Physical exercise and sarcopenia in older people: an OrtoMed position paper

Antimo Moretti [1], Federica Tomaino [1], Marco Paoletta [1], Sara Liguori [1], Silvia Migliaccio [2], Angelo Di Iorio [3], Raffaello Pellegrino [4], Davide Donnarumma [5], Daniele Di Nunzio [5], Giuseppe Toro [1], Maria Luisa Brandi [6], Giovanni Iolascon [1]

[1] Department of Medical and Surgical Specialties and Dentistry, University of Campania "Luigi Vanvitelli", Naples, Italy; [2] Department of Experimental Medicine, University Sapienza of Rome, Rome, Italy; [3] Laboratory of Clinical Epidemiology, Department of Medicine and Sciences of Aging, University G. D'Annunzio, Chieti Scalo, Italy; [4] Department of Scientific Research, Campus Ludes, Off-Campus Semmelweis University, 6912 Lugano-Pazzallo, Switzerland; [5] Rehabilitation Unit, University Hospital "Luigi Vanvitelli", Naples, Italy; [6] Donatello Bone Clinic, Villa Donatello Hospital, Sesto Fiorentino (FI), Italy

ABSTRACT

Sarcopenia, an age-related degenerative disorder, leads to reduced skeletal muscle mass and function, and it is associated with increased fall risk, mobility limitations, and higher mortality rates. With no approved pharmacological treatments available, physical exercise (in combination with an appropriate nutritional intervention) remains the primary approach for managing the condition. This paper reviews the evidence supporting exercise as a key treatment for sarcopenia, emphasizing the benefits of resistance, aerobic, balance, and flexibility exercises. Resistance exercise has been shown to improve muscle strength and mass, while aerobic exercise supports cardiovascular health and muscle endurance. Additionally, multimodal approaches combining exercise with nutritional interventions (such as administration of whey protein and vitamin D) have proven effective in patients with osteosarcopenia. Emerging research is highlighting molecular mechanisms, including a role for "exerkins", signaling molecules released during physical activity, which enhance both muscle and overall health. The updated program described in this paper offers evidence-based recommendations for prescribing tailored physical activity to older adults with sarcopenia, stressing the importance of individualized exercise prescriptions based on patients' comorbidities and fitness levels. The integration of various exercise modalities and nutritional support is critical to improving function and quality of life in this vulnerable population.

KEYWORDS

Rehabilitation, physical exercise, sarcopenia, physical activity, therapeutic exercise, aging, skeletal muscle, muscle strength, muscle mass, resistance exercise.

Introduction

Sarcopenia is a progressive degenerative disorder of skeletal muscle characterized by reduction of muscle mass and function [1]. This age-related disease has profound implications, such as increased risk of falls, mobility limitations, decreased independence in daily activities, and higher mortality rates [2].

As the global population ages, sarcopenia is becoming an increasingly significant public health challenge that is highlighting the importance of effective management strategies. The appropriate management of patients with sarcopenia encompasses nutritional and physical exercise interventions [3-5]. Currently, no specific pharmacological treatments for sarcopenia have been approved by international regulatory agencies [6], making exercise a frontline treatment against age-related muscle wasting. In 2014, the Italian Society of Orthopedics and Medicine and Rare Diseases of the Skeleton (OrtoMed) issued a position paper on the role of physical exercise for treating sarcopenia in older people [7]. Around the same time, sarcopenia was officially recognized as a muscle pathology (ICD-10: M62.84) [8], characterized by a decline of muscle function due to a decrease in muscle mass [9].

Article history
Received 16 Sep 2024 – Accepted 16 Oct 2024

Contact
Sara Liguori; sara.liguori@unicampania.it
Department of Medical and Surgical Specialties and Dentistry, University of Campania "Luigi Vanvitelli", Naples, Italy

Current guidelines strongly recommend exercise for managing sarcopenia [4]. This manuscript aims to provide an update of a program of tailored physical exercise for sarcopenic patients.

Evidence on physical exercise interventions for older people with sarcopenia

Evidence supports the use of resistance exercise (RE) as a key intervention in the management of sarcopenia, although heterogeneous exercise protocols have been proposed by different authors. Most studies include this intervention, either alone or in combination with other types of exercise.

Low-intensity resistance training (LIRT), involving loads up to 50% of the individual's one-repetition maximum (1RM), improves muscle strength. On the other hand, high-intensity resistance training (HIRT), performed at 80% of 1RM, maximizes strength gains. Training sessions comprising 1 to 4 sets of 8 to 15 repetitions, performed 2 to 3 times a week for 6 to 12 weeks, are recommended. It is also recommended to combine different approaches: RE, aerobic exercise, and balance exercises, and RE with blood flow restriction (BFR). The latter approach, providing an alternative perspective on training interventions, involves restricting venous outflow and maintaining arterial inflow to target muscles. It is important to note that low-intensity BFR training is more effective than LIRT for enhancing muscle strength. However, it is less effective than HIRT [10].

