COMPARISION OF RESTING METABOLIC RATE IN AN ADOLESCENT WITH DOWN SYNDROME PRE AND POST A WEIGHT TRAINING INTERVENTION: A CASE STUDY

A Thesis
Presented in Partial Fulfillment
Of the Requirements for the Degree of
Master of Science
In the department of Nutrition and Kinesiology
University of Central Missouri

August, 2014

COMPARISION OF RESTING METABOLIC RATE IN AN ADOLESCENT WITH DOWN SYNDROME PRE AND POST A WEIGHT TRAINING INTERVENTION: A CASE STUDY

by

Jessica L. Stout

August, 2014

APPROVED:

Thesis Chair: Dr. Scott Strohmeyer

Thesis Committee Member: Dr. Ken Bias

Thesis Committee Member: Dr. Brad Mears

ACCEPTED:

Chair, Department of Kinesiology: Dr. Michael Godard

UNIVERSITY OF CENTRAL MISSOURI
WARRENSBURG, MISSOURI

TABLE OF CONTENTS

Page

LIST OF TABLES

Table Page

Abstract

Individuals with Down syndrome (DS) often display special health conditions such as: congenital heart disease, atlantoaxial instability, low levels of physical fitness, and a lower maximum heart rate (ACSM, 2014). When the individual with DS displays these conditions, they tend to avoid and have difficulty performing some exercises due to balance, skeletal, cardiorespiratory, muscular, and other safety concerns. This then leads to the individual not achieving adequate amounts of physical activity and having lower levels of muscular strength, commonly resulting in obesity. **Purpose:** The purpose of this study was to examine the effects of an individuals' resting metabolic rate pre post weight training intervention in an adolescent diagnosed with Down syndrome. **Methods:** The subject was diagnosed with Down syndrome, had no previous weight training experience. The subject had her resting metabolic rate measured using the BodyGem system prior to starting the weight training intervention. The subject then participated in six weeks of weight training. The subject performed 2-3 one hour sessions a week, for six weeks. Once the weight training intervention was complete, the subject then returned to have her resting metabolic rate measured. **Results:** After twelve, one hour, full body resistance training workout sessions, the subject was able to raise their RMR level from 890 to 960. The apparent increases in the subjects' resting metabolic rate were evidenced by the BodyGem measurements pre and post the resistance training intervention.

Chapter One

NATURE AND SCOPE OF STUDY

Down syndrome is a disorder that may affect an individual in many ways. It is stated, "One in every 600 individuals born in the United States is affected by this chromosomal anomaly" (Sanyer, 2006, p. 315). Individuals with Down syndrome (DS) have distinct physical characteristics that distinguish them from individuals without Down syndrome. Individuals diagnosed with DS tend to function in the mild to moderate range of mental retardation. Along with other intellectual/developmental disabilities, Down syndrome displays a wide variation in mental abilities and developmental progress (Pueschel, 2013). It is understandable that the psychological traits are the main focus of the individual with the Down syndrome. However, physical characteristics and health should also be a concern.

The physical and psychological traits of individuals diagnosed with DS usually lead to a lower physical fitness level. Individuals of any age with developmental disabilities tend to demonstrate lower physical fitness levels which are inferior to their non-disabled peers, this population also known for exhibiting a sedentary lifestyle (Fernhall and Pitetti, 2011; Pitetti and Campbell, 1991; Pitetti, Rimmer, and Fernhall, 1993; Pitetti, Jongmans, and Fernhall, 1999; Pitetti, Yarmer, and Fernhall, 2001)". Sedentary lifestyles contribute to the individual with DS to develop unhealthy qualities such as: higher percent body fat (PBF), lower levels of fat free mass and increased waist and hip circumference, according to the American College of Sports Medicine (ACSM 2014). When an individual has these unhealthy qualities, their chances of developing chronic health diseases increase.

Individuals with DS have physical and psychological characteristics that may affect the type and amount of physical activity in which they may participate. "Over 80 clinical physical

characteristics are seen in individuals with Down syndrome, characteristics most related to exercise are: muscle hypotonicity, hypermobility of the joints or ligamentous laxity, and mild to moderate obesity" (Rimmer and Kelly, 1991, p. 146). These skeletal issues may likely cause the physical activity duration (if any) and intensity to decrease in adolescents with DS. These characteristics may also lead to a decreased amount of muscular strength and endurance training in individuals diagnosed with DS.

It has been found muscular strength in individuals with DS is impaired by muscular hypotonia and laxity of ligaments which may harm the propagation of strength during the execution of exercises performed by certain muscles (Barbosa, 2009). It is commonly seen in individuals with DS to have muscles that may be stretched far beyond normal limits, and to have increased flexibility in their joints that may lead to increased susceptibility to subluxation and dislocations. Individuals with DS have less stability in the upper neck and head joints, which puts them at a higher risk for spinal cord injuries. Weight training is essential for increasing ones fat free mass, and may improve their body composition. Not only is it essential for the individual to decrease their body fat level, but to increase their muscle mass as well, in order to decrease health risks for obesity related diseases. "A major concern for the athlete with Down syndrome is cervical spine instability, which may lead to progressive neurological decline, catastrophic paralysis, and even death" (Fanter, 2012, p. 2).

> Strength training can boost metabolic rate by up to 15%, depending on how hard you train. Resistance exercise increases the muscle temperature, which in turn slightly increases the rate at which you burn calories over the hours following a weight training session. (Fahey, Insel, and Roth, 2013, p. 102)

It is stated the greater amount of fat free mass an individual has, they higher their metabolic rate will be. Individuals' resting metabolic rate decreases when they become obese Individuals with DS have many of the predisposing factors for obesity. These factors include: the coexistence of certain genetic syndromes that are known to be associated with obesity, reduced levels of physical activity, and the use of centrally acting medications which may cause weight gain. With all of the predisposing factors for obesity, decreasing amount and motivation for physical activity, and the increase susceptibility for skeletal injuries when performing strength training exercises previously mentioned, it is estimated the chances for individuals with DS to obtain obesity related chronic diseases increase (Lobstein, Baur, & Uauy 2004). As individuals continue to obtain more fat-free mass the individuals resting metabolic rate will also increase. In return, their body composition will most likely improve and their chances of obtaining obesity related chronic diseases may decrease (Fahey et al., 2013). The main objective for future research in this particular field should be to determine whether exercise (aerobic, strength, or a combination of both) could benefit individuals with DS, and in return help them have a healthier body composition and physical fitness, which could lead to a healthier and better quality of life (González-Agüero et al., 2010).

Need for the Study

Further research in the area of physical fitness and adolescents with DS is needed for numerous reasons. Individuals with DS are living longer and becoming more involved in the society. As these individuals are living longer, more research is needed involving the physical health and fitness of this population.

The life expectancy of the population with DS is increasing with time; hence, cases of diseases some illnesses and diseases related to age (until now relatively unreported for

> the DS population) such as osteoporosis or cellular aging begin to appear earlier than in the population without DS (González-Agüero et al., 2010, p. 723).

These individuals have many predisposing factors for obesity and are prone to developing obesity related chronic diseases. This population has many physical characteristics which lead to many safety concerns involving exercise and physical activity. Individuals with DS commonly avoid physical activity and exercise training programs, because of the higher risk of injuries (National Center on Health, Physical Activity, and Disability, 2014). "More studies on this population are required so that the benefits can be documented and training programs can be incorporated for all children with Down's syndrome" (Gupta, Rao, & SD, 2011, p. 430).

