International Journal of Nutrology
(Official Journal of the ABRAN - Brazilian Association of Nutrology)

REVIEW ARTICLE

DOI: 10.54448/ijn23103

Major considerations of sarcopenia in the elderly: a concise systematic review

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E-mail: kleberreinertmd@gmail.com
DOI: https://doi.org/10.54448/ijn23103
Received: 09-15-2022; Revised: 01-10-2023; Accepted: 01-17-2023; Published: 01-26-2023; IJN-id: e23103

Abstract

The present work aims to highlight throughout the contents presented the main aspects of sarcopenia in the elderly, promoting to readers an understanding of the diagnosis, possible treatments, and exams that are relevant for the identification of the disease. The general objective of the research is to describe the main aspects of sarcopenia in the elderly, regarding the specific objectives, are highlighting information about the elderly; assessing how sarcopenia develops; present procedures for the diagnosis and treatment of sarcopenia among the elderly. For a better foundation of the contents presented, a literature review was carried out, highlighting some of the main concepts and analyzes of renowned authors on sarcopenia, consolidating how this disease impacts the routines and quality of life of the elderly. It can be concluded that over the years some research has been developed and treatment methods have been developed seeking to give the elderly an opportunity to treat sarcopenia, especially with the practice of physical activities aimed at strengthening the limbs and joints.

Keywords: Sarcopenia. Elderly. Treatment.

Introduction

Sarcopenia leads to a decline in muscle strength and power. However, numerous other factors lead to a decrease in strength **[1, 2]**. These include altered energy, changes in the tendon insertion with increased collaboration leading to an altered pan nation angle, altered nerve motor unit input to the muscle altering muscle coordination, and decreased blood flow due to decreased release of nitric oxide into the bed. muscle capillary **[3, 4]**.

As for the contents presented, they are justified as a way of guiding or highlighting how sarcopenia can be identified and treated, seeking a better quality of life for the elderly who are the most affected by this disease. It is, therefore, necessary to promote a broad knowledge of the efficient processes in the laboratory routine of sarcopenia.

Therefore, this study aimed to describe the main aspects of sarcopenia in the elderly. The specific objectives were to highlight the information about the elderly; evaluate how sarcopenia develops; present procedures for diagnosing and treating sarcopenia in elderly people.

Methods

Study Design

The present study followed a concise systematic review model, following the systematic review rules - PRISMA (Transparent reporting of systematic review and meta-analysis: //www.prisma-statement.org/).

Search Strategy and Search Sources

The literary search process was carried out from September to October 2022 and was developed based on Scopus, PubMed, Science Direct, Scielo, and Google Scholar, addressing scientific articles from various eras to the present day. The descriptors (MeSH Terms) were used "*Sarcopenia. Elderly. Treatment*", and using the Boolean "and" between the MeSH terms and "or" between the historical discoveries. Works carried out between 2015-2020, with themes that were limited to the theme, were considered, therefore works published in the last 5 years (except for classic books), with the

defined languages Portuguese and English. To search for information on the subject, the following terms were used "Falls in the elderly", "Fall prevention in the elderly", and "Physiotherapy in the prevention of falls in the elderly", associating their synonymous terms and a list of sensitive terms for the search.

The inclusion criteria were works that discussed Physiotherapy as an instrument for preventing falls in the elderly. The exclusion criteria were works that did not contemplate the proposed objective of the research; that did not adhere to the research area and that were unavailable at the time of collection and that, therefore, would not be relevant for this study. In total, 29 materials were selected, consisting of 16 books, 10 articles from scientific journals, 1 dissertation, and 2 websites.

Study Quality and Risk of Bias

Quality was rated as high, moderate, low, or very low for risk of bias, clarity of comparisons, accuracy, and consistency of analyses. The most evident emphasis was on systematic review articles or meta-analysis of randomized clinical trials, followed by randomized clinical trials. The low quality of evidence was attributed to case reports, editorials, and brief communications, according to the GRADE instrument. The risk of bias was analyzed according to the Cochrane instrument through the analysis of the Funnel Plot graph (Sample size versus Effect size), using Cohen's test (d).

Results and discussion

Summary of Findings

As a corollary of the literary search system, a total of 104 articles were found that were submitted to the eligibility analysis, and, then, 54 of the 20 final studies were selected to compose the results of this systematic review. The listed studies presented medium to high quality (Figure 1), considering in the first instance the level of scientific evidence of studies in types of study such as meta-analysis, consensus, randomized clinical trial, prospective and observational. The biases did not compromise the scientific basis of the studies. According to the GRADE instrument, most studies showed homogeneity in their results, with I2 =97.9% >50%. Considering the Cochrane tool for risk of bias, the overall assessment resulted in 16 studies with a high risk of bias and 24 studies that did not meet GRADE.

