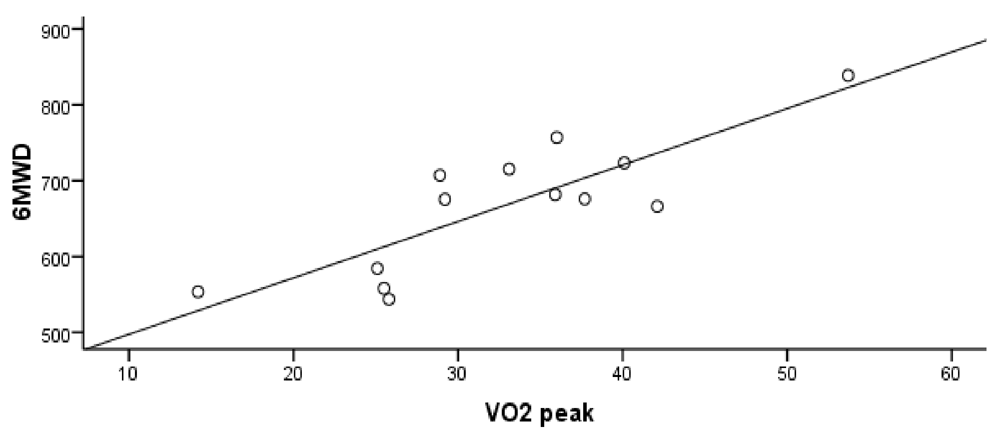

Figure 2. Relationship between VO_2 peak and the furthest distance walked during the 6MWT.

Table 3

Regression Analysis

	R	R^2	Adjusted R^2	SEE	Sig.
6MWD	.84	.70	.67	5.64	< .001

Chapter 4: Discussion

The assessment of an individual's response to exercise is an important clinical tool as it provides a global evaluation of the respiratory, cardiac, and metabolic systems. The current gold standard for measuring aerobic power is the GXTT (Solway et al., 2001; Thomas, Nelson, & Silverman, 2005). The GXTT is expensive to administer, and requires a laboratory and gas analysis measuring equipment. Conversely, the 6MWT is quick, easy to administer and minimal equipment and space are necessary; it is inexpensive, safe, and better tolerated by a wide variety of participants compared to other field tests (Lipkin et al., 1986; Solway et al., 2001). The primary aim of this study was to determine the test-retest reliability and concurrent validity of the modified 6MWT with the GXTT in healthy adults with ID. The results of this study established that the modified 6MWT demonstrated high reliability ($\alpha = .98$) and accounted for 67% of the variance in VO_2 peak.

There are certain limitations to the present study. The small sample size may limit the statistical power of our study; it does not allow for comparisons between male and female participants or participants with and without Down syndrome; nor does it permit for the establishment of a prediction equation. There were limitations with the GXTT protocol. If a participant was aerobically fit and able to continue the test beyond the 12-minute mark (i.e. the point at which the grade was kept constant at 12.5%, but the speed increased by 0.5 mph each subsequent minute), the pace was awkward in that the speed was too slow for a comfortable run, and too fast for a comfortable fast walk. Having said this, seven participants were able to continue the GXTT beyond the 12-minute mark. Though not yet validated for adults with ID, a protocol that began at a running speed might have been more appropriate for participants who were on a track team, were accustomed to running, or had greater aerobic power.

Despite these limitations, the reliability of the modified 6MWT was equivalent to or higher than that of other field tests that have been explored for use in assessing aerobic power in adults with ID; namely the Modified Canadian Step Test (R = .97), the Modified Leger and Lambert Shuttle Run (R = .90) (Montgomery et al., 1992); the Cooper 12-minute Walk-Run (R = .81) (Cressler et al., 1988); and the 1 Mile Walk Test (R = .91 - .97) (Kittredge et al., 1994; Rintala et al., 1992; Rintala et al., 1997). Compared to field tests whose reliability has been established, the validity of the 6MWT fared as follows. It was higher than that of the Modified Canadian Step Test (r = .72) which was found to overestimate VO_2 peak by 21% and the investigators reported that the participants found it difficult to keep up with the tempo. It was equivalent to the Modified Leger and Lambert Shuttle Run, although the authors reported that the test was not ecologically valid (Montgomery et al., 1992). A few studies have found the 1-Mile Walk Test to have values of validity (r = .78 - .87) similar to those of the modified 6MWT in our study (Kittredge et al., 1994; McCubbin et al., 1997; Rintala et al; 1992), but Rintala et al. (1997) reported that the prediction equation from Rintala et al. (1992) significantly overestimated VO_2 peak. Compared to other field tests whose validity is equivalent to that of the modified 6MWT, the modified 6MWT is more useful for assessing aerobic power in adults with ID (with and without Down syndrome) because it can be used in settings where space is limited, it is less demanding, and better tolerated by many populations with compromised health.

The 6MWT was initially used in populations with pulmonary or cardiac disease, and more recently it has been explored for use in gauging aerobic power in healthy populations. In our study we found that the 6MWD explained a higher proportion of the variance in VO_2 peak (R = .84 and R^2 = .67) compared to other 6MWT validation studies. Enright and Sherrill (1998) reported that 6MWD, age, and BMI, together in a regression equation produced a R^2 = .42 and

.38 in healthy adult men and women, respectively; r = .44 in healthy adolescents (Li et al., 2005); and r = .34 in obese children and adolescents 8-16 years (Morinder, Mattsson, Sollander, Marcus, & Evers Larsson, 2009). In another study with older adults aged 60-87 years, the correlation coefficient was higher than in healthy adults populations (.71 < r < .82) (Rikli & Jones, 1998), and closer to the value obtained in our study. The higher R and R^2 values in our study could be explained by the implementation of a pacer and practice test which would have positively influenced motivation; or perhaps be due to the level of fitness of our study population. Compared to other studies that have used the 6MWT, the participants in this study walked less than the mean distance (698 ± 96 m) walked by healthy adults of mean age 45 years (Gibbons, Fruchter, Sloan, & Levy, 2001). However, they walked further than the healthy males (576m) and females (494 m) of mean age 61 years (Enright & Sherrill, 1998), and further than the overweight (458 m) or obese adults (452 m) (Beriault et al., 2009).

The secondary purpose of this study was to identify variables that influenced the distance walked during the modified 6MWT. In our study BMI was correlated with 6MWD (r = -.62), and peak torque during extension (but not peak torque during flexion, and average power during flexion and extension) was correlated with both 6MWD (r = .65) and with aerobic power (r = .62). In previous studies that investigated walking tests, BMI or weight, height, age, and gender have been significant predictors of distance walked in healthy adults 20-80 years old without ID (Enright & Sherrill, 1998; Gibbons et al., 2001); peak torque and average power during extension and flexion have been positively correlated with VO_2 peak in adults with ID without Down syndrome (Pitetti & Boneh, 1995); and peak torque during extension in adults with Down syndrome (Fernhall et al., 2007). In youth 10-17 years old with ID peak torque during extension and flexion was found to be correlated with VO_2 peak (Pitetti & Fernhall, 1997) and with distance walked/run during the 20 m shuttle run and 600 m run/walk (Fernhall & Pitetti, 2000). In our study peak torque during extension was positively correlated with 6MWD and VO_2 peak, but was not included in the regression analysis. It has been speculated that there may exist a "threshold" of leg strength that influences VO_2 peak in that cardiovascular capacities may be limited if leg strength falls below that "threshold" (Pitetti & Fernhall, 1997). Adults with ID tend to exhibit a different fatigue profile (Zafeiridis et al., 2009) and lower values of muscular strength compared to adults without ID (Pitetti & Campbell, 1991; Pitetti et al., 1992; Pitetti et al., 1993); therefore it may be the case that their cardiovascular power was limited by their leg strength. Another possibility might be that the methods with which we measured their cardiovascular power were limited by their leg strength.

The VO_2 peak herein (33 ± 9.8 ml/kg/min) is considered low when compared to the norms for males without ID between 20 and 39, and fair when compared to those for females without ID of the same age (Nieman, 2007). When testing individuals with ID, instead of using the term maximal oxygen uptake (VO_2 max), peak oxygen uptake (VO_2 peak), the highest oxygen uptake observed under specific circumstances (Rowell, 1974) is used. VO_2 peak implies that the individual being tested has reached volitional exhaustion, which is the point when the participant feels that they can no longer continue to exercise and that they have put forth their best effort (Pitetti et al., 1993). For most individuals with disabilities, "...progressively increasing the work rate in a cardiovascular fitness test to a point of fatigue produces a peak VO_2 that closely approximates VO_2 max even when the plateau is not evident" (Pitetti, Jongmans, & Fernhall, 1999, p. 364). We are confident that the VO_2 peak observed by most of our participants is close to their true VO_2 max for a number of reasons. Twelve participants reached a heart rate that was greater than 85% or within ± 15 bpm of their predicted max HR (Fernhall et al., 2001). Five participants reached a RER of at least 1.1, and all participants were able to continue the GXTT until reaching lactate or ventilatory threshold (McArdle, Katch, & Katch, 2010). A plateau in VO_2, measured as an increase of less than 0.15 L/min with an increase in work (Astrand, 1967; Powers & Howley, 2007; Rintala et al., 1995), was observed in six participants. In previous studies that have tested aerobic power in adults with ID, not all participants achieved a sudden drop or plateau in VO_2 (Fernhall, Tymeson, Millar, & Burkett, 1989). Furthermore, a series of measures were taken to minimize the impact of motivation and the many other potentially confounding factors to achieving VO_2 max and putting forth maximal effort (Pitetti & Fernhall, 2005). These measures included: following the validated and reliable protocol for the GXTT; using a modified protocol of the 6MWT established by the ATS (2002) which included familiarization sessions, a pacer, and extra encouragement; and ensuring that each participant felt as though they were an important contribution to the research study. Furthermore, we found that % HR max achieved during the modified 6MWT was negatively correlated with VO_2 peak (r = -.58). This suggests that participants were putting forth their best effort during the modified 6MWT, and the adults with higher aerobic power did not need to work as hard in order to walk as quickly as possible for six minutes.

The results of this study suggest that the 6MWT can be used to gauge aerobic power in adults with ID. Practical implications for its use include testing aerobic power before and after a training program or before and after a Special Olympics training season. The modified 6MWT could also be used as a one-time measure to gauge aerobic power for research purposes.

Directions for future research include furthering the same study using this modified 6MWT protocol with more participants to establish a prediction equation, and including broader populations, for example older adults with ID, and adults with ID with co-morbidities. The results from this study suggest that individuals with greater leg strength, as measured by peak torque during extension, are more aerobically fit and walked further during the modified 6MWT. An intervention aimed at improving leg strength and/or aerobic power might tease out whether leg strength affects aerobic power, or vice versa, in adults with ID. It could also be of interest to investigate whether or not there is a relationship between 6MWD, aerobic power, and daily step counts.

No major adverse events occurred during familiarization and testing. Two participants complained of slight pain in their shins during the modified 6MWT but chose to continue with the test, and the pain had subsided by the end of the test. No adverse events occurred during the GXTT or during testing of leg strength.

The authors declare that there were no competing interests.

References

Americal Thoracic Society. (2002). ATS statement: Guidelines for the six-minute walk test. *American Journal of Respiratory and Clinical Care Medicine, 166*, 111-117.

Andersson, C., Asztalos, L., & Mattsson, E. (2006). Six-minute walk test in adults with cerebral palsy: A study of reliability. *Clinical Rehabilitation, 20*, 488-495.

Astrand, P. O. (1967). Measurement of maximal aerobic capacity. *Canadian Medical Association Journal, 96*, 732-735.

Astrand, P. O., & Saltin, B. (1961). Maximal oxygen uptake and heart rate in various types of activity. *Journal of Applied Physiology, 16*, 977-981.

Baynard, T., Pitetti, K. H., Guerra, M., & Fernhall, B. (2003). Heart rate variability at rest and during exercise in persons with Down syndrome. *Archives of Physical Medicine and Rehabilitation, 85*, 1285-1290.

Baynard, T., Pitetti, K. H., Guerra, M., Unnithan, V. B., & Fernhall, B. (2008). Age-related changes in aerobic capacity in individuals with mental retardation: A 20-yr review. *Medicine & Science in Sports & Exercise, 40*, 1984-1989.

Beange, H., McElduff, A., & Baker, W. (1995). Medical disorders of adults with mental retardation. *American Journal on Mental Retardation, 99*, 595-604.

Beasley, C. R. (1982). Effects of a jogging program on cardiovascular fitness and work performance of mentally retarded adults. *American Journal of Mental Deficiency, 86*, 609-613.

Beriault, K., Carpentier, A. C., Gagnon, C., Menard, J., Baillargeon, J.-P., Ardilouze, J. –L. et al. (2009). Reproducibility of the 6-minute Walk Test in obese adults. *International Journal of Sports Medicine, 30*, 725-727, Blair, S. N., Kohl, H. W., Paffenbarger, R. S., Clark, D. G., Cooper, K. H., & Gibbons, L. W. (1989). Physical fitness and all-cause mortality: A prospective study of healthy men and women. *American Medical Association Journal, 262*, 2395-2401.

Bland, J. M., & Altman, D. G. (1996). Measurement error. *British Medical Journal, 313*, 744.

Butland, R. J., Pang, J., Gross, E. R., Woodcock, A. A., & Geddes, D. M. (1982). Two-, six-, and 12-minute walking tests in respiratory disease. *British Medical Journal, 284*, 1607-1608.

Carmeli, E., Ayalon, M., Barchad, S., Sheklow, S. L., & Reznick, A. Z. (2002). Isokinetic leg strength of institutionalized older adults with mental retardation with and without Down's syndrome. *Journal of Strength and Conditioning Research, 16*, 316-320.

Carmeli, E., Barak, S., Morad, M., & Kodesh, E. (2009). Physical exercise can reduce anxiety and improve quality of life among adults with intellectual disability. *International Sports Medicine Journal, 10*, 77-85.

Caspersen, C. J., Powell, K. E., & Christenson, G. M. (1985). Physical activity, exercise, and physical fitness: Definitions and distinctions for health-related research. *Public Health Reports, 100*, 125-131.

Chanias, A. K., Reid, G., & Hoover, M. L. (1998). Exercise effects on health-related physical fitness of individuals with an intellectual disability: A meta-analysis. *Adapted Physical Activity Quarterly, 15*, 119-140.

Civil Aeromedical Research Institute. (1963). *A simple field test for the assessment of physical fitness*. USA: Balke.

Cooper, K. H. (1968). A means of assessing maximal oxygen intake: Correlation between field and treadmill testing. *American Medical Association Journal, 203*, 201-204.

Cowley, P. M., Ploutz-Snyder, L. L., Baynard, T., Heffernan, K., Jae, S. Y., Hsu, S. et al. (2010). Physical fitness predicts functional tasks in individuals with Down syndrome. *Medicine and Science in Sports and Exercise, 42*, 388-393.

