



## EXERCISE-BASED STRATEGIES FOR THE MANAGEMENT AND PREVENTION OF SARCOPENIA IN OLDER ADULTS: A REVIEW

Ibrahim Karaca<sup>i</sup>

Independent Researcher

[orcid.org/0000-0002-4767-4219](https://orcid.org/0000-0002-4767-4219)

### Abstract:

Sarcopenia, characterized by the decline in muscle mass and function that occurs with aging, is a significant clinical condition that threatens independent living in older adults. It leads to reduced physical capacity, greater risk of falls, and deterioration in quality of life, creating a considerable burden on healthcare systems. The purpose of this review is to examine comprehensively the role of current exercise modalities in the management of sarcopenia, in light of its pathophysiology and epidemiological characteristics. Progressive resistance training, power-oriented exercises, low load blood flow restriction training, combined programs, and multicomponent approaches are evaluated in terms of their physiological effects and implementation parameters. The findings indicate that exercise is a central intervention for addressing sarcopenia, particularly when it is applied as a multidisciplinary, individualized, and sustainable strategy.

**Keywords:** sarcopenia; resistance training; exercise therapy; aging

### 1. Introduction

Sarcopenia is a progressive disorder of the musculoskeletal system that develops in association with the aging process and is characterized by declines in muscle strength, muscle mass, and physical performance. According to the updated definition of the European Working Group on Sarcopenia in Older People (EWGSOP2), the primary criterion for diagnosis is reduced muscle strength; accompanying loss of muscle mass and/or diminished physical performance are considered secondary diagnostic indicators (Cruz-Jentoft *et al.*, 2019). Functional assessments such as handgrip strength and gait speed are regarded as key parameters during clinical evaluation.

The physiological basis of sarcopenia is multifactorial and reflects systemic changes that occur with advancing age. Decreased levels of hormones such as testosterone and IGF-1, degeneration of motor neurons, mitochondrial dysfunction, chronic inflammation involving mediators such as IL-6 and TNF- $\alpha$ , and oxidative stress

---

<sup>i</sup> Correspondence: email [fzt.ibrahimkaraca@gmail.com](mailto:fzt.ibrahimkaraca@gmail.com)

contribute to the disruption of muscle protein balance and lead to atrophy of muscle fibers (Wilkinson *et al.*, 2021). Environmental factors including a sedentary lifestyle and insufficient protein intake further accelerate these biological processes, promoting the development of sarcopenia (Park and Lee, 2023).

From an epidemiological perspective, sarcopenia has a high prevalence in older age groups. For example, among individuals aged 80 years and above, the prevalence exceeds 30 percent (Zhang *et al.*, 2022). Its clinical consequences include increased incidence of falls and fractures, greater rates of hospitalization, higher demand for long-term care, and elevated mortality risk (Papadopoulou *et al.*, 2020). In addition, sarcopenia has psychosocial effects such as loss of functional independence, social isolation, and reduced quality of life (Wu *et al.*, 2025).

## 2. Pathophysiology of Sarcopenia and the Role of Exercise

Sarcopenia is a multifactorial syndrome that develops through the interaction of physiological, molecular, and environmental factors associated with aging. Key mechanisms in its pathogenesis include disruption of muscle protein balance, reduced activity of anabolic signaling pathways such as IGF-1 and testosterone, chronic inflammation marked by increased IL-6 and TNF- $\alpha$  levels, and oxidative stress (Tieland *et al.*, 2018; Wilkinson *et al.*, 2021). Loss of motor neurons also contributes by preventing the reinnervation of muscle fibers, resulting in both structural and functional muscle loss. These biological changes lead to reduced muscle fiber diameter, a higher threshold for response to stimuli, and diminished contractile capacity (Ogawa *et al.*, 2024).

In contrast to these degenerative processes, exercise emerges as a potent intervention that initiates physiological repair and adaptation. Resistance training in particular stimulates muscle protein synthesis, thereby activating anabolic processes. This adaptation is mediated through molecular pathways such as mTOR and PGC-1 $\alpha$ , supporting both the preservation and regeneration of muscle mass (Landi *et al.*, 2023). Recent studies indicate that the molecular responses of muscle tissue to exercise are modulated by age, with the PGC-1 $\alpha$  pathway showing weaker activation in individuals with sarcopenia despite exercise stimulation (Korean Working Group on Sarcopenia, 2023). Power and balance training also enhance neuromuscular coordination, strengthening nerve–muscle interactions that reduce the risk of falls. These effects contribute both to prevention and to slowing the progression of sarcopenia.