Evidence also supports the use of a kettlebell training (KT); in a trial of an 8-week training program [11], KT significantly improved muscle mass, sarcopenia index, grip strength, back strength, and peak expiratory flow at 1- to 2-month follow-ups with effects persisting at 12 weeks.

In patients with osteosarcopenia, a condition characterized by the coexistence of osteopenia/osteoporosis and sarcopenia, a long-term, twice-weekly, high-intensity RE program combined with a nutritional approach (administration of whey protein, vitamin D, and calcium) significantly maintained bone mineral density and increased skeletal muscle mass index and strength at the proximal muscles of the lower limbs [12].

Combining a multimodal exercise program (RE, aerobic and balance training) with nutritional interventions seems to be more effective than exercise alone on muscle strength, while combined RE and balance training appears to be most effective for improving physical performance [13]. This latter intervention also seems to be effective in reducing disability, as measured by the Barthel Index, in older patients with sarcopenia, even though no benefits on fall risk reduction were reported [14].

Aerobic exercise is considered a fundamental complement to resistance training, contributing to maintaining muscle and cardiorespiratory function. Regular aerobic exercise (30 minutes per day performed more than three times a week for at least five months)[15] should include common activities such as walking, brisk walking, jogging, cycling, swimming, dancing, and tai chi. Some authors advise starting start with low-intensity activity practiced for 5-10 minutes per day at least 5 times a week before progressing to moderate-intensity activity practiced for at least 10 minutes per day at least 5 times a week; finally, patients can move on to high-intensity activity sessions lasting at least 20-30 minutes per day, performed at least 3 times a week [16-18].

The molecular basis for clinical benefits arising from different modes of exercise have been investigated [19]. High-intensity interval training (HIIT) and combined training (RE plus HIIT), significantly improve insulin sensitivity, lean mass, aerobic capacity, and skeletal muscle mitochondrial respiration. On the other hand, RE alone improved insulin sensitivity and lean mass without effects on aerobic capacity and mitochondrial respiration. In this context, new actors in the modulation of the effects of exercise on general health, including muscle function, are now emerging. "Exerkines", secreted from various sources, are signaling molecules released in response to physical activity, and they may influence different organs and tissues, producing muscular and extra-muscular benefits, including metabolic, immune, and neurological effects [20].

A broad variety of exerkines are released, such as IL-6, IL-8, IL-1 receptor antagonist, and IL-10 [21]. These factors have multiple effects on the cardiovascular system, promoting vascularization and angiogenesis while also improving blood pressure [22]. Additionally, in adipose tissue, exerkines boost metabolic processes by increasing fatty acid uptake, and enhancing lipolysis, thermogenesis, and glucose metabolism [23]. Finally, exerkines facilitate muscle formation, maintenance, and repair, and also stimulate glucose uptake, lipid oxidation, mitochondrial biogenesis, and capillarization of skeletal muscle [24].

Another interesting aspect is that exerkine expression is promoted differently by acute versus chronic exercise [22]. In HIIT, for example, the greater exercise intensity is associated with elevated plasma levels of IL-6, while IL-10 levels do not change compared to pre-exercise levels. Acute exercise is linked to responses aimed at maintaining metabolic homeostasis, where acute inflammation is counterbalanced by anti-inflammatory mediators [25].

On the other hand, chronic exercise is associated with sustained metabolic changes and reduced inflammation [22]. These effects should prompt us to consider the type of exercise prescribed according to the outcomes we aim to achieve from the treatment.

Expert opinion and practical recommendations for prescribing exercise to older people with sarcopenia

This document is an update of the OrtoMed position paper published in 2014 [7]. In general, a combination of exercise and nutritional approaches, including supplementation of micro- and macronutrients, is effective in managing sarcopenia in elderly individuals [26]. This program should be prescribed after a multidimensional evaluation of the patient's comorbidities and physical fitness.

With the aim of providing clear, evidence-based guidelines, we formulated specific recommendations for prescribing therapeutic exercise in patients with age-related sarcopenia.

