

Review

Effects of resistance-based exercise interventions on sarcopenic obesity in postmenopausal women: systematic review

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Abstract: Sarcopenic obesity, defined as the coexistence of excess adiposity with reduced muscle mass and function, is highly prevalent in postmenopausal women due to menopause-related hormonal and metabolic changes. This systematic review aimed to synthesise evidence on the effects of resistance-based exercise interventions, defined as programmes in which resistance training constituted the main component, on outcomes related to sarcopenic obesity in postmenopausal women. Following PRISMA 2020 guidelines, *PubMed*, *Web of Science*, *Scopus*, and *SPORTDiscus* were searched from 2016 to 2026. A total of 101 records were identified, and 13 intervention studies met the inclusion criteria. Eligible studies included randomised and non-randomised intervention trials conducted in postmenopausal women with sarcopenic obesity who were exposed to structured resistance-based exercise programmes lasting ≥ 8 weeks, implemented either as standalone interventions or as the core component of multicomponent programmes. The included studies predominantly applied moderate-intensity resistance-based exercise, frequently using elastic bands, and in some cases combined with aerobic exercise and/or nutritional strategies. Improvements in muscle strength were reported in 11 of the 12 studies assessing this outcome, and functional performance improved in 9 of the 11 studies evaluating physical function. In contrast, effects on body composition were heterogeneous, with favourable changes reported in 7 of the 11 studies assessing fat mass or lean mass outcomes. Evidence regarding bone mineral density was inconsistent, with positive effects observed in 3 of the 6 studies, while metabolic and inflammatory markers showed variable responses across interventions. Resistance-based exercise interventions are consistently associated with improvements in muscle strength and functional capacity in postmenopausal women with sarcopenic obesity. Evidence regarding effects on body composition, bone mineral density, and metabolic outcomes remains heterogeneous and inconclusive. Further well-designed randomised controlled trials with longer follow-up periods and standardised diagnostic criteria are required to clarify these effects.

Keywords: Sarcopenic obesity; Older women; Menopause; Postmenopausal women; Resistance training; Multicomponent exercise.



1. Introduction

Menopause and Current State of Knowledge - Menopause is characterised by a progressive decline in oestrogen and progesterone levels, leading to hormonal and metabolic alterations that promote visceral fat accumulation, insulin resistance, and the gradual loss of skeletal muscle mass. These changes substantially increase the risk of metabolic, cardiovascular, and bone-related disorders in postmenopausal women (Wei et al., 2023). In addition, the combined reduction in muscle mass and increase in adiposity negatively affect physical function and functional independence, thereby contributing to reduced health-related quality of life during this life stage (Ciudin et al., 2020).

Despite the growing recognition of its clinical relevance, the interrelationship between menopause, sarcopenic obesity, and physical exercise remains insufficiently investigated, particularly with regard to the development of targeted therapeutic strategies. Exercise has been consistently proposed as a key non-pharmacological intervention for both the prevention and management of sarcopenic obesity. It contributes to improved body composition, enhanced insulin sensitivity, reduced systemic inflammation, and the preservation of bone health. Evidence supporting these benefits has been primarily derived from studies conducted in postmenopausal women or older female populations with comparable metabolic and functional profiles (Majchrzycki et al., 2013; Mendoza et al., 2016).

Accordingly, the implementation of well-structured exercise programmes tailored to the specific physiological needs of

postmenopausal women may play a relevant role in mitigating functional decline and reducing the burden of chronic disease associated with sarcopenic obesity (Ciudin et al., 2020; Thyfault and Rector, 2020). Nevertheless, further high-quality research is warranted to optimise exercise-based therapeutic approaches that comprehensively address sarcopenic obesity during this critical stage of life.

Pathophysiological Background of Sarcopenic Obesity - Sarcopenic obesity is a multifactorial condition defined by the coexistence of excess adiposity and reduced muscle mass and function. It is frequently associated with physical inactivity, chronic low-grade inflammation, and endocrine dysregulation. From a pathophysiological perspective, the concomitant loss of muscle mass and increase in adipose tissue promotes insulin resistance, oxidative stress, and a sustained pro-inflammatory state (Ciudin et al., 2020; Rodríguez et al., 2009).

During menopause, declining oestrogen levels further exacerbate these mechanisms, facilitating visceral fat accumulation and increasing susceptibility to both sarcopenic obesity and metabolic syndrome (Majchrzycki et al., 2013). Metabolic syndrome comprises a cluster of interrelated abnormalities, including central obesity, dyslipidaemia, hypertension, and type 2 diabetes, all of which have detrimental implications for cardiovascular, skeletal, and functional health (Gómez-Cabello et al., 2012; Pavón de Paz et al., 2006).

Sarcopenic Obesity and Physical Exercise - Physical exercise represents a cornerstone therapeutic strategy for mitigating the adverse consequences of sarcopenic obesity. In particular, resistance-

based exercise improves muscle strength, preserves muscle mass, and contributes to favourable adaptations in body composition, while attenuating inflammation and insulin resistance, mechanisms that are central to the pathogenesis of this condition (Gómez-Cabello et al., 2012; Mendoza et al., 2016).

Recent systematic reviews and meta-analyses have reported that resistance training-based interventions in postmenopausal women induce significant reductions in inflammatory markers among postmenopausal women. Improvements in systemic inflammation, commonly assessed via C-reactive protein, as well as in metabolic risk profiles, have been documented, with more pronounced effects observed in protocols characterised by higher training volumes (Khalafi et al., 2021; Nunes et al., 2024).

Furthermore, regular participation in structured exercise programmes is associated with better functional performance, reduced fall risk, and improved mobility, outcomes that are particularly relevant in the context of sarcopenic obesity and ageing (Majchrzycki et al., 2013).

Taken together, the integration of resistance-based exercise as the core component of structured or multicomponent programmes, potentially combined with appropriate nutritional strategies, appears to represent an effective approach for the management of sarcopenic obesity during the postmenopausal period (Mendoza et al., 2016). Although hormone-based therapies remain commonly prescribed, the potential of exercise as a robust, non-pharmacological intervention continues to be comparatively under-recognised.

The primary aim of this systematic review was to analyse the scientific evidence derived from experimental and quasi-experimental studies examining the effects of sarcopenic resistance-based exercise programmes, defined as interventions in which resistance training constituted the main component, on the management of obesity in postmenopausal women. The specific objectives were: (a) to evaluate the effects of these interventions on body composition, muscle strength, and domains of physical function (including strength-related, balance-related, and gait-related outcomes); and (b) to examine their impact on bone mineral density and key metabolic markers in this population.

2. Materials and Methods

Study Design - A systematic review with qualitative synthesis was conducted in accordance with the PRISMA 2020 statement (Page et al., 2021). The protocol was prospectively registered in the PROSPERO database (registration number: CRD420261299636). No deviations from the registered protocol occurred. The last database search was conducted in February 2026.

Eligibility criteria - The included studies met the following predefined inclusion and exclusion criteria.

Inclusion Criteria

- Studies primarily aimed at evaluating the effects of physical exercise in postmenopausal women with sarcopenic obesity.
- Articles published in peer-reviewed scientific journals between 2016 and 2026.
- Articles written in English or Spanish.

