

# Effects of Resistance Training on the Elderly Population

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## ABSTRACT

Worldwide, there is a fracture occurring every three seconds due to bone fragility (CNN health, 2018). These fractures occur largely due to poor balance and low bone density. The NL Balance and Dizziness Center specializes in rehabilitating those who have poor balance, and throughout my 16 week placement at the clinic, 100% of the patients seeking balance rehabilitation were above the age of 65. I worked with a number of the patients in our balance exercise class where we take them through a number of strengthening and balance focused exercises in order to improve their balance. Along with this I also worked one on one with a couple of patients. Due to my background in resistance training, I was immediately drawn towards performing strengthening exercises with these patients when given the opportunity. I started to show all balance patients which I worked with how to squat and deadlift. For the squats I would use a TRX, which is a piece of equipment available in the clinic, and for deadlifts I would use a kettlebell. These exercises are fundamental movements to building a strong lower body, core and back, all of which are essential components in regaining and maintaining balance. I received extremely positive feedback from multiple patients on improvements in balance and feeling stronger in general, and this is what sparked my interest in researching the effects of resistance training on the elderly population. For this report I researched many articles, journals, websites, and any literature I could find relevant to the topic. The main focus of my report surrounds muscle atrophy and how it is caused in the elderly, the health benefits of resistance training, and how to start resistance training to achieve the most benefits. From my research, I ascertained that the majority of muscle atrophy among the elderly is caused by aging, injury or medications. The most common health benefits that are a result of resistance training are fall prevention or improved balance, increased bone density, improved quality of sleep, and a reduction in hypertension. In order to achieve these benefits I found many sources of literature on the importance of using specific ranges of intensity and volume to achieve particular results (Perri et al., 2002). As well as how one should begin resistance training and what training method, they should use to avoid injury. Through the research obtained I came to the conclusion that resistance training is essential in maintaining

longevity and improving the quality of life among the elderly population. I would recommend resistance training to all people looking to improve their quality of life, and I would state that you just have to start, join a class, get a membership, or visit a physiotherapist for help, once you try it the results will speak for themselves.

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## INTRODUCTION

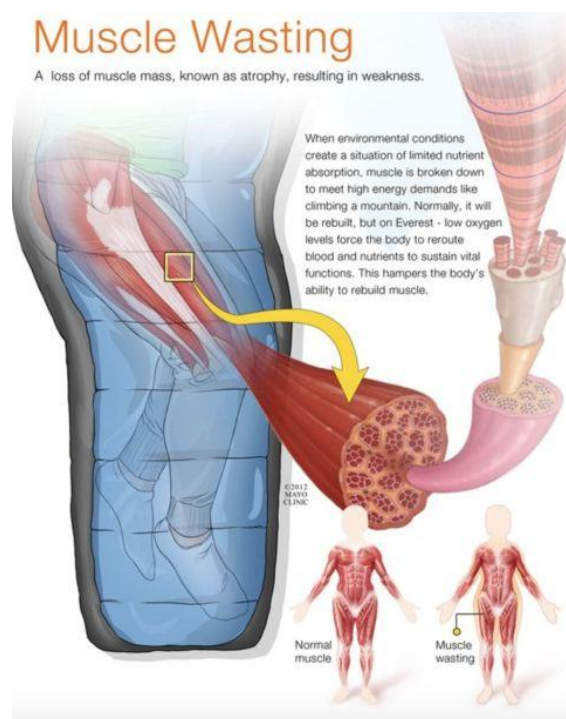
Throughout my placement at the NL Balance and Dizziness Center, the majority of my work revolved around resistance training with an elderly population. The center specializes in balance rehabilitation, and I was lucky to have had the chance to work closely with cases regarding neurological and vestibular damage caused by disease, aging and injury. While there are many causes surrounding these areas of expertise, unfortunately the most common cause of balance rehabilitation is caused by the degeneration of muscle tissue due to aging and lack of activity. It was very difficult to witness so many elders coming into the clinic with no hope of improving their quality of life because they claimed they were too sore from their arthritis, too tired due to not sleeping, or because it wasn't safe with their high blood pressure. Unfortunately, many are unaware of the dangers present due to their lack of balance, and do not recognize the correlation between their immobility and muscle loss as they age. One of the greatest risks of poor balance in seniors would be falling and the injuries that result due to these falls. Osteoporosis and osteopenia are both common among seniors and occur when bone mass or density decrease passed the normal amount. ( Schnell, S., Friedman, S. M., Mendelson, D. A., Bingham, K. W., & Kates, S. L., 2010 ) These conditions result in frail bones, which can easily be broken by a fall, or a sudden jolt in more serious cases. According to CNN Health, "Worldwide, one in three women and one in five men experience a fracture caused by such bone fragility, with a fracture occurring every three seconds ." ( <https://www.cnn.com/2019/05/13/health/hip-fracture-death-partner/index.html> , 2019). In terms of quality of life and even morbidity, hip fractures have the most devastating consequences compared to a fracture of any other bone, as one in three elders die within 12 months of suffering a hip fracture. With this in mind it is crucial that we inform and educate this population on the risks that are linked with a lack of balance and strength. We also aim to educate the population facing these issues about the importance of resistance training to reduce these risks through increasing strength and therefore improving balance. Although at the age of most in this population it is hard to tell someone they should change their behaviour, there are ways of convincing them to try some form of physical activity or resistance training