Exercise further benefits muscle function through metabolic and vascular mechanisms. Regular physical activity promotes mitochondrial biogenesis and oxidative capacity, improves glucose metabolism, and increases insulin sensitivity (Dent *et al.*, 2023). Suppression of intramuscular inflammatory responses and preservation of vascular integrity also support the regenerative capacity of muscle tissue. Taken together, these multidimensional benefits make exercise a more comprehensive and effective approach than the isolated effects of pharmacological agents (Lee *et al.*, 2024).

### 3. Exercise Models: Theoretical Basis and Implementation Parameters

#### 3.1 Progressive Resistance Training (PRT)

Progressive resistance training is considered the most effective exercise model for counteracting the loss of muscle mass and strength associated with aging. This approach involves applying gradually increasing resistance to muscles in order to maximize mechanical loading and stimulate the anabolic response. The physiological basis of PRT lies in the activation of mTOR signaling pathways through mechanotransduction in muscle fibers, which leads to increased protein synthesis. This process promotes muscle hypertrophy and neuromuscular adaptations, thereby improving functional performance in older adults (Valenzuela *et al.*, 2021; Park and Lee, 2023).

In clinical practice, PRT is generally recommended two to three times per week, at an intensity of 60 to 80 percent of one repetition maximum (1RM), with 8 to 12 repetitions for two to three sets. Selecting multi-joint exercises that target major joints such as the hip, knee, and ankle enhances functional transfer. Due to its favorable safety profile, this protocol can be adapted for older adults at beginner levels and applied in both home and clinical settings (Lee *et al.*, 2024).

Randomized controlled trials have demonstrated that 12 weeks of PRT can lead to significant improvements in gait speed, the five-times sit-to-stand test, and Short Physical Performance Battery (SPPB) scores (Landi *et al.*, 2023). In addition, the literature reports that PRT has positive effects on depressive symptoms, cognitive function, and sleep quality. These multidimensional benefits make PRT one of the primary interventions in the clinical management of sarcopenia.

#### 3.2 Power Training

Power training aims to develop the ability of muscles to produce maximum force in the shortest possible time and is essential for preserving functional reserve in older adults. Because muscle power declines earlier with age than maximal strength, programs that target not only hypertrophy but also speed-related neuromuscular adaptations are recommended (Fragala *et al.*, 2019). This type of training activates fast-twitch type II muscle fibers, which helps reduce the risk of falls and improves mobility (Geraedts *et al.*, 2023).

Power training typically involves concentric muscle contractions performed at high speed with low loads, usually 30 to 60 percent of one repetition maximum (1RM). Exercises often include explosive movements such as step-ups, fast squats, and repeated sit-to-stand actions. These sessions can be integrated into the weekly program one or two times per week and have been shown to improve balance, reaction time, and gait speed in older adults (Izquierdo *et al.*, 2021). Recent research suggests that power training may have superior effects compared to progressive resistance training in outcomes such as muscle power, quickness, and walking speed (Ramírez-Vélez *et al.*, 2023).

Comparative studies further indicate that power training produces greater improvements in mobility and balance than progressive resistance training. For

individuals with low muscle power and slow walking speed, introducing power-based exercises at an early stage is important for preventing functional decline. Consequently, for older adults at risk of falls, it is advisable to include power training either in conjunction with or prior to progressive resistance training (Chen *et al.*, 2023).

### **3.3 Blood Flow Restriction (BFR) Training**

Blood flow restriction exercise is an innovative approach that can promote muscle hypertrophy and strength gains even at low loads. The protocol involves applying elastic cuffs to the proximal portion of a limb to partially restrict venous return. This restriction increases metabolite accumulation and reduces intramuscular oxygen levels, creating localized muscle stress and enabling high levels of muscle activation despite the use of low loads (Centner *et al.*, 2021).