- Randomised controlled trials (RCTs).

- Quasi-experimental studies with or without a control group.

Exclusion Criteria

- Studies not primarily focused on sarcopenic obesity, physical exercise, and postmenopausal women.

- Articles published outside the predefined inclusion period.

- Articles written in languages other than English or Spanish.

- Systematic reviews and meta-analyses addressing the aforementioned topic.

Research Question and PICOS Framework - The research question and eligibility criteria were formulated according to the PICOS framework (Population, Intervention, Comparator, Outcomes and Study design), as recommended for *Cochrane handbook for systematic reviews of interventions* (McKenzie et al., 2022).

Population (P). Postmenopausal women, defined as those with ≥ 12 consecutive months of amenorrhoea or with biochemical criteria consistent with menopause, with a mean age ≥ 60 years or a minimum age ≥ 55 years when the sample was clearly postmenopausal, and diagnosed with sarcopenic obesity. Studies including mixed-sex samples were considered only when results were reported separately for women. Only postmenopausal women were considered eligible; studies including women in the menopausal transition were excluded unless participants were clearly postmenopausal according to clinical or biochemical criteria.

Intervention (I). Structured exercise programmes in which resistance training

constituted the main component of the intervention. Multicomponent programmes were eligible provided that resistance training represented at least 50% of the total training volume or sessions. Interventions could additionally include aerobic exercise, balance, power or flexibility training and/or nutritional strategies. The minimum required intervention duration was ≥ 8 weeks.

Comparator (C). Comparators included passive control conditions (usual care, no intervention or waiting list) and active control groups. Active comparators could involve alternative exercise modalities, provided that resistance training was absent or clearly represented a lower proportion of the intervention than in the experimental group.

Primary Outcomes (O). Indicators of sarcopenic obesity or its components:

Muscle mass: appendicular lean mass measured by dual-energy X-ray absorptiometry (DXA) or skeletal muscle mass index (ASM/height²).

Adiposity: total body fat percentage and/or visceral or central fat assessed via DXA or validated bioelectrical impedance analysis.

Muscle strength and physical function: handgrip strength, maximal strength (1RM), Short Physical Performance Battery (SPPB), gait speed, and chair-rise test.

Diagnostic criteria used to define sarcopenia and/or sarcopenic obesity were extracted as descriptive study characteristics.

Physical function was predefined a priori as a primary outcome domain and operationalised through functional performance measures (e.g., gait speed, balance or composite tests), while muscle

strength was considered a distinct but related primary outcome domain.

Secondary Outcomes (O). Bone mineral density (DXA at the lumbar spine and femoral neck); metabolic function parameters (fasting glucose, HOMA-IR, lipid profile, and systemic inflammatory markers); health-related quality of life; adherence to the intervention; and exercise-related adverse events.

Study Designs (S). Randomised controlled trials (RCTs), non-randomised controlled trials, and quasi-experimental studies including a defined comparator group were eligible. Cross-sectional studies, case series, studies without a comparator

group, observational studies without intervention, and qualitative designs were excluded. Quasi-experimental studies were eligible provided that they included a clearly defined comparator group, either a non-exercising control or an alternative exercise intervention.

Search Strategy and Databases - A comprehensive literature search was conducted using the following electronic databases: *Web of Science*, *PubMed*, *Scopus* and *SportDiscus*. A combination of keywords and Boolean operators ("AND", "OR") was used to construct database-specific search strings (Table 1).

Table 1. *Electronic databases and search strategies.*

Databases	Search strategy	Filters
Web of Sciences	TITLE-ABS-KEY(("postmenopause" OR "menopause" OR "older women" OR "aged women") AND ("sarcopenic obesity" OR (sarcopenia AND obesity)) AND ("exercise" OR "physical activity" OR "resistance training" OR "strength training" OR "multicomponent exercise" OR "combined exercise")) AND (LIMIT-TO (DOCTYPE,"ar")) AND (LIMIT-TO (LANGUAGE,"English") OR LIMIT-TO (LANGUAGE,"Spanish")) AND (LIMIT-TO (PUBYEAR,2025,2024,2023,2022,2021,2020,2019,2018,2017,2016,2015))	Document Type: Academic Journals Language: English or Spanish Year of publication: 2016-2026 Study Design: - Randomized Controlled Trial - Clinical Trial - Experimental Study - Quasi-experimental Study (In SPORTDiscus, this can be selected under "Document Type" and "Methodology", where available).
Scopus*	((postmenopause OR menopause OR "older women" OR "aged women") AND ("sarcopenic obesity" OR (sarcopenia AND obesity)) AND (exercise OR "physical activity" OR "resistance training" OR "strength training" OR "multicomponent exercise" OR "combined exercise")) AND PUBYEAR > 2015 AND PUBYEAR < 2027 AND (LIMIT-TO (DOCTYPE,"ar")) AND (LIMIT-TO (LANGUAGE,"English"))	Age: 60+ years (if the database allows filtering by age group). Access: Full text (optional, if required by the institution)
PubMed	((("Postmenopause"[MeSH Terms] OR menopause OR "older women" OR "aged women" OR elderly) AND ("Sarcopenic obesity" OR (sarcopenia AND obesity)) AND ("Exercise"[MeSH Terms] OR "Physical activity" OR "Resistance training" OR "Strength training" OR "Multicomponent exercise" OR "Combined exercise") AND ("Randomized controlled trial"[Publication Type] OR "Clinical trial" OR "Experimental study" OR "Quasi-experimental study"))	
SportDiscus	((postmenopause OR menopause OR "older women" OR "aged women" OR "elderly women") AND ("sarcopenic obesity" OR	

	(sarcopenia AND obesity)) AND ("exercise" OR "physical activity" OR "resistance training" OR "strength training" OR "multicomponent exercise" OR "combined exercise")) AND (randomized OR "clinical trial" OR experimental OR quasi-experimental)	
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Note: “AND”, “OR” (Boolean operators). *The Scopus database allows filtering by female gender.

The search covered studies published between January 2016 and February 2026. This time frame was selected to capture evidence generated after the publication of updated international diagnostic criteria for sarcopenia and sarcopenic obesity. Searches were

limited to studies published in English or Spanish due to resource constraints and because most relevant literature in this field is published in these languages.

Exercise Intervention Description and Reporting Quality (CERT) - Exercise interventions were described in detail by extracting information on exercise type, frequency, intensity, time, volume and progression (FITT-VP principle), when reported by the original studies. To enhance transparency and reproducibility, the

reporting quality of exercise interventions was additionally assessed using the Consensus on Exercise Reporting Template (CERT) (Slade et al., 2016).

The CERT comprises 16 items covering key aspects of exercise prescription, delivery and adherence, including materials and equipment, provider qualifications, exercise setting, supervision, progression rules and fidelity of implementation. Each included study was evaluated against the 16 CERT items based on the information reported in the published manuscripts. The aim of this assessment was descriptive, to identify the completeness of intervention reporting rather than to generate a summary quality score. A detailed description of exercise interventions and CERT item coverage for each study is provided in Table 2.

Table 2. Detailed description of exercise interventions and CERT reporting.

