The effect of a 6-week progressive, combined resistance and cardiovascular training program on muscular strength, endurance, and body composition in young adults with a mild to moderate intellectual global delay

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Abstract

Individuals with an intellectual disability (ID) are defined as people who have significant limitation in both intellectual functioning such as learning and problem solving, as well as in adaptive behavior such as social and practical skills (Schalock et al., 2010). As a result of these issues they do not participate in regular physical activity and most exhibit a sedentary lifestyle leading to a multitude of health issues (Segal et al., 2016). In fact, Dixon-Ibarra and colleagues (2013) reported that only 6% of older adults (age 50+) and 13% of young adults (age 18- 49) with ID and were meeting daily activity guidelines on a regular basis. In previous research, a number of different approaches were implemented in order to improve the health status of these individuals (Boer & Moss, 2016; Carmeli et al, 2005; Temple & Stanish, 2008). However, the majority of the programs did not incorporate resistance training and only prescribed cardiorespiratory exercises at very moderate intensity (Sungmen et al, 2016; Tamin et al, 2015). Also, the two studies that did include a combination of resistance and cardiovascular training have not incorporated full body strength training (Carmeli et al, 2005; Temple & Stanish, 2008). In addition, the past programs devised for this population did not include the principle of progressive training, a crucial component of the American College of Sports Medicine (ACSM, 2017) exercise guidelines. Therefore, the purpose of this study was to investigate the effect of a 6-week, progressive combined training program on muscular strength, cardiorespiratory fitness, and body composition in young adults with a mild to moderate global delay (M= 23.1 years, SD= 2.29). The sessions were implemented 3 times a week for 1-hour sessions and incorporated full body resistance training with machine and free weights, followed by cardiorespiratory training (treadmill, stationary bike and elliptical). The progressive training principle was applied individually after the participants completed the first 3 weeks of the program. The participants

completed a 10RM seated chest and leg press, Legers 20m shuttle run and hip to waist ratio measurements at the pre-, mid- and post- times of the study. The analysis of the results showed a statistically significant improvement in upper body ($F (2) = 19.84$, $p < .0001$, $\eta^2 = .77$), and lower body strength ($F (2) = 18.00$, $p < .0001$, $\eta^2 = .75$), as well in cardiorespiratory fitness ($F (2) = 7.73$, $p < .007$, $\eta^2 = .56$). The analysis of the corresponding effect sizes confirmed that as the program continued more meaningful changes were emerging, particularly from the mid-test on. Likely, this was due to an increase in volume and intensity of resistance training after the 3-week midway test of fitness. However, no significant changes in body composition were evident across the testing time ($t (6) = 1.508$, $p < .18$, $d = .02$). This was to be expected as only 2 of the individuals were classified as overweight when the study began, and therefore most did not have excess fat to lose. The analysis of the individual profiles, across all the measures, confirmed the inferential analysis as 6 out of the 7 participants improved their 10RM seated chest press score between the pre- to post-test. The same 6 participants were also able to substantially improve their 10RM seated leg press scores between the pre- and post- tests. Finally, 5 out of the 7 participants were able to improve their score in the Leger shuttle run. Participant 7 was the only individual who did not show improvements across any domains of physical fitness tested.

The results from this study showed that individuals were able to make improvements in their fitness within just 6-weeks. This is in contrast to previous exercise programs for this population that showed improvements after a training period of 4-6 months (e.g., Guerra- Balc et al, 2015). This finding indicates that by implementing a progressive and combined type of training approach, individuals with ID can experience improvements in their fitness status at a faster rate, which is essential from a health as well as motivational perspective. This is likely due to the fact that the program combined full body resistance training which targeted all major muscle groups, as well as different forms of intense cardiorespiratory training. The principle of progression was also applied within the program in order to continue to challenge the participants throughout the duration of the study. Also, the data showed that participants experienced a more substantial improvement in strength measures when compared to cardiorespiratory improvements. This was to be expected as improvements in the former generally occur within the first 1-2 weeks of starting a resistance training program. This is due to a general neural adaptation made within the skeletal muscles which enhanced the contractile capabilities and synergistic relations between the different muscle groups (Jones, Rutherford & Parker, 1989). On the other hand, cardiorespiratory changes can be seen within the first 3-4 weeks and occur at a slower pace as compared to strength improvements, in particular when new exercisers are considered (White, 2017). These results carry practical implications that may supplement current exercise prescription methods for individuals with intellectual disabilities. They provide initial evidence that individuals with a mild to moderate global delay, as per ACSM (2017) guidelines, can benefit from exercise programs that incorporate progressive training involving both resistance and cardiorespiratory exercises. Also, as evident here, individuals with ID are capable of, and can benefit from participation in exercise programs that are physically more demanding than simply walking or light strength training.

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Intellectual Disabilities (ID)

Individuals with an intellectual disability (ID) are defined as people who have significant limitations in both intellectual functioning, such as learning and problem solving, as well as in adaptive behavior related to social and practical skills (Schalock & Borthwick- Duffy & Bradley, 2010). Approximately 1 to 3% of the global population has an intellectual disability and there are over 300,000 people in the Canada alone who have been diagnosed with an ID (National Institute of Health, 2017). The American Association on Intellectual and Developmental Disabilities (AAIDD) (2017) stated that limitations in intellectual functioning can be inferred through the use of an IQ test, where a score below 70 indicates such limitation. On the other hand, limitations in adaptive behavior are more commonly diagnosed by physicians observing a lack of cognitive, social and practical skills (AAIDD, 2017). Cognitive skills are defined as language, and money-related abilities as well as time and number conceptualization capabilities. Social skills are defined as the ability to follow rules, the degree to which someone is gullible, social problem solving and avoidance of being victimized. Consequently, practical skills are defined as the ability to complete activities of daily living such as personal hygiene, occupational skills, having and being able to follow schedules and routines, ability to use transportation/ travel as well as use of money and time (AAIDD, 2017). Over half of intellectual disability diagnoses cannot be captured as a specific syndrome and are therefore diagnosed as mild to profound global delay (American Psychiatric Association, 2014).

Defining Global Delay

There are many different types of intellectual disability. Some common types include Down syndrome (DS), autism, Asperger's and fetal alcohol syndrome (FAS). All of these intellectual disabilities are diagnosed based on a list of characteristics that are evident in each specific syndrome. While some of these are easy to identify, such as Down Syndrome due to the distinct physical characteristics, others may be more complex in their diagnosis (National Institute of Health, 2017). The term global delay has been assigned as a general label to describe people who have an intellectual disability that does not fall into a specific category or syndrome such as Down Syndrome or Autism (American Academy of Neurology, 2017). As a result of the high heterogeneity in the characteristics that may be present in an individual with an intellectual disability, a scale was developed to categorize the severity of the disability called the American Psychiatric Association Diagnostic and Statistical Manual for Mental Disorders (APA- DSM 5) used by physicians to infer the severity level of individuals who have a "Global Delay". A physician then assesses the severity of the condition using the APA-DSM 5 to categorize the global delay as either mild, moderate, severe or profound. This diagnostic tool separates activities of daily living into: conceptual, social and practical categories. Each category is then assessed to determine how much support an individual requires in order to meet the demands of each of these aspects of daily living.

A person with mild global delay is someone who needs support in all three sub-categories of the APA- DSM 5. Within the conceptual sub-category an individual is considered mildly globally delayed if they require assistance with activities related to academic skills such as reading, writing, arithmetic or money. It is also expected that the person may exhibit an impairment in planning, prioritizing, and strategizing, as well as in his/her ability to use short term memory. He/she may also have difficulty with the functional application of academic skills such as proper use of money, which is taught at the elementary school level (APA-DSM 5, 2017). Within the social sub- category of the APA-DSM 5, an individual is considered to have a mild global delay if they have “difficulty accurately perceiving peers’ social cues” (p.34). He/ She may have difficulty regulating emotion and behavior, as noted by peers while involved in social situations. In social settings, individuals with mild global delay would exhibit immature social judgements. These individuals also have a limited understanding of risk in social situations; their social judgement is immature for their age and he/ she is at risk of being manipulated by others (APA- DSM 5, 2017). In the final sub- category coined as practical behavior, the individuals are assessed based on their functional abilities in different aspects of daily living. Subsequently, they are categorized as having a mild global delay if they need some support with complex daily living tasks such as grocery shopping, transportation, nutritious food preparation, money management and banking. However, the individuals may function in an age-appropriate manner with regards to personal care and hygiene. Recreational skills would typically resemble those of their normally developing counterparts for people diagnosed with mild global delay. Also, the individuals may be able to maintain meaningful employment as long as the context does not require a high level of conceptual skills (APA- DSM 5, 2017). Overall, a diagnosis of mild global delay will be assigned when an individual requires little to no support with activities of daily living. These people can typically live an independent life but may require some support with decision making.

Moderate global delay is diagnosed using the same criteria as mild global delay. However, there are some differences in the support required by the individual and his/her level of development in comparison to people diagnosed with a mild global delay. It is expected that development within the conceptual domain for individuals with a moderate delay lags noticeably behind their typically functioning peers. Their progress in reading, writing, math, time management and understanding of money occurs slowly across their school career and is significantly delayed. For adults, academic skills typically only reach an elementary level and support is required for the use of these skills in work and personal life (APA-DSM 5, 2017). Socially, people diagnosed with a moderate global delay, exhibit limited use of spoken language, may not perceive or interpret social cues accurately and need assistance with life decisions such as social judgements. In the workplace, significant assistance is also required in order to function successfully. Finally, in the practical category, which assesses independence in activities of daily living, people are considered moderately delayed if they display the need for constant reminders and an extensive amount of time is taken to teach them these skills. Skills such as eating, dressing, personal hygiene and use of the washroom can be conducted by the individual but only with extensive practice. The individual may reach a point where he/she can participate in household activities of daily living such as cleaning and cooking for themselves in adulthood. However, an extensive period of time is needed to teach the individual these skills and some ongoing support may be needed for reminders throughout their adult life (APA- DSM 5, 2017).

Health and Intellectual Disability

The ability to live independently and transition from a protected childhood life to that of a self-sufficient adult is a constant goal for people living with an ID and their families (Leonard, Foley, Pikora, & Bourke, 2016). A key factor in a successful transition into independent living is an individual's ability to complete activities of daily living (ADL's). Those generally include personal hygiene, dressing, cooking and cleaning (Leonard et al., 2016). The transition to independent living is important for those with ID because it creates a sense of fulfillment, allowing for life skill development- such as the independent completion of ADL's- and may lead to employment opportunities (Leonard et al, 2016). According to a study by Foley, Jacoby and Girdler (2013) one of the main setbacks these individuals face in this transition is their poor health. Obesity, muscular weakness and a lack of gross motor skills represent some of the main limitations these individuals face when attempting to transition to independent living (Foley et al, 2013). Aside from preventing them the opportunity to live independently, these factors have a harmful effect on their overall quality of life and longevity. Therefore, having a higher rate of health complications and decreased function, places individuals with an intellectual disability at risk of having a shorter lifespan as compared to the members of the general population.

Sedentary lifestyle.

Living a sedentary lifestyle represents the primary threat to people with ID's well-being above all of the many other contributing factors to poor health exhibited by people with ID (Segal et al., 2016). It has been shown that individuals with ID have a lower participation rate in physical activity than their typically developing counterparts at all stages of life from childhood through adulthood (Koritsas & Ianco, 2016). In a recent study, Dixon-Ibarra and colleagues (2013) reported that only 6% of older adults (age 50+) and 13% of young adults (age 18- 49) with ID and were meeting daily activity guidelines on a regular basis. When compared to a national estimate released by the Center of Disease Control and Prevention in 2016 that 22% of the general population is meeting the recommended activity guidelines of 150 minutes of moderate to vigorous physical activity per day these statistics are particularly low. A lack of regular physical activity increases an individual's risk of obesity, cardiovascular disease, diabetes and muscular atrophy (Segal, Eliasziw, & Phillips, 2016). Prevalence of these health-related risks are already high among those with ID as previous literature has shown (Segal et al.,

2016) and a lack of participation in any form of physical activity adds to the high probability they will experience poor health (Sugmin, Byoungjin & Heejung, 2016).

Obesity.

Although there are many health risks associated with having an intellectual disability (e.g., higher likelihood of having metabolic syndrome, diabetes and cardiovascular disease), obesity represents one of the most critical threats to the health of these individuals (Room, Timmermans, & Roodbol, 2016). In fact, the risk for obesity is almost double as compared to that of their typically developing counterparts (Segal et al, 2016). This is a troubling fact because being overweight or obese places an individual at a greater risk for other diseases, which could lead to a lower life expectancy. According to Segal and colleagues, "the prevalence of obesity among school aged children with ID was 28.9% compared to 15.5% among children without ID. Children with ID were 2.22 times more likely to be obese". This high rate of obesity may prevent these children from being physically active resulting in future complications such as joint pain, respiratory problems, feelings of fatigue and inability to perform even seemingly simple movements (Katz, McHorney & Atkinson, 2000). As childhood obesity is a predictor of obesity in adulthood, these findings show that a population with ID needs a method to combat this predisposition. All of these complications may affect a person's ability to perform ADLs as an adult, which in turn would affect their overall quality of life from a physical, social and psychological standpoint.