BFR training is typically performed with resistance set at 20 to 30 percent of one repetition maximum (1RM), following a four-set structure of 30, 15, 15, and 15 repetitions. This method is particularly advantageous for frail older adults and for individuals with conditions such as osteoarthritis or coexisting cardiac disease, where heavy load lifting is contraindicated. Recent randomized controlled trials have reported significant improvements in muscle cross-sectional area, gait speed, balance, and functional performance following BFR exercise (Zhang *et al.*, 2024).

However, certain risk factors must be carefully considered before initiating this protocol. Contraindications include cardiovascular disease, coagulopathy, a history of deep vein thrombosis, and uncontrolled hypertension. For appropriate individuals, BFR offers a valuable alternative in clinical settings, as it enables effective muscle activation with low mechanical loads and can improve exercise tolerance.

### **3.4 Combined (Resistance and Aerobic) Programs**

Combined exercise programs are comprehensive approaches designed to improve muscle strength and cardiorespiratory endurance simultaneously in older adults. Adding aerobic exercise to resistance training creates a synergistic effect that supports muscle hypertrophy, strength gains, cardiovascular health, and metabolic regulation, making this combination particularly valuable in the management of sarcopenia (Carcelén Fraile *et al.*, 2023).

In a randomized controlled trial conducted by Liu *et al.* (2024), a 12-week home-based program combining resistance and aerobic training for community-dwelling individuals with sarcopenia led to significant improvements in physical performance measures, including knee extensor muscle strength and six-minute walking distance. These findings highlight the clinical and practical benefits of combined exercise for enhancing functional capacity.

A large-scale epidemiological study also found that individuals meeting both aerobic and resistance exercise recommendations demonstrated the highest preservation of handgrip strength compared to those adhering to only one exercise type. This suggests

that combined training offers a protective effect on physical functions that are more sensitive to decline (Sung *et al.*, 2022).

### 3.5 Multicomponent Exercise Approaches

Multicomponent exercise programs integrate resistance, balance, agility, flexibility, and aerobic elements to simultaneously reduce the risk of falls and enhance overall functional capacity in older adults. These approaches promote concurrent positive adaptations in neuromuscular and cardiometabolic systems, playing a key role in maintaining functional independence (Sánchez-Sánchez *et al.*, 2023).

For example, in a randomized controlled trial conducted by Makizako *et al.* (2020), a 12-week home-based multicomponent program consisting of resistance, balance, flexibility, and aerobic exercises led to significant improvements in chair stand performance and Timed Up and Go (TUG) test results. Although no statistically significant change was observed in muscle mass, the program had a clear positive impact on physical function.

## 4. Implementation Parameters and Clinical Adaptations

An exercise prescription should be carefully individualized according to the person's clinical condition, functional capacity, age related limitations, and level of motivation. The FITT VP model recommended by the American College of Sports Medicine, which includes frequency, intensity, time, type, volume, and progression, serves as the foundation for this process (Baptista *et al.*, 2024). The model suggests starting older adults who are new to exercise at 40 to 50 percent of one repetition maximum (1RM) and gradually increasing the load as tolerated.

Exercise programs should begin under the supervision of a physiotherapist, followed by a gradual transition to home-based individual routines. During this adaptation phase, technological solutions such as mobile applications and tele-rehabilitation systems can be valuable for remote monitoring, feedback, and adherence (He *et al.*, 2024). Incorporating social support and behavioral strategies further enhances long term commitment to exercise.

When evaluating the effects of exercise, it is important to consider not only physical performance but also quality of life, mental health, and the ability to perform activities of daily living. Sustainability and personal relevance of the program should be reinforced through regular feedback sessions, goal setting, and progress tracking strategies. This comprehensive approach optimizes the intervention and strengthens participant motivation.

## 5. Safety, Screening, and Monitoring

In prescribing exercise, safety should be given as much priority as effectiveness. In individuals with sarcopenia, comorbidities such as hypertension, cardiac rhythm

disorders, osteoporosis, and metabolic diseases are common. For this reason, a thorough pre-exercise evaluation is necessary. The clinical assessment should include medical history, medication use, physical activity level, balance status, and cardiovascular risk factors (Damluji *et al.*, 2023; Lin *et al.*, 2024).

