Journal of Education, Health and Sport. 2026;88:68065. eISSN 2391-8306.

https://doi.org/10.12775/JEHS.2026.88.68065

Journal of Education, Health and Sport. eISSN 2450-3118

Journal Home Page
https://apcz.umk.pl/JEHS/index

MALON, Paulina, ŚLIWA, Karol, PIEŃKOWSKA, Anita, TROJAŃSKA, Aleksandra, GEWORKIAN, Nel, HARIASZ, Natalia, PIETZ, Martyna and SZYMAŃSKA, Anita. Dynapenia syndrome in geriatrics – clinical characteristics, distinction from sarcopenia, and contemporary therapeutic approaches. Journal of Education, Health and Sport. 2026;88:68065. eISSN 2391-8306.
https://doi.org/10.12775/JEHS.2026.88.68065

The journal has had 40 points in Minister of Science and Higher Education of Poland parametric evaluation. Annex to the announcement of the Minister of Education and Science of 05.01.2024 No. 32318. Has a Journal's Unique Identifier: 201159. Scientific disciplines assigned: Physical culture sciences (Field of medical and health sciences); Health Sciences (Field of medical and health sciences).
Punkty Ministerialne 40 punktów. Załącznik do komunikatu Ministra Nauki i Szkolnictwa Wyższego z dnia 05.01.2024 Lp. 32318. Posiada Unikatowy Identyfikator Czasopisma: 201159. Przypisane dyscypliny naukowe: Nauki o kulturze fizycznej (Dziedzina nauk medycznych i nauk o zdrowiu); Nauki o zdrowiu (Dziedzina nauk medycznych i nauk o zdrowiu).
The authors declare that there is no conflict of interests regarding the publication of this paper.
Received: 08.01.2026. Revised: 01.02.2026. Accepted: 04.02.2026. Published: 14.02.2026.

Dynapenia syndrome in geriatrics – clinical characteristics, distinction from sarcopenia, and contemporary therapeutic approaches

Paulina Malon

Nicolaus Copernicus University in Toruń, Collegium Medicum, Bydgoszcz https://orcid.org/0009-0008-9311-001X

Karol Śliwa

University of Warmia and Mazury in Olsztyn, Collegium Medcium, ul. Oczapowskiego 2, 10-719 Olsztyn, Poland https://orcid.org/0009-0006-4181-9778

Anita Pieńkowska

Independent Physician, Białystok, Poland https://orcid.org/0009-0008-9903-007X

Aleksandra Trojańska

University Clinical Hospital in Poznań, Przybyszewskiego 49, 60-355 Poznań, Poland https://orcid.org/0009-0005-9659-875X

Nel Geworkian

University Clinical Hospital in Poznań, Przybyszewskiego 49, 60-355 Poznań, Poland; https://orcid.org/0009-0008-2248-6052

Natalia Hariasz

4th Military Clinical Hospital in Wroclaw, Rudolfa Weigla 5, 50-981 Wrocław https://orcid.org/0009-0000-5397-0324

Martyna Pietz

University Clinical Hospital in Poznań, Przybyszewskiego 49, 60-355 Poznań, Poland; https://orcid.org/0009-0003-7628-9517

Anita Szymańska

Independent Physician, Poznań, Poland https://orcid.org/0009-0005-9762-3347

Abstract

Introduction

Dynapenia is an age-related loss of muscle strength despite preserved muscle mass, leading to functional decline, loss of independence, falls, and higher mortality. Its development is influenced by neuromuscular, endocrine, and metabolic changes, compounded by chronic inflammation, low activity, and inadequate nutrition.

Results

Resistance training is the most effective strategy to mitigate strength loss, enhancing neuromuscular function and physical performance. Aerobic exercise improves endurance and mobility. Adequate protein intake (1.0–1.2 g/kg) and supplementation with vitamin D, creatine,

leucine, and omega-3 fatty acids support training adaptations. Early detection via handgrip strength allows timely interventions.

Discussion

Combining targeted exercise with optimal nutrition and supplementation maintains strength and independence in older adults. Interventions should be individualized based on health and functional status. Emerging molecular and gene-based therapies are experimental but may complement lifestyle approaches.

