Journal of Human Movement Science (2024)
Clausius Scientific Press, Canada

DOI: 10.23977/jhms.2024.050214
ISSN 2523-5850 Vol. 5 Num. 2

A Systematic Review and Network Meta-Analysis of the Efficacy of Various Exercise Interventions for Sarcopenia in Older Adults

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Keywords: Sarcopenia; exercise intervention; exercise prescription

Abstract: Sarcopenia is a progressive condition associated with aging, characterized by a reduction in muscle strength and mass, which can coincide with various chronic diseases. Exercise is a critical component in the therapeutic approach to sarcopenia. Regular physical activity significantly enhances the quality of life for elderly patients with the condition. However, due to the variability in the progression of sarcopenia among individuals, a one-size-fits-all exercise program is not suitable. This study, therefore, examines the existing literature on exercise-based interventions, analyzing the diverse exercise modalities, regimens, and their respective effectiveness in improving the condition. The goal is to develop personalized exercise prescriptions for individuals with sarcopenia, providing a robust theoretical framework and empirical evidence to guide clinical practice and future research.

1. Introduction

Sarcopenia, also known as sarcopenia, was first proposed by Rosenberg in 1989[1]. It is a progressive disease associated with aging, which can be divided into primary and secondary sarcopenia. Sarcopenia is characterized by a decrease in skeletal muscle mass, accompanied by decreased muscle strength and decreased muscle function. According to the 2019 Asian Working Group for Sarcopenia (AWGS2019) diagnostic criteria, the prevalence of sarcopenia in the elderly was 13.05%. In addition to geographic, economic, and cultural differences in prevalence, there are also gender differences. Due to the decrease of estrogen level in postmenopausal women, the incidence of sarcopenia in most areas of China is mainly in elderly women[2].Sarcopenia is a global health issue that is gaining increased attention due to its impact on the quality of life, particularly among the elderly. The prevalence of sarcopenia is significant, with estimates suggesting that around 50 million people worldwide are affected, a number that is projected to rise to 500 million by 2050. This condition is not only associated with a decline in physical function but also with an increased risk of adverse outcomes such as falls, fractures, and loss of independence.

Exercise plays a crucial role in mitigating the symptoms of sarcopenia. Engaging in regular physical activity, particularly resistance trai ning, has been shown to help maintain and even increase muscle mass and strength. This can lead to improved physical performance and a reduced risk of

related health issues. The AWGS 2019 consensus update emphasizes the importance of early identification and intervention, recommending lifestyle modifications, including exercise and nutritional supplementation, as primary interventions for sarcopenia. The update also introduces the concept of "possible sarcopenia," which is defined by the presence of either low muscle strength or low physical performance, to facilitate earlier interventions in primary care settings.

In summary, sarcopenia is a global health challenge that is being addressed through increased research and updated diagnostic criteria. Exercise is a key component in the management of this condition, with the potential to significantly improve the quality of life for those affected. The AWGS 2019 consensus update provides a comprehensive framework for the diagnosis and treatment of sarcopenia, highlighting the importance of exercise and nutrition in combating this age-related syndrome.

2. Exercise intervention of Sarcopenia

Exercise intervention an irreplaceable role in the prevention and treatment of sarcopenia. It is one of the most efficient and reliable methods to acquire and maintain muscle mass and strength. From adolescence onwards, individuals should be actively encouraged to engage in exercise to build and consolidate a solid foundation of muscle mass, muscle strength and bone mass, and to lay the foundation for a healthy life as they grow older, as individuals enter the middle and old age stage, continuous and regular exercise becomes especially critical to maintain these key physiological parameters. Exercise intervention has shown significant effects in the treatment of sarcopenia and its adverse health outcomes, exercise intervention plays an important role in enhancing skeletal muscle mass and muscle strength of patients with sarcopenia.

