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Combined Exercise–Nutrition Intervention Strategies for Older Adults with Sarcopenia: A Scoping Review

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Abstract: *This scoping review aims to examine combined exercise-nutrition interventions for sarcopenic older adults, providing evidence to guide the design and implementation of future programs. We followed Arksey and O'Malley's five-step scoping-review framework and the PRISMA-ScR guideline. PubMed, Web of Science, Embase, the Cochrane Library and CINAHL were searched frominception to June 2025. We descriptively analysed the composition and outcomes of combined interventions. A total of 673 studies met the screening criteria, and 25 were eligible for analysis; most were randomized controlled trials. Participants were older adults diagnosed with either primary or secondary sarcopenia. Resistance exercise was the predominant intervention (60%), and most studies provided protein-based nutritional supplementation (64%). Among individuals with sarcopenia, the combined intervention exerted a synergistic effect. Combined exercise and nutrition therapies enhance muscle mass, strength and physical function in sarcopenic older adults. Future research should include long-term follow-up and test adherence-enhancement strategies.*

Keywords: *sarcopenia; exercise therapy; nutritional intervention; older adults; scoping review*

1. Introduction

Sarcopenia is a progressive skeletal muscle disorder associated with aging, characterized by loss of muscle mass, reduced strength, and impaired function. In 2019, the EWGSOP2 explicitly recognized sarcopenia as an independent muscle disorder[1]. The global prevalence among older adults is approximately 10% (12% in men, 10% in women)[2]. This condition substantially increases the risk of fall, fractures, functional decline, and chronic diseases thereby intensifying the healthcare burden. The etiology can be classified as primary (age-related) or secondary[1]. Insufficient physical activity and inadequate protein intake are recognized as major risk factors. Non-pharmacological management mainly includes resistance training and nutritional interventions[3]. Recent studies have emphasized combined exercise and nutritional strategies; however, inconsistencies in intervention protocols and assessment criteria hinder consensus on their effectiveness. This systematic review synthesizes evidence from combined intervention studies to provide guidance for optimizing clinical decision-making and public health policies, with the goal of improving patient outcomes and alleviating societal healthcare burdens.

2. Methods

This scoping review followed the methodological framework of Arksey and O'Malley[4], which comprises five stages: (1) formulating the research question; (2) identifying relevant studies; (3) selecting eligible studies; (4) extracting data; and (5) collating, summarizing, and reporting the findings.

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2.1. Formulating the research question

Our specific research questions were as follows: ① What combined exercise-and-nutrition intervention strategies have been described for older adults with sarcopenia? What are the key characteristics of these strategies?② How effective are these combined interventions?

2.2. Identifying relevant studies

We performed a computerized search of Web of Science, PubMed, the Cochrane Library, Embase, and CINAHL. From database inception to June 2025, we used controlled vocabulary and free-text keywords linked with Boolean operators to identify studies on combined exercise-and-nutrition interventions for sarcopenia in older adults. The final strategy combined three concept blocks: population('Aged' or 'elderly' or 'older people' or 'older adult*' or 'old age' or 'older age'), condition('sarcopenia' or 'sarcopenias'), and interventions('Exercise Therapy' or'Exercise, Remedial' or'Exercises, Remedial' or 'Remedial Exercises' or 'Therapy, Exercise' or 'Exercise Therapies' or 'Therapies, Exercise' or 'Rehabilitation Exercise' or'Exercise, Rehabilitation' or'Exercises, Rehabilitation' or'Rehabilitation Exercises') and('Nutrition Therapy' or 'Therapy, Nutrition' or 'Medical Nutrition Therapy' or 'Nutrition Therapy, Medical' or 'Therapy, Medical Nutrition'), incorporating all relevant synonyms and MeSH terms. This review defined inclusion and exclusion criteria using the PICOS[5]. Inclusion criteria: (P) Population: Adults ≥ 60 years diagnosed with sarcopenia by the Asian Working Group for Sarcopenia (AWGS)[6], the European Working Group on Sarcopenia in Older People (EWGSOP)[1]. (I) Intervention: Multimodal programmes combining exercise with nutritional supplementation. (C) Comparison: Nutrition alone, exercise alone, placebo, or usual care. (O) Outcomes: Sarcopenia-related measures, including muscle mass, strength (grip or lower-limb), calf circumference, gait speed, and muscle quality. (S) Study design: Randomized controlled trials (RCT) or prospective cohort studies. Exclusion criteria:①Participants did not meet the eligibility criteria.②Unavailable full text.③Duplicate publication.④Intervention consisting of exercise or nutrition alone.⑤Protocols or studies reporting no outcome data.

