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Effects of different strength training protocols on sarcopenia influencing parameters in older adults: a systematic review

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ABSTRACT

Introduction: Sarcopenia is characterized by the reduction of skeletal muscle mass and its functionality. Several of the parameters that influence sarcopenia are modified by strength training. **Objective:** To review the effects of different strength training protocols (frequency, duration, and intensity) on parameters that influence sarcopenia. **Methods:** This is a systematic review of original, quantitative, observational studies, published between 2010 in 2020, in English, Spanish and Portuguese, and indexed in the SciELO, PubMed, and CAPES databases. The terms used search were: "muscle strenght" ("força muscular", "fuerza muscular"), "sarcopenia" ("sarcopenia"), "aging" ("envelhecimento", "envejecimiento"), "olders" ("idosos", "ancianos"), "strength training" ("treinamento de força/resistência", "entrenamiento de fuerza"). 215 articles were retrieved and 11 met the inclusion criteria, being included in the review. **Results:** Among the 11 studies analyzed, it is observed that strength training applied in different protocols was efficient in improving parameters such as muscle mass and strength, body balance, and performance in diagnostic tests of sarcopenia. **Conclusion:** This review highlights the benefits of the practice of strength exercise in different protocols on parameters that influence the onset of sarcopenia in older adults. The exercise of strength is presented as an applicable, practical, and non-pharmacological means of preventing sarcopenia.

Keywords: aging; aged; sarcopenia; exercise.

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INTRODUCTION

Sarcopenia was first defined by Rosenberg[1] as a progressive loss of muscle mass, strength, and muscle function associated with aging. Currently, according to the European Working Group on Sarcopenia in Older People (EWGSOP), sarcopenia can be defined as a geriatric syndrome characterized by a global and progressive decrease in muscle mass and strength (usually measured by hand dynamometry), implying major impairments to the functionality of the older adults[2]. It is characterized by the ICD-10 code M62.5, and can also be classified into degrees (pre-sarcopenia, sarcopenia, or severe sarcopenia). Several factors are involved in its development, which it is possible to highlight hormonal changes, the loss of motor neurons (numbers and functions), inadequate nutrition, physical inactivity, and even chronic low-grade inflammation[3,4].

Referring to the older adult population, aging is related to physiological and anatomical changes that worsen the physical capabilities and well-being of the older adults during this last period of life. These changes can compromise the body composition, increasing adiposity and decreasing skeletal muscle mass, which represents 50% of the body weight in adults; this decrease in muscle mass associated with age characterizes sarcopenia[5].

The World Health Organization (WHO) states that the percentage of older adults will increase from 12.5% to 30 by 2050[6]. In this sense, there will also be a substantial increase in this population in Brazil. Under this perspective it is noted that the prevalence of sarcopenia in older adults, both worldwide and in Brazil, may consequently increase, thus becoming a public health problem[7].

According to the EWGSOP, the prevalence of sarcopenia varies from 5-13% in individuals between 60 and 70 years of age[2]. These individuals already present the alterations caused by sarcopenia, such as a reduction in strength and functional capacity, in which muscle impairment is observed, especially in its concentric component, responsible for most of the voluntary movements of the body[8-12]. In addition, these alterations can cause a decrease in the gait speed, a greater risk of falls, and a reduction in the capacity to develop daily activities.

A primary strategy to reduce the effects of the different pathophysiological manifestations caused by sarcopenia is through physical exercise, especially strength training, which is an accessible, non-pharmacological measure to reverse sarcopenia. It is one of the most appropriate forms of physical exercise to promote the increase and maintenance of strength and muscle mass in individuals of different age groups[13].

Still, on the subject, Rhodes et al.[14] reported that structured exercise programs, based mainly on strength training, help prevent the loss of physical independence, and consequently improve the quality of life of older adult women. A very similar finding was observed by Liu-Ambrose et al.[15], in a study involving 28 women aged 75 to 85 years, they observed that strength training can play an important role in increasing quality of life, walking agility, and maintenance of densitometry.

Therefore, as reported, studies have addressed strength training as a possible intervention for the prevention and control of sarcopenia, presenting itself as a non-drug, applicable, and practical alternative.

Thus, this study aimed to search for studies that evaluated the influence of different strength training protocols on parameters related to sarcopenia in older adults.

METHODS

This is a systematic review that gathers information on strength training with different protocols that influence sarcopenia. Regarding eligibility, the searched articles had to follow the following inclusion criteria, namely: having as a sample of interest the older adults (>60 years), and they could be of both genders; being about strength training that evaluated parameters that influence sarcopenia; being original articles, national and international; having been published in Portuguese, Spanish or English between 2010 and 2020.