Figure 1. Flowchart showing the article selection process.

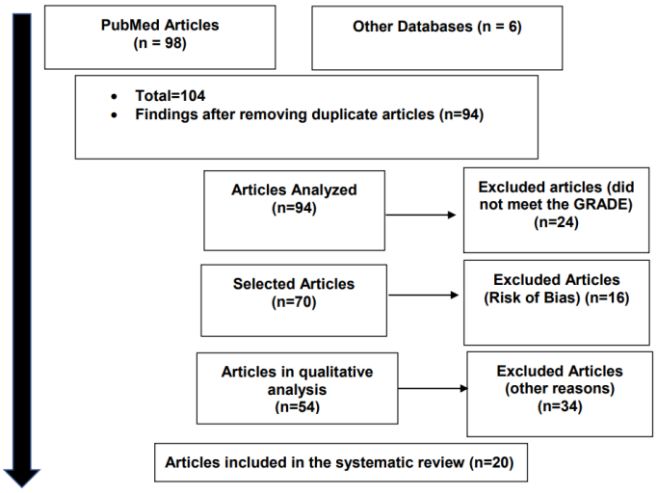
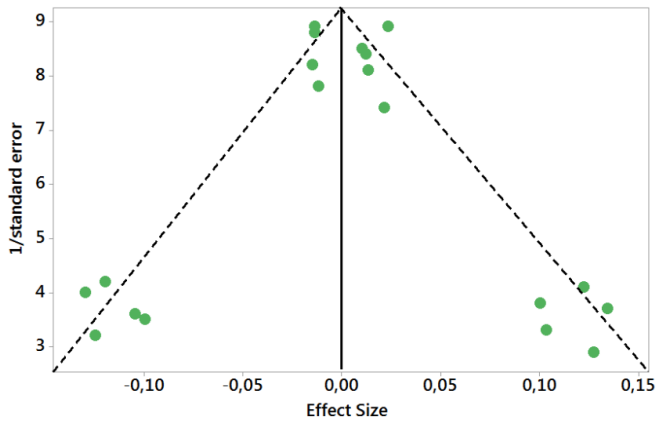


Figure 2 presents the results of the risk of bias of the studies through the Funnel Plot, showing the calculation of the Effect Size (Magnitude of the difference) using the Cohen Test (d). Precision (sample size) was indirectly determined by the inverse of the standard error (1/Standard Error). This graph had a symmetrical behavior, not suggesting a significant risk of bias, both between studies with small sample sizes (lower precision) that are shown at the bottom of the graph (studies shown in red color) and in studies with large sample sizes that are presented at the top (studies shown in blue color).

Figure 2. The symmetrical funnel plot does not suggest a risk of bias among the small sample size studies that are shown at the bottom of the plot (studies shown in red color). High confidence and high recommendation studies are shown above the graph (studies shown in blue color) (n=20 studies).



Literary Development

Elderly

The increasing number of elderly people aged 65 or over has been increasing in Brazil, the aging process

represents a worrying demographic phenomenon in modern society [2]. Aging can be understood as a physiological process that begins at conception and continues throughout life, becoming an individual and unique process, influenced by several factors such as the environment, genetics, culture, lifestyle, and factors related to self-care and health promotion activity.

Aging is a natural process that everyone goes through, and some of the consequences are the loss of sensitivity and control over movements. Activities such as feeding or dressing, for example, start to generate difficulties in this phase. In light of this, geriatric physiotherapy was developed to help both treats and prevent these afflictions [1].

Population aging brings with it health problems that challenge health systems and social security. Getting old doesn't necessarily mean getting sick. In the absence of associated disease, aging is associated with good health [3]. In addition, advances in health and technology have allowed the population to have access to inadequate public or private services, resulting in a better quality of life at this stage.

One of the most pressing problems facing humanity today is the aging of the general population, especially in terms of quality of life. As a result of population aging, sarcopenia has also become a worldwide social issue. Sarcopenia is a common disorder in elderly populations and is characterized by age-related loss of muscle mass, reduced muscle strength, and/or poor physical performance that contributes to functional decline, disability, frailty, and falls [4].

Sarcopenia

Sarcopenia is a subject of great interest to geriatricians, and the possibility of considering it as a geriatric syndrome has been in the air since 2010 [5]. The first author to talk about sarcopenia was Rosenberg, who asked himself in 1989 why the loss of muscle mass observed in the elderly had not received adequate attention.

Sarcopenia was a term applied by Irwin Rosenberg to define the loss of muscle mass that occurs with advancing age. The loss of muscle mass was first noticed by the famous English neurologist MacDonald Critchley, who pointed out that this loss of muscle mass was more pronounced in the hands and feet [6]. Today, sarcopenia is considered a loss of muscle mass in an elderly person, which is 2 SDs less than the average for young people. Sarcopenia can be considered to muscle as osteoporosis is to bone.