Study	EM	EP	F	I	D/V	P	S	OC	CERT
Liao et al. (2017)	Elastic resistance exercise training	Elastic band (Theraband)	3 training session/week	Band color (yellow, red, green, blue, black, and silver)	12 weeks. session 10 min. warm-up; 35-40 min (ERET).	Band colours and RPE (Borg scale)	Supervised	Cool-down routine (to finally)	9/16
Forsyth et al. (2023)	Jump-based exercise	Vertical and multidirectional jumps	3×/week	Not reported	8 months; volume not specified	Not reported	Monthly supervision	Balance exercises (control group)	7/16
Isenmann et al. (2023)	Resistance training	Squat, bench press, upper- and lower-limb exercises	2×/week	Moderate- vs low-intensity RT	5 exercises/session; 10-week RT phase	Load/deload alternation	Supervised	Standardized diet	10/16
Vasconcelos et al. (2016)	Resistance training	Open- and closed-chain resistance exercises (lower limbs)	2×/week	Not reported	60 min/session; 10 weeks	Not reported	Supervised	Telephone monitoring (control)	8/16
Huang et al. (2017)	Elastic-band resistance training	Whole-body elastic-band exercises	3×/week	No reported	55 min/session; 12 weeks	Not reported	Supervised	Health education/home advice (control)	9/16
Villareal et al. (2017)	Resistance, aerobic, or combined exercise	Large-muscle RT and/or aerobic exercise	3×/week	Moderate aerobic; progressive RT	26 weeks	Progressive loading	Supervised	Hypocaloric diet	12/16
Gutiérrez-López et al. (2021)	Multicomponent exercise	Aerobic exercise, isotonic resistance with weights, stretching	3×/week	Moderate (60–70 % VO ₂ max / HRmax)	3 months	Progressive external load	Supervised	Flexibility training	11/16
Lee et al. (2021)	Elastic-band resistance training	Elastic-band group exercises (<6 participants)	3×/week	Progressive	36 sessions; 12 weeks	Progressive band resistance	Supervised	Lectures/home instructions (control)	9/16
Zhong et al. (2022)	Combined aerobic & resistance training	Aerobic, resistance, balance and functional exercises	4×/week	Not reported	8 weeks	Not reported	Not reported	Lifestyle maintenance (control)	8/16
Gad El-Hak et al. (2021)	Aerobic & core exercise	Walking, aerobic exercise, core strengthening	3×/week	Moderate	3 months	Not reported	Supervised	Hypocaloric diet + walking	9/16
Nabuco et al. (2019)	Resistance training & supplementation	Full-body RT (8 exercises; 3 × 8-12 RM)	3×/week	8-12 RM	12 weeks	Progressive loading	Supervised	Whey-protein supplementation	13/16
Banitalebi et al. (2020)	Elastic-band resistance training	Major-muscle elastic-band exercises	3×/week	OMNI scale	12 weeks	Progressive band colour/load	Supervised	Diet activity monitoring (control)	11/16
Banitalebi et al. (2021)	Elastic-band resistance training	Elastic-band resistance exercises	3×/week	Progressive	12 weeks	Progressive intensity/volume	Supervised	Habitual activity counselling	10/16

The methodological quality of the included studies was assessed using the Physiotherapy Evidence Database (PEDro) scale, a validated tool for the appraisal of randomised controlled trials. The PEDro scale consists of 11 items, of which 10 contribute to the final methodological quality score, with higher scores indicating greater methodological rigour.

The PEDro assessment was applied exclusively to randomised controlled trials included in the review, whereas non-randomised and quasi-experimental studies were not scored using the PEDro scale and were instead described qualitatively, in accordance with the scope and intended use of the instrument.

Each randomised controlled trial received one point for each PEDro criterion fulfilled, resulting in a total score ranging from 0 to 10. Consistent with established

conventions, scores of 9-10 were considered indicative of excellent methodological quality, 6-8 of good quality, 4-5 of moderate quality, and < 4 of low methodological quality (Maher et al., 2003).

The methodological quality assessment was conducted independently by two reviewers, and any discrepancies were resolved through discussion until consensus was reached. PEDro scores and quality classifications for each included randomised controlled trial are presented in Table 3. .

Table 3. PEDro scale scores for the included studies.

Study references	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	PEDro	Level
Gutiérrez-López et al. (2021)	YES	NO	NO	NO	NO	NO	YES	YES	NO	YES	YES	NA	C
Lee et al. (2021)	YES	YES	YES	YES	NO	NO	YES	YES	YES	YES	YES	8/10	A
Zhong et al. (2022)	YES	YES	NO	YES	NO	NO	NO	YES	NO	YES	YES	5/10	B
Gad El-Hak et al. (2021)	YES	YES	NO	YES	NO	NO	NO	NO	NO	YES	YES	4/10	C
Nabuco et al. (2019)	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	9/10 (evaluation based on double-blind trial)	A
Banitalebi et al. (2021)	YES	YES	NO	YES	NO	NO	YES	YES	NO	YES	YES	6/10	B
Banitalebi et al. (2020)	YES	YES	YES	YES	NO	NO	YES	NO	YES	YES	YES	7/10	B
Forsyth (2023)	YES	YES	NO	YES	NO	NO	YES	NO	NO	YES	YES	5/10	C
Isenmann et al. (2023)	YES	YES	NO	YES	NO	NO	YES	NO	NO	YES	YES	5/10	C
Vasconcelos et al.(2016)	YES	YES	YES	YES	NO	NO	YES	YES	YES	YES	YES	8/10	A
Villareal et al.(2017)	YES	YES	YES	YES	NO	NO	YES	YES	YES	YES	YES	7/10	A/B*
Huang et al. (2017)	YES	YES	YES	YES	NO	NO	YES	YES	YES	YES	YES	7/10	B
Liao et al. (2017)	YES	YES	NO	YES	NO	NO	YES	YES	YES	YES	YES	7/10	A

Risk of Bias Assessment - The risk of bias assessment was conducted in accordance with the PRISMA 2020 recommendations, applying design specific tools appropriate to the methodological

characteristics of the included studies. Randomised controlled trials were assessed using the Cochrane Risk of Bias tool (RoB 2) (Sterne et al., 2019), whereas non randomised

intervention studies were evaluated using the ROBINS I tool (Sterne et al., 2016).

Cross sectional and observational studies without an intervention component were not eligible for inclusion in this systematic review and were therefore not considered in the risk of bias assessment.

The RoB 2 tool evaluates bias across five domains: (1) bias arising from the randomisation process, (2) bias due to deviations from intended interventions, (3) bias due to missing outcome data, (4) bias in the measurement of the outcome, and (5) bias in the selection of the reported result. Each domain was rated as “low risk”, “some concerns”, or “high risk of bias”, leading to an overall judgement for each study.

The ROBINS I tool was used to assess risk of bias in non randomised intervention studies, covering domains related to confounding, selection of participants, classification of interventions, deviations from intended interventions, missing data, measurement of outcomes, and selection of the reported result. Overall risk of bias was classified as low, moderate, serious, or critical, according to the ROBINS I guidance.

Risk of bias assessments were performed independently by two reviewers, and any disagreements were resolved through discussion until consensus was achieved. A summary of the risk of bias judgements for each included study is presented in Table 4.