More research is needed especially in the field of weight training involving adolescents with DS. Adolescence is a strategic time to implement an exercise program for individuals with DS to help establish good exercise habits which could develop into a pattern of continued healthy activity into adulthood (Telama et al., 2014). Certain muscular physiological characteristics may make it difficult to design a weight training program with this population. Little information is available about the best methods of weight training, which exercises are beneficial, which exercises to avoid, and benefits of participation in the weight training program (Gupta et al., 2011). One benefit of participating in weight training is the increase in the individuals RMR (Fahey et al., 2013). Due to the little information available in this area of research the following research questions may arise: Do individuals with DS experience the same increase in RMR? Does their RMR increase more or less when compared to individuals without DS? If the individual with DS's RMR does increase, this could help decrease their percent body fat, and increase their fat free mass. This could in return decrease the chances for DS individuals to obtain obesity related chronic diseases. If more studies involving the physical

health and fitness of individuals with DS were completed, the prevention and early identification of health concerns and diseases could improve (Lobstein et al., 2004). The following information was found:

> High prevalence rates of overweight and obesity in children and adolescents with developmental disabilities highlights the need to develop and implement strategies for the prevention, early identification and management of excess weight gain as a universal component of health care for this group (De, Small, & Baur, 2008, p.47).

Statement of the Problem

The purpose of this intervention was to examine the effects of a weight training intervention on an individual diagnosed with Down syndromes' resting metabolic rate. This study was conducted to determine if the individuals' RMR will increase after the weight training intervention was completed. Research on this topic will help to better determine if individuals diagnosed with Down syndrome respond to, and have similar results, when participating in a weight training intervention compared to adolescents without Down syndrome.

Hypothesis

It was hypothesized that the individuals' metabolic rate would increase once the individual diagnosed with Down syndrome completed six weeks of weight training.

Basic Assumptions

It was assumed that:

1) participant had a high level of motivation to perform their best;

2) subject had listened to and learned the intervention given during the instruction by the researcher;

3) subject followed the regulations set before measuring their resting metabolic rate;

4) the BodyGem System measures resting metabolic rate accurately; and

5) the researcher was accurate in the administration of the test and recording of the data.

Delimitations

This investigation was delimited to:

1) a purposive sample consisting of 1 adolescent diagnosed with Down syndrome;

2) the use of the 1-rep max muscular strength test to determine sub maximal repetitions;

3) the use of the BodyGem System to measure an individual's resting metabolic rate;

4) the use of a resistance training program designed by the investigator; and

5) the duration of six weeks to complete the study.

Limitations

This study was limited by:

1) The sample size of this study is small (N=1) necessitating caution in the extrapolation of the data to a larger population of adolescents diagnosed with Down syndrome;

2) Daily activities of the subject other than the exercise program are not controlled;

3) Although the subject was requested to maintain normal activities and eating habits, occasional variance from this may occur; and

4) Since, resting metabolic rate may be affected by conditions other than exercise; it is possible that such conditions may exist.

Definitions

For the purpose of this study, terms were defined as follows:

DS- Down syndrome-a developmental/intellectual disorder in which the individual has recognizable physical characteristics and limited intellectual endowment due to the presence of an extra chromosome 21 (Pueschel, 2011).

RMR- Resting metabolic rate, the energy expenditure required to maintain normal physiological processes during rest in a post absorptive state (Byrne and Wilmore 2001).

PBF- Percent Body Fat, the percentage of fat mass when compared to the subject's total body mass

BGS- BodyGem System-equipment used to measure resting metabolic rate

RM- Repetition Max- a muscular strength fitness assessment used to determine a starting point for individuals beginning a weight training program

Chapter Two:

REVIEW OF LITERATURE

The purpose of this study was to examine the effects of a weight training intervention on an individual diagnosed with Down syndromes' resting metabolic rate. The review of literature has been divided into three sections: (1) physical characteristics and safety concerns; (2) weight training intervention programs for Down syndrome; (3) resting metabolic rate; and (4) summary.

Physical Characteristics and Safety Concerns

Hresko, McCarthy, & Goldberg, (1993) performed a study which examined hip disease in adults with DS. Radiographs were performed on 65 patients, of those subjects 29 hips showed radiographic abnormalities. Of the 65 patients, 47 patients had "normal hips .Out of the subjects with "normal hips" however, seven of the subjects were wheelchair-dependent, three were household ambulators, and 37 were community ambulators. Hip disease was found in 18 subjects. Hresko et al., (1993) found "hip disease is common, and that it does affect function: there was a significant difference in the proportion able to be independent community ambulators between patients with radiographically normal and abnormal hips" (p. 606). From this study, it was concluded hip disease is common in adults with Down syndrome, and hip dysplasia may develop with ageing and could progressively lead to the inability to walk.

Fernhall and Tymeson (1987) found several studies have suggested that individuals with DS have maximum heart rate levels which are around 10% lower compared individuals without DS. With the difficulties that arise when trying to obtain an appropriate heart rate while exercising, and not properly able to test the aerobic capacity of individuals with DS, it is probable the risk of obesity and obesity related diseases may increase. According to Sanyer (2006), "Individuals with DS are at greater risk for obesity, and have been shown to have

decreased cardiorespiratory capabilities, even when congenital cardiac anomalies are not present" (p. 315).

Pueschel, (2011) found individuals with DS have certain physical characteristics which put them at risk while exercising. Some of these characteristics include: decreased muscle tone, loose ligaments, small hands and small feet. Skeletal and Orthopedic problems have also been noted a higher frequency in children with DS. In this population there is also a wide variation in mental abilities and developmental progress. For example, their motor development is slow; children without DS tend to start walking around 11 to 14 months, while children with DS usually learn to walk between 15 to 36 months. Their language development is also delayed distinctly. These qualities may make physical activity, and using exercise equipment difficult. Around 50 percent of children with DS have congenital heart disease; because of this, it is common for children to have cardiac surgery and require long-term cardiac care. These individuals often have mitral valve prolapse in their adolescent years. With heart conditions in mind, testing the aerobic capacity of an adolescent diagnosed with DS may be difficult.

Congenital heart disease may affect an individual diagnosed with DSs' amount of exercise he or she participates in. With this heart disease, effective aerobic exercise and having the individual reach their target heart rate zone becomes much more difficult. Millar, Fernhall, & Burket (1993) performed a study which studied the effects of aerobic training in adolescents with DS. It was mentioned in the study, how to date, there have been no training studies involving only individuals with DS. This proves how significant, research in the field of aerobic training with these individuals is. The 14 individuals with DS were divided randomly into two groups; 10 in the experimental group and four in the control group. The control group did not participate in any regular physical training, while the experimental group participated in a training

intervention. The aim of the study was to determine whether individuals with DS could improve their cardiovascular fitness following a 10-wk walk/jog training program. The training intervention consisted of 10 min of warm up, 30 min of continuous brisk walking and jogging, followed by a 5-10 min cool down, three times a week, for 10 weeks. The individuals target heart rate were calculated at 65-75% of their maximal heart rate. Results from the study showed, the exercise group demonstrated significant improvement in peak exercise time and grade. Although the training program designed did not produce significant improvements in aerobic capacity, it did produce significant gains in walking capacity.

According to the National Center on Health, Physical Activity, and Disability (2014), weight training also brings difficulty when working with adolescents with DS. The most common muscle related physical characteristics most related to exercise are muscle hypotonicity and hypermobility of the joints or ligamentous laxity, including hip stability. These issues make certain weight training exercises safety concerns. Gupta et al., (2011) performed a study in which the purpose was to determine the effect of exercise training on strength and balance in children with DS. In the study, 23 children were randomized into two groups: intervention and control. The intervention group participated in progressive resistance exercises for lower limbs and balance training for six weeks, while the control group continued with their regular activities. Participants in the intervention group completed progressive resistance exercises for six weeks, three times a week. The results of the study indicated that the strength of all the muscle groups measured improved after the completion of the intervention, and that six weeks is sufficient to produce a significant measurements. In the findings, it was indicated for future recommendations to start at a lower resistance because of the skeletal muscle hypotonia and ligamentous laxity, hence higher resistance loads may increase the risk of musculoskeletal injuries.