On the other hand, studies excluded: that mentioned other age groups, children, adults, and adolescents; data that did not refer to the influential parameters of sarcopenia preponderated by strength training; that collected information in a language other than Spanish, English, and Portuguese; qualitative, theoretical, review, and opinion articles, such as editor's letter, books, book chapters, and research reports

The electronic search was conducted in three databases: SciELO, PubMed, and CAPES journal. The screening strategies were adapted for each database due to their peculiarities in search methods. The English and Spanish descriptors were standardized by Medical Subject Heading (MeSH), while their correspondents in Portuguese were standardized through the *Descritores em Ciências da Saúde* (DeCS).

The research was conducted by combining the descriptors in Portuguese and/or English, and/or Spanish, in three blocks of information: the first, related to the group of interest ("idoso", "elderly", "older adults", "ancianos"), the second, with terms related to the independent variable ("exercício", "exercise", "ejercicio"; "treinamento de resistência", "resistence training", "ejercicio de fuerza"), and the third group, related to the independent variable ("sarcopenia", "sarcopenia", "sarcopenia"). The logical operator "OR" was used to combine information within each block, and the logical operator "AND" was used to combine information between blocks. When possible, we used filters referring to the period (from the year 2010 to 2020), research conducted with humans, and publications from journals. For the selection of the articles included in this study, all of them were independently evaluated by two researchers according to the inclusion and exclusion criteria. In case of disagreement between these two researchers, a third researcher was consulted.

To avoid the loss of relevant research, a complementary manual analysis was also conducted on the references of the set of articles selected for the synthesis and on our collection. Articles could be included in the systematic review as long as they met the eligibility criteria. The management of references collected in this review was done using Mendeley Desktop®, version 1.19.1, free access.

Regarding the retrieval of articles in the different databases, the selection of publications was made according to the established search criteria. Afterward, the total number of articles found in all the databases was calculated, and then duplicates were excluded.

Next, a careful screening of titles and abstracts was performed to discard publications that did not fit the eligibility criteria. If the paper did not have an abstract, it was disregarded. Subsequently, a more thorough evaluation of possible articles for inclusion in the synthesis was performed.

The data extracted from the selected articles were classified into three groups: descriptive data (author's name, year the study was conducted, sample size, age), methodological/protocol data (training frequency, intensity, duration, volume), and parameters assessed, and results. The findings were summarized using a qualitative synthesis.

RESULTS

General Search Features

The search procedure in the databases of interest retrieved a total of 215 articles. After excluding the duplicates (n=9), 206 studies proceeded to the screening of titles and abstracts, and a large part of the studies was excluded during this stage (n=187) because they did not meet the proposed eligibility criteria, and the remaining studies (n=19) proceeded to the full-text reading stage.

Subsequently, the articles were excluded for the following reasons: did not analyze the variables of interest (older adults over 60 years, strength training protocols, evaluation of parameters influencing sarcopenia) (n=9). Thus, in total, 11 articles met the inclusion criteria and remained in the qualitative synthesis. Figure 1 presents in detail the flowchart of this whole process of search and screening, the exclusion criteria, and the final selection of articles, as well as the N of all steps. The studies included in the present review, are described in Table 1.

DISCUSSION

Sarcopenia is a geriatric disease mediated by multiple and interrelated factors that contribute to its development and progression. These factors undoubtedly contribute in varying proportions, being those related to age, loss of muscle mass, strength, muscle quality, and degree of functional impairment[2,3]. This systematic review addresses different strength training protocols (frequency, duration, and intensity) that interfere with parameters that influence the onset of sarcopenia.

Different studies have reported that strength training with varied application protocols influences parameters related to sarcopenias such as increased muscle mass, functional capacity, and balance in older adults[16-18]. Prado et al.[19] evaluated parameters such as balance, functional capacity, and quality of life in older adults before and after 5 weeks of a resistance exercise program, which consisted of dynamic exercises with free weights or mechanotherapy equipment. At the end of the study, these authors identified that resistance exercise is an effective way to increase the evaluated parameters, and improve the physical and psychological domains of the quality of life of older women, evaluated by the WHOQOL - BREF questionnaire. In the same way, Silva et al.[20] observed that a strength training program is beneficial in improving balance, coordination, and agility in older adults who practiced resistance training.

Corroborating these works, Albino et al.[21] reinforced this idea, showing that 11 weeks of resistance training were sufficient to improve the body balance indexes of older women. These same authors also added that strength training can generate muscle hypertrophy caused by an increase in the contractile capacity of skeletal muscles, and even reduce the sarcopenia process. Anderson et al.[22] found positive effects on muscle volume and strength, as well as on body balance in older adults, these being important factors to prevent falls in cases of imbalance.