so they are able to experience first-hand the benefits of doing so. This paper aims to inform not only the elderly population but the general population of the benefits of resistance training for elderly persons. With this new knowledge, we hope there will be a decrease in injuries among the elderly caused by falls and improve their overall quality of life. It is important to remember that it is difficult for many elderly to find the motivation and reasoning to physically exert themselves, especially when the results do not immediately show. Due to time constraints I was not able to conduct my own study on this topic, but the findings of others will serve as the impetus for my further work in this area.

## DISCUSSION

### What Causes Muscle Strength and Balance to Diminish?

With the loss of muscular strength comes the diminishment of balance. The causes of these diminishments are largely age-related, and are based on, both physical and societal aspects. The loss or wasting away of muscle tissue is defined as muscle atrophy. There are three types of muscle atrophy; physiological, pathological, and neurogenic. All three of these types of muscle atrophy can commonly be found among elderly persons due to their lifestyle (Xiao, & SpringerLink, 2018). As people grow older they become less active and are not using their muscles enough, this is how physiological atrophy occurs. People who are most affected are those who have health problems which limit movement, are bedridden, or are recovering from a serious injury such as a broken hip.



This image provides an in depth look at the muscle fibers affected by atrophy and also a comparison between active muscle and atrophic muscle.

(<https://proteinfactory.com/cortisol-crushing-cocktail-new-muscle-growth/>)

