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Effects of a Strength Training Intervention and Quality of Life: Case Study on a Sedentary Adult Female

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Abstract

The purpose of the project is to evaluate physiological and quality of life changes in a sedentary, senior-aged (55 or older) female using a six-week strength training intervention. This case study will instruct how to perform a push-pull-legs split routine by going to the gym three times per week. Prior to the six week intervention, both quantitative and qualitative variables will be collected to assess baseline data, including the subject's resting heart rate, resting blood pressure, grip strength, one-repetition maximum on seven whole body exercises (dumbbell bicep curl, tricep pushdown, barbell bench press, wide-grip lat pull-down, seated dumbbell press, hamstring curl, and leg press), body composition (using air density in the BodPod), as well as subjective questionnaires, the 36-Item Short Form Survey (SF-36) and Malay-McGill Quality of Life Questionnaire (MMQOL), to measure the subject's quality of life. Throughout the six-week intervention, the subject will also be asked to keep a journal each day she goes to the gym, in which she will record the exercises performed, how long she was at the gym, and overall feedback on how she felt during each exercise session. Upon completion of the six-week intervention, variables will be collected again to examine changes in strength and/or quality of life.

Introduction

As we age, the human body undergoes a series of negative health-related variables, such as higher blood pressure, higher percentage of body fat, lower cardiac output, lower muscular strength, and lower bone mass (Pescatello 2014). Additionally, prolonged periods of sedentary behavior can lead to detrimental health consequences, such as a greater risk for cardiovascular disease, cancer, Type II diabetes mellitus, and sudden death (Pescatello 2014). Due to COVID-19, the format of this research project, an individual case study, has changed to accommodate social distancing. The following experiment, a case study, would have been performed over a 6-week intervention period on a senior-aged, sedentary female. The individual is an apparently healthy adult and although the subject has no history of chronic disease or symptoms suggestive of cardiovascular, renal, or metabolic disease, implementing a resistance exercise regimen may help to slow the physiological effects of aging, as well as reduce the risk of being diagnosed with future chronic diseases linked to a sedentary lifestyle.

Literature Review

Importance of Strength Training

The benefits of performing regular exercise, such as decreasing blood pressure, lowering the risk of cardiovascular disease, aiding in weight loss, and improving mental health, are well documented (Pescatello 2014). With so many potential benefits, it is reasonable to think that prescribing exercise as a treatment method for chronic disease should be utilized, as recommended by the global initiative “Exercise is Medicine.”

Sallis (2019) writes that by prescribing aerobic and resistance exercise to at-risk individuals, we can increase cardiorespiratory fitness, prevent chronic disease, and extend the lives of many (Sallis 2019). Feigenbum (1999) highlights how specifically prescribing resistance training can be used to prevent and treat disease, stating that regular resistance training can lower risk of Type II diabetes. The body can store carbohydrates in two locations - the liver and in our muscles. As muscle mass increases through resistance training, the body can store these carbohydrates more readily in the muscles rather than entering the bloodstream, thus decreasing blood glucose levels that are spiked in diabetic patients (Feigenbum et al. 1999). Furthermore, Braith (2006) outlines how resistance training can prevent cardiovascular disease, finding that performing resistance exercises 2-3 times per week had been able to reduce both systolic and diastolic blood pressure by 3 mmHg in only two months (Braith et al. 2006).

Braith (2006) also writes how resistance training can be used to prevent weight gain and reduce obesity. Typically, men store excessive adipose tissue, or fat, centrally around the abdomen, whereas women tend to store excessive adipose tissue below the hips. In both cases, excessive adipose tissue has been linked to higher blood pressure, insulin resistance, and heart disease. To prevent these effects of obesity, Dr. Braith writes that resistance training along with dieting has been shown to decrease central body fat levels by 39% (Braith et al 2006).