3. The influence of different exercise modes on patients with sarcopenia

3.1. Aerobic exercise

Aerobic Exercise (AE) is a form of physical activity that is conducted with an adequate supply of oxygen, characterized by its low to moderate intensity and prolonged duration. It is recognized for its capacity to effectively metabolize sugars and fats within the body, while simultaneously enhancing and improving cardiovascular and respiratory functions. The benefits of AE in the context of sarcopenia, a condition associated with the progressive loss of skeletal muscle mass and strength in older adults, are multifaceted. Globally, sarcopenia is a significant health concern as the population ages, with the number of individuals affected projected to increase dramatically by 2050. The condition is not only linked to a decline in physical performance but also to an elevated risk of adverse health outcomes such as falls, fractures, and a loss of independence. Exercise, particularly AE, has been identified as a non-pharmacological intervention that can mitigate the decline in muscle mass and function associated with sarcopenia. Studies have shown that regular engagement in AE can lead to improvements in muscle strength, physical performance, and overall quality of life in older adults with sarcopenia.

In the elderly, low-intensity AEs such as brisk walking, jogging, and even performing household chores are commonly recommended due to their accessibility and adaptability. These activities have been demonstrated to improve muscle strength and function. For instance, Ossowski's research indicated[3] that a 12-week Nordic walking program significantly improved the skeletal muscle mass index and knee muscle strength in elderly patients with sarcopenia, along with notable reductions in body mass, body mass index, and body fat percentage. Given the heterogeneity in the progression of sarcopenia and the varying physical capabilities of elderly individuals, a tailored approach to exercise prescription is essential. AE serves as an inclusive and adaptable intervention, suitable for those with

limited physical resilience or those who cannot engage in more strenuous resistance exercises. It is a cornerstone of comprehensive sarcopenia treatment plans, complementing other interventions such as resistance training and nutritional support to holistically address the condition.

In conclusion, aerobic exercise is a vital component in the therapeutic arsenal against sarcopenia, offering a viable and effective means to improve muscular and overall health in the elderly. Its role in global sarcopenia management is underscored by a growing body of evidence that highlights its efficacy and the need for its integration into standard care practices. The AWGS 2019 consensus update provides a comprehensive framework for the diagnosis and treatment of sarcopenia, emphasizing the importance of exercise and nutrition in combating this age-related syndrome.

3.2. Resistance exercise

Resistance exercise is an effective therapeutic modality for sarcopenia, involving active muscle movement against external resistance. Currently, resistance band resistance and weight resistance are primary forms of resistance exercise for the elderly sarcopenia population. It is recommended that the training load should be progressively increased from low to high, aiming for a moderate to high-intensity training load[4]. Progressive resistance exercise is suggested to be performed 2-3 times per week for 8-12 weeks, with the duration of training and the number of exercises gradually increased in conjunction with improvements in physical capacity[5]. Among various forms of resistance exercise, elderly individuals are advised to engage in resistance exercises using elastic bands with appropriate poundage. Some researchers have found that after 12 weeks of progressive resistance training with elastic bands in elderly female patients with sarcopenia, there was a significant improvement in the patients' body composition and physical function[6]. Given the variability in physical condition among older adults, the Borg scale is recommended for assessing and controlling exercise intensity during workouts to develop appropriate individualized exercise prescriptions[7]. Studies have indicated that resistance exercise intervention has a positive effect in the early stages of sarcopenia, with more pronounced improvement effects[8].In the treatment of sarcopenia, resistance exercise is considered the best-recommended form of exercise for enhancing muscle protein synthesis, stimulating muscle hypertrophy, and increasing muscle strength. It can increase the quadriceps strength and power in the elderly, thereby reducing the risk of falls and fractures associated with sarcopenia. Studies have shown that after 14 weeks of resistance exercise in a population of 65-year-olds, with two sessions per week and each session lasting one hour, there was a significant increase in lower limb isometric strength, as well as improvements in muscle strength and mass. The specific mechanism may involve upregulating IGF-1 expression and activating the PI3K/Akt/mTORC1 pathway, thereby promoting protein synthesis. Resistance exercise can also increase the expression of suppressor of cytokine signaling 2 (SOCS2), reduce inflammatory factors, and alleviate issues such as the reduction in mitochondrial number, decline in oxidative capacity, and functional degradation due to aging.