As one ages the importance of muscular strength, muscular endurance, and balance becomes more important. Islam, Takeshima, Rogers, Koizumi, & Rogers (2004) found balance performance in older adults is connected with functional and physical fitness. When the individual displays a higher level of physical fitness (high levels of aerobic capacity, muscular strength, and muscular endurance), the daily functions and activities throughout their lifespan become easier. González-Agüero et al., (2010) found the lifespan of individuals with DS is increasing; because of this, it is important to study the level of strength in this population and support programs which help improve it. As adolescents with Down syndrome age, they lose muscular strength and their aerobic capacity decreases when continuing to have a sedentary lifestyle, which may affect and decrease the amount of daily functions and activities they participate in. When individuals with DS cannot perform daily tasks, their job (if they have one) may suffer. The muscular strength and aerobic capacity of the individual are related to vocational performance in adolescents and adults with DS. Cowley et al., (2011) found individuals with DS tend to perform manual-related jobs (e.g. filling boxes, carrying, standing), which rely mainly on their muscular strength, in return their performance could become impaired with further losses in strength that occur with aging

Weight Training Intervention Programs

Shields and Taylor (2010) led a progressive resistance training program to 23 adolescent's ages 13-18 diagnosed with Down syndrome. The aim of the study was to determine the effects of a resistance program led by students to adolescents with DS. All the participants were randomly selected to be part of either the control group or experimental group. The experimental group participated in a ten week progressive resistance training program, while the participants of the control group continued with their usual daily activities. The subjects

participated in assessments which tested muscular strength for both upper and lower body on the first and last week of the weight training program. For the assessments, a 1 repetition max (1RM) test was used with 40% of their max being the starting point for the weight training program. To test upper body a 1RM test was done on the chest press machine, and to test lower body strength the leg press machine was used. These exercises were chosen because they involve using the major muscle groups over multiple joints. For the experimental group, the subjects completed training twice a week, with the training program designed according to the recommendations provided by the American College of Sports Medicine (ACSM, 2014). Each training period contained six exercises all done using weight machines. Three upper body exercises such as: chest press, seated rows, and lat pull-downs were used, and three lower body exercises such as: leg press, knee extensions, and calf raise machines. The participants performed 3 sets of 12 repetitions, with a recovery time of 2 minutes in between each set. As the subjects progressed, the resistance was then increased when the subject could perform the 3 sets of 12 easily. These exercises were chosen for numerous reasons: they strengthened the major multi-joint muscles of the upper and lower limbs, all exercises may be done on pin loaded machines which are considered safer with less chance of injuries to occur, and the exercises could be modified to suit the needs of the individual. The results of this study showed, the experimental groups' lower limb muscle strength increased more when compared to the control group. It was reported the data showed progressive resistance training is an acceptable form of exercise which individuals with DS may participate in.

Cowley et al., (2011) performed a study involving a progressive resistance training program on adolescents diagnosed with DS. In the study the effects of a progressive resistance training program on leg strength, aerobic capacity, and the functional tasks of daily living were

studied. Participants were assigned to either be in the intervention group or the control group. The subjects performed 10 weeks of resistance training, while the control group maintained their daily activities. Results indicated resistance training led to functional improvements in daily functions such as the ability to go up and down stairs, and is an effective intervention for individuals with Down syndrome to improve leg strength as well.

Gupta et al. (2010) studied the effects of exercising on children with Down syndromes' strength and balance. In this study, 28 participants between the ages of 7-15 had their height and weight measured, and their IQ level was determined using the Binet kamat test. Out of the 28 participants, only 23 children continued to be part of the study due to the study criteria the researchers established. The subjects used a handheld dynamometer to measure the strength of hip flexors, hip abductors, hip extensors, knee flexors, knee extensors and ankle plantarflexors. Each child subject performed three test trials for each muscle group, with the best performance on the right limb used in the data analysis. After collecting the baseline measurements, the subjects were randomly divided into the experimental and control groups. Participants in the experimental group underwent progressive resistance training for the lower limbs, and balance training exercises for six weeks, three times a week. For each muscle group, the participants did two sets of 10 repetitions. Resistance was increased by half a kilogramme when the child was able to complete all of the sets with ease. The control group was told to continue their activities that were being followed in their school. After the six weeks, the strength and balance of each participant was measured. Results of this study showed after six weeks of an exercise training program the children in the experimental groups' lower limb strength and overall balance improved, compared to the control group. The results indicated the strength of all of the muscle groups measures improved in the experimental group as well. In this study it was concluded, a

six week protocol was sufficient to produce a significant difference, and more studies on this population is needed to design programs which may be incorporated for all children with DS.

Resting Metabolic Rate

Resting metabolic rate can be measured using various open and closed circuit indirect calorimetry equipment. Nieman, Austin, Chilcote, & Benezra (2005) studied the validity and reliability of the MedGem device to measure resting metabolic rate (RMR) in children. In this study, 59 children (29 boys, 30 girls) between the ages of 7 and 13 were given four RMR tests during one test session. The tests consisted of two Douglas bag and two MedGem tests, in random order. The MedGem is an inexpensive, easy-to-use, portable, and accurate device for measurement of RMR. The individual holds the unit while breathing through an attached mouthpiece or facemask for 5 to 12 minutes, the MedGem sensors measure and provide a digital readout of RMR in kcal/day. Douglas bag collections of expired gases were made for 10 min using a mouthpiece connected to a Hans-Rudolph small 2-way valve and noseclip. RMR was collected with the individual in a supine position, measured immediately after at least 8 hours of sleep and 12 hours of fasting at the same time of day to reduce the effect of diurnal variation. After completion of anthropometric measurements, subjects sat quietly for 10 min and were given orientation to the testing procedures before the 4 RMR measurements. Each RMR measurement was of 12 min duration, and subjects were given a 2-3 min seated break between tests. The results of this study indicated that the MedGem is a reliable and valid system for measuring oxygen consumption and RMR in boys and girls ranging in age from 7 to 13 years old. No significant difference in RMR measurement was found between the Douglas bag and MedGem system. The results also indicated that the RMR measurements using either system is highly reproducible, and that a single measurement is sufficient in clinical, research, or fitness

club settings. The MedGem provides a quick and convenient estimate of RMR in children that is accurate and reliable, and should facilitate the process of pediatric weight-management counseling.

Kravitz (2011) stated, “Because of its robust role in TEE (total 24-hour energy expenditure), RMR has become the target of many substantiated and unsubstantiated weight loss propositions” (p. 21). When it comes to weight loss techniques, physical exercise and diet can play an effect on RMR levels. In the article discussing metabolism he mentioned, people tend to lose a considerable portion of muscle mass in diet-only weight loss programs. However, one of the key contributions from weight loss exercise programs is the preservation of muscle mass and RMR. Long term studies show that both aerobic exercise and weight lifting independently increase RMR, which in return can contribute to the desired energy balance goals of weight management programs.

For this study, a comparison of RMR will be studied before and after the subject participates in six weeks of resistance training. Hunter, Wetzstein, Fields, Brown, & Bamman (2000) conducted a 26-week resistance training study with beginning, sedentary and older males and females. In this study the subjects completed workouts consisting of 2 sets of 10 repetitions with 2 minutes of rest between sets. Some examples of the resistance exercises are: lateral pull down, seated row, leg extension, leg curl, back extension, etc. The subjects trained at intensity within 65%-80% of their 1-repetition maximum (1RM). Hunter and colleagues carefully integrated progressive overload into the program after daily training logs and retesting 1-RM every 3 weeks. Results of this study indicated by the end of the 6-month investigation, both male and female subjects had increased their RMR by 7% which is approximately 100 additional calories per day.