Aside from disease prevention, several studies have shown other benefits of resistance training. Hamdy et al. (1994) demonstrated the difference in bone mineral density (BMD) of healthy young males involved in either weight-lifting, running, cross-

training, or recreational activities. By using absorptiometry to scan the upper limbs, the participants who belonged to the weight-lifting group had the highest BMD, whereas the runners were found to have the lowest BMD. By lifting weights, the bones involved in the exercise are stressed, resulting in the activation of osteoblasts, or bone-forming cells. Eventually, through regular resistance training, “the bones can become stronger, denser, and less likely to fracture” (Hamdy et al 1994).

Additionally, Holfelder (2019) designed an experiment to discover the effects of free weights and weight training on the muscular strength of older adults. In the study, 32 men and women aged 50 to 76 were randomly placed in one of two groups: machine exercisers (chest press, leg press, upper row, bicep cable curls, and tricep cable extension) or free weight exercisers (barbell squats, bench press, bent-over rowing, dumbbell bicep curls, and EZ bar tricep press). Prior to the testing period, each individual’s 10 repetition maximum (10RM) was recorded, and again the value for each subject was obtained following a 26 week intervention. On average, the machine group displayed a 44% increase in their leg strength exercises, whereas the free weight group displayed a 113% increase in their 10RM values for leg strength. Lastly, the machine group showed a 28.3% increase in tricep strength, while the free weight group showed a 89% increase in their 10RM tricep strength. While a significant difference between the free-weight group and machine group did not exist, both modalities displayed an increase in over strength (Holfelder 2019).

Resistance Training and Aging

As part of the aging process, many individuals will undergo sarcopenia, or the progressive loss of muscle mass and strength. As a result of sarcopenia, the senior population are apt to suffering from mobility issues, weakness, osteoporosis (bone weakness), and loss of physical function required to perform activities of daily living (ADL's) (Bavaresco et al. 2019). Ming (2019) investigated sarcopenia in older adults, using 384 participants aged 50 and older from Chengdu, China. After collecting baseline data of age, gender, presence of coronary heart disease, hypertension, diabetes, and history of falls in the previous year, the researchers asked all participants after 6 and 12 months if they had fallen in the last 6 months. Of the 224 female participants in the study, 63 reported a fall in the first 6 months, with 30 of these instances requiring hospitalization (Ming et al 2019). During the one-year follow-up, over a quarter (26.5%) of the participants reported at least one fall in the prior six months. From this data, the researchers concluded that sarcopenia was a major cause of falls in the senior subjects, as the decrease in muscle mass has a high probability of causing muscular imbalances and weakness that significantly increases the risk of falls in the aging population (Ming et al. 2019).

Englund (2019) found benefits in strength training a senior population, placing seventy participants aged 60 and older who lived sedentary lifestyles on a twelve-week resistance training program. All participants trained three times a week for twelve weeks, and the regimen each training day consisted of the leg press, seated row, leg extension, chest press, and leg curl. After completing a baseline assessment for these exercises, the researchers progressively overloaded each patient based on individual

responses. After the twelve week intervention, all participants showed significant improvements in their one-repetition maximum value in the leg press, leg extension, and chest press, as well as progressive decreases in subjective fatigue levels following strength training (Englund et al 2019). These increases in muscular strength among the senior population thus have the ability to lead to safer performance of ADL's, increased balance, and decreased risk of early death. Bavaresco (2019) selected 43 healthy, yet sedentary, women aged 50-68. Each subject's 10RM value was determined in the barbell bench press and leg press exercises and recorded by the researchers. After this baseline data was collected, the participants were placed on a resistance training program twice per week for ten weeks consisting of four exercises: leg press, seated row, leg curl, and bench press. After the 10 week intervention, the 10RM for each subject were again determined for the bench press and leg press. In the bench press, the subjects displayed a 53.8% increase in their 10RM values, and a 40.0% increase in their 10RM values for the leg press (Bavaresco et al 2018).