Furthermore, progressive resistance training (PRT) continuously increases resistance load during exercise, providing a continuous adaptive stimulus to the muscles and is a safe and effective mode of exercise to improve muscle strength in middle-aged and older adults. Studies have found that PRT can significantly improve the skeletal muscle mass in elderly patients, and compared to simple resistance exercise methods, PRT can enhance the therapeutic effect of exercise and effectively increase muscle strength.

Individualized exercise prescriptions are crucial for the rehabilitation of sarcopenia patients. Considering the differences in physical condition and exercise capacity among the elderly, appropriate adjustments in exercise intensity and volume are necessary. The Borg scale, as an assessment tool, can help control the intensity of training and ensure the safety and effectiveness of

the exercise. At the same time, the effect of resistance exercise in the early intervention of sarcopenia is particularly evident, which emphasizes the importance of early diagnosis and treatment. With the continuous deepening of research on sarcopenia, there may be more studies on the role of exercise, nutrition, and protein supplements in alleviating sarcopenia in the future, as well as exploring new therapeutic interventions, such as stem cell therapy.

3.3. Whole-body vibration training

Whole-body vibration training (WBVT) is a form of ground-based vibration that can be performed by standing on one or both feet, supporting your hands, or sitting, the shock vibration stimulation is transmitted to the muscle group through the limbs, which increases the activation degree of the initiative muscle and increases the activity of the high threshold motor units, causing the participating motor units to discharge at a high frequency, whereas reaching the training effect of increased excitability of the neuromuscular system[9]. Huang Shuo et al, after 12 weeks of whole body vibration training intervention in the elderly, found that the lower extremity muscle strength, balance and mobility in elderly patients have significantly improved [10]. Zhu adopted a whole-body vibration training program with frequency of 12-16 Hz and amplitude of 4 mm, which can effectively improve the muscle strength of iliopsoas, quadriceps femoris and tibialis anterior muscles and grip strength in elderly patients with myasthenia gravis, and the 5 times sitting time and the time of standing-walking test were significantly shortened, which showed a significant improvement in muscle strength but no significant improvement in muscle mass[11]. It is suggested that the whole body vibration training should be carried out for the elderly patients with myasthenia gravis, and the intervention program should be followed as follows: exercise frequency three times a week, single intervention time of 5-10 minutes, vibration table frequency of 50 Hz, amplitude of 4 mm[12]. At first, whole-body vibration training was used as a training method for high-level athletes, but in recent years, it was gradually applied in the field of rehabilitation, in the future, more studies are needed to confirm the effect of whole body vibration training on muscle strength and muscle mass in patients with myasthenia gravis.

3.4. Blood flow restriction training

In recent years, with the development of population ageing and sports medicine, blood flow restriction training (BFRT) has received much attention as an innovative training method, BFRT showed significant effects in low-weight women, athletes during recovery and the elderly, which significantly increased muscle cross-sectional area and muscle strength, this method has shown great advantages and potential in improving muscle decay in the elderly, patients with musculoskeletal injuries, or patients undergoing surgery. BFRT, also known as pressure Training, was proposed by Professor Yoshihiro Sato in Japan. BFRT applies external pressure to the limbs through special devices such as inflatable cuffs or elastic bandages, partial occlusion of arterial blood flow and venous blood flow can be achieved to increase muscle strength and volume and improve body function. Foreign scholars have found that the main mechanism of muscle hypertrophy induced by blood flow restriction training is mechanical stress and metabolic stress, which ultimately affect protein synthesis process to promote muscle hypertrophy [13]. Pan Weimin et al found that compared with traditional resistance training and walking, low load blood flow restriction training and blood flow restriction walking can effectively increase muscle strength and muscle mass in the elderly, compared with high-load training, it was more significant[14]. Letieri et al conducted a 16-week blood flow restriction combined with low-intensity resistance exercise intervention in 11 elderly women with sarcopenia, muscle Mass, grip strength and chair test were significantly improved in the experimental group, and no adverse reactions were observed[15]. These studies show that blood flow restriction training can be applied to the treatment of sarcopenia, and has a higher safety, and compared with other types of

