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Resistance Training and Healthy Aging: Effects on Sarcopenia, Cognitive Function and Quality of Life - A Narrative Review

Maksymilian Sito[2]

ORCID: https://orcid.org/0009-0009-5436-6706

E-mail: maksymilian.sito@gmail.com

Kinga Zachar[1]

ORCID: https://orcid.org/0009-0007-8966-5867

E-mail: kinga.zachar@gmail.com

Filip Jurkowski[3]

ORCID: https://orcid.org/0009-0003-0561-6162

E-mail: filipjurkowskiii@gmail.com

Łukasz Wójcik[4]

ORCID: https://orcid.org/0009-0003-1516-3478

E-mail: lukaszjaw571@gmail.com

Natalia Gawron[5]
ORCID: https://orcid.org/0009-0009-4285-1755
E-mail: gawronnatalia@wp.pl

Hubert Tomasz Bojanowski[6]
ORCID: https://orcid.org/0009-0000-6899-6914
E-mail: hubert.bojan@gmail.com

Aleksandra Dobracka[7]
ORCID: https://orcid.org/0009-0004-1009-3631
E-mail: lek.a.dobracka@gmail.com

Zuzanna Marczak[8]
ORCID: https://orcid.org/0009-0002-9539-9255
E-mail: zuziam9@hotmail.com

Monika Jarowicz[2]
ORCID: https://orcid.org/0009-0005-4752-2572
E-mail: monjarowicz@gmail.com

Jędrzej Czmyr[2]
ORCID: https://orcid.org/0000-0002-3898-5322
E-mail: jedrekcz@gmail.com

[1] Czerniakowski Hospital, Stępińska Street 19/25, 00-739 Warsaw, Poland
[2] University Clinical Center of the Medical University of Warsaw, Banacha Street 1a, 02-097 Warsaw, Poland
[3] District Medical Centre in Grójec, Piotra Skargi Street 10, 05-600 Grójec, Poland
[4] Nicolaus Copernicus Hospital, Copernicus PL Sp. z o.o., Nowe Ogrody Street 1-6, 80-803 Gdańsk, Poland
[5] Independent Public Healthcare Complex in Płońsk, Henryka Sienkiewicza Street 7, 09-100 Płońsk, Poland
[6] Medical University of Warsaw, Żwirki and Wigury Street 61, 02-091 Warsaw, Poland
[7] Masovian Bródnowski Hospital, Kondratowicza Street 8, 03-242 Warsaw, Poland

[8] National Medical Institute of the Ministry of the Interior and Administration, Wołoska Street 137, 02-507 Warsaw, Poland
Corresponding Author
Maksymilian Sito E-mail: maksymilian.sito@gmail.com

Abstract

Background. Population aging causes loss of muscle strength, mass and functional reserve, increasing the risk of sarcopenia, frailty, falls, disability and lower quality of life. Resistance training is a documented non-pharmacological strategy for preserving musculoskeletal function and may support cognition and well-being.

Aim. To summarize evidence on resistance training in healthy aging, focusing on sarcopenia, cognition and quality of life.

Material and methods. PubMed/MEDLINE sources were reviewed, prioritizing consensus documents, randomized trials, systematic reviews and meta-analyses.

Results. Sarcopenia is defined mainly by low muscle strength; low muscle quantity or quality confirms diagnosis, and poor physical performance indicates severe disease. Progressive resistance training improves strength and function in older adults. In sarcopenia, meta-analyses show benefits for handgrip strength, gait speed and sit-to-stand performance, with variable effects on muscle mass and quality of life. Cognitive effects are promising but inconsistent, with possible benefits for global cognition and memory.

Conclusions. Resistance training is a core healthy-aging intervention and first-line non-pharmacological strategy for sarcopenia. Strongest evidence concerns strength and physical function; cognitive and quality-of-life effects are relevant but less uniform. Safe use requires individualized progression, supervision, fall-risk reduction and nutrition or aerobic/balance exercise.

Keywords: resistance training, healthy aging, sarcopenia, muscle strength, cognitive function, quality of life, older adults, frailty, physical performance

1. Introduction and purpose

Healthy aging is not limited to survival into older age. It refers to the preservation of functional capacity, independence, mobility, cognition, emotional well-being and social participation for as long as possible. In clinical practice, the loss of these capacities is frequently driven by interacting syndromes: sarcopenia, frailty, falls, multimorbidity, polypharmacy, cognitive impairment, pain, depression, fear of movement and social isolation. Among these, loss of skeletal muscle function is especially important because muscle strength is required for nearly every basic activity of daily living, including rising from a chair, walking, climbing stairs, carrying objects, preventing falls and recovering from illness.

