The Benefits of Strength Training Programs in Older Adults: A Literature Review

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ABSTRACT

Objective: This article provides an overview of literature concerning the importance that strength training plays in older adults. Emphasis is given to the involvement of the neuromuscular system and its benefit to the health of older individuals as they age. A brief overview of inflammatory effects, proprioception, and bone density as it relates to strength training will be presented. Finally, a brief overview of strength training programs will be covered.

Data Collection: A computer search using PubMed and EBSCO Host generated articles relevant to strength training in the elderly, muscular neural reactivation in elderly, and risk prevention in the elderly. Referenced sources were identified from the individual searches and from an accumulated review of literature including: literature reviews, indexed journals, meta-analyses, and randomized controlled trials.

Data Synthesis: Deterioration of muscle mass and endurance with aging is a significant risk factor in the health of our aging adults. In order to provide the most effective prevention programs to aid in degenerating health with aging, a review of optional strength training programs is crucial.

Conclusions: A consensus of articles consisting of selective reviews and controlled studies, in addition to several noteworthy texts, supports the concepts of including strength training to provide prevention of deteriorating health in older adults. Emerging evidence suggests that specific inflammatory effects of resistance training must be studied further along with the effectiveness of supplementation. Important consideration should be given to implementing strength training programs when treating depression, insulin dependence, and combating cases of deteriorating bone density in aging adults. Although other forms of exercise programs provide health benefits aerobically and by increasing flexibility, strength training when implemented as part of an exercise regimen can provide specific improvements in bone density, muscle mass, strength, neuromuscular firing, and coordination of muscle fibers. These improvements allow for an independent lifestyle while aging and aid in building prevention from chronic disease.

Key Indexing Terms: *osteoporosis, sarcopenia, Type 1 muscle fibers, Type 2 muscle fibers, neuro-muscular education, high-intensity, moderate intensity, low intensity*

INTRODUCTION

The presence of a sedentary lifestyle for most Americans can lead to various adverse affects with increasing age. We have increased the life span by nearly 3 decades in American society, although we see the need for additional care for those not ambulatory. With increased need for assistance due to the lack of strength, a greater number of elderly individuals are utilizing nursing homes at the end stage of life. When decreased self efficacy in daily activities is encountered changes in mental status and depression in older adults is often observed.

Research suggests that, the decrease in physical activity seen in our society today can lead to decreased lean body mass, decreased flexibility and strength, and increased fat composition around viscera [1]. Increased visceral fat dangerously affects the ability of organs to function effectively by adding stress and workload to our vascular, respiratory, and cardiovascular structures. This added workload can increase our risk for high blood pressure and further increase our risk of cardiovascular disease. Cardiovascular disease is the leading cause of mortality in the United States.

Lack of physical fitness in our society today is related to the levels of chronic disease that are suffered in aging adults. With the importance that physical fitness plays in healthy aging and prevention, public health awareness has included fitness that combines flexibility and aerobic training. As different methods of maintaining physical fitness were explored we found the powerful role that strength training can play in preventing age related declines and chronic disease. The mechanical stimuli that strength training affords have been found in the literature to provide sufficient prevention in offsetting aging declines [14].

Physical activity is important to help in the prevention of falls, osteoporosis, cardiovascular diseases, atherosclerosis, immune function, cancer rates, depression, and other various diseases. The lack of strength in the aging can be a large risk factor alone. Individuals who have fallen one or more times had reduced grip strength and were less mobile than those who had not fallen [45] .As we age we see a decrease in neural activation of muscles, proprioception in gait, and strength. The decrease in these factors compromises our elderly populations' ability to meet everyday demands and results in needed assistance or injury. Lack of

strength and its effects specifically are a high risk factor for our elderly. Strength training in the elderly is an effective intervention against sarcopenia because it produces substantial increases in the strength, mass, power and quality of skeletal muscle. It is also shown to provide benefits such as the following: increased endurance performance; normalizes blood pressure in those with high normal values; reduces insulin resistance; decreases both total and intra-abdominal fat; increases resting metabolic rate in older men; prevents the loss of BMD with age; reduces risk factors for falls; and may reduce pain and improve function in those with osteoarthritis in the knee region [36].

