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Preventing sarcopenia in older adults: the role of strength training

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Abstract

The skeletal, striated muscles constitute approximately 42% of body mass in male subjects and 36% in female subjects. The process of ageing is associated with a decline in the mass of these muscles, resulting in impaired mobility and increased difficulty in performing daily activities. This phenomenon is particularly pronounced in the elderly population as it is closely related to the development of a progressive muscle disease, known as sarcopenia. Both resistance and endurance training can serve as effective tools for reducing the likelihood of developing this disease, as well as for preventing its progression. It is essential that health and fitness professionals are aware of the therapeutic benefits of training in sarcopenia and should therefore encourage older adults to engage in physical activity.

Running title: The role of strength training in preventing sarcopenia

Keywords: elderly, endurance training, resistance training, sarcopenia, striated muscles

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Introduction

As individuals age, their muscle mass undergoes constant changes. Initially, an increase in muscle mass is observed but it is followed by a subsequent gradual decrease from the third decade of life. The extent of this loss varies depending on the initial muscle weight and physical activity of the individual. Together with physical inactivity, poor diet and chronic diseases frequently observed in elders, it leads to the onset of sarcopenia.

Sarcopenia is a progressive medical condition characterized by a systemic decline in skeletal muscle mass, function and strength that frequently occurs at an accelerated rate in older individuals. It is associated with the development of numerous complications, including osteoporosis, dyslipidaemia, increased cardiovascular risk, metabolic syndrome, and immunosuppression. Additionally, it is related to an elevated incidence of various adverse medical events, such as diminished locomotor performance, amplified morbidity and mortality [1]. The most recent diagnostic criteria for sarcopenia were published by the European Working Group on Sarcopenia in Older People (EWGSOP2). These guidelines are based on a combination of low muscle mass, reduced muscle strength, and impaired physical performance, outlining an appropriate diagnostic pathway. The first clinical step is a screening assessment conducted using the five-item sarcopenia screening questionnaire (SARC-F). In the event of a positive result, a functional assessment is performed as a second step. This is typically accomplished through the use of the five-times chair stand test or grip strength measurement. Achieving affirmative outcomes at this stage markedly increases the likelihood of a sarcopenia diagnosis. The third step comprises an imaging examination of the quantity and/or quality of skeletal muscles using either MRI or CT, as these are considered the gold standard for diagnosing this condition. The fourth and final step involves measuring the severity of sarcopenia using one of four tests: gait speed assessment, the short physical performance battery test, the "get up and go" test or the 400-meter walk test. These analyses are essential for determining the appropriate treatment intensity and evaluating the risk of adverse events related to this health impairment [2]. The phenomenon of sarcopenia primarily affects individuals aged 65 and above, with prevalence rates ranging widely from 9.25% to 18%. Furthermore, forecasts based on the Eurostat online database (covering 28 European countries) clearly indicate that by 2045, the number of individuals affected by sarcopenia in Europe will dramatically increase, making the consequences of this disease a substantial public health concern [3]. A variety of factors have been identified as contributing to the elevated risk of developing sarcopenia. These include: age, marital status (single, divorced, or widowed), disability in activities of daily living, weight deficiency, smoking, lack of physical activity, malnutrition or risk of malnutrition, long or short periods of sleep, living alone, diabetes, cognitive impairment, heart disease, respiratory diseases, osteopenia/osteoporosis, osteoarthritis, depression, falls, anorexia, and anaemia [4]. It is essential to highlight that sarcopenia significantly affects an individual's health and overall well-being, as it is associated with an increased risk of falls, loss of independence and deterioration in quality of life [2,5].

In this article, we aim to provide comprehensive information on sarcopenia, focusing primarily on its risk factors and training strategies that can reduce the likelihood of developing this condition as well as prevent its progression.