Resistance Training and Women

As previously mentioned, the aging process is associated with loss of skeletal muscle mass as well as increase in intramuscular fat. To maintain the highest level of muscular strength and function, a strength training regimen should be performed 2-3 times per week to reverse the effects of sarcopenia and to preserve bone density to prevent osteoporosis. Strength loss begins early in life; beginning at age 30, both males and females have been found to have decreases in muscle mass by 1-5% each year (Stojanovic et al 2017). Fisher (2018) studied muscular adaptations in senior-aged

women participating in strength training. Grip strength was used to evaluate strength gains and upon completing a three-month resistance training program. Findings in the study revealed women on average displayed a 7% increase in quadricep strength when comparing their one-repetition maximum values. Furthermore, when comparing grip strength values before and after the intervention, the women showed an 11% increase when using the dynamometer (Fisher et al 2018).

Bagatini (2017) reported that researchers tested the effects of a resistance training regimen on senior aged women who previously lived sedentary lifestyles. Subjects participated in a water-based resistance training program twice a week for 12 weeks. Following the 12-week training period, using leg extension and leg flexion machines, the women on average experienced 12% increase in leg extension strength and 14% increase in leg flexion strength (Bagatini 2017).

Resistance Training and Mental Health

While the discussion about exercise benefits often focuses on musculoskeletal strength and disease reduction, the improvements of exercise on one's mental health cannot be ignored. Klaperski (2019) conducted a study to observe the effects of physical activity on 142 adult participants. The participants completed the Multidimensional Mood State Questionnaire (MMSQ), which is a 30-question questionnaire used to assess an individual's mood, anxiety, and stress levels on a 1-6 scale. The study instructed participants to exercise 6 hours per week using a modality of their choice (aerobics, swimming, running, weight-lifting, cycling, etc.) for three consecutive weeks. Following the three-week intervention, the participants repeated

the MMSQ and their respective results were compared pre-intervention and post-intervention. Researchers observed significant reductions of restlessness, bad mood, perceived stress levels, and state anxiety, thereby demonstrating the acute psychological benefits of exercise (Klaperski 2019).

Aside from the MMSQ, other questionnaires used to assess an individual(s) psychological health include the Beck Depression Inventory (BDI) and the Nottingham Health Profile (NHP). The BDI 21 is a 21-item self-scored rating inventory that measures characteristics and symptoms of depression on a 0-3 scale. A cumulative score of 0-16 suggests mild mood disturbances, whereas a score of 17 and above indicates potential presence of clinical depression. Similarly, the NHP is composed of 45 “Yes” or “No” questions designed to provide information about an individual’s emotional, social, and physical health to their healthcare provider. Each question has an associated “Weight,” and the weight of each question answered “Yes” to is added together after completion. Cumulative scores range from 0 to 100, with 0 being no perceived stress, and 100 being maximum perceived stress.

Taspinar (2014) evaluated strength training and mental health of sedentary adults using the BDI and NHP to measure quality of life, depression symptoms, body image, and self-esteem. Findings revealed subjects who participated in resistance training experienced a significant decrease in depression symptoms, an increase in body image and self-esteem, and a slight increase in energy level in comparison to the control group (Taspinar 2014).

Baseline Fitness Assessments

Living a sedentary lifestyle as a senior-aged individual can lead to several health detriments, such as high blood pressure, obesity, cardiovascular disease, and early death. Copeland (2010) found that older adults (aged 50 and over) spend more than half of their waking hours engaged in sedentary behavior, such as driving and watching television. Chase (2019) assessed the baseline fitness level of 1,687 sedentary adults using five different measures: 1) a self-reported, 36-question health survey, also called the SF-36 2) difficulty performing ADL's, such as getting out of bed, getting around the house, and getting dressed, 3) cognitive performance assessment, 4) number of self-reported chronic conditions, such as hypertension, diabetes, cancer, etc., and 5) subjective well-being assessment based on feelings of competency within the past month. When all surveys were returned, Dr. Chase found that 32.6% of the subjects reported difficulty with one or more ADL within the last month as a result of poor health due to their sedentary lifestyle. Additionally, Dr. Chase determined that each participant had an average of 2.3 chronic conditions and a moderately high subjective well-being (Chase et al 2019).