Conclusion

Dynapenia is not inevitable with aging. Early recognition, regular training, and proper nutrition can slow strength loss, reduce fall risk, and improve well-being.

Materials and methods

A review of scientific articles from PubMed, Google Scholar, and Dove Press Medical focused on dynapenia, muscle aging, and physical and nutritional interventions in older adults.

Keywords: dynapenia, muscle aging, resistance training, supplementation, protein, vitamin D, functional capacity in older adults, fall prevention.

Introduction

Dynapenia is a reduction in muscle strength arising with age despite relatively stable muscle mass [1]. Clinically, this decline translates into poorer mobility, functional limitations in daily tasks, and an increased rate of falls and related injuries [2]. In older adults, dynapenia often coexists with chronic diseases, which can exacerbate disability and worsen clinical outcomes [3–5].

Unlike sarcopenia defined by low muscle mass, dynapenia captures the dimension of reduced strength specifically [4,5]. Contemporary recommendations emphasize the central role of structured resistance exercise and adequate nutrient intake, particularly dietary protein and vitamin D [6–9].

Definition and clinical significance of dynapenia

Dynapenia is characterized as a gradual, age-related weakening of muscular strength that cannot be attributed to acute neurological or musculoskeletal pathology [10]. It typically presents as reduced neuromuscular performance despite preserved, or only slightly diminished, muscle mass [1,2]. Clark and Manini introduced the term in 2008 to distinguish it conceptually from sarcopenia [1].

Strength loss in older adults has important clinical implications: it impairs physical functioning, contributes to dependency, and is associated with increased rates of falls, hospitalization, and death [2,11]. Prevalence estimates vary, with reports indicating notable occurrence in individuals over 60 years old (roughly 10% in Japanese cohorts) [12]. As such, early detection enables more effective preventative strategies.

1. Pathophysiology

1.1. Neuromuscular adaptations

Dynapenia develops through multifactorial biological processes. Progressive denervation, reduced motor unit numbers, atrophy of type II fibers, and accumulation of intramuscular fat are among the principal neuromuscular contributors [13]. Degenerative changes at the neuromuscular junction and impaired neural activation further diminish strength.

1.2. Hormonal insufficiency

Declining concentrations of anabolic hormones such as testosterone, growth hormone, and IGF-1 limit muscle protein synthesis and contribute to strength loss [14,15].

1.3. Chronic inflammation and oxidative damage

Persistent systemic inflammation and oxidative stress also have important roles in the degradation of muscle tissue [16,17].

1.4. Physical inactivity

Additionally, sedentary behavior accelerates functional decline via disuse-related atrophy [1,18].

1.5. External modifying factors

External factors including long-term glucocorticoid therapy, certain antihypertensive medications, and inadequate dietary intake: low protein, vitamin D, and omega-3 fatty acids may worsen these processes [7–9]. The cumulative effect is a measurable decline in muscle quality and performance capacity.

Clinical Presentation and Diagnostics

Patients typically describe a generalized sense of weakness or difficulty executing strength-dependent activities such as stair climbing or rising from a seated position. Objective assessments reveal impaired functional performance and reduced movement efficiency. Handgrip strength (HGS) remains a widely adopted, reliable method for detecting decreased muscle strength [11,19].
Diagnosis relies on identifying low muscle strength with no concurrent criteria for sarcopenia based on muscle mass. Clinical tools commonly employed include the Sit-to-Stand (STS) test, Timed Up and Go (TUG), and Short Physical Performance Battery (SPPB) [20,21]. Suggested thresholds for dynapenia include HGS <30 kg in men and <20 kg in women, though no universal standard has been established [22]. Body composition assessment via DXA may provide supportive data but cannot differentiate dynapenia from sarcopenia [23].
Neurological evaluation is indicated when neuromuscular pathology must be excluded.

Differentiation from sarcopenia

Although both disorders emerge with aging, dynapenia and sarcopenia refer to distinct physiological phenomena. Sarcopenia encompasses both low muscle mass and impaired muscle function, while dynapenia pertains solely to strength decline with relatively maintained mass [1,24,25].
Clinically, assessing both strength and mass is necessary. Sarcopenia is diagnosed when both parameters are reduced; dynapenia is diagnosed when only strength falls below thresholds [26]. According to AWGS criteria, dynapenia may be identified exclusively with low HGS values (26-28 kg in men, <18 kg in women) regardless of measured muscle mass [27].
Mechanisms underlying strength loss often differ from those causing mass loss for example, reduced central neural drive or qualitative changes in muscle tissue [10,17,28]. Proper differentiation allows clinicians to tailor interventions more effectively.