Muscle structure changes in the ageing process

Skeletal muscles (**Fig. 1**) are of paramount importance to the proper functioning of the human body. These muscles perform a variety of functions, including but not limited to generating force, maintaining posture, and regulating movement [6]. Notably, the proportion of body weight accounted for by skeletal, transversely striated muscles is reported to be 42% in male subjects and approximately 36% in female subjects [7]. It is evident that muscle tissue is closely connected to the nervous system. The nervous system exerts a significant influence on the activation and adaptation of muscle tissue in response to fluctuating physiological conditions [8]. It has been indicated that people over 60 years of age may experience a loss of up to 50% of alpha motor neurons, thereby reducing the number of motor units, negatively affecting motor coordination and also impairing the regenerative capacity of muscle fibres [9]. The proper functioning of muscles depends upon several factors: anabolism, the equilibrium between protein synthesis and degradation, and a sufficient blood supply.

Recent years have been marked by an ageing population, a phenomenon that is projected to worsen in the coming years. According to the World Health Organization, the global population of individuals aged 65 and over is currently estimated at 830 million [10]. As a result of aging a number of physiological changes occur, including a gradual loss of muscle mass, a decrease in metabolic rate, a reduction in biosynthesis and mitochondrial function, and a concurrent increase in protein catabolism [11]. These processes have been associated with a more rapid loss of muscle mass parameters, particularly in skeletal muscles, therefore contributing to the development of sarcopenia [12]. A separate analysis of the studies by Fuchs CJ et al., Ham DW et al. and Mizuno T et al., revealed that the most significant changes occur in the muscles of the thigh and gluteal region [13–15]. Of particular significance is