Skeletal muscle is not only a locomotor tissue. It is a metabolic and endocrine organ involved in glucose disposal, insulin sensitivity, inflammatory regulation, amino-acid storage, postural control and energy expenditure. Age-related decline in muscle strength and neuromuscular power therefore reduces physiologic reserve and may accelerate the transition from independence to dependency. The clinical consequences are not theoretical: low strength and poor physical performance are associated with mobility limitation, falls, disability, hospital admission, nursing-home placement and mortality [1,2].

Resistance training, also called strength training or progressive resistance exercise, involves repeated muscular contractions against external resistance. Resistance can be provided by free weights, machines, elastic bands, body weight, weighted vests, pneumatic devices or functional tasks such as sit-to-stand movements. Unlike general physical activity advice, resistance training is designed to overload muscle and neuromuscular systems in a controlled way so that adaptation occurs. This adaptation can include increased motor-unit recruitment, improved rate of force development, tendon and connective tissue changes, muscle hypertrophy, improved balance-relevant strength, and greater confidence in movement [2-7].

The importance of resistance training in older adults is now reflected in major recommendations. The World Health Organization recommends that older adults perform muscle-strengthening activities at moderate or greater intensity involving all major muscle groups on at least 2 days per week, together with aerobic activity and multicomponent balance-focused activity when fall risk is present [13]. The National Strength and Conditioning Association position statement similarly concludes that resistance training is a powerful intervention to counteract loss of muscle strength and mass, physical vulnerability, functional decline, chronic-disease burden, psychological well-being impairment and reduced quality of life [2].

The purpose of this review is to synthesize current evidence on resistance training and healthy aging, focusing on three clinically relevant outcomes: sarcopenia, cognitive function and quality of life. The review deliberately separates strong conclusions from emerging hypotheses. The evidence that resistance training improves strength and many physical performance outcomes in older adults is robust. Evidence for cognitive and quality-of-life benefits is promising but more heterogeneous and depends on population, baseline impairment, intervention duration, intensity, supervision, outcome measures and adherence.

Research objective. The objective of this review is to evaluate resistance training as a healthy-aging intervention and to summarize evidence for its effects on sarcopenia, cognitive function and quality of life.

Research problems. The review addresses the following questions: (1) how sarcopenia is defined and why resistance training is clinically relevant; (2) which musculoskeletal and functional outcomes improve with resistance training; (3) what dose and implementation principles are supported by the literature; (4) whether resistance training improves cognitive outcomes in older adults; and (5) how resistance training influences quality of life, mood, independence and clinical practice.

Research hypotheses. The central hypothesis is that resistance training is a key non-pharmacological intervention for healthy aging because it directly targets muscle strength, physical function and functional reserve. A second hypothesis is that cognitive and quality-of-life benefits are most likely when resistance training is progressive, sustained, supervised or well supported, and embedded in broader programs that include nutrition, aerobic activity, balance training and management of comorbidities.

2. Material and methods

This article is a narrative review. The literature search focused on PubMed/MEDLINE-indexed publications, international guidelines and peer-reviewed medical sources available up to 26 July 2026. Search terms included combinations of: "resistance training", "strength training", "progressive resistance training", "healthy aging", "older adults", "sarcopenia", "frailty", "muscle strength", "physical function", "quality of life", "cognitive function", "mild cognitive impairment", "depression", "exercise prescription", "protein supplementation" and "falls".

Priority was given to systematic reviews, meta-analyses, randomized controlled trials, consensus definitions, clinical practice guidelines and position statements. Particular attention was given to the European Working Group on Sarcopenia in Older People revised consensus

(EWGSOP2), the National Strength and Conditioning Association position statement on resistance training for older adults, Cochrane evidence on progressive resistance strength training, and recent meta-analyses of exercise interventions for sarcopenia, cognition and quality of life [1-14,24-32].

The review was organized around clinically meaningful domains rather than around a formal quantitative synthesis. Evidence was grouped into: definitions and diagnosis of sarcopenia; mechanisms linking resistance training with aging biology; effects on muscle strength, muscle mass and physical performance; exercise prescription and safety; combined exercise-nutrition strategies; cognitive outcomes; and quality-of-life outcomes. Numerical results are reported only when directly supported by cited studies or meta-analyses.

No new patient data, clinical intervention, identifiable personal information or animal experiment was used. Therefore, ethics committee approval and informed consent were not applicable. AI assistance was used only to support drafting, organization and language consistency. Scientific source selection, interpretation, clinical caution and final responsibility require human author verification.

3. State of knowledge

3.1. Sarcopenia and healthy aging: definitions and clinical relevance

Sarcopenia is now understood as a muscle disease characterized primarily by low muscle strength rather than by low muscle mass alone. EWGSOP2 emphasizes low muscle strength as the key clinical feature, uses low muscle quantity or quality to confirm the diagnosis, and identifies low physical performance as a marker of severe sarcopenia [1]. This shift is clinically important because strength and power decline faster than muscle mass and are more directly related to disability, falls and loss of independence.