Cressler, M., Lavay B., & Giese, M. (1988). The reliability of four measures of cardiovascular fitness with mentally retarded adults. *Adapted Physical Activity Quarterly*, *5*, 285-292.

Croce, R., & Horvat, M. (1992). Effects of reinforcement based exercise on fitness and work productivity in adults with mental retardation. *Adapted Physical Activity Quarterly*, *9*, 148-178.

Cullum, L., & Liebman, J. (1969). The association of congenital heart disease with Down syndrome (Mongolism). *American Journal of Cardiology*, *24,* 354-357

Draheim, C. C. (2006). Cardiovascular disease prevalence and risk factors of persons with mental retardation. *Mental Retardation and Developmental Disabilities Research Reviews*, *12*, 3-12.

Draheim, C. C., Williams, D. P., & McCubbin, J. A. (2002a). Physical activity, dietary intake, and the insulin-resistance syndrome in nondiabetic adults with mental retardation. *American Journal of Mental Retardation, 107,* 361-75.

Draheim, C. C., Williams, D. P., & McCubbin, J. A. (2002b). Prevalence of physical inactivity and recommended physical activity in community-based adults with mental retardation. *Mental Retardation*, *40*, 436-444.

Draheim, C. C., Williams, D. P., & McCubbin, J. A. (2003). Cardiovascular disease risk factor differences between Special Olympians and non-Special Olympians. *Adapted Physical Activity Quarterly*, *20*, 118-34.

Enright, P. L., & Sherrill, D. L. (1998). Reference equations for the six-minute walk in healthy adults. *American Journal of Respiratory and Critical Care Medicine, 158*, 1384-1487.

Evers Larsson, U., & Reynisdottir, S. (2008). The six-minute walk test in outpatients with obesity: Reproducibility and known group validity. *Physiotherapy Research International, 13,* 84-93.

Falvo, M. J., & Earhart, G. M. (2009). Six-minute walk distance in person with Parkinson's disease: A hierarchical regression model. *Archives of Physical Medicine and Rehabilitation, 90*, 1004-1008.

Fernhall, B. (1993). Physical fitness and exercise training of individuals with mental retardation. *Medicine and Science in Sport and Exercise, 25,* 442-50.

Fernhall, B., Figueroa, A., Collier, S., Baynart, T., Giannopoulou, I,. & Gouloupoulou, S. (2005). Blunted heart rate response to upright tilt in individuals with Down syndrome. *Archives of Physical Medicine and Rehabilitation, 86,* 813-818.

Fernhall, B., Jae, S. Y., Heffernan, K., Hsu, S., Ploutz-Snyder, L., Cowley, P. et al. (2007). Aerobic capacity is related to muscle strength in individuals with Down syndrome. *Medicine & Science in Sports & Exercise, 39*, S245,

Fernhall, B., McCubbin, J. A., Pitetti, K. H., Rintala, P., Rimmer, J. H., Millar, A. L., et al. (2001). Prediction of maximal heart rate in individuals with mental retardation. *Medicine & Science in Sport & Exercise, 33*, 1655-1660.

Fernhall, B., & Otterstetter, M. (2003). Attenuated responses to sympathoexication in individuals with Down syndrome. *Journal of Applied Physiology, 94,* 2158-2165.

Fernhall, B., & Pitetti, K. H. (2000). Leg strength is related to endurance run performance in children and adolescents with mental retardation. *Paediatric Exercise Science*, *12*, 324-333.

Fernhall, B., Pitetti, K. H., Rimmer, J. H., McCubbin, J. A., Rintala, P., Millar, A. L. et al. (1996). Cardiorespiratory capacity of individuals with mental retardation including Down syndrome. *Medicine & Science in Sport & Exercise*, *28*, 366-371.

Fernhall, B., Pitetti, K., Vukovich, M. D., Stubbs, N., Hensen, T., Winnick, J. P. et al. (1998). Validation of cardiovascular fitness field tests in children with mental retardation. *American Journal of Mental Retardation*, *102*, 602-612.

Fernhall, B., & Tymeson, G. (1987). Graded exercise testing of mentally retarded adults: A study of feasibility. *Archives of Physical Medicine and Rehabilitation*, *68*, 363-365.

Fernhall, B., & Tymeson, G. T. (1988). Validation of cardiovascular fitness field tests for adults with mental retardation. *Adapted Physical Activity Quarterly*, *5*, 49-59.

Fernhall, B., Tymeson, G., Millar, L., & Burkett, L. (1989). Cardiovascular fitness testing and fitness levels of adolescents and adults with mental retardation including Down syndrome. *Education and Training of the Mentally Retarded*, *23*, 133-138.

Fox, R., & Rotatori, A. F. (1982). Prevalence of obesity among mentally retarded adults. *American Journal of Mental Deficiency*, *87*, 228-230.

Frey, G. (2004). Comparison of physical activity levels between adults with and without mental retardation. *Journal of Physical Activity and Health*, *1*, 235-245.

Frey, G. C., McCubbin, J. A., Hannigan-Downs, S., Kasser, S. L., & Skaggs, S. O. (1999). Physical fitness of trained runners with and without mild mental retardation. *Adapted Physical Activity Quarterly*, *16*, 126-137.

Geiger, R., Strasak, A., Treml, B., Gasser, K., Kleinsasser, A., Fischer, V., et al. (2007). Six-minute walk test in children and adolescents. *Journal of Pediatrics, 150*, 395-399.

Gibbons, W. J., Fruchter, N., Sloan, S., & Levy R. D. (2001). Reference values for a multiple repetition 6-minute walk test in healthy adults older than 20 years. *Journal of Cardiopulmonary Rehabilitation, 21*, 87-93.

Gibson, T. M., Harrison, M. H., & Wellicome, R. M. (1979). An evaluation of a treadmill work test. *British Journal of Sports Medicine, 13*, 6-11.

Gremeaux, V., Iskandar, M., Kervio, G., & Deley, G. (2008). Comparative analysis of oxygenuptake in elderly subjects performing tow walk tests: the six-minute walk test and the 200-m fast walk test. *Clinical Rehabilitation, 22*, 162-168.

Grindrod, D., Paton, C. D., Knez, W. L., & O'Brien, B. J. (2006). Six minute walk distance is greater when performed in a group than alone. *British Journal of Sports Medicine, 40*, 876-877.

Guerra, M., Llorens, N., & Fernhall, B. (2003). Chronotropic incompetence in persons with Down syndrome. *Archives of Physical Medicine and Rehabilitation, 84*, 1604-1608.

Guyatt, G. H., Sullivan, M. J., Thompson, P. J., Fallen, E. L., Pugsley, S. O., Wayne Taylor, D. et al. (1985). The six-minute walk: A new measure of exercise capacity in patients with chronic heart failure. *Canadian Medical Association Journal, 132*, 919-923.

Guyatt, G. H., Pugsley, S. O., Sullivan, M. J., Thompson, P. J., Berman, L. B., Jones, N. L. et al. (1984). Effect of encouragement on walking test performance. *Thorax, 39*, 818-822.

Hall, S. J. (2007). *Basic biomechanics (5th Ed.)*. New York, N.Y.: McGraw-Hill.

Harris, J. C. (2006). *Intellectual disability*. New York, N. Y.: Oxford University Press.

Heller, T., Hsieh, K., & Rimmer, J. H. (2004). Attitudinal and psychosocial outcomes of a fitness and health education program on adults with Down syndrome. *American Journal of Mental Retardation, 109*, 175-185.

Jenkins, S., Cecins, N., Camarri, B., Williams, C., Thompson, P., & Eastwood, P. (2009). Regression equations to predict 6-minute walk distance in middle aged and elderly adults. *Physiotherapy Theory and Practice, 25*, 516-522.

Karlsson, A., & Opava, C. H. (2008). Cycling or walking? Comparing the six-minute walk with the cycle ergometer test in patients with rheumatoid arthritis. *Advances in Physiotherapy, 10*, 203-208.

Kittredge, J. M., Rimmer, J. H., & Looney, M. A. (1994). Validation of the Rockport Fitness Walking Test for adults with mental retardation. *Medicine and Science in Sports and Exercise, 26*, 95-102.

Kunde, K., & Rimmer, J. H. (2000). Effects of pacing vs. nonpacing on a one-mile walk test in adults with mental retardation. *Adapted Physical Activity Quarterly, 17*, 413-420.

Lavay, B., & McKenzie, T. L. (1991). Development and evaluation of a systematic run/walk program for men with mental retardation. *Education and Training in Mental Retardation, 26*, 333-341.

Leger, L. A., & Lambert, J. (1982). A maximal multistage 20m shuttle run test to predict VO_2 max. *European Journal of Applied Physiology, 49*, 1-5.

Li, A. M., Yin, J., Au, J. T., So, H. K., Tsang, T., Wong, E. et al. (2007). Standard reference for the six-minute walk test in healthy children aged 7 to 16 years. *American Journal of Respiratory and Clinical Care Medicine 176*, 174-180.

Li, A. M., Yin, J., Yu, C. C. W., Tsang, T., So, H. K., Wong, E. et al. (2005). The six-minute walk test in healthy children: Reliability and validity. *European Respiratory Journal, 25*, 1057-1060.

Lin, S-J., & Bose N. H. (2008). Six-minute walk test in persons with transtibial amputation. *Archives of Physical Medicine and Rehabilitation, 89*, 2354-2359.

Lipkin, D. P., Scriven, A. J., Crake, T., & Poole-Wilson, P. A. (1986). Six minute walk test for assessing exercise capacity in chronic heart failure. *British Medical Journal, 292*, 653-655.

Maher, C. A., Williams, M. T., & Olds, T. S. (2008). The six-minute walk test for children with cerebral palsy. *International Journal of Rehabilitation Research, 31*, 185-188.

Maksud, M. G., & Hamilton, L. H. (1974). Physiological responses of EMR children to strenuous exercise. *American Journal of Mental Deficiency, 79*, 32-38.

McArdle, W. D., Katch, F. I., & Katch, V. L. (2010). *Exercise Physiology: Nutrition, Energy, and Human Performance* (7th ed.). Baltimore, MD: Lippincott Williams & Wilkins.

McCubbin, J. A., Rintala, P., & Frey, G. C. (1997). Correlational study of three cardiorespiratory fitness tests for men with mental retardation. *Adapted Physical Activity Quarterly, 14*, 43-50.

McGavin, C. R., Gupta, S. P., & McHardy, G. J. R. (1976). Twelve-minute walking test for assessing disability in chronic bronchitis. *British Medical Journal, 1*, 822-823.

Montgomery, D. L., Reid, G., & Koziris, L. P. (1992). Reliability of three fitness tests for adults with mental handicaps. *Canadian Journal of Sport Sciences, 17*, 309-315.

Montgomery, D. L., Reid, G., & Seidl, C. (1987). The effects of two physical fitness programs designed for mentally retarded adults. *Canadian Journal of Sport Sciences, 13*, 73-78.

Morinder, G., Mattsson, E., Sollander, C., Marcus, C., & Evers Larsson, U. (2009). Six-minute walk test in obese children and adolescents: Reproducibility and validity. *Physiotherapy Research International, 14,* 91-104.

Nieman, D. C. (2007). *Exercise Testing and Prescription* (6th ed.). New York: McGraw-Hill.

Nixon, P. A., Joswiak, M. L., & Fricker, F. J. (1996). A six-minute walk test for assessing exercise tolerance in severely ill children. *Journal of Pediatrics*, *129,* 362-366.

Nordgren, B. (1971). Physical capacity and training in a group of young adult mentally retarded persons. *Acta Paediatrica, 217*, 119-121.

Pitetti, K. H. (1990). A reliable isokinetic strength test for arm and leg musculature for mildly mentally retarded adults. *Archives in Physical Medicine and Rehabilitation, 71*, 669-672.

Pitetti, K. H., & Boneh, S. (1995). Cardiovascular fitness as related to leg strength in adults with mental retardation. *Medicine and Science in Sports and Exercise, 27,* 423-428.

Pitetti, K. H., & Campbell, K. D. (1991). Mentally retarded individuals: A population at risk? *Medicine and Science in Sports and Exercise*, *23,* 586-593.

Pitetti, K. H., Climstein, M., Campbell, K. D., Barrett, P. J., & Jackson, J. A. (1992). The cardiovascular capacities of adults with Down syndrome: A comparative study. *Medicine and Science in Sports and Exercise, 24*, 13-19.

Pitetti, K. H., Climstein, M., Mays, M. J., & Barret, P. J. (1992). Isokinetic arm and leg strength of adults with Down syndrome: A comparative study. *Archives of Physical Medicine and Rehabilitation*, *73*, 847-50.

Pitetti, K. H., Fernandez, J. E., Pizarro, D. C., & Stubbs, N. B. (1988). Field testing: Assessing the physical fitness of mildly mentally retarded individuals. *Adapted Physical Activity Quarterly*, *5*, 318-331.

Pitetti, K. H., & Fernhall, B. (1997). Aerobic capacity as related to leg strength in youths with mental retardation. *Pediatric Exercise Science*, *9*, 223-236.

Pitetti, K. H., & Fernhall, B. (2004). Comparing run performance of adolescents with mental retardation with and without Down syndrome. *Adapted Physical Activity Quarterly*, *21,* 219-228.

Pitetti, K. H., & Fernhall, B. (2005). Mental Retardation. In J. S. Skinner (Ed.), Exercise testing and exercise prescription for special cases (pp. 392-403). Baltimore: Lippincott Williams & Wilkins.

Pitetti, K. H., Jackson, J.A., Stubbs, N.B., Campbell, K.D., & Battar, S.S. (1989). Fitness levels of adult Special Olympic participants. *Adapted Physical Activity Quarterly, 6*, 354-370.

Pitetti, K. H., Jongmans, B., & Fernhall, B. (1999). Feasibility of a treadmill test for adolescents with multiple disabilities. *Adapted Physical Activity Quarterly, 16*, 362-371.

Pitetti, K. H., Rimmer, J. H., & Fernhall, B. (1993). Physical fitness and adults with mental retardation. *Sports Medicine, 16*, 23-56.

Pitetti, K. H., & Tan, D. M. (1990). Cardiorespiratory responses of mentally retarded adults to air-brake ergometry and treadmill exercise. *Archives of Physical Medicine and Rehabilitation, 71*, 318-321.

Powers, S. K., & Howley, E. T. (2007). *Exercise physiology: Theory and application to fitness and performance* (6^{th} ed.). New York: McGraw-Hill.

Reid, G., Dunn, J. M., & McClements, J. (1993). People with disabilities as subjects in research. *Adapted Physical Activity Quarterly*, *10,* 346-358.

Ries, J. D., Echternach, J. L., Nof, L., & Gagnon Blodgett, M. (2008). Test-retest reliability and minimal detectable change scores for the timed "up & go" test, the six-minute walk test, and gait speed in people with Alzheimer disease. *Physical Therapy, 89*, 569-579.

Rikli, R. E., & Jones, C. J. (1998). The reliability and validity of a 6-minute walk test as a measure of physical endurance in older adults. *Journal of Aging and Physical Activity, 6*, 363-375.

