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The Effect of Various Exercise Programs on the Physical Function of Older Adults with Sarcopenic Obesity: A Systematic Review

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ABSTRACT

Introduction: Sarcopenic obesity is characterized by low muscle mass and high body fat; its prevalence increases with age, particularly after the age of 65 years. It is associated with increased risk of physical disability in elderly people. Exercise is the most common intervention for sarcopenic obesity.

Objective: This review aims to investigate the impact of various exercise programs on the physical function of older adults with sarcopenic obesity.

Methodology: A systematic review of the literature was conducted based on a comprehensive search strategy implemented across different electronic databases including PubMed, PEDro and Google Schoolar. Randomized controlled studies from 2014 till now were included. Studies with irrelevant outcomes and those published before 2014 were excluded. The relevant information was collected with the aid of a standardized data extraction form (PRISMA).

Results: 8 studies were included in the final systematic review. The included studies showed that high-intensity strength exercises performed in isolation, either alone or in combination with aerobic exercise, led to improvements in muscle mass and muscle strength.

Conclusions: The findings suggest that exercise intervention can effectively improve muscle function and physical performance in older adults with sarcopenia. Additionally, it is highly recommended to implement group-based and supervised resistance training, as well as multicomponent exercise, in the prevention and treatment of sarcopenic obesity among the older population.

Keywords: Sarcopenia; Obesity; Exercise; Elderly; Muscle Strength; Muscle Mass; Muscle Activity

Introduction

Sarcopenia, derived from the Greek sarx (flesh) and penia (loss), was introduced by Rosenberg, [1] to describe the loss of skeletal muscle mass (Rosenberg, [1]). A related disorder is sarcopenic obesity. The coexistence of diminished muscle mass/strength/physical function with increased fat mass is referred to as sarcopenic obesity (Baumgartner, [2]). Aging increases the risk of unfavorable changes in body composition, including a decrease in muscle and an increase in fat mass. With age, intramuscular and visceral fat increases while subcutaneous fat declines, thus leading to poor muscle quality (Baumgartner, [2]). So, as the population ages, the prevalence of sarcopenic obesity increases, along with rising rates of both obesity and sarcopenia. This trend is particularly notable among adults aged 65 years or older (Batsis & Villareal, [3]). Although sarcopenic obesity is more common among older people, it is being diagnosed more and more often in people across the entire age spectrum. Muscle mass and strength begin to decline gradually around the age of 30, accelerating after the age of 60 (Stenholm, et al. [4]). This decline is believed to be associated with factors such as, insulin resistance, reduce levels of growth hormones and testosterone, inflammation, oxidation, fat infiltration (Nascimento, et al. [5]).

Compounding the effects of both sarcopenia and obesity, sarcopenic obesity has negative consequences on individuals, which can lead to metabolic problems, cardiovascular disease, physical disability, poor quality of life, institutionalization, morbidity and mortality (Stenholm, et al. [4]). These changes have been shown to be associated with negative health outcomes in the elderly and have significant implications for health care cost (Stenholm, et al . [6]). Sarcopenic-obesity management requires a multifactorial approach that includes lifestyle interventions such as physical exercise, nutrition or diet-induced weight loss (Newman, et al. [7]). Exercise can affect hormonal balance, reduce oxidative stress, induce mitochondrial synthesis, alter immunological and motor function and improve muscle oxidative capacity (Joseph, et al. [8]). Increased muscle protein synthesis with exercise sensitizes muscle insulin action and promotes anabolism (Carraro, et al. [9]). Sarcopenia is their associated with reduced muscle protein synthesis. Aerobic exercise, resistance training, and combination, increase muscle protein synthesis in older adults despite age-related decreases in anabolic signaling (Cuthbertson, et al. [10]).

Physical activity in general has been broadly recommended to minimize functional decline in the elderly and it may also be a key factor in the prevention of sarcopenia and obesity (American College of Sports Medicine, et al. [11]). Studies have shown that various exercise programs, either alone or in combination with nutritional supplementations, are effective to promote positive changes in body composition among older people (American College of Sports Medicine, et al. [11]). Body weight-based and elastic band resistance training is an alternative training method for sarcopenia to minimize the age-related adverse effects on muscle function and quality (Seo, et al. [12]). This systematic review aims to investigate randomized controlled studies to figure out the effects of various types of physical training (exercises programs) on sarcopenia in older people with sarcopenic obesity.