Muscular atrophy.

Muscular strength represents an important component of physical fitness. Research has shown that individuals with ID have lower levels of muscular strength and muscle tone as compared to a typical population (Carmeli, Imam & Merrick, 2012). Thus, muscular atrophy represents another health risk that may negatively affect the ability of individuals with ID to live independently. In the general population, muscular atrophy begins to emerge later in life and the process can be delayed through participation in regular physical activity (Kortisas & Ianco, 2016). However, among individuals with ID this process may begin at a younger age and is likely due to low levels of physical activity (Carmeli et al., 2012). The study by Carmeli et al, (2012) found that in a population of adults with ID, upper body strength (biceps, chest, hand grip) was much lower than lower body strength (quadriceps) relative to individual body weight. However, both upper and lower body strength were noticeably lower than that of a general population (Carmeli et al, 2012). Therefore, this study concluded that total body muscle mass and strength needed to be improved in order to combat the negative effects of early muscular deterioration (Carmeli et al, 2012). Bastiaanse, Hilgenkamp, Echteld and Evenhuis (2012) compared the rate of sarcopenia (loss of skeletal muscle mass and strength) among older adults with and without ID. It was reported that a population of 884 people with mild to profound ID experienced a 14.2% rate of sarcopenia as compared to the same age population without ID, as they only experienced a 9% rate of sarcopenia (Bastiannse et al., 2012). However, this study also noted that with consistent resistance training the rates of sarcopenia can be significantly lowered. According to the National Institute of Health (2017), the best way to delay the onset of sarcopenia is to participate in regular resistance training at least 3 times a week targeting all major muscle groups.

Barriers to Physical Activity for Individuals with ID

Leaving the schooling system.

Some of the main barriers to physical activity for people with ID are lack of money, transportation and accessibility of inclusive facilities (Leonard, Foley & Pikora, 2016). Aside from lack of motivation and physical constraints, individuals with intellectual disabilities typically have lower physical activity rates also due to lack of availability of fitness facilities and programs that accommodate their needs (Sungmin et al., 2016). Typically, once an individual with an intellectual disability graduates from the schooling system (e.g., elementary or high school), their physical activity levels significantly decrease (Queralt et al., 2016). Therefore, it is expected that there would be a substantial decline in physical activity participation occurring after the age of 18. It has been suggested that school based physical activity (recess, gym class and play) accounts for over 50% of the exercise that these individuals receive (Queralt et al., 2016). Therefore, there is a decrease in participation in physical activity after the age of 18 because these individuals no longer have access to these facilities once they leave high school (Sungmin et al, 2016). A decrease in physical activity rate after high school is also due to the fact that being physically active is no longer a regularly scheduled activity in their day to day lives (Sungmin et al, 2016). Due to this significant drop in physical activity after high school, individuals with ID need an alternative method of maintaining and improving their physical capabilities as they progress through adulthood. Introducing an exercise intervention after high school by providing access to facilities and a continuation of regularly scheduled activity, can enhance the likelihood of lifelong adherence to exercise (Sungmin et al., 2016).

Comprehension and instruction.

In order for an individual with ID to adhere to an exercise program it must be easy to comprehend (Guerra- Balc et al., 2015). It has been shown that if a movement requires excessive instruction and has multiple components it is less likely to be performed properly by an individual with ID (Sungmin et al., 2016). In a recent study by Schijndel- Speet, Evenhius, Wijck and Montfort (2017) males and females with intellectual disabilities were divided into two groups and provided with different exercises and instruction. The first group was given thorough verbal instruction and support throughout the entire exercise program which involved single joint movements such as bicep curls or leg extensions. The second group was given minimal verbal instruction at the beginning of the session and multi-joint complex movements such as dumbbell thrusters and burpees. This result showed that there was a significantly higher participation rate among individuals included in the group performing movements under constant verbal instruction. Although this study concluded that the single joint movements were easier for individuals with ID to adhere to, it also concluded that having constant verbal instruction throughout any of the movements, significantly increased success rates (Schijndel- Speet et al, 2017). The systematic review by Lang, Koegel, Ashbaugh and Regerster (2010) confirmed that the most effective instructional method to enhance understanding and participation of individuals with ID was to provide them with constant verbal feedback throughout a movement or task. This instructional method allowed for the participants to complete the activity properly and safely (Lang et al., 2010). This study reviewed instructional methods in 18 different studies when teaching exercises to individuals with ID. It was concluded that the most common and effective teaching method used in the studies was modeling and verbal reinforcement throughout a movement (Lang et al, 2010). Therefore, in order to ensure that participation in physical activity is accessible for all individuals with ID, it must be delivered in a way that is easy for them to understand.

Physical Fitness and Activity

Physical activity refers to any movement made by the body that requires energy expenditure ranging from walking or dancing to playing basketball or biking (World Health Organization, 2017). Typically, as an individual increases his/her physical activity levels, their physical fitness levels are also enhanced (Steinback, 2001). Physical fitness can be defined as the ability to perform movements associated with sport, occupation and activities of daily living without excess fatigue (Caspersen, Powel & Christenson, 1985). A person's overall fitness level can be described on a scale from low to high (Caspersen et al., 1985). Generally, a person with a high level of physical fitness is able to perform most movements associated with work, sport and daily living with ease. The degree to which a person is physically fit is directly associated with an individual's amount of participation in physical activity. Physical fitness levels can be operationalized based on five different components which include: muscular strength and endurance, cardiorespiratory endurance, body composition and flexibility (World Health Organization, 2017).

Measuring muscular strength, cardiorespiratory endurance and body composition for individuals with ID

The three constructs of interest for the purpose of this study are muscular strength, cardiorespiratory endurance and body composition. The first component of fitness is muscular strength which is defined as the amount of external force a muscle can apply in a single contraction. Muscular strength is important in daily life and is used in many different activities. It is important for an individual with an ID to maintain a high level of muscular strength in order to perform ADLs independently. Common activities of daily living that require muscular strength that benefit this population are: lifting household objects to clean, carrying groceries, opening jars of food and the ability to go from a sit to stand position.

There are numerous ways to measure muscular strength, however, the most common is a 1 repetition maximum test (Levenger, Goodman, & Hare, 2007). However, a 10-repetition maximum test has been shown to be a safer method of testing muscular strength for a population with ID (Karinharju, 2005). It has also been determined that this measurement approach has a high reliability and validity when employed with this population (ACSM, 2000; Karinharju, 2005; Keskinen et al, 2004). Lavay et al. (1995) also concluded that a 10-rep max test was a reliable strength measure when used with male and female adolescents with mild to moderate ID. In this testing method the individual would be asked to perform an exercise with a weight with which they can only complete 10 repetitions. According to the CSEP guidelines, they are allowed 3 trials to achieve the highest weight. This protocol involves starting with an unweighted set of the exercise. It is recommended to use weight machines for testing a 10 RM in a population with ID (ACSM, 2017). Therefore, if a seated leg press was being used to test lower limb muscular strength, the individual would perform a warm up set with no weight. This would be followed by adding a weight the participant can complete for 10 repetitions. If that is the absolute maximum amount of weight the participant can perform for 10 full repetitions, then the test would stop. If the participant believes he/she can add more weight and perform the same amount of repetitions, then he/she would have two more sets to achieve a maximum weight lifted for that exercise, with 2 minutes rest between each trial to avoid muscle fatigue.

Another important construct of physical fitness is cardiorespiratory endurance. Cardiorespiratory endurance refers to the ability of the circulatory and respiratory system to supply the body with sufficient energy during prolonged periods of physical activity in order to maintain that activity. When the heart, lungs and blood vessels efficiently carry large amounts of oxygen throughout your body you are considered to have a high aerobic capacity.

Cardiorespiratory endurance can be measured through a variety of different tests which indicate an individual's aerobic capacity. One of the most commonly used tests to infer aerobic capacity is a VO_2 max test (Bassett, 2000). Having a high VO_2 max level indicates that a person is able to use a large amount of oxygen during intense maximal exercise, which in turn is taken as an indication of a high level of cardiorespiratory fitness. VO_2 max can be measured in many ways including the Legers shuttle run, 3-minute step test or a 12-minute walk test (Pentry, Wilcox & Yun, 2011). Based on the review of literature it appears that the Leger shuttle run is the most common field test used to estimate VO_2 max for individuals with ID (Fernhall, Miller, Pitetti, Heusen & Vukovich, 2000; Gillespie, 2009; McCubin, Rintala & Frey, 1997; Montgomery, Reid & Koziris, 1992). The test is easy to complete in any environment and does not require complex equipment, which creates a less formal testing environment that is beneficial for individuals with ID (Gillespie, 2009). For a population with ID, it is important to ensure that testing instructions are easy to understand and comply with, in order to ensure accurate results, which is true for the Leger 20-meter shuttle run (Karinharju, 2005). Fernhall et al, (2000) concluded that the 20-meter shuttle run is a valid test of cardiorespiratory fitness for children and adolescents, both male and female with mild ID. Gillespie (2009) also confirmed that the shuttle run produces reliable results when used on a population with ID. This testing method involves the participants moving back and forth between two cones which are positioned 20 m apart along with the pace set by the audio track. A sound signal is emitted from the recording to indicate to the participant that he/she can cross the 20-meter distance from one cone to the next. The frequency of the sound signal is increased 0.5 km/h for each level achieved starting from a speed of 8.5 km/h. The test ends when the participant can no longer cross the 20-meter distance to the pace set by the tape. The final level that is achieved is then recorded and used to compare to normative data to find the estimated VO_2 max. The results can also be used to determine progress by comparing results across time (Gillespie, 2009). For example, as each level increases 0.5 km/h in running speed, if an individual improves from level 7 to a level 9 he/she was able to increase their final running speed from 12km/h to 13km/h. Each level involves running the 20-meter distance ten times. Therefore, if an individual increases his/her final level from 7 to 9 they are able to run an extra 400-meters. Using the final level achieved to determine if any improvements were made has been shown to be a valid measurement of cardiorespiratory fitness for a population with ID (Fernhall et al, 2010; Gillespie, 2009; Karinharju, 2005). By analyzing the difference between final running velocity and total distance completed it can provide context to the information given in the shuttle run. For example, if a participant increased his/her shuttle run score from level 2.3 to level 2.4 he/she would have run an extra 20 meters. Which would not be considered a large increase. However, if he/she increased his/her final distance by 400m that would be considered a large increase (Gillespie, 2009). A study by Oppewal et al (2013), found that this testing method was beneficial because all individuals could participate, the instructions were easy to follow and the movements required (walking/ running) were easy for most individuals with a mild to moderate global delay to complete.

Another component of physical fitness is body composition. This relates to the relative amount of muscle, fat, bone and other vital tissue an individual has. Body composition is typically measured by comparing the percentage of body fat to the percentage of fat free mass. Fat free mass includes muscle, water and other vital tissue mass (Lee, Blaire, Jackson, 1998). There are numerous ways to determine an individuals' body fat percentage, including: hip to waist ratio, skinfolds, the BOD POD and dual energy x-ray absorptiometry (DEXA). The most common method of measuring body composition for a population with ID is waist circumference or skinfolds because they are the two most accessible and least invasive tests for these individuals (Fox & Rotatori 1982; Kelly, Rimmer & Rosentswieg 1987; Pitetti et al. 1988; Stalker, 2012). The use of hip to waist ratio as a tracking method for body composition has been shown to be a more reliable representation of overall body composition than skin calipers (Stalker, 2012). Kelly et al, (1987) stated that the accuracy of the hip to waist ratio is dependent on the measurement itself and the skill of the measurer. However, Pitetti et al (1998) concluded that these measurements produce valid and reliable results when the same person is performing all of the measurements following the same procedures. Therefore, using hip to waist ratio produces accurate results on a population with ID and has been found to be an appropriate testing method because it is simple and easy to administer (Karinharju, 2005; Pitetti et al, 1988; Kelly et al, 1987; Stalker, 2012). Pitetti et al. (1988) concluded that this form of testing is easy to perform on participants with ID and it would be a logical test to use to determine the body composition of males and females with ID.

Improving Muscular Strength, Cardiorespiratory Endurance and Body Composition in Individuals with ID

Resistance training.

Having an appropriate level of muscular strength is important because most activities of daily living require some form of strength (Brill, Macera, Davis, Blaire & Gordon, 2000). Participating in regular strength training has many benefits. Aside from improving muscular strength, it also has positive effects on increasing bone density, prevention of chronic diseases, also improving mobility and posture among many other health benefits (Chanias, Reid & Hoover, 1998). Among the elderly, a low level of muscular strength has been associated with an increased risk for diseases such as osteoarthritis, as well as an early onset of overall physical decline (Brill et al, 2000). In order to maintain a high level of muscular strength, it is recommended that individuals participate in regular strength building activities such as resistance training (Chanias et al., 1998). Resistance training can include use of free weights, weight machines or body weight training (Chanias et al.,1998). The American College of Sports Medicine (ACSM) guidelines for strength training recommends participating in resistance exercises a minimum of twice a week for beginners and up to five times a week for increased gains in strength (ACSM, 2017). These guidelines also recommend including 8-10 different exercises that target all major muscle groups for a balanced workout program. These exercises should be performed for 8-12 repetitions in 2-4 sets (ACSM, 2017). Therefore, in order for an individual to improve muscular strength they must participate in regular physical activity involving resistance training in accordance with these guidelines (ACSM, 2017).