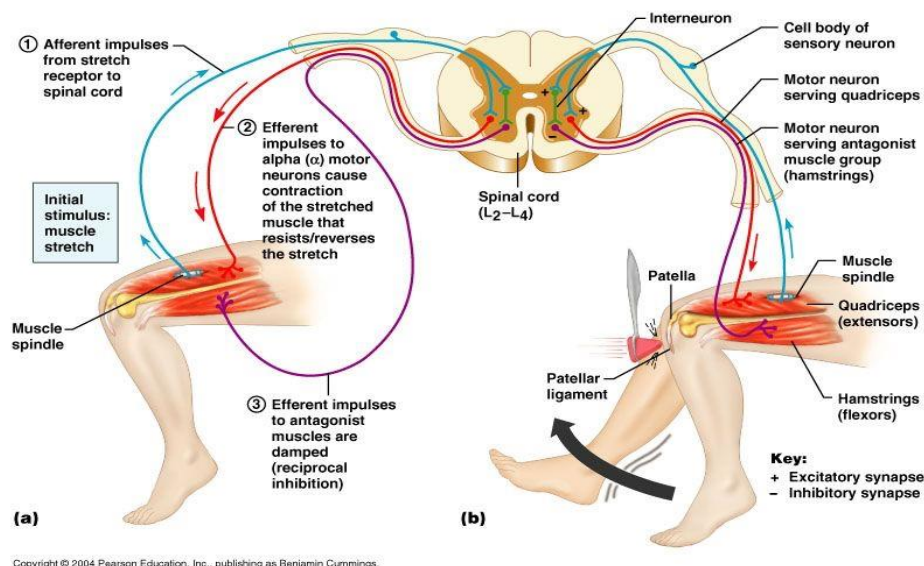
Pathological muscle atrophy is the most commonly witnessed form of atrophy found in the aging population. This atrophy is often the result of starvation or caused by diseases where there is an excessive use of corticosteroids. Corticosteroids are used for their anti-inflammatory effects and in some conditions related to immune system function. Unfortunately, they often lead to muscle weakness through pathological muscle atrophy. Finally, the most severe type of muscle atrophy is neurogenic atrophy. Neurogenic atrophy is usually caused by an injury or disease to a nerve that connects to a muscle. This type of atrophy tends to occur more suddenly than the other forms of atrophy and can be caused from something as serious as a spinal cord injury to carpal tunnel syndrome where there is damage to a single nerve. (Xiao, & SpringerLink)

#### Health Benefits of Resistance Training

Resistance training has numerous health benefits for people of all ages, but can be even more essential to our health as we grow older. As we discussed in the previous topic, muscular strength often diminishes as we grow older due to multiple different causes. According to a study done by Hakkinen et al. (2015), “Resistance training is particularly important from the 5th–6th decade of life onwards, since it currently represents the only effective and widely applicable tool to control and even reverse sarcopenia, i.e., the age-associated losses in muscle size and function”. Along with this loss of muscular strength comes a loss of balance. The primary health benefit from resistance training for the elderly population is fall prevention. Statistics of the number of injuries caused by falls among elders is very hard to determine, but globally, there is fracture occurring every three seconds due to bone fragility (CNN health, 2018). Bone fragility is due to a lack of bone density and joint health and will be touched on further as to how resistance training can enhance these aspects in the case of a fall. It is more common for older adults to fall than younger adults because they often fail to recover from a temporary loss of balance (García-Flores, Rivera-Cisneros, Sánchez-González, Guardado-Mendoza, & Torres-Gutiérrez, 2016). Balance can be defined as the ability to maintain the body’s center of mass over its base of support (Shumway-Cook &



Woollacott, 2001). A complex set of sensorimotor control systems are necessary in order to maintain balance. These include sensory input from vision, proprioception, and the vestibular system, which sends signals to the brain to form nerve impulses, causing motor output to the eyes and muscles. Resistance training is most influential upon the proprioceptive system. Sensory receptors in our body send impulses to our brain every time we move, so that our body is aware of where we are in space. Over time, without resistance training, muscles become weak and the body becomes less mobile. When the body is unable to move as fluently and efficiently, the brain does not receive impulses as efficiently either and can lose track of where the body is in space. This is what results in the loss of balance (Hanes & McCollum, 2006).



This image provides a visual representation of how the proprioceptive system works and how the muscles are important in this process.

<http://mathewhawkesphysiotherapy.blogspot.com/2013/09/proprioception.html>

The best way to recover one's balance while falling would be to take a step (Bergquist et al., 2019). To do so adequately requires strength in your calf, thigh and hip muscles. According to an article by Bergquist et al., the most common test of strength in young seniors (60-70 years old) was a test of reliability in a five times sit-to-stand. The sit-to-stand exercise consists of an individual beginning in a sitting position on a chair or something of similar height and standing up onto their feet. This exercise requires strength in the legs, hips, back and abdominal muscles, all which are essential in recovering from a fall and maintaining balance.