Rimmer, J. A., Braddock, D., & Fujiura, G. (1994). Cardiovascular risk factor levels in adults with mental retardation. *American Journal on Mental Retardation, 98*, 510-518.

Rimmer, J. H., Braddock, D., & Marks, B. (1995). Health characteristics and behaviours of adults with mental retardations residing in three living arrangements. *Research on Developmental Disabilities, 16*, 489-99.

Rimmer, J. H., Heller, T., Wang, E., & Valerio, I. (2004). Improvements in physical fitness in adults with Down syndrome. *The American Journal on Mental Retardation, 109*, 165-174.

Rimmer, J. H., & Yamaki, K. (2006). Obesity and intellectual disability. *Mental Retardation and Devolopmental Disabilities Research Reviews, 12*, 22-27.

Rintala, P., Dunn, J. M., McCubbin, J. A., & Quinn, C. (1992). Validity of a cardiorespiratory fitness test for men with mental retardation. *Medicine and Science in Sports and Exercise, 24*, 941-945.

Rintala, P., McCubbin, J. A., Downs, S. B., & Fox, S. B. (1997). Cross-validation of the 1-mile walking test for men with mental retardation. *Medicine and Science in Sports and Exercise, 29*, 133-137.

Rintala, P., McCubbin, J. A., & Dunn, J. M. (1995). Familiarization process in cardiorespiratory fitness testing for persons with mental retardation. *Sports Medicine, Training, and Rehabilitation, 5*, 15-27.

Rowell., L.B. (1974). Human cardiovascular adjustments to exercise and thermal stress. *Physiological Reviews, 54,* 75-159.

Sadaria, K. S., & Bohannon, R. W. (2001). The 6-minute walk test: A brief review of literature. *Clinical Exercise Physiology, 3*, 127-132.

Saltin, B., & Astrand, P. O. (1967). Maximal oxygen uptake in athletes. *Journal of Applied Physiology, 23*, 353-358.

Schurrer, R., Weltman, A., & Brammell, H. (1985). Effects of physical training on cardiovascular fitness and behaviour patterns of mentally retarded adults. *American Journal of Mental Deficiency, 90*, 167-169.

Shapiro, B. L. (1983). Down syndrome – A disruption of homeostasis. *American Journal of Medical Genetics, 14*, 241-269.

Solway, S., Brooks, D., Lacasse, Y., & Thomas, S. (2001). A qualitative systematic overview of the measurement properties of functional walk tests used in the cardiorespiratory domain. *Chest, 119*, 256-270.

Spencer, L. M., Alison, J.A., & McKeough, Z. J. (2007). Six-minute walk test as an outcome measure. *American Journal o f Physical and Medical Rehabilitation, 87*, 224-228.

Stanish, H. I., & Draheim, C. C. (2005a). Assessment of walking activity using a pedometer and survey in adults with mental retardation. *Adapted Physical Activity Quarterly, 22*, 136-45.

Stanish, H. I., & Draheim, C. C. (2005b). Walking habits of adults with mental retardation. *Mental Retardation*, *43*, 421-427.

Stanish, H. I., Temple, V. A., & Frey, G. C. (2006). Health-promoting physical activity of adults with mental retardation. *Mental Retardation & Developmental Disabilties Research Reviews, 12*, 13-21.

Taylor, H. L., Buskirk, E., & Henschel, A. (1955). Maximal oxygen intake as an objective measure of cardio-respiratory performance. *Journal of Applied Physiology*, *11*, 72-78,

Temple, V. A., Anderson, C., & Walkley, J. W. (2000). Physical activity levels of individuals living in a group home. *Journal of Intellectual and Developmental Disability, 25*, 327-341.

Temple, V. A., & Walkley, J. W. (2003). Physical activity of adults with intellectual disability. *Journal of Intellectual and Developmental Disability, 28*, 342-52.

Thomas, J. R., Nelson, J. K., & Silverman, S. J. (2005). *Research methods in physical activity* (5th ed.). Windsor, ON, Canada: Human Kinetics.

Thompson, J. R., Bryant, B. R., Campbell, E. M., Craig, E. M., Hughes, C. M., Rotholz, D. et al. (2004). *AAMR Supports Intensity Scale.* Washington, D.C.: American Association on Mental Retardation.

Troosters, T., Gosselink, R., & Decramer, M. (1999). Six minute walking distance in healthy elderly subjects. *European Respiratory Journal*, *14*, 270-274.

Vis, J. C., Thoonsen, H., Duffels, M. G., de Bruin-Bon, R. A., Huisman, S. A., van Dijk, A. P. et al. (2009). Six-minute walk test in patients with Down syndrome: Validity and reproducibility. *Archives of Physical Medicine and Rehabilitation, 90*, 1423-1427.

Warburton, D. E. R., Katzmarzyk, P., Rhodes, R. E., & Shephard, R. (2007). Evidence-informed physical activity guidelines for Canadian adults. *Canadian Journal of Public Health*, *98*, S16-S68.

Winnick, J. P., & Short, F. X. (2005). Conceptual framework for the Brockport physical fitness test. *Adapted Physical Activity Quarterly, 22*, 323-332.

World Health Organization. (2001). Fact sheet: The world health report 2001. Geneva: World Health Organization & NMH Communications.

World Health Organization website. (2006). Mental retardation: From knowledge to action. Retrieved 15 September 2008 from: http://www.searo.who.int/en/Section1174/Section1199/Section1567/Section1825_8086.htm.

Zafeiridis, A., Gaigazoglou, P., Dipla, K., Sonikidis, K., Karra, C., & Kellis, E. (2009). Muscle fatigue during intermittent exercise in individuals with mental retardation. *Research in Developmental Disabilities*, doi: 10.1016/j.ridd.2009.10.003.

Appendix

Appendix A
Review of Literature

Intellectual Disability

Intellectual disability (ID) is used to describe a specific subset of the population. The American Association on Mental Retardation [AAMR] (2002) characterizes the disability by significant limitations in both intellectual functioning and in adaptive behaviour which originates before age 18. There are three elements to this definition. Firstly, limitations in intellectual functioning imply performance of at least two standard deviations below the mean of an appropriate assessment instrument. Individuals with lower IQ scores will find it more difficult to sustain independent lifestyles and will need a greater amount of supervision and support in carrying out activities of daily living. Secondly, adaptive behaviour constitutes the conceptual, social, and practical skills that have been learned and are necessary to function in everyday life; for example, skills required for reading, writing, responsibility, self-esteem, obeying laws, meal preparation, housekeeping, transportation, and occupational skills. Limitations in adaptive skills affect daily life and one's ability to respond to changes in life and in the environment. Thirdly, the development and manifestation of the described limitations must occur sometime between conception and 18 years of age.

It is estimated that 1-3% of people have ID (Harris, 2006; World Health Organization [WHO], 2001). The International Classification of Disease, the American Psychiatric Association, and the World Health Organizations classify ID based on four levels of severity: mild, moderate, severe, and profound (AAMR, 2002; Harris, 2006). Mild ID constitutes an approximate IQ of 50-69, with a mental age of 9-12 years for adults; and moderate ID is classified by an IQ score of 35 to 49, with a mental age of 6-9 years (AAMR, 2002). It is estimated that 65-75% of people with ID have mild ID (WHO, 2006). Individuals with mild or moderate ID can learn to develop some degree of independence and be able to work in the community (AAMR, 2002).

ID can be caused by any condition that impairs the development of the brain before birth, during birth, or during childhood. For example, maternal infections during pregnancy such as rubella, HIV, hepatitis, cytomegalovirus, toxoplasmosis, syphilis, and hydrocephalus; use of alcohol, tobacco, and drugs by a pregnant mother; malnutrition of the mother and fetus; genetic conditions such as abnormalities of inherited genes (e.g. fragile X syndrome), unequal chromosome division during meiosis (e.g. Down syndrome), and genetic disruptions caused by overexposure to x-rays during pregnancy; oxygen deprivation during pregnancy; premature birth; low birth weight; childhood diseases like whooping cough, chicken pox, and measles that can lead to meningitis and encephalitis; accidents such as a blow to the head or near drowning; brain damage caused by environmental toxins such as lead and mercury; demyelinating or degenerative disorders; and more controversial causes such as environmental, social, and educational disadvantages (AAMR, 2002; Harris, 2006; Pitetti & Fernhall, 2005).

An individual's level of functioning can be obtained via a number of methods and tools. Tests of intellectual aptitude provide information on an individual's level of intellectual functioning. Such tests give a minor indication of how an individual participates in society. On the other hand, tests that functionally describe disabilities, "...do not focus solely on biological characteristics; rather on a person's performance on tasks that are required for successful functioning in contemporary society" (Thompson et al., 2004, p.3). The Supports Intensity Scale (SIS) (Thompson et al., 2004) was created by the AAMR and focuses on the supports (frequency, intensity, and type) needed for an individual to succeed in life activities. These activities are grouped under the categories: home living, community living, lifelong learning, employment, health and safety, and social activities. This measure provides a more global perspective on the individual, compared to tests that measure IQ or specific adaptive skills. The scale is completed (via interview) by persons who are close to the individual; such as a parent, care provider, or coach. The individual with ID can also partake in providing answers alongside the person being interviewed. The test-retest reliability for the total SIS score was r = 0.79 when completed twice by the same interviewer, and r = 0.997 when the test was completed for the same individual by two different interviewers. Content validity, criterion-related validity, and construct validity with tests of intelligence and adaptive behaviour have been established (Thompson et al.).

Physical Activity and Health

Physical activity is any bodily movement produced by skeletal muscle that results in increased energy expenditure above the resting level (Caspersen et al., 1985). Ample evidence suggests that high levels of physical activity (specifically 30-45 minutes of moderate aerobic activity on four to six days of the week) delays all-cause mortality in men and women, primarily due to lowered rates of cardiovascular disease, type II diabetes, and colon and breast cancers (Blair et al., 1989; Warburton et al., 2007). Pitetti and Campbell (1991) reported that people with ID are at a greater risk of developing certain chronic diseases, primarily because of sedentary lifestyles. In a recent review, Draheim (2006) reported that cardiovascular disease-related deaths were greater for people with ID than in the general population. Furthermore, there was a decrease in the proportion of deaths due to cardiovascular disease in the general population from 1930 to 1980, but cardiovascular disease-related deaths increased among people with ID during this time (Draheim).

Risk factors for cardiovascular disease are also a major health concern for people with ID. A larger percentage of women with ID had hypertension compared to women without ID (Beange, McElduff, & Baker, 1995); and there is a high prevalence of hyperinsulinemia and low levels of HDL cholesterol in adults with ID living in community settings (Draheim et al., 2002a). In a recent review, Rimmer and Yamaki (2006) found that the prevalence of obesity in adults with ID in the United States had increased from 19.4% in 1985 to 34.6% in 2000, and the rate of increase, as well as the proportions across those years, was greater than those of the general population. In an earlier study, Beange et al. (1995) found that both males and females with ID between the ages of 20 and 50 had higher rates of obesity compared to the general local population. Others have reported a higher prevalence of obesity among women with ID, than men with ID (Fox & Rotatori, 1982; Rimmer et al., 1993; Rimmer, Braddock, & Marks, 1995).

People with ID could greatly benefit from the decreased health risks associated with physical activity, but they are not engaging in the recommended levels. Compared to the general population adults with ID are less active (Beange et al., 1995; Temple & Walkley, 2003), and they engage in physical activity patterns similar to those of their sedentary peers without ID (Frey, 2004). In a recent review, Stanish et al. (2006) reported that only 17% - 33% of adults with ID were participating in physical activity at levels consistent with public health guidelines. Draheim et al. (2002a) conducted a study with 145 adults with ID and found that only 45% of the adults with mild or moderate ID participated in moderate to vigorous physical activity at least five times a week. The same investigators also reported that men and women with ID living in community settings were similarly inactive, with 47%-51% of them participating in little or no leisure-time physical activity (Draheim et al., 2002b). Stanish and Draheim (2005b) used pedometers to investigate walking habits and reported that only 21.1% of women and 21.5% of men with ID accumulated the recommended 10 000 steps per day. Walking is the primary activity mode, more-so than any other activity of mild-moderate intensity (Draheim et al., 2002b; Temple et al., 2000; Temple & Walkley, 2003); despite the finding that the intensity of the activity was usually not sufficient enough to meet the minimum recommendations to achieve health benefits (Stanish et al., 2006).

Physical fitness comprises a set of attributes related to the ability to perform physical activity (Caspersen et al., 1985). Compared to the general population, people with ID have lower levels of physical fitness for their age group (Fernhall & Tymeson, 1987). For adults with ID this includes lower peak heart rates (Fernhall & Tymeson, 1987; Pitetti & Fernhall, 2005), lower maximal oxygen uptake (VO_2 max) and VO_2 peak (Baynard, Pitetti, Guerra, Unnithan, & Fernhall, 2008; Fernhall et al., 1996; Fernhall & Tymeson, 1987; Fernhall et al., 1989). There is similar evidence for adolescents with ID indicating that they have low levels of aerobic fitness (Fernhall et al., 1989; Fernhall et al., 1998) compared to their peers without ID (Fernhall, 1993; Pitetti & Fernhall, 2004); with males having low or close to expected values of VO_2 peak, and females lower than expected VO_2 peak values (Fernhall, 1993). Children with ID have VO_2 peak values lower than (Maksud & Hamilton, 1974) or similar to those reported for children without ID (Fernhall, 1993). However, there is promise in that active adults with ID who engage in regular physical activity and exercise have high levels of physical fitness comparable to active individuals without ID (Frey, McCubbin, Hannigan-Downs, Kasser, & Skaggs, 1999).

Exercise is a subcategory of physical activity which is planned, structured, and repetitive bodily movement for the purpose of improving or maintaining physical fitness (Caspersen et al., 1985). Exercise training can positively affect risk factors associated with cardiovascular disease and help improve the physical fitness of individuals with ID, with and without Down syndrome (Fernhall, 1993; Rimmer, Heller, Wang, & Valerio, 2004). Cardiovascular fitness levels can be improved in adults with mild to moderate ID through a walking or running program (Lavay & McKenzie, 1991; Montgomery, Reid, & Seidl, 1987; Schurrer, Weltman, & Brammell, 1985); or through other cardiovascular activities such as aerobic dance and low-skill games for forty minutes, three times per week for four months (Montgomery et al., 1987). Chanias, Reid, and Hoover (1998) conducted a meta-analysis which demonstrated large effects of exercise on health-related physical fitness (particularly cardiovascular and muscular endurance) in individuals with ID. Eighteen effect sizes were used to determine the effects on cardiovascular endurance and on average, participants raised their cardiovascular fitness from the 50th to the 84th percentile in response to exercise. Furthermore, studies that employed programs longer than nine weeks whose frequency was at least three times per week produced significantly larger effect sizes than programs with shorter frequencies and durations. Intensity and type of exercise were not evaluated in the meta-analysis because the authors reported a lack of description of these variables in most of the studies that were included.