Table 4. Risk of bias analysis of the included studies.

Reference	StudyDesign	Tool	OverallRisk of Bias	Key Domains
Lee et al. (2021)	RCT	RoB 2	Someconcerns	No blinding; remaining domains adequate.
Zhong et al. (2022)	RCT	RoB 2	Someconcerns	Allocation concealment unclear; very small sample size.
Gad El-Hak et al. (2021)	RCT	RoB 2	High	Weak randomisation; no ITT analysis; uncontrolled deviations.
Nabuco et al. (2019)	RCT	RoB 2	Low	Double-blind; minimal attrition; objective measurements
Banitalebi et al. (2021)	RCT	RoB 2	Someconcerns	Ocultación no detallada; pérdidas moderadas.
Banitalebi et al. (2020)	RCT	RoB 2	Someconcerns	Allocation concealment not detailed; moderate attrition.
Forsyth (2023)	RCT	RoB 2	High	High attrition without ITT; limited transparency in randomisation.
Isenmann et al. (2023)	RCT	RoB 2	High	Significant attrition; unclear allocation concealment; no prior registration.
Vasconcelos et al. (2016)	RCT	RoB 2	Low	Adequate allocation concealment; blinded assessors; solid follow-up.
Villareal et al. (2017)	RCT	RoB 2	Low	Robust randomisation; centralised assessment; protocol available.

Huang et al. (2017)	RCT	RoB 2	Some concerns	Partial blinding; small sample size.
Gutiérrez-López et al. (2021)	Non-randomised	ROBINS-I	Serious	Residual confounding; selection bias; appropriate measurement.
Liao et al. (2017)	RCT	RoB 2	Moderate	No allocation concealment; no blinding of participants/therapists; assessor blinding adequate; low attrition; selective reporting unclear.

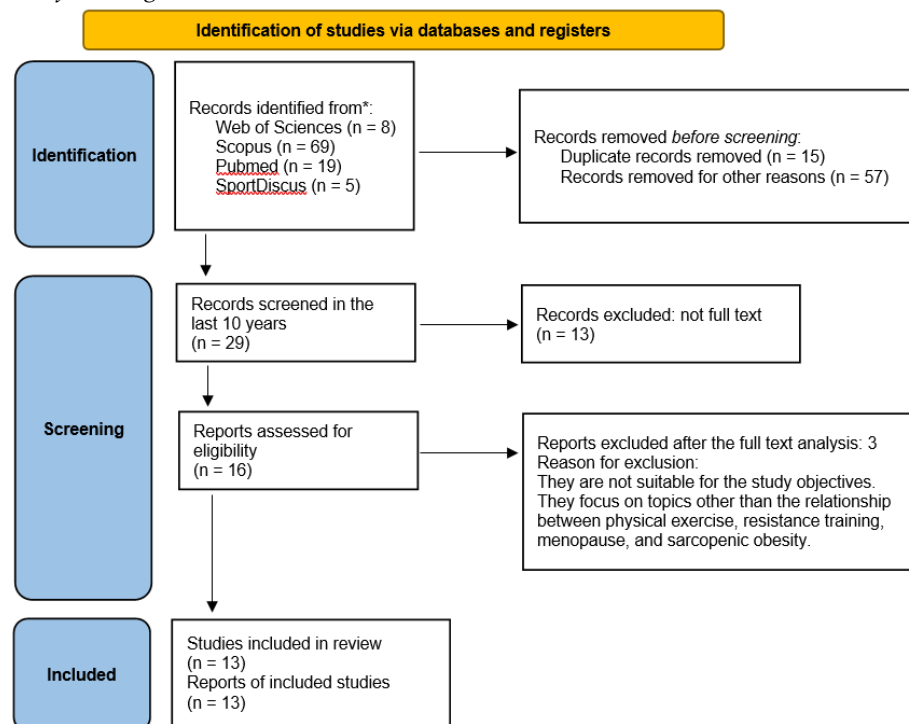
3. Results

Study Selection - Figure 1 presents the PRISMA flow diagram summarising the process of study identification, screening, eligibility assessment, and final inclusion. A total of 101 records were identified through database searching, including 77 records from *Web of Science* (n = 8) and *Scopus* (n = 69), 19 from *PubMed*, and 5 from *SPORTDiscus*. After removal of duplicate records (n = 15) and records excluded for other reasons (n = 57), 29 records published within the last 10 years were screened by title and abstract.

Of these, 13 records were excluded because full-text versions were not available, and 16 full-text articles were assessed for eligibility. Following full-text evaluation, 3 studies were excluded because they did not meet the predefined eligibility criteria, as they did not specifically address the relationship between physical exercise, menopause, and sarcopenic obesity or were not aligned with the objectives of the review.

Ultimately, 13 studies met all inclusion criteria and were included in the qualitative synthesis

Figure 1. PRISMA flow diagram



Characteristics of Included Studies -

Table 5 provides a detailed overview of the methodological characteristics and principal findings of the 13 studies included in the qualitative synthesis. The studies predominantly investigated samples of older women, with most participants aged between 65 and 80 years, although two studies included younger postmenopausal women with mean ages between 55 and 65 years.

From an intervention perspective, the included studies were classified according to the overall design of the intervention programme. Eight studies evaluated standalone resistance- or impact-based exercise interventions ($n = 8$), whereas five studies investigated multicomponent interventions in which resistance training was combined with aerobic exercise, dietary strategies, protein supplementation, or other complementary components ($n = 5$). This classification was performed at the study level rather than according to individual intervention arms, thereby avoiding double-counting of the included studies. Standalone interventions included resistance- or impact-based exercise programmes using elastic bands, free weights, machine-based resistance exercises, or jumping protocols. In contrast, multicomponent interventions combined resistance training with aerobic exercise, balance training, dietary counselling, protein supplementation, or other complementary therapeutic strategies. The majority of interventions were conducted at moderate intensity, as explicitly reported or inferred from training descriptions based on established exercise prescription criteria.

Intervention duration ranged from 8 to 26 weeks, with most programmes lasting between 10 and 12 weeks, and training frequency varying from two to four sessions per week. Considerable heterogeneity was observed in session structure, exercise selection, supervision, and progression models, as well as in the inclusion of complementary components such as dietary counselling or protein supplementation.

Across studies, the most frequently assessed outcomes were muscle strength ($n = 12$ studies), physical function ($n = 11$ studies), and body composition parameters ($n = 11$ studies). Bone mineral density was evaluated in 6 studies, while metabolic, inflammatory, or hormonal markers were assessed in 7 studies, reflecting variability in outcome prioritisation across trials.

With respect to body composition, reductions in fat mass and/or increases in lean mass were reported in 7 of the 11 studies assessing these outcomes, although the magnitude and consistency of changes varied across intervention. In particular, Liao et al. (2017) reported significant improvements in lean mass and reductions in fat related parameters following a 12 week elastic band resistance training programme, compared with a control group receiving health education only. Improvements in muscle strength were observed in 11 of the 12 studies evaluating this outcome, commonly assessed using handgrip strength, one repetition maximum tests, knee extensor strength, or chair stand performance.