2.3. Selection of studies

Literature search records were imported into EndNote X9 for deduplication, after which screening was performed according to predefined inclusion and exclusion criteria. Firstly, two reviewers independently screened titles and abstracts to exclude clearly irrelevant studies. Subsequently, full-text reviews were conducted for studies considered potentially eligible. Any discrepancies were resolved through discussion, with a third reviewer providing final adjudication when necessary.

3. Results

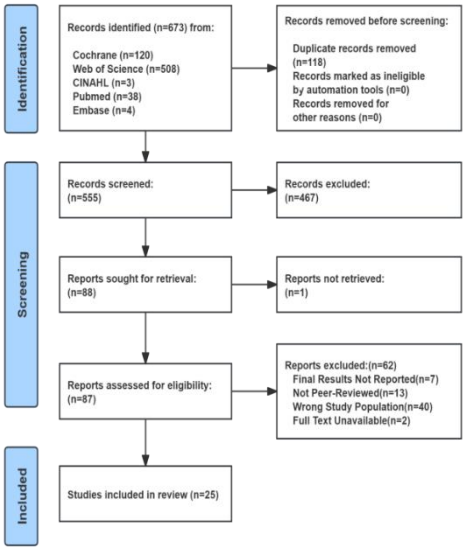

Figure 1 Literature screening specific flowchart

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The initial search identified 673 records across five databases: Cochrane Library (n = 120), PubMed (n = 38), Web of Science (n = 508), Embase (n = 4), and CINAHL (n = 3). After de-duplication, 555 unique records remained. Title and abstract screening excluded records with age discrepancies, conference abstracts, and other ineligible reports, leaving 87 articles. Full-text review excluded articles lacking full text, final results, or peer review, resulting in 25 eligible studies. The study selection flowchart is presented in Figure 1.

3.1. General characteristics

The studies were conducted in 11 countries. China contributed the most (n = 8), followed by Japan (n = 5), Germany (n = 3), and Brazil (n = 2). One study each originated from Canada, Spain, Australia, South Korea, Denmark, Finland, and Italy. Most trials were randomized controlled (n = 22); the remainder comprised one non-randomized controlled trial, one self-controlled study, and one prospective cohort study. Publications spanned 2012–2025, with most appearing after 2019. Sample sizes ranged from 22 to 218 participants. Table 1 summarizes the key characteristics of the included studies.