In the current literature pertaining to the most beneficial way to increase the physical fitness of those with ID, interventions involving a six to eight-week program have been implemented. These studies generally found that a program lasting at least 6 weeks involving cardiovascular training with supplemental light lower limb resistance training improved the physical fitness of those with ID (Boer & Moss, 2016; Carmelli, Zinger- Vaknin & Morad, 2005; Temple & Stanish, 2008). All of the previous studies did not include a balance between resistance and cardiorespiratory training where both forms of exercise were equally prescribed. In contrast, they maintained a primary focus on cardiorespiratory training as the most important aspect of the exercise program. One study by Temple and Stanish (2008) prescribed body weight resistance exercises as the main method of improving lower limb strength, including air squats, unweighted single leg step ups and birddogs. In this study, the exercises were completed three times a week in 3 sets of 10-15 repetitions. Temple and Stanish (2008) did not include upper limb strengthening exercises. This type of training was excluded as the researchers aimed to target larger muscle groups and when combining resistance training with cardiovascular training, did not want to fatigue these individuals (Temple & Stanish, 2008). The results showed that a combination of lower body resistance and cardiorespiratory training was effective in improving both leg strength as well as cardiorespiratory fitness for individuals with ID. Therefore, implementing a lower limb resistance training program within ACSM guidelines for sets and repetitions can improve muscular strength for individuals with ID. In a different study by Carmeli et al, (2005) 22 individuals with global delay between the age of 18-50 participated in seven different strength training exercises three times a week for 6 months. Five of the exercises involved lower limb strength machines (quadricep extension and flexion, ankle plantarflexion, hip extension and hip flexion), and the other two exercises were geared to abdominal training. All of the exercises were performed in 2 sets of 10 repetitions. This study also aimed to target only the major muscle groups for resistance training and did not include any exercises for upper body strengthening. After the 6-month program the individuals showed a significant improvement in overall lower limb strength (Carmeli et al, 2005).

The majority of the studies involving exercise interventions for people with ID focused on lower limb resistance training as the main method of improving strength (Carmelli, Zinger-Vaknin & Morad, 2005; Temple & Stanish, 2008). Therefore, there is a gap in the literature examining the effectiveness of full body resistance training programs in accordance with the ACSM guidelines for improving muscular strength.

Cardiorespiratory training.

Aside from muscular strength, it is also important to maintain a high level of cardiorespiratory fitness. Having a high level of cardiorespiratory fitness can decrease a person’s risk for cardiovascular disease, help maintain a healthy body weight, increase bone density, reduce blood pressure as well as improve energy efficiency (Pentry et al., 2011). In order to maintain a high level of cardiorespiratory fitness, an individual must participate in activities that engage the cardiovascular system (heart, lungs and blood vessels). Some cardiorespiratory exercises that aid in improving fitness include: walking, biking, running, swimming or dancing (Pentry et al., 2011). The ACSM recommends that adults participate in 150 minutes of moderate intensity exercise per week to maintain a high level of cardiorespiratory fitness. It is recommended that cardiorespiratory training should occur three to five times a week for 20-60 minutes in each session depending on the individual's fitness levels (ACSM, 2017). These cardiorespiratory exercises can be any form of physical activity that elevates the heart rate to 55-85% of an individual's maximum heart rate for the duration of the training time. A gradual increase in exercise time, frequency and intensity is recommended for maximum training benefits (ACSM, 2017).

For individuals with intellectual disabilities the majority of exercise interventions focused primarily on cardiovascular training as the only method of improving their fitness levels. Steady state cardiovascular training is the most common form of intervention used for people with ID (Tamin et al, 2015). Studies have been conducted on the effectiveness of interval training (Boer & Moss, 2016), steady state training (Tamin, Idris, Mansuyer & Soegondo, 2015) and simple exercises such as walking (Sungmen, Byoungjin & Heejung, 2016). Walking is an activity that is relatively easy for the majority of the population with ID as it is not complicated to explain or understand (Sungmen et al., 2016). Therefore, the majority of exercise programs that were administered to improve the cardiorespiratory fitness of people with ID, focused on steady state walking as the main form of training. (Tamin et al, 2015; Sungmen et al, 2016). The study by

Tamin et al (2015), used a steady state cardiorespiratory training program to improve VO_2 max levels of 212 participants with ID, between the ages of 10 to 30. The study used brisk walking at 60-80% MHR for either 20-25 minutes or 25-30 minutes. Tamin et al (2015), found that both groups saw an improvement in their VO_2 max levels and concluded that this form of training was simple and effective at improving overall VO_2 max levels for this population. Another study which confirmed that walking is a very effective method of exercise for individuals with intellectual disability was carried out by Sungmen, Byoungjin and Heejung, (2016). This study involved 9 participants, both males and females, with ID who participated in 100 minutes of walking 3 times a week, for 4 months. This study concluded that walking was able to elicit improvements in the cardiovascular fitness of individuals with ID. It also found that due to the fact that walking can be done by most people regardless of their age, fitness level or technique with low risk of injury it is a safe, suitable and effective form of cardiovascular exercise for individuals with ID. (Sungmen, Byoungjin & Heejung, 2016).

In a different study involving 44 individuals with ID over the age of 18, steady state cardiovascular and interval training were compared to determine the most effective method of improving VO_2 max and decreasing body fat percentage (Boer & Moss, 2016). Steady state cardio training involved cycling or walking at 60-70% maximum heart rate (MHR) for 20 consecutive minutes. On the other hand, the interval training involved 20 minutes of cycling or walking completing 10-30 second all out sprints, followed by 90 seconds of low intensity walking or cycling that was completed at 1:3 work to rest ratio. The researchers concluded that an interval training method for those with intellectual disabilities was more effective in improving cardiovascular fitness than regular steady state cardio training. However, steady state cardio was viewed as a “more realistic” training method for this population (Boer & Moss, 2016).

The third important component of physical fitness aside from muscular strength and cardiorespiratory endurance is body composition. It is important to maintain a healthy body composition. This is particularly true for individuals with ID as they are at a greater risk of diabetes, obesity, cardiovascular disease and joint pain (Lee, Blaire & Jackson, 1998). Maintaining a healthy body composition has also been related to improved quality of life, effectiveness and efficiency of movement and to increased longevity (Chanais, Reid, & Hoover, 1998). In order to maintain a healthy body composition, it is necessary to participate in regular physical activity and eat a healthy well-balanced diet (Jeukendrup & Gleeson, 2010). The acceptable body fat percentage in the 18-25 age category for females is between 8-30%, and for males it is between 5-20% (Jeukendrup & Gleeson, 2010). Many of the exercise intervention studies conducted on individuals with ID aimed to improve their body composition as well as their overall fitness (Boer & Moss, 2016; Carmeli et al, 2005; Sungmen, Byoungjin & Heejung, 2016; Tamin et al, 2015). A meta- analysis conducted by Shin and Park (2012), reviewed the effects of exercise programs on individuals with ID. This review concluded that participating in physical activity 3 or more times a week aided these individuals in maintaining a healthy body composition. Generally, the programs that were the most effective in decreasing excess adipose tissue were the programs that were longer than 6 months in duration. This was due to the fact that it took approximately 3 months to see a decrease in body fat, and studies that did not control for nutrition of the participants had a slower rate of weight loss amongst participants (Shin & Park, 2012). This analysis also noted that the main form of exercise prescribed to combat overweight and obesity amongst people with ID was walking. Although regular exercise has been shown to help maintain a healthy body composition for this population (Shin & Park, 2012), other studies have concluded that there have not been significant decreases in overall body fat through simply walking as the only method of weight control (Stanish & Draheim, 2007). The study by Stanish and Draheim (2007) analyzed the walking patterns of 103 overweight or obese individuals with ID to determine the effectiveness of walking as a weight loss tool. The study found that individuals who walked more did not have a significantly healthier body composition. They also stated that the intensity of walking as the only form of exercise may have been inadequate for individuals to achieve health benefits.

Combining cardiorespiratory and resistance training.

Although there have been numerous studies conducted on the effects of simple exercises, such as walking, on well-being of individuals with intellectual disabilities (Boer & Moss, 2016; Sungmin, Byoungjin & Heejung, 2016; Temple & Stanish, 2008) there are very few that investigated the effectiveness of a combined workout program. More specifically, there is a lack of research into the effectiveness of combining full body resistance and cardiorespiratory training to improve the overall physical fitness of individuals with ID. This fact could be due to the assumption that individuals with ID are not able to perform intense exercise. There have been only two previous studies that have implemented a combined resistance and cardiorespiratory training intervention. The results of these studies showed that combining lower extremity muscular endurance exercises followed by steady state cardiovascular exercise can improve the overall fitness levels of those with ID (Guerra-Balc et al., 2015; Wu, Lin, Hu & Yin, 2010). For example, one of the studies by Guerra-Balc et al, (2015) found that both males and females with a mild to moderate global delay over the age of 18 exhibited significant improvements when involved in a four month, three times per week workout routine. This workout routine combined lower extremity body weight strength exercises as well as light to moderate walking. In this study, moderate walking at about 50-60% of a max heart rate, for over twenty minutes three times a week proved to be an effective method of improving participants' cardiovascular capacity (Guerra-Balc et al., 2015). In the other combined training study carried out by Wu and colleagues (2010) 146 males and females with mild ID participated in an exercise program which included strength and cardiorespiratory training three times a week for 6 months. The strength training involved sit ups, pushups, air squats, v-holds and step ups, which were performed for 3 sets of 15 repetitions each. These strength sessions were then followed by 20 minutes of steady walking. The study found that at the end of 6 months period there was a decrease in BMI and an improvement in the sit up and push up performance (Wu et al., 2010). Therefore, there is some initial evidence that indicates that combining both strength training and cardiovascular training can be an effective method to improve the physical fitness of individuals with an intellectual disability. Nevertheless, no current research has incorporated the progressive training principle into their exercise programs which may result in further positive health impacts for individuals with ID.

Progressing a Training Program

ACSM (2017) guidelines state that in order to obtain maximum training benefits, a gradual increase in the intensity and volume of exercise should be implemented. This is a well-known training principle which has been implemented in many research studies involving elite athletes (Peterson, Rhea & Alvar, 2004), youth (Faigenbaum, Westcott, Loud & Long, 1999), and the elderly (Sylliaas, Wyller & Bergland, 2013). However, all of the current training interventions for people with ID prescribe activity that remains the same throughout the course of the intervention. ACSM guidelines indicate that there should be a slow increase in intensity or frequency of the exercises after the first 2 to 4 weeks of training. For example, for a beginner exerciser, their cardiorespiratory training should start at 45-55% MHR and increase it to 55-65% MHR, and continue to increase as individuals make improvements.

The progressive training principle also applies to resistance training. In order for an individual to make maximal gains in strength, their bodies need to be continuously challenged. All of the exercise interventions that incorporated lower limb weight training for individuals with ID also maintained the same intensity levels of training throughout the program (Carmeli et al, 2005; Guerra-Balc et al., 2015; Temple& Stanish, 2008; Wu, Lin, Hu & Yin, 2010). However, according to ACSM guidelines, in order to see maximum benefits in strength it is important to implement a progressing training model (approach). It is recommended that after the first 2 to 4 weeks a 10% increase in weight should be encouraged for each exercise (ACSM, 2017). Also, it is recommended that beginner exercisers should start with 2-3 sets of 12-15 repetitions of each exercise at 60-70% 1RM. After 2-4 weeks of consecutive muscular strength training that intensity can be increased to 3-4 sets of 8-12 repetitions in order to elicit maximal benefits of training.

Overall, it is evident that individuals with ID are at a higher risk of negative health complications such as obesity, cardiovascular disease and muscular atrophy (Bastiannse et al., 2012; Room, Timmermans, & Roodbol, 2016; Segal et al, 2016). It is encouraging that many research studies have been devoted to enhancing the overall physical fitness of these individuals in order to combat the negative health complications these individuals face. However, none of these research studies have explored the effectiveness of a combined full body resistance and cardiorespiratory training program that applies a gradual progression in intensity in order to maximize health benefits. This type of progressive and combined exercise training has historically been prescribed for many typically functioning populations from the general public to elite athletes (Haskell, Montoye & Orenstein, 1985). These typically functioning populations experience a multitude of health benefits from participating in regular resistance and cardiorespiratory training that is prescribed at a high intensity and volume (Haskell, Montoye & Orenstein, 1985). Whether or not individuals with an ID can experience the same health benefits through participation in similar exercise prescription methods that are applied to a typically developing population, has not been explored in the current literature.