Participation in physical activity and sport can contribute to one's overall well-being. Psychological benefits for persons with ID include changes in attitude towards exercise, positive expected outcomes, fewer cognitive-emotional barriers, improved life satisfaction, lower depressive symptoms, increased exercise self-efficacy (Heller, Hsieh, & Rimmer, 2004); and decreased severity of anxiety symptoms (Carmeli, Barak, Morad, & Kodesh, 2009). Benefits have also been reported on some adaptive skills that are concerned with health, leisure, work responsibilities, work opportunities (Pitetti & Fernhall, 2005); work productivity (Beasley, 1982; Croce & Horvat, 1992; Fernhall, 1993); and physical work capacity in men (Nordgren, 1971). Since people with ID are more likely to use physical rather than cognitive skills in the work setting, physical activity and improved physical fitness can positively affect their independence and overall social and vocational development.

Fitness Testing for Individuals with ID

Laboratory Tests: Measuring VO_2 max

Measuring physical fitness is necessary in order to evaluate the progress of a program or intervention aimed at increasing fitness; to motivate and educate someone on how to take actions in order to arrive at their next fitness goal; and to determine the status of one's current fitness level (Nieman, 2007). Cardiorespiratory endurance is a health-related component of physical fitness that relates to the ability of the circulatory and respiratory systems to supply oxygen to working muscle during sustained physical activity (Caspersen et al., 1985). Tests have been developed that measure the degree to which someone has this ability. The most accurate "gold standard" method of measuring aerobic power is the graded maximal oxygen consumption test in a laboratory (Solway et al., 2001; Thomas et al., 2005). VO_2 max is measured from respired gas analysis. The criteria used to evaluate whether a state of maximal exercise has been obtained during the treadmill test are the following: (1) a plateauing in VO_2 when the workload is increased, as indicated by an increase of less than 150mL/min; (2) no increase in heart rate with a concomitant increase in workload, or a heart rate value that approaches the age-predicted maximum (within ±15 beats per minute or more than 85% of the participant's age-predicted maximum); (3) a respiratory gas exchange ratio greater than 1.1; and (4) volitional exhaustion (Astrand, 1967; Powers & Howley, 2007; Rintala et al., 1995). A combination of these criteria is usually evaluated.

Graded exercise testing has been successfully used with adults with ID. Due to a number of factors that are specific to individuals with ID, modified protocols are necessary to ensure valid and reliable measurements. Fernhall and Tymeson (1987) developed a walking protocol for a graded maximal exercise test on the treadmill (GXTT) for adults with ID. A walking versus running protocol was employed because the investigators reported that the participants in the study could not run comfortably on the treadmill and most of them found it difficult to maintain even a fast walk. The test protocol involved walking on a treadmill at 3 mph at 0% grade for 2 minutes, followed by 3 mph at 2.5% grade for 2 minutes, and the remainder of the test continued at 3 mph with a 2.5% increase in grade every two minutes until exhaustion. This protocol (with slight modifications) has become a popular standard for testing aerobic power in individuals with ID.

Maximal effort necessary to reach exhaustion is not easily obtainable in individuals with ID. "Many sedentary participants, including some with ID, may be poorly motivated as well as unaccustomed to strenuous exercise, thus it is often difficult to attain a true physiological measure of maximum performance" (Rintala et al., 1995, p. 16). Stanish et al. (2006) recently contested the "poorly motivated" notion; reporting that 60% of the global population did not meet the minimum physical activity guidelines, thus it remained unclear whether adults with ID were any less motivated to be active compared to adults without ID. Familiarization protocols can help control for motivation, task understanding, and comfort level in the laboratory environment when conducting cardiovascular fitness tests with populations with ID. Fernhall and Tymeson (1987) made recommendations for evaluating the aerobic power of individuals with ID in a laboratory setting. These included familiarization of the participant with the laboratory, staff, protocol, equipment, and their role in the study; ample practice time; the provision of safety features like having the investigator stand beside the participant to ensure participants did not fall or fear falling; providing an environment in which the participant felt that they were a contributing member; and tailoring the protocol to the population. For example, selecting a speed that is too fast for the participant could result in early termination of the test because of trepidation rather than fatigue (Pitetti et al., 1993). Rintala et al. (1995) suggested that participants undergo a minimum of two familiarization sessions for laboratory tests, and that well-defined criteria be used to evaluate whether a participant is ready to advance from one familiarization phase to the next.

When testing individuals with ID, instead of using the term maximal oxygen uptake (VO_2 max), peak oxygen uptake (VO_2 peak); the highest oxygen uptake observed under specific circumstances (Rowell, 1974) is used. This is because for most individuals with disabilities, "...progressively increasing the work rate in a cardiovascular fitness test to a point of fatigue produces a peak VO_2 that closely approximates VO_2 max even when the plateau is not evident" (Pitetti et al., 1999, p. 364). According to Pitetti et al. (1993), using VO_2 peak implies that the individual being tested has reached volitional exhaustion, which is the point when the participant feels that they can no longer continue to exercise and that they have put forth their best effort. The criteria necessary to establish VO_2 peak are the following: the test starts at a relatively low work rate and progressively increases in increments, the test lasts approximately 10 minutes, the participant is stressed at a high work rate for a couple of minutes, and the incremental increase in work rate is uniform in magnitude and in duration.

As recommended by Pitetti and Fernhall (2005) the treadmill protocol for measuring VO_2 peak in adults with ID involves starting at a speed between 2 mph and 3.5 mph that is most comfortable for the participant, which is established during the familiarization sessions. The speed is kept constant, starting at 0% grade for 2 minutes, after which time the grade is increased by 2.5% every 2 minutes until a 12.5% grade is reached. At this point the grade is kept constant and the speed is increased by 0.5 mph each minute until the participant is too exhausted to continue. This protocol was found to be valid and reliable, and has been repeatedly used with adults with ID (Fernhall et al., 2001; Fernhall & Tymeson, 1988; McCubbin et al., 1997; Pitetti & Tan, 1990; Rintala et al., 1992).

Field Tests: Predicting VO_2 peak

Field tests that estimate or predict aerobic functioning can be conducted outside of the laboratory setting and tend to be more cost- and time-efficient than metabolic testing on the treadmill or cycle ergometer. Table 4 describes the laboratory and field tests that have been explored for use in gauging aerobic power in adults with ID. Five field tests have been validated to assess aerobic power for adults with ID. They are the modified Canadian Step Test (Montgomery et al., 1992), the bicycle ergometer test using the Schwinn "Air-Dyne" (Pitetti et al., 1988), the modified Leger and Lambert (1982) shuttle run (Montgomery et al., 1992), the 1 mile (1.6 km) walk test (Rockport Fitness Walking Test) (Rintala et al., 1992; McCubbin et al., 1997), and the 1.5-mile (2.4 km) walk/run test (Ferhall & Tymeson, 1988).

Table 4

Tests to Assess Aerobic Power in Adults with ID

Study	Test	Participants	Course/ Protocol	Reliability	Validity	Notes
			Cycle Ergometer Tests			
Cressler, Lavay, & Giese (1988)	Modified PWC	N = 17 (15M, 2F) mild-moderate ID mean age = 35	18 min in duration	*R* = 0.64	Not assessed	4 participants were dropped due to inability to perform procedure, inconsistency in performance, difficulty in following direction, and/or low interest level.
Pitetti et al. (1988)	Using Schwinn "Air-Dyne"	N = 10 (gender nm) mild-moderate ID mean age = 24		Not assessed	With GXTT* *r* = 0.91	Using prediction equation: $\%VO_2max = (1.41 \times \%max\ HR) - 42$ Not valid for adults with DS
Montgomery et al. (1992)	Submax	N = 18 (gender nm) moderate ID mean age = 26	Minimum 15min	*R* = 0.93	*r* =0.39 **	
McCubbin et al. (1997)	Submax Astrand-Ryhming	N = 15 (all M) mild ID mean age = 26	6 minute duration	Not assessed	With GXTT* *R* = 0.64 $R^2 = 0.41$	Difficult to administer because participants experienced problems with cadence adherence and handling changes in workload
Step Tests						
Cressler et al. (1988)	Canadian Step Test	N = 17 (15M, 2F)		*R* = 0.95	Not assessed	4 participants were dropped due to inability to perform procedure,

		mild-moderate ID mean age = 35				inconsistency in performance, difficulty in following direction, and/or low interest level.
Montgomery et al. (1992)	Modified Canadian step test	N = 18 (gender nm) moderate ID mean age = 26	Minimum 9min	*R* = 0.97	*r* =0.72 **	Overestimated VO_2 peak by 21%
Walk and/or Run Tests						
Montgomery et al. (1992)	Modified Leger & Lambert shuttle run	N = 18 (gender nm) moderate ID mean age = 26		*R* = 0.90	*r* =0.78 **	Test duration was 2.7 ± 1.4min → poor performance on the test; attributed to lack of motivation Underestimated VO_2 peak by 28%
Cressler et al. (1988)	Balke Ware TM	N = 17 (15M, 2F) mild-moderate ID mean age = 35		*R* = 0.93	Not assessed	4 participants were dropped due to inability to perform procedure, inconsistency in performance, difficulty in following direction, and/or low interest level.
Cressler et al. (1988)	Cooper 12-min. walk/run	N = 17 (15M, 2F) mild-moderate ID mean age = 35	Indoor track, 1/10 mile Pacer	*R* = 0.81	Not assessed	As above. Also, issues with pacing, motivation, and inability to cope with breathlessness and fatigue.
Fernhall & Tymeson (1988)	300-yard run	N = 15 (gender n/a) mild ID mean age = 29	Indoor track, 1/8 mile Pacer	Not assessed	With GXTT* Not valid;	height and weight significant contributors
Fernhall & Tymeson (1988)	1.5 mile run/walk	N = 20 (6M,1 4F) mild ID mean age = 29	Indoor track, 1/8 mile Pacer	Not assessed	With GXTT* = -0.88	
Rintala et al. (1992)	1 mile walk	N = 19 (all M) moderate ID mean age= 26	1/8 mile Pacer 2-4 people tested at once	*R* = 0.97	With GXTT* = 0.78 - 0.83	VO_2 peak = 101.92 – 2.356 (time in min) – 0.42 (mass in kg) 85% of total variance SE = 4.06 ml/kg·min
Kittredge et al. (1994)	1 mile walk	N = 25 (12M, 13F)	Indoor track,	*R* = 0.97	With GXTT*	Predicted VO_2 peak from equation (Rintala et al., 1992) significantly

		mild-moderate ID mean age = 33	1/8 mile Pacer		*r* = 0.87	overestimated measured VO_2 peak
Rintala et al. (1997)	1 mile walk	N = 19 (all M) mild-moderate ID mean age = 27	Same as Rintala et al. (1992)	*R* = 0.91- 0.93	Cross-validation of Rintala et al. (1992): underestimated VO_2 peak in 74%-79% of participants	
McCubbin et al. (1997)	1 mile walk	N = 15 (all M) mild ID mean age = 26	1/8 mile straight course Duration approx. 10-18min	Not assessed	With GXTT* $R = -0.84$ $R^2 = 0.71$	

Note. *GXTT protocol modified from Fernhall and Tymeson (1987); **Bruce protocol; not validated for adults with ID; nm = not mentioned.

Montgomery et al. (1992) validated the modified Canadian Step Test with 18 adults with mild-moderate ID. They modified the step test by starting at a slower tempo because the investigators found it difficult to teach the participants the desired testing tempo. The step test was validated with a treadmill protocol that has not yet been validated with this population. Furthermore, they found that the equation usually used to predict VO_2 peak in the general population with the step test, overestimated VO_2 peak by 21% in the participants in their study.

Of the three studies that sought to validate the use of a cycle ergometer to predict VO_2 peak in this population, Pitetti et al. (1988) established the highest validity ($r = 0.91$) with a validated maximal treadmill protocol. However, this tool is not useful for adults with Down syndrome because the prediction equation ($\%VO_2 \text{ max} = (1.41 \times \% \text{HRmax}) - 42$) requires heart rate values, which tend to be lower in adults with Down syndrome compared to those of the general population (Pitetti et al., 1992). The test would also require one to have a Schwinn "Air-Dyne" bicycle ergometer, and only one person could be tested on the bike at a time.

A modified version of the Leger and Lambert (1982) shuttle run is a valid test to predict aerobic power in adolescents with ID (Winnick & Short, 2005), but not in adults with ID. Montgomery et al. (1992) found that it was not ecologically valid because some participants exhibited poor performance on the test. The average duration of the test was short (2.7 ± 1.4 minutes), compared to their peers without ID, and the investigators attributed the poor performance to poor motivation. As a result, it was found that the test underestimated VO_2 peak by 28%.

Rintala et al. (1992) first validated the 1 mile walk test with a group of 19 adult males with ID and found that there was a high correlation with VO_2 peak obtained from a validated GXTT. Since then, two studies have sought to cross-validate the test using the prediction equation by Rintala et al. (1992). One study found that the predicted VO_2 significantly overestimated the measured VO_2 peak (Kittredge et al., 1994). This may have been accounted for by the fact that females were included in this study, and comprised the majority of the participants. Furthermore, Rintala et al. (1992) tested 2 to 4 people at once, which may have influenced their motivation to walk at a quicker pace. Conversely, Rintala et al. (1997) found that the prediction equation (Rintala et al., 1992) underestimated VO_2 peak in 74 - 79% of their all-male participants. McCubbin et al. (1997) also validated the 1 mile walk for 15 males with ID and found a high correlation between the time taken to complete the test and the VO_2 peak obtained from a validated GXTT protocol. Completion of the 1 mile walk took between 10 and 19 minutes (McCubbin et al., 1997). The 1.5 mile run/walk was also found to be valid (Fernhall & Tymeson, 1988), but reliability has not yet been established for this population. Furthermore, when given the option to walk or run, pacing can be more difficult than when one is simply required to walk.

The Six-Minute Walk Test

The first field test that required a best-effort walk or run was developed for aviator and traffic controllers (Civil Aeromedical Research Institute, 1963). The test involved a 15 minute best-effort run around an oval track, with the goal of covering as much distance as possible. A 12-minute walk-run field test was later developed which showed a high correlation with VO_2 max, measured against the GXTT (Cooper, 1968). Field tests that involve running are not appropriate for clinical populations, therefore walking tests were developed to infer aerobic power, as well as to evaluate other health-related attributes.

A 12-minute walk test was first used to evaluate the extent of disability in patients with chronic obstructive pulmonary disease (McGavin, Gupta, & McHardy, 1976). Since then, other walking tests have been developed which require best-effort walks in 2, 4, 5, 6, and 9 minutes, but the 6MWT has gained the widest acceptance and is the test of choice when using a walk test for clinical or research purposes (Sadaria & Bohannon, 2001; Solway et al., 2001). Butland, Pang, Gross, Woodcock, and Geddes (1982) found a high correlation between the 2-minute, 6-minute, and 12-minute walk tests in adults with respiratory disease. This indicated that they were similar measures of exercise tolerance for that population. Shorter times like the 2-minute test discriminated less, and 12 minutes could be time-consuming and exhausting for the participant, therefore the 6MWT was a compromise between the longer and shorter distances.