Sarcopenia is commonly associated with fat infiltration into muscle (sarcopenic obesity) and connective tissue enlargement. Sarcopenia is very common, with a prevalence of ~5% in people aged 65 and as high as 1 in 2 people over the age of 80 [7]. Fat infiltration into muscle (myosteatosis) is associated with decreased strength and an increased prevalence of disability. Strength is also not directly related to muscle power, that is, to the product of muscle strength (torque) by velocity (velocity). This can be defined as dynapenia.

The inability to develop adequate muscle power is one of the causes of frailty. A person with frailty can be considered as having such a borderline general condition that any stressor will lead to a bad outcome, such as hospitalization, disability, or death [8]. Characteristics of frailty are fatigue, inability to climb a flight of stairs, inability to walk a block, more than five illnesses, and weight loss.

There are numerous causes of sarcopenia. Overall, the most prominent cause of sarcopenia is inactivity. Exercise (muscle contraction) causes the release of muscle growth factors [insulin growth factor (IGF-Ea) and mechanogrowth factor] to activate satellite cells and protein synthesis. This leads to muscle regeneration. All these processes are less active with aging [9]. Adequate nutrient intake is essential for maintaining muscle mass. Thus, the decline in dietary intake with aging plays a role in the development of sarcopenia. In particular, the maintenance of muscle mass requires adequate protein intake [6].

It is postulated that to maintain muscle mass, the elderly need at least 1.2 g/kg of protein per day. Several studies have shown that an essential amino acid blend enriched with leucine enhances protein synthesis to a greater extent than other forms of protein [6]. They do this by activating the muscle target of the rapamycin pathway, which is a key regulator of anabolism. Protein works synergistically with exercise to increase muscle mass.

Sarcopenia in the lower extremities has long been recognized as a contributing factor to physical frailty. Many studies have found an association between physical frailty and sarcopenia. Sarcopenia and physical frailty have been considered two sides of the same coin [10]. They can overlap and contribute to impaired physical function, such as slow walking speed or poor balance. Sarcopenia and physical frailty can also affect each other, strongly impacting critical physiological parameters. Recent studies carried out in elderly trauma patients have further confirmed that sarcopenia and frailty work hand in hand in critical discharge disposition parameters, for example, skilled nursing facilities, nursing homes, rehabilitation, and home and home health [11].

Therefore, older adults should undertake progressive resistance exercise training to delay or prevent the development of physical frailty and its significant negative health consequences **[10]**. Physicians can adapt the ACMS guidelines to design progressive and rigorous resistance training programs tailored to the elderly to delay sarcopenia and therefore improve the quality of life of the elderly.

Sarcopenia, the loss of muscle mass and strength, has a crucial negative impact on physical functioning, independence, and quality of life in the elderly. Some biological and lifestyle factors that occur during aging, such as a decrease in the number of motor units, lower rates of mixed protein synthesis, and changes in circulating hormones, contribute to the occurrence of sarcopenia in the elderly. Progressive resistance training involving major muscles is a simple and effective way to combat sarcopenia **[4]**.

Epidemiology of Sarcopenia

Numerous epidemiological studies using different measurement methods and cut-off points have attempted to establish the prevalence of sarcopenia. Overall, it appears that 5-13% of people aged 60-70 and 11-50% of people in their 80s have sarcopenia. Sarcopenia is associated with a high predictive value for disability. There is an even greater association of disability in people with obese sarcopenia. Although some authorities consider muscle wasting in cancer sarcopenia, in almost all cases it is best classified as either cachexia or myopenia **[12]**.

Clinically, DEXA or ultrasound appears to be the best measure of sarcopenia. Ultrasound has the added advantage of being able to measure changes in the tendons as well. Magnetic resonance imaging or computed tomography provide excellent muscle measurements and delineate fat infiltration, but are very expensive **[13]**. Electrical bioimpedance measurements have questionable value in individuals, given the uncertainty regarding their hydration level. Arm muscle circumference or calf circumference are inexpensive but inaccurate measures of muscle mass.

Magnetic resonance imaging (MRI) allows for calculating the segmental and total muscle mass and assessing muscle quality by calculating the infiltration of fat in the muscle, which is a very interesting parameter. Magnetic resonance imaging has many advantages, but it is very expensive, not easily accessible, and not routinely indicated for studying muscle mass, it has been used mainly for research purposes. It is a very complex test that requires highly specialized personnel, specific software, and a relatively large amount of time **[14]**.