Table 1 Basic characteristics of the included studies

Authors	Year	Country	Intervention Strategy	Application Effects
Besora-Moreno M et al. [7]	2017	Canada	RT/ HIRT＋WP/ VD/ Ca/FO	A combined nutritional and exercise program targeting strength and body composition effectively mitigates sarcopenia in aging.
Meza-Valderrama D et al.[8]	2024	Spain	RT＋HMB	Supplementing Ca-HMB with resistance exercise may significantly improve muscle strength and physical performance in older women with sarcopenia.
Peng LN et al.[9]	2022	Tai Pei, China	RT＋BCAA	Sarcojoint (R) plus resistance exercise significantly increased muscle mass and serum levels of VD
Yamada M et al.[10]	2019	Japan	RT＋Protein / VD	The synergistic effect of bodyweight resistance exercise and protein supplement with VD on muscle quality and muscle strength in sarcopenic or dynapenic olderly
Chang KV et al.[11]	2023	Tai Pei, China	RT＋BCAA/VD/ Ca	Sarcopenic patients exhibit elevated levels of TNF-alpha, IL-1 beta, and IL-6, which declined after nutrition support and exercise interventions
Daly RM et al.[12]	2014	Australia	PRT＋Protein	A protein-enriched diet (~1.3 $g \cdot kg^{-1} \cdot d^{-1}$) from lean red meat safely enhances PRT effects on lean mass, muscle strength, and lowers IL-6 in elderly women.
Ji S et al.[13]	2025	Korea	RT/AE＋Protein Powder	A 12-week exercise and nutritional intervention improved physical performance, grip strength, and quality of life in community-dwelling older adults with sarcopenia.
Kim HK[14]	2012	Japan	RT/BT＋BCAA	Exercise combined with AAS may enhance muscle strength, muscle mass, and walking speed in sarcopenic women.
Li W et al.[15]	2022	China	RT/AE＋WP/ FO/VD	Nutrition supplementation and physical exercise contribute to muscle mass and body fat improvement among sarcopenic
Rondanelli M et al.[16].	2016	Italy	RT/BT＋ WP/BCAA/VD	WP, essential amino acids, and VD supplementation with age-appropriate exercise increase fat-free mass, strength, and overall well-being in sarcopenic elderly.
Wang B et al.[17]	2025	China	RT＋WP/VD/FO	Combined exercise and nutritional interventions effectively improve muscle mass, strength, and physical function in the elderly.
Zdzieblik D et al.[18]	2015	Germany	RT＋CP	Compared with placebo, collagen peptide supplementation combined with RT increased fat-free mass, enhanced strength, and reduced fat mass.
da Cruz Alves NM et al.[19]	2022	Brazil	RT＋FO	FO supplementation enhances training-induced neuromuscular response, improving strength and performance in sarcopenic older women.
Mori H et al.[20]	2022	Japan	RT＋WP	Combined intervention of RT and PRO showed long-term maintenance in treating sarcopenia than RT only at 24 weeks after de-training.
Gade J et al.[21]	2019	Denmark	RT＋ Protein	Protein supplementation does not appear to increase the adaptive response to low-intensity resistance in geriatric patients
Osuka Y et al.[22]	2022	Japan	RT＋HMB	Adding HMB supplements to RT did not significantly help improve muscle mass
Bjorkman MP et al.[23]	2020	Suomi	RT/AE＋WP	Whey protein supplementation combined with low-intensity home-based physical activity did not reduce deterioration of muscle and body functions
Yamamoto K et al.[24]	2017	Japan	RT/WE＋ Protein/HMB	Preoperative exercise and nutritional support may reduce muscle loss and improve postoperative outcomes in elderly gastric cancer patients.
Kemmler W et al.[25]	2018	Germany	WB-EMS＋WP	WB-EMS combined with WP supplements has positive effects on local and overall muscle/fat distribution as well as lower limb function.
Nabuco HCG et al.[26]	2019	Brazil	RT＋WP	WP plus RT increases limb lean tissue, reduces total and trunk fat, improves sarcopenia, and lowers SO in elderly women.
Kemmler W et al.[27]	2020	Germany	HIRT＋WP	HIRT training with WP is a safe, feasible, and effective strategy against osteoporotic sarcopenia in elderly men.
Xiang Q et al.[28]	2024	China	AE＋BCAA	Walking exercise plus BCAA supplementation improves muscle mass and strength and may prevent atrophy in cirrhotic patients with sarcopenia.
Guan Y et al.[29]	2023	China	RT/AE＋Protein	Nutritional intervention with RT improves muscle strength and function, further enhanced by adding AE.
Hu H et al.[30]	2023	China	RT＋WP	On top of heart failure treatment, nutritional intervention plus rehabilitation exercise significantly improves muscle mass, strength, function, and cardiac function in elderly patients with sarcopenia.
Nie N et al.[31]	2023	China	RT/AE＋WP	Nutritional intervention plus muscle exercise alleviates symptoms of osteoporotic femoral fractures in sarcopenic patients and promotes recovery.