EWGSOP2 recommends a practical diagnostic pathway beginning with case finding, followed by assessment of muscle strength, confirmation by muscle quantity or quality, and severity grading by physical performance. Common measures include grip strength, chair stand testing, appendicular skeletal muscle mass, gait speed, Short Physical Performance Battery, Timed Up and Go and the 400-m walk test [1]. For European populations, EWGSOP2 cut-offs include grip strength below 27 kg for men and below 16 kg for women, chair stand time above 15 seconds for five rises, gait speed of 0.8 m/s or less, and SPPB score of 8 or less [1].

The distinction between sarcopenia, frailty and disability is important. Sarcopenia refers to muscle failure. Frailty is a broader syndrome of reduced physiological reserve across systems. Disability reflects difficulty or dependence in activities. These conditions overlap but are not

identical. Resistance training is relevant to all three because it targets a modifiable pathway: weakness. Even when muscle mass changes are modest, improved strength, balance-relevant function and confidence can reduce the practical consequences of aging.

Aging muscles undergo motor-unit remodeling, preferential loss or atrophy of type II fibers, reduced anabolic sensitivity to protein and exercise, mitochondrial changes, low-grade inflammation, hormonal changes, intramuscular fat infiltration and reduced neuromuscular activation. These mechanisms contribute to slower gait, reduced stair-climbing ability, poorer balance reactions and difficulty recovering from acute illness [1,2,35]. Resistance training addresses several of these mechanisms through progressive overload, neural adaptation and stimulation of muscle protein synthesis.

The clinical relevance extends beyond the musculoskeletal system. Low muscle strength is associated with poorer cardiometabolic health, lower physical activity, reduced participation, falls, pain, depression and loss of autonomy. Therefore, resistance training should be viewed not as optional fitness advice but as a core geriatric and public-health intervention when safely adapted to age, disease burden and baseline ability.

Table 1. Key concepts linking resistance training, sarcopenia and healthy aging.

Concept	Operational meaning	Clinical relevance
Probable sarcopenia	Low muscle strength, commonly assessed by grip strength or chair-stand test.	Triggers clinical action and further assessment. Strength is the central clinical feature in EWGSOP2.
Confirmed sarcopenia	Low muscle strength plus low muscle quantity or quality.	Supports formal diagnosis and targeted management.
Severe sarcopenia	Sarcopenia plus low physical performance, such as slow gait speed, low SPPB, prolonged TUG or poor 400-m walk performance.	Indicates higher functional risk and need for broader intervention.

Concept	Operational meaning	Clinical relevance
Frailty	Reduced physiological reserve across systems, often including weakness, slowness, exhaustion, low activity and weight loss.	Resistance training may reduce weakness and improve reserve but must be individualized.
Healthy aging	Maintenance of functional ability, independence, cognition and participation rather than only absence of disease.	Resistance training supports intrinsic capacity and autonomy.

Source: own elaboration based on the cited medical literature.

3.2. Biological mechanisms: why resistance training remains effective in older age

Resistance training improves function through both neural and muscular mechanisms. Early gains in strength often occur before meaningful hypertrophy and are largely attributable to improved motor-unit recruitment, synchronization, firing rate, intermuscular coordination and task-specific skill. This is particularly important in older adults because the capacity to generate force quickly may determine whether a person can prevent a fall, rise from a chair or recover from a perturbation.

Hypertrophic adaptation is also possible in older adults. Meta-analytic evidence shows that resistance exercise increases lean body mass in aging adults, although the magnitude is influenced by training volume, age and baseline status [5]. Older adults often show smaller hypertrophic responses than younger adults, partly because of anabolic resistance, lower training loads, comorbidity, undernutrition, inflammation or medication effects. Nevertheless, skeletal muscle retains trainability even in very old age [16].

Resistance exercise stimulates muscle protein synthesis through mechanical tension, mechanotransduction pathways and amino-acid-dependent signaling. Adequate protein intake may augment these adaptations, especially in frail or undernourished older adults [18-20]. This does not mean protein alone is sufficient. The most consistent functional improvements occur when nutrition supports an exercise stimulus rather than replacing it.

Resistance training may also affect cardiometabolic and inflammatory pathways. Increased muscle mass and contractile activity improve glucose disposal and insulin sensitivity, while exercise-associated myokine signaling may influence systemic inflammation. Improved

strength enables greater overall activity, creating a positive feedback loop in which the individual can walk more, participate socially, perform daily tasks and maintain independence.