Purpose

Therefore, the primary purpose of the study is to investigate the effect of a 6-week, progressive, combined training program on muscular strength, cardiorespiratory fitness, and body composition in individuals with a mild to moderate global delay. The aim of this research is to determine if the participants will demonstrate an improvement in these three categories.

Hypotheses

It was hypothesized that after the 6-week intervention, individuals would show an improvement in muscular strength. This would be demonstrated through an increased 10 repetition maximum in both the upper body measure (seated chest press) and lower body measure (seated leg press) between pre-test and post-test measures.

A second hypothesis for this study was that after the 6-week intervention individuals would show an improvement in cardiorespiratory fitness. This would be demonstrated through an improved score between the pre- and post-test Leger 20-meter shuttle run.

The final hypothesis for this study was that after the 6-week intervention individuals would show an improvement in overall body composition. This would be demonstrated through the results of the hip to waist ratio measurements indicating an improvement in body composition.

Methodology

Participants

This study involved seven participants from the Thunder Bay Special Olympics community both males and females between the age of 18-25 years old. This age range was selected because this is typically the age when individuals with ID physical activity levels drastically decrease once graduating from high school (Queralt et al., 2016). The participants had been previously diagnosed with a mild to moderate global delay intellectual disability by a physician through the use of the Diagnostic and Statistical Manual of Mental Disorders (APA DSM-5). The APA DSM-5 defines mild intellectual disability through the following characteristics: “Individuals in this group are mostly self-sufficient with some supports and in many cases, they can live independently within their communities. These supports might include assistance with life decisions. Additional time, instructions, and reminders may be needed for other life skills such as finances, nutrition, shopping, and transportation.” (APA DSM-5, pg 34). Similarly, the APA DSM-5 defines moderate intellectual disability by stating that these individual’s social cues, social judgment, and social decisions regularly need support. Most self-care activities can be performed independently but may require extended instruction and support from others. Likewise, independent living may be achieved with moderate supports such as those available in group homes. As mild and moderate global delay make up 95% of the combined diagnosis for intellectual disability, these were the two categories that were included in this study. The participants had also not participated in any regular resistance or aerobic training more than twice a week for the previous 4 weeks. Finally, they were all cleared to participate in physical activity using the physical activity readiness questionnaire (Par-Q+).

Individuals with a diagnosis of severe or profound global delay were excluded from this study because the intervention required a certain level of independence and understanding from the participants. Also, individuals who had a physical disability, such as cerebral palsy, spinal injuries, muscular dystrophy or scoliosis, that would have prohibited them from being able to complete the movements required from the set training intervention, were excluded. Any person who had an injury within the last 3 months that had prevented them from participation in their regular Special Olympics activities were also excluded from the study. Finally, any person who had a preexisting condition that may have been aggravated or made worse by beginning an exercise program was not asked to take part. The examples of conditions that would have excluded a person from this study were coronary artery disease, fibromyalgia, autoimmune disease and cardiovascular disease.

Recruitment

Purposive sampling was used according to the inclusion criteria, from the Thunder Bay Special Olympics community. There are over 300 individuals with various intellectual disabilities from ages 10-80 who participate in different Special Olympics sports in Thunder Bay, Ontario. This program offers over 15 different recreational sports for people with intellectual disabilities to participate in throughout the year. Typically, individuals participate in one sport which takes place once a week in a 1-hour recreational session. A total of seven individuals both male and female, between the age of 18-25 were recruited through purposive sampling from the Thunder Bay Special Olympics community. An initial contact letter (Appendix A) was sent to the head of Special Olympics Thunder Bay, Denita Minoletti to ask permission to approach the athletes within the program. Once permission was granted, the initial contact e-mail (Appendix B) was sent to all the parents and athletes of the appropriate ages, inviting them to stay after the next Special Olympics practice to hear more about the study, if they were interested. This e-mail provided a brief description of the study and indicated that if any of the athletes were interested in learning more about the study, they may stay after the next Special Olympics Basketball practice, which was held at Ecole Gron Morgan elementary school, for a meeting with the researcher in one of the empty classrooms. At this meeting all of the interested participants received a recruitment letter (Appendix C) containing all of the pertinent information about the study including dates, times and location of the exercise program. Parents or caretakers of these athletes were included in the conversation and also received a copy of the recruitment letter (Appendix D). This was done to ensure that the potential participants could have a close family member explain any part of the study they may not have understood. During this meeting, the study was described to potential participants and their caregivers, and interested participants were asked to write down their name and contact information on a sheet for the researcher.

Instruments

The three components of physical fitness that were tested within this study were: cardiovascular endurance, muscular strength, and body composition. The cardiovascular testing was done using the Legers 20m shuttle run (Leger & Mercier & Gadoury, 1987). Muscular strength was tested through the 10-repetition maximum in the seated leg press (lower body strength) and seated chest press machine (upper body strength). Finally, body composition was measured through the use of hip to waist ratio (Stalker, 2001).

The Leger 20-meter shuttle run was used for this study to assess cardiorespiratory fitness because it was a simple test to administer and was safe for the population. The 20-meter shuttle run is a multistage test that is designed to estimate maximal aerobic power (Leger & Mercier & Gadoury, 1987). Each participant was asked to run back and forth between two cones set up 20 m apart from one another following the pace set by the audio recording. A sound signal was emitted from the prerecorded audio file to indicate to the participant that he/she could run the 20-meter distance from one cone to the next. At the sound of each beep emitted from the CD, the participant ran the distance of 20 meters. The frequency of the sound signal was increased 0.5 km/h for each level achieved starting from a speed of 8.5 km/h. The final level that the participant was capable of reaching was then recorded. This number was then used to compare the participants progress throughout the pre-, mid- and post- tests by determining if he/she was able to increase the distance and final running velocity, he/she was able to achieve. The final level achieved by each participant at each testing time was also compared to normative data in the Leger 20- meter shuttle run for their respective ages to determine their estimated VO_2 max.

The 10-RM procedure for seated leg press and seated chest press were used to assess muscular strength of lower and upper body, respectively. These testing procedures were conducted using the Canadian Society for Exercise Physiology (CSEP PATH, 2017) guidelines. These guidelines indicated that each participant was to complete a 5-minute warm up, followed by a light set of the exercise being tested in order to learn the proper form. For the seated leg press, the participant completed one warm up set with no weight to ensure that they were using proper form. Next, he/she set the machine to a weight that he/she could complete 10 repetitions for while maintaining proper form. If that was the absolute maximum weight that he/she could complete 10 leg presses for, then the test was over. However, if the individual thought they could add more weight and still complete 10 full repetitions, then he/she completed another trial after a two-minute recovery time between trials. Each participant had 3 trials to determine a maximum weight they were able complete 10 full repetitions of the exercise for, without muscular failure (Brzycki, 1993). The same protocol was used for the 10 RM seated chest press test. The difference in weight lifted for the seated leg press between pretest and posttest indicated an increase or decrease in lower body muscular strength. The final weight achieved at each testing time was used to calculate a percentage change in muscular strength. This was calculated by subtracting the original weight lifted by the final weight lifted, dividing the result by the original weight and then multiplying that output by 100%. For example, if an individual was able to achieve 100lbs in the pre-test and 120lbs in the post-test, their percentage gain in strength would have been: ((120-100)/ 100) x 100 or 20%. Typically, for untrained individuals an increase of up to 40% strength can be seen within the first 4 months of beginning a regular resistance training program (Haug, 2011). The difference in weight used for the seated chest press between pretest and posttest indicated an increase or decrease in upper body muscular strength (Karinharju, 2005). The final weight achieved at each testing time was used to calculate a percentage change in upper body strength as well. According to Haug (2011), any increase between 15-40% in muscular strength should be expected for a beginner.

Finally, body composition was measured through the use of hip to waist ratio. A flexible measuring tape was used to measure the circumference of each participants waist in inches. This measurement was taken at the midway point between the lower margin of the last palpable rib and the top of the iliac crest. Next, the circumference of their hips was measured in inches as well, which was located at the widest part of the buttock. All measurements were taken with the measuring tape parallel to the ground. Both sites were measured a total of 3 times to ensure accuracy, and an average of the measurements was used (Karinharju, 2005). The waist circumference in inches was then divided by the hip circumference in inches to provide a hip to waist ratio. Once this information was collected it was used to compare pre-test and post-test results to determine if there was any change in body composition indicated by an increase or decrease in their final hip to waist ratio.

Procedure

Once the seven participants were recruited, they attended an information session at the Lakehead University Fieldhouse in room SB 1016. During this session the study was explained in detail and the benefits as well as the potential risks were discussed. Parents and/or caregivers of the potential participants were invited to attend this information session as well to ensure that informed consent was obtained and to ensure that the participants were comfortable. By ensuring that there was an individual present that the participant was familiar with, it created a welcoming environment, which is important when conducting research with this population (Lang et al., 2010). If a participant did not understand any aspect of what the study entailed, then the parent was there to offer further explanation and consent if needed. The student researcher also explained that the study was in no way affiliated with Special Olympics and participation in the study would have no effect on their regular participation in Special Olympics sports and social events. After the study was explained in detail, the student researcher took all of the participants and their guardians down to the Lakehead University Hangar to explain and familiarize the participants with the testing procedures. The student researcher demonstrated the proper procedures for the Leger 20- meter shuttle run, 10 RM seated leg press and 10 RM seated chest press at this time. She also asked that each individual demonstrate their understanding of what each test entailed by having them describe the procedures back to her and completing a small “trial” of each test. This small trial involved the participants demonstrating their ability to perform each test correctly. This was done in order to ensure that the participants were comfortable with the testing procedures before the study started. This step was important for a population with ID to ensure that the testing procedures provided valid results and were measuring the individual’s ability, rather than their understanding of how to complete the test (Lang et al., 2010). After the student researcher was satisfied that all of the participants understood the testing procedures everyone returned to SB 1016. At that time, any questions from the participants or their caregivers were answered by the student researcher. Next, consent forms (Appendix E, Appendix F) were signed by both parents and participants. One consent form was for parents or guardians to sign (Appendix E) and a different consent form (Appendix F) was used for participants to fill out. This was done to ensure that both participants and parents had a full understanding of what the study entailed. Par-Q+ forms were also signed at this time to ensure the participants could safely begin an exercise program. Along with this information, demographic information on the participants was collected at this time including: age, height, weight, Special Olympics sport and gender for each individual. Finally, pretest dates and times were assigned to each participant and the researcher instructed them to arrive to their time slot prepared to exercise. They were also instructed to avoid ingesting food, alcohol, caffeine or tobacco products 3 hours prior to the testing time in accordance to ACSM (2017) exercise testing guidelines.

On the day of the pre-test the individual came to the Lakehead University Fieldhouse in their allotted time slot and the researcher met them at the front door. When the participant arrived, the student researcher lead him/her to the Hangar and through a 5-minute warm up of light jogging around the track followed by 5 minutes of dynamic stretching including leg swings, high knees, butt kicks and arm swings. Next the participant was instructed on the proper protocol for a 10-rep max seated leg press. The individual then performed an unweighted set of the exercise in front of the researcher to ensure proper form was being used. When the student researcher was confident that the individual was comfortable with the movement, the participant had 3 attempts to achieve their highest weight lifted as per CSEP protocol. This procedure was followed by 3 attempts to achieve the highest weight in the seated chest press machine for 10 consecutive reps. The final weight achieved for each exercise was recorded. This was followed by a 10-minute rest period to allow the participant time to recover before cardiorespiratory fitness testing took place. The student researcher then provided verbal instruction to the participant about the protocol for the shuttle run. Once the participant had finished the 20-meter shuttle run, the final level achieved was recorded as well as the estimated VO_2 max level based off of the Leger 20-meter shuttle run normative data for age. After these tests were completed the researcher took the participant to SB 1028 to a blocked off area to ensure privacy for body composition testing with hip to waist ratio. Both the waist and hip measurements were tested a total of three times each to ensure consistency of the measurements and the mean score from each site was recorded. After all of the pre-testing was finished the participant received a schedule print out of the exercise program dates and times that they could take home.

The exercise program took place 3 times a week at the Lakehead University Hangar. All seven participants met for the sessions which lasted one hour each. These sessions were led by the student researcher who is a CanFit Pro certified personal trainer and NCCP level 1 coach who has been personal training for over 2 years. The student researcher also has over 6 years of experience coaching and training individuals with intellectual disabilities and has a Special

Olympics Coaching Level 1 certification which ensured proper completion of the exercises, proper instruction and safety.

Each session began with a five-minute warm up walking/ jogging on the track or stationary bike at an easy intensity, followed by five minutes of dynamic stretching involving leg swings, high knees, arm swings and walking lunges. After the warm up was completed the group was led through the twenty-minute weight training program consisting of 5-7 different exercises that target all major muscle groups, using a combination of machine and free weights as well as body weight exercises. This was followed by the twenty-minute cardiovascular type training for that day consisting of steady state treadmill, stationary bike, elliptical or running on the track. The full program can be seen in (Appendix A). After each session of weight training and cardio was completed, all of the participants completed a five-minute cool down of light walking around the track, followed by five minutes of static stretching all of the major muscle groups, focusing on the muscles that were stressed throughout that day's specific workout.