For the 6MWT, the distance that a person can quickly walk on a flat, hard surface in a period of 6 minutes, is measured. Participants are allowed to choose their own intensities, and to stop and rest during the test (without stopping the timer). The total distance walked is, "...an evaluation of the global and integrated responses of all the systems involved during exercise, including the pulmonary and cardiovascular systems, systemic circulation, peripheral circulation, blood, neuromuscular units, and muscle metabolism" (American Thoracic Society [ATS], 2002, p. 111) and assesses the sub-maximal level of aerobic power and endurance (Sadaria & Bohannon, 2001). The 6MWT is quick, easy to administer, and minimal equipment and space are necessary; it is inexpensive, safe, and better tolerated by a wide variety of participants compared to other field tests (Lipkin et al., 1986; Solway et al., 2001).

The ATS (2002) recently developed a protocol for conducting the 6MWT which has gained wide acceptance and has been employed in many studies. The 6MWT has been investigated for use as a predictor of morbidity and mortality, for pre-operative and post-operative evaluation (Alahdab, Mansour, Napan, & Stamos, 2009; ATS, 2002); to measure aerobic power and functional rehabilitation in adults (Guyatt et al., 1985; Lipkin et al., 1986; Spencer et al., 2008) and children (Nixon et al., 1996) with moderate to severe heart and lung disorders; as a measure of functional ability in children (Maher et al., 2008) and adults with cerebral palsy (Andersson et al., 2006), Parkinson's disease (Falvo & Earhart, 2009), Alzheimer disease (Ries, Echternach, Nof, & Gagnon Blodgett, 2009), and with a transtibial amputation (Lin & Bose, 2008); as a measure of aerobic power in adults with rheumatoid arthritis (Karlsson & Opava, 2008); as a measure of aerobic power and walking ability in obese adults (Beriault et al., 2009; Evers Larsson & Reynisdottir, 2008); and in healthy older adult (Gremeaux et al., 2008; Troosters et al., 1999), adult (Enright & Sherrill, 1998; Gibbons et al., 2001; Jenkins et al., 2009; Rikli & Jones, 1998; Troosters et al., 1999), and child (Geiger et al., 2006; Li et al., 2005) populations.

The 6MWT has recently been used with an adult population of individuals with Down syndrome to examine its utility as a tool to evaluate aerobic power (Vis et al., 2009). Of the 81 participants, 29 did not have cardiac disease and 52 had severe cardiac disease, categorized by cardiac echocardiography. The distance walked during the test (6MWD), was not significantly different between groups; but older age, female sex, and level of intellectual disability were found to be independently and significantly correlated with lower 6MWD. In particular, level of intellectual functioning accounted for 29% of the variation in distance walked by the participants. The coefficient of variation between the first and second 6MWD was 11%, indicating high reproducibility. Although highly reproducible, the test was used without validation of its actual purpose; measurement of cardiovascular fitness in adults with Down syndrome.

A number of factors can influence the distance covered during a field test. Such factors include the health, age, body mass, height, resting heart rate, leg length, and leg strength of the participants; the course layout; practice tests; familiarization with the test protocol; and participant motivation.

The distance an individual can walk during a fitness test is reduced by diseases such as lung disease, heart failure, arthritis, and neuromuscular disease (Butland et al., 1982; Cooper, 1968); as well as by genetically-caused physical conditions. People with Down syndrome have anatomical, physiological, and motor responses that are different from the general population (Shapiro, 1983). For example, children with Down syndrome have incidences of heart defects 20 times higher than that of the general population (Cullum & Liebman, 1969; Shapiro, 1983); adults with Down syndrome have decreased VO_2 peak, minute ventilation, blood pressure responses, and heart rates compared to their peers with ID but without Down syndrome (Baynard et al., 2008; Fernhall et al., 2005; Fernhall & Otterstetter, 2003; Fernhall et al., 1996; Pitetti et al., 1992); chronotropic incompetence (Baynard, Pitetti, Guerra, & Fernhall, 2003; Guerra, Llorens, & Fernhall, 2003); and decreased leg strength than adults with ID but without Down syndrome (Carmeli, Ayalon, Barchad, Sheklow, & Reznick, 2002; Pitetti et al., 1992). The presence of Down syndrome may affect the distance walked during the 6MWT.

In healthy adults, age, body mass, and height were independently associated with distance walked (Enright & Sherrill, 1998). Pitetti and Boneh (1995) found that leg strength (measured by isokinetic knee extension and flexion) was significantly correlated with VO_2 peak, relative to body weight, for adults with ID (*r* = .61); and this relationship was even more substantial for adults with Down syndrome (*r* = .84). The effect of leg strength on performance of the 6MWT in adults with ID remains to be investigated.

The course layout can influence the total distance walked during the 6MWT. The 6MWT has been conducted in hallways of 20-m to 53-m long, along circular paths, rectangular paths, and on motorized treadmills. The furthest distance is walked when the course is oval or rectangular, followed by walking back and forth, and lastly by walking on a treadmill (Sadaria & Bohannon, 2001). Although the furthest distance is covered using an oval or rectangular course, an area of such a size to accommodate this type of course may not be as readily accessible as a straight course such as a corridor. Furthermore, the variability in distance walked when using a circular path can be greater than that of a straight path unless the width of the circular path is narrow. The ATS (2002) suggests that the 6MWT be conducted indoors (unless the weather is comfortable, in which case it can be performed outdoors), along a long, flat, straight, enclosed corridor with a hard surface. The corridor should be at least 30-m long, with orange cones marking the turnaround points and red tape marking the starting line. Furthermore, a treadmill should not be used because the distance walked on a treadmill is not equivalent to the distance walked during the 6MWT because participants are not able to pace themselves on a treadmill, even if they are allowed to adjust the speed of the treadmill themselves throughout the test (ATS, 2002).

The ATS (2002) proposed that a practice test is not needed in clinical populations, but should be considered because the distance walked is slightly greater when performed a second time, though performance usually reaches a plateau after 2 tests are completed within a week. Andersson et al. (2006) found that the 6MWD was significantly shorter ($p < 0.008$) on the first trial than on the second, third, and fourth trials in adults with cerebral palsy. The training effect was perhaps due to finding optimal stride length and overcoming anxiety. Sadaria and Bohannon (2001) suggested familiarizing participants with a practice trial to minimize such training effects.

Notwithstanding the importance of practice tests to reduce training effects, practice tests and familiarization are especially important for participants with ID to ensure validity of the test. Motivation and encouragement have a substantial impact on walking test scores. In one study, cardiac and respiratory patients were randomly assigned to receive or not receive encouragement for five trials of the 6MWT. The encouragement group received encouraging phrases such as "you are doing well" or "keep up the good work" once every 30 seconds, with the investigator facing the participants. The supervisor of the group that did not receive encouragement avoided eye contact with participants and said nothing other than "stop" at the end of the test. It was found that encouragement was associated with a significant increase in distance walked ($p < .02$). Furthermore, ANOVAs for 2-minute intervals of the test revealed a significant interaction between interval and encouragement: the effect of encouragement was greater during the second two 2-minute intervals. The investigators thus suggested that administration of test be rigorously standardized to control for the effects of encouragement (Guyatt et al., 1984; Guyatt et al., 1985).

Guyatt et al. (1984) stated that there was no compelling reason to either give or not give encouragement so long as tests were conducted in a consistent manner. However, when conducting tests with individuals with ID, motivation is essential for accurate results (Fernhall, 1993). The ATS's guidelines (2002) include standard phrases of encouragement once every minute and 15 seconds prior to the end of the test; for example, "You are doing well, you have 'x' minutes to go." They recommend that no words other than those recommended be used, nor body language that would be suggestive that the participant speed up. Encouragement beyond that suggested by the ATS, if standardized, may be appropriate when conducting the 6MWT with individuals with ID.

Walking distance can be greatly affected if performing a walking test alone, versus with other people. Grindrod, Paton, Knez, and O'Brien (2006) investigated the effect on the 6MWD when adults performed the test by themselves versus in a group of four people. They found that social facilitation increased the 6MWD by 13-14%. When testing individuals with ID pacers are often used. Pacers are individuals who walk or run with the participant during a field test. They provide motivation and verbal encouragement throughout; help to set the pace of the test so that participants do not start at too fast a pace, using anaerobic versus aerobic systems; they keep participants on task; and are essential to ensuring valid and reliable test results (Fernhall et al., 1996; Kunde & Rimmer, 2000; Pitetti & Fernhall, 2005). Fernhall et al. (1996) conducted a study using the ½-mile run-walk test with adults with ID. Each participant performed the test twice with a pacer and twice without a pacer. Each participant had their own pacer, and the pacer was instructed to run or walk 2-3 feet in front of the participant and give verbal encouragement. There was a significant difference in average time between conditions (p = .008), but no significant difference in heart rate. In a similar study with adults with ID, Kunde and Rimmer (2000) reported that average walk times were approximately 1 minute shorter when participants performed the 1-mile walk test with a pacer, versus without. Thus, it is recommended that a pacer be used for a walk test with individuals with ID to assure maximum performance and to enhance motivation.

Engaging in adequate levels of physical activity and increasing, or having a high physical fitness profile, can reduce the risk of cardiovascular disease and its risk factors. One's level of fitness can be assessed via laboratory or field tests. The GXTT conducted in a laboratory setting is suitable for measuring aerobic power in adults with ID, but its utility cannot compare to that of field tests. The aim of this study was to determine whether a modified version of the 6MWT (American Thoracic Society, 2002) could be used to assess aerobic power in adults with ID. Potentially the 6MWT has great utility as it is simple, has been used with people of various ages and health conditions, and requires minimal equipment and space. The ATS's 6MWT protocol was modified by incorporating a pacer, including additional phrases of encouragement throughout the test, and allowing for participant familiarization.

Appendix B
Recruitment Email to Organizations

Dear [name]

My name is Gabriella Nasuti and I am a graduate student working under the supervision of Dr. Viviene Temple in the School of Exercise Science, Physical and Health and Education. We are conducting a study on the effectiveness of the Six-Minute Walk Test as a tool to measure cardiorespiratory endurance in individuals with intellectual disability.

If possible, I would like to recruit members of your organization to participate in the study. We are looking for individuals with mild or moderate intellectual disability 18-50 years old. What we are asking of you is permission to post or hand out flyers advertising the study to members of your organization. Participating in this study may help to validate a fitness test for individuals with intellectual disability that could potentially be used by fitness professionals, physical education teachers, and researchers.

Our project has obtained ethical approval and participants (and their parents/guardians) will be instructed of all informed consent aspects of the study prior to participation in the study.

If you would like to help or have any questions, please contact me, Gabriella Nasuti, at gnasuti@uvic.ca or (250) 893-5308 to discuss this further. If you have any further questions about the project, please do not hesitate to contact Dr. Viviene Temple at vtemple@uvic.ca. Appended you will find the flyer inviting adults to participate in the study.

Thank you for your time,

Gabriella Nasuti

Appendix C
Recruitment Flyer

Volunteers needed for a study on **Exercise** and **Fitness Testing**

The University of Victoria is doing a study to see if a 6-minute walking test can be used to measure fitness in adults with intellectual disability.
The study is supported by Special Olympics BC – Victoria Local

Eligibility

- 18-50 years old
- Able to come to the University 4 times
- Doctor's "OK" to participate
- Able to walk without assistance
- Enjoy being active!!! ☺

Procedures

- 2 fitness tests:
  (1) You will walk in a gym
  (2) You will walk on a treadmill
- One test of leg strength

*You will have the opportunity to learn the tests and practice them

Benefits

- Small gifts as a Thank You after each visit (including compensation for expenses; e.g. parking/bus)
- Being active during each of the visits
- Find out your level of aerobic fitness and what you can do to improve it!
- Find out about the importance of exercise and fitness testing

For more information contact Gabriella Nasuti
(250) 893-5308 gnasuti@uvic.ca

Appendix D
Consent Form – Participants

Consent Form for Participants

The Six-Minute Walk Test for Adults with Intellectual Disability

You are being asked to take part in a project. The name of this project is The Six-Minute Walk Test for Adults with Intellectual Disability. My name is Gabriella Nasuti and I am the leader of the project. I am a student at the University of Victoria. If you ever have any questions about the project, you can email me at gnasuti@uvic.ca. or phone me at (250) 893-5308.
As part of my school work, I have to do research. This project is the research project. My supervisor is Dr. Viviene Temple. She is a professor at the University. You can email her at vtemple@uvic.ca or phone her at (250) 721-7846.

Purpose of this Study
The purpose of this project is to see if a new test is good to measure fitness in adults with intellectual disability. Other tests that are being used now are complicated and not much fun.

Importance of this Research

It is really important for your heart to be healthy. You can help to keep your heart healthy by being active like playing sports or doing exercise. We are trying to make a test that measures how healthy your heart is. This test would be easy and fun. You walk during this test.

Participants Selection

We are asking you to help us with our project because you are between 18 and 50 years old and because you have an intellectual disability.

What is Involved

If you say yes to helping with this project, this is what you will have to do. Before starting, your doctor has to say that it's ok for you to help us. I am also going to ask your parents/caregivers questions about things you do during the day, and whether anyone helps you with it. Every time you come to help us you have to wear running shoes, a T-shirt, and comfortable pants (like jogging pants or shorts). You can't eat or do exercises like running for 2 hours before coming to help.

There are two different running or walking tests that we're going to ask you to do.

(1) The Six-Minute Walk Test

For the Six-Minute Walk Test you have to walk as far as you can in 6 minutes along a 30-m, straight line. 30 meters is long like three big freight trucks behind each other. The starting line and 30-m line will be marked by red cones, and every 2-m along the way will by marked by red tape. You will get to practice this test too. Someone will be walking a little bit in front of you. They will be encouraging you, and will help you to not go too fast or too slow. This test will happen three times on three different days.

(2) The graded treadmill test

For the first treadmill visit, we are going to ask you to take your shoes off. Then we'll see how much you weigh, how tall you are, and how long your legs are. Then we'll show you what you will have to do on the treadmill. After watching us on the treadmill, you will try walking on the treadmill. We'll see how fast or slow you can walk. Then you'll walk on the treadmill and it will feel like you're walking up a hill. We will also show you how to step on the side of the treadmill and press the STOP button so that you can stop walking whenever you want. Then you will get off the treadmill and try on a mask that covers your mouth and nose. This mask collects the air that you breathe out.

The second time you come for the treadmill visits, you will get to practice walking on the treadmill again at the speed that you are comfortable with. The treadmill will feel like you are walking up a hill. Then we will put on the same mask you tried on last time. You will also wear something that listens to your heart. It looks like a belt. You wear it around your chest.