Neuromuscular power deserves special attention. Many daily tasks require rapid force production rather than maximal strength alone. Programs incorporating controlled high-velocity concentric movements, when appropriate and supervised, may improve power and functional performance. However, such approaches require attention to safety, technique, joint status and cardiovascular tolerance, and they should not be introduced before basic movement competence is established.

3.3. Effects on muscle strength, muscle mass and physical performance

The strongest evidence for resistance training in healthy aging concerns muscle strength. The Cochrane review by Liu and Latham included 121 randomized controlled trials with 6,700 participants and concluded that progressive resistance training improves strength and physical function in older people [3]. Improvements were seen in simple and complex activities, including chair rise, stair climbing and walking-related outcomes, although adverse-event reporting was incomplete in many trials [3].

Peterson and colleagues similarly found that resistance exercise is effective for increasing muscular strength in older adults and has public-health relevance for preventing or treating age-related decline in muscle function [4]. Dose-response analyses suggest that higher intensity progressive resistance training often produces larger strength gains than low-intensity approaches, although tolerability and individualization are essential [6,7]. In clinical practice, the optimal program is not the most aggressive program, but the one that is sufficiently challenging, progressive and sustainable.

Effects on lean mass are meaningful but more variable than effects on strength. Peterson et al. reported that resistance exercise increases lean body mass in aging adults, with higher-volume interventions associated with greater increases and older age associated with smaller gains [5]. This pattern is consistent with clinical observation: an older adult may become substantially stronger and more functional without dramatic changes on body-composition testing.

In sarcopenic populations, recent meta-analyses support clinically relevant benefits. Bao et al. reported that exercise programs improved muscle mass, muscle strength and physical performance in older adults with sarcopenia [8]. Zhang et al. found significant improvements in grip strength, knee extension, chair-stand performance, Timed Up and Go, gait speed,

skeletal muscle mass index and appendicular skeletal muscle mass, although intervention heterogeneity was substantial [9].

A 2026 BMC Geriatrics meta-analysis of 13 randomized controlled trials involving 546 participants reported significant improvements in handgrip strength, gait speed, appendicular skeletal muscle mass index and five-times sit-to-stand performance after resistance exercise in older adults with sarcopenia. Reported pooled mean differences were 2.95 kg for handgrip strength, 0.15 m/s for gait speed, 0.25 kg/m2 for ASMI and -1.79 seconds for five-times sit-to-stand performance [10].

Another 2026 systematic review in Scientific Reports included 72 studies and found that physical exercise was superior to control conditions for skeletal muscle mass, muscle strength and physical performance in older adults with sarcopenia. Resistance exercise was more effective than aerobic exercise for increasing skeletal muscle mass, while combined exercise and nutritional supplementation appeared more beneficial for muscle mass and strength than either intervention alone. However, certainty varied from very low to moderate, and effects on quality of life were not significant in that analysis [11].

These findings support a practical message: resistance training is not merely preventive. It can be therapeutic in older adults who already have sarcopenia, frailty or functional limitation. However, outcomes should be measured realistically. Grip strength, chair-stand performance, gait speed, TUG and SPPB often provide more clinically useful information than muscle mass alone.

Table 2. Major evidence sources for resistance training and sarcopenia-related outcomes.

Evidence source	Population/design	Main outcomes	Interpretation
Liu and Latham, Cochrane 2009	121 RCTs, 6,700 older adults.	Improved strength and several physical function outcomes. Serious adverse events were rare when reported, but harms reporting was limited.	PRT is effective for older adults, but clinical implementation should monitor safety.

Evidence source	Population/design	Main outcomes	Interpretation
Peterson et al., 2010	Meta-analysis of resistance exercise and strength in older adults.	Resistance exercise improved muscular strength.	Supports full-body resistance exercise as protection against functional decline.
Peterson et al., 2011	Meta-analysis of lean body mass in aging adults.	Resistance exercise increased lean body mass; higher volume predicted greater gains.	Hypertrophy occurs, but magnitude varies by age, volume and baseline factors.
Bao et al., 2020	Systematic review/meta-analysis in older adults with sarcopenia.	Exercise improved muscle mass, strength and physical performance.	Exercise is central in sarcopenia management.
Li et al., 2026	13 RCTs, 546 sarcopenic older adults.	Improved grip strength, gait speed, ASMI and five-times sit-to-stand.	Recent evidence reinforces beneficial effects of resistance exercise in sarcopenia.

Source: own elaboration based on the cited medical literature.

3.4. Training prescription: dose, progression and individualization

Resistance training must be prescribed rather than merely recommended. The key variables are frequency, intensity, volume, exercise selection, progression, contraction velocity, rest intervals, supervision, recovery and adherence. For older adults, the initial prescription should match baseline function and medical status. A previously sedentary 85-year-old with falls and osteoarthritis requires a different starting point than a healthy 65-year-old with prior training experience.