This program was carried out for six consecutive weeks. At the end of week 3, a mid-way test took place. All of the participants completed the same muscular strength, cardiorespiratory fitness and body composition tests as in the pre-test, in the same order, with the same instruction. This mid-way test provided the student researcher with feedback on potential improvements the participants had made throughout the program. This also allowed for a gradual increase in volume and intensity of the exercise program when the individuals showed improvement after the 3-week mark. According to ACSM guidelines, a gradual increase in training intensity and volume is recommended for maximum training benefits (ACSM, 2017). Therefore, by incorporating a mid-way test, the researcher was able to determine that it was appropriate to increase their training intensity based on the individuals testing scores after the first 3 weeks of the program were complete. After this mid-way test, regularly scheduled training resumed with an increase in intensity and volume of the exercises (Appendix A). At the end of six weeks the individuals were then booked for a posttest date for testing within one week of the program final date. All of the post-tests were completed at the Lakehead University Fieldhouse and the participants were given the same instructions as prior to the pretest. On the day of their scheduled posttest the participant arrived at the Lakehead Fieldhouse and was met at the front door by the student researcher and completed the same tests as in the pretest, in the same order, with the same instructions given. After each test was completed the individual results were recorded, analyzed and compared to pretest values for each participant to evaluate the changes that were made over the six-week intervention period.

Design & Analysis

This study implemented a repeated measures design using a pre-, mid-, and post-test. This is a quasi-experimental study as a control group was not implemented. The respective variables were examined via a series of repeated measures ANOVAs. In the case of a significant factorial effect, subsequent dependent samples t-tests were implemented to compare the possible differences among the levels of the independent variable (pre-; mid; post-test). Effect sizes were also employed in the case of ANOVAs, in the form of eta-squared. Also, d statistics were reported for the dependent samples t-tests. The d-value of 0.2 indicates a small effect size. A value of 0.5 indicates a medium effect and a value of 0.8 indicates a large effect size (Cohen, 1969). Individual data was also analyzed for each participant in order to infer any differences amongst the group in response to the treatment.

Results

Demographic Information

Seven participants were recruited for this study (see Table 1). None had previously engaged in regular exercise programs, prior to or during the study, aside from their participation in respective Special Olympics practices once per week. The mean age of the group was 23.1 years old and there were 3 female and 4 male participants. All of the individuals had a mild to moderate global delay intellectual disability. Based on BMI calculations, at the beginning of the study, participants 1, 4, 5 and 6 were classified as normal weight, participant 3 was classified as overweight, participant 2 was classified as type 1 obese, and participant 7 was classified as type 2 obese.

Table 1- Demographic data for each participant. The BMI values were calculated by dividing the weight (kg) by height (meters) and squaring the resulting value.

Participant	Gender	Age	Height (cm)	Weight (kg)	BMI
1	M	25	181	70.5	21.5
2	F	24	160	80	31.2
3	F	24	159	66	26.1
4	M	18	183	77	23
5	M	24	179	58.5	18.1
6	M	22	172	61	20.6
7	F	25	162	104	39.6
Mean		23.1	170.8	73.8	25.7
SD		2.29	9.67	14.29	6.89

Muscular Strength

Upper body strength.

A 10RM chest press test was used to measure the potential changes in the upper body strength across the sessions. The results from a repeated measures ANOVA showed a significant main effect for time ($F(2) = 19.84$, $p < .0001$, $\eta^2 = .77$). The analysis of simple comparisons, via a dependent samples t-test, showed significant differences between t_1 (M = 70lbs, SD = 13) and

t_2 (M = 73lbs, SD = 13.32) (t (6) =2.82, $p < .03$, d = 0.2), with a small effect size. Also, a significant difference was found between t_2 (M = 73lbs, SD = 13) and t_3 (M = 84lbs, SD = 15) (t (6) = 4.66, $p < .003$, d = 0.7) with a medium effect size. Finally, there was a significant difference between t_1 (M = 70lbs, SD = 13) and t_3 (M = 84lbs, SD = 15) (t (6) = 4.47, $p < .004$, d = 0.9) with a large effect size.

Individual results.

All individuals were able to increase the final amount of weight they achieved in the 10RM seated chest press. Participant 3 showed the largest improvement by increasing her chest press from 55lbs to 75lbs for a 36% improvement. Percentage increase was included to provide a value to indicate the individual participants relative improvement aside from their raw values. Participant 1 showed the second largest improvement by increasing his lift by 25lbs between pre- and post- tests which translated into a 33% increase. Participant 4 increased his chest press from 90lbs to 110lbs for a 22% improvement. Participants 2 and 6 both increased their chest press by 10lbs between pre- and post- tests, which accounted for an 18% increase. Participants 5 and 7 both had the smallest improvement of the group, however, still increased their upper body strength by 5lbs (or 7%) each. All of the individual scores for each participant at each trial can be seen in Table 2 below.

Table 2- Individual results for the 10RM Seated Chest Press across the Pre-, Mid- and Post sessions. The value represents the highest weight lifted for 10 full repetitions by each participant.

Participant	Time 1 (lbs)	Time 2 (lbs)	Time 3 (lbs)	% Gain
1	75	80	100	33
2	55	55	65	18
3	55	60	75	36

4	90	95	110	22
5	85	85	90	7
6	60	65	70	18
7	70	70	75	7
Mean	**70**	**73**	**84**	**20**
SD	**13**	**13**	**15**	**10**

Lower body strength.

A 10RM seated leg press test was used to measure lower body strength. The results from a repeated measures ANOVA showed a significant main effect for time (F (2) = 18.00, p <.0001, η^2= .75). The analysis of simple comparisons, via a dependent samples t-test, showed significant differences between t_1 (M = 163lbs, SD = 24) and t_2 (M = 169lbs, SD = 27) (t (6) = 2.71, $p < .03$, d = 0.2) with a small effect size. This analysis also indicated a significant difference between t_2 (M = 169lbs, SD = 27) and t_3 (M = 182lbs, SD = 27) (t (6) = 4.5, $p < .004$, d = 0.4) with a medium effect size. Finally, there was a significant difference between t_1 (M = 163lbs, SD = 24) and t_3 (M = 182lbs, SD = 27) (t (6) = 4.5, $p < .004$, d = 0.7), with a large effect size.

Individual results.

All individuals with the exception of one were able to increase the final weight lifted in the seated leg press. Participants 1, 2 and 3 all increased their leg press by 30lbs from the pre- to the post- testing times. Participant 2 and 3 had the largest relative improvement of the group by increasing their leg press weight from 150lb to 180lbs which translated to a 20% increase. For participant 1, an improvement from 195lbs to 225lbs indicated a 15% increase over the 6-week intervention. Participants 4, 5 and 6 all improved their leg press by 15lbs from the pre- to the post- test. For participant 6 this translated to a 12.5% relative increase. Participant 5 improved from 165lbs to 180lbs which showed a 9% relative increase between pre- and post- tests. Participant 4 improved from 195lbs to 210lbs which translated to a 7% increase in lower body strength. Participant 7 was the only person who maintained the same performance across the three different testing sessions, consistently lifting 165lbs. All of the individual results for each participant at the pre-, mid- and post- tests can be seen in Table 3.

Table 3- Individual results for the 10RM Seated Leg Press across the Pre-, Mid- and Post sessions. The value represents the highest weight pressed for 10 full repetitions by each participant.

Participant	Time 1 (lbs)	Time 2 (lbs)	Time 3 (lbs)	% Gain
1	195	210	225	15
2	150	165	180	20
3	150	155	180	20
4	195	200	210	7
5	165	170	180	9
6	120	120	135	12
7	165	165	165	0
Mean	**163**	**169**	**182**	**11**
SD	**24**	**27**	**27**	**6**

Cardiorespiratory Endurance

The Legers 20- meter shuttle run was used to measure cardiorespiratory fitness. Both the final level achieved, as well as their corresponding estimated VO_2 max were analyzed for each participant. This test was implemented at three different times during the study (pre-, mid- and post-) to determine if any improvements emerged in their VO_2 max or the final level of the shuttle run the individuals were able to attain.

The results from a repeated measures ANOVA using final shuttle run scores showed a significant main effect for time (F (2) = 7.73, $p < .007$, $\eta^2 = .56$). The eta square value of .56 indicated a large effect size for the group across all of the testing periods. When VO_2 max was used to analyze results, the same significant main effect for time was observed (F (2) = 7.21, $p <$ .009, $\eta^2 = .55$). The analysis of simple comparisons, via a dependent samples t-tests, revealed a significant difference between t_1 (M = 4.9 level, SD = 2.2) and t_2 (M = 5.1 level, SD = 2.3) (t (6)

= 2.36, $p < .05$, d = .08). The d-value of .08 indicated a small effect size between the first and second testing time. The same analysis indicated a significant difference between t_2 (M = 5.1 level, SD = 2.3) and t_3 (M = 5.6 level, SD = 2.5) (t (6) = 2.69, $p < .03$, d = 0.20), with a corresponding small effect size. A significant difference between t_1 (M = 4.9 level, SD = 2.2) and t_3 (M = 5.6 level, SD = 2.5) (t (6) = 2.92, $p < .02$, d = 0.29) with once again a small effect size. When estimated VO_2 Max was used, the same pattern of results emerged between t_1 (M = 35.1 ml/min/kg, SD = 6.6) and t_2 (M = 36.2 ml/min/kg, SD = 6.9) (t (6) = 2.43, $p < .05$, d = .16). The d-value of .16 indicated a small effect size between the first and second testing time. When VO_2 max was analyzed the same significant difference was found between t_2 (M = 36.2 ml/min/kg, SD = 6.9) and t_3 (M = 36.9 ml/min/kg, SD = 7.4) (t (6) = 2.37, $p < .05$, d = 0.09), with a corresponding small effect size. The same results appeared when VO_2 max was analyzed between the first and final trail as well t_1 (M = 35.1 ml/min/kg, SD = 6.6) and t_3 (M = 36.9 ml/min/kg, SD = 7.4) (t (6) = 2.87, $p < .02$, d = 0.26) with once again a small effect size.

Individual results.

At the individual level of analysis, most participants, with the exception of participants 5 and 7, improved their final level achieved from pre- to post- test. In regards to estimated VO_2 max, the participants experienced between a 0.9 to 4.0 ml/min/kg increase. Participant 1 exhibited the largest improvement increasing from level 9 to level 10.2. An increase of 1.2 level indicates that at the post test his final running velocity had increased from 13 km/hr by 0.5 km/hr from the pre- test and he was able to run an extra 250 meters. At each level of the Leger Shuttle run the running speed of the participant increases 0.5km/h. Continuing with the same pattern of results, Participant 1 experienced the largest improvement in cardiorespiratory fitness as represented by estimated VO_2 max as well as final level achieved. He was able to increase from

47.6- 51.5 ml/min/ kg. Participant 6 improved by one full level from pre- to post- indicating his final running velocity increased by 0.5 km/hr and that he was able to run an additional 200 meters. This corresponded to a 3.4 ml/min/ kg improvement in estimated VO_2 max, when compared to normative data. Participant 4 had an improvement of 0.8 of a level which indicated that he was able to run an additional 160 meters at the post- test. This corresponded to an estimated VO_2 max improvement of 2.7 ml/min/kg as well. Participant 3 improved her shuttle run score by 0.4 of a level, which results in an 80-meter change, as well as a 0.9 ml/min/kg estimated VO2 max improvement. Finally, participant 2 improved their score by 0.3 levels, which coincides with an additional 60 meters and 1.3 ml/min/kg estimated VO_2 max. Individual results for each participant can be seen in Table 4 below.

Table 4- Individual results for the Leger 20- meter shuttle run across the Pre-, Mid- and Post sessions. The table indicates the highest level achieved by each participant and the corresponding VO_2 max value in (ml/min/kg).

Participant	Time 1 (level)	Estimated VO_2 (ml/min/kg)	Time 2 (level)	Estimated VO_2 (ml/min/kg)	Time 3 (level)	Estimated VO_2 (ml/min/kg)
1	9	47.6	9.4	48.9	10.2	51.6
2	2.7	28.3	3	29.6	3	29.6
3	4	32.6	4	32.6	4.4	33.5
4	7.2	41.9	7.7	44.2	8	44.6
5	5.1	35.8	5	35.6	5.1	35.8
6	3.5	30.1	4	32.6	4.5	33.5
7	3	29.6	3	29.6	3	29.6
Mean	**4.9**	**35.1**	**5.1**	**36.2**	**5.6**	**36.9**
SD	**2.2**	**6.6**	**2.3**	**6.9**	**2.5**	**7.4**

Body Composition

To examine potential changes in body composition across time, a hip to waist ratio measurement was taken at the pre- and post- testing times. The analysis of simple comparisons, via a dependent samples t-tests, revealed no significant difference between t_1 (M = 0.86, SD = 0.03) and t_2 (M = 0.85, SD = 0.03) (t (6) = 1.508, $p < .18$, d = .02) with no significant effect size. No mid- test was taken of this construct because the results were not being considered when determining if the participants were able to progress onto the next phase of the workout program.