Recommendations for physical activity in sarcopenia (Table I)

Aerobic exercise:

- Frequency: 3-5 days/week
- Intensity:
  - Moderate: Rated at 5-6 on the 10-point RPE-Borg scale
  - Vigorous: Rated at 7-8 on the 10-point RPE-Borg scale
- Volume: 30 min/day at moderate intensity, in sessions of at least 10 min each
- Rest periods: 5 min between sessions
- Mode: Treadmill or stationary bike
- Protocol duration: 12 weeks
- Recommended activities: Treadmill, walking, jogging, cycling, swimming, dance

Resistance exercises:
- Frequency: 2 days/week
- Intensity: 50-70% 1 RM progressing to 70-80% 1 RM
- Volume: 10 exercises per session, 2-3 sets per exercise, 8-12 repetitions per set
- Rest periods: 2 min between sets, 3 min between exercises, 48 hours between sessions
- Mode: Leg press, squat, leg extension, leg curl, leg abduction, leg adduction, calf raise; chest press, seated row, butterfly with extended arms, back extension
- Resistance type: Dumbbells, free weights, elastic therapy bands, and body weight
- Additional exercises: Repeated sit-to-stand and/or wall press

Balance exercises:
- Frequency: 3 days/week
- Intensity: Rated at 3 on the 10-point RPE-Borg scale
- Volume: 20 min/session
- Rest periods: 3 min between exercises
- Mode: Different weeks devoted to different specific balance-improving exercises
- Recommended exercises: Heel and toe raise, static balance, quick-stepping, reaching, single-leg standing, heel-to-toe walking, complex cross-over stepping.
- Recommended activities: Exercises with feet together, standing in tandem, weight shifting, standing on one foot, dance, tai chi

Flexibility exercises:
- Frequency: 5 days/week
- Intensity: Slow movements, held until a slight feeling of muscular or joint discomfort is perceived
- Volume: 10 min/session; 3 sets, maintaining each pose for 15 seconds
- Rest periods: 30 seconds between exercises
- Mode: Static stretching of major upper and lower limb muscle groups
- Recommended exercises: Self-stretching of hamstring, quadriceps, and calf muscles against the wall.

Conclusions

Sarcopenia remains a significant health challenge in the aging population, contributing to decreased muscle mass, strength, and functional ability. Given the absence of approved pharmacological treatments, physical exercise, particularly resistance and multimodal training, remains the cornerstone of sarcopenia management. Evidence strongly supports the integration of various exercise modalities, such as resistance, aerobic, balance, and flexibility exercises, in conjunction with nutritional interventions for optimizing outcomes. Tailoring exercise programs based on individual patient needs, comorbidities, and physical capabilities is essential for maximizing the benefits, improving overall function, and enhancing quality of life in older adults with sarcopenia.

References

1. Cruz-Jentoft AJ, Sayer AA. Sarcopenia. Lancet. 2019;393(10191):2636-46. Erratum in: Lancet. 2019;393(10191):2590.
2. Greco EA, Pietschmann P, Migliaccio S. Osteoporosis and sarcopenia increase frailty syndrome in the elderly. Front Endocrinol (Lausanne). 2019;10:255.
3. Bauer J, Morley JE, Schols AMWJ, et al. Sarcopenia: a time for action. An SCWD position paper. J Cachexia Sarcopenia Muscle. 2019;10(5):956-61.
4. Uchitomi R, Oyabu M, Kamei Y. Vitamin D and sarcopenia: potential of vitamin D supplementation in sarcopenia prevention and treatment. Nutrients. 2020;12(10):3189.
5. Dent E, Morley JE, Cruz-Jentoft AJ, et al. International Clinical Practice Guidelines for Sarcopenia (ICFSR): screening, diagnosis and management. J Nutr Health Aging. 2018;22(10):1148-61.
6. Iolascon G, Moretti A, de Sire A, Liguori S, Toro G, Gimigliano F. Pharmacological therapy of sarcopenia: past, present and future. Clin Cases Miner Bone Metab. 2018;15(3):407-15.
7. Iolascon G, Di Pietro G, Gimigliano F, et al. Physical exercise and sarcopenia in older people: position paper of the Italian Society of Orthopaedics and Medicine (OrtoMed). Clin Cases Miner Bone Metab. 2014;11(3):215-21.
8. Anker SD, Morley JE, von Haehling S. Welcome to the ICD-10 code for sarcopenia. J Cachexia Sarcopenia Muscle. 2016;7(5):512-4.

Table I Comparison between different types of exercise.