The third time you come for the treadmill visits, you will do the test. The test will happen at the speed you've been practicing at. The speed will always stay the same. It may only change and get a little bit faster towards the end of the test. The hill in the treadmill will keep getting steeper. During the test you'll wear the mask and the heart monitor.

We are also going to measure how strong your legs are. This is going to happen two times, during the first two treadmill visits. For the test you will be sitting down and have to move your leg as though you were kicking a ball. You will get to practice this test too.

Inconvenience
Helping with this project will take a lot of your time. You and your parent/caregiver have to go to the University of Victoria six times. Some of the tests might take place at your school. Each time it will take 30-60 minutes. That is the same amount of time as 1 or 2 TV shows. You will be taking tests that will make your body feel tired.

Risks
Your body will feel tired at the end of the tests. More tired than it usually does. During the tests there is a possibility that you will feel uncomfortable for a little while. There is also the possibility that you will feel thirsty, that your muscles will hurt, that you will feel dizzy, and that you will feel like vomiting. There is also the possibility that you will fall off the treadmill.
We will do our best to try to make sure that these things don't happen, or that the chance of them happening is very small. You will only take the tests if your doctor says it's ok. Before going on the treadmill, we will teach you how to push the button to stop the treadmill. We will also teach you hand signals to let us know if you want us to push the button to stop the treadmill; and how to step on the side of the treadmill so that you can stop the test even while the treadmill is still moving. Someone will be watching the computer screen to keep track of how fast your heart is beating and how hard you are breathing. At least two people will be beside you while you are one the treadmill to keep you from falling. If it looks like you're getting close to the back/end of the treadmill, they will touch your back with one of their hands and let you know to walk a little bit faster. If this happens they might stop the treadmill. After the tests we are going to help you stretch your muscles so that they don't hurt the day after. You will be offered juice if you are thirsty after the tests. It's also important that you don't eat for 2 hours before any of the tests.

Benefits
Your help with this project will help us understand if this test is a good test to measure how healthy your heart is. The name of the test is the Six-Minute Walk Test. If it is good, then it could be used in your physical education classes, at a fitness centre, or by other project leaders for other adults with intellectual disability. At the end of the tests we will also tell you how healthy hour heart is and how you can make it healthier.

Compensation
As a thank you for your help, we will give you a small gift after every test or every time you come to practice a test. The prizes are a movie coupon, a water bottle, or a T-shirt. After each test, you will probably feel thirsty, so you can have a drink of juice or Gatorade if you want. When all the tests are over and you are finished helping us, you'll get a picture of yourself on the treadmill that you can take home and put in your room. You will also receive a family movie pass.
If you say yes to participating, it can't be because of the gifts, or the picture, or the family movie pass. It's not right to give you those things to force you to help us. If you wouldn't help because you were not getting anything, then you should say no to helping us. You will only get the picture of yourself in the frame and the movie pass when the project is finished.

Voluntary Participation
Your help with this project has to be completely voluntary. That means that if you decide to help, you can stop helping at any time without getting into trouble or having to tell us why you want to stop. If you stop

helping, your information will only be used if you and your parent/caregiver say it's ok. You will only get the picture of yourself when the project is finished.

On-going Consent
To make sure that you want to continue in the project, ever time I see you I will ask you, "Do you still want to be part of the project?" I will also remind you that you can stop any of the tests any time you want. Or, if you don't want to take the test, you don't have to.

Anonymity
No one will know that you were part of this study. Only if it's ok with you and your parent/caregiver, will I take pictures of you while you do the tests. These pictures will be part of a presentation.

Confidentiality
No one will know that you were a part of this project. When I give a presentation about the results of this project, I won't use your name. All your information will be kept in a computer and a locked cabinet at the University. Only people with the password for the computer and key for the cabinet will be able to see your information.

Dissemination of Results
The results of the tests will be part of a presentation or be written in a research paper.

Disposal of Data
Your information and the results of your test will be cut into small pieces or erased from the computer 5 years after the project is finished.

Contacts
The people that you can talk to about this project are Gabriella and Viviene. Their phone numbers and email addresses are on the first page of this form.
You can also talk to the people who said it was ok to do this project. They are the Human Research Ethics Office at the University of Victoria. Their phone number is (250) 472-4545. Their email address is ethics@uvic.ca.

We are going to ask you to sign your name. Only sign your name if you understand what you have to do to help with the project and if you don't have any more questions. If you still have questions, you can ask them now, or anytime.

________________________	________________________	__________________
Name of Participant	*Signature*	*Date*

A copy of this consent will be left with you, and a copy will be taken by the researcher.

Appendix E
Assent Form – Participants

Assent Form for Participants

The Six-Minute Walk Test for Adults with Intellectual Disability

You are being asked to take part in a project. The name of this project is The Six-Minute Walk Test for Adults with Intellectual Disability. My name is Gabriella Nasuti and I am the leader of the project. I am a student at the University of Victoria. If you ever have any questions about the project, you can email me at gnasuti@uvic.ca. or phone me at (250) 893-5308.
As part of my school work, I have to do research. This project is the research project. My supervisor is Dr. Viviene Temple. She is a professor at the University. You can email her at vtemple@uvic.ca or phone her at (250) 721-7846.

Purpose of this Study
The purpose of this project is to see if a new test is good to measure fitness in adults with intellectual disability. Other tests that are being used now are complicated and not much fun.

Importance of this Research

It is really important for your heart to be healthy. You can help to keep your heart healthy by being active like playing sports or doing exercise. We are trying to make a test that measures how healthy your heart is. This test would be easy and fun. You walk during this test.

Participants Selection

We are asking you to help us with our project because you are between 18 and 50 years old and because you have an intellectual disability.

What is Involved

If you say yes to helping with this project, this is what you will have to do. Before starting, your doctor has to say that it's ok for you to help us. Every time you come to help us you have to wear running shoes, a T-shirt, and comfortable pants (like jogging pants or shorts). You can't eat or do exercises like running for 2 hours before coming to help.

There are two different running or walking tests that we're going to ask you to do.

(1) The Six-Minute Walk Test

For the Six-Minute Walk Test you have to walk as far as you can in 6 minutes along a 30-m, straight line. 30 meters is long like three big freight trucks behind each other. The starting line and 30-m line will be marked by red cones, and every 2-m along the way will by marked by red tape. You will get to practice this test too. Someone will be walking a little bit in front of you. They will be encouraging you, and will help you to not go too fast or too slow. This test will happen three times on three different days.

(2) The graded treadmill test

For the first treadmill visit, we are going to ask you to take your shoes off. Then we'll see how much you weigh, how tall you are, and how long your legs are. Then we'll show you what you will have to do on the treadmill. After watching us on the treadmill, you will try walking on the treadmill. We'll see how fast or slow you can walk. Then you'll walk on the treadmill and it will feel like you're walking up a hill. We will also show you how to step on the side of the treadmill and press the STOP button so that you can stop walking whenever you want. Then you will get off the treadmill and try on a mask that covers your mouth and nose. This mask collects the air that you breathe out.

The second time you come for the treadmill visits, you will get to practice walking on the treadmill again at the speed that you are comfortable with. The treadmill will feel like you are walking up a hill. Then we will put on the same mask you tried on last time. You will also wear something that listens to your heart. It looks like a belt. You wear it around your chest.

The third time you come for the treadmill visits, you will do the test. The test will happen at the speed you've been practicing at. The speed will always stay the same. It may only change and get a little bit faster towards the end of the test. The hill in the treadmill will keep getting steeper. During the test you'll wear the mask and the heart monitor.

We are also going to measure how strong your legs are. This is going to happen two times, during the first two treadmill visits. For the test you will be sitting down and have to move your leg as though you were kicking a ball. You will get to practice this test too.

Inconvenience
Helping with this project will take a lot of your time. You (and your parent/caregiver) have to go to the University of Victoria four times. Each time it will take 30-60 minutes. That is the same amount of time as 1 or 2 TV shows. You will be taking tests that will make your body feel tired.

Risks
Your body will feel tired at the end of the tests. More tired than it usually does. During the tests there is a possibility that you will feel uncomfortable for a little while. There is also the possibility that you will feel thirsty, that your muscles will hurt, that you will feel dizzy, and that you will feel like vomiting. There is also the possibility that you will fall off the treadmill.
We will do our best to try to make sure that these things don't happen, or that the chance of them happening is very small. You will only take the tests if your doctor says it's ok. Before going on the treadmill, we will teach you how to push the button to stop the treadmill. We will also teach you hand signals to let us know if you want us to push the button to stop the treadmill; and how to step on the side of the treadmill so that you can stop the test even while the treadmill is still moving. Someone will be watching the computer screen to keep track of how fast your heart is beating and how hard you are breathing. At least two people will be beside you while you are one the treadmill to keep you from falling. If it looks like you're getting close to the back/end of the treadmill, they will touch your back with one of their hands and let you know to walk a little bit faster. If this happens they might stop the treadmill. After the tests we are going to help you stretch your muscles so that they don't hurt the day after. You will be offered juice if you are thirsty after the tests. It's also important that you don't eat for 2 hours before any of the tests.

Benefits
Your help with this project will help us understand if this test is a good test to measure how healthy your heart is. The name of the test is the Six-Minute Walk Test. If it is good, then it could be used in your physical education classes, at a fitness centre, or by other project leaders for other adults with intellectual disability. At the end of the tests we will also tell you how healthy hour heart is and how you can make it healthier.

Compensation
As a thank you for your help, we will give you a small gift after every test or every time you come to practice a test. The prizes are a movie coupon, a water bottle, or a T-shirt. After each test, you will probably feel thirsty, so you can have a drink of juice or Gatorade if you want. When all the tests are over and you are finished helping us, you'll get a picture of yourself on the treadmill that you can take home and put in your room. You will also receive a family movie pass.
If you say yes to participating, it can't be because of the gifts, or the picture, or the family movie pass. It's not right to give you those things to force you to help us. If you wouldn't help because you were not getting anything, then you should say no to helping us. You will only get the picture of yourself in the frame and the movie pass when the project is finished.

Voluntary Participation
Your help with this project has to be completely voluntary. That means that if you decide to help, you can stop helping at any time without getting into trouble or having to tell us why you want to stop. If you stop helping, your information will only be used if you and your parent/caregiver say it's ok. You will only get the picture of yourself when the project is finished.
On-going Consent

To make sure that you want to continue in the project, ever time I see you I will ask you, “Do you still want to be part of the project?” I will also remind you that you can stop any of the tests any time you want. Or, if you don’t want to take the test, you don’t have to.

Anonymity
No one will know that you were part of this study. Only if it’s ok with you and your parent/caregiver, will I take pictures of you while you do the tests. These pictures will be part of a presentation.

Confidentiality
No one will know that you were a part of this project. When I give a presentation about the results of this project, I won’t use your name. All your information will be kept in a computer and a locked cabinet at the University. Only people with the password for the computer and key for the cabinet will be able to see your information.

Dissemination of Results
The results of the tests will be part of a presentation or be written in a research paper.

Disposal of Data
Your information and the results of your test will be cut into small pieces or erased from the computer 5 years after the project is finished.

Contacts
The people that you can talk to about this project are Gabriella and Viviene. Their phone numbers and email addresses are on the first page of this form.
You can also talk to the people who said it was ok to do this project. They are the Human Research Ethics Office at the University of Victoria. Their phone number is (250) 472-4545. Their email address is ethics@uvic.ca.

We are going to ask you to sign your name. Only sign your name if you understand what you have to do to help with the project and if you don't have any more questions. If you still have questions, you can ask them now, or anytime.

______________________	______________________	______________________
Name of Participant	*Signature*	*Date*

A copy of this consent will be left with you, and a copy will be taken by the researcher.

Appendix F
Consent Form – Parents/Guardians

Consent Form for Parents/Guardians

The Six-Minute Walk Test for Adults with Intellectual Disability

Your child is being invited to participate in a study entitled The Six-Minute Walk Test for Adults with Intellectual Disability that is being conducted by Gabriella Nasuti, a graduate student in the School of Exercise Science, Physical and Health Education, at the University of Victoria. You may contact me, Gabriella, at gnasuti@uvic.ca or (250) 893-5308.
As a graduate student, I am required to conduct research as part of the requirements for a Masters degree in Kinesiology. It is being conducted under the supervision of Dr. Viviene Temple, an associate professor in the School of Exercise Science, Physical and Health Education. You may contact my supervisor at vtemple@uvic.ca or (250) 721-7846.

Purpose of this Study
The purpose of this research project is to evaluate the effectiveness of the Six-Minute Walk Test as a tool to measure cardiorespiratory capacity, an aspect of physical fitness, for adults with intellectual disability (ID). Field tests that are currently being used are not as participant-friendly as the Six-Minute Walk Test is.

Importance of this Research

Research of this type is important because cardiovascular health is a growing concern, especially for individuals with ID. In this population the prevalence of cardiovascular disease and its risk factors is high and apparent earlier in life compared to the general population. Despite the direct association between physical activity and cardiovascular disease, most individuals with ID are physically inactive. The ability to perform physical activity can be measured by fitness tests. The ideal test is valid, reliable, easy to administer, inexpensive, participant-friendly, and requires minimal equipment. Current field tests that predict cardiorespiratory capacity for adults with ID do not meet all of these criteria.

The Six-Minute Walk Test has been used for over thirty years with clinical and healthy populations, but has never been explored to predict cardiorespiratory capacity in adults with ID. If the Six-Minute Walk Test is found to be valid and reliable, it could be used in a variety of settings.

Participants Selection
Your child is being asked to participate in this study because they are between 18-50 years old and have ID.

What is Involved

If you and your child agree to voluntarily participate in this research, your participation will include the following. Clearance from your child's doctor is necessary in order to participate, and proof of physician approval will need to be handed in to the investigator prior to any testing. For each visit, your child will be asked to wear light, comfortable clothing (track pants or shorts, a T-shirt, and running shoes), and to not eat or engage in physical activity for 2 hours prior to the visit.

Your child will participate in two tests that measure cardiovascular fitness and one test that measures muscular leg strength. Each test will happen on separate occasions and will each require a minimum of two visits in order for you child to feel comfortable with the testing protocols. The tests will occur in the following order.

1) The 6-Minute Walk Test
2) The Graded Test on the Treadmill and Leg Strength test

For the Six-Minute Walk Test, participants will be required to walk as far as possible in 6 minutes along a 30-m, straight course. The starting line and 30-m line will be marked by pylons. Every 2-m along the way will by marked by red tape. One familiarization session is required prior to data collection. Familiarization will involve an explanation and demonstration of the protocol. Participants will then be allowed to try the test. Data collection will occur on two occasions, each time with a pacer walking 2-3 feet ahead of the participant to help set the pace and provide encouragement.