Strength levels in older adults are directly related to their capability to perform everyday tasks and in turn the increasing of quality of life. Sarcopenia is a common term used to describe the decrease in strength and muscle mass with aging. This loss can be attributed to various factors including neurological, hormonal, and lack of activity. This review will further discuss the relevancy of strength training programs to aid with caring for older adults and building prevention programs. The discussion will include an overview differentiating types of muscle fibers and their neurological role in proprioception and balance training. Concerns to prepare older adults in aging include such health concerns as osteoporosis, depression, injury due to falls, and cardiovascular compromise. We will discuss the positive role that strength training implementation has played in prevention and maintaining a level of health that will aid aging adults in coping with age related decreased independence.

DISCUSSION

Muscle Cell Categories:

The human body has cells known as satellite cells. These cells promote muscle growth, repair, and regeneration when activated. These skeletal muscle cells are mononucleated cells located between the sarcolemma and the basement membrane of terminally differentiated muscle fibers. These cells are shown to be inactive as adults unless injury or increased loading activates them to regenerate muscle, or add to the reserve of satellite cells. Age is shown to be a factor in satellite cell migration with the rate of migration being half that of younger satellite cells and with more disorganization [10]. This alteration in proliferation may be a factor in difficulty of

muscle growth with age. However, further research explains that there are methods to reactivate the cells. Resistance training has been shown to stimulate the protein anabolic response through the utilization of satellite cell proliferation and enhanced activation [43]. Through resistance training we see what is considered microtrauma to the sarcolemma of muscle fibers acting as an activation pathway. The response is regeneration through alteration in gene expression. In relation to building muscle mass and power certain gene expression is important. An MGF variant of gene expression is only shown to be detectable after mechanical stimulation, but its expression is shown to decline with age [17].

Muscles inherently have the ability to adapt to differences in work load placed upon them by coordinating different muscle types and adding muscles fibers. We have two types of muscle fibers within that body that are part of motor units. Type 1, also known as slow twitch, is for endurance and highly aerobic activities, while Type 2 are faster twitch fibers and are for fast anaerobic bursts in strength. In the older adults Type 2 muscles fibers are less often utilized in their daily activities and therefore results in atrophy of these muscle fibers with the Type 1 muscle fibers remaining [24]. It is shown that we see this change occurring more frequently in the thigh muscles as compared to the arm muscle due to the continued use of the arms everyday throughout aging and less ambulation on our legs. The transformation of the Type 2 muscle fibers into Type 1 muscle fibers is in part the result of deinnervation and reinnervation [37]. Type 2 muscle fibers are large diameter fibers that are utilized for quick powerful contractions; most weight lifters carry more type 2. Type 1 muscle fibers are more extensively utilized in slow endurance type athletics. It is easy to see how with age we preserve Type 1 fibers while losing type 2 because we don't engage in as much lifting with age. With the use of strength training we can maintain the number of type 2 fibers and preserve strength.

Muscle strength is not forever lost with disuse and increased activity can bring us back to a healthier state. The literature provides evidence that shows that age-related changes in body composition can be retarded and even reversed through resistance training [1]. In 2001 Marques examined the effect of strength training in elderly women for eight months using DEXA, hand grip, walking performance, and anthropometric data to evaluate. Utilizing 27 subjects in the strength training group and 22 in a control group performing other activities the following was found:

> After 8 months, the ET group decreased percent fat mass and improved handgrip strength, postural sway, strength on knee flexion at 180%, and BMD at the femoral neck (+2.8%). In both groups improvement in dynamic balance, chair stand performance, strength on knee extension for the right leg at 180%, and knee flexion for both legs at 60% were found [28].

The following findings demonstrate some of the benefits of adding strength training for the elderly population and its effects on bone mineral density.

We often envision the elderly as doing low force activities such as walking or water aerobics because of possible fragility and decreased strength. This holds no truth because it is found that older individuals are just as capable of building muscle as the younger generations. Utilizing strength training instead of strictly aerobic exercise will exhibit higher muscle mass, increased strength, and maintain bone density.

It was found that individuals who are trained in swimming and running showed a cross sectional area of muscle mass similar to the 69-70 year old individuals who were in the control group. Another group who was resistance trained was evaluated and demonstrated a cross sectional area identical to a group of 28 year old individuals who were trained [1]. This explains that strength training can counteract the age-related changes in function and morphology of the ageing human skeletal muscle. Other sources agree that resistance training can result in muscle gain in 80 year old adults just the same as it would in younger population [37].