resistance exercise, blood flow restriction training can achieve the same or higher results as high resistance exercise in a shorter period of time. Exercise load, frequency, and cuff width and pressure values are key factors affecting the effectiveness of blood flow restriction training, and in general, 50% -80% of total occluded artery pressure values are selected as pressure values[16], in the choice of cuff generally choose the smaller size of the cuff for the upper limb, the larger size of the width of the cuff for the lower limb[17]. In the selection of exercise load and frequency, because there are few studies on the effect of blood flow restriction training on myasthenia gravis, there is no uniform conclusion on the intensity of blood flow restriction training in the elderly, shimizu et al used a load of 20% 1RM for blood flow restriction training with a more significant effect[18] and no adverse effects were found. However, Lixandr ão et al considered the ideal load to be 20% -50% 1RM[19] , and Cook et al used a flow restriction training with a 30% -50% 1RM load that similarly yielded significant results[20] , the study of above scholars proved that the most suitable exercise load for blood flow restriction training in the elderly is 20-50% 1RM intensity.

3.5. Exercise considerations and existing problems in patients with sarcopenia

Because of the different symptoms of each patient with muscular dystrophy, it is necessary to develop a more personalized exercise prescription for individual patients with muscular dystrophy. For instance, the type of exercise should be tailored to the patient's physical capacity. Patients with diminished physical strength may opt for less strenuous aerobic activities, such as walking. In cases where there is a significant decline in muscle strength or mass, particularly in patients with advanced sarcopenia who are unable to sustain prolonged exercise, alternative training methods like blood flow restriction training or whole-body vibration training can be employed. These methods aim to achieve a more pronounced improvement in a shorter period. Conversely, for patients with mild myasthenia gravis who are in good physical condition, progressive resistance training using elastic bands can be beneficial, with the exercise intensity starting high and gradually decreasing. At the same time, attention should also be paid to the movement before and after the warm-up, as well as wearing appropriate sneakers and protective equipment, sports protection. The most attention should be paid to the safety of the elderly in the process of exercise, always pay attention to the elderly in the exercise of heart rate and fatigue, and so on, to prevent the occurrence of danger. At present, many elderly people in our country lack the relevant knowledge of myasthenia gravis. Therefore, hospitals, schools, communities and relevant functional departments can jointly carry out publicity or popular science activities to strengthen health education on how to prevent and treat age-related muscular dystrophy, and encourage patients to promote health through exercise.

4. Conclusion

Exercise is an effective means to intervene the disease. Different exercise methods can improve the body composition and function of the patients, so as to improve the balance and reduce the risk of falls, improve the ability of daily living. However, the physiological mechanism of exercise intervention in amyotrophic lateral sclerosis in the elderly is not clear, and more relevant studies are expected in the future, emphasis should also be placed on developing more specific and individualized exercise prescriptions for patients with different stages of sarcopenia.

References

[1] Rosenberg I. (1989). Summary comments and methodological problems in Determining Nutritional Status of Older Persons.Am J Clin Nutr. 50: 1231-1243.

[2] Wen Li, Li Tuan, Li Yue, etc. Current status and influencing factors of sarcopenia in the elderly in China [J]. Modern medicine and health, 2023, 39(07): 1194-1198.