Functional assessment tests play an important role in both diagnosis and follow-up. Handgrip strength, gait speed, the five times sit to stand (5×STS) test, and the Short Physical Performance Battery (SPPB) are widely used to objectively evaluate an individual's physical capacity (Lin *et al.*, 2024). The 5×STS test is also a safe and valid measure of lower limb strength, balance, and fall risk (de Melo *et al.*, 2023).

During exercise, parameters such as heart rate, blood pressure, and perceived exertion (RPE) should be regularly monitored. Symptoms such as dizziness, chest pain, or shortness of breath after exercise should be regarded as warning signs. Before implementing specific protocols, such as blood flow restriction training, contraindications, including thromboembolism, coagulation disorders, and uncontrolled hypertension, should be clearly identified (de Melo *et al.*, 2023; Toro Román *et al.*, 2024). In addition, regular assessment of psychosocial parameters such as exercise adherence, quality of life, and sleep patterns can enhance the overall effectiveness of the intervention.

## 6. Future Perspectives and Recommendations

In the fight against sarcopenia, accessibility and sustainability of exercise-based approaches are becoming as critical as their effectiveness. In this context, the development of community-based exercise programs is among the most strategic steps. Group exercise sessions organized through local resources, such as municipalities or senior centers, can increase participation in physical activity while also promoting social interaction (Sepúlveda Loyola *et al.*, 2025).

Digital health technologies make home-based exercise programs more accessible and trackable. Mobile applications, tele-physiotherapy systems, and wearable devices allow real-time sharing of exercise data with health professionals, enabling personalized interventions. For example, the PF Life mobile health program demonstrated high adherence, usability, and safety in pre-frail older adults and resulted in significant improvements in physical functions such as the Timed Up and Go (TUG) test and handgrip strength (Li *et al.*, 2024).

Looking ahead, it will be important to investigate not only the physical but also the cognitive, psychological, and social effects of exercise through multicenter studies. Multidisciplinary approaches yield stronger outcomes, with teams consisting of physiotherapists, geriatricians, nutrition specialists, and psychologists delivering comprehensive interventions at both clinical and community levels (Park *et al.*, 2023). Strategies that account for cultural, socioeconomic, and individual differences will enhance the reach and sustainability of these interventions within the broader population.

## 7. Conclusion

This review has provided a comprehensive overview of the scientific evidence and practical strategies for exercise-based interventions in the prevention and management of sarcopenia. Strong evidence in the literature demonstrates that progressive resistance training has a clear effect on increasing muscle mass and strength, while power-focused training plays a critical role in maintaining functional independence and reducing the risk of falls. Low-load blood flow restriction exercise offers an effective option for individuals who are frail or have painful joint conditions, whereas multicomponent programs stand out for their benefits in improving overall physical performance and quality of life.

The success of exercise programs depends not only on accurate prescription but also on individualized dosing, ensuring safety, and adopting a multidisciplinary approach. Regular use of functional assessment tests allows the effectiveness of exercise programs to be monitored. Similarly, monitoring strategies supported by telehealth systems and digital tools are important elements for enhancing long-term adherence and participation.

Looking ahead, personalized exercise prescriptions, artificial intelligence-assisted health technologies, and community-based initiatives will be at the forefront of combating sarcopenia. Promoting evidence-based, accessible, and sustainable exercise strategies should be considered a priority in health policy to enable older adults to maintain an active and independent life.

## Acknowledgements

The authors declare that there is no funding and no acknowledgements for this review.

## About the Author

Dr. İbrahim Karaca, PT, specializes in musculoskeletal rehabilitation, geriatric exercise programs, and the integration of emerging technologies in physiotherapy practice. He has authored and co-authored several research articles and reviews published in national and international peer-reviewed journals. He is a member of the Turkish Physiotherapy Association.