Methodology

Development of Search Strategy

A comprehensive research strategy was developed using appropriate keywords along with database-specific indexing terms related to "sarcopenia, obesity, exercise, elderly, muscle strength, muscle mass, muscle activity. Boolean operators "AND" and "OR" were used to generate a variety of combinations of the above-mentioned keywords. The final search expression used was (((((((elderly OR older adults OR aged) AND (sarcopenia) AND (exercise OR exercise programs OR muscle activity OR muscle strength OR muscle mass) AND (randomized controlled trial)).

Inclusion and Exclusion Criteria

The search strategy and study selection process followed the guidelines of PICOSD (participants, interventions, comparisons, outcomes, and study design) to establish the inclusion and exclusion criteria.

Inclusion Criteria

The participants consisted of community-dwelling elderly individuals diagnosed with sarcopenia. The interventions involved a range of exercises and training programs incorporating physical activity. Comparisons were made with usual care or control groups. The outcome measures focused exclusively on variables (muscle activity, muscle strength, and lower extremity strength). The study design specifically targeted randomized controlled trials (RCTs) sourced from the database.

Exclusion Criteria

The exclusion criteria for this review included studies not written in English and studies not published within the last 10 years were excluded (studies published before 2014. In addition, when considering the qualitative factors of study design and the trends of intervention studies were excluded according the PICOSD.

Database Selection and Search

The search was executed across electronic databases including the National Library of Medicine (PubMed), PEDro and Google Schoolar (first 100 results) databases. Following the PRISMA flow diagram, an initial screening was conducted based on the titles and abstracts of the identified papers based on the inclusion and exclusion criteria. Full-text articles were retrieved for highly relevant studies by assessing their suitability for inclusion.

Data Extraction

This article is based on a literature review. Data were extracted from international data baseses (PubMed, PEDro) during the period from 2014 to 2024.

Report Writing Developed

The systematic review manuscript based on PRISMA (Preferred Reported Items for Systematic Reviews and Meta-Analysis, (Figure 1) guidelines and it's organized under clear sections including Introduction, Methodology, Results, Discussion, and Conclusion.

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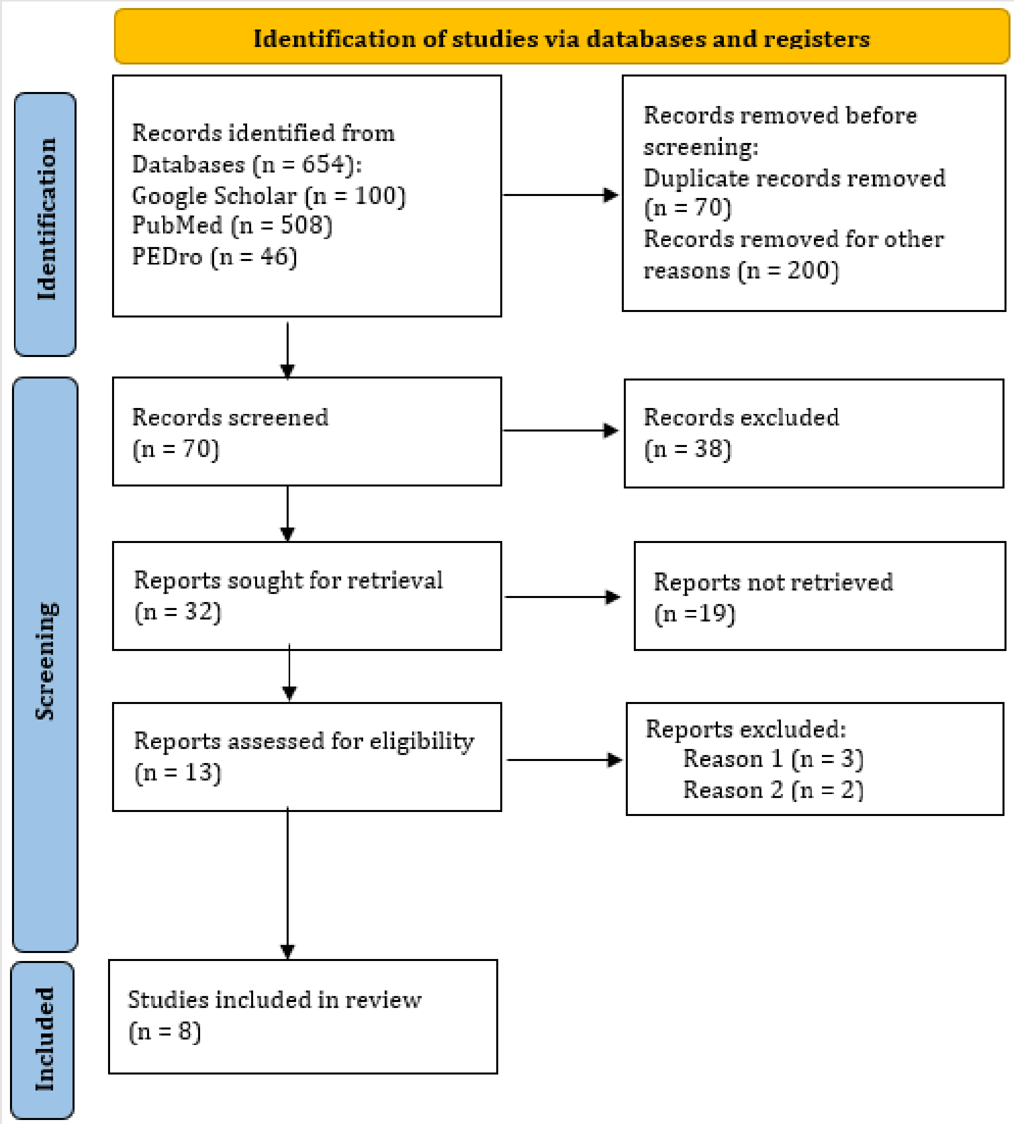