Still, on the subject, Gonzalez et al.[23] reported that strength training is an effective non-drug therapeutic measure for preventing balance changes during aging. Likewise, Mann et al.[24] demonstrated the efficacy of regular strength training practice in older adults on body balance. Whereas better balance levels may positively impact an older adult's quality of life, increasing independence and reducing the risk of falls.

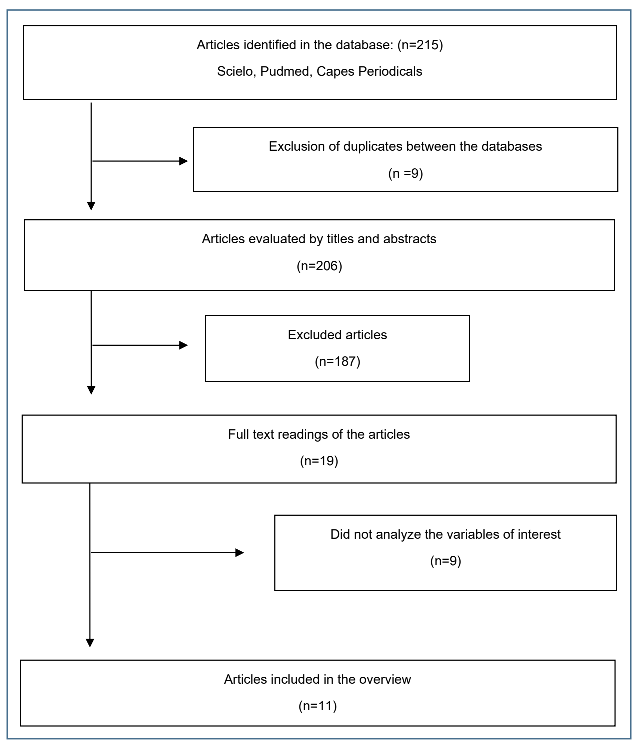

Figure 1: Flowchart of the search and screening process, including exclusion and inclusion criteria, for the selection of articles.

Validating the previous studies, Kannus et al.[25] referring to the training of muscle strength and balance, identified a reduction between 15 and 50% in the number of falls. For them, this improvement was due to the improvement of factors such as muscle strength, flexibility, balance, coordination, proprioception, reaction time, and gait. In summary, the regular practice of physical exercises, especially strength, improves body stability, balance, and gait, decreases the risk of falls and fractures, as well the quality of life[26,27].

Kannus et al.[25], and de Valença et al.[26] when comparing muscle mass, muscle strength, and balance in older adults who practiced weight training and sedentary older adults, found that there were great differences between the groups. Furthermore, these findings show that through strength training, the body balance and quality of life of the older adults showed several improvements, these apply to the physical and social spheres.

Regarding studies that evaluate the effect of strength training on muscle mass, strength, and physical performance in older adults, Mariano et al.[28] evaluated the effect of resistance training on maximal isometric muscle strength of the lumbar spine and knee extensors, pre- and post-training, in 36 older women aged 60 years or older. They observed that the exercise performed increased both the muscle strength and the quality of life of the participants. Similarly, Queiroz & Munaro[29] reported that strength training developed significant results in increasing muscle strength in older women.

Table 1: References and descriptive characteristics of the articles included in the synthesis.