International public-health guidance provides a minimum target: muscle-strengthening activities involving all major muscle groups on at least 2 days per week [13]. This is a population-level recommendation, not a complete rehabilitation prescription. Clinical programs often use 2-3 sessions per week, 1-3 sets per exercise, 8-12 repetitions, moderate to high perceived effort, and gradual progression as tolerated [2,6,7,15].

Progressive overload is essential. If the same low stimulus is repeated indefinitely, adaptation plateaus. Progression can occur by increasing resistance, repetitions, sets, range of motion, movement complexity, session frequency or movement speed. In frail adults, progression may begin with chair rises, wall push-ups, band rows and step-ups before machines or free weights. In healthier adults, machine-based or free-weight programs can be used when technique and supervision are adequate.

Intensity should be interpreted clinically. High-intensity resistance training can produce strong gains and has been used successfully even in very old adults under supervision [16]. However, intensity does not mean unsafe maximal lifting. It means the load is sufficient to challenge the muscle relative to the person, with correct technique and adequate recovery. Rating of perceived exertion, repetition reserve and movement quality can be useful when one-repetition maximum testing is impractical.

Power training may be useful because loss of power often exceeds loss of maximal strength with aging. A practical approach is to teach controlled eccentric lowering and intentionally faster but safe concentric movement once basic strength and technique are present. This may be especially relevant for chair rise, stair negotiation and balance recovery. However, high-velocity training should be avoided or modified when pain, instability, uncontrolled cardiovascular disease or poor motor control increases risk.

Supervision matters. It improves technique, progression, confidence and adherence, and may reduce injury risk. In clinical and community settings, supervision can be delivered by physiotherapists, exercise physiologists, trained instructors or structured programs. Home-based programs can work, but they require clear instructions, progression rules, safety screening and follow-up. Adherence is often improved when exercises are linked to meaningful goals such as carrying groceries, climbing stairs, playing with grandchildren or remaining independent.

Table 3. Practical resistance-training prescription variables in older adults.

Prescription variable	**Evidence-informed practical approach**	**Clinical cautions**
Frequency	Usually at least 2 days/week; many trials use 2-3 sessions/week.	More is not always better if recovery, pain or adherence worsen.

Prescription variable	Evidence-informed practical approach	Clinical cautions
Intensity	Moderate to high relative effort can be effective; start lower in frailty and progress gradually.	Avoid unmonitored maximal efforts in high-risk or untrained patients.
Volume	Often 1-3 sets per exercise; higher volume may support lean-mass gains.	Volume should increase only when technique and recovery are adequate.
Exercise selection	Major muscle groups; emphasize lower-limb and trunk tasks relevant to gait, transfers and falls.	Adapt for osteoarthritis, neuropathy, balance impairment and pain.
Progression	Increase resistance, repetitions, sets, complexity or velocity when exercises become easy.	No progression usually means no continued adaptation.
Supervision	Useful for frailty, sarcopenia, cognitive impairment, fear of movement or comorbidity.	Home programs need simple rules and periodic reassessment.
Integration	Combine with aerobic activity, balance training and nutrition when indicated.	Do not treat resistance training as a replacement for comprehensive care.

Source: own elaboration based on the cited medical literature.

3.5. Safety, adverse effects and contraindication-oriented thinking

Resistance training is generally safe for older adults when appropriately prescribed, but safety cannot be assumed without assessment. The Cochrane review reported that serious adverse events were rare and not directly attributed to exercise programs in studies that monitored them, but also noted that adverse events were not adequately reported across all trials [3]. This means clinicians should be reassured but not careless.

Common minor adverse effects include delayed-onset muscle soreness, transient fatigue, joint discomfort and temporary exacerbation of musculoskeletal pain. These are usually

managed by adjusting load, range of motion, volume, tempo or recovery. Persistent pain, swelling, neurologic symptoms, chest pain, syncope, severe dyspnea or abnormal blood-pressure responses require clinical evaluation.

Absolute contraindications are uncommon but include unstable cardiovascular disease, acute illness, uncontrolled severe hypertension, active inflammatory or infectious states, unstable fractures, and situations where a physician has advised temporary avoidance of exertion. Many chronic diseases are not contraindications; they require adaptation. For example, osteoarthritis may require joint-friendly range, slower progression and attention to pain; osteoporosis requires avoiding high-risk spinal flexion or loaded twisting; diabetic neuropathy requires foot safety and balance precautions.

Fall risk must be addressed explicitly. Lower-limb strength training improves capacity but can itself create risk if performed standing without support in a person with severe balance impairment. Safe programs use stable chairs, rails, appropriate footwear, supervised transitions, progressive difficulty and balance training where indicated. For cognitively impaired patients, simple routines and caregiver involvement may be necessary.