Next, in *American College of Sports Medicine's Guidelines for Exercise Testing and Prescription*, the preparticipation screening algorithm is used to identify participants at risk for cardiovascular complications during or immediately after exercise. The algorithm states that for a subject with no cardiovascular, metabolic, or renal disease and no signs or symptoms suggestive of cardiovascular disease, no medical clearance is necessary prior to beginning exercise. Although medical clearance is not warranted for the participant in this study, the text also states that "preparticipation health

screening by a self-screening tool should be done for all individuals wishing to initiate an exercise program" (Pescatello 2014).

Lastly, the Malay-McGill Quality of Life Questionnaire (MMQOL), a 16-item questionnaire that asks the subject to rate their physical and psychological well-being on a 1-10 scale based on the past two days, can be given to individuals to assess their baseline health levels. Scores of 1 to 4 indicate normal mood disruptions, and scores of 5 and above indicate possible presence of depression. In a study conducted by Lua et al. (2005), when the MMQOL was given to 116 subjects aged 45-50 diagnosed with cancer, researchers found that, "The MMQOL was a feasible, reliable, and valid health questionnaire instrument in the selected population" (Lua et al 2005). The Physical Activity Readiness Questionnaire (PAR-Q) is another tool that can be used to assess the baseline fitness health of intended individuals. The PAR-Q is a self-administered form that contains seven "Yes" or "No" questions designed to highlight potential risk factors that may impede an individual's ability to partake in an exercise program.

Behavior Change

Older sedentary individuals can often find it difficult to adhere to physical lifestyle changes. Ostendorf (2017) sought to explore if an association between exercise adherence and sedentary adults existed, using 69 participants (87% female) to take part in a 26-week exercise intervention. The researchers accepted exercise adherence as attending over 80% of the exercise sessions, as attendance was monitored for all 26 weeks. Following this testing period, researchers found that 67% of the subjects attended over 80% of the sessions, which was a value lower than the researchers

predicted. From these results, the researchers concluded that those starting an exercise program with poor fitness levels struggle with adherence to an exercise program, as only 46 of the 69 participants continually showed up to exercise (Ostendorf et al 2017).

Next, Fontaine (2011) studied how effective behavior change interventions were in adults not actively participating in an exercise program. In this study, 46 sedentary adults (97% female) aged between 50 and 55 were challenged to become more physically active. To do this, they were instructed to perform 15 minutes of moderate-intensity exercise 7 days a week, and then asked to increase the daily duration of activity by 5 minutes each week for 12 weeks. After the twelve-week testing period, 65% of the participants reported to retain the exercise program immediately following the intervention (Fontaine et al. 2011).

Lastly, Sullivan-Marx (2011) sought to discover the correlation between resistance exercise adherence and sedentary, adult females. In the study, 52 participants were asked to participate in a group exercise session consisting of hip flexion, hip extension, knee extension, bicep curls, and chair squats at least three days per week for 16 weeks. At the conclusion of the intervention, the researchers determined that only 48% of the participants attended the exercise sessions three days per week. The researchers also found that the “completers” of the 16-week program reported a decrease in depressive symptoms and easier completion of their ADL’s when compared to the “noncompleters” (Sullivan-Marx 2011).

