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IMPACT OF RESISTANCE EXERCISE ON NEUROCOGNITIVE HEALTH AND SARCOPENIA IN THE ELDERLY

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ABSTRACT

Introduction: Sarcopenia (progressive muscle loss/weakness) and neurocognitive decline are serious, interrelated difficulties of aging, with shared pathophysiological pathways including inflammation and disrupted muscle-brain communication. Resistance exercise training (RET) counters sarcopenia and additionally may be beneficial for cognition via myokine release.
Methods: Systematic review (PubMed/Google Scholar) of the impact of RET on sarcopenia and neurocognitive health in adults aged ≥ 65 years was done. The search words were "resistance exercise", "sarcopenia", "neurocognitive health", and "elderly". Clinical studies, trials, meta-analyses, and RCTs after 2017 were included. After screening 348 records and applying exclusion criteria, 21 studies were analyzed.
Results: RET significantly improves sarcopenia, increasing muscle strength (e.g., knee extension SMD=1.26), mass (especially with protein supplementation), and physical function (e.g., gait speed SMD=1.28), reducing fall risk. RET also yields domain-specific cognitive improvements, most consistently in executive function and processing speed, that are coupled with hippocampal expansion and expanded functional connectivity. RET elevates neurotrophic factors (e.g., BDNF) and reduces inflammation (e.g., IL-6). Crucially, several studies demonstrate concurrent improvements in both cognition and muscle strength/function, with strength improvement being related to cognitive improvement (up to 40% mediation).
Discussion: RET provides two-fold protection through mechanisms like heightened protein synthesis, reduced inflammation, and neurotrophic support. Barriers include low adherence, access, and standardization of protocols (e.g., optimal dose: ≥2 sessions/week, 70–80% 1RM). Future research needs validated biomarkers, optimized protocols (including nutritional co-interventions), and high-quality RCTs on minimal effective doses and synergies.
Conclusions: RET is a robust, evidence-based intervention counteracting both sarcopenia and cognitive impairment in older adults, and promoting functional independence and healthy aging. The resolution of implementation concerns and outstanding research questions is necessary to maximize its public health impact.

KEYWORDS
Resistance Exercise, Sarcopenia, Muscle Loss, Neurocognitive Health

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Introduction.

World demographic transition towards an elderly population is among the most evident 21st-century public health issues, with an increasing burden of disabling age-related illnesses [1,2,3]. Of these, sarcopenia- i.e., diffuse and progressive loss of muscle mass, strength, and function [4]- and neurocognitive impairment, from Mild Cognitive Impairment (MCI) to dementia [5], pose exceptional challenges to healthcare sustainability, functional autonomy, and quality of life. Sarcopenia is a twofold threat by doubling frailty, falls, functional disability, loss of autonomy, and premature death [4,6]. Meanwhile, neurocognitive disorders severely compromise decision-making capacity, executive function, and memory, imposing enormous individual, social, and economic burdens [5].

Of principal importance here is a two-way, strong association between cognitive impairment and sarcopenia, with recent evidence [7]. The two conditions are also suggested to be interdependent because of common pathophysiologic processes, such as chronic low-grade inflammation, metabolic dyregulation (e.g., insulin resistance), physically inactive lifestyle habits, and deranged muscle-brain crosstalk through myokines—signaling proteins secreted by muscles that regulate brain plasticity and function [7]. The degradation of one system seems to expedite that of the other, thus producing a vicious cycle that stimulates age-related vulnerability. Resistance exercise training (RET) has emerged as a successful countermeasure for sarcopenia, evidently enhancing muscle mass, strength, and physical function in even frail older adults [8,9,10]. Its efficacy ranges from prevention of loss of muscle during caloric restriction [8] to enhancing rehabilitation in sarcopenic patients [10]. As RET's established role in maintaining muscle and its potential for modulating myokine release (e.g., irisin, BDNF, cathepsin B) has been proposed, this paper critically examines whether RET can simultaneously slow the onset of both sarcopenia and cognitive impairment in older participants. We review the mechanistic pathways in the muscle-brain axis potentially underlying RET's systemic benefit, positioning it as a strategic non-pharmacological intervention for healthy neurological and musculoskeletal aging.

Methodology

This study investigates the current state of knowledge Impact of Resistance Exercise on Neurocognitive Health and Sarcopenia in the Elderly. We conducted a systematic search of PubMed and Google Scholar using the following keywords: "resistance exercise", ("sarcopenia" or "muscle loss"), "neurocognitive health", "elderly". We include case reports clinical studies, clinical trials, meta-analysises and randomized controlled trials. This review analyzes articles published in 2017 or later to ensure up-to-date evidence. We obtained 348 records. Duplicate records removed (n= 16). Removed non-English articles (n=1). Removed animal studies and articles about people <65 years old and (n=64). Reports screened (n=284). Records excluded (n=195). Reports sought for retrieval (n=89). Reports not retrieved (n=40). 49 reports were obtained and assessed for eligibility. Studies included in review (n=21).