## References

- American College of Sports Medicine. (2021). *ACSM's guidelines for exercise testing and prescription* (11th ed.). Wolters Kluwer.
- Baptista, F. M., Andias, R., Rocha, N. P., & Silva, A. G. (2024). A practice guide for physical therapists prescribing physical exercise for older adults. *Journal of Aging and Physical Activity*, 32(6), 771–783. <https://doi.org/10.1123/japa.2023-0283>

- Beaudart, C., Sanchez-Rodriguez, D., Locquet, M., Reginster, J. Y., & Bruyère, O. (2022). Diagnostic tools for sarcopenia: An update and review of their validity. *Ageing Research Reviews*, 74, 101530. <https://doi.org/10.1016/j.arr.2021.101530>
- Carcelén Fraile, M. C., et al. (2023). Resistance training combined with aerobic training has better effects than resistance only in older male adults with sarcopenia: Systematic review. *Frontiers in Public Health*. <https://doi.org/10.3389/fpubh.2022.1037464>
- Centner, C., Wiegel, P., Gollhofer, A., & König, D. (2021). Effects of blood flow restriction training on muscular strength and hypertrophy in older individuals: A systematic review and meta-analysis. *Sports Medicine*, 51(3), 525–537. <https://doi.org/10.1007/s40279-020-01390-6>
- Chen, H. T., Chen, Y. J., Chung, Y. C., et al. (2023). Effects of power training on neuromuscular performance and functional capacity in older adults: A randomized controlled trial. *Journal of Strength and Conditioning Research*, 37(4), 752–760. <https://doi.org/10.1519/JSC.0000000000004307>
- Cruz-Jentoft, A. J., Bahat, G., Bauer, J., Boirie, Y., Bruyère, O., Cederholm, T., ... & Cooper, C. (2019). Sarcopenia: Revised European consensus on definition and diagnosis. *Age and Ageing*, 48(1), 16–31. <https://doi.org/10.1093/ageing/afy169>
- Damluji, A. A., et al. (2023). Low muscle mass should be determined based on the risk of muscle weakness: Association between sarcopenia and cardiovascular diseases. *Circulation*. <https://www.ahajournals.org/doi/10.1161/CIRCULATIONAHA.123.064071>
- de Melo, T. A., Silva Guimarães, F. S., & Lapa e Silva, J. R. (2023). The five times sit to stand test: Safety, validity and reliability with critical care survivors at ICU discharge. *Archives of Physiotherapy*, 13, Article 2. <https://doi.org/10.1186/s40945-022-00156-z>
- Dent, E., Morley, J. E., Cruz-Jentoft, A. J., Arai, H., Kritchevsky, S. B., Guralnik, J., ... & Woo, J. (2023). International clinical practice guidelines for sarcopenia (ICFSR): Screening, diagnosis and management. *Journal of Nutrition, Health and Aging*, 27, 1–20. <https://doi.org/10.1007/s12603-022-1812-7>
- Fragala, M. S., Cadore, E. L., Dorgo, S., Izquierdo, M., Kraemer, W. J., Peterson, M. D., & Ryan, E. D. (2019). Resistance training for older adults: Position statement from the National Strength and Conditioning Association. *Journal of Strength and Conditioning Research*, 33(8), 2019–2052. <https://doi.org/10.1519/JSC.0000000000003230>
- Geraedts, H. A., Dijkstra, B., & Meulenbelt, M. (2023). Power training in sarcopenia: Systematic review of effectiveness in older adults. *BMC Geriatrics*, 23(1), 145. <https://doi.org/10.1186/s12877-023-03794-6>
- He, S., Meng, D., Wei, M., Guo, H., Yang, G., & Wang, Z. (2024). Proposal and validation of a new approach in tele rehabilitation with 3D human posture estimation: A randomized controlled trial in older individuals with sarcopenia. *BMC Geriatrics*, 24, Article 586.