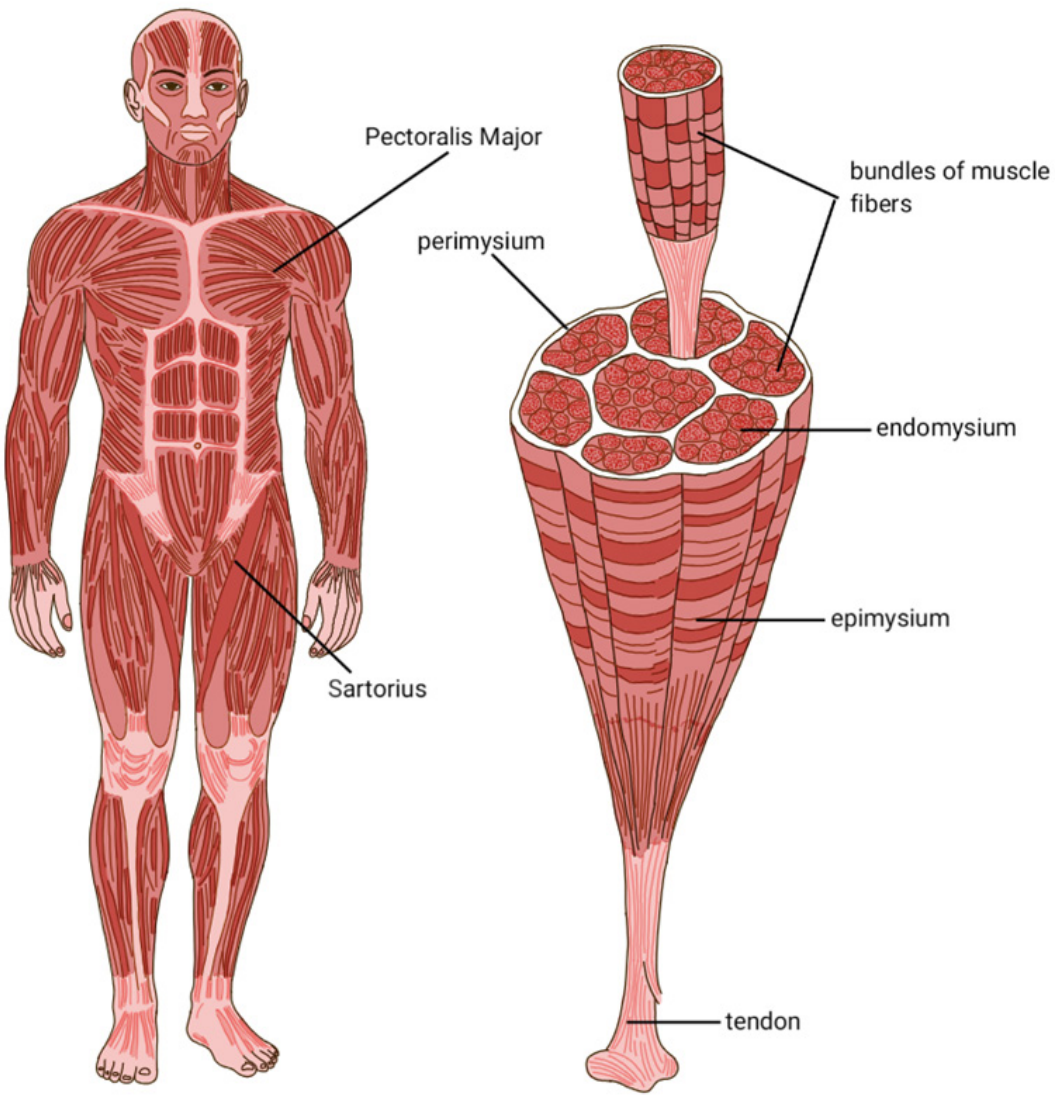

FIGURE 1 The structure of the normal human musculoskeletal system. Anatomical illustration showing the arrangement of skeletal muscles and bones in a healthy individual

the decline in type II muscle fibres, also known as fast twitch muscle fibres, which are responsible for short, strong contractions. Their weakness has been associated with an increased risk of falls, as well as with difficulties in performing basic activities, such as rising from a seated position and maintaining balance, that can potentially lead to immobility [16,17]. Atrophy of this type of muscle fibre has been demonstrated to contribute to a slower reaction time and a reduced ability for dynamic movements. Furthermore, sarcopenia is accompanied by a decline in satellite cells, a group of skeletal muscle stem cells, that play a pivotal role in the growth and regeneration of damaged muscle fibres [18]. In addition, ageing has been associated with an increase in the proportion of type I fibres (slow-contractile), which are responsible for endurance activities. This phenomenon is caused by the trophic effect of the motor nerve on the muscle fibres, resulting in a decreased ability to generate force [12,19].

The aforementioned changes in muscle structure and function, occurring in the course of sarcopenia, have a negative effect on the independence of elderly individuals, thereby reducing their quality of life. It is important that anatomists specializing in the human muscular system are aware of these facts, as they allow not only a comprehensive understanding of the progression of sarcopenia, but also the development of more efficacious rehabilitation and prevention strategies for this condition.

The sarcopenia basics

The aetiology of sarcopenia may be related to natural mechanisms occurring as a consequence of the aging process itself or may be associated with the presence of other disease states, particularly those involving severe systemic inflammation. In light of this, a distinction is made between primary sarcopenia, characterized by a lack of identified causes, and secondary sarcopenia, which arises from a variety of known factors, including chronic disease, hormonal deficiency, malnutrition, lack of physical activity and the use of certain medications [2]. In its recommendations, the EWGSOP2 places particular emphasis on the importance of low muscle strength as the defining characteristic and key feature for the diagnosis of sarcopenia. The decline in muscle strength is observed from the age of 30 onwards. Therefore, thresholds have been established at which this decline is considered to be clinically significant. For men it equates to a grip strength of less than 26 kg, while for women it is less than 16 kg [20]. As individuals age, there is a notable decline in physical activity and a concomitant reduction in protein intake. This, in combination with hormonal changes, including a decrease in the secretion of growth hormone, testosterone, thyroid hormones and insulin-like growth factor 1 (IGF-1), leads to an imbalance between anabolic and catabolic processes. Catabolic processes begin to dominate over anabolic ones, resulting in a loss of muscle mass and strength [21].

It is noteworthy that physical exercise has been observed to stimulate an increase in IGF-1, thereby promoting muscle growth through its positive impact on protein synthesis. Furthermore, physical activity has been shown to suppress the secretion of pro-inflammatory cytokines, which are known to be responsible for protein degradation and mitochondrial turnover. Moreover, individuals diagnosed with sarcopenia have exhibited an elevated concentration of reactive oxygen species that exert a detrimental effect on cells. These molecules originate from the mitochondria of cells that have undergone apoptosis [22]. The positive impact of activity on protein synthesis has prompted numerous studies to investigate the effect of resistance training on muscle growth and strength. The findings indicate that this approach can effectively promote muscle development and enhance strength, suggesting it as a promising strategy for both the prevention and treatment of sarcopenia [23].