Results

Synthesized evidence convincingly demonstrates that resistance exercise (RE) exerts significant and clinically relevant effects in mitigating sarcopenia and enhancing neurocognitive health in older adults. In relation to sarcopenia, RE consistently yields large and often significant increases in muscle strength and power, outcomes crucial for maintaining functional independence [11,12,13]. Crucially, RE is resistant to age-related muscle atrophy, showing preservation or gain in muscle mass; this anabolic impact is powerfully enhanced when RE training is coupled with adequate protein intake, showing the potential for nutritional co-interventions [11,14,15]. Consequently, RE programs yield significant gains on many measures of physical function, including gait speed, dynamic balance, chair stand performance, and mobility overall. These functional improvements directly translate into a quantifiable reduction in risk of falling, a major concern in frail older individuals [16,17]. Within the neurocognitive health arena, RE training yields domain-specific cognitive improvement. The most robust and consistent evidence is available for large-scale improvements in executive function (planning, working memory, and cognitive flexibility) and processing speed [12,18]. There is also evidence for positive effects on global cognitive status and, with greater study-to-study and inter-individual variability, on memory function [19,20,21]. These cognitive enhancements are underpinned by showable, positive neurobiological adaptations observed with chronic RE participation. The most significant findings are hippocampal expansion, a brain region fundamental to learning and memory, and increased functional connectivity of neural circuits [20,22]. Furthermore, RE impacts biomarkers of neuroplasticity and brain health modulating the bioavailability of brain-derived neurotrophic factor (BDNF), an important neurotrophin for the continued survival and growth of neurons, and lowering circulating levels of pro-inflammatory biomarkers such as interleukin-6 (IL-6), indicating an anti-inflammatory effect [23,24,25]. Observational evidence also contributes to the evidence base for RE, linking regular activity with reduced long-term risk of cognitive decline and incident dementia, suggesting its potential preventive role [26,27]. Particularly impressive is the fact that a number of investigations exhibit a dramatic dual benefit: carefully crafted RE programs yield concomitant, statistically significant improvement of both muscle strength/physical function and cognitive function in the same cohort of older adults [12,18,22] Correlational analyses within these investigations suggest that a mechanistic relationship might be present, with the magnitude of muscle strength increase achieved via RE positively correlated with the magnitude of cognitive improvement observed, implicating common or interacting physiological mechanisms [22,28].

Discussion

Resistance training (RT) counteracts sarcopenia by various physiological mechanisms, including enhanced neuromuscular metabolism, reduced inflammation, and maximized regulation of hormones (i.e., IGF-1 and growth hormone) [1]. These alterations increase muscle protein synthesis and mitochondrial function, which directly challenge the accelerated rate of muscle loss typical of sarcopenia [4]. Notably, RT enhances strength (handgrip: SMD = 0.81; knee extension: SMD = 1.26) and physical function (gait speed: SMD = 1.28; timed up-and-go: SMD = -0.93), although muscling effects remain inconsistent between studies [11]. Beyond musculoskeletal effects, RT leads to neurocognitive gain through enhanced IGF-1 and reduced homocysteine levels, improving overall synaptic plasticity and reducing neuronal toxicity [22]. Clinical trials show that RT enhances executive function, memory, and global cognition in older adults with mild cognitive impairment, and gains in cognition are mediated by increases in strength (up to 40% of cognitive gain attributable to strength gain) [22]. Despite strong evidence, clinical application is hampered by low adherence to RT by older adults because of restricted access to equipment, safety issues, and low awareness among healthcare professionals [16]. Obstacles to standardization persist, including varying diagnostic criteria for sarcopenia (e.g., EWGSOP vs. AWGS), which interfere with RT prescription and comparison of effects [11]. The optimal RT protocols are in dispute; meta-analyses suggest ≥2 sessions/week at 70–80% 1RM is effective, but practical implementation in home or low-resource setting requires further validation. Individualized RT regimens incorporating nutritional supplementation (e.g., protein/creatine) should be investigated as a high priority in future studies to maximize musculoskeletal and cognitive impact [14]. High RCTs must establish minimum effective doses and examine synergies with cognitive training. Furthermore, biomarkers like inflammatory cytokines (e.g., IL-6 reduction following RT) and neurotrophic factors must be validated, which would refine interventions and monitor efficacy [24].

Conclusions

Resistance exercise training provides powerful, evidence-based dual protection against the closely related challenges of sarcopenia and cognitive decline in older adults. RET serves as a flagship form of exercise for supporting healthy aging, health span, functional independence, and quality of life by promoting both musculoskeletal and neurocognitive health through common physiological mechanisms. Next steps to maximize its potential for public health and clinical longevity and normative improvement will be to address implementation challenges associated with the effective prescription of RET in older adults, and the previously identified critical research questions based through high-quality trials.

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Author's contributions:
Research concept and design: Sebastian Polok, Krzysztof Pietrzak
Data collection and/or compilation: Krzysztof Pietrzak
Data analysis and interpretation: Sebastian Polok, Małgorzata Wasilewska
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