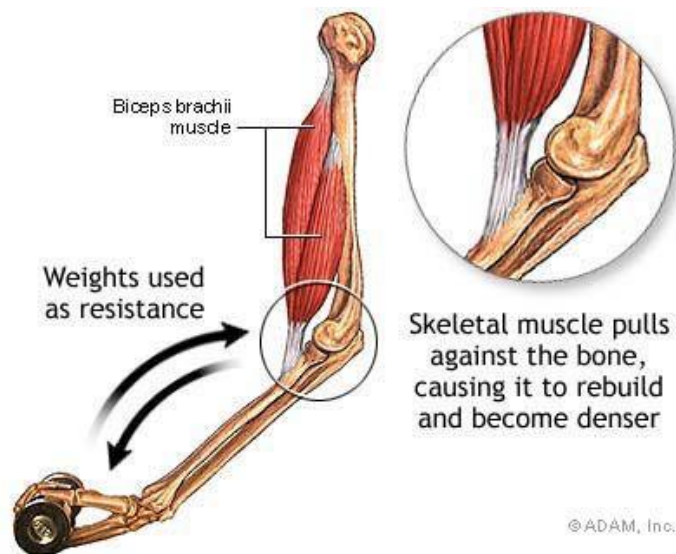
This image demonstrates the starting and finishing positions of a sit to stand exercise. It is important to notice that the woman in the image is seated at the edge of her chair and her toes are behind her knees. She then would proceed to lean forward putting her nose over her toes and push through her legs to reach the standing position shown.

<https://www.sharecare.com/health/bone-joint-muscle-health/slideshow/knee-exercises>



As mentioned earlier, bone fragility is caused by a lack of bone density and is one of the major reasons why the elderly are often injured when they fall. In a study by Beavers et al.(2017), they determined that performing resistance training over aerobic training during a caloric restriction resulted in a decreased loss of hip and femoral neck bone mineral density in over weight and obese older adults (Beavers, et al.). This study is transferable, as it shows the benefits of resistance training on bone density in the older population. Bemben and Bemben (2011) wrote an article on the response of bone mineral density in a 40 week trail of resistance training. They found that “ resistance training programs, regardless of intensity and frequency, were effective in improving bone mineral density of the proximal femur and lumbar spine

but not the total body. Both men and women responded similarly for the hip sites but men show a greater response at the lumbar spine than women.” Resistance training can help to strengthen your bones by causing stress on the bones. When performing any sort of resistance training muscle contractions occur and cause the muscle to pull on the bone. This creates lines of stress in the bone and stimulates the bone to increase its density ( Hakkinen et al., 2015).