Summary

As seen in previous studies, individuals with Down syndrome possess many physical and physiological characteristics for becoming overweight and/or obese. While the intellectual disorder itself is the main focus for the individual, the physical health should not be overlooked. Even with the heart, skeletal, and safety concerns, individuals with DS still need to participate in regular physical activity which includes weight training. Previous studies have shown weight training interventions have resulted in improved strength and balance in children with DS. González-Agüero et al. (2010) stated the following:

> The ultimate objective of future research in this field should be to test whether exercise (aerobic, strength and/or a combination of both) could benefit children and adolescents with DS, and help them have a healthier body composition and physical fitness, all of which result in a healthier and a better quality of life in this population. (p.723)

Kravitz (2011) found, the more fat-free mass one has, the higher their metabolic rate will be, which in turn, may help one decrease their percent body fat. It has been shown resting metabolic rates in individuals without DS increase when participating in resistance training exercise programs. After reviewing the previous studies, the research question was developed; does the resting metabolic rate increase when an individual diagnosed with DS participates in a weight training intervention?

Chapter Three:

METHODS

Introduction

This research study was conducted to compare the resting metabolic rate pre and post a weight training intervention in an individual diagnosed with Down syndrome.

Subject

The subject is diagnosed with DS, had no previous weight training experience, and is a student in the THRIVE program at the University of Central Missouri participated in this study. The subject was a 25 years old female. The subject's height (4 ft 2 in) and weight (107lbs) were recorded. Subject and subject's legal guardians signed a university approved informed consent and assent prior to participation.

Instrumentation

To determine the effects of the weight training intervention on the subjects' resting metabolic rate the subject had her resting metabolic rate measured using the BodyGem system prior to starting the weight training intervention. The subject then participated in six weeks of weight training. The subject then performed 2 one hour sessions a week, for six weeks. Once the weight training intervention was complete, the subject then returned to have her resting metabolic rate measured.

Procedures

Once the subject, along with the subjects' parents or legal guardians enters the testing area, the researcher read and gave the subject and the parents or legal guardians their consent forms. Upon acceptance by the subject and subjects' parents, the researcher then gave instructions for measuring the resting metabolic rate prior to the weight training intervention. For

the first resting metabolic rate measurement the subject reported to the Human Performance Lab at 7:00 a.m. Before starting the measurement, it was made sure the subject had followed the instructions prior which included: no food consumed for the 12 previous hours, no physical activity for a minimum of 2 hours prior to the assessment, no eating before the measurement, and the subject must rest supine for about 30 minutes in a comfortable, thermoneutral environment before resting metabolic rate is measured. After the subject rested for 30 minutes the subject then sat up placed a noseclip on their nose, and breathed into the BodyGem. The subject was in a relaxed position, stayed still while breathing into the BodyGem until the measurement was obtained, which took around ten minutes. After the measurement was obtained, the result was recorded. The subjects' measured RMR was 890.

The subject was then informed of what the weight training intervention process will include. To determine the subjects' starting weight for the weight training intervention the subject completed a 10RM test twice. The subject performed the test once for upper body using the chest press machine, and then again for the lower body using the leg press machine. After the tests, the results were then multiplied by 50% to determine a starting point for the subject. The subject performed the 10RM on the chest press machine first. Prior to starting, the seat was lowered to ensure proper form. Since the subjects' 1RM was unknown, the subjects' weight was multiplied by 2/3 to estimate their 1RM for this subject this was 107lbs X.75=80.25lbs. Once their estimated 1RM was obtained, this number will be taken to determine the subjects' 10RM. The subject then began with a warm up set 1 with 6 reps of 40%-60% of 10RM, followed by a 3 minute rest. For this subject this warm up set was 6 reps of 30 lbs (~32lbs). For the second warm up set (6 reps of 60%-80%) the subject lifted 45 lbs (~48 lbs). The subject could not do this more than once however, so the weight was reduced to 40 lbs, and attempted again, after a three

minute rest. The subject did 1 rep of 40lbs, and this was determined her 1RM for upper body. This process was then repeated for the leg press machine. Before beginning the test, the machine was adjusted for the subject. This included moving the back rest to the most upright position and the "press" part of the machine closer to the subject to ensure proper form. The subject began with warm-up set 1 with 6 reps of 60 lbs (~64lbs) followed by a 3 minute rest. This was easy for the subject. Warm up set 2 consisted of 6 reps of 90lbs (~85lbs) followed by a 3 minute rest. This set was harder, however we continued. For the third warm up set the subject did 6 reps of 100lbs (~96lbs) followed by a three minute rest. For the last warm up set, the subject did 110 lbs for 10 reps followed by a three minute rest. The subject then tried 120lbs one time. This was difficult for her, but she was able to complete 1 rep with proper form. It was then determined the subjects estimated 1RM for lower body was 120 lbs. For upper body and core exercises, to determine starting weight the 1RM was multiplied by 30% and 50%. The result of this equaled 10lbs and 20lbs for upper and core exercises. For lower body exercises the 1RM was multiplied by 50% and 80%. The results of this equaled 60lbs and 100lbs for lower body exercises. It was decided that the subject will participate in two nonconsecutive days of resistance training for an hour each session, 3 sets of 10 reps for each exercise, and completing ten exercises including: upper, lower, and core exercises. At the University of Central Missouri's Student Recreation and Wellness Center there are 4 lower body machines available, 7 upper body machines available, and 3 abdominal machines available for the subject to use. Due to shoulder joint dislocation risks the lateral raise machine will not be available to use. Warm up will consist of two laps walking around the indoor track, including arm swings while walking.

The subject then participated in a full body weight training workout 2 days a week which consisted of upper body, lower body, and core exercises. For each exercise the subject performed

3 sets of 10 repetitions. There was no particular order for the exercises. The order for each day was determined by what the subject preferred and what machines were available for use. When it came to increasing the weight the subject followed the "two for two" rule: When the subject could perform two additional repetitions with a given weight on two consecutive training sessions, it is appropriate to increase the weight. When increasing the weight, the instructor increased the weight previously performed by 5%. After the six week intervention, the subject then returned to the human performance lab to measure their resting metabolic rate. For the last resting metabolic rate measurement the subject reported to the Human Performance Lab at 7:00 a.m. Before starting the measurement, it was made sure the subject had followed the instructions previously mentioned. After the subject rested for 30 minutes the subject then sat up placed a noseclip on their nose, and breathed into the BodyGem. The subject was in a relaxed position, stayed still while breathing into the BodyGem until the measurement was obtained, which took around ten minutes. After the measurement was obtained, the result was recorded. The subjects' measured RMR was 960. The charts below show the exercises the subject performed every day of the six week weight training program.