- Hurst, C., Weston, K. L., McLaren, S. J., Weston, M., & Page, R. M. (2022). The effects of combined resistance and aerobic exercise training on functional performance and quality of life in older adults: A systematic review and meta-analysis. *Ageing Research Reviews*, 74, 101543. <https://doi.org/10.1016/j.arr.2021.101543>
- Izquierdo, M., Rodríguez-Mañas, L., Sinclair, A. J., & Morley, J. E. (2021). What is new in exercise regimes for frail older people: How does the Erasmus Vivifrail project fit? *Journal of the American Medical Directors Association*, 22(3), 388–394. <https://doi.org/10.1016/j.jamda.2020.12.022>
- Izquierdo-Gómez, R., Esteban-Cornejo, I., Gómez-Martínez, S., Padilla-Moledo, C., & Veiga, O. L. (2021). Effects of concurrent training on physical fitness and adiposity in adolescents: A systematic review and meta-analysis. *Sports Medicine*, 51(5), 1051–1070. <https://doi.org/10.1007/s40279-020-01414-1>
- Korean Working Group on Sarcopenia. (2023). 2023 update of the Korean clinical practice guideline for sarcopenia: Exercise intervention and molecular adaptations. *Journal of Cachexia, Sarcopenia and Muscle*, 14(2), 240–256. <https://doi.org/10.1002/jcsm.13206>
- Landi, F., Calvani, R., Tosato, M., Martone, A. M., Ortolani, E., Saveria, G., ... & Marzetti, E. (2023). Resistance exercise and protein intake to combat sarcopenia: A combined strategy. *Aging Clinical and Experimental Research*, 35, 1–9. <https://doi.org/10.1007/s40520-022-02117-w>
- Lee, J., et al. (2024). Efficacy of a combined exercise and nutrition intervention study for outpatients with possible sarcopenia in community-based primary care clinics (ENdSarC). *BMC Geriatrics*, 24. <https://doi.org/10.1186/s12877-024-05434-y>
- Li, N., et al. (2024). Feasibility, usability and acceptability of a lifestyle integrated functional exercise (LiFE) program supported by an mHealth platform in pre-frail older adults. *BMC Geriatrics*, 24, Article 555. <https://doi.org/10.1186/s12877-024-05523-y>
- Lin, W. S., et al. (2024). Predicting sarcopenia in community-dwelling older adults: Functional fitness components and risk factors. *BMC Geriatrics*, 24, Article 535. <https://doi.org/10.1186/s12877-024-05528-7>
- Liu, M. (2024). Graded progressive home-based resistance combined with aerobic exercise in community-dwelling older adults with sarcopenia: A randomized controlled trial. *Patient Preference and Adherence*, Article 45968. <https://pubmed.ncbi.nlm.nih.gov/39355281/>
- Loenneke, J. P., Buckner, S. L., Abe, T., & Thiebaud, R. S. (2022). Blood flow restriction training: A novel way to enhance muscle size and strength. *Strength & Conditioning Journal*, 44(1), 14–23. <https://doi.org/10.1519/SSC.0000000000000600>
- Makizako, H., Nakai, Y., Tomioka, K., Taniguchi, Y., Sato, N., Wada, A., ... & Takenaka, T. (2020). Effects of a multicomponent exercise program in physical function and muscle mass in sarcopenic/pre-sarcopenic adults. *Journal of Clinical Medicine*, 9(5), 1386. <https://doi.org/10.3390/jcm9051386>

- Martínez-Amat, A., Aibar-Almazán, A., Cruz-Díaz, D., de la Torre-Cruz, M., & Hita-Contreras, F. (2023). Multicomponent exercise programs for older adults: A meta-analysis of randomized controlled trials. *Journal of Aging and Physical Activity*, 31(2), 217–228. <https://doi.org/10.1123/japa.2022-0111>
- Park, S.-H., & Lee, H.-W. (2023). Effectiveness of combined exercise and nutrition interventions in preventing and improving sarcopenia in frail or healthy older adults: A systematic review. *Research in Gerontological Nursing*, 1–9. <https://doi.org/10.3928/19404921-20230817-03>
- Park, W. T., Shon, O. J., & Kim, G. B. (2023). Multidisciplinary approach to sarcopenia: A narrative review. *Journal of Yeungnam Medical Science*, 40(4), 352–363. <https://doi.org/10.12701/jyms.2023.00726>
- Ogawa, M., et al. (2024). Age-associated muscle atrophy mechanisms and exercise-induced remodeling: Focus on satellite cells and mitochondria. *Aging and Disease*, 15(1), 1–13. <https://doi.org/10.14336/AD.2023.0901>
- Papadopoulou, S. K., Tsintzas, D., & Papandreou, D. (2020). Effects of sarcopenia on quality of life and daily living. *Aging Clinical and Experimental Research*, 32(3), 477–484. <https://doi.org/10.1007/s40520-019-01380-z>
- Ramírez-Vélez, R., et al. (2023). Power versus traditional resistance training for improving physical function and quality of life in older adults: A systematic review and meta-analysis. *Experimental Gerontology*, 174, 112143. <https://doi.org/10.1016/j.exger.2023.112143>
- Sánchez-Sánchez, J. L., Udina, C., Medina-Rincón, A., Esbrí-Victor, M., Bartolomé-Martín, I., Moral-Cuesta, D., ... & Casas-Herrero, Á. (2023). Correction: Effect of a multicomponent exercise program and cognitive stimulation (VIVIFRAIL-COGN) on falls in frail community older persons with high risk of falls: Study protocol for a randomized multicenter control trial. *BMC Geriatrics*, 23, 31. <https://doi.org/10.1186/s12877-022-03624-0>
- Sepúlveda-Loyola, W., Silva-Díaz, Y. A., Teixeira, D. D. C., Solis, C. S., Caputo, D. D. C. D. S., Barrios, O. E. A., & Álvarez-Bustos, A. (2025). New exercise programs for older adults in the community: Evidence and applicability in the Latin American context. *Geriatrics, Gerontology and Aging*, 19, 1–3. <https://doi.org/10.53886/gga.e2025>
- Sung, J. H., et al. (2022). The association of aerobic, resistance, and combined exercise with preserved handgrip strength in older adults. *BMC Geriatrics*, 22, Article 929. <https://doi.org/10.1186/s12877-022-03483-7>
- Tieland, M., Trouwborst, I., & Clark, B. C. (2018). Skeletal muscle performance and ageing. *Journal of Cachexia, Sarcopenia and Muscle*, 9(1), 3–19. <https://doi.org/10.1002/jcsm.12238>
- Toro Román, V., et al. (2024). Functionality, muscular strength and cardiorespiratory fitness in older adults: Performance indicators. *Aging Clinical and Experimental Research*. <https://doi.org/10.1007/s40520-024-02694-7>