Neural Components: As we age certain nerves have a predetermined time frame until its death. One nerve can innervate several muscle fibers if it is a large muscle or a smaller portion of muscles fibers if it is for controlled specific movements. Once a muscle fiber loses its nerve input, it undergoes atrophy unless connection with another nerve terminal can be restored [37]. The nerve that restores function is usually an adjacent slow twitch muscle fiber that will work in its place. A slow twitch fiber is less contractile, with slower speeds, and less power owing to the decrease in strength as the process continues. This helps us understand that to reverse the downfall of fast twitch fiber loss and eventually increase strength we also have to look at the role that nerve remodeling will have and how strength training could affect this. Strength training increases neurological recruitment of a group of muscles. The initial 20% gain in muscle strength

in a strength training routine is contributed to more coordination and recruitment of nerves innervating muscular fibers [13].

Neural components play a greater role in activation of antagonist and agonist muscles during strength training then previously examined. Middle and elderly aged adults were examined for 6 months of neural activation of antagonist verses agonist. It was found that large increases in agonist were found in both groups with significant reductions in antagonist coactivation found through EMG examination [18]. Neural adaptations play a large role in explaining strength and power gains with training. Weakness in aging can be reduced by decreasing agonist activation. Neural activation is found to be dependent upon the loads put upon them through outside forces such as running, jumping, and strength training. Outstanding research supports the premise that heavy resistance exercises should be included in rehabilitation programs to induce neuromuscular activation that is sufficient enough to stimulate muscle growth and strength [4].

Proprioception is the body's sense of what positions it is put into. We are conscious of our static positions but we also have a movement sense that gives us information about joint planes, angulations, and rates of change. This input is fed by various receptors in the body including skin receptors and muscle spindles. Other tissues surrounding joints feed receptors known as Ruffini's endings and pacinian corpuscles. These are all responsible for sending information concerning rapid changes in body position and sending information to the dorsal columns and reflex systems to respond appropriately. If reflexes are not utilized, then the information is sent through the dorsal column or the anterolateral pathway into the brain where higher centers control coordination and motor programs. Balance is accomplished through an interaction of central anticipation channels combined with reflexes as well as restraints provided by the muscular strength [3].Without this input, we would be unable to respond to the stimuli around us and fail to respond appropriately to keep our bodies upright.

Muscles function to produce movement and play a large role in providing proprioception through neural connections. In aging individuals, atrophy of these neuro-muscluar pathways put them at risk of falling due to the inability to detect correct structural position and to respond to postural sway[22]. This leads to the older population becoming fearful of falling and can contribute to their decreased independence. Findings have shown that utilizing resistance training over regular exercise protocols will both increase movement and proprioception. The group not

utilizing resistance training did not benefit from the amount of added strength whereas the strength trained group did.[22]

Cardiovascular Risks: Cardiovascular disease has become predominantly one of the most threatening diseases to our society. It places burdens on our health care and puts our older adults at risks for comorbid factors, mortality, and leads to declines in function. At the height of this threat we must foster healthy habits and aim for prevention programs in our aging adults. The inflammatory response is linked to cellular damage and chronic disease. High intensity exercise has been shown to induce heat-shock protein expression, which is responsible for cellular protection in high stress situations. This protein and other cytokines shows the anti-inflammatory promotion that strength training plays. This anti-inflammatory effect is found though decreased high stress proteins and various other circulating markers in the blood such as cytokines.[7]

Inflammation in the body, specifically blood vessels, has been suggested as a prediction of coronary heart disease. Inflammation in the body can be measured utilizing C-Reactive protein levels. C-reactive protein is an inflammatory marker found in the blood and is believed to be valuable in predicting the risk of a coronary event.[12] Current research suggests that inflammatory levels can be decreased through the use of exercise that will decrease inflammation markers. Inflammatory receptors will aid in restoring fast twitch muscle fibers and decrease overall systemic inflammation aiding in various diseases.[11] One such receptor is melanocortin receptor found on the surface of monocytes. In recent research the effect of strength training on inflammation was as follows:

> "The present study includes 40 adults (aged 19-27 years) and implements a 12wk periodized, intensive resistance training intervention. Melanocortin 1 (MC1R) and 3 (MC3R) receptor expression on systemic monocytes and inflammatory markers, including C-reactive protein (CRP), interleukin 6 (IL-6), 1 beta (IL-1β) and 10 (IL-10), were measured before (PRE) and after (POST) the intervention. Resistance training significantly altered MCR systemic monocyte cell surface expression, had no chronic effects on IL-6, IL-1β or IL-10 expression but significantly decreased CRP levels from a moderate to a low cardiovascular disease (CVD) risk category. More specifically, decreased MC3R expression significantly correlated with decreased CRP, independent of changes in adiposity. These data suggest that the observed responses in MCR expression and decreases in CVD risk in response to resistance training represent an important anti-inflammatory mechanism in regulating exercise-induced decreases in chronic inflammation that occur independent of chronic changes in systemic cytokines" [20].