Week One Session Results

	DAY ONE	
BICEP CURLS	3 SETS OF 10	10 LBS
INNER/OUTER THIGH	3 SETS OF 10	30 LBS
LATERAL PULL DOWN	3 SETS OF 10	10 LBS
LEG CURLS	3 SETS OF 10	30 LBS
SEATED ROWS	3 SETS OF 10	20 LBS

LEG EXTENSIONS	3 SETS OF 10	20 LBS
CHEST PRESS	3 SETS OF 10	20 LBS
LEG PRESS	3 SETS OF 10	100 LBS
SHOULDER PRESS	3 SETS OF 10	10 LBS
BACK EXTENSION	3 SETS OF 10	30 LBS

Table 1

	DAY TWO	
CHEST FLIES	3 SETS OF 10	10 LBS
ABDOMINAL CRUNCH	3 SETS OF 10	10 LBS
LEG PRESS	3 SETS OF 10	100 LBS
SHOULDER PRESS	3 SETS OF 10	10 LBS
ROTARY TWIST	3 SETS OF 10	10 LBS
INNER/OUTER THIGH	3 SETS OF 10	30 LBS
TRICEP EXTENSION	3 SETS OF 10	20 LBS
BACK EXTENSION	3 SETS OF 10	30 LBS
CHEST PRESS	3 SETS OF 10	20 LBS
LATERAL PULL DOWN	3 SETS OF 10	10 LBS

Table 2

Week Two Session Results

	DAY THREE	
CHEST FLIES	3 SETS OF 10	10 LBS

ABDOMINAL CRUNCH	3 SETS OF 10	10 LBS
LEG PRESS	3 SETS OF 10	120 LBS
SHOULDER PRESS	3 SETS OF 10	10 LBS
ROTARY TWIST	3 SETS OF 10	10 LBS
INNER/OUTER THIGH	3 SETS OF 10	30 LBS
TRICEP EXTENSION	3 SETS OF 10	20 LBS
BACK EXTENSION	3 SETS OF 10	30 LBS
LEG CURLS	3 SETS OF 10	30 LBS
LATERAL PULL DOWN	3 SETS OF 10	10 LBS

Table 3

	DAY FOUR	
CHEST FLIES	3 SETS OF 10	10 LBS
LEG CURLS	3 SETS OF 10	30 LBS
LEG EXTENSIONS	3 SETS OF 10	20 LBS
CHEST PRESS	3 SETS OF 10	20 LBS
ABDOMINAL CRUNCH	3 SETS OF 10	10 LBS
LEG PRESS	3 SETS OF 10	100 LBS
TRICEP EXTENSION	3 SETS OF 10	20 LBS
SHOULDER PRESS	3 SETS OF 10	10 LBS
BACK EXTENSION	3 SETS OF 10	30 LBS
LATERAL PULL DOWN	3 SETS OF 10	10 LBS

Table 4

Week Three Session Results

	DAY FIVE	
LATERAL PULL DOWN	3 SETS OF 10	20 LBS
LEG CURLS	3 SETS OF 10	30 LBS
ABDOMINAL CRUNCH	3 SETS OF 10	10 LBS
BICEP CURLS	3 SETS OF 10	10 LBS
INNER/OUTER THIGH	3 SETS OF 10	20 LBS
SEATED ROWS	3 SETS OF 10	20 LBS
BACK EXTENSION	3 SETS OF 10	30 LBS
LEG PRESS	3 SETS OF 10	100 LBS
SHOULDER PRESS	3 SETS OF 10	10 LBS
LEG EXTENSIONS	3 SETS OF 10	20 LBS

Table 5

	DAY SIX	
TRICEP EXTENSION	3 SETS OF 10	20 LBS
*LEG PRESS	3 SETS OF 10	100 LBS
*ABDOMINAL CRUNCH	3 SETS OF 10	10 LBS
*LATERAL PULL DOWN	3 SETS OF 10	30 LBS
LEG CURLS	3 SETS OF 10	30 LBS
CHEST PRESS	3 SETS OF 10	20 LBS
*BACK EXTENSION	3 SETS OF 10	40 LBS

LEG EXTENSIONS	3 SETS OF 10	20 LBS
SHOULDER PRESS	3 SETS OF 10	10 LBS
BICEP CURLS	3 SETS OF 10	10 LBS

Table 6 *=Increased Resistance

Week Four Session Results

	DAY SEVEN	
LEG PRESS	3 SETS OF 10	120 LBS
LEG CURLS	3 SETS OF 10	30 LBS
SEATED ROWS	3 SETS OF 10	20 LBS
CHEST PRESS	3 SETS OF 10	20 LBS
ABDOMINAL CRUNCH	3 SETS OF 10	20 LBS
SHOULDER PRESS	3 SETS OF 10	10 LBS
INNER/OUTER THIGH	3 SETS OF 10	30 LBS
CHEST FLIES	3 SETS OF 10	10 LBS
LEG EXTENSIONS	3 SETS OF 10	20 LBS
ROTARY TWIST	3 SETS OF 10	10 LBS

Table 7

	DAY EIGHT	
SHOULDER PRESS	3 SETS OF 10	10 LBS
LEG EXTENSIONS	3 SETS OF 10	20 LBS
*CHEST PRESS	3 SETS OF 10	30 LBS

ABDOMINAL CRUNCH	3 SETS OF 10	20 LBS
LEG PRESS	3 SETS OF 10	120 LBS
ROTARY TWIST	3 SETS OF 10	10 LBS
SEATED ROWS	3 SETS OF 10	20 LBS
BACK EXTENSIONS	3 SETS OF 10	40 LBS
CHEST FLIES	3 SETS OF 10	10 LBS
LEG CURLS	3 SETS OF 10	30 LBS

Table 8

Week Five Session Results

	DAY NINE	
BICEP CURLS	3 SETS OF 10	10 LBS
LEG PRESS	3 SETS OF 10	120 LBS
LATERAL PULL DOWN	3 SETS OF 10	30 LBS
CHEST FLIES	3 SETS OF 10	10 LBS
ROTARY TWIST	3 SETS OF 10	10 LBS
CHEST PRESS	3 SETS OF 10	30 LBS
LEG CURLS	3 SETS OF 10	30 LBS
BACK EXTENSIONS	3 SETS OF 10	40 LBS
SEATED ROWS	3 SETS OF 10	20 LBS
ABDOMINAL CRUNCH	3 SETS OF 10	20 LBS

Table 9

	DAY TEN	
TRICEPS EXTENSIONS	3 SETS OF 10	20 LBS
LEG PRESS	3 SETS OF 10	120 LBS
ABDOMINAL CRUNCH	3 SETS OF 10	20 LBS
SHOULDER PRESS	3 SETS OF 10	10 LBS
LEG CURLS	3 SETS OF 10	30 LBS
BACK EXTENSIONS	3 SETS OF 10	40 LBS
CHEST PRESS	3 SETS OF 10	30 LBS
LEG EXTENSION	3 SETS OF 10	20 LBS
SEATED ROWS	3 SETS OF 10	20 LBS
ROTARY TWIST	3 SETS OF 10	10 LBS

Table 10

Week Six Session Results

	DAY ELEVEN	
SHOULDER PRESS	3 SETS OF 10	10 LBS
LEG PRESS	3 SETS OF 10	120 LBS
LATERAL PULL DOWN	3 SETS OF 10	30 LBS
LEG CURLS	3 SETS OF 10	30 LBS
ABDOMINAL CRUNCH	3 SETS OF 10	20 LBS
CHEST PRESS	3 SETS OF 10	30 LBS
LEG EXTENSION	3 SETS OF 10	20 LBS
TRICEPS EXTENSIONS	3 SETS OF 10	20 LBS

INNER/OUTER THIGH	3 SETS OF 10	30 LBS
BACK EXTENSIONS	3 SETS OF 10	40 LBS

Table 11

	DAY TWELVE	
BICEP CURLS	3 SETS OF 10	10 LBS
LEG EXTENSION	3 SETS OF 10	20 LBS
SEATED ROWS	3 SETS OF 10	20 LBS
LEG PRESS	3 SETS OF 10	120 LBS
SHOULDER PRESS	3 SETS OF 10	10 LBS
LEG CURLS	3 SETS OF 10	30 LBS
ROTARY TWIST	3 SETS OF 10	10 LBS
CHEST FLIES	3 SETS OF 10	10 LBS
BACK EXTENSIONS	3 SETS OF 10	40 LBS
INNER/OUTER THIGH	3 SETS OF 10	30 LBS

Table 12

Chapter Four:

RESULTS

After day one of the weight training program, some issues were noticed about the subject when using the exercise machines. Most of the machines were complicated for the subject to use, especially considering her height. Almost every machine had to be adjusted for her, in order to ensure proper form. Even with the adjustments on the machines, the subject was still not able to use the machines as they were made to be used. The subject counted out loud every repetition, and did very well on all the exercise machines, even with the difficulties.