Individual results.

Four of the seven participants had a small change in their hip to waist ratio from the pre- to the post- test times. Participant 1, 2 and 3 maintained the same hip to waist ratio from the pre- to the post- test. All three of these individuals began with a measurement that placed them within a “normal” body composition category for their age and gender. Participant 4 decreased their hip to waist ratio from 0.85 to 0.84 for a minimal difference and maintained a “normal” categorization based on body composition. Participant 5 decreased their ratio from 0.88 to 0.85, which was the largest change for the group. Participant 6 decreased their ratio from 0.88 to 0.87 and participant 7 decreased their score from 0.93 to 0.92. Individual results for each participant can be seen in Table 5 below.

Table 5- Individual results for hip to waist ratio across the Pre- and Post- sessions. The value represents the average of 3 measurements of the waist divided by the average of 3 measurements of the hips in inches.

Participant	Time 1	Time 2
1	0.83	0.83
2	0.81	0.81
3	0.85	0.85
4	0.85	0.84
5	0.88	0.85
6	0.88	0.87
7	0.93	0.92
Mean	**0.86**	**0.85**
SD	**0.037**	**0.033**

Discussion

Combined and Progressive Training

The 6-week progressive and combined resistance/ cardiovascular training program was designed to improve the physical fitness of young adults with a mild to moderate global delay intellectual disability. Based on previous literature, the majority of exercise programs implemented with this specific population included either type of the training, performed at relatively low levels of intensity (Boer & Moss 2016; Carmeli et al, 2005; Sungmen et all, 2016; Tamen et all, 2015). The two previous studies that have used combined resistance and cardiorespiratory training only incorporated light lower body resistance exercises rather than engaging the entire body (Carmeli et al, 2005; Temple & Stanish, 2008). In contrast, the current study incorporated resistance training that engaged all muscle groups as well as the cardiorespiratory system. The results uniformly confirmed that this type of program was able to elicit a significant improvement in both upper and lower body muscular strength as well as cardiorespiratory endurance.

In addition to implementing a combined program, the current study also followed ACSM (2017) guidelines in regards to a progressive principal of training. This principle is used in exercise programs for many different populations, from elite athletes to the elderly, and has successfully demonstrated improvements in physical fitness (Faigenbaum, Westcott, Loud & Long, 1999; Peterson, Rhea & Alvar, 2004; Sylliaas, Wyller & Bergland, 2013). According to ACSM (2017) in order for an individual to experience physiological adaptations to exercise, an appropriately enhanced physical program must be implemented. Therefore, in the current study, at the end of week 3, the volume and intensity of both the resistance and cardiorespiratory training were increased individually for each participant. In line with ACSM guidelines, resistance training should be performed 2-3 times a week and target all major muscle groups, using a variety of different machine and free weight exercises. The ACSM also recommends that cardiorespiratory training be done 3-5 times a week for 20-60 minute per session at a moderate to vigorous intensity (55-85% MHR). By combining both types of training into each session it ensures that the individual is receiving all of the benefits from both cardiorespiratory and resistance training (ACSM, 2017). Unfortunately, the majority of exercise programs developed for individuals with ID only involve light walking and no resistance training, with no progressions in volume and intensity made throughout (Shin & Park, 2012).

The overall pattern of results from the current study showed that implementation of this novel progressive and combined training approach was beneficial to the majority of the participants as inferred from group and individual data, across the different domains of fitness.

Muscular Strength

Upper body strength.

Generally, individuals with ID have substantially lower muscular strength than a typically developing population (Bastiannse et al., 2012; Carmeli et al., 2012). As a result, any program that attempts to enhance their motor status should involve some kind of strength training. Here, it was hypothesized that a 6-week combined resistance and cardiovascular training intervention would positively affect the upper body strength of the participants, as assessed using the maximum seated chest press. The present results confirmed this hypothesis as the use of machine and free weight, as well as body weight exercises, had a positive effect on a seated chest press task, by improving participants scores by up to 36% between pre- and post- test. This finding is in line with previous research which indicated that participation in regular resistance training benefited individuals with ID (Boer & Moss, 2016; Carmelli et al, 2005; Temple & Stanish, 2008). The training program implemented here was unique as it used a combination of 5 to 7 different resistance exercises in each session that focused on specific muscle groups, thus placing a higher demand on muscular strength as compared to previous studies. In the current study, the exercises were performed at an increased weight and number of sets once the program was progressed after three weeks. Therefore, the current study was able to demonstrate a larger improvement in muscular strength than previous studies as a result of incorporating more resistance training exercises than previous studies where light lower limb resistance training was the only method of enhancing muscular strength (Carmeli et al, 2005; Temple & Stanish, 2008). Although Carmelli et al (2005) incorporated the same number of resistance training exercises in each session as the current study, 5 of the 7 exercises were designed for strengthening the lower limbs only. Also, these exercises were only performed for 2 sets of 10 repetitions throughout the entirety of the 6-month program. Carmeli and colleagues (2005) reported a significant increase in knee muscle strength for the participants, however, did not report any significant improvements in upper body strength. In line with those findings, Temple and Stanish (2008) also reported a significant improvement in lower limb muscular strength as a result of completing 3 lower limb body weight exercises in 3 sets of 10-15 repetitions, 3 times a week. However, they did not report any improvements in upper body muscular strength. The differences in findings between the previous literature and the current study can be attributed to the fact that here, full body resistance training was implemented. The improvement in upper body muscular strength may also be attributed to the progression of the current program increasing the demand placed on the body throughout. Therefore, the participants experienced faster improvement in strength than previous studies.

In addition to statistically significant differences, the analysis of effect sizes further confirmed the increase in upper body strength between each testing period. A small effect size was observed between the pre- and mid- test, which took place 3 weeks after the start of the program. However, a larger effect size was observed between the mid- and post- test times, and the largest effect size was evident when the pre- and post- 10RM seated chest press scores were compared. This indicated that the most meaningful change in performance occurred between the initial and final measurements. This result was to be expected as there was a longer training period, as well as an increase in the intensity of the exercises between these testing times, therefore allowing for more improvements in strength (White, 2017). The smallest effect size occurring between the pre- and mid- tests could be a result of the first 3 weeks of the program involving the lightest intensity and volume of resistance training. Once the program was progressed to a higher work load, after the end of week 3, the difference in upper body strength between testing times was more pronounced.

The analysis of the individual profiles confirmed statistical results as there was a 7 to 36% gain in upper body strength as indicated by their 10RM seated chest press results. Six out of the seven participants were able to increase their final weight lifted by over 10lbs for 10 repetitions. This is in line with the literature that indicated that beginner exercisers can expect to exhibit up to a 40% increase in muscular strength within the first 4 months of starting a resistance training program (Haug, 2011). This large range of improvement between the participants can be attributed to a person by treatment effect. As some of the individuals began the program with a higher level of upper body muscular strength, they were able to experience a more substantial increase in strength than their fellow participants. This difference in improvement could be attributed to having more confidence and coordination while performing the upper body exercises, training with heavier weight or an increased motivation throughout the duration of the program. Participant 7 was the only individual with a less than 10lb improvement. It should be pointed out that this participant demonstrated the least amount of improvements or changes across all components of fitness after the intervention. This could be due to lack of motivation or lack of understanding the testing method, which are common variables that affect the performance of individuals with ID (Temple & Walkley, 2009). Collectively the data showed that the majority of participants were able to make substantial improvements in upper body strength within the 6-week period.

From a physiological perspective, performing full body resistance training would help improve upper body strength specifically due to a general neural adaptation within all skeletal muscles. This is particularly true for beginner exercisers who start a new resistance training program (Jones, Rutherford & Parker, 1989). When an individual begins weight training exercises, the neural synapses which are present in every skeletal muscle, become more efficient at sending signals from the brain to the muscle creating a contraction (Jones, Rutherford & Parker, 1989). The literature suggested that these initial gains in strength can be attributed to neural adaptations as the nervous system learns to activate muscle fibers more efficiently (Haug, 2011). Although the actual size of the muscle fiber may not increase within the first 6-8 weeks, there is still an increase in strength due to improved muscular recruitment, for beginner exercisers (Haug, 2011). Due to this phenomenon, individuals who are new to resistance training typically experience the fastest gains in strength in the shortest amount of time, when compared to experienced weight lifters.

Lower body strength.

It was also hypothesized that after completing a progressive 6-week combined resistance and cardiovascular training program, the participants would experience an increase in lower body strength, as inferred from the 10RM seated leg press. The present results confirmed this hypothesis as the use of machines, free weight, as well as body weight exercises elicited a statistically significant improvement in the seated leg press task. The program incorporated 5 to 7 different exercises that targeted all muscle groups, and included lower limb resistance training. The program did not incorporate seated chest or leg press throughout the 6-week study, in order to eliminate a learning effect of the testing protocol from affecting the improvements observed at the end of the study. The significant improvement in lower limb muscular strength can be attributed to the program progressing the volume and intensity of the resistance training at the end of the first 3 weeks. The participants lower body muscular strength also increased as a result of the program prescribing a variety of resistance exercises in accordance with ACSM (2017) guidelines.

As a group, the participants demonstrated up to a 20% gain in lower body strength, which coincided with a 15 to 30lb increase in their final weight achieved. This result is in line with the literature which indicated that beginner exercisers can experience up to a 40% increase in overall muscular strength within the first 4 months of starting a resistance training program (Haug, 2011). Such increase in strength, for beginner exercisers, is typically attributed to a general neural adaptation to resistance training, as it was the case with upper body strength (Sale, 1988). As this new stimulus of weight training is placed on the body, the neural synapses become more efficient at coordinating the contractions of the skeletal muscles, therefore increasing the maximal contractile force exhibited by these muscles (Jones, Rutherford & Parker, 1989). An improvement in lower limb muscular strength between 0 to 20% suggests that there was a high variability within the group's results. At the pre- test time the mean score for the leg press was 163lbs with a standard deviation of 24 lbs. Whereas, at the post test time the group mean was 182lbs with a SD of 27lbs. The standard deviation of improvement between pre- and post- test for the group was within 3lbs, which indicated that the participants all improved their lower body strength relatively the same amount over the course of the 6-weeks. This is to be expected as all of the individuals followed the same training schedule and completed the same exercises in the same number of repetitions and sets. As a result, they should all have experienced similar improvements in lower body strength (Sale, 1988).

The analysis of effect sizes was also able to confirm an increase in lower body strength between each testing period, in line with inferential analysis. A small effect size was demonstrated for the group between the pre- and mid- test of seated leg press. A medium effect size was observed between the mid- and post- test times and there was a large effect associated with the differences between the pre- and post- tests. Effect size indicates the magnitude of the difference between two groups. Therefore, a large effect size indicates that there is a substantial difference in overall leg strength between the pre- to the post- test scores. These differences were expected as there was a longer training period between the pre- and post- testing times, therefore allowing for more improvements in strength to be obtained (White, 2017). These results are in line with the analysis of upper body strength where a similar magnitude of effect sizes was observed. The increase from small to medium to large effect size between each of the testing times is a result of the increase in duration and intensity of the intervention as the program progressed.

When individual results were reviewed, they were consistent with the hypothesis that participation in a regular combined resistance and cardiovascular training program would improve lower body strength. The three participants that demonstrated the largest improvement, increased their 10RM seated leg press by 30lbs between the pre- and post- test. This increase in weight lifted coincided with a 15%, 20% and 20% increase in lower body strength for participants 1, 2 and 3. Three other participants were able to add 15lbs to their seated leg press weight, which coincided with a 7%, 9% and 12% increase in lower body strength for participants 4, 5, and 6. One participant did not see any change in the final weight lifted between pre- and post- test. The individual who showed no improvement was participant 7, and as per previous measures this individual exhibited minimal improvements in performance throughout the study.

These results are in line with previous research which indicated that participation in regular resistance training improved the lower body muscular strength of individuals with ID (Guerra-Balc et al., 2015; Wu, Lin, Hu & Yin, 2010). One study which examined the benefits of regular exercise for males and females with mild ID showed significant improvements in lower body muscular strength after participation in a combined training program (Wu et al, 2010). However, despite the fact that Wu et al (2010) examined a population comparable to the present research, they only incorporated 5 resistance exercises, 3 of which focused on lower body, and 2 focusing on abdominal training. Wu and colleagues (2010) maintained the same volume and intensity and did not increase the stimulus placed on the body throughout the program duration. In another study, the 6-month program implemented by Guerra-Balc et al (2015) involved walking and 5 lower body resistance exercises completed in 2 sets of 10, 3 times a week. The frequency of resistance training prescribed by Guerra-Balc et al (2015) was similar to the present study, as both involved training 3 times a week. However, the current study used a higher intensity and volume of training where 5 to 7 different exercises at each session were implemented, in 2-3 sets of 8-15 reps, as per ACSM exercise guidelines. On the other hand, Guerra-Balc et al (2015) used the same 5 exercises at each training session throughout the entirety of the intervention and did not vary the type, volume or intensity of each exercise. Although Guerra-Balc and colleagues (2015) reported significant improvements in lower limb muscular strength at the end of the study, their treatment time was 6 months in duration, in comparison to the current study, which was able to elicit significant improvements in lower limb muscular strength in just 6-weeks.