Not only has increased muscle mass been shown to decrease inflammation and aid in decreasing cardiovascular risk but its implementation will increase the body's endurance and make us more efficient in our daily activities. Endurance helps our cardiovascular system to sustain workloads for a longer amount of time.

It is shown that strength training can provide an increase in strength but it is also important to discuss its role in building endurance. More research seems to be interested in the strength and power of muscles as compared to the endurance. The Journal of Medicine & Science in Sports Exercise states:

"Increases in strength, secondary to neurological, metabolic, and/or hypertrophic adaptations, are likely to translate into increased muscular endurance by 1) reducing the motor-unit activation required to activate sub-maximal tasks 2) reducing activation of antagonist muscles 3) increasing high energy phosphate 4) shifting from type IIb to IIa muscle fibers 5) Increasing mitochondrial density and oxidative capacity. Marked improvements (34-200%) in musclular endurance have been reported after resistance training using moderate- high intensity protocols" [9].

This research outlines the importance of strength training by allowing us to look at more than increase in muscle mass. With the benefits of training we will be capable of efficiently utilizing these trained muscles to perform sub-maximal activities of life and reduce limitations with added energy.

Hormonal Influences

The drop of estrogen postmenopausal is the leading cause of osteoporosis secondary to senile osteoporosis. It is estimated that throughout life after the age of 35 we lose 1% of bone density with 2% loss in strength every year and jumping to a staggering 6% bone density loss per year once menopause has hit [41]. After menopause the inhibitory effect that estrogen has on the body is lost and osteoclasts break down bone. The literature explains the increasing number of hip fractures has doubled in the last 20 years and treatment for these have been slow and expensive: 15% of those who fall die and 33% are dead within one year [5]. Prevention for these hip fractures starts by ensuring that peak bone density is obtained before we reach the older ages.

By placing demand and pressure on bone through the piezoelectric effect we can counteract this loss with the stimulation of osteoblasts to lay down more bone and maintain density and therefore strength. With the increasing amount of baby boomers that will soon enter this phase, approximately 3 million, strength training could possibly be one of the core preventative measures our nation can take to avoid the life threatening effects that bone loss can contribute to. Strength training for elderly men, who could suffer from senile osteoporosis, has shown just as beneficial as it has been for women. Men from ages 60-72 trained hamstrings and quadriceps 3 days a week, doing 3 sets of 8 at 80% of maximum weight. A 107% and 226% increase in dynamic strength was recorded with area increasing 11.4% and 9.3% and type I fibers increased 33.5% and type II 27.6% [1]. Further investigation shows the added benefit of including supplementation of Vitamin D, Vitamin C, and protein post workout increased lean body mass and bone mineral density [21].

Other significant hormonal influenced responses discussed in literature are the effect that strength training has on insulin and insulin resistance.

> "Ageing is associated with a loss in both muscle mass and in the metabolic quality of skeletal muscle. This leads to sarcopenia and reduced daily function, as well as to an increased risk for development of insulin resistance and type 2 diabetes. Strength training has been shown to improve insulin-stimulated glucose uptake in both healthy elderly individuals and patients with manifest diabetes, and likewise to improve muscle strength in both elderly healthy individuals and in elderly individuals with chronic disease. Elderly individuals have preserved the capacity to improve muscle strength and mass with training, but seem to display a reduced sensitivity towards stimulating protein synthesis from nutritional intake, rather than by any reduced response in protein turnover to exercise [16].

Strength training has significant literature to support that insulin sensitivity and concentration decreases are linked to lean body mass that is built through the use of strength training programs [31]. No significant changes in the levels of other commonly named hormones such as cortisol or testosterone have been shown with strength training [19].