Resistance Training in the Routine of Elderly People with Sarcopenia

In addition to having more energy and vitality in the elderly, resistance training works together with the increase in lean mass and reduction in the percentage of body fat. In addition, the physiological variables also benefit from the combination of associated training and conventional training **[15]**. Resistance training for the elderly is an important tool to improve physical fitness and the quality of life of the group. Muscle strength and power are important for the autonomy of the elderly, in a few weeks of strength training it is possible to observe an increase in the level of these factors. In addition, flexibility and aerobic resistance are also benefited from resistance training **[16]**.

Exercise has been proposed as a potential strategy to manage osteoporosis; however, the magnitude of benefit from exercise intervention has traditionally been perceived as modest at best. It is known that bone preferentially responds to mechanical loads that induce highmagnitude stresses at high rates or frequencies and that weight-bearing load is vital **[16]**.

Resistance movement training is used in athletic conditioning to attempt to improve power and athletic performance by performing a sport-important movement with added resistance that is not excessive and does not adversely affect the movement pattern **[17]**. Resistance movement training provides greater resistance than normal training and can provide a greater stimulus to working muscles and optimize training adaptations and crossover for dynamic athletic performance. This training methodology is becoming more and more relevant among elderly people with osteoporosis since it promotes a stimulus or prevention of the bone part **[17]**. High-intensity progressive resistance and impact weightlifting (HiRIT) training can be employed to generate such loads but has not been routinely prescribed by health professionals in the absence of evidence to support its efficacy and safety.

For resistance training to be efficient, it is necessary to follow the fundamentals of basic training regarding the number of repetitions, series, execution techniques, and the type of muscular contraction. According to Carvalho (2018) **[18]**, currently, bodybuilding has been the physical modality most sought after by children, the elderly, and adults, each group trains according to their needs and goals. Although the demand for an aesthetic training program is still the majority, the demand for a preventive program has increased significantly.

The workload is an aid used during physical activity that has a broad definition. According to Chagas and

Lima (2017) [19], it is an incentive capable of regulating changes in the body and is influenced by frequency (1), density (2), volume (3), duration (4), and intensity (5).

1. Frequency: the amount of training per week, with more than one training session per day;
2. Density: Association between stimulus time and pause/resume. In the bodybuilding program, the use of this ratio is frequent, as changes in time, number, and time of repetitions can lead to changes in the training density;
3. Volume: expressed in the Joule unit of measurement. Corresponds to the total action in a given time;
4. Duration: can also express the volume;
5. Intensity: the effort made during an exercise. Some authors understand that the intensity is related to the amount of weight used in training.

Resistance training has a favorable effect on metabolic syndrome as it decreases fat mass, including abdominal fat. It also increases insulin sensitivity, improves glucose tolerance, and lowers blood pressure values. Such training should be a central component of public health promotion programs, along with aerobic exercise. Many studies show that resistance training can maintain or even increase bone mineral density [19].

It can be concluded that through resistance training in the elderly, some issues of fragility such as those caused by osteoporosis can be minimized or even worked on, giving individuals greater resistance and over time becoming an important part of the recovery process [19].

Rosenberg (2017) [7] classified sarcopenia as primary, which is age-related; and secondary, which includes sarcopenia related to physical inactivity (after prolonged bed rest, low physical activity, sedentary lifestyle), diseases (advanced organ failure, inflammation, malignancy, and endocrinopathy) and nutrition (inadequate diet, malabsorption, gastrointestinal disorders, and anorexia).

Two criteria are necessary for the diagnosis: low muscle mass and strength and/or low physical performance (decreased muscle power and functionality) with adequate measurements and tests [20]. The gold standard measure of muscle mass is the dual-energy X-ray absorptiometry (DXA) method, which is inexpensive, easy to apply, and also reliable. It measures the skeletal muscle mass of the four limbs and thus the appendicular skeletal muscle mass (ASMM) can be calculated.

The diagnosis of sarcopenia, based on the definition of the European Working Group on Sarcopenia (EWGSOP) as well as the definition of the International Working Group on Sarcopenia (IWGS), includes measurements of muscle mass, gait speed, and/or handgrip per trained operators, which generally cannot be performed, nursing homes or critical care settings. Therefore, the population to be screened for sarcopenia needs to be pre-screened with an easyto-use and widely available instrument [13].

ASMM, measured by DXA, is useful in diagnosing sarcopenia. A value representing the patient's measurement is needed to study ASMM, therefore, sarcopenia can be defined by one of the following: ASMM/height 2 or skeletal muscle mass index (SMI) in weight per square meter (kg/m2). Individuals with an SMI of less than two standard deviations (SD) below the mean SMI of a young reference population were considered sarcopenic.

SMI measurement has some disadvantages; for example, the need for a full-body DXA device and the threshold, which is defined from the calculated ASMM/height2 ratio less than compared to the normal value for the average young adult of each study, which often differs [5]. Other disadvantages are the