①RT：Resistance Training ② HIRT：High-Intensity Resistance Training ③WP：Whey Protein ④VD：Vitamin D ⑤Ca：Calcium ⑥FO：Fish Oil ⑦HMB：β-Hydroxy-β-Methylbutyrate ⑧BCAA： Branched-Chain Amino Acids ⑨PRT：Progressive Resistance Training ⑩AE：Aerobic Exercise ⑪BT：Balance Training ⑫CP：Collagen Peptides ⑬WE：Walking Exercise ⑭WB-EMS： Whole-Body Electromyostimulation

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3.2. Characteristics of combined exercise-nutrition intervention strategies

Most studies employed RT(n = 16)[7-12, 17-23, 26, 27, 30], whereas AE(n = 1)[28] was uncommon. Several trials combined RT with AE (n = 5)[13, 15, 24, 29, 31] or BT(n = 2)[14, 16]. One study [25] used WB-EMS as a substitute for conventional exercise. Protein (n = 18) [7, 10, 12, 13, 15-18, 20, 21, 23-27, 29-31] and VD(n = 8) [7, 10, 11, 15-17, 23, 29] were the primary nutritional supplements, followed by BCAA (n = 5) [9, 11, 14, 16, 28], FO (n = 4) [7, 15, 17, 19], HMB (n = 3) [8, 22, 24], and Ca (n = 2) [7, 11]. Participants included primary sarcopenia (n = 17) [7-23] and sarcopenia secondary to type 2 diabetes (n = 1) [29], obesity (n = 2) [25, 26], osteoporosis (n = 1) [27], chronic heart failure (n = 1) [30], liver cirrhosis (n = 1) [28], femoral fracture (n = 1) [31], and gastric cancer (n = 1) [24].

3.3. Effectiveness of combined exercise-nutrition interventions across sarcopenia subgroups

Combined exercise and nutritional interventions are effective in individuals with primary sarcopenia. Meza-Valderrama[8] reported that adding 3 g/day HMB to RT raised the SPPB score by 2.1 points and hand-grip strength by 3.7 kg, indicating clinically meaningful gains. By contrast, Kim, H.K[14] showed that combining RT and AE with BCAA increased muscle mass by 3.1 % and muscle strength by 9.3 %. Multiple studies have confirmed that exercise combined with nutritional support is effective in secondary sarcopenia. Nabuco,H.C.G.[26] reported that RT combined with WP supplementation increased appendicular lean soft tissue (ALST) by 6.0 % in obese adults with sarcopenia. Total and trunk fat mass fell by 5.1 % and 1.1 %, and IL-6 dropped by 34.6 %. The finding indicate that adding whey protein to exercise increases ALST, reduces adiposity, and ameliorates sarcopenic obesity.

4. Discussion

4.1. Combined exercise–nutrition interventions are highly effective

This study indicates that combined exercise and nutrition interventions can effectively increase muscle mass and strength: 21 trials[7, 8, 10-20, 24-31] reported improvements in sarcopenia or primary-disease symptoms, whereas 2 trials [9, 23] showed no significant change in muscle or physical function, and another 2 [21, 22] found no added benefit from nutritional supplements during exercise. Most included trials were preliminary randomized controlled studies with small samples and short durations. Few reported standardized training for interventionists, and several used unsupervised home-based exercise. These limitations weaken the reliability of the findings; larger, longer, and more rigorously designed studies are required.

4.2. Future Innovative Directions for Combined Exercise–Nutrition Interventions

The primary strategies for managing sarcopenia include exercise and nutritional supplementation. However, these strategies can present substantial challenges for older adults with limited physical capacity. Therefore, this population urgently requires safer and more accessible exercise alternatives. Future research should develop non-traditional interventions tailored to specific age groups to enhance feasibility and effectiveness. For example, advances in artificial intelligence (AI) and digital platforms are improving intervention delivery. Patients can access professional instructional videos at home and follow standardized exercise protocols. This internet-based model remove geographical and temporal barriers, reduce costs and time demands, and thereby improve feasibility and adherence.

5. Conclusion

This scoping review analyzed exercise-nutrition interventions in older adults with sarcopenia. Combined approaches showed greater benefits than single components, with resistance training plus protein supplementation yielding synergistic gains in muscle mass, strength, and performance in both primary and secondary sarcopenia. Future research should refine multi-component programs to sustain long-term benefits and improve function and quality of life in this population.

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