Frailty does not mean resistance training should be avoided. It means the entry point must be lower and the progression slower. Very frail individuals may begin with repeated sit-to-stand attempts, assisted rising, ankle strengthening, supported stepping and light elastic resistance. The purpose is to increase reserve, not to impose an athletic program. This distinction reduces fear and improves acceptability.

3.6. Nutrition and combined interventions

Resistance training and nutrition interact biologically. Older adults often have anabolic resistance, meaning that a given dose of dietary protein or exercise may stimulate muscle protein synthesis less effectively than in younger adults. Frailty, inflammation, low appetite, dental problems, gastrointestinal disease, poverty, restrictive diets and polypharmacy may further reduce protein intake or absorption. Therefore, exercise prescription should not ignore nutrition.

Protein supplementation can augment resistance-training adaptations in selected older adults. Tieland et al. showed that protein supplementation increased muscle mass gain during prolonged resistance-type exercise training in frail elderly people [18]. Cermak et al. found in a meta-analysis that protein supplementation augments the adaptive response of skeletal muscle to resistance-type exercise training [19]. Morton et al. later showed that protein

supplementation increases resistance-training-induced gains in fat-free mass and strength, with effects influenced by training status, age and total protein intake [20].

However, nutritional supplementation should not be presented as a universal substitute for training. Protein alone may improve some outcomes in frail or undernourished patients, but the strongest functional stimulus remains mechanical loading. A rational approach is to assess dietary intake, weight trajectory, renal function, chewing and swallowing problems, vitamin D status when clinically relevant, and overall diet quality. Supplementation is most justified when intake is low, weight loss is present, sarcopenia is diagnosed, or training is being initiated in a frail or nutritionally vulnerable patient.

Combined exercise and nutrition interventions are increasingly supported in sarcopenia. The 2026 Scientific Reports meta-analysis concluded that exercise plus nutritional supplementation yielded greater benefits than either intervention alone for muscle mass and strength, although certainty for some comparative analyses was low or very low [11]. A 2025 systematic review of combined exercise and nutrition interventions similarly found improvements in handgrip strength, skeletal muscle mass index, gait speed and sit-to-stand performance, while emphasizing differences across subpopulations [21].

In clinical practice, the most important principle is personalization. Patients with chronic kidney disease, advanced liver disease, gout, malnutrition, dysphagia, cancer cachexia or severe obesity require individualized nutrition advice. Resistance training is still useful in many of these conditions, but the nutrition plan should be medically appropriate rather than based on generic high-protein advice.

3.7. Cognitive function: evidence and mechanisms

The cognitive effects of resistance training are biologically plausible but less established than its effects on strength. Potential mechanisms include improved insulin sensitivity, reduced inflammation, better sleep and mood, increased cerebral blood flow during activity, neurotrophic signaling, improved vascular risk profile, increased self-efficacy, and indirect benefits mediated by greater mobility and social participation. Resistance training may also recruit executive control because it requires attention to technique, sequencing, posture, breathing and progression.

Early randomized evidence suggested benefit for executive function. Liu-Ambrose et al. conducted a 12-month randomized controlled trial in community-dwelling older women and reported that once-weekly or twice-weekly resistance training improved selective attention and conflict resolution compared with balance and tone training [24]. This study is important

because it tested a structured intervention over a relatively long period rather than relying on brief exposure.

Nagamatsu et al. later reported that resistance training promoted cognitive and functional brain plasticity in seniors with probable mild cognitive impairment, including changes compatible with functional brain adaptation [25]. The study was small, but it contributed to the idea that resistance exercise may be relevant not only to normal aging but also to early cognitive vulnerability.

Meta-analytic evidence is cautiously supportive. Coelho-Junior et al. found that resistance training improved overall cognitive function in cognitively healthy and cognitively impaired older adults, although individual domains varied [26]. A 2025 systematic review and meta-analysis including 17 randomized controlled trials and 739 participants found significant improvements in overall cognitive function, working memory, verbal learning and memory, and spatial memory span, while effects on processing speed, executive function and attention were not significant [27].

These findings require careful interpretation. Cognitive outcomes vary widely across studies because of different tests, baseline cognitive status, age, sex distribution, training protocols, supervision, adherence and control conditions. Some improvements may be mediated by mood, sleep, physical activity, social engagement or practice effects. Therefore, resistance training should not be described as a proven dementia treatment. It is more accurate to present it as a promising component of cognitive-health promotion and rehabilitation, especially when combined with aerobic activity, vascular-risk management, sleep optimization and social participation.

The clinical implication is practical: older adults should not be told that resistance training is only for muscles. Maintaining strength may indirectly support cognition by preserving independence, enabling outdoor activity, reducing fear of movement and supporting social participation. Direct cognitive benefits may occur, but they should be presented as probable in selected domains and still under active investigation.