Psychological Role: As older adults are assessed we find a trajectory of cognitive impairment. Cognitive impairments are typically preliminary to the formation of dementia. Impairment can include deficits in memory, attention span, conflict resolution, and functional brain plasticity. Caring for older adults with dementia is a large burden of time and money on behalf of those

caring for the individual and affects the national cost of health care overall. Differing levels of dementia exist and it is found that caring for a cognitive adult takes 4.5 hours, for those with mild dementia it is an added 8.5 hours, and for those with severe dementia it can range from 17.4 to 41.5 hours per week [25]. "The associated additional yearly cost of informal care per case was $3,630 for mild dementia, $7,420 for moderate dementia, and $17,700 for severe dementia. This represents a national annual cost of more than $18 billion." [26] Not only is this a cost to our nation but an emotional cost to those closest to the adult as older adults become less independent and lose every day function. This lack of functioning can aid in the development of depression and further comorbidities. In a randomized trial of 6 months, 86 women with cognitive impairment were analyzed utilizing aerobic training, balance and tone, and strength training. Prelimary outcome measures where compared before and after and the following was found:

> "Compared with the BAT group, the RT group significantly improved performance on the Stroop Test(cognitive test for selective attention/conflict resolution. (P = .04) and the associative memory task (P = .03). Compared with the BAT group, RT also led to functional changes in 3 regions of the cortex—the right lingual (P = .03) and occipital-fusiform (P = .02) gyri and the right frontal pole (P = .03)—during the encoding and recall of associations. In addition, there was a significant positive correlation between change in hemodynamic activity in the right lingual gyrus and change in behavioral associative memory performance (r = 0.51; P = .02). The AT group significantly improved general balance and mobility (P = .03) and cardiovascular capacity (P = .04) compared with the BAT group."[33]

This represents some of the many pieces of evidence that promote strength training in older adults and its positive effect on cognitive improvements [28]. As medication is typically palliative transiently we need to look to more important options of intervention such as physical exercise [23].

Depression is commonly seen in older adults either in addition to dementia or solely and both can have an effect on one another. Throughout the literature findings have supported that physical activity plays a protective role in guarding against depression [38]. In a population found to be the most representative of the US population, the prevalence of depression in adults over 55 were observed and found that 13.7% of men and 18.2% of females were found with depression. Relationships were established linking socioeconomic conditions, marital status, and age to the prevalence. The most significant correlation found was that of reported physical health and depression [32].Finding that physical health was such an important indicator it is more likely that

these individuals will seek help from a physician than that of a psychiatrist. It will be the duty of primary care physicians to properly recognize and make appropriate recommendation or referrals for care of depression. Depression is prevalently linked to higher levels in individuals who are obese and with diabetes, and it is found that these depressive moods were reduced with implemented strength training regimens [27].

No literature with significant evidence was found to link better outcomes in treating elderly depression with strength training over other forms or physical activity were found. Results found that depressive symptoms where decreased utilizing physical exercise and was shown to be better than antidepressant medications [6].

Program Options: Strength in older adults is a combination of neural recruitment of motor units and their firing rate. Muscle mass can be increased by utilizing 60-85% of maximum strength. To increase the rate of force training above this 85% is required. The literature supports a rate of 3-4 sessions of strength training a week for strength improvements [30].

A common concern in strength training is the affect of heightened levels of blood pressure while training. To reduce this effect a recommendation of lower weight levels and increased repetitions or more frequent breaks to allow muscle relaxation [15].

Many conclusions have been drawn concerning the importance of low- intensity programs in comparison to moderate or high intensity strength training programs. Improvements in muscular endurance have been found after resistance exercise using moderate-high intensity protocols over lower intensity resistance training [9]. In both lower intensity and higher intensity training there are significant gains in muscle mass due to hypertrophy and increased Type II fibers, though neither translate into alterations of tissue composition [39]. This shows that regardless of the intensity level there are benefits of the percent fat composition and cardiovascular benefits. Only those who engaged in high intensity routines were able to get the benefits of maintaining bone densities and increases in strength and cross sectional areas of muscle. According to Roberts and Romberg, bone mineral density increases can be accomplished in heavy intensity training as compared to lower intensity training. The following were found:

> "High intensity resistance exercise also resulted in a significant increase in bone mineral density of the greater trochanter for both men and women. However, only men achieved the added result of a significant increase in lumbar spine bone mineral density. High-intensity resistance training resulted in significant increases in lean mass (8.1% for women and 3.2% for men), strength, and peak force for both men and women as well." [35]

Further literature investigation explains that, the highest level of neural activation in muscles was found with opened chained resistance exercises. This reveals the importance that high intensity programs in neuromuscular activation and should be included when appropriate in rehabilitation programs [4]. Other literature reviewed found that individuals 65-99 who occupied a residential care facility had severe physical and cognitive impairments and demonstrated no improvements in muscle mass or body weight on a three month high-intensity program [8]. It was indicated that the high intensity demand in a high intensity program can lead to negative long-term effects on muscle to meet this demand. This study was only looking at the effects of muscle mass via bio-electrical impedance.