Figure 1: PRISMA Chart, Reason 1 = irrelevant to the topic, Reason 2 = no conclusion.

Results

A total of 654 studies were found in the initial search, from which 70 duplications were removed, and 200 records were removed for other reasons. 8 articles were considered eligible for the systematic review after applying the exclusion and inclusion criteria mentioned above. All of them were, randomized clinical trials. Although the number is small, this fact only highlights the importance of more research about sarcopenic obesity, specifically on the topic about exercise program for older adults, which is the central theme of this systematic review. All articles used in this systematic review are included in Table 1. This systematic review explores various exercises modalities including strength training and aerobic exercises among older adults. The review provides insights into the effectiveness of various exercise strategies in managing the challenges associated with sarcopenic obesity in older adults.

Table 1: Studies included for results.

Study	Population	Intervention		Duration	Outcomes and Results
		Experimental Group	Control Group	time	
Balachandran et al. [19]	21 men and women: EXP (n=11, 71.6 ± 7.8 years) CON (n=10, 71 ± 8.2 years)	High-speed circuit (HSC). Same as SH but with no recovery between sets. When the patterns of power increase plateaued (within 5%), loads were increased by 5% and training continued until the next power plateau.	Conventional strength/hypertrophy 3 sets of 10–12 repetitions at 70% of their 1-RM on each machine before moving to the next exercise with 1–2 min recovery between sets. When participants could do 3 sets of 12 repetitions, the load was increased by 5% for the next workout session	15 weeks, 2 times per week	No significant differences in skeletal muscle index (SMI). Within-group comparisons. Only significant results: Leg press peak power: EXP ($p< 0.01$) and CON ($p=0.03$). Leg press 1-RM: Only CON ($p < 0.01$) Chest press1-RM: EXP ($p< 0.01$) and CON ($p=0.03$).
Kemmler et al. [13]	43 men EXP (n=21) control group CON (n=22)	Periodized high-intensity DRT protocol defined as single-set exercise training with high intensity and effort. Intensity of the exercise was consistently scheduled by prescribing a range of reps (i.e., 5–7 or 8–10 reps) and the corresponding degree of work to failure ("effort") (e.g., maximum effort minus 1–3 reps; defined as non- repetition maximum	Both groups were adequately supplemented with whey protein, vitamin D, and calcium	24 weeks, 3 times per week	Skeletal muscle mass index increased significantly in the EXP and decreased significantly in the CON ($p<0.001$). Whereas changes in maximum hip−/ leg-extensor strength were much more prominent ($p<0.001$) in the EXP group.
Chen et al. [14]	93 men and women randomiz ed to RT (n=15; 68.9±4.4 years). AT (n=15; 69.3±3.0 years). CT: n=15; 68.5±2.7 years). CON (n=15; 68.6±3.1 years)	RT: 8 weeks, 2 times per week. Weight-training at 60–70% of 1-RM, 60- minute sessions. Resistance training (RT) AT: 8 weeks, 2 times per week. 60-minute sessions (moderate intensity) aerobic training (AT) CT: Participants performed each training mode once a week with the AET following 48 hours after the RET. combination training (CT)	Participants maintained their day-to-day lifestyles and dietary habits, and they were prohibited from engaging in any exercises.	2 times per week 8 weeks	Between-group comparisons. Compared to CON (difference was significant at $p<0.05$) Back extensor strength: Higher in RT, AT and CT (week 8), but only in RT and CT at week 12. Knee extensor strength: In RT was greater compared to AET, CT and CON (week 8) and to AT and CON (week 12). CT was superior to the AT and CON (8 weeks) and CON (12 weeks). The elderly with sarcopenic obesity received RT, AT, or CT demonstrated increased muscle mass and reduced total fat mass.
Seo et al. [12]	22 women EXP(n = 12) 70.3 ± 5.38 CON(n=10) 72.9 ± 4.75	Elastic band exercise similar fitness level and 2–3 set of 12–15 kinds of exercise (15-25repetitions/set) using red band (Thera-band1,) -weight bearing exercise. Training for large muscle groups: 5 resistance exercises and 4 light plyometric exercises. All exercises were carried out using bodyweight as the load. The training load was increased by progressive overload and the OMNI resistance for active muscle scale (OMNI-RES AM, 0-extremely easy to 10-extremely hard) was used.	Non-exercising in the control group	3 times per week 16 weeks	The EXP group improved their functional fitness, grip strength, and isometric muscle strength ($p< 0.01$) while these variables did not change in the CON.