After day two, every machine that will be used throughout the six weeks of resistance training has been used. After this it has been determined the machines which will always need adjustments before starting are: bicep curls, leg curls, seated rows, leg extensions, leg press, chest flies, and triceps extensions. The subject mentioned how she prefers lower body exercises over upper body and core exercises. Subject also mentioned the most difficult machines for her are: shoulder press, lateral pull down, seated rows, and triceps extensions.

During week two, it was clear that besides adjusting the machines, the client did not need much guidance or help with any of the resistance exercises. While some machines are more difficult than others, the subject still completed each rep of each set completely without complaining. The subject continued to count out loud for each rep of each set. This helped the subject keep track, and also keeps a steady pace while doing the exercise. The subject was always on time for each session, motivated/excited for each session, and worked hard for the complete session.

As the third week begins, the subject again mentioned how she prefers lower body exercises over upper body and core exercises. Some upper body exercises that are particularly

difficult for the subject was bicep curls and triceps extensions. These exercises are not difficult because of the resistance, but because the machine cannot fully be adjusted for her. If the seat is moved lower to keep her feet flat on the floor, the subjects' arms are not in the correct position to perform the exercise correctly. If the seat is moved up so the subjects' arms are in the correct position for the exercises, however, the subjects' feet are not completely flat on the floor. The subject doesn't have as many difficulties with lower body exercises. However, the leg curl and leg extension machines are difficult for the subject. Even with the machine adjusted as much as possible, the subject still has difficulty using the machine as it was meant to be used. The subject is too short for most of the resistance machines, with leg curls and leg extension machines being the most difficult.

Day 6 was the halfway point for the resistance training program. On this day the subject also increased resistance for some exercises. It was decided to increase the resistance on certain exercises because the subject could do two more reps at the end of the last set easily. The charts in chapter three show which exercises the weight was increased for. These exercises included: leg press, abdominal crunch, lateral pull down, and back extension. The resistance increased by 20 lbs on the leg press machine, 10 lbs on the abdominal crunch machine, 20 lbs on the lateral pulls down machine, and 10 lbs on the back extension machine. On this day, the subject was not feeling the best. The subject had a headache and was very tired; the subject mentioned that she did not get much sleep the night before. This may have prevented the subject from increasing weight in other exercises.

On day 7 and day 8, the subject was not in a great mood. The subject was sad, due to the fact that a close friend of the family had died. The subject still participated in the resistance program. The subject worked hard and still pushed herself throughout the two sessions that

week. However, the subject was not her normal cheerful, happy self. The subject instead was sad and seemed a little depressed. During the workout sessions, it was also observed that certain exercises hurt the subjects' hands and shoulders. These machines included: lateral pull down, shoulder press, abdominal crunch, and chest flies machines. For the lateral pull down machine and the shoulder press, the subject preferred to use the wide grip option. The subject informed the instructor the wide grip did not hurt the subjects' shoulders as much. The abdominal crunch, and chest flies machines, hurts the subjects' hands. This is may be due to the fact, that the subject has smaller hands which make gripping the machines difficult.

On day 9 and day 10, the subject was in a much better mood. However, because of this the subject also had to be reminded constantly to keep lifting and not take too long of breaks in between. The subject started becoming more comfortable talking, and explaining her daily life with the researcher. Finals week and graduation was also coming up, so the subject was becoming more stressed as well. However, even with the constant reminding to keep lifting, the subject still worked very hard, and completed the two one hour sessions very well. One problem that did arise was one day the subject showed up in jeans and boots, not workout clothes. The subject was running late and showed up in these clothes. The session was delayed, while the subject went back to her room and changed into the appropriate clothes. On day 9, the subject also tried to increase the resistance on the rotary twist machine, however, the next resistance was too heavy to complete all the sets.

The subject did very well for the last week of the resistance training program. The last week of the program took place during the spring semester finals week. Since no classes were taking place this week, the subject was less stressed and felt less rushed to do the resistance training program. The subject moved through the machines very well, and did not need

reminding to focus at all. The subject used the two workout sessions this week to forget about the stress of graduation and finals. This was the best week of the resistance program for the subject. She worked very hard, remained focused, and was very excited throughout the entire session. On the last day of the resistance program, the subject was sad the program was ending.

For the last day of the study, the subject returned to the University of Central Missouri's Human Performance Lab at 7:00 a.m. to have her resting metabolic rate measured again. Before starting the measurement, it was indicated the subject had followed all instructions, which she had been reminded of the day before. After the subject rested for 30 minutes the subject then sat up placed a noseclip on their nose, and breathed into the BodyGem. The subject was in a relaxed position, stayed still while breathing into the BodyGem until the measurement was obtained, which took around ten minutes. After the measurement was obtained, the result was recorded. The subjects' measured RMR was 960.

Chapter Five:

DISCUSSION

With all of the predisposing factors for obesity, decreasing amount and motivation for physical activity, and the increase susceptibility for skeletal injuries when performing strength training exercises previously mentioned, it is estimated the chances for individuals with DS to obtain obesity related chronic diseases increase. As individuals continue to obtain more fat-free mass the individuals resting metabolic rate will also increase In return, their body composition will most likely improve and their chances of obtaining obesity related chronic diseases may decrease (Fahey et al., 2013). The main objective for future research in this particular field should be to determine whether exercise (aerobic, strength, or a combination of both) could benefit individuals with DS, and in return help them have a healthier body composition and physical fitness, which could lead to a healthier and better quality of life (González-Agüero et al., 2010).

More research is needed especially in the field of weight training involving adolescents with DS. Adolescence is a strategic time to implement an exercise program for individuals with DS to help establish good exercise habits which could develop into a pattern of continued healthy activity into adulthood (Telama et al., 2014). Certain muscular physiological characteristics may make it difficult to design a weight training program with this population. Little information is available about the best methods of weight training, which exercises are beneficial, which exercises to avoid, and benefits of participation in the weight training program (Gupta et al., 2011). One benefit of participating in weight training is the increase in the individuals RMR (Fahey et al., 2013). Unfortunately, little information is available about the best methods of weight training, which exercises are beneficial, which exercises to avoid, and

benefits of participation in the weight training program. Do individuals with DS experience the same increase in RMR? Little information is available in this area of research as well. The purpose of this intervention was to examine the effects of a weight training intervention on an individual diagnosed with Down syndromes' resting metabolic rate. It was hypothesized that the individuals' metabolic rate would increase once the individual diagnosed with Down syndrome completed six weeks of weight training.

In response to the research question proposed, it appeared that the subjects' resting metabolic rate did change after participating in six weeks of resistance training. After twelve, one hour, full body resistance training workout sessions, the subject was able to raise their RMR level from 890 to 960. The apparent increase in the subjects' resting metabolic rate was evidenced by the BodyGem measurements pre and post the resistance training intervention. This indicates the individuals' energy requirement to maintain vital body functions, including respiration, heart rate, body temperature, and blood pressure at rest increased. An individuals' RMR accounts for about 65-70% of their daily energy expenditure. (Fahey et al., 2013) stated, a higher RMR also means that a person burns more calories while at rest and can therefore take in more calories without gaining weight. Therefore, after participating in the six weeks of resistance training it is estimated her amount of lean body mass increased (even though this was never measured) which in return caused her resting metabolic rate to also increase.

As mentioned in chapter four, to estimate a starting point for the subject, in terms of resistance a 10 repetition max was done for the chest press and leg press machine. From the results of the 10RM, a 1 repetition max was then estimated. However, the 10RM was not able to be completed due to the fact the subject could not complete all the warm up sets. The 1RM was then estimated to be what the subject could lift one time while progressing through the warm up

sets. Since the subject could not complete the entire protocol for the 10RM, the estimation for the 1RM was not estimated as usual. However, the machine itself could have also been a factor, due to the fact the subject was not able to use correct form throughout the entire time of the exercise.