Physical function outcomes showed improvements in 9 of the 11 studies assessing functional performance, particularly in gait speed, chair rise performance, and composite functional tests, whereas balance related

outcomes were less consistently affected. The study by Liao et al. (2017) also demonstrated significant improvements in physical capacity, reinforcing the beneficial effects of resistance-based exercise on functional performance in women with sarcopenic obesity.

Bone mineral density outcomes were heterogeneous, with positive effects reported in 3 of the 6 studies, mainly at the lumbar spine or calcaneal sites. Positive changes were most commonly observed following elastic band resistance training or impact-based exercise programmes, as reported by Forsyth (2023), Huang et al. (2017), and Lee et al. (2021), whereas the remaining studies reported no statistically significant changes over the intervention period.

Studies incorporating nutritional strategies alongside resistance training reported additional benefits in selected outcomes. For example, Nabuco et al. (2019)

observed greater increases in appendicular lean mass and greater reductions in fat mass and interleukin 6 levels when resistance training was combined with whey protein supplementation, compared with resistance training alone. Similarly, multicomponent interventions combining aerobic and resistance exercise were associated with concurrent improvements in body composition and functional outcomes, as reported by Zhong et al. (2022).

Overall, the included studies demonstrate substantial methodological and clinical heterogeneity with respect to participant characteristics, intervention design, and outcome assessment. This heterogeneity underscores the need for cautious interpretation of aggregated findings and justifies the use of a qualitative synthesis.

Table 5. Methodological characteristics and principal findings of the included studies.

Cite	Objective	Methodology			Main Findings
		Sample	Variables and instruments	Design / Intervention	
Forsyth et al. (2023)	To evaluate the effects of a jumping program on bone mineral density and MS in postmenopausal women compared with a balance-exercise CG.	49 postmenopausal women aged ≥ 50 years; 37 completed the study.	- BMD assessed using QUS at the calcaneus (BUA and SOS), including stiffness index (SI), T and Z scores. - TUG, GRF, SF-36 v2 and BPAQ.	Participants were randomly assigned to a jumping intervention group or a balance-exercise CG, 3 times per week for 8 months. The intervention included vertical and multidirectional jumps, while the CG performed single-leg balance exercises. Monthly supervision and messaging applications were used to promote adherence.	The intervention group showed increases in BUA (3.0% vs. 1.2% control) and SI (6.4% vs. 2.4% control), as well as a smaller decline in T-score (-17.2% vs. -44.1%). Jump height increased by 9.6% and GRF/BM by 31.1% in the intervention group. Significant improvements in balance were observed in both groups, with no relevant changes in other parameters. Based on these data, 56 participants would be required in future studies to achieve 80% statistical power.
Isenmann et al. (2023)	To evaluate the impact of moderate- and low-intensity RT in pre- and postmenopausal women, analysing changes in BC, MS, and muscle thickness.	41 healthy women: 17 premenopausal and 24 postmenopausal, assigned to three groups (PreMeno MI-RT, PostMeno MI-RT, PostMeno LI-RT). Mean age: 47.4–55.6 years.	-BC by bioimpedance. - Hormones: estradiol, progesterone, testosterone, DHEA, FSH (saliva/blood; ELISA/CLIA). - Muscle thickness: vastus lateralis, rectus femoris, triceps brachii (ultrasound). - Maximal strength: handgrip dynamometer; 1-RM squat and bench press.	Two-phase study (10 weeks without exercise followed by 10 weeks of RT). RT performed twice weekly with 5 exercises per session, alternating load and deload weeks. Assessments (T0, T1, T2) conducted in the morning under fasting conditions with exercise and alcohol/cafeine restrictions 48 hours prior.	No changes in weight or BMI. Only the PreMeno MI-RT group showed a significant increase in FFM ($p=0.02$). All groups improved in 1-RM squat and bench press. Increased muscle thickness in rectus femoris and vastus lateralis in PreMeno MI-RT; no change in triceps. Diet remained standardised.
Vasconcelos et al. (2016)	To evaluate the effect of a resistance exercise program on physical function in older women with sarcopenic obesity.	Women aged 65–80 years with sarcopenic obesity (BMI ≥ 30 kg/m ² and HS ≤ 21 kg). 395 recruited; 31 randomised to	-Muscle performance (knee extensor strength and power). - SPPB, GS, SF-36. Sociodemographic and clinical data BMI, WC and depressive symptoms.	Ten-week resistance exercise program, 1 hour/session, twice per week, including open- and closed-chain exercises. CG received telephone monitoring. Assessments at baseline and after 10 weeks.	High adherence (85%). Significant improvement in knee extensor muscle power (15 W/kg, $p=0.01$). No significant differences in anthropometric measures or quality of life.

		control and intervention groups.			
Huang et al. (2017)	To evaluate the effect of elastic band RT on BC in elderly women with sarcopenic obesity.	35 postmenopausal women aged 60-90 years who were independent in daily activities and met criteria for obesity and sarcopenia.	-TSM and BF%by BIA. - BMI, BMDby DEXA. - Laboratory data: lipid profile, liver enzymes, renal function, CPK, and hs-CRP.	12-week pilot randomised controlled trial with a TG and a CG. TG: elastic band resistance program, 3 times per week, 55 minutes per session, including exercises for all major muscle groups. CG: health education and home exercise advice.	Significant reduction in body fat percentage in the TG ($p=0.02$). -Reduction in limb fat ($p=0.03$ right; $p=0.04$ left) and total fat ($p=0.03$). - Significant increase in BMD ($p=0.03$), T-score ($p=0.03$), and Z-score ($p=0.02$) in the TG.
Liao et al. (2017)	To identify the clinical efficacy of elastic resistance exercise training (RET) in patients with sarcopenic obesity	Female patients aged 60 to 80 years, only patients who were defined as having sarcopenic(CEW GSOP).	- BC, - HG and MQ, - Physical capacity: functional mobility tasks including SLS, GS, TUG and TUG,TCR.	EG attended 3 training sessions weekly and were supervised by a licensed senior physical therapist. Each exercise session involved a general warm-up of 10 minutes, followed by resistance training exercises (35-40 minutes), and finally a cool-down routine. The 15-point Borg scale was used to rate the patients' perceived exertion ranging from 6 ("no exertion at all") to 20 ("maximal exertion") during the training sessions. In resistance training, exercise loads for individual elasticity levels (as indicated by the band color (yellow, red, green, blue, black, and silver).	Significant between-group difference was observed in fat-free mass, MQ, and physical capacity ($p < .05$); and a significant correlation was found between leg-lean-mass change and gait speed ($r = 0.36$; $p < .05$). After 12 weeks of elastic RET intervention, the EG had significantly fewer patients exhibiting sarcopenia ($p < .05$) and experiencing physical difficulty ($p < .001$) than the CG.
Villareal et al. (2017)	To compare the effects of aerobic exercise, RT, and their combination, within a hypocaloric dietary intervention, on physical function in obese older adults.	160 obese older adults (~70 years old) capable of performing supervised exercise.	-PPT. - BC by DXA. - MS assessed by 1-RM testing. -Cardiorespiratory fitness assessed by graded exercise test with peak VO_2 . - Metabolic parameters from fasting blood samples, including insulin sensitivity.	26-week randomised clinical trial. Participants were assigned to hypocaloric diet alone or diet combined with aerobic exercise, RT, or both. RT: supervised large muscle group exercises, 3 times per week with progressive loading. Aerobic training: moderate intensity. All sessions supervised and adherence monitored.	Exercise groups showed greater improvements in physical function than diet alone, with the largest increase in the combined group (+6.7 PPT points), followed by resistance (+5.1) and aerobic (+3.9), versus +2.3 in controls. Lean mass loss was smaller with resistance (-0.6 kg) and combined exercise (-1.2 kg) compared with diet alone (-2.8 kg).