Push-Pull-Leg Split

For an individual living a sedentary lifestyle, it can be overwhelming when deciding how to begin working out. The Push-Pull-Leg Split (PPL) during the six-week resistance training intervention has been shown to be beneficial. Rather than having a separate day for each major muscle group, the PPL routine splits the body into three parts: push muscles (chest, shoulders, and triceps), pull muscles (back and biceps), and legs (quadriceps, hamstrings, and calves). Boyle (2017) found the PPL routine to be the most efficient workout split for individuals who are inexperienced in the gym, as it combines multiple muscle groups into one gym visit. He states that the PPL routine is an optimal workout split because the subject "will have minimum overlap of movement between workouts," which "will facilitate better recovery than other workout splits" (Boyle 2017). Next, according to ACSM guidelines, individuals of all ages should participate in resistance training 2-3 times per week for 2-3 sets of 8-12 repetitions at minimum to reach and maintain a healthy lifestyle (Pescatello 2014). Additionally, Rahmati (2013) designed an experiment in which 24 novice, healthy males and females aged 20-49 were either placed into a control group or a resistance training group. The 12 subjects in the resistance training group were placed on a PPL routine for 10 weeks, in which muscular strength was compared before and after the intervention. As compared to the control group, the study found significant improvements in the one-repetition maximum values for the leg extension, leg curl, and bench press exercises in the resistance training group (Rahmati 2013).

The studies presented above contain key procedures and elements that I would incorporate into my own case study. First, for the reasons presented in Boyle (2017)

and Rahmati (2013), the subject in this case study would be instructed to go to the gym three times a week and utilize a PPL routine to maximize muscular strength gains while allowing for proper recovery between training days. Next, the results from Holfelder (2019) concluded that both free weights and machines provided significant whole-body strength gains in senior-aged women. Therefore, when designing a PPL routine for the subject to follow, I would assign exercises that implement both weights and machines. The data from Taspinar (2014) suggested that exercise had positive psychological effects on the sedentary subjects, according to mental health questionnaires. Because I hypothesized that exercise would have a positive effect on the subject's mental health in the case study, I will also implement the SF-36 and MMQOL questionnaires to measure psychological changes in the subject pre-and post-intervention. Lastly, Pescatello (2014) states that all individuals beginning an exercise program should complete a self-screening tool to assess their pre-participation health. Therefore, the subject in this case study would be given the PAR-Q prior to engaging in the intervention to confirm that she does not have any medical conditions or physical inabilities that would limit exercise capacity.

Methodology

It has been documented that aging in females often leads to a decrease in skeletal muscle mass and function, a condition known as sarcopenia (Pescatello 2014). It has also been well documented in the literature the benefits of resistance training with seniors. To witness first-hand the effects of implementing resistance training and quality

of life, this current project comprises numerous variables in a case study format. The purpose of the case study intervention is to assess the role of resistance training and quality of life. This intervention case study uses a 55-year old female using a push-pull-leg split routine for six weeks along with pre-post intervention quality of life assessments. Comprehensive baseline assessment includes pre-intervention and repeated post-intervention to evaluate changes with the six-week intervention.

Prior to beginning the intervention, the subject was to be given an SF-36 health survey (Chase 2019) , an MMQOL survey (Lua et al 2005), and a PAR-Q (Pescatello 2014) to evaluate her current health status and quality of life. To measure pre-participation hemodynamic values, resting blood pressure and resting heart rate would be measured using the apical pulse of the subject. Lastly, to assess body composition of the subject prior to being placed on the exercise intervention, the subject was to be placed in the BodPod (National Institute for Fitness and Sport, Indianapolis, Indiana) to collect estimated percentage body fat. Quantitative baseline data would be collected for several variables: hemodynamics, one-repetition maximum values, body composition, and grip strength. The subject's preparticipation strength values would be measured using one-repetition maximum values for seven whole-body exercises consisting of: dumbbell bicep curl, tricep pushdown, barbell bench press, wide-grip lat pull-down, seated dumbbell press, hamstring curl, and leg press. To evaluate strength, a hand dynamometer to measure grip strength prior to the intervention serves as a variable to measure changes post-intervention. Post-intervention data collection would be conducted after the 6-week intervention.