The issue of machine adjustments did bring some difficulties within this study. Due to the fact that the subject was 5'2 and 107 pounds she frequently experienced difficulties when it came to adjusting the machine, in order to achieve proper form for the exercise. For most of the machines, the subject could not do the exercise completely, but she did so to the best of her abilities. For example the bicep curl and triceps extension, if the subject would move the seat to where her feet would be flat on the ground, her elbows were not the correct position to do the exercise. However, if she would adjust the seat to ensure her arms where in the correct position to complete the exercise, her feet do not touch the floor. Two other machines the subject had much difficulty on was the leg extension and leg curls. Even with the back adjustment moved in as far as possible, the subject legs could not be or reach the equipment to do the exercise completely. At the same time, if the subject adjusted her legs to do the exercise properly, she could not sit back against the back rest, like instructed. In conclusion, the subjects' short stature and frame made performing the resistance exercises properly difficult.

However, even with the difficulties of the machines the subject was still able to make some progress throughout the duration of the resistance training program. Throughout the duration of the program the "two for two" rule would be followed. As mentioned previously in chapter three, the "two for two rule" states that when the subject could complete two additional reps at the end of the last set easily then it was appropriate for the resistance to be increased. The subject did achieve this and increased weight on some of the machines. These machines included: leg press, abdominal crunch, lateral pull down, back extension, and chest press. The

subject was able to achieve these increases on the third week of the resistance training program. The resistance was increased by ten pounds for each of the exercises with the exception of the leg press machine. The subject informed the researcher that she felt she could increase the resistance on other machines if she didn't have trouble with proper form while doing the exercises.

If this study was repeated some suggestions are: to use bodyweight exercises instead of machines, longer duration of resistance program, meet more than two times a week, different age group of individuals with Down syndrome to study, and combining an aerobic/resistance training program to have individuals with Down syndrome participate in. With bodyweight exercises there is the higher chance of range of motion injury, but the probability of the exercise being completed with proper form throughout the duration increases when compared to using resistance machines. It is also recommended that the duration of the resistance training program be increased as well. Even though the subject did progress with increased resistance, and the subjects' RMR did increase, a longer duration is recommended. It is estimated that with a longer duration and meeting more than twice a week, the subject would be able to increase their resistance per exercise more, and the possibility of their RMR would also increase more. These increases could help the subject obtain more fat-free mass and obtain a healthier lifestyle. Another way to help individuals with Down syndrome obtain a healthier lifestyle and more fat-free mass is having them participate in a combination of aerobic/anaerobic exercise program. As they participate in more aerobic activities it is predicted their amount of fat mass will decrease. While at the same time it is predicted their fat-free mass will increase, as they would also be participating in anaerobic/resistance training.

Further investigation in this field is greatly needed. As mentioned in chapter two, as seen in previous studies, individuals with Down syndrome possess many physical and physiological characteristics for becoming overweight and/or obese. Previous studies have also shown weight training interventions have resulted in improved strength and balance in children with Down syndrome. González-Agüero et al. (2010) stated the following:

> The ultimate objective of future research in this field should be to test whether exercise (aerobic, strength and/or a combination of both) could benefit children and adolescents with DS, and help them have a healthier body composition and physical fitness, all of which result in a healthier and a better quality of life in this population. (p.723)

Even though the psychological disorder itself is the main priority in these individuals' lives, the physical health and well-being should also be a top priority. More research and studies in this area can help individuals with Down syndrome obtain a healthier lifestyle.

References

American College of Sports (2014). ACSM's guidelines for exercise testing and prescription. Baltimore, MD: Lippincott Williams & Wilkins.

Byrne, H., & Wilmore, J. (2001). The effects of a 20 week exercise training program on resting metabolic rate in previously sedentary, moderately obese women. *International Journal of Sport Nutrition and Exercise Metabolism, 11,* 15-31.

Cowley, P. M., Ploutz-Snyder, L. L., Baynard, T., Heffernan, K. S., Young Jae, S., Hsu, S., & ... Fernhall, B. (2011). The effect of progressive resistance training on leg strength, aerobic capacity and functional tasks of daily living in persons with Down syndrome. *Disability & Rehabilitation, 33,* 2229-2236.

De Lucena Barbosa, E., Fernandes, P., & Filho, J. (2009). Anthropometry, muscular strength and dermatoglyphics of individuals with Down's syndrome. *Fitness & Performance Journal (Online Edition), 8*, 269-278.

De, S., Small, J., & Baur, L. A. (2008). Overweight and obesity among children with developmental disabilities. *Journal of Intellectual & Developmental Disability, 33*, 43-47.

Fahey, T. D., Insel, P. M., & Roth, W. T. (2013). *Fit & Well: Brief Edition. Core Concepts and Labs in Physical Fitness and Wellness* (10th ed.). New York: McGraw-Hill Companies, Inc.

Fanter, N. J. (2012). Down syndrome and orthopaedic problems. *Hughston Health Alert, 24*, 1-2.

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

Fernhall, B. (1993). Physical fitness and exercise training for individuals with mental retardation. *Medical and Science in Sport and Exercise, 25,* 442-450.

González-Agüero, A. A., Vicente-Rodríguez, G. G., Moreno, L. A., Guerra-Balic, M. M., Ara, I. I., & Casajús, J. A. (2010). Health-related physical fitness in children and adolescents with Down syndrome and response to training.

Scandinavian Journal of Medicine & Science In Sports, 20, 716-724.

Gupta, S., Rao, B., & SD, K. (2011). Effect of strength and balance training in children with Down's syndrome: a randomized controlled trial. *Clinical Rehabilitation, 25,* 425-432.

Hresko, T. M., McCarthy, J. C., Goldberg, M. J. (1993) Hip disease in adults with Down syndrome. *Journal of Bone and Joint Surgery, 75,* 604-607.

Hunter, G. R., Wetzstein, C. J., Fields, D. A., Brown, A. A., & Bamman, M. M. (2000). Resistance training increases total energy expenditure and free-living physical activity in older adults. *Journal Of Applied Physiology, 89,* 977-984.

Islam, M. M., Takeshima, N., Rogers, M. E., Koizumi, D., & Rogers, N. L. (2004). Relationship between Balance, Functional Fitness, and Daily Physical Activity in Older Adults. *Asian Journal of Exercise & Sports Science, 1,* 9-18.

Izquierdo-Gomez, R., Martínez-Gómez, D., Tejero-Gonzalez, C., Cabanas-Sánchez, V., Ruiz Ruiz, J., & Veiga, Ó. L. (2013). Are poor physical fitness and obesity two features of the adolescent with Down syndrome?. *Nutricion Hospitalaria, 28,* 1348-1351.

Kravitz, L. (2011). Metabolism make-over: fact or fiction? Resting metabolic rate and weight loss questions answered and explained. *IDEA Fitness Journal, 8*(6), 21-23.

Lobstein, T. T., Baur, L. L., & Uauy, R. R. (2004). Obesity in children and young people: a crisis in public health. *Obesity Reviews, 5,* 54-85.

Millar, A. L., Fernhall, B. B., & Burkett, L. N. (1993). Effects of aerobic training in adolescents with Down syndrome. / Effets d ' un entrainement aerobie chez des adolescents trisomiques. *Medicine & Science in Sports & Exercise, 25*, 270-274.