Latest recommendations and training strategies for the prevention of sarcopenia

The fundamental methods of treating sarcopenia encompass exercise, appropriate physiotherapy and the implementation of a well-balanced diet. It should be noted that these strategies are only capable of preventing the progression of sarcopenia and alleviating its symptoms. In this article, we will focus on two types of exercise, namely endurance training (ET) and resistance training (RT).

ET such as walking, jogging, swimming, cycling, has been shown to be effective for preserving muscle mass and reducing the risk of developing sarcopenia among middle-aged and elderly individuals [24]. It is worth noting that ET has been demonstrated to enhance cardiovascular function and oxygen efficiency, as well as cellular respiration (mitochondrial functions). Despite the fact that ET has been shown to exert a lesser effect on overall strength and muscle mass, it has been proven to increase the cross-sectional area of muscle fibres [25,26]. In addition to the above, ET is also responsible for mitigating the effects of aging, including low-grade inflammation, reduced oxygen efficiency, and changes in connective tissue (vascular stiffness and fibrosis) [25].

RT, otherwise known as strength training, involves working the entire skeleton and muscles of the body by overcoming external resistance. RT is responsible for increasing the recruitment of satellite cells, leading to muscle hypertrophy. The benefits of these exercises are numerous and encompass improved bone mineral density, decreased haemoglobin A1c (particularly beneficial for individuals with diabetes), reduced inflammation and even potential improvements in cognitive function [20,27]. Zhao H et al., conducted a meta-analysis comprising 13 randomized controlled trials with the objective of comparing the effects of RT with kettlebell or rubber band training on grip strength, gait speed and skeletal muscle index in patients with sarcopenia. The authors of this research demonstrated that the respective training for the elderly is highly effective in enhancing muscle mass and quality, resulting in improved gait speed, static and dynamic balance, and thus reducing the risk of falls. Additionally, the researchers suggested that moderate-intensity RT involving elastic bands, performed over a 12-week period, three times a week for 40-60 minutes, may be the best training approach for older people [28]. Furthermore, a meta-analysis carried out by Chen N et al. indicated that RT has an effect on decreasing body fat mass in addition to the benefits previously discussed [29]. The efficacy of training in improving strength and muscle hypertrophy depends on the duration, frequency and intensity of the training regimen. However, it should be noted that this process may be impeded in older adults due to the diminished adaptability of muscle fibres [25]. As demonstrated by Carneiro MAS et al., the use of RT in acutely hospitalized patients can be an effective method of achieving improved muscle strength in both the upper and lower extremities, while also aiding in the mitigation and/or prevention of muscle loss [30]. In order to investigate the effect of RT on patients with sarcopenia, Hassan BH et al. conducted a study involving 42 nursing care residents aged 85.9 ± 7.5 years. The participants were randomly assigned to two groups: 20 individuals underwent scheduled exercise, whereas 21 constituted the control group that did not engage in any exercise. The researchers observed that the exercise group exhibited a notable enhancement in grip strength compared to the control group. Furthermore, they suggested that RT improves neural and metabolic muscle fitness thereby reducing disability and the severity of sarcopenia [31].

The current guidelines recommend combining both types of exercise due to their efficacy in improving neuromuscular and cardiovascular function, as well as functional abilities [20]. The frequency and intensity of RT and ET sessions can be gradually increased and modified as progress is made, allowing for adaptation of the training to the growing abilities and needs of the exerciser [32]. To optimize gains in strength and muscle mass gains in older individuals, it is recommended that they engage in exercise at a frequency of 2-3 times per week. Training sessions should consist of 2-3 sets, each with a range of 6-12 repetitions with a load equal to 50-80% of one repetition maximum (1RM) per muscle group. Over the course of the training cycle, the weight should be progressively increased until it reaches 70-85% of the 1RM in order to maximize strength gains [20]. Individuals with no prior experience with exercise or those who are physically weak should initially engage in balance, flexibility and coordination exercises, subsequently advancing to RT and strength training. The incorporation of balance training in this context has been observed to improve muscle strength and alignment, which may explain why addition of balance training to RT seems to provide greater benefits than RT alone [33]. The study by Qi M et al., examined the impact of integrating Tai Chi, classified as ET, with RT in adults aged 50 years and above. Participants engaged in a training regimen comprising 2 to 7,5 hours per week over a period of 12 weeks to 12 months. The study showed significant improvements in limb muscle strength, oxygen endurance, balance and mobility [34].