Throughout the intervention period, the subject would be required to go to the gym three days per week on nonconsecutive days, with each day designated as either a push, pull, or legs day. The training days occurring on nonconsecutive days were chosen to allow the subject to recover from the acute effects of exercise, such as fatigue and soreness. The exercises performed each training day would remain the same throughout the intervention, while the subject would be progressively overloaded each week by increasing the load lifted according to the subject's physiological adaptations. Additionally, prior to engaging in her strength exercises, the subject would perform a series of dynamic and an aerobic warm-up by either walking on the treadmill or the stair-stepper at a light intensity for 10 minutes. This warm-up period would be designed to increase blood flow and muscle temperature to prepare the body for the resistance exercises. The subject and researcher agreed it was appropriate to meet at the gym on the first training day (push day) each week to track the subject's progress, answer any questions, and show proper exercise form when needed. Throughout the six weeks, both the subject and the investigator would have been required to keep personal journals, in which the subject would write down exercises performed each day, as well as notable, general feelings on that day, such as motivation, fatigue, and perceived benefits of exercise. Additionally, because the investigator was to meet with the subject once per week at the gym, the investigator was to write down how well the subject is progressing and adhering to the exercise plan. Using the SF-36 and MMQOL questionnaires and journal entries, the researcher would then make note of general trends in the subject's attitude and quality of life that developed throughout the intervention. Personally, I intend to learn the benefits of strength exercises on a

sedentary, senior female subject and apply the information I've learned from my courses about human anatomy and exercise physiology throughout the intervention.

Data Analysis

Although the initial experiment was unable to be performed due to recent events of COVID-19, the hypothesis for the experiment is as follows: The push-pull-legs exercise intervention on a previously sedentary, senior-aged female would cause improvements in psychological and physical health, quality of life, whole-body strength measurements, and grip strength. Additionally, I expect to see slight decreases in the subject's resting heart rate, resting systolic blood pressure, and estimated body fat percentage, as aforementioned literature has shown that resistance training can improve a subject's hemodynamic values.

At the conclusion of the 6-week intervention, both qualitative and quantitative data would be analyzed. Pre-and post-participation data collection using SF-36 and MMQOL surveys would have been compared to evaluate any notable differences in the quality of the subject's life due to exercise participation. Additionally, using qualitative data analysis, both the subject's and investigator's personal journals would be evaluated for major themes that develop, such as improvements and/or decrements in the subject's quality of life, energy levels and physical and psychological health due to exercise. The quantitative data to be evaluated would include the subject's preparticipation and post-participation resting heart rate, resting blood pressure, grip strength, one-repetition maximum values, and percentage of body fat. At the conclusion

of the 6-week intervention, these pre-test and post-test data would be compared using t-tests to determine if statistically significant changes occurred in the subject.

Conclusion

Although the intended case study was unable to be performed, the information acquired from the literature review helped me to develop a hypothesis confirmed by the results from the cited studies. As the human body ages, the individual will experience a number of negative physiological changes, such as higher heart rate, higher blood pressure, lower bone-mineral density, and progressive loss of muscle mass and decreasing quality of life. Additionally, prolonged sedentary behaviors lead to an increased risk of cardiovascular disease, cancer, and sudden death. As seen in the cited studies, resistance training has the ability to not only increase muscular strength, but also decrease risk of chronic disease, increase bone-mineral density, and improve psychological health and quality of life. Therefore, if the experiment were able to be performed, I believe the senior-aged, sedentary female would develop an increase in whole-body muscular strength and grip strength, a decrease in resting heart rate, resting blood pressure, and body fat percentage, and a more positive quality of life shown by a decrease in the severity of depressive symptoms according to the SF-36 and MMQOL Likert scales. While we have a tendency to use pharmacological prescriptions to treat ailing health and diseases, exercise may be the key intervention to living improved, longer and healthier lives.

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