During the treadmill and leg strength visits the following will occur. On the first treadmill visit, your child's height, weight, and leg length will be measured. The treadmill protocol will then be demonstrated to them. Your child will then try walking on the treadmill at a comfortable walking speed (between 2.5-3.5mph), and the pace that they are most comfortable with will be established. Your child will then walk on the treadmill at the established speed while experiencing changes in grade/elevation. Your child will be shown how to end the test whenever they want by stepping on the sides of the treadmill and/or pressing the STOP button. Your child will try on the mouth-nose mask used for collecting expired air without walking on the treadmill.

On the second treadmill visit, your child will practice walking on the treadmill at the previously established speed, with increases in grade, while wearing the mouth-nose mask and heart rate monitor.

On the third treadmill visit, data collection will occur. The test will begin at 0% grade for 2 minutes at the selected speed. The speed will remain constant, while the grade increases by 2.5% every two minutes, until a grade of 12.5% is reached. After two minutes at 12.5% grade, the speed is increased by 0.5mph every minute until your child can no longer continue.

The test for measuring leg strength will occur during the first and second treadmill visits, soon after performing the treadmill test. Walking on the treadmill will serve as a warm-up. Leg strength through knee extension and knee flexion will be measured using a dynamometer. Measurements will only be taken for the dominant leg; determined by asking your child which leg they would use to kick a soccer ball. Data collection will involve 6 practice repetitions of knee extension and flexion. Angle speed for testing will be 60°/second.

Inconvenience

Participation in this study may cause some inconveniences to you and your child. The main inconvenience for you is time. You and your child would be required to travel to the University of Victoria on 4 occasions, each time for 30-60 minutes. The main inconvenience to your child is physical exertion, caused by taking the fitness tests.

Risks

The nature of the fitness tests requires that your child exert him/herself more than they would in their everyday life. There are some potential risks to your child by participating in this research which include temporary physical discomfort and fatigue, dehydration, exhaustion, vertigo, muscle cramps, nausea, vomiting, and falling off the treadmill.

To minimize these risks the following preventive actions will be taken:

Prior to commencing any of the tests, medical clearance will be obtained. By doing this anyone who is more susceptible to any of the risks will be monitored more closely or perhaps not be part of the study. Prior to taking the treadmill test, participants will be taught how to end the test should they feel fatigued, exhausted, experience muscle cramps, nausea, vertigo, or other discomfort. Participants will be taught and be given the opportunity to practice how to end the test: by stepping on the sides of the treadmill, pressing the STOP button, or giving the appropriate hand signal.

One investigator is will have their full attention on the screen displaying metabolic data, particularly to monitor the participant's respiratory exchange ratio and heart rate. This investigator will end the test when 90% of the participant's predicted maximal heart rate has been reached, or when a respiratory exchange ratio of 1.0 has been reached. A minimum of two researchers will be standing next to the participant and have their full attention on him/her so that any discomfort will be noticed promptly. Should it appear that the participant is about to fall off the treadmill, one of the spotters will place a hand on the participant's back and ask them to pick up their speed. They will then stop the treadmill if necessary.

The participant will be led through cool-down activities and stretching after the tests so as to minimize the risk of experiencing muscle soreness the following day. The participant will be offered water and Gatorade after the tests so that they don't feel dehydrated after the test. They will also be advised to not eat or engage in vigorous activity for 2 hours prior to any of the testing in order to minimize the risk of vomiting during the tests.

Benefits

The potential benefits of your participation in this research include aiding in the validation of a field test that could potentially be used to measure aerobic capacity in youth with intellectual disability in a variety of settings, including physical education classes. Furthermore, your child will be told their level of cardiovascular fitness and how it could be improved.

Compensation

As a way to compensate you and your child for any inconvenience related to your participation, a parking pass will be given to you every time that you and your child travel to the university and park on university grounds for purposes of this study.

After each practice session and test that your child undertakes, he/she will be offered juice or Gatorade as well as a small token, for example a $5 coupon to the movies, a water bottle, or a T-shirt. Upon completion of all the tests and visits, your child will receive a framed photo of them on the treadmill. A photo of themselves will only be taken with approval. You will also receive a family movie pass.

If you and your child agree to participate in this study, these forms of compensation must not be coercive. It is unethical to provide undue compensation or inducements to research participants. If you or your child would not participate if the compensation was not offered, then you should decline.

Voluntary Participation

Yours and your child's participation in this research must be completely voluntary. If you and your child decide to participate, you may withdraw at any time without any consequence or explanation. If you and your child withdraw from the study, your child's data will only be used if you grant us permission to do so. If you and your child withdraw prior to completion of all the tests, your child will not receive the framed photo or movie pass. He/she will still receive a token after each test or familiarization, regardless of whether it has been completed. If your child chooses to terminate a test before finishing it, they will still receive a drink of juice or Gatorade, and you will still receive a parking pass for the time of the visit.

On-going Consent

To make sure that you continue to consent to participate in this research, I will remind you and your child that you are free to withdraw at any point during the course of the study. I will ensure that your child understands that they are under no obligation to take the tests, or to finish them; rather they can stop any of the tests whenever they choose to.

Anonymity

In terms of protecting your and your child's anonymity, when the results of the study have been analyzed and disseminated, no one will be aware that your child was part of this study. Only if you approve, will photos be taken of your child and included in a presentation of the results. The photo however, would not be linked to any specific results or names.

Confidentiality

Your child's confidentiality and the confidentiality of the data will be protected. Names and personal information will not be released to anyone other than the investigators. Once the data has been collected, the participants' data will be assigned a number (e.g. Participant #1) and will be referred to on a numerical basis. From this point on, no data will contain names, and all results will be interpreted and displayed as group data and individual data by their assigned number. All data will be kept in a password-protected computer and locked in a cabinet in the office of Dr. Temple at the University of Victoria.

Dissemination of Results

It is anticipated that the results of this study will be shared with others in the following ways: group data will be published in a scholarly journal, presented at a conference, and used in a thesis.

Disposal of Data

Data from this study will be disposed of five years after completion of the study. Computer files will be deleted and data on paper will be shredded.

Contacts
Individuals that may be contacted regarding this study include Gabriella Nasuti and Dr. Viviene Temple. Their contact information can be found on the first page of this form.
In addition, you may verify the ethical approval of this study, or raise any concerns you might have, by contacting the Human Research Ethics Office at the University of Victoria (250-472-4545 or ethics@uvic.ca).

Your signature below indicates that you understand the above conditions of participation in this study and that you have had the opportunity to have your questions answered by the researchers.

______________________	______________________	______________
Name of Participant's Parent/Guardian	*Signature*	*Date*

A copy of this consent will be left with you, and a copy will be taken by the researcher.

Appendix G
Medical Clearance Form

The 6-Minute Walk Test for Adults with Intellectual Disability:
A Study of Validity and Reliability

Medical Clearance for Testing and Participation

Participant's name____

The client who has made this appointment with you is planning to participate in a study investigating whether the 6-minute walk test is a valid and reliable test for assessing aerobic capacity in adults with intellectual disability. Participation will involve undergoing two tests of cardiovascular fitness and one test of leg strength at the University of Victoria in the School of Exercise Science, Physical and Health Education. Should you have any questions please contact the primary investigator, Gabriella Nasuti, at (250) 893-5308 or gnasuti@uvic.ca; or her supervisor, Dr. Viviene Temple, at (250) 721-7846 or vtemple@uvic.ca.

TESTING

The tests described below (except for the 6-Minute Walk test) have been specifically designed for adults with physical and intellectual disabilities. Each test has established validity and reliability for use with adults with intellectual disability.
The tests for aerobic capacity and muscular strength will elicit maximal or near maximal effort in most individuals. The tests will be administered by a kinesiology student and are **not medically supervised**. The tests that the client will be asked to do following 1-3 familiarization/practice sessions are:

- The 6-minute walk test: a **cardiovascular fitness** test that has been used for over 30 years with clinical and healthy populations, but has never been explored with adults with intellectual disability. The test involves walking up and down a 30-m course for 6 minutes. The aim is to walk as far as possible.

- The graded maximal oxygen consumption test on the treadmill: a **cardiovascular fitness** test. The speed is kept constant at 2-3.5mph. The test starts at 0% grade and is increased by 2.5% every two minutes until a grade of 12.5% is reached. At this point the grade is kept constant and the speed is increased by 0.5mph every minute. The test is finished when the participant has reached volitional exhaustion. The participant will be wearing a heart rate monitor strapped around their chest and breathing through a mouth-nose mask.

- Leg **muscular strength** will be assessed with a Cybex dynamometer through extension and flexion of the participant's dominant leg. In a seated position, the participant will perform two sets of 3 repetitions at maximal effort for leg extension and flexion, with a 30 second resting period between sets. Repetitions will be performed at a speed of 60°/second, and for each repetition the participant will extend their leg past an angle of 25° then immediately flex their leg beyond an angle of 75°.

PHYSICIAN CLEARANCE

1. Is this individual taking any medication that could affect normal physiological responses to exercise (ex. heart function or blood pressure)?

   No______ Yes_______ If YES, please explain.

2. Does the individual have any congenital heart defects?

   No ______ Yes______ If YES, please explain.

3. Does the individual have any orthopaedic or motor impairment that would prevent them from walking, jogging, or running?

   No ______ Yes______ If YES, please explain.

4. Is there any medical reason that this individual should not undertake very strenuous exercise?

   No ______ Yes______ If YES, please explain.

I certify that this applicant has been given a medical examination and is medically fit to undertake the physical fitness tests described above.

Physician's Name: ____

Date: __________________________

Address:____

Telephone: _________________________

Signature: ___________________________________

--- Please keep one copy for your files, and return the other copy to your patient. Thank you. ---

Appendix H
Protocols

The Six-Minute Walk Test

Equipment: measuring tape, measuring wheel, red floor tape, 2 orange pylons, clipboard with recording sheet, pencil/pen, heart rate monitor, 2 stopwatches, lap counter/clicker, juice

Set-up:
1. Measure a straight distance of 30m.
2. Mark the start and end of the course with a pylon.
3. Mark the starting line with red tape
4. Mark the distance with red tape, every 2m.

Protocol:
Familiarization and Practice
(minimum 1x)
1. Explain the protocol (described below) to the participant
2. Demonstrate the test
3. Explain the purpose of the heart rate monitor and have participant try it on
4. Participant tries the full test while wearing the heart rate monitor, with a pacer

Data Collection
(2 times, each test separated by a minimum of 48 hours; the first test should be administered no later than 1 week after the practice test; NO warm-up)
1. Place heart rate monitor on the participant
2. Ensure lap counter is set to zero and the timer is set to 6 minutes
3. Instruct the participant as follows:

“For this test you are going to walk as far as possible for 6 minutes. You will walk back and forth along this line. Six minutes is a long time to walk, so your body will feel tired. You are allowed to slow down, to stop, and to take a rest if you feel like you need to. Start walking again as soon as you feel ready. You will be walking back and forth around the orange cones. When you get to the orange cone, don’t slow down. I will now show you how to turn around without slowing down”

Investigator demonstrates walking one lap and pivoting around the cone without hesitation.

“Are you ready to do that? I am going to use this clicker to count the number of times you walk back and forth. I will click it each time you turn around at this line with the red tape. It’s the starting line. Remember that you are trying to walk AS FAR AS POSSIBLE for 6 minutes, but don’t run or jog. [name of pacer] will be walking a little bit in front of you, try to follow them as closely as possible.

Start now, or whenever you are ready.”

4. Position the participant at the starting line and the pacer 2 feet ahead
5. As soon as the participant starts to walk, start the timer
6. Use the following standard phrases of encouragement while standing at the starting line and facing the participant.
    - Every 10-15 seconds (except when the phrases below are said), one of:
        - “Great job!”
        - “You’re doing awesome!”
        - “Keep up the great work and quick pace”
    - After 1 minute: “You are doing well. You have 5 minutes to go.”
    - After 2 minutes: “Keep up the good work. You have 4 minutes to go.”
    - After 3 minutes: “You are doing well. You are halfway done.”

- After 4 minutes: "Keep up the good work. You have only 2 minutes left."
- After 5 minutes: "You are doing well. You have only 1 minute to go."
- After 5 minutes, 45 seconds: "In a moment I am going to tell you to stop. When I do, just stop right where you are and I will come to you."
- When the timer rings (after 6 minutes): "Stop!"
    - If the participant stops walking during the test and need a rest: "You can lean against the wall if you would like; then continue walking whenever you feel like you can." The timer will not be stopped. If the participant does not continue, note the time they stopped, the distance, and the reason for stopping.

7. Walk over the participant and mark the spot where they stopped with a piece of tape on the floor.
8. Record the number of laps on the counter and the additional distance covered, rounding to the nearest meter.
9. Congratulate the participant on a good effort and offer them juice.
10. Cool-down and stretching for 10 minutes

The Graded Oxygen Consumption Test on the Treadmill

Equipment: treadmill, metabolic cart, heart rate monitors, water and juice, towel, breathing apparatus, foam mats (behind and around treadmill)

Protocol:
Phase ONE
1. Establish a comfortable walking speed.
   - The participant starts walking on the treadmill at a speed of 2.0mph.
   - Once the participant has adjusted to the speed it is increased by 0.2mph
   - The participant is given time to adapt to this speed, before it is increased again by 0.2mph
   - This process is repeated until the participant experiences discomfort* with the speed, to a maximum of 3.5mph

   *Discomfort with speed will be exhibited by constantly holding onto the railings, reaching out for a staff member standing near the treadmill to gain balance, or by verbalizing their anxiety. Once one or more of these signs has been displayed, the treadmill speed is lowered to the previous level. This speed will be used for the remainder of the evaluation.
2. Allow the participant to experience changes in elevation and feel comfortable with changes in treadmill elevation while walking at the selected speed.
   - Changes in treadmill grade will occur in incremental increases of 2.5%
3. The participant wears and breathes through the nose/mouth mask without walking on the treadmill. Establish best mask size for participant.

Phase TWO:
1. Confirmation of comfort with the walking speed selected during *Phase one*.
2. The participant comfortably wears the nose/mouth mask and heart rate monitor while walking on the treadmill at the selected speed, with increases in grade.

Phase THREE: (data collection)
1. The participant sits quietly for ten minutes, then warms-up.
   - Resting heart rate is recorded.
   - Warm-up on treadmill for 5 minutes
2. Testing:
   - 0% grade for 2 minutes at the selected speed.
   - The speed remains constant. The grade increases by 2.5% every two minutes, until a grade of 12.5% is reached.
   - After two minutes at 12.5% grade, the speed increases by 0.5mph every minute until the participant can no longer continue.
   - cool-down activities and stretching
3. Participant is offered water and juice

Notes:
-A minimum of 2 people (researcher plus one other person, at least) is present for testing
- Each familiarization phase may require that the participant visit the laboratory more than once, depending on their comfort level.