Cardiorespiratory Endurance

Any program that aims to improve the physical fitness of individuals with ID should incorporate some form of cardiorespiratory training, as they exhibit substantially lower levels of this type of fitness than a typically developing population (Foley et al, 2013). In the present study, it was hypothesized that a progressive 6-week combined resistance and cardiovascular training program would have a positive effect on the cardiorespiratory fitness of the participants, as inferred from the Leger 20-meter shuttle run. The same pattern of results emerged from both final level achieved, and corresponding estimated VO_2 max. Therefore, for the purpose of the discussion, final level of the Leger 20-meter shuttle run will be used to avoid redundancy. The results confirmed this hypothesis as the use of steady state training on the elliptical, stationary bike, treadmill and track improved their cardiorespiratory fitness, demonstrated through improved final scores in the shuttle run. As per ACSM guidelines, the cardiovascular training was implemented 3 times a week at 50-70% MHR, and was completed for 15-25 minutes in total for each session. As a group, the participants experienced steady improvements in cardiorespiratory fitness throughout the 6-weeks, showing a significant improvement between pre- and mid-, as well as a significant improvement between mid- and post- tests.

In order to further validate the significance emerging from the inferential analysis, the effect sizes were examined. A small effect size was observed across all of the comparisons. Conceptually, this result was to be expected as changes in cardiorespiratory fitness typically take 3 to 4 weeks to be observed when participating in a regular training program (White, 2017).

Therefore, as there was 3-weeks in between each testing time a small difference was expected to be seen between each trial. These results showed that although statistically significant, the changes were not as meaningful as compared to the analysis of strength within this study. This was to be expected as beginner exercisers can expect to see initial gains in strength occur at a faster rate than improvements in cardiorespiratory fitness in response to a new exercise program (Haug, 2011).

When individual performance was reviewed it was evident that 5 of the 7 participants were able to improve their score on the shuttle run between 0.3 to 1.2 levels. Each increase of 0.1 of a level in the shuttle run indicates an additional 20 meters accomplished. Therefore, these individuals were able to add between 60 to 220 meters to the distance they had achieved at the beginning of the study. Although there was a large difference in improvement across the participants, an additional distance of over 50 meters is considered a substantial improvement when maintaining maximal running velocity (Gillespie, 2009). This large range is due to person by treatment interaction effect (Frey, Stanish & Temple, 2008). The presence of such effect indicates that there was variability amongst the participants with regards to how they responded to the program. As a result of each individual having different levels of cardiorespiratory fitness at the beginning of the program, it is expected that there would be a large range in the improvements made at the end of the 6-weeks. Two individuals did not exhibit any change in their shuttle run results. However, this could be due to the fact that these two individuals had the lowest initial levels of cardiorespiratory fitness, which may have in turn affected their training throughout the 6-week program. These individuals may not have had the fitness levels or motivation to complete the full 15-25-minute allotted to cardiorespiratory training each day and therefore, did not receive the full benefit from the program. This may also be due to the fact that maximal cardiorespiratory testing for individuals with ID have sometimes been shown to have variable results due to lack of motivation (Temple & Walkley, 2009).

This increase in cardiorespiratory fitness can be attributed to the heart, lungs, and capillaries becoming more efficient at delivering oxygen to the blood in response to the new stimulus of regular cardiorespiratory training (White, 2017). When an individual begins aerobic training, their respiration increases as the demand for oxygen within the skeletal muscles increases. As a result, the lungs have to work harder to deliver oxygen throughout the body and as training becomes more consistent the lugs adapt to this oxygen demand and become more efficient at producing a higher oxygen for the body (Burton, Stokes & Hall, 2004). When an individual is participating in cardiorespiratory training the increased oxygen demand also requires the heart to pump blood more efficiently throughout the body. This is done in order to deliver the oxygen to the working muscles (Burton, Stokes & Hall, 2004). Therefore, as a beginner exerciser starts a new training program, the increase demand placed on the cardiorespiratory system requires it to adapt and become more efficient. This accounts for improvements in cardiorespiratory fitness, which can be experienced within the first 4 weeks (Burton, Stokes & Hall, 2004).

This variety and intensity of training methods made this program unique as compared to previous methods which focused on light steady state walking as the only form of cardiorespiratory training (Sungmen et al., 2016; Tamin et al., 2015). By using a variety of cardio machines and progressing the training by increasing the amount of time and intensity, the participants were able to improve their cardiorespiratory fitness more substantially in a shorter period of time than previous studies. These results are in line with previous research which indicated that participation in regular cardiorespiratory training benefited a population with ID

(Boer & Moss, 2016; Sungmen et al., 2016; Tamin et al., 2015). The study by Tamin et al, involved individuals with ID under the age of 30 and prescribed cardiorespiratory training for a similar duration (20-30 minutes) at a similar intensity (60-80% MHR) as the current study. Tamin and colleagues (2015) demonstrated significant improvements in VO_2 max of the participants. Although this study was able to produce significant improvements, the only form of activity that was prescribed was brisk walking. However, in the current study there were multiple different methods of cardiorespiratory training that the participants performed throughout the course of the 6-week program. In the other study by Sungmen et al. (2016), 9 males and females participated in brisk walking 3 times a week for 4 months. The individuals had to walk for a total of 100 minutes a week, and at the end of the 4-month program the participants showed significant improvements in their cardiorespiratory fitness (Sungmen et al., 2016). Although this study showed significant improvements, they took 4 months to achieve this, whereas, the current study elicited significant improvements in cardiorespiratory fitness after just 6-weeks. Therefore, this indicated that individuals with ID can experience faster improvements in cardiorespiratory fitness by participating in a combined and progressive training program which makes use of a variety of training types, rather than only walking.

Body Composition

Obesity represents one of the most common health risks for individuals with ID. In fact, the majority of exercise programs for this population are implemented with the intention to lower obesity rates. Therefore, another aim of this research was to investigate if this 6-week training program would have an effect on overall body composition of the participants. Any improvement was to be inferred from differences in the hip to waist ratio measurements indicating a loss of abdominal fat. Contrary to the hypothesis, the participants in this study did not show any significant changes in body composition at the end of the 6-week period. The analysis of effect size (0.08) also confirmed that there was no significant effect of the exercise program on body composition between the pre- and post- test of hip to waist ratio.

When individual results were reviewed, only 1 participant experienced a decrease in hip to waist ratio that was larger than 0.1. This lack of change in body composition could be attributed to the study having a short duration and not controlling for nutrition. There was also a high variability in the sample in terms of starting body composition. At the start of the program, only 2 of the individuals were considered obese according to their BMI, and the other 5 were considered as having normal weight. Individuals who already have a “normal” body composition, typically do not lose weight as quickly when starting an exercise program as overweight or obese individuals (Ekkekakis, Lind & Vazou, 2010). Therefore, they would have experienced a ceiling effect as they had little weight to lose at the beginning of the study and participation in a cardiorespiratory and resistance training program would have no effect on the nature of their body composition.

These results are consistent with previous literature which demonstrated that participants with ID did not have significant changes in body composition with an exercise program shorter than 6 months in duration (Shin & Park, 2012). The meta- analysis carried out by Shin and Park (2012), also noted that when nutrition is not controlled for, the participants had lower success rates in decreasing excess fat. For individuals with ID, weight loss appears to be a more complex issue than for a typically developing population. This has been attributed to lack of motivation (Carmeli, Zinger, Morad & Merrick, 2008), nutritional knowledge (Ozmen, Yildirim, Yuktasir & Beets, 2007), support from family/ workers (Sungmin et al, 2016), as well to the effects of different medications and economic status of individuals with ID (Shin & Park, 2012).

Conclusions and Practical Implications

Individuals with an ID are defined as people who have significant limitation in both cognitive functioning such as learning and problem solving, as well as in adaptive behavior such as social and practical skills (Schalock et al., 2010). Due to these issues, often they do not participate in regular physical activity and most exhibit a sedentary lifestyle leading to a multitude of health issues (Segal et al., 2016). Also, it has been shown that they have a lower participation rate in physical activity, as compared to their typically developing counterparts, at all stages of life from childhood through adulthood (Koritsas & Ianco, 2016). Therefore, the purpose of this study was to investigate the effect of a 6-week, combined progressive training program on muscular strength, cardiorespiratory fitness, and body composition in 7 individuals with a mild to moderate global delay.

In contrast to previous research (Carmeli et al, 2005; Temple & Stanish, 2008) which involved participants with a mild to moderate global delay ID between the ages of 18-30, the current protocol was devised in line with training principles as outlined in the ACSM (2017) exercise guidelines. It incorporated a combined resistance and cardiorespiratory program that also followed a progressive approach to training, which was implemented on an individual basis. The program was implemented for 6 weeks, 3 times a week in 1-hour sessions and incorporated full body resistance training with machine and free weights, followed by cardiorespiratory training on the treadmill, stationary bike and elliptical for 15-25 minutes.

The results of the study showed statistically significant improvements in upper and lower body muscular strength as well as cardiorespiratory fitness, however, no significant changes in body composition were shown. This pattern of results was evident at the group level of analysis, as inferred via inferential statistics and effect sizes, as well as based on individual data. Nevertheless, some intra-group variability in the data was also observed. Hence, some participants were affected by the training program to a larger extent as compared to others. This can be attributed to many different factors. High (intra-group) variability in initial fitness levels of the participants, may have affected the overall performance of these individuals differently throughout the 6-week program. Another possible reason may have been a lack of motivation or understanding of the training/ testing protocols, which are common factors that can affect performance of individuals within this population (Temple & Walkley, 2009). However, despite those inter-individual differences, the majority of the participants, across the different measures of fitness, did exhibit similar patterns of behavior which confirms the effectiveness of the protocol implemented.

The results from this study showed that individuals were able to make improvements in their fitness within just 6-weeks. This is in contrast to previous exercise programs for this population that showed improvements after a training period of 4-6 months (Guerra- Balc et al, 2015; Sungmen et al, 2016; Tamin et al, 2015; Wu et al, 2015). This finding indicates that by implementing a progressive and combined type of training approach, individuals with ID can experience improvements in their fitness status at faster rate, which is essential from health as well as motivational perspective. Hence, the significant improvements evident here in upper body as well as lower body strength and cardiorespiratory fitness, were not previously reported to the date. This is likely due to the fact that combined full body resistance training targeting all major muscle groups, as well as different forms of intense cardiorespiratory training. It also progressed the difficulty of the exercises within the program in order to continue to challenge the participants throughout the duration of the study. Also, the data showed that the participants experienced a more substantial improvement in strength measures when compared to cardiorespiratory improvements. This was to be expected as improvements in strength can occur within the first 1-2 weeks of starting a resistance training program, as a result of the neural adaptations made within the skeletal muscles improving contractile coordination (Jones, Rutherford & Parker, 1989). Cardiorespiratory changes in response to exercise, can be seen within the first 3-4 weeks and occur at a slower pace than strength improvements, especially for new exercisers (White, 2017).

Collectively, these results suggest that individuals with ID are capable of, and can benefit from, participating in activities which place a higher physical demand on their cardiorespiratory and muscular system than the simple steady state walking and supplementary light lower limb resistance training. However, it should be kept in mind that such adaptations were made on an individual basis and involved on-going monitoring of how the participants responded to it, in order to prevent fatigue, injuries or decreases in motivation.

In terms of limitations of this study, the small sample size may not allow for generalizability of the results for other individuals with mild to moderate global delay. This study also did not monitor the nutrition of the participants throughout the duration of the program, which may have led to variability in performance. These results also carry practical implications that may supplement current exercise prescription methods for individuals with intellectual disabilities. Future research focusing on exercise programs for individuals with ID can use the results of this study to explore the potential health benefits of a program that is delivered for a longer duration, with more progressions throughout. This would allow for inferences about the sustainability of this type of exercise program as a long term means of health management for these individuals.