					All groups reduced fat mass, with greater reductions in the combined group (−8.6 kg) compared to control (−5.6 kg). MS increased only in resistance-based groups (~+20–23% 1-RM). Peak VO ₂ improved mainly in groups including aerobic exercise (~+15–17%).
Gutiérrez-López et al. (2021)	To develop a moderate-intensity exercise program for older women with sarcopenic obesity and evaluate its effects on oxidative damage and physical function.	N = 60 30 healthy women (68 ± 5.05 years) 30 women with sarcopenic obesity (68 ± 5.75 years)	-BMI - MS: dynamometer - Functional performance: GS and TUG - BIA: muscle mass - Anthropometry: age, height, weight, waist circumference, blood pressure, skinfold thickness - Oxygen consumption: Astrand test - Biomarkers: oxidative, lipid and protein damage; thiols (Ellman method)	Program included warm-up, flexibility exercises, moderate-intensity aerobic exercise (60–70% VO ₂ max and HRmax), low-intensity isotonic exercises with progressive weights (starting at 250 g and increasing every two weeks to 750 g), and global stretching. Performed 3 times per week for 3 months.	Women with sarcopenic obesity initially showed worse health indicators. After the program, they significantly reduced body fat and increased muscle mass, flexibility, and GS. Oxidative damage biomarkers decreased, suggesting improvements in oxidative stress and antioxidant defenses.
Lee et al. (2021)	To investigate the effects of progressive elastic band resistance exercise on physical capacity and BC in older women with osteosarcopenic adiposity.	N = 27 women Exercise group: 15 CG: 12 (no exercise intervention)	-Height (Leicester stadiometer) - Weight (electronic scale) - Appendicular lean mass, lean mass index, skeletal mass index (DXA; Hologic QDR 1000/W) - Physical capacity: FFR, SLS, GS, TUG, TCR, HS	12-week elastic band resistance program (36 sessions) in small groups (<6 participants). CG received group lectures and home instructions with a yellow band. Follow-up assessment at 6 months.	No adverse events or dropouts. No significant changes in BC. After 12 weeks, improvements were observed in lumbar spine BMD and some physical capacity parameters (GS, TUG, TCR), although effects were not maintained at 6-month follow-up. No significant changes in HS or SLS.
Zhong et al. (2022)	To investigate the effects of an 8-week combined aerobic and RT program on CVD risk and gut microbiota composition in	N = 14 women Exercise group: n = 8 CG: n = 6	-Demographic data: age, sex, income, educational level, alcohol consumption, smoking status - height, weight, BMI. - Physical assessment: flexibility, balance, aerobic	Participants were divided into two groups. Exercise group performed combined aerobic and RT 4 times per week for 8 weeks. CG maintained their usual daily lifestyle.	After 8 weeks, the exercise group showed significant improvements in gut microbiota diversity, reduced waist circumference, and increased skeletal MM compared with controls. Cardiovascular risk factors improved, with lower blood glucose, cortisol, and TNF-α levels. Increases in HS and balance were associated

	physically active older women.		capacity, MS, functional mobility (HS, GS, ChRT). - TSMM and BF by BIA. - Gut microbiota: DNA sequencing analysis.		with favourable microbiota modifications, suggesting exercise may reduce cardiovascular risk in older women.
Gad El-Hak et al. (2021)	To determine the efficacy of aerobic and core exercise training in improving MM and physical performance in postmenopausal women with sarcopenic obesity.	N = 40 postmenopausal women aged 55-65 years.	- Weight and height; BMI - WC and waist-to-hip ratio - MM and BC (by BIA) - GS: 4-m walk test - HS by hydraulic dynamometer. - ChRT: 5 consecutive repe.	Random allocation to two groups. CG (n=20): hypocaloric diet (1,200 kcal/day) modified weekly + physical activity (30-minute walks, 3 times/week). Intervention group (n=20): same diet and activity + core exercises 3 times/week. Duration: 3 months. Assessments at baseline and post-intervention.	Both groups showed significant reductions in weight, BMI, waist circumference, and chair rise time, along with increases in muscle mass, GS, and HS. Only the intervention group showed significant reduction in WHR and greater improvement in HS compared with control. No other significant between-group differences were observed.
Nabuco et al. (2019)	To analyse the effects of whey protein (WP) supplementation combined with RT on BC, MS, functional capacity, and plasma metabolic biomarkers in older women with sarcopenic obesity.	N = 26 women with sarcopenic obesity	- BM, height, WC, HC, BMI, WHR. - BC: dual-energy X-ray absorptiometry (DXA). - Functional capacity: 10-m walk test (10MWT) and ChRT, RSP. - Biochemical analysis, blood pressure, and dietary intake.	Randomised, double-blind, placebo-controlled trial. Participants assigned to WP or placebo (PLA). 35 g of hydrolysed whey protein or placebo consumed after each training session. Both groups completed supervised RT 3 times per week for 12 weeks (full-body protocol with 8 strength exercises, 3 sets of 8-12 repe. with progressive loading). Variables measured pre- and post-intervention. Two-way repeated measures ANOVA applied.	WP + RT resulted in greater increases in appendicular lean mass. Significant reductions in total, relative, and trunk fat mass were observed. Both groups improved in MS, functional capacity, and several metabolic biomarkers. Only the WP group showed significant reduction in IL-6. No significant between-group differences were observed in other parameters. WP combined with RT improved BC and reduced inflammation, with limited impact on other inflammatory markers.
Banitalebi et al. (2020)	To investigate the effects of elastic band RT (EBRT) on MQ, serum biomarkers of OSO, bone density, and functional profile in women living with OSO.	N = 63 women (65–80 years) EG: n = 32 CG: n = 31	- FFQ. - Fried frailty criteria - EFS - Barthel Index (ADL) - BC and MS: 30-second chair stand test, HS, MQ calculation, OSO Z-score - Serum biomarker assessment - tests: TUG, 6MWT, 10MWT	12-week supervised EBRT, 3 times per week, alternating major muscle groups. Initial familiarisation sessions to determine target repe. and OMNI intensity scale. 4-week adaptation phase (1×12 reps) with yellow bands, followed by progressive resistance (red/black bands). CG received telephone follow-up regarding diet and habitual activity.	ANOVA showed significant increases in estradiol (E2) and reductions in leptin in the EG, along with improvements in muscle quality and OSO Z-score. HS and chair stand performance improved. No significant differences in CTX-I, adiponectin, sclerostin, or BC parameters. Significant correlations between serum markers and functional variables suggest EBRT may

					improve selected outcomes in older women with OSO.
Banitalebi et al. (2021)	To investigate the effects of 12-week elastic band RT on myomiRs (miR-206 and miR-133), vitamin D, CTX-I, ALP, and FRAX score in elderly women with OSO.	N = 63 women (65–80 years) from 102 screened EG: n = 32 CG: n = 31	- FRAX®, DXA, BMC, BMD, total BC, TSM - ELISA kits: vitamin D, ALP, CTX-I - mirVana PARIS Ambion kit: miRNAextraction - RT-PCR: serummiRNAquantification	EG completed 12-week elastic band RT, 3 times per week. First 4 weeks: adaptation with yellow bands; progressive increase in intensity (red/black bands) and volume. CG received telephone or face-to-face follow-up regarding diet and habitual activity.	No significant between-group differences in bone markers or myomiRs. Correlations observed between some myomiRs and vitamin D, ALP, and FRAX scores, suggesting a potential role of myomiRs in bone health.