National Center on Health, Physical Activity, and Disability (2014). Down syndrome and Exercise: Position statement. Retrieved from http://www.ncpad.org/117/909/Down~Syndrome~and~Exercise

Nieman, D. C., Austin, M. D., Chilcote, S. M., & Benezra, L. (2005). Validation of a new handheld device for measuring resting metabolic rate and oxygen consumption in children. *International Journal of Sport Nutrition & Exercise Metabolism, 15,* 186-194.

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

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

Pitetti, K. H., Rendoff, A. D., Grover, T., & Beets, M. W. (2007). The efficacy of a 9-month treadmill walking program on the exercise capacity and weight reduction for adolescents with severe autism. *Journal of Autism & Developmental Disorders, 37*, 997-1006.

Pitetti, K.H., Rimmer, J. H., & Fernhall, B. (1993). Physical fitness and and adults with mental retardation: An overview of current research and future directions. *Sports Medicine, 16,* 23-56.

Pitetti, K.H., Yarmer, D. A., & Fernhall, B. (2001). Cardiovascular fitness and body composition in children and adolescents with and without mental retardation. *Adapted Physical Activity Quarterly, 18,* 127-141.

Pueschel, Siegfried M. (2011). Down syndrome. *Down syndrome Association.*

Rimmer J.H., Kelly L.E., (1991). Effects of a resistance training program on adults with mental retardation. *Adapted Physical Activity Quarterly. 8,* 146-153.

Sanyer, O. N. (2006). Down syndrome and Sport Participation. *Current Sports Medicine Reports, 5*, 315-318.

Shields, N., & Taylor, N. F. (2010). A student-led progressive resistance training program increases lower limb muscle strength in adolescents with Down syndrome: a randomised controlled trial. *Journal Of Physiotherapy, 56*, 187-193.

Telama, R., Xiaolin, Y., Leskinen, E., Kankaanpää, A., Hirvensalo, M., Tammelin, T., & ... Raitakari, O. T. (2014). Tracking of physical activity from early childhood through youth into adulthood. *Medicine & Science In Sports & Exercise*, *46*(5), 955-962.

Tershakovec, A., Kuppler, K., Zemel, B., Katz, L., Weinzimer, S., Harty, M., & Stallings, V. (2003). Body composition and metabolic factors in obese children and adolescents. *International Journal Of Obesity & Related Metabolic Disorders*, *27*(1), 19.

Winnick, J.P., (1995). Adapted Physical Education and Sport. Champaign, Illinois: Human Kinetics.

APPENDIX A
CONSENT FORM FOR THE SUBJECT

Identification of Researchers: This research is being done by Jessica Stout a graduate student with the Kinesiology Department at University of Central Missouri.

Purpose of the Study: The purpose of this study is to examine the effects of an individuals' resting metabolic rate pre and post a weight training intervention in adults diagnosed with Down syndrome.

Request for Participation: We are inviting you to participate in a study on resting metabolic rate in individuals with Down syndrome pre and post a weight training intervention. It is up to you whether you would like to participate. If you decide not to participate, you will not be penalized in any way. You can also decide to stop at any time without penalty.

Exclusions: You must be diagnosed with Down syndrome, between the ages of 18 and 25, not pregnant, and not participating in any weight training program at the time.

Description of Research Method: This study involves you measuring your resting metabolic rate (RMR) pre and post a weight training intervention. The weight training program will last six weeks, with meeting 2-3 times a week for an hour each session. We will meet before the weight training program begins to measure your RMR and you will also have a chance to ask questions you might have.

Privacy: All of the information I collect will be confidential. I will not record your name, student number, or any information that could be used to identify you. This form, along with any other forms with information will also be kept confidential and locked in a file cabinet.

Doctor Approval: In order to participate in this study you must have clearance from your physician, which states it is safe for you to participate.

Explanation of Risks: The risks associated with participating in this study are similar to the risks of everyday life. Any medical treatments provided if an injury occurs will be at the expense of the participant and/or the participant's parents or legal guardians.

Explanation of Benefits: You will benefit from participating in this study by getting to participate in a weight training program and obtain regular amounts of physical activity for six weeks.

Questions: If you have any questions about this study, please contact me, Jessica Stout. I can be reached at stout@ucmo.edu or at (660) 216-8490. If you have any questions about your rights as a research participant, please contact the Human Subjects Protection Program at (660) 543-4621.

If you would like to participate, please sign a copy of this letter and return it to me. The other copy is for you to keep.

I have read this letter and agree to participate.

Signature: _____
Print:_____
Date: _____
Reviewed 10/2010 J

APPENDIX B
ASSENT FORM FOR THE SUBJECT

Researcher and Research Topic: My name is Jessica Stout. I am trying to learn about your rate of energy use and how fast it is before and after you participate in six weeks of a weight training program. If you would like, you can be in my study.

What will happen in this Research? If you decide you want to be in my study, you will come in at the beginning of the program with your parents/legal guardians and measure your metabolism, which is very easy, not painful, and will not take long at all. Then you will participate in a weight training program for six weeks. You will come to the gym 2-3 times a week and workout for an hour each time. After the six weeks you will come back in and we will measure your metabolism again.

What are the good and bad things that come from you being in the research study? If you decide you want to be in my study, you will get to work out 2-3 times a week for an hour. However, you must be between the ages of 18-25 and not pregnant.

We will not share your personal information: Other people will not know if you are in my study. I will put items I learn about you together with items I learn about other subjects, so no one can tell what items came from you. When I tell other people about my research, I will not use your name, so no one can tell who I am talking about.

Parent/Guardian Approval: Your parents or guardian have to say it's OK for you to be in the study. After they decide, you get to choose if you want to do it too. If you don't want to be in the study, no one will be mad or upset with you. If you want to be in the study now and change your mind later, that's OK. You can stop at any time.

Doctor Approval: To be part of this study you must have clearance from your local doctor, which states it is safe for you to participate.

Researcher Contact Information: My telephone number is 660-216-8490, and my email address is stout@ucmo.edu. You can call me if you have questions about the study or if you decide you don't want to be in the study any more. I will give you a copy of this form in case you want to ask questions later.

Agreement: I have decided to be in the study even though I know that I do not have to do it. Jessica Stout has answered all my questions and I know that I can stop being in the study at any time. If you have any questions about this, please contact the Human Subjects Protection Program at (660) 543-4621.

_____ _____
Signature of Study Participant Date

_____
Printed Name of Study Participant

_____
Printed Name of Parent/Guardian

_____ _____
Signature of Researcher Date

APPENDIX C
HUMAN SUBJECTS APPROVAL

UNIVERSITY OF CENTRAL MISSOURI
Est. 1871

Human Subjects Protection Program
Ward Edwards 1800
Warrensburg, MO 64093
Office 660-543-4621
FAX 660-543-4778
www.ucmo.edu

3/25/2014

Jessica Stout
509 Anderson St. Apt C3
JLS60240@ucmo.edu
Warrensburg, MO

Dear Jessica Stout,

Your research project, 'Comparison of Resting Metabolic Rates in Individuals with Down Syndrome Pre and Post a Weight Training Intervention', was approved by the Human Subjects Review Committee on 3/25/2014. Your informed consent is also approved until 3/25/2015.

Please note that you are required to notify the committee in writing of any changes in your research project and that you may not implement changes without prior approval of the committee. You must also notify the committee in writing of any change in the nature or the status of the risks of participating in this research project.

Should any adverse events occur in the course of your research (such as harm to a research participant), you must notify the committee in writing immediately. In the case of any adverse event, you are required to stop the research immediately unless stopping the research would cause more harm to the participants than continuing with it.

At the conclusion of your project, you will need to submit a completed Project Status Form to this office. You must also submit the Project Status Form if you wish to continue your research project beyond its initial expiration date.

If you have any questions, please feel free to contact me at the number above.

Sincerely,

Janice Putnam Ph.D., RN
Associate Dean of The Graduate School
putnam@ucmo.edu