In summary, all forms of exercise have the potential to enhance physical functioning and reduce the incidence of falls and associated fractures in older adults, which can subsequently decrease healthcare costs. Therefore, it is crucial to investigate the most effective methods for encouraging physical activity and exercise among those at elevated risk of developing sarcopenia.

Conclusions

Muscle mass is an important factor in predicting the quality and rapidity of ageing. Furthermore, the loss of muscle mass has been demonstrated to be a reliable indicator of the onset of sarcopenia in subsequent years. Sarcopenia is set to affect an increasing number of patients in the coming years, representing a significant public health concern. It is therefore vital to gain an understanding of the factors that can help to protect against it. As has been previously outlined, both RT and ET are fundamental in preventing the progression of this disease and alleviating its symptoms. It has been demonstrated that ET is effective in preventing muscle loss and reducing the risk of developing sarcopenia in middle-aged and elderly individuals. This is achieved by influencing a number of mechanisms, including cardiovascular function, aerobic capacity, increasing the cross-sectional area of muscle fibres, improving mitochondrial metabolism, skeletal muscle oxidative capacity, protecting neuromuscular junctions, and reducing inflammation. The positive effects of RT are manifold and include augmented bone mineral density, diminished abdominal and visceral adipose tissue, a reduction in haemoglobin A1c, the reduction of inflammatory processes and an enhancement in cognitive performance. Moreover, research has shown that RT and ET can improve walking speed, static and dynamic balance, and reduce the risk of falls. It is also noteworthy that the stimulation of IGF-1 by exercise has been demonstrated to facilitate muscle growth as a consequence of its favourable impact on protein synthesis. In conclusion, maintaining an optimal physical condition is pivotal in both halting the advancement of the disease and alleviating its impact, while also minimizing the likelihood of falls, which represent a significant challenge for healthcare systems, particularly in the elderly.

Ethical approval

The conducted research is not related to either human or animal use.

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Not applicable.

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Conflict of interest

The authors declare they have no conflict of interest.

References

1. Tournadre A, Vial G, Capel F, Soubrier M, Boirie Y. Sarcopenia. Joint Bone Spine. 2019;86(3):309–14; DOI:10.1016/j.jbspin.2018.08.001.
2. Cruz-Jentoft AJ, Bahat G, Bauer J, Boirie Y, Bruyère O, Cederholm T, Cooper C, Landi F, Rolland Y, Sayer AA, Schneider SM, Sieber CC, Topinkova E, Vandewoude M, Visser M, Zamboni M, Bautmans I, Baeyens JP, Cesari M, Cherubini A, Kanis J, Maggio M, Martin F, Michel JP, Pitkala K, Reginster JY, Rizzoli R, Sánchez-Rodríguez D, Schols J. Sarcopenia: revised European consensus on definition and diagnosis. Age Ageing. 2019;48(1):16–31; DOI:10.1093/ageing/afy169.
3. Ethgen O, Beaudart C, Buckinx F, Bruyère O, Reginster JY. The future prevalence of sarcopenia in Europe: a claim for public health action. Calcif Tissue Int. 2017;100(3):229–34; DOI:10.1007/s00223-016-0220-9.
4. Gao Q, Hu K, Yan C, Zhao B, Mei F, Chen F, Zhao L, Shang Y, Ma Y, Ma B. Associated factors of sarcopenia in community – dwelling older adults: a systematic review and meta-analysis. Nutrients. 2021;13(12):4291; DOI:10.3390/nu13124291.
5. Xu J, Wan CS, Ktoris K, Reijnierse EM, Maier AB. Sarcopenia is associated with mortality in adults: a systematic review and meta-analysis. Gerontology. 2022;68(4):361–76; DOI:10.1159/000517099.
6. Noto RE, Leavitt L, Edens MA. Physiology, muscle [Internet]. Treasure Island (FL): StatPearls Publishing; 2023 [cited 2025 Sep 05]. 7 p. Available from: https://www.ncbi.nlm.nih.gov/books/NBK532258/.
7. Marieb EN, Hoehn K. Human anatomy & physiology. Vol. 1. 7th ed. San Francisco: Pearson Benjamin Cummings; 2007. 317 p.
8. Omar A, Marwaha K, Bollu PC. Physiology, neuromuscular junction. [Internet]. Treasure Island (FL): StatPearls Publishing; 2025 [cited 2025 Sep 05]. 17 p. Available from: https://www.ncbi.nlm.nih.gov/books/NBK470413/.
9. Piekarz KM, Georgescu C, Wren JD, Towner RA, Van Remmen H. Pharmacologic treatment with OKN-007 reduces alpha-motor neuron