Impact on functioning of feriatric patients

Dynapenia has marked consequences for the daily lives of older adults. It limits autonomy, complicates routine self-care tasks, and contributes to overall declines in physical activity [2,11]. It is associated with slower gait speed, poorer balance, and diminished mobility. Elevated fall risk is among the most serious outcomes: studies indicate that individuals with dynapenia may experience up to a twofold higher likelihood of falling compared with peers with preserved

strength [29]. Beyond physical injury, this contributes to anxiety, fear of falling, and reduced quality of life, particularly in older women [26,29].
Weakness also correlates with increased prevalence of metabolic and cardiovascular disorders and higher all-cause mortality [3-5,30,31]. Therefore, maintaining muscular strength is a cornerstone of preventive geriatric care.

2. Treatment Strategies

2.1 Exercise

The primary approach to treating dynapenia is structured exercise. Resistance training performed at least 2-3 times weekly is strongly supported by evidence for improving strength, neuromuscular control, and balance, while reducing fall risk [6,32].

2.2. Nutrition

Dietary optimization is essential. Older adults are generally encouraged to consume 1.0-1.2 g/kg/day of high-quality protein, along with a nutrient-dense diet supporting anabolic processes [35].

2.3. Micronutrient and Supplement

Vitamin D and calcium supplementation are commonly recommended, with vitamin D doses of 800-1000 IU/day showing modest benefits for muscle strength, although results remain mixed [36].
Creatine, leucine, and omega-3 fatty acids have shown promising effects but require additional large trials for definitive recommendations [8].

2.4. Hormonal and anabolic therapies

Pharmacological options remain largely experimental. Testosterone therapy, growth hormone, and SARMs have been investigated but are limited by safety considerations [8,37–39]. Future therapies may act on specific signaling pathways, but for now, exercise and management of comorbidities remain the pillars of treatment.
Fall-prevention components such as balance training and home modifications should also be routinely incorporated [1,40].

Prevention and Future Research Directions

Preventive strategies should emphasize lifelong physical activity and proper diet. Maintaining regular resistance training, meeting protein requirements, and ensuring adequate vitamin D status can considerably slow age-related strength loss [1,6–9].
Handgrip strength is emerging as a simple, cost-effective screening tool for identifying early declines in function.
Current research explores personalized interventions based on genetic and phenotypic factors, the discovery of molecular biomarkers, and pharmacological targets such as AMPK or ATF4, as well as the potential role of gut microbiota modulation [41].

Experimental approaches include cellular and gene-based therapies, such as myostatin inhibition [42,43]. Advances in telemedicine and artificial intelligence may further improve early detection of dynapenia and support the development of personalized exercise and nutrition programs [44].

Conclusion

Although dynapenia progresses gradually, its long-term impact on mobility, independence, and fall risk can be profound. Importantly, strength loss is modifiable: resistance training is the most powerful intervention available, and nutritional optimization (including adequate protein intake and targeted supplementation) can significantly enhance training outcomes. The combination of exercise and diet provides a realistic means to slow or partially reverse age-related declines in muscle strength, promoting sustained functional independence in older adults.

Author's contribution

Conceptualization: **Paulina Malon Methodology: Karol Śliwa**

Software: not applicable;

Formal analysis: Anita Pieńkowska

Research: Nel Geworkian Resources: Martyna Pietz Writing- rough preparation: Natalia Hariasz Writing- review and editing: Anita Szymańska Visualization: Karol Śliwa

Project administration: Paulina Malon Funding

acquisition: not applicable.

All authors have read and agreed with the published version of the manuscript.

Founding Statement: The study did not receive funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Not applicable.

Conflict of Interest Statement: The authors declare no conflicts of interest.

Acknowledgments: Not applicable

During the preparation of this work, the authors used AI for the purpose of language and text formatting. After using this tool, the authors reviewed and edited the content as needed and took full responsibility for the substantive content of the publication.

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