Leg Strength

Equipment: Cybex dynamometer, juice or water, clipboard with recording sheet, pen/pencil

Protocol:

1. To determine which leg is dominant for the participant, ask them which leg they would use to kick a soccer ball
2. 6-10 minute warm-up (on the treadmill or 6MWT).
3. 5-10 minute resting period, during which time the protocol is demonstrated

Data Collection

4. Positioning: the lever pad is placed on the distal anterior tibia three inches above the lateral malleolus. Participant's arms are by their sides, hands holding the handles by their hips, and they are strapped in at the waist, chest, and thigh.
5. Participants are given the opportunity to practice knee extension/flexion until they demonstrate proper testing procedure.
    - Criterion for proper testing procedure: consistent extension of the leg past an angle of 25° then immediately flexing the leg beyond an angle of 75°
6. 5 minutes of rest
7. 2 sets of 3 maximal efforts
    - 30 seconds rest between each set
    - Reps performed at a speed of 60°/second
    - Constant encouragement provided
8. Leg stretching
9. Participant is offered water and juice

Notes:

-Data collection will occur twice, separated by a minimum of 48 hours.

Appendix I
Data Recording Sheets

Participant Overview

Name: ____
Parent/Caregiver: ____
Contact Information: ____
Emergency contact (if different from above contact):
____

Physician Approval? Y / N $_ Physician Name & Contact: ________________

Notes: ____

Gender: M / F Down Syndrome? Y / N

Age: _____ Height:_______ Weight: _______ Leg Length: _____

SIS consent/assent obtained? _________________________
score: __________________________
Interviewees ____
____

Smoker? Y / N

Does the participant engage in walking or running activities? Y / N
If yes, how often and which types of activities?
____

Any other tyes of physical activites? ____________________________
Number of years in Special Olympics? ______________

Likes/dislikes:

Tokens etc. given:

Notes:

6MWT

Participant's name:

	Date, Time, Location	Pacer Name	# laps (1 lap = 30m)	Extra distance (m)	Total distance (m)	Resting HR (bpm)	End HR (bpm)	Peak HR (bpm)
Familiarization & Practice								
Familiarization & Practice #2 (if necessary)								
Test #1								
Test #2								

Treadmill Test

Participant's name:

Phase 1

Researchers: ____

Date: ______________________ Time: ______________________

Walking speed: ____________________

Is the participant comfortable with changes in elevation at the specified walking speed? **Y / N**

Is the participant comfortable breathing through the mask? **Y /N** Size of Mask: ____

Notes:

Phase 2

Researchers: ____

Date: ______________________ Time: ______________________

Is the participant still comfortable walking at the above speed? **Y / N**

Is the participant comfortable wearing the heart rate monitor and breathing mask while walking on the treadmill at the above speed, while experiencing changes in elevation: **Y /N**

Notes:

Phase 3 (data collection)

Researchers: ____

Date: ______________________ Time: ______________________

Resting heart rate: ____________

Notes:

Leg Strength

Participant's name:

Dominant leg: ___________
Back translation: ____ Back angle: ____ height: ____ Leg arm: _____

	Date, Time	Researcher	Trial #	Flexion		Extension	
				Torque (Nm)	Power (W)	Torque (Nm)	Power (W)
Day #1			1				
			2				
			3				
			4				
			5				
			6				
Day #2			1				
			2				
			3				
			4				
			5				
			6				

Summary	**Flexion**		**Extension**	
	Peak Torque (Nm)	Average Power (W)	Peak Torque (Nm)	Average Power (W)
Day 1				
Day 2				

Appendix J
Raw Data

Par-tici-pant	age	sex	DS	height (m)	weight (kg)	BMI (kg/m²)	leg length (m)	SIS (%)	6MWD #1 (m)	6MWD #2 (m)
1	40	M	Y	1.65	94.3	34.6	0.97	< 1	523.9	557.9
2	30	M	N	1.8	85.2	26.3	0.91	19	838.7	835.0
3	30	F	Y	1.57	88.9	36.1	0.83	18	553.3	553.4
4	32	F	N	1.62	54.8	20.9	0.88	6	668.3	675.4
5	22	F	N	1.53	60.8	26	0.83	32	678.2	723.5
6	18	F	N	1.565	82.4	33.6	0.84	9	696	707.1
7	33	M	N	1.85	88.5	25.9	1.04	N/A	757	715.3
8	35	M	N	1.78	94.3	29.8	1	N/A	667.7	675.9
9	20	M	N	1.705	90.9	31.1	0.95	1	653.1	666.2
10	36	F	N	1.68	60.1	21.3	0.87	< 1	715.3	675.1
11	25	M	Y	1.66	82.4	29.9	0.81	27	579.8	584.2
12	30	M	Y	1.585	83.5	33	0.76	27	531.1	543.6
13	44	F	N	1.665	72.5	26	0.87	N/A	663.7	681.7

Partici-pant	# fam	HR rest (bpm)	HR peak (bpm)	RER	VO_2 peak (ml/kg/min)	Peak Torque Extension (Nm)	Average Power Extension (W)	Peak Torque Flexion (Nm)	Average Power Flexion (W)
1	3	72	138	1.1	25.5	65	41	43	32
2	2	51	173	1.16	53.7	180	98	113	71
3	3	98	166	1	14.2	98	54	73	52
4	4	68	161	1.06	29.2	65	39	43	30
5	2	76	169	1.14	40.1	104	74	73	55
6	2	84	176	1.06	28.9	133	87	98	73
7	2	68	173	1.14	36	108	46	64	44
8	2	54	112	1	37.7	100	65	95	69
9	2	58	190	1.15	42.1	115	52	26	18
10	3	75	165	1.02	33.1	100	67	65	49
11	2	79	145	1.03	25.1	108	72	100	73
12	2	66	148	1.08	25.8	102	63	100	69
13	4	61	152	1	35.9	106	69	81	61

DS = Down syndrome
BMI = Body Mass Index
SIS = Supports Intensity Scale
6MWD = Six Minute Walk Distance
# fam = number of familiarization sessions prior to treadmill testing
HR = Heart Rate
RER = respiratory exchange ratio
VO_2 peak = peak oxygen uptake

Appendix K
Participant Bookings 2009

	Monday	Tuesday	Wednesday	Thursday	Friday
MAY	**4** 1:15 NB #1 2:00 DS #1	**5** 10am EB #1 3:00 SM #1	**6** 2:00 DS #2 3:30 AW & LW #1	**7** 10am SM #2 3:15 NB #2	**8** 8:30am SJ #1 10am EB #2 2:00 DS #3
	11	**12** 8:30am SJ #2 2:00 DS #4 3:30 NB #3	**13** 1:00 EB #3 2:30 SM #3 3:30 AW & LW #2	14 3:15 NB #4	15 8:30am SJ #3 11am CH #1 3:00 SM #4
	18	**19**	**20** 3:30 AW & LW #3	**21** 9am SJ #4 11am CH #2 2:00 EB #4 3:30 SM #5	**22**
	25	**26** 11am CH #3	**27** 9am DM #1 3:30 AW & LW #4	**28**	**29**
JUNE	**1** 9am DM #2	**2** 11am CH #4	**3** 9am DM #3	**4**	**5** 9am DM #4
	8	**9** 11am CH #5	**10**	**11**	**12**
AUG	**17**	**18**	**19**	**20**	**21** 4:30 MH #1
	24 3pm MH #2	**25**	**26** 3pm MH #3	**27**	**28** 3pm MH #4
SEPT	**7**	**8**	**9**	**10**	**11** 7pm AC #1
	14 11:45am AC #2	**15**	**16** 11:45am AC #3	**17**	**18**
	21	**22** 11:30am AC #4	**23**	**24**	**25**
	28	**29**	**30**	**October 1**	**2** 2:30pm DO & CN #1
OCT	**5**	**6**	**7**	**8**	**9** 2:30pm DO & CN #2
	12	**13**	**14**	**15**	**16** 2:30pm DO & CN #3
	19	**20**	**21**	**22**	**23** 2:30pm DO & CN #4
NOV	**16**	**17**	**18**	**19**	**20** 4:30 CS #1
	SUNDAY 22 8:45am CS #2	**24** 3:15 CS #3	**25**	**26**	**27**
	30	**DEC. 1** 3:15 CS #4			

Appendix L
Booklet for Participants

Property of: [Participant's Name]

The Six-Minute Walk Test for Adults with Intellectual Disability

Gabriella Nasuti
(250) 893-5308
gnasuti@uvic.ca

Dr. Viviene Temple
(250) 721-7846
vtemple@uvic.ca

General Notes

- Preparation for each visit:

    - Wear clothing that will allow you to move freely, for example:
        - Shorts or track pants
        - T-shirt
        - Running shoes
    - Do not eat a heavy meal for at least 2 hours before your visit
    - Do not drink coffee or other caffeinated drinks for at least 6 hours before your visit
    - Do not engage in strenuous or heavy physical activity the day of the visit (before the visit)
    - You can brink a water bottle if you want; however we will have water and juice in the lab for you

- We will meet in the foyer/lobby of McKinnon for every visit unless we decide on and discuss another option

- If you do not feel well after your visit, please contact Gabriella or Dr. Viviene Temple at the numbers provided on the first page; and/or contact your doctor

Visit #1 (30-45 minutes)

Date: ____________________________ Time: _________________

What we will do today:

- Introduce and practice the 6 Minute-Walk test in the gym with Gabriella
- Go upstairs to the Cybex Lab:
    - Measure your height
    - Measure how much you weigh
    - Measure how long your legs are
    - Test how strong your legs are on the Cybex
    - Stretch your legs (so you don't feel sore)

Visit #2 (45-60 minutes)

Date: ____________________________ Time: _________________

What we will do today:

- Do the 6 Minute-Walk test in the gym with Gabriella and another assistant
- Go upstairs to the Cybex Lab:
    - Test how strong your legs are on the Cybex (2^{nd} time)
- Go to the Treadmill Lab:
    - Learn how to STOP the treadmill by yourself
    - Practice using the treadmill and find a comfortable walking speed
    - Try on the breathing mask while standing on the floor and find the right size mask
- Stretch your legs (so you don't feel sore)

Visit #3 (30-45 minutes)

Date: ___________________________ Time: ________________

What we will do today:

- Do the 6 Minute-Walk test in the gym with Gabriella and another assistant (the same one as during *Visit #2*)
- Go to the Treadmill Lab:
    - Practice using the treadmill and see if the speed that was comfortable during *Visit #2* is still comfortable
    - Wear the heart rate monitor
    - Breathe through the mask while walking on the treadmill
    - Try the treadmill test
- Stretch your legs (so you don't feel sore)

Visit #4 (30-45 minutes)

Date: ___________________________ Time: ________________

What we will do today:

- Go to the Treadmill Lab:
    - Do the treadmill test (while wearing the mask and heart rate monitor)
- Stretch your legs (so you don't feel sore)
- We will talk about the results from the leg strength and treadmill tests

****an extra visit may be scheduled if more time is needed to practice any of the test protocols*

Appendix M
Fitness Test Results for Participants

Fitness Test Results

Name: ________________________________ Date: ____________________

Weight: ______________
Height: ______________
BMI: ______________

-------------VO_2 Test on the Treadmill -------------

VO_2 max: __________________

What *is* VO_2 max/peak (a.k.a. aerobic capacity & maximal oxygen consumption)? → The fastest that your body can move and use the air that you breathe (specifically, oxygen) during exercise that keeps getting harder. This tells me about your physical fitness. It is shown in litres of oxygen per minute (L/min) or in millilitres of oxygen per kilogram of your body weight (how much you weigh) per minute (ml/kg/min).

Resting heart rate (the speed that your heart beats when you are sitting quietly): ___

Peak Heart Rate (the fastest that your heart was beating): ____

What can you do to *improve* your fitness (i.e. get a higher VO_2 max value and decrease your heart rate when you are resting and when you are exercising)?

- Walking 10,000 steps each day
- Include strength and flexibility exercises into your day
- According to Canada's Guide to Physical Activity:
    - Doing at least 60 minutes of light activity per day (in bouts of at least 10 minutes). Light activities include golfing, light walking, stretching, and gardening.
    - Doing 30-60 minutes of moderate intensity activity. Moderate activities include fast walking, biking, softball, and dancing.
    - Doing 20-30 minutes of vigorous activity. Examples of vigorous activity include jogging, soccer, fast swimming, and aerobics.

Appendix N
Supports Intensity Scale

Instructions:
Identify the Frequency, Daily Support Time, and Type of Support that is reported necessary for the person to be successful in the six activity domains (Parts A-F). Circle the appropriate number (0-4) for each measurement. (See rating key below.) Add across each line [scores of frequency, daily support time, type of support] item to obtain the Raw Scores. Sum the Raw Scores down to obtain the Total Raw Score for each Part.

Rating Key
FREQUENCY: How frequently is support needed for this activity?
0 = none or less than monthly
1 = at least once a month, but not once a week
2 = at least once a week, but not once a day
3 = at least once a day, but not once an hour
4 = hourly or more frequently

DAILY SUPPORT TIME: On a typical day when support in this area is needed, how much time should be devoted?
0 = none
1 = less than 30 minutes
2 = 30 minutes to less than 2 hours
3 = 2 hours to less than 4 hours
4 = 4 hours or more

TYPE OF SUPPORT: What kind of support should be provided?
0 = none
1 = monitoring
2 = verbal/gestural prompting
3 = partial physical assistance
4 = full physical assistance

Complete ALL items, even if the person is not currently performing a listed activity.

Part A: Home Living Activities
1. Using the toilet
2. Taking care of clothes (includes laundering)
3. Preparing food
4. Eating food
5. Housekeeping and cleaning
6. Dressing
7. Bathing and taking care of personal hygiene and grooming needs
8. Operating home appliances

Part B: Community Living Activities
1. Getting from place to place throughout the community (transportation)
2. Participating in recreation/leisure activities in the community setting
3. Using public services in the community
4. Going to visit friends and family
5. Participating in preferred community activities (church, volunteer, etc.)
6. Shopping and purchasing goods and services
7. Interacting with community members
8. Accessing public building and settings

Part C: Lifelong Learning Activities
1. Interacting with other in learning activities
2. Participating in training/educational decisions
3. Learning and using problem-solving strategies
4. Using technology for learning
5. Accessing training/educational settings
6. Learning functional academics (reading signs, counting change, etc.)
7. Learning health and physical education skills
8. Learning self-determination skills
9. Learning self-management strategies

Part D: Employment Activities
1. Accessing/receiving job/task accommodations
2. Learning and using specific job skills
3. Interacting with co-workers
4. Interacting with supervisors/coaches
5. Completing work-related tasks acceptable speed
6. Completing work-related tasks with acceptable quality
7. Changing job assignments
8. Seeking information and assistance from an employer

Part E: Health and Safety Activities
1. Taking medications
2. Avoiding health and safety hazards
3. Obtaining health care services
4. Ambulating and moving about
5. Learning how to access emergency services
6. Maintaining a nutritious diet
7. Maintaining physical health and fitness
8. Maintaining emotional well-being

Part F: Social Activities

1. Socializing within the household
2. Participating in recreation/leisure activities with others
3. Socializing outside the household
4. Making and keeping friends
5. Communicating with others about personal needs
6. Using appropriate social skills
7. Engaging in loving and intimate relationships
8. Engaging in volunteer work