loss in spinal cord of aging mice. Geroscience. 2022;44(1):67–81; DOI:10.1007/s11357-021-00506-y.

10. Simon van Teutem. The global number of people aged 65 years and older is set to double within the next thirty years [Internet]. Oxford: Global Change Data Lab; 2024 [cited 2025 Apr 11]. Available from: https://ourworldindata.org/data-insights/by-2060-the-number-of-people-aged-65-and-older-will-be-more-than-four-times-what-it-was-in-2000.
11. Wu J, Ding P, Wu H, Yang P, Guo H, Tian Y, Meng L, Zhao Q. Sarcopenia: molecular regulatory network for loss of muscle mass and function. Front Nutr. 2023;10; DOI:10.3389/fnut.2023.1037200.
12. Yin L, Li N, Jia W, Wang N, Liang M, Yang X, Du G. Skeletal muscle atrophy: From mechanisms to treatments. Pharmacol Res. 2021;172:105807; DOI:10.1016/j.phrs.2021.105807.
13. Fuchs CJ, Kuipers R, Rombouts JA, Brouwers K, Schrauwen-Hinderling VB, Wildberger JE, Verdijk LB, van Loon LJC. Thigh muscles are more susceptible to age-related muscle loss when compared to lower leg and pelvic muscles. Exp Gerontol. 2023;175:112159; DOI:10.1016/j.exger.2023.112159.
14. Ham DW, Lee J, Choi G, Kwon BT, Song KS. The cross-sectional area of gluteal muscle on multiaxial CT scan as a predictor for diagnosing sarcopenia in patients with degenerative lumbar disease. Eur Spine J. 2024;33(10):3857–64; DOI:10.1007/s00586-024-08452-x.
15. Mizuno T, Matsui Y, Tomida M, Suzuki Y, Ishizuka S, Watanabe T, Takemura M, Nishita Y, Tange C, Shimokata H, Imagama S, Otsuka R, Arai H. Relationship between quadriceps muscle computed tomography measurement and motor function, muscle mass, and sarcopenia diagnosis. Front Endocrinol (Lausanne). 2023;14; DOI:10.3389/fendo.2023.1259350.
16. Herbison GJ, Jaweed MM, Ditunno JF. Muscle fiber types. Arch Phys Med Rehabil. 1982;63(5):227–30.
17. Wiedmer P, Jung T, Castro JP, Pomatto LCD, Sun PY, Davies KJA, Grune T. Sarcopenia – molecular mechanisms and open questions. Ageing Res Rev. 2021;65:101200; DOI:10.1016/j.arr.2020.101200.
18. Alway SE, Myers MJ, Mohamed JS. Regulation of satellite cell function in sarcopenia. Front Aging Neurosci. 2014;6; DOI:10.3389/fnagi.2014.00246.
19. Siparsky PN, Kirkendall DT, Garrett WE Jr. Muscle changes in aging: understanding sarcopenia. Sports Health. 2014;6(1):36-40; DOI:10.1177/1941738113502296.
20. Fragala MS, Cadore EL, Dorgo S, Izquierdo M, Kraemer WJ, Peterson MD, Ryan ED. Resistance training for older adults: position statement from the national strength and conditioning association. J Strength Cond Res. 2019;33(8):2019–52; DOI:10.1519/JSC.0000000000003230.
21. Papadopoulou S. Sarcopenia: A contemporary health problem among older adult populations. Nutrients. 2020;12(5):1293; DOI:10.3390/nu12051293.
22. Bowen TS, Schuler G, Adams V. Skeletal muscle wasting in cachexia and sarcopenia: molecular pathophysiology and impact of exercise training. J Cachexia Sarcopenia Muscle. 2015;6(3):197–207; DOI:10.1002/jcsm.12043.