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Appendix A

6-week Exercise Program

Day 1, 2, 3: Week 1-3

Exercise	Sets x Reps	Weight	Rest
Body weight squat	2x12-15	Body weight	45 seconds
Wall Sit	3x 30 seconds	Body Weight	45 seconds- 1 min
Laying Glute bridge	3x12-15	Body Weight	30 seconds
Incline Push Ups (Perform push up with hands on weight bench and feet on ground)	2x12-15	Body Weight	45 seconds
Shoulder Press	2x12-15		30 seconds
END OF WORKOUT CARDIO 10-15 minutes steady state treadmill	Target HR zone= 50-60% MHR		

Exercise	Sets x Reps	Weight	Rest
DB lateral raise	2x 12-15		45 seconds
Seated close grip row	2x 12-15		30 seconds
DB Hammer curl	2x 12-15		45 seconds
KB Goblet Squat	2x 12-15		45 seconds
Laying Hamstring Curl	2x 12-15		45 seconds
Core Circuit -crunches -Bicycle crunch -plank Cardio: 10-15 minutes steady state stationary bike	Perform circuit 2x X 25 X 16 total X 30 seconds @ 50-60% MHR		Rest 1-2 minutes between circuits

Exercise	Sets x reps	Weight	Rest
Lateral Pulldown	2x 12-15		45 seconds
Machine chest fly	2x 12-15		45 seconds

Tricep rope push down	2x 12-15		45 seconds
Seated leg extension	2x 12-15		45 seconds
Walking lunges	2x 12-15		45 seconds
CARDIO 10 minutes steady state elyptical + 5 minutes steady state jog around track	 @ 50-60% MHR		

Day 1,2,3: Weeks 4-6

Exercise	Sets x reps	Weight	Rest
DB squat	3x 8-12		45 sec
Wall Sit	4x 30-45 sec	Body weight	45 sec
Laying Glute Bridge	3x 12-15	Body weight	45 sec
Push- ups (modified or full)	3x max rep	Body weight	1 min
DB Shoulder Press	3x 8-12		45 sec
End Cardio 15-20 minute steady state treadmill	 Target HR zone= 60-70% MHR		

Exercise	Sets x reps	Weight	Rest
DB lateral raise	3x 8-12		45 sec
Seated close grip row	3x 3-12		45 sec
DB hammer curls	3x 8-12		45 sec
KB goblet squat	3x 8-12		45 sec
Laying hamstring curl machine	3x 8-12		45 sec
Core Circuit Legs at 90 crunch Med ball twist Knees bent leg lifts 15-20 minutes steady state stationary bike	Perform circuit 3x X 25 X 10 X 10 60-70% MHR		

Exercise	Sets x Reps	Weight	Rest
Lat Pull down	3x 8-12		45 sec
Machine chest fly	3x 8-12		45 sec
Tricep rope push down	3x 8-12		45 sec
Seated leg extension	3x 8-12		45 sec
DB walking lunges	3x 8-12		45 sec
Cardio 12 minutes steady state elliptical + 10 minutes steady state jog around track	60-70% MHR		

Appendix B

Initial e-mail to head of Special Olympics Thunder Bay

Date

Dear Miss Denita Minoletti,

My name is Tyler McDougall, and I am a second year student in the Master's program, in the School of Kinesiology, at Lakehead University. My adviser, Dr. Eryk Przysucha and I have a keen interest and extensive experience working with individual with intellectual disabilities. My current thesis project, titled "The effect of a 6-week combined resistance and cardiovascular training program on muscular strength, endurance and body composition in young adults with a mild to moderate global delay" focuses on implementing an exercise program that would enhance the physical abilities of these individuals. As a result, I am writing to ask your permission to recruit potential participants for my study from Special Olympics program. Please note that the project has received an ethical approval from Lakehead University Research Ethics Board.

I am hoping to recruit ten male and/or female participants between the ages of 18-25, diagnosed with a mild to moderate global delay intellectual disability by a physician. The athletes will be asked to participate in one-hour session, 3 times a week, for 6-weeks. The sessions will involve cardiorespiratory and resistance training which is safe and suitable for individuals with the cognitive and physical characteristics of those diagnosed with ID. They will be supervised at all points during the study by myself, a CanFitPRO certified personal trainer, NCCP coaching level 1 and 2 and Special Olympics coaching certified trainer, as well as 2 other Special Olympics trained coached. The potential participants may see many benefits as a result of taking part in this study which can include increased muscular strength, cardiorespiratory endurance and overall improvement in body composition. Such expected positive changes may enhance their performance in Special Olympics sport and more importantly their ability to complete activities of daily living.

As a result, I would like to ask you to send the attach e-mail to all the individuals and their parents and caregivers. Those who are interested in the study will be invited to stay after the next Special Olympics practice to hear more about the study. At this information session I will explain the purpose of the study, along with all the details involved in the study. The researcher will also stress that the study is not affiliated with Special Olympics and participation in the study will completely voluntary, and will have no effect on their regular participation in Special Olympics sports and social events. Subsequently, those who are interested in taking part will receive a recruitment letter, one for the potential participants and one for the parents/ guardians. Please see the attached documents, respectively.

If you have any questions or concerns about the athlete's potential participation in this study please do not hesitate to ask for further clarification. Thank you for your consideration in allowing me to recruit athletes from Special Olympics Thunder Bay. Also, if you require further information you can contact my adviser Dr. Eryk Przysucha (807-343-8189 or at eprzysuc@lakeheadu.ca).

Sincerely, Tyler McDougall

Appendix C

Initial e-mail to parents/ caregivers

To parent/ caregiver of ___________,

Hello, my name is Tyler McDougall and you know me from coaching your child in Special Olympics Basketball, floor hockey or soccer. I am a student at Lakehead University currently completing my Masters of Kinesiology. I will be conducting a study entitled: “The effect of a 6-week combined resistance and cardiovascular training program on muscular strength, endurance and body composition in young adults with a mild to moderate global delay” for my Master’s Thesis. I am sending this e-mail as your child meets the inclusion criteria to be a potential participant in this study.

Involvement in this study is completely voluntary and is not associated with Special Olympics in any way. Participation in this study will have no effect on your child’s involvement with Special Olympics. If you and your athlete are interested in learning more about this study please stay after our next basketball practice on ___________ . If you are interested in hearing more about this study but cannot attend this session please feel free to contact me through e-mail or by phone at 1-807-630-6376.

Thank you for your time,

Tyler McDougall

Appendix D

Athlete Information Letter

Information Letter

Title: The effect of a 6-week combined resistance and cardiovascular training program on muscular strength, endurance and body composition in young adults with a mild to moderate global delay

Dear Potential Participant.

My name is Tyler McDougall, and I am a Master's Student in School of Kinesiology, at Lakehead University. I would like to invite you to participate in a research study titled "The effect of a 6-week combined resistance and cardiovascular training program on muscular strength, endurance and body composition in young adults with a mild to moderate global delay". The purpose of the study is to see if doing a regular weight and cardio training program can help improve your strength, endurance and weight. You may be able to be in this study if you are between the age of 18-25 years old and have been diagnosed with a mild to moderate global delay intellectual disability.

You will be asked to do testing of your endurance, strength and body composition which will be done by completing the 20-meter shuttle run, a 10-repetition maximum test for seated leg press and seated chest press and hip to waist measurements. We will be doing this to test your current fitness levels. You will then come to 3, 1-hour training sessions a week with weight and cardio exercises for 6 weeks. These will be led by myself who is a NCCP, CanFit Pro personal trainer and Special Olympics Coach Level 1 certified who has over 6 years of experience training. There will also be 2 other volunteers from Special Olympics at every session.

In the middle of the program you will do the same three tests to see if there have been any improvements. After 6-weeks of the program you will be asked to do these tests again to see if your strength, endurance and body composition have gotten better. The same 3 tests will be used that you did on the first day.

There is very low risk of harm in this study. You will be under direct supervision of the trainer and 2 other trained volunteers at each session. This is so that all exercises are done in a safe controlled matter. You may have some general muscle soreness from the weight lifting. However, you may also see improvements in endurance, strength and body composition over the 6 weeks of the study.

Participation in the study is completely your choice, and you may stop participating at any time during the study without any questions. **This study has nothing to do with Special Olympics and taking part in this study will not affect your participation in any Special Olympics sport or social events.** You can refuse to answer any questions asked, and refuse to participate in any part of the study. Results from the study will not use your name. Only my supervisor and I will have access to the data.

This study has been approved by the Lakehead University Research Ethics Board. If you have any questions related to the ethics of the research and would like to speak to someone outside of the research team please contact Sue Wright at the Research Ethics Board at 807-343-8283 or research@lakeheadu.ca.

If you would like to participate or you have any questions or concerns, please attend our information session on:

Thank you for reading about this research and for your consideration, Tyler McDougall

Appendix E

Parent Copy of Information Letter

Information Letter

Title: The effect of a 6-week combined resistance and cardiovascular training program on muscular strength, endurance and body composition in young adults with a mild to moderate global delay

Dear Parent of the Potential Participant.

My name is Tyler McDougall, and I am a Master's Student in School of Kinesiology, at Lakehead University. I would like to invite your child to participate in a research study titled "The effect of a 6-week combined resistance and cardiovascular training program on muscular strength, endurance and body composition in young adults with a mild to moderate global delay". The purpose of the study is to see if doing a regular weight and cardio training program can help improve strength, body composition and cardiorespiratory fitness of your child. He/she would be eligible if he/she is between the age of 18-25 years old and have been diagnosed with a mild to moderate global delay intellectual disability.

Your child will be asked to complete initial baseline measurements of cardiorespiratory fitness, muscular strength and body composition which will involve completing the Leger 20-meter shuttle run, a 10-repetition maximum test for seated leg press and seated chest press and a hip to waist ratio measurement. They will then participate in 3, 1-hour resistance and cardiorespiratory training sessions a week for 6 weeks. These sessions will be led by me who is a NCCP and CanFit Pro certified personal trainer. I also have over 6 years of experience working with athletes who have intellectual disabilities. There will also be 2 other certified volunteers present at each session.

At the mid-way point of the study your child will complete the same three tests to identify if any improvements have been made. After the 6-week intervention I will ask you and your child to return again to collect information about potential improvements made in your child's muscular strength, cardiorespiratory endurance and body composition. The same measurement protocols will be used in the mid and posttest as the initial assessment.

Your child is at very minimum risk of harm through the entire study. They will be under direct supervision of the trainer and volunteers throughout the duration of each session. They may experience general muscle soreness as a result of the resistance training. However, they may also experience general improvements in cardiorespiratory fitness, muscular strength and body composition over the course of the study.

Participation in the study is completely voluntary, and your child may stop participating at any time during the study without any consequences. **This study is in no way associated with Special Olympics and participation in this study will have no effect on participation in any Special Olympics sport or event.** Your child may refuse to answer any questions asked, and refuse to participate in any part of the study. Confidentiality will be maintained throughout the study, as names will be replaced with numbers. Only my supervisor and I will have access to the data. As per Lakehead University's policies, the results will be kept for 5 years at Lakehead University on a password protected hard drive.

This study has been approved by the Lakehead University Research Ethics Board. If you have any questions related to the ethics of the research and would like to speak to someone outside of the research team please contact Sue Wright at the Research Ethics Board at 807-343-8283 or research@lakeheadu.ca.

You may access individual or overall results of the study upon request. If you have any questions or concerns, please attend our information session on:
Thank you very much for reading and for your consideration, Tyler McDougall

Appendix F

Consent Form Parent

I ____________________, agree to allow my child participate in a study being conducted by a graduate student at Lakehead University. I agree that:

- I have read and fully understand all the information presented in the information letter.
- I understand that my child will participate in a pre-, mid- and post intervention session as well as 3, 1-hour training sessions a week over the next 6 weeks.
- I understand the procedures used to collect data, and I understand what is to occur during my childs training sessions.
- I understand all potential risks, as well as all potential benefits to my child and to society associated with participation in this study.
- I understand that participation is completely voluntary and that my child and I may refuse to answer any questions and stop participating at any time with no consequences.
- I understand that this study is in no way associated with Special Olympics and nothing that occurs throughout the course of the study will affect my child's involvement with Special Olympics in any way.
- I understand that all information provided by my child and I will remain completely confidential and we will remain anonymous in all results coming from the study.
- I understand that all information will be stored at Lakehead University for 5 years, and will only be accessed by the researcher and supervisor.
- I understand that I may receive my child's results at any time by contacting the researcher after the study is complete.

Participants Name: __________________
Participants Age: ______
Parent/ Guardian's Name: __________________
Parent/ Guardian's Signature: _________________
Participants Signature: ____________________
Phone Number: __________________

Would you wish to view your child's results (circle one)? (Yes/No)
Email (optional): ___________________

Date:_____________________

Does your child have any medical condition that may interfere with performance? (y/n)

Appendix G

Consent Form Participant

I _________ agree to be in the study conducted by Tyler McDougall, who is a Masters student in the School of Kinesiology at Lakehead University.

I fully understand that:

- I will be asked to take part in the tasks which involve cardiorespiratory endurance, muscular strength and body composition

- I will be asked to do these tasks at three different times

- I will participate in 1-hour training sessions 3 times a week for the next 6 weeks.

- There are some risks involved in participation

- I am a volunteer and I can stop being in the study any time, if I want to.

- I don't have to answer any questions I don't want to

- My name will be kept secret during the study, and that I can get my results from the researcher.

- This study has nothing to do with Special Olympics

- All the information will be kept at Lakehead for 5 years and will only be looked at by the researcher and his supervisor.

Participant Name: ________
Participant Signature: ________