	FREQUENCY	INTENSITY	MODE	VOLUME
Aerobic exercise	3-5 days/week	Moderate: Rated at 5-6 on the 10-point RPE-Borg scale Vigorous: Rated at 7-8 on the 10-point RPE-Borg scale	Treadmill or stationary bike	30 min/day at moderate intensity, in sessions of at least 10 min each
Resistance exercises	2 days/week	50-70% 1 RM progressing to 70-80% 1 RM	Leg press, squat, leg extension, leg curl, leg abduction, leg adduction, calf raise; chest press, seated row, butterfly with extended arms, back extension	2-3 sets per exercise, 8-12 repetitions
Balance exercises	3 days/week	Rated at 3 on the 10-point RPE-Borg scale	Different weeks devoted to different specific balance-improving exercises	20 min/session
Flexibility exercises	5 days/week	Slow movements, held until a slight feeling of muscular or joint discomfort is perceived	Static stretching of major upper and lower limb muscle groups	10 min/session; 3 sets, 15 seconds each pose

9. Wiegmann S, Felsenberg D, Armbrecht G, Dietzel R. Longitudinal changes in muscle power compared to muscle strength and mass. J Musculoskelet Neuronal Interact. 2021;21(1):13-25.
10. Beckwée D, Delaere A, Aelbrecht S, et al. Exercise interventions for the prevention and treatment of sarcopenia. a systematic umbrella review. J Nutr Health Aging. 2019;23(6):494-502.
11. Chen HT, Wu HJ, Chen YJ, Ho SY, Chung YC. Effects of 8-week kettlebell training on body composition, muscle strength, pulmonary function, and chronic low-grade inflammation in elderly women with sarcopenia. Exp Gerontol. 2018;112:112-8.
12. Kemmler W, Kohl M, Fröhlich M, et al. Effects of high-intensity resistance training on osteopenia and sarcopenia parameters in older men with osteosarcopenia — one-year results of the randomized controlled Franconian Osteopenia and Sarcopenia Trial (FrOST). J Bone Miner Res. 2020;35(9):1634-44.
13. Shen Y, Shi Q, Nong K, et al. Exercise for sarcopenia in older people: a systematic review and network meta-analysis. J Cachexia Sarcopenia Muscle. 2023;14(3):1199-211.
14. Liang Y, Wang R, Jiang J, Tan L, Yang M. A randomized controlled trial of resistance and balance exercise for sarcopenic patients aged 80-99 years. Sci Rep. 2020;10(1):18756.
15. World Health Organization. Guidelines on Physical Activity and Sedentary Behaviour. Geneva: World Health Organization; 2020.
16. Nascimento CM, Ingles M, Salvador-Pascual A, Cominetti MR, Gomez-Cabrera MC, Viña J. Sarcopenia, frailty and their prevention by exercise. Free Radic Biol Med. 2019;132:42-9.
17. Ziaaldini MM, Marzetti E, Picca A, Murlasits Z. Biochemical pathways of sarcopenia and their modulation by physical exercise: a narrative review. Front Med (Lausanne). 2017;4:167.
18. American College of Sports Medicine; Chodzko-Zajko WJ, Proctor DN, Fiatarone Singh MA, et al. American College of Sports Medicine position stand. Exercise and physical activity for older adults. Med Sci Sports Exerc. 2009;41(7):1510-30.
19. Robinson MM, Dasari S, Konopka AR, e tal. Enhanced protein translation underlies improved metabolic and physical adaptations to different exercise training modes in young and old humans. Cell Metab. 2017;25(3):581-92.
20. Chow LS, Gerszten RE, Taylor JM, et al. Exercises in health, resilience, and disease. Nat Rev Endocrinol. 2022;18(5):273-89.
21. Cullen T, Thomas AW, Webb R, Hughes MG. Interleukin-6 and associated cytokine responses to an acute bout of high-intensity interval exercise: the effect of exercise intensity and volume. Appl Physiol Nutr Metab. 2016;41(8):803-8.
22. Leuchtmann AB, Adak V, Dilbaz S, Handschin C. The role of the skeletal muscle secretome in mediating endurance and resistance training adaptations. Front Physiol. 2021;12:709807.
23. Wedell-Neergaard AS, Lang Lehrskov L, Christensen RH, et al. Exercise-induced changes in visceral adipose tissue mass are regulated by IL-6 signaling: a randomized controlled trial. Cell Metab. 2019;29(4):844-855.e3.
24. Kwak SE, Cho SC, Bae JH, et al. Effects of exercise-induced apelin on muscle function and cognitive function in aged mice. Exp Gerontol. 2019;127:110710.
25. Ostrowski K, Rohde T, Asp S, Schjerling P, Pedersen BK. Pro- and anti-inflammatory cytokine balance in strenuous exercise in humans. J Physiol. 1999;515 (Pt 1)(Pt 1):287-91.
26. Eijsvogels TMH, Thompson PD, Franklin BA. The "Extreme Exercise Hypothesis": recent findings and cardiovascular health implications. Curr Treat Options Cardiovasc Med. 2018;20(10):84.