Effects of Resistance-Based Exercise Interventions on Primary and Secondary Outcomes

Muscle Strength and Physical Function - Muscle strength outcomes were assessed in 12 of the 13 included studies, most commonly using handgrip strength, one-repetition maximum tests, chair-stand performance, or knee extensor strength and power (Banitalebi et al., 2020; Banitalebi et al., 2021; Gad El Hak et al., 2021; Gutiérrez-López et al., 2021; Huang et al., 2017; Liao et al., 2017; Isenmann et al., 2023; Lee et al., 2021; Nabuco et al., 2019; Vasconcelos et al., 2016; Villareal et al., 2017; Zhong et al., 2022). Improvements in at least one strength-related variable were reported in 11 of these studies, regardless of whether resistance training was implemented as a standalone intervention or as part of a multicomponent programme.

Physical function outcomes were evaluated in 11 studies, using measures of gait speed, chair-rise performance, balance tests, or composite functional assessments (Banitalebi et al., 2020; Gad El Hak et al., 2021; Gutiérrez-López et al., 2021; Huang et al., 2017; Liao et al., 2017; Lee et al., 2021; Nabuco et al., 2019; Vasconcelos et al., 2016; Villareal et al., 2017; Zhong et al., 2022). Nine studies reported improvements in functional performance, particularly in gait speed and chair-rise tasks, whereas balance-related outcomes showed less consistent changes across interventions.

Bone Mineral Density - Bone mineral density was assessed in 6 of the included studies, primarily at the lumbar spine, femoral neck, forearm, or calcaneal sites, using dual-energy X-ray absorptiometry or

quantitative ultrasound (Banitalebi et al., 2020; Banitalebi et al., 2021; Forsyth, 2023; Huang et al., 2017; Lee et al., 2021; Villareal et al., 2017). Positive changes in bone mineral density were reported in 3 studies, particularly following elastic band resistance training or impact-based exercise programmes (Forsyth, 2023; Huang et al., 2017; Lee et al., 2021), while the remaining studies reported no statistically significant changes over the intervention period. Overall, bone-related outcomes were heterogeneous across studies, with variability depending on skeletal site and intervention characteristics.

Metabolic and Inflammatory Markers - Metabolic, inflammatory, or hormonal markers were evaluated in 7 studies, including fasting glucose, lipid profile, inflammatory cytokines, oxidative stress biomarkers, and selected hormonal parameters (Banitalebi et al., 2020; Banitalebi et al., 2021; Gad El Hak et al., 2021; Gutiérrez-López et al., 2021; Huang et al., 2017; Liao et al., 2017; Nabuco et al., 2019; Zhong et al., 2022). Reductions in inflammatory or oxidative stress markers were reported in 4 studies, particularly following moderate-intensity exercise programmes or resistance training combined with nutritional strategies (Gutiérrez-López et al., 2021; Nabuco et al., 2019; Zhong et al., 2022). However, changes in metabolic markers were not consistently observed across studies, and several trials reported no significant between-group differences for selected biochemical outcomes.

Body Composition - Body composition outcomes were assessed in 11

studies, using dual-energy X-ray absorptiometry or bioelectrical impedance analysis to quantify fat mass, lean mass, appendicular muscle mass, or body fat percentage (Banitalebi et al., 2020; Banitalebi et al., 2021; Gad El Hak et al., 2021; Gutiérrez-López et al., 2021; Huang et al., 2017; Liao et al., 2017; Isenmann et al., 2023; Lee et al., 2021; Nabuco et al., 2019; Villareal et al., 2017; Zhong et al., 2022). Seven studies reported reductions in fat mass and/or increases in lean or appendicular muscle mass, whereas three studies found no significant changes in body composition variables. Improvements in body composition were more frequently reported in interventions combining resistance training with nutritional supplementation or aerobic exercise, although the magnitude and consistency of changes varied across studies.

Adherence and Adverse Events -

Adherence to the exercise interventions was explicitly reported in a limited number of studies, with high adherence rates observed in supervised programmes (Liao et al., 2017; Vasconcelos et al., 2016; Lee et al., 2021). Only one study explicitly reported the absence of adverse events during the intervention period (Lee et al., 2021), while most studies did not provide systematic or detailed information regarding exercise-related adverse events. Consequently, a structured synthesis of adherence and safety outcomes was not feasible due to inconsistent reporting across studies.

4. Discussion

The present systematic review synthesises the available evidence on the effects of different exercise interventions in postmenopausal women with sarcopenic obesity, with particular emphasis on resistance training programmes using elastic bands and their combination with protein supplementation strategies. Overall, the findings consistently support beneficial effects of resistance-based exercise on muscle strength and functional performance, whereas evidence regarding body composition, bone health, and metabolic outcomes remains more heterogeneous.

Muscle Strength and Physical Function - Improvements in muscle strength and physical function represented the most consistent findings across the included studies. Strength gains were reported following both standalone resistance-based interventions and multicomponent exercise programmes, irrespective of the specific training modality employed (e.g., elastic bands, free-weight exercises, machine-based resistance, or combined protocols) (Banitalebi et al., 2020; Banitalebi et al., 2021; Gad El-Hak et al., 2021; Nabuco et al., 2019; Vasconcelos et al., 2016; Zhong et al., 2022).

Notably, the CONSORT-compliant randomised controlled trial by Liao et al. (2017) demonstrated significant improvements in muscle strength and physical capacity following a 12-week supervised elastic band resistance training programme in older women with sarcopenic obesity. These findings reinforce the robustness of resistance-based exercise as an effective intervention for improving

neuromuscular function, even when implemented using low-cost and accessible training modalities.

Similarly, functional outcomes such as gait speed, chair-rise performance, and composite functional tests improved in most studies assessing these domains (Gutiérrez-López et al., 2021; Huang et al., 2017; Lee et al., 2021; Villareal et al., 2017). Collectively, these improvements are clinically meaningful, given the strong association between functional performance, independence, and fall risk in older women.

From a physiological perspective, resistance training is known to stimulate neuromuscular adaptations and muscle protein synthesis, even in the presence of menopause-related anabolic resistance. Although oestrogen deficiency may impair muscle regenerative capacity and contribute to declines in muscle quality, the mechanical loading provided by resistance-based exercise appears sufficient to induce functional gains. This interpretation is consistent with previous systematic reviews and meta-analyses conducted in postmenopausal populations (Daly et al., 2021).