Setting aside the intensity level, it is important to investigate which style of training would be more beneficial concerning strength goals. If just beginning a strength program the technique of lifting must be monitored and safety should be addressed until further strength is gained. Both free weight and machine weights could be implemented but which will provide us with the most efficient training? Not only the gain in strength or size but functionally which is better at mimicking everyday activity of our elderly and providing us with the most benefit? Free weights are inexpensive and easily accessible to many as compared to machines which are not home-accessible and are expensive. Free weights allow full range of motion and incorporate the use of stabilizing muscle where weight machines don't force us to stabilize but allow access to more specific muscles. Free weights have been shown to utilize full range of motion of a joint allowing us to maintain flexibility and enhancing our ability to coordinate motions in the elderly [1]. With increasing age flexibility decreases within joints due to lack of stretching and overall use. Many elderly will use flexibility exercises such as yoga to maintain flexibility. To improve overall motion strength training has been shown to provide more range then traditional flexibility exercises [2]. As flexibility decreases through age the body takes on additional stress while not maintaining its biomechanical advantages within joints. This in turn can place added stress on

musculature and joint surfaces allowing for compensations of other areas around the joint leading to musculoskeletal problems. The use of strength training will allow flexibility to remain along with ambulation and independence in life activities.

Many young healthy adults use supplements to further contribute to their muscle gain while training such as protein shakes, DHEA, or growth hormone. The benefit of adding this ergonomic factor to elderly training is skeptical. It was found that administering protein supplementation in a group 65-85 years of age before and after exercise had little effect. The use of DEXA was utilized to estimate increase in muscle composition and with a 1 repetition, 12 week program including a control group. Conclusions stated that with the routine use of protein supplementation in healthy, well protein-nourished adults there was little to no difference when compared to the control group in muscle strength and composition [43]. The use of growth hormone therapy is also skeptical. Research supports that the use of growth hormone alone in elderly men offered no benefit to increasing strength or power of muscle [40]. Alternatively those administered growth hormone with a routine of resistance training saw benefits in body composition and fat composition, yet there was no difference in muscle mass or strength. This group also had numerous side effects [26]. Overall the literature was inconclusive as to if supplementing had any additional benefit when added to nutritionally healthy subjects.

Conclusion: In older adults we are finding increased numbers of individuals who are frail and exhibit muscle loss as they age. This is known as sarcopenia, which has multiple other factors contributing such as decreased activation of type II muscle fibers and a decrease in bone density. Overall, these components affect the individuals' life by decreasing their independence. Once a person's independence is decreased we can see more tendencies of fear avoidance or decreased activity while simultaneously care from others increase. This leads us into a cycle that could spiral into decreased function, increased care, and emotional and physical strains on the individual and those caring for them. The risk of mental decline and depression are more possible in these individuals without the ability to perform their daily activities as they wish. Along with these psychological factors, decreasing health will ensue consisting of insulin dependence and cardiovascular threats if one takes on a sedentary life. The cost to our nation would include caring for these various health concerns, increased time caring for the individuals overall, increased risk of falling, and possible mortality or morbidity.

Review of the current literature has shown the effectiveness of choosing a proper strength training program for our older adults. It is one of the most important steps that we can make in providing a plan of prevention against a decline in health as we age. Multiple forms of exercises have been implemented over the years with highly successful rates of improving mood and building cardiovascular benefits. We focused on strength training as a rehabilitation program as it provides us an avenue to get moving but also improve bone density and strength in the process. It is important that we understand the underlying mechanisms that will allow us to make better informed decisions in the care of older adults.

The literature contained a substantial amount of information to support the use of strength training rehabilitation programs in older adults and its ability to increase quality of life. Conclusions that are strongly supported by evidence are as follows: (1) Decreased strength and neural activation within muscle fibers are encountered in aging that can be treated with a strength training regimen. (2) Strength training shows increased levels of balance, coordination, strength, and bone density. (3) Mood and bone cognition are positively affected with strength training. (4) Higher intensity resistance programs show the best outcomes for improving bone density, strength, and endurance.

More research is needed to evaluate the affect that strength training has on inflammation and if there are added benefits of supplementation. There is conflicting information concerning muscle mass being built in elderly adults specifically utilizing a high intensity program. Cardiovascular benefits are noted with various forms of exercise and are more specific to aerobic exercise, although strength training was shown to have an effect on inflammatory markers that could possibly contribute to atherosclerosis. More specific research in connection with strength training is needed to compound the evidence of its importance in vessel maintenance. Strength training should be considered when looking to address lifestyle and provide prevention in older adults.

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