Liao et al. [15]	56 women EXP (n=33) 66.67 ± 4.5 CON (n=23) 68.32 ± 6.0	The exercise protocol was performed with a moderate-intensity on the RPE scale up to 13, which corresponded to a 60%–70% of 1RM load and was utilized with a 10RM and a 20RM exercise prescription. Session was supervised by a senior licensed physical therapist	Receiving no exercise intervention.	3 times per week/	Compared with the CON group the EXP exhibited significantly greater changes in TSM at ($p < 0.05$). The ERT exerted a significant beneficial effect on muscle mass, muscle quality, and physical function in older women with sarcopenic obesity 0.72 kg (95%, $p < 0.01$), similar results were observed for SMI.
Kim et al. [16]	139 women EXP+N (n=36; 80.9 ±4.2 years). EXP (n=35; 81.4 ±4.3 years). N (n=34; 81.2± 4.9 years). CON (n=34; 81.1 ±5.1 years).	Sessions of 60 min. Progressive sequence of resistance and weightbearing exercises (chair excise, resistance band exercise and hydraulic exercise machine) and aerobic training (stationary bicycle) Nutrition: Amino acid supplementation. (3.0 g of leucine enriched essential amino acid and 20 mg vitamin D) and Tea catechin (350mL of tea fortified with 540 mg of catechin). 1/day, 3 months	General health education class, once every 2 weeks for 3 months	2 times per week	No significant differences regarding muscle mass. Within-group comparisons. Only significant results: Knee extension strength significantly increased in Ex+N, Ex, and N groups. Between-group comparisons. Compared to CON, only significant results TBF (Total Body fat): in Ex+N ($p=0.036$)
Kemmler et al. [17]	75 women randomiz ed to: WB-EMS (n=25; 77.1±4.3 years). WB EMS+P (n=25; 78.1±5.1 years). CON (n=25; 76.9±5.1 years)	Exercise intervention: 26 weeks. 1time per week. WB-EMS: Sessions of 11 min (first 4 weeks) and 20 min for the rest of the intervention period (85 Hz, 350 µs, 4 s of strain–4 s of rest), performed with moderate to high intensity. Phases: Conditioning (weeks 1-4), advance conditioning (weeks 5-8), training phase I (weeks 9-18), training phase II (weeks 19-26). Protein supplementation: 40 g/day (635 kJ) with 21 g of (whey).	All the women of the WBEMS and CON were provided with of cholecalciferol (800 IU/day). Supplements and vitamin D were provided on a monthly basis. CON group was requested to maintain their habitual lifestyle.	1 time per week/ 12 weeks	Within-group comparisons: SMI: Increased significantly in both WB-EMS and WBEMS+P ($p \leq 0.003$) Between-group comparisons. Compared to CON: SMI: Improvements in WBEMS and WB-EMS+P ($p \leq 0.002$)
Vasconcelos et al. [18]	28 women EXP (n = 14) CON (n=14)	1-4 weeks - resistance exercise, concentric and eccentric movements at a low speed, following with high-speed, (muscle power). 5-7 weeks - concentric exercises (as fast as possible). 7-10th week, concentric and eccentric at high speeds (one-repetition maximum test (1 RM)	CON group: was monitored by physical therapists once a week by phone for a 10-week period	2 times per week/	There were no significant between-group differences for any of the outcomes.