23. Morley JE. Frailty and sarcopenia in elderly. Wien Klin Wochenschr. 2016;128(S7):439–45; DOI:10.1007/s00508-016-1087-5.
24. Kim SH, Kim TH, Hwang HJ. The relationship of physical activity (PA) and walking with sarcopenia in Korean males aged 60 years and older using the Fourth Korean National Health and Nutrition Examination Survey (KNHANES IV-2, 3), 2008–2009. Arch Gerontol Geriatr. 2013;56(3):472–7; DOI:10.1016/j.archger.2012.12.009.
25. 25. Gustafsson T, Ulfhake B. Aging skeletal muscles: what are the mechanisms of age-related loss of strength and muscle mass, and can we impede its development and progression? Int J Mol Sci. 2024;25(20):10932; DOI:10.3390/ijms252010932.
26. Short KR, Vittone JL, Bigelow ML, Proctor DN, Nair KS. Age and aerobic exercise training effects on whole body and muscle protein metabolism. Am J Physiol Endocrinol Metab. 2004;286(1):E92–101; DOI:10.1152/ajpendo.00366.2003.
27. Damanti S, Senini E, De Lorenzo R, Merolla A, Santoro S, Festorazzi C, Messina M, Vitali G, Sciorati C, Rovere-Querini P. Acute sarcopenia: mechanisms and management. Nutrients. 2024;16(20):3428; DOI:10.3390/nu16203428.
28. Zhao H, Cheng R, Song G, Teng J, Shen S, Fu X, Yan Y, Liu C. The effect of resistance training on the rehabilitation of elderly patients with sarcopenia: a meta-analysis. Int J Environ Res Public Health. 2022;19(23):15491; DOI:10.3390/ijerph192315491.
29. Chen N, He X, Feng Y, Ainsworth BE, Liu Y. Effects of resistance training in healthy older people with sarcopenia: a systematic review and meta-analysis of randomized controlled trials. Eur Rev Aging Phys Act. 2021;18(1):23; DOI:10.1186/s11556-021-00277-7.
30. Carneiro MAS, Franco CMC, Silva AL, Castro-e-Souza P, Kunevaliki G, Izquierdo M, Cyrino ES, Padilha CS. Resistance exercise intervention on muscular strength and power, and functional capacity in acute hospitalized older adults: a systematic review and meta-analysis of 2498 patients in 7 randomized clinical trials. Geroscience. 2021;43(6):2693–705; DOI:10.1007/s11357-021-00446-7.
31. Hassan BH, Hewitt J, Keogh JWL, Bermeo S, Duque G, Henwood TR. Impact of resistance training on sarcopenia in nursing care facilities: a pilot study. Geriatr Nurs (Minneap). 2016;37(2):116–21; DOI:10.1016/j.gerinurse.2015.11.001.
32. Veen J, Montiel-Rojas D, Nilsson A, Kadi F. Engagement in muscle-strengthening activities lowers sarcopenia risk in older adults already adhering to the aerobic physical activity guidelines. Int J Environ Res Public Health. 2021;18(3):989; DOI:10.3390/ijerph18030989.
33. Shen Y, Shi Q, Nong K, Li S, Yue J, Huang J, Dong B, Beauchamp M, Hao Q. Exercise for sarcopenia in older people: a systematic review and network meta-analysis. J Cachexia Sarcopenia Muscle. 2023;14(3):1199–211; DOI:10.1002/jcsm.13225.
34. Qi M, Moyle W, Jones C, Weeks B. Tai Chi Combined with resistance training for adults aged 50 years and older: a systematic review. J Geriatr Phys Ther. 2020;43(1):32–41; DOI:10.1519/JPT.0000000000000218.