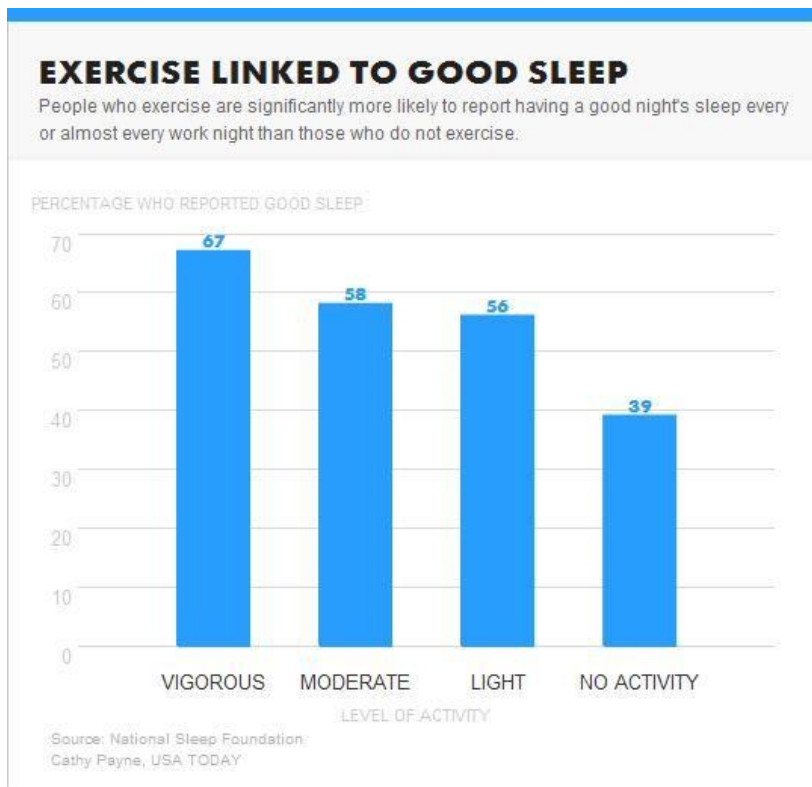


The source shown demonstrates an arm performing a bicep curl. In this movement the biceps brachii muscle contracts to work against the resistance of the weight. When the muscle contracts it pulls against the bone, creating stress lines. Once rebuilt, the bones are stronger and more dense than before.

<https://archive.nytimes.com/www.nytimes.com/imagepages/2007/08/01/health/adam/19081Bonebuildingexercise.html>

Many individuals experience poor sleep quality as they become older. A study by Ferris et al. (2004), examines the effects of six months of resistance training on eight subjects between the ages of 70 and 90. Their results showed that after just three months of resistance training there was significant improvements

in the sleep quality of the subjects. With improvements in quality of sleep comes improvements in motor and cognitive function and therefore quality of life.



This source from Cathy Payne, supports the discussion that resistance training is linked to sleep quality improvements. This source also adds that the harder the subject trained the more likely they were to report a good sleep.

<https://katclassics.wordpress.com/2015/08/13/does-exercise-affect-the-way-you-sleep/>

High blood pressure, also known as hypertension, is a common condition where blood pressure against the artery walls is high enough to cause health problems. Hypertension is defined as a blood pressure over 140/90 mm Hg, and affects more than two thirds of individuals over the age of 75. Over time, hypertension can cause some serious damage to the arteries, heart, brain and even lead to obstructive sleep apnea and the loss of bone density (Sorace, Mahady, & Brignola, 2009). This disease is common among elderly people and decreases one's quality of life in more ways than one. In their study, Sorace et

al. provided evidence to indicate that resistance training can lower resting blood pressure. According to the study, engaging in regular resistance training resulted in “approximately a 2% decrease in systolic pressure and a 4% reduction in diastolic pressure”. This may not seem significant, but in conjunction with increased cardiovascular activity, decreased sodium intake, and a healthy diet the small adjustments add up. High blood pressure can also cause an increase in the amount of calcium in your urine, leading to an excessive elimination of calcium and possibly bone density loss.

Blood Pressure Category	Systolic mm Hg (upper #)		Diastolic mm Hg (lower #)
<b>Normal</b>	less than <b>120</b>	and	less than <b>80</b>
<b>Prehypertension</b>	<b>120 – 139</b>	or	<b>80 – 89</b>
<b>High Blood Pressure (Hypertension) Stage 1</b>	<b>140 – 159</b>	or	<b>90 – 99</b>
<b>High Blood Pressure (Hypertension) Stage 2</b>	<b>160 or higher</b>	or	<b>100 or higher</b>
<b>Hypertensive Crisis (Emergency care needed)</b>	Higher than <b>180</b>	or	Higher than <b>110</b>

The source above provides a chart of the various blood pressure categories and the systolic and diastolic amounts that fall under these categories.

<https://healthiack.com/blood-pressure-chart>

### Effective Resistance Training

Today, there are numerous different resistance training methods for people of all ages. It is difficult to claim and support that a particular training style or method is ideal for the elderly population, but there are certain guidelines and general training methods that would be beneficial to keep in mind when dealing with the elderly population. Slow progression is key for all individuals partaking in resistance training in