[3] Ossowski Z M, Skrobot W, Aschenbrenner P, et al. Effects of short-term Nordic walking training on sarcopenia-related parameters in women with low bone mass: a preliminary study[J]. Clinical interventions in aging, 2016: 1763-1771.
[4] Lichtenberg T, Stengel Sv, Sieber C, et al. The Favorable Effects of a High-Intensity Resistance Training on Sarcopenia in Older Community-Dwelling Men with Osteosarcopenia: The Randomized Controlled FrOST Study. Clin Interv Aging. 2019; 14: 2173-2186.
[5] Ali S, Garcia JM. Sarcopenia, cachexia and aging: diagnosis, mechanisms and therapeutic options - a mini-review[J]. Gerontology, 2014, 60(4): 294-305.
[6] Liao Cd, Tsauo Jy, Lin Lf, et al. Effects of elastic resistance exercise on body composition and physical capacity in older women with sarcopenic obesity: A CONSORT-compliant prospective randomized controlled trial. Med. 2017; 96(23): e7115.
[7] Liu CJ, Latham NK. Progressive resistance strength training forimproving physical function in older adults[J]. Cochrane Database SystRev, 2009, 19(3): CD002759.
[8] De Mello RB, Dalla Corte RR, Gi Ocsiaj. et al. Effects of physical exercise pro-grams on sarcopenia management, dynapenia, and physical performance in the elderly: A sys-tematic review of randomized clianical trials[J]. J Aging Res, 2019, 2019:1959486.
[9] Song Peicheng, Li Yuzhang. Advances in vibration training [J]. Sports Science, 2010, 31(02): 78-82.
[10] Huang Shuo, Zhao Xiaofeng. Effects of whole body vibration training on lower limb muscle strength and mobility in elderly patients with sarcopenia [J]. Chinese rehabilitation, 2024, 39(03): 160-162.
[11] Zhu Yq, Peng N, Zhou M, et al. Tai Chi and whole-body vibrating therapy in sarcopenic men in advanced old age: a clinical randomized controlled trial.Eur J Ageing. 2019; 16(3):273-282.
[12] Lu Donglei, Feng Zhanpeng, Cao Liquan, et al.. Exercise intervention in senile muscular dystrophy [J]. Chinese tissue engineering study, 2024, 28(35): 5723-5731.
[13] Fujita S, Abe T, Drummond Mj, et al. Blood flow restriction during low-intensity resistance exercise increases S6K1 phosphorylation and muscle protein synthesis. J Appl Physiol (1985). 2007; 103(3):903-910.
[14] Pan Weimin, Wang Bing, Han Yabing, etc. Meta-analysis of the effects of blood flow restriction training on the changes of muscle strength, mass and physical ability in the elderly [J]. Chinese tissue engineering study, 2023, 27(05): 805-812.
[15] Letieri Rv, Furtado Ge, Barros Pmn, et al. Effect of 16-week blood flow restriction exercise on functional fitness in sarcopenic women: A randomized controlled trial. Int J Morphol. 2019; 37(1):59-64.
[16] Rossow Lm, Fahs Ca, Loenneke Jp, et al. Cardiovascular and perceptual responses to blood-flow-restricted resistance exercise with differing restrictive cuffs. Clin Physiol Funct Imaging. 2012; 32(5):331-337.
[17] Wernbom M, Järrebring R, Andreasson Ma, et al. Acute effects of blood flow restriction on muscle activity and endurance during fatiguing dynamic knee extensions at low load. J Strength Cond Res. 2009; 23(8): 2389-2395.
[18] Shimizu R, Hotta K, Yamamoto S, et al. Low-intensity resistance training with blood flow restriction improves vascular endothelial function and peripheral blood circulation in healthy elderly people. Eur J Appl Physiol. 2016; 116(4):749-757.
[19] Lixandrão Me, Ugrinowitsch C, Laurentino G, et al. Effects of exercise intensity and occlusion pressure after 12 weeks of resistance training with blood-flow restriction. Eur J Appl Physiol. 2015; 115(12):2471-2480.
[20] Cook SB, Cleary CJ. Progression of Blood Flow Restricted Resistance Training in Older Adults at Risk of Mobility Limitations. Front Physiol. 2019; 10:738.