Table 4. Cognitive outcomes associated with resistance training in older adults.

Outcome domain	Evidence summary	Strength of conclusion
Global cognition	Meta-analyses suggest modest improvement in older adults with and without cognitive impairment.	Promising, but affected by heterogeneity of tests and populations.

Outcome domain	Evidence summary	Strength of conclusion
Working memory and verbal/spatial memory	A 2025 meta-analysis reported significant benefits in these domains.	Moderate promise; requires replication and clearer dose-response data.
Executive function	Individual RCTs show benefit, but pooled results are inconsistent.	Heterogeneous; not a uniform effect.
Processing speed and attention	Some analyses do not show significant pooled effects.	Insufficient for strong claims.
Mild cognitive impairment	Small RCTs suggest possible brain and cognitive benefits.	Clinically interesting but not a substitute for dementia prevention or treatment programs.

Source: own elaboration based on the cited medical literature.

3.8. Quality of life, depression and psychosocial outcomes

Quality of life is a central outcome in healthy aging because older adults often value independence, pain reduction, social participation and confidence more than laboratory or imaging changes. Resistance training may improve quality of life through several pathways: better physical functioning, reduced pain, improved self-efficacy, increased participation, reduced fear of falling, improved body image, better sleep and mood, and reduced dependence on caregivers.

Khodadad Kashi et al. performed a systematic review and meta-analysis of resistance training in adults aged 60 years or more and found improvements in physical functioning, mental health, bodily pain, general health, social functioning and mental component score. Depression also improved, as did upper-limb strength, lower-limb strength and handgrip strength. However, no benefits were found for vitality, physical component score, total quality-of-life score or 6-min walk distance, and the authors emphasized that more evidence was needed for solid conclusions [31].

The distinction between quality-of-life domains is important. A person may improve pain, confidence and chair-rise ability without showing a large change in total quality-of-life score. Conversely, severe social isolation, poverty, grief, multimorbidity or cognitive decline may limit quality-of-life improvement even when strength improves. Therefore, resistance training should be part of a broader person-centered plan rather than a single isolated intervention.

Resistance training may also reduce depressive symptoms. A JAMA Psychiatry meta-analysis reported that resistance exercise training was associated with a significant reduction in depressive symptoms among adults [32]. In older adults, mood effects may be mediated by improved self-efficacy, sleep, physical function, pain, social interaction and metabolic health. However, resistance training should not replace evidence-based treatment for major depression when such treatment is clinically indicated.

Psychological barriers are common. Older adults may fear injury, believe they are too old, lack access to equipment, experience embarrassment, or have pain and low confidence. Clinicians should address these barriers directly. Effective messages include: strength can improve at any age; exercises can begin with body weight or bands; soreness is not required; training should be adapted to pain and disease; and the goal is not bodybuilding but independence.

Social context can influence adherence. Group programs may provide motivation, accountability and social connection. Home programs may improve accessibility but can reduce supervision. Digital tools may help some adults but may exclude others. The best model depends on physical ability, cognition, transport, finances, preferences and local resources.

3.9. Clinical implications for primary care, geriatrics, rehabilitation and public health

Resistance training should be integrated into routine care for older adults. In primary care, a brief screen can identify low strength and function: difficulty rising from a chair, slow gait, falls, weight loss, reduced grip strength or reduced activity. Patients with probable sarcopenia should receive further assessment and an intervention plan rather than only reassurance.

In geriatric practice, resistance training should be considered alongside medication review, nutrition, vitamin D assessment when appropriate, osteoporosis management, fall-risk evaluation, vision and footwear assessment, pain treatment and cognitive screening. Sarcopenia rarely exists in isolation; successful management requires addressing the conditions that prevent training, such as pain, fear, depression, malnutrition or unsafe home environments.

In rehabilitation, resistance training should be task-specific. For a patient whose main limitation is chair rise, repeated sit-to-stand progression may be more relevant than isolated knee-extension training alone. For a patient with slow gait, hip and knee extensor strengthening, plantar-flexor work, balance and walking practice should be integrated. For a patient with osteoporosis, spinal safety and posture should be considered. For a patient with cognitive impairment, exercises should be simple, repetitive and caregiver-supported.

Public health strategies should avoid presenting resistance training as a gym-only activity. Many older adults can begin with chair stands, wall push-ups, elastic-band rows, step-ups, heel raises, carries and supported squats. Community centers, physiotherapy clinics, senior clubs and primary-care networks can deliver scalable programs. The message should be that muscle-strengthening activity is as important for healthy aging as walking.