- Valenzuela, P. L., Morales, J. S., Pareja-Galeano, H., Lucia, A., & Castillo-Garzon, M. J. (2021). Effects of physical exercise on sarcopenia in the elderly: A systematic review and meta-analysis. *Scandinavian Journal of Medicine & Science in Sports*, 31(5), 942–956. <https://doi.org/10.1111/sms.13925>
- Wilkinson, D. J., Piasecki, M., & Atherton, P. J. (2021). The age-related loss of skeletal muscle mass and function: Measurement and physiology of muscle fibre atrophy and muscle fibre loss in humans. *Ageing Research Reviews*, 67, 101273. <https://doi.org/10.1016/j.arr.2021.101273>
- Wu, N., Li, M., & Chen, X. (2025). Adherence to exercise intervention for community-dwelling older adults with sarcopenia: A systematic review and meta-analysis. *Age and Ageing*, 54(4). <https://doi.org/10.1093/ageing/afae070>
- Zhang, L., Song, X., Wang, H., *et al.* (2024). Effects of blood flow restriction combined with aerobic stepping exercise in sarcopenia: A study protocol for a randomized clinical trial. *International Journal of General Medicine*, 17, 85–94. <https://doi.org/10.2147/IJGM.S490060>
- Zhang, X., Wang, C., Dou, Q., Zhang, W., Yang, Y., & Xie, Y. (2022). Prevalence of sarcopenia and its associated factors in older Chinese adults: A systematic review and meta-analysis. *BMJ Open*, 12(3), e051724.

Creative Commons licensing terms

Author(s) will retain the copyright of their published articles agreeing that a Creative Commons Attribution 4.0 International License (CC BY 4.0) terms will be applied to their work. Under the terms of this license, no permission is required from the author(s) or publisher for members of the community to copy, distribute, transmit or adapt the article content, providing a proper, prominent and unambiguous attribution to the authors in a manner that makes clear that the materials are being reused under permission of a Creative Commons License. Views, opinions and conclusions expressed in this research article are views, opinions and conclusions of the author(s). Open Access Publishing Group and European Journal of Social Sciences Studies shall not be responsible or answerable for any loss, damage or liability caused in relation to/arising out of conflicts of interest, copyright violations and inappropriate or inaccurate use of any kind content related or integrated into the research work. All the published works are meeting the Open Access Publishing requirements and can be freely accessed, shared, modified, distributed and used in educational, commercial and non-commercial purposes under a [Creative Commons Attribution 4.0 International License \(CC BY 4.0\)](https://creativecommons.org/licenses/by/4.0/).