Body Composition - In contrast to the relatively consistent findings for strength and function, changes in body composition were less uniform across the included studies. While several trials reported reductions in fat mass and/or increases in lean or appendicular muscle mass (Gutiérrez-López et al., 2021; Huang et al., 2017; Liao et al., 2017; Nabuco et al., 2019), others observed no significant changes despite concurrent improvements in muscle

strength and physical function (Isenmann et al., 2023; Lee et al., 2021; Villareal et al., 2017).

The study by Liao et al. (2017) contributes relevant evidence in this context, as it reported significant improvements in lean mass and fat-related parameters following elastic band resistance training compared with a non-exercise control group. These findings suggest that resistance-based exercise can positively influence body composition in women with sarcopenic obesity, although the magnitude of these changes may depend on factors such as intervention duration, training volume, baseline body composition, and dietary intake.

Overall, the observed heterogeneity aligns with previous evidence indicating that resistance training alone may be insufficient to elicit substantial body composition changes in postmenopausal women, particularly when interventions are of short duration or not combined with nutritional strategies (Daly et al., 2021). Interventions incorporating nutritional supplementation, especially adequate protein intake, tended to yield more favourable body composition outcomes. For example, Nabuco et al. (2019) reported greater increases in appendicular lean mass and reductions in fat mass when resistance training was combined with whey protein supplementation. These findings support the hypothesis that optimising nutrient availability may enhance the anabolic response to resistance exercise and partially

counteract postmenopausal anabolic resistance.

Bone Mineral Density - Evidence regarding the effects of resistance-based exercise on bone mineral density (BMD) was heterogeneous. Only a subset of studies reported significant improvements, typically at specific skeletal sites such as the lumbar spine or calcaneus (Forsyth, 2023; Huang et al., 2017; Lee et al., 2021), whereas other trials observed no significant changes (Banitalebi et al., 2020; Villareal et al., 2017).

These inconsistencies likely reflect differences in exercise modality, loading characteristics, impact forces, and intervention duration. Given the accelerated bone loss associated with oestrogen deficiency, short-term or low-impact resistance-based interventions may not provide a sufficiently osteogenic stimulus to induce detectable changes in BMD. Previous literature suggests that bone adaptations to exercise are highly site-specific and dependent on achieving adequate mechanical strain, which may not be consistently reached across all resistance-based protocols.

Metabolic and Inflammatory Markers - Findings related to metabolic, inflammatory, and hormonal markers were also variable across the included studies. Reductions in inflammatory or oxidative stress markers were reported in some interventions, particularly following moderate-intensity resistance-based exercise or multicomponent programmes combining exercise with nutritional

strategies (Gutiérrez-López et al., 2021; Nabuco et al., 2019; Zhong et al., 2022).

The trial by Liao et al. (2017) assessed a comprehensive panel of biochemical markers, contributing valuable information on the metabolic safety and potential anti-inflammatory effects of elastic band resistance training. However, changes in metabolic markers were not consistently observed across studies, and several trials reported no significant between-group differences for selected biochemical outcomes (Banitalebi et al., 2020; Huang et al., 2017). The limited number of studies and the heterogeneity in biomarker selection restrict firm conclusions regarding the metabolic effects of resistance-based exercise in this population.

Methodological Considerations and Limitations - Several methodological limitations should be considered when interpreting these findings. First, no meta-analysis was conducted due to substantial heterogeneity in participant characteristics, diagnostic criteria for sarcopenic obesity, intervention protocols, and outcome measures. Second, methodological quality and risk of bias varied across studies, with several trials characterised by small sample sizes, short intervention durations, and incomplete reporting of adherence and adverse events, which may influence the robustness and generalisability of the observed effects.

Although the trial by Villareal et al. (2017) provides valuable conceptual support for multicomponent exercise approaches in obese older adults, its population and clinical focus differ from the specific context of postmenopausal women with sarcopenic

obesity. Therefore, its findings should be interpreted with caution to avoid excessive extrapolation.

Implications and Future Research

Taken together, the available evidence supports resistance-based exercise as a key non-pharmacological strategy to improve muscle strength and functional capacity in postmenopausal women with sarcopenic obesity. However, evidence for effects on body composition, bone mineral density, and metabolic health remains less consistent and appears dependent on intervention characteristics and methodological quality. Future research should prioritise longer-term randomised controlled trials, standardised diagnostic criteria, and comprehensive reporting of adherence and safety outcomes to clarify the sustainability and clinical relevance of these adaptations.

5. Practical applications

The findings of this review suggest that structured exercise programmes, particularly those combining resistance training with aerobic components, may represent an effective strategy to improve musculoskeletal and functional health, as well as to reduce the risk associated with sarcopenic obesity and osteosarcopenia in menopausal women.

In this context, resistance training using elastic bands emerges as a safe, accessible, and low-cost alternative, particularly suitable for older women with functional limitations or limited prior experience in resistance training. However, the observed benefits appear to depend largely on programme adherence and continuity, highlighting the importance of sustained, long-term interventions.

Furthermore, combining exercise with nutritional strategies, particularly appropriately dosed protein supplementation, may enhance favorable adaptations in body composition, muscle strength, and systemic inflammation. These findings support the need for integrated and multidisciplinary approaches in the prevention and management of sarcopenic obesity during menopause.

6. Conclusions

This systematic review analysed the effects of resistance-based exercise interventions on outcomes related to sarcopenic obesity in postmenopausal women, including muscle strength, physical function, body composition, bone mineral density, and metabolic and inflammatory markers.

The findings indicate that muscle strength and functional capacity are the outcomes with the most consistent and robust evidence of improvement following resistance-based exercise interventions in this population. These benefits were observed across a wide range of training modalities and programme designs, including elastic band resistance training and multicomponent interventions, supporting resistance-based exercise as a relevant and feasible non-pharmacological strategy to preserve physical function in postmenopausal women with sarcopenic obesity.

In contrast, evidence relating to body composition, bone mineral density, and metabolic or inflammatory parameters was heterogeneous and, in several cases, inconclusive. Although some studies

reported favourable changes in these outcomes, results were not consistent across interventions, and the magnitude of effects varied according to study design, intervention characteristics, and methodological quality. Consequently, the available evidence does not permit definitive conclusions regarding the effectiveness of resistance-based exercise alone for improving these domains.

These conclusions should be interpreted in light of several limitations, including substantial methodological heterogeneity among studies, variability in the diagnostic criteria for sarcopenic obesity, relatively short intervention durations, incomplete reporting of adherence and adverse events, and the absence of a meta-analysis.

Overall, the current evidence supports resistance-based exercise as a key component of intervention programmes targeting muscle strength and functional performance in postmenopausal women with sarcopenic obesity. However, future well-designed randomised controlled trials, incorporating standardised diagnostic criteria, longer follow-up periods, and comprehensive reporting of secondary outcomes, are needed to clarify the role of resistance-based exercise, alone or in combination with nutritional or multicomponent strategies, in modifying body composition, bone health, and metabolic regulation.

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