Outcome monitoring improves implementation. Useful measures include grip strength, five-times sit-to-stand, gait speed, TUG, SPPB, fall history, pain scores, quality-of-life domains and patient-specific goals. Tracking these outcomes shows patients that progress is not only reflected by body weight or appearance but by real functional capacity.

Equity is also relevant. Resistance training advice is less useful if patients cannot access safe spaces, equipment, supervision or transport. Low-cost home and community models are needed. Elastic bands, body-weight exercise and chair-based programs can reduce barriers, but professional oversight remains important for frail adults and those with complex disease.

4. Discussion

This review supports resistance training as one of the most important non-pharmacological interventions for healthy aging. Its primary evidence base is strong for muscle strength and many physical performance outcomes. It directly targets sarcopenia, a central pathway linking aging with frailty, falls, disability and loss of independence. The evidence is also increasingly supportive for cognitive and quality-of-life outcomes, although these domains are more heterogeneous and should be described with appropriate caution.

The modern concept of sarcopenia emphasizes strength rather than muscle mass alone. This is important because resistance training may produce functional benefit even when changes in muscle mass are modest. A patient who rises from a chair more easily, walks faster and falls less often has achieved a clinically meaningful outcome even if appendicular lean mass changes only slightly. For this reason, strength and performance tests should be routine outcomes in both research and clinical care.

The literature also shows that resistance training is not reserved for young or athletic populations. Very old and frail adults can adapt when the program is appropriately designed. High-intensity or power-oriented approaches may be effective in selected older adults, but the principle of individualization is essential. Resistance training should start at a safe level, progress systematically and remain aligned with patient goals.

Nutritional status can modify training response. Adequate protein and energy intake are important, especially in frail, sarcopenic or undernourished older adults. However, nutrition

should be considered supportive rather than replacing mechanical loading. Combined exercise and nutrition programs may be particularly useful, but the best regimen remains dependent on baseline nutrition, kidney function, comorbidities and patient preferences.

Cognitive benefits are plausible and supported by some RCTs and meta-analyses, but the evidence should not be overstated. Resistance training may improve global cognition, working memory and selected memory domains, while executive function and attention effects are inconsistent. It should therefore be included as part of a broader cognitive-health strategy rather than presented as an isolated anti-dementia treatment.

Quality-of-life effects are clinically important but difficult to measure. Resistance training can improve physical function, pain, mood, social participation and confidence, but total quality-of-life scores may remain unchanged if social, psychological or medical burdens persist. This explains why patient-centered outcomes and individualized goals are crucial. The purpose of resistance training in older adults is not only to increase strength numbers but to preserve autonomy and meaningful participation.

Implementation remains the major challenge. Many older adults do not perform regular muscle-strengthening exercise despite guideline recommendations. Barriers include fear, pain, lack of knowledge, cost, transport, poor access to supervision and misconceptions about age. Clinicians should provide concrete prescriptions and referrals rather than simply advising patients to exercise. Public-health programs should frame strength training as essential aging care, not optional recreation.

The main limitation of this review is its narrative design. No new meta-analysis was performed, and evidence from heterogeneous populations and protocols was summarized qualitatively. Studies differ in diagnostic criteria for sarcopenia, intervention duration, intensity, supervision, comparator conditions, adherence and outcome measures. Long-term effects on dementia incidence, institutionalization, hospitalization and mortality remain less certain than short-term effects on strength and function. Future research should define optimal prescriptions for different clinical phenotypes and assess sustained implementation in real-world settings.

5. Conclusions

Resistance training is a core intervention for healthy aging and should be included in routine strategies to preserve independence, mobility and functional reserve in older adults.

The strongest evidence supports improvements in muscle strength and physical performance. In older adults with sarcopenia, resistance training improves clinically relevant

outcomes such as grip strength, gait speed, appendicular skeletal muscle mass index and sit-to-stand performance, although effect sizes and certainty vary across analyses.

Current sarcopenia definitions emphasize low muscle strength as the central feature; therefore, strength testing and functional performance measures should guide diagnosis, intervention and monitoring.

Cognitive benefits of resistance training are promising but more heterogeneous than musculoskeletal outcomes. Improvements may occur in global cognition, working memory and selected memory domains, while executive function, attention and processing speed show less consistent results.

Resistance training may improve several quality-of-life domains, including physical functioning, mental health, pain and social functioning, but total quality-of-life effects are not uniform and depend on broader medical and psychosocial context.

Safe and effective implementation requires individualized prescription, progressive overload, attention to frailty and comorbidity, monitoring of pain and adverse effects, supervision when needed, and integration with nutrition, aerobic exercise and balance training.

Future research should clarify dose-response relationships, long-term adherence strategies, cognitive mechanisms, patient selection, effects in frailty and multimorbidity, and real-world implementation models that are accessible to older adults with different resources and abilities.

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