Reference	Sample (n)	Exercise Protocol	Measured Parameters	Results
Guedes et al. [18]	35 women (65.7±6.68 years) in 3 groups: TC; n=15, TF; n=10 and TA; n=10 for eight weeks.	Combination Training (CT) Strength Training (ST) Aerobic Training (AT)	Handgrip strength (HGS), Muscle mass, Endurance Aerobic power	Significant (p ≤ 0.05) improvement in VO2 peak values ↑ in FPP ↑ in muscle mass
Prado et al. [19]	4 older women with a mean age of 70.25+8.61 years	Resistance exercises	-Balance -Timed Up and Go - Functional Mobility Test (TUG) -Gait speed (GS) -Quality of life	- Improved in balance by 3.92% and 3.70%. - Reduced the time to perform the TUG by 14% and 12.28% - GS improved by 48%. - Psychological domain improved by 71.42%.
Albino et al. [21]	22 women from 60 to 75 years old	Strength Training Flexibility training	Balance	In both groups, the balance was significantly higher after the training programs (p<0.05).
Gonzales et al. [23]	23 seniors aged 65 and older	Endurance training	Static Balance	↑ 42.1% of static balance
Wang et al.[27]	121 older adults above 80 years old (mean age 77.7±8.9 years)	Mixed training that included aerobic, balance, and endurance exercises.	Activities of daily living Walking Speed Handshake strength	Improvement in activities of daily living, as estimated by the change in the Barthel index from baseline to the end of the two-week intervention (p<0.001). Improvement in gait speed p=0.011).
Mariano et al. [28]	36 older women aged 60 years and older.	Strength Training	Maximum isometric muscle strength of the lumbar spine and knee extensors	Strength gains, in the knee extensors (p=0.0032; 30.23%) and lumbar spine extensors (p=0.0207; 12.33%).
Queiroz & Munaro [29]	17 older women with a mean age of 68.76±5.95 years	Endurance training	Muscle strength for the upper limbs (straight supine, elbow flexion, and elbow extension) and lower limbs (leg press and extension chair)	↑ in elbow extension muscle strength (69.8%) and leg press (69.5%)
Lima et al. [30]	61 older women mean age 66.8±5.8 years	Strength Training (ST)	Muscle strength (MS) of the knee extensors	↑ MS of 16.7% and 54.7% for isokinetic and 1RM respectively.
Viana et al. [32]	18 older women 65 years and older	Endurance training	-Knee extensor muscle strength -Muscle mass -Functional performance	↑ in power (p=0.01) and torque (p= 0.01) ↑ DXA (5.49 kg/m2 vs. 6.01 kg/m2; p= 0.03) Improvement in SPPB scores (9.06 vs. 10.28; p=0.01)
Cervantes et al. [34]	19 older above 60 years old (mean age 77.7±8.9 years)	Endurance training	Muscle mass Physical performance Muscle strength Nutritional intake	↑ of muscle strength (p=0.0001) ↑ of nutritional intake (p=0.001) Improvement of physical performance (p= 0.0001), in the variables: balance (p=0.0001), getting up from chair (p=0.036), gait speed (p=0.0001)
Letieri et al. [35]	Trained group - TG (low-intensity exercises with restricted blood flow) n=11, age 69.40±5.73; control group - CG n=12, age 69.00±6.39	Resistance training with blood flow restriction.	Physical Performance Anthropometry	TG improved after training, in all parameters of physical performance (p<0.05); as well as appendicular muscle mass (p<0.01), and muscle mass index (p<0.01)

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Similar to the findings of Mariano et al.[28] and Queiroz & Munaro[29], Lima et al.[30] showed positive results in the increase of muscle strength for the knee extensor in older women submitted to six months of training. Likewise, Hess et al.[31] confirmed in their study the hypothesis that strength training can increase strength in the lower limbs of older adults.

Viana et al.[32] evaluated the impact of a progressive resistance exercise program on muscular and functional performance in sarcopenic older women, noting that comparing the pre-and post-training moments, there was an improvement in muscular strength after the eight weeks of training. Still, in this perspective, De Morais et al.[33] Cervantes et al.[34], and Letieri et al.[35] demonstrated that strength training is fundamental for improving the levels of muscular strength and the ability to perform activities of daily living in older adults.

Regarding the frequency and intensity of training, Fragala et al.[36] reported that resistance exercises with a frequency of 2 to 3 times per week and intensity between 70 and 85% of 1-RM can provide stimuli for increased strength and skeletal muscle hypertrophy in older adults. Strength training in older adults is recommended to slow the decline in muscle mass and strength commonly observed in the aging process[37,38]. Rhodes et al.[14] recommended strength training as an integral part of physical conditioning in adults to minimize and prevent the reduction in muscle strength and muscle mass which are the parameters most affected in the development of sarcopenia.

Izquierdo et al.[39] compare the effects of resistance training, aerobic resistance training, or combined aerobic resistance and strength training, on the muscle mass of leg and arm extensors. In the end, they found that combined aerobic resistance training and strength training seemed to lead to similar gains in muscle mass. The study also suggested that the combination of just one strength training session (once a week) and one aerobic endurance training session (once a week) may be a valid option for promoting neuromuscular endurance fitness.

These findings may have important practical relevance for the optimal construction of strength and aerobic endurance training programs, because muscular strength, the ability to rapidly develop strength, and aerobic endurance performance are important health-related fitness components that contribute to various tasks of daily living.

This study has the limitation of not involving only clinical studies in this review, which limits the external validity of its results.

Conclusion

This review study demonstrates that strength training with different protocols is capable of improving physical parameters such as muscle strength, body composition, physical performance, and balance, all of which influence sarcopenia in older adults. In this way, strength training presents itself as a non-drug alternative, applicable and practical in the prevention of sarcopenia in older adults.

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