order to avoid injury on the muscles and joints. For sedentary individuals who have little experience in resistance training, a bridging exercise program would be beneficial for them. Bento and Rodacki (2015) carried out an experiment over the course of 12 weeks comparing exercise programs on land and in water, where the dynamic strength, the isometric peak, and rate of torque development for the lower limbs were assessed before and after the exercise programs. Both programs provided similar improvements in most components, differing only in isometric peak torque, where it increased around the hip and ankle joints in the water-based group, and around the knee joint in the resistance-training or land group. This shows that a water-based aerobic/resistance exercise program would be beneficial for the elderly individuals who have little experience in resistance training and also beneficial for any who struggle with balance loss as the programs have shown significant improvement in isometric peak torque around the hip and ankle joints, areas which are key in maintaining balance. Resistance training can provoke many beneficial adaptations if done properly. Many leading organizations in exercise research have confirmed that resistance training with higher loads are associated with greater gains in both strength and muscle size. Lower resistance training loads may be beneficial for the elderly population, as heavy loads may contradict their benefits in individuals suffering from uncontrolled hypertension or cardiovascular disease (Williams et al., 2007). According to King, Haskell, Taylor, Kraemer, DeBusk (1992), due to the perceived increased effort in training with heavier loads, older adults prefer low exercise intensity. Another reason why low to moderate loads are more beneficial for the elderly population is because “an inverse relationship between exercise adherence and intensity exists.” (Perri et al., 2002). This means that the elderly are more likely to continue resistance training over a longer period of time if they train at a lower intensity, or what appears to be a lower intensity, i.e., low to moderate loads at a higher repetition range.

**TABLE 19.1**  
**A Periodization Model for Resistance Training**

Period	Preparation → First transition			Competition		Second transition (active rest)
Phase Variable	Hypertrophy and endurance	Basic strength	Strength/power	Peaking	OR Maintenance	
Intensity	Low to moderate	High	High	Very high	Moderate	Recreational activity (may not involve resistance training)
	50-75% 1RM	80-90% 1RM	87-95% 1RM <sup>†</sup> 75-90% 1RM <sup>‡</sup>	≥93% 1RM	≈80-85% 1RM	
Volume*	High to moderate	Moderate	Low	Very low	Moderate	
	3-6 sets	3-5 sets	3-5 sets	1-3 sets	≈2-3 sets	
	10-20 repetitions	4-8 repetitions	2-5 repetitions	1-3 repetitions	≈6-8 repetitions	

\*These assignments do not include warm-up sets and typically apply to core exercises only (1, 14).

†These percentages of the 1RM and the repetition ranges apply to nonpower core exercises only.

‡These percentages of the 1RM and the repetition ranges apply to power exercises only and are *not consistent* with the typical %1RM–repetition relationship described in chapter 15. Refer to the section “Assigning Percentages for Power Training” on page 400 for further explanation.

© 2008 Human Kinetics

In the above source is a chart which provides general intensity and volume levels

for particular goals in regards to an individual's one repetition maximum (1RM).

For the elderly population the “Hypertrophy and Endurance” phase would be

most beneficial as the intensity is at a low to moderate level.

<https://app.emaze.com/@AOORFZIW#19>

Periodization is defined as the “long-term cyclic structuring of training and practice to maximize performance to coincide with important competitions.” (Verkhoshansky, 2007). Basically, with regards to resistance training periodization is the planning of intensity and volume over a period of time in order to achieve maximum benefits from training and avoid injury. A study by Zalma et al. (2018) compared the effects of linear periodization and concurrent periodization on the activities of daily living in the elderly population. Linear periodization, also known as the traditional model, consists of simply making changes to volume and intensity over mesocycles, meaning a certain number of weeks. This model is said to be most appropriate for beginner strength athletes or athletes training for other sports. As compared to



the concurrent model which is done in microcycles, meaning weekly changes in training volume and intensity ( Rhea et al., 2002). In the study by Zalma et al., the two different training styles were tested on an elderly population over the span of a 14 week period. Both groups demonstrated significant improvements in strength and their ability in activities of daily living. There were no significant differences observed between the two on any outcome variable. This shows that a specific training periodization is not better than another for the elderly population, but it is beneficial to follow one as significant increases in strength were observed.