Note: DRT = Dynamic resistance exercise; ERT = elastic band resistance training; TSM = total skeletal mass WB-EMS = whole-body electromyostimulation; RPE = Rating of perceived exertion; DRT = Dynamic resistance exercise. RM = repetition maximum; OMNI = resistance exercise scale of perceived exertion with Thera-band resistance bands; SMI = skeletal muscle mass index (whole body skeletal muscle mass/weight, %)

Discussion

The objective of full-text screening of the selected studies was to investigate the randomized controlled studies to figure out the effects of different types of physical training (exercises programs) on sarcopenia in older people with sarcopenic obesity. The main findings suggested that the most marked benefit is achieved with high-intensity strength exercises programs. In four studies, researchers found that various types of training, including resistance training, aerobic training, and body weight-based exercises, improved functional fitness and muscle quality in elderly individuals with sarcopenia (Kemmler, et al. [13-17]). The study results are shown in Table 1. Kemmler et al. [17] used whole-body electromyostimulation and found its significant impact on muscle mass along with moderate effects on functional parameters. They used a different intervention compared to the other studies included in the literature review, which is likely one of the reasons they achieved better results. Kim et al. [17] implemented a training program similar to Chen et al. [14], but with longer duration (3 months) and inclusion of food supplements. It is surprising that participants in the study by Chen achieved better results than those in the study by Kim et al. [17] considering that Kim et al. [17] concluded that improvements in physical functions were not observed.

Further large-scale and long-term investigations are necessary. A separate consideration should be made regarding the frequency and duration of the proposed training sessions, as they will undoubtedly impact the changes generated by the exercise, particularly in the elderly. In this regard, the conclusions of the study by Kemmler et al. [16] which demonstrated benefits when the training frequency was higher than 2 weekly sessions are interesting. Chen et al. [14] designed a training program that included resistance training, aerobic training, and a combination of both. Conversely, Seo et al. [12] developed a bodyweight-based and elastic resistance training program without incorporating aerobic training and they rejected the hypothesis that 16 weeks of resistance training affected muscle growth factors in sarcopenic older women. Similarly Vasconcelos, et al. [18] designed the progressive resistance exercise program without aerobic exercises, which was found to be ineffective. Balachandran, et al. [19] also did not find any effects of two 15-week resistance exercise programs on the body composition of older women with sarcopenic obesity. Most studies used multimodal programs, including aerobic, resistance, and balance exercises.

Therefore, the isolated effects of resistance exercise on older people with sarcopenic obesity remain unclear. Balachandran, et al. [19] suggest further research to determine whether the adaptation period would be sufficient for protocols using different loading patterns, training durations, or population samples. Additionally, studies of longer duration with careful regulation or assessment of caloric intake are needed. More studies should be conducted to examine the effects of various additional exercise training methods and to categorize the results according to gender, age groups, and gender-specific age groups. This is necessary to understand how exercise training impacts muscle strength and physical performance in older individuals with sarcopenia Bao, et al. [20]. Sarcopenic obesity in older adults after the age of 65 years is significant public health concern. Therefore, it is important to develop and conduct new evidence-based interventions targeting sarcopenic obesity. Resistance training with body weight-based training and elastic bands can be an alternative and practical method for sarcopenia prevention, minimizing the age-related adverse effects on muscle function and quality (Bao, et al. [20]).

While aerobic exercises like walking are commonly prescribed, they do not yield significant benefits for elderly patients with sarcopenic obesity. Current evidence highlights the efficacy of strength-resistance training and its integration into multimodal programs alongside aerobic and balance exercises, significantly improving anthropometric and muscle function parameters (Vasconcelos, et al. [18]). Limitations of the included articles in the review are the

(1) Small sample sizes,

(2) Variations in diagnostic criteria,

(3) And the use of different instruments to diagnose sarcopenia, leading to high heterogeneity among the studies.

Additionally, the majority of studies focused on female participants, leaving the question of whether gender differences impact training effects unanswered.

Conclusion

Based on the studies included in review, exercise has significant benefits in elderly patients with sarcopenic obesity. Current evidence shows that training based on strength-resistance and its combination in multimodal programs with have significantly beneficial effects on and muscle function parameters. Resistance training using body weight-based training and elastic bands can be an alternative and practical method for sarcopenic obesity prevention, minimizing the age-related adverse effects on muscle function and quality.

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