## **CONCLUSION**

In conclusion, resistance training is beneficial for the elderly population in many ways. It is well supported that strength diminishes over time, and with that goes balance. Due to the stigma surrounding elders, their sedentary behaviour and frequency of injuries due to falls, muscle atrophy in most is no surprise. As we treat old people like frail little people, they become that. In order to avoid falls and improve their overall quality of life, elderly people must stay active and part-take in resistance training. With the commencement of resistance training comes, lower risk of serious injury, better sleep, and lower blood pressure. Although, specific training methods have not proven beneficial for the elderly population, there is research that supports training periodization and the use of low to moderate loads at high repetitions. Regardless, the technicalities will be sorted with time, the main point is to begin today to better your tomorrow.

## **RECOMMENDATIONS**

Slow progress is essential for the elderly when it comes to resistance training. If you are foreign to resistance training, it is recommended that you should begin with something such as water-based aerobics/resistance training. These water based classes can be found taught at most community swimming

complexes and are often discounted for seniors. If you are experienced in resistance training, research suggests that you should follow some sort of periodization plan in order to benefit the most from your training. These periodization training plans can be found for free online and can be very helpful for those who have reached a plateau. For those struggling with direction in resistance training and balance, a physiotherapist or kinesiologist would be more than helpful in this area. For those working in the kinesiology and exercise physiology domain, it would be beneficial to research the best training periodization and programming for the elderly population. Foremost, it doesn't matter where you start, as long as you're active and striving towards living an active lifestyle.

## References

- Beavers, K. M., Beavers, D. P., Martin, S. B., Marsh, Anthony P., Lyles, M. F., Lenchik, L., Nicklas, B. J. (2017). Change in Bone Mineral Density During Weight Loss with Resistance Versus Aerobic Exercise Training in Older Adults. *Journals of Gerontology Series A: Biomedical Sciences and Medical Sciences*, 72(11), 1582-1585
- Bemben, D., & Bemben, M. (2011). Dose–response effect of 40 weeks of resistance training on bone mineral density in older adults. *Osteoporosis International*, 22(1), 179-186.
- Bento, P., & Rodacki, A. (2015). Muscle function in aged women in response to a water-based exercises program and progressive resistance training. *Geriatrics & Gerontology International*, 15(11), 1193-1200.
- Bergquist, R., Weber, M., Schwenk, M., Ulseth, S., Helbostad, J., Vereijken, B., & Taraldsen, K. (2019). Performance-based clinical tests of balance and muscle strength used in young seniors: A systematic literature review. *BMC Geriatrics*, 19(1), 1-14.
- Ferris, L., Williams, J., Shen, C., Albus, K., & Hale, K. (2004). Resistance Training Improves Sleep Quality in Older Adults. *Medicine & Science in Sports & Exercise*, 36(Supplement), S287.
- García-Flores, F., Rivera-Cisneros, A., Sánchez-González, J., Guardado-Mendoza, R., & Torres-Gutiérrez, J. (2016). Correlation between gait speed and muscular strength with balance for reducing falls among elderly. *Cirugia Y Cirujanos*, 84(5), 392-397.
- Worldwide hip fracture rates. Sharon Brennan-Olsen (2018) <https://www.cnn.com/2019/05/13/health/hip-fracture-death-partner/index.html>
- Hanes, D. A., & McCollum, G. (2006). Cognitive-vestibular interactions: A review of patient difficulties and possible mechanisms. *Journal of Vestibular Research*, 16(3), 75–91.
- Hakkinen, K., Kallinen, M., Izquierdo, M., Jokelainen, K., Lassila, H., Malkia, E., Kraemer, W. J., Newton, R. U., Alen, M. (1998). Changes in agonist-antagonist EMG, muscle CSA, and force during strength training in middle-aged and older people. *Journal of Applied Physiology*, 84, 1341 – 1349.
- King, A. C., Haskell, W. L., Taylor, C. B., Kraemer, H. C., DeBusk, R. F. (1991) Group- vs home-based Exercise Training in healthy older men and women. A community-based clinical trial. *JAMA*, 266, 1535 – 1542.
- Perri, M. G., Anton, S. D., Durning, P. E., Ketterson, T. U., Sydemann, S. J., Berlant, N. E., Kanasky, W. F. Jr, Newton, R. L. Jr, Limacher, M. C., Martin, A. D. (2002). Adherence to exercise prescriptions: effects of prescribing moderate versus higher levels of intensity and frequency. *Health Psychology*, 21, 452 – 458.
- Rhea, M. R., et al. (2002). A Comparison of Linear and Daily Undulating Periodized Programs With Equated Volume And Intensity For Strength, *Journal of Strength and Conditioning Research*, 16(2), 250–255.

Schnell, S., Friedman, S. M., Mendelson, D. A., Bingham, K. W., & Kates, S. L. (2010). The 1-year mortality of patients treated in a hip fracture program for elders. *Geriatric Orthopaedic Surgery & Rehabilitation*, 1(1), 6–14. doi:10.1177/2151458510378105

Shumway-Cook A., & Woollacott, M.H. (2001) *Motor control: Theory and practical applications*. Philadelphia, Lippincott, Williams & Wilkins.

Sorace, P. P., Mahady, T., & Brignola, N. (2009). Hypertension and Resistance Training. *Strength and Conditioning Journal*, 31(1), 33-35.

Verkhoshansky, Y. (2007). Sport Strength Training Methodology . Comment on Magnush.

Williams, M. A., Haskell, W. L., Ades, P. A., Amsterdam, E. A., Bittner, V., Franklin, B.A., Gulanick, M.,

Laing, S. T., Stewart, K. J., American Heart Association Council on Clinical C, American Heart Association Council on Nutrition PA, Metabolism. Resistance exercise in individuals with and

Without cardiovascular disease: 2007 update: a scientific statement from the American Heart Association Council on Clinical Cardiology and Council on Nutrition, Physical Activity, and Metabolism. *Circulation* 2007, 116, 572 – 584.

Xiao, J., & SpringerLink. (2018). Muscle Atrophy. (Advances in Experimental Medicine and Biology, 1088.). Springer eBooks.

Zalma, B., Buskard, A., Dent, C., Armitage, C., & Signorile, J. (2018). Effects Of Linear Periodization Versus Concurrent Periodization Training On Adl's In An Elderly Population: 1521 Board #8

May 31 1. *Medicine & Science in Sports & Exercise*, 50, 366.

## Appendices

Anonymous. (2009). Prevention package for falls aims to reduce number of broken hips. *Nursing Older People* (through 2013), 21(8), 6.

Bradlee, M., Mustafa, J., Singer, M., & Moore, L. (2018). High-Protein Foods and Physical Activity Protect Against Age-Related Muscle Loss and Functional Decline.(1), 88-94

Bryant, C. (2006). *ACE's guide to resistance training for older adults* (revised edition)(Sports medicine and exercise science in video). Monterey, CA: Healthy Learning.

Cai, Wang, Liu, Jia, Feng, & Tian. (2018). Effects of different types of exercise on skeletal muscle atrophy, antioxidant capacity and growth factors expression following myocardial infarction. *Life Sciences* , 213, 40-49.

Csapo, R., & Alegre, L. (2016). Effects of resistance training with moderate vs heavy loads on muscle mass and strength in the elderly: A meta-analysis. *Scandinavian Journal of Medicine &*

*Science in Sports*, 26(9), 995-1006.

Peterson, M. D., Rhea, M.R., Sen, A., Gordon, P.M. (2010). Resistance exercise for muscular strength in older adults: a meta-analysis. *Ageing Res Rev*, 9, 226 – 237.

Westcott, W., & Healthy Learning Videos, production company. (2008). Strength training for sedentary adults.

Zubala, A., MacGillivray, S., Frost, H., Kroll, T., Skelton, D., Gavine, A., . . . Morris, J. (2017). Promotion of physical activity interventions for community dwelling older adults: A systematic review of reviews. *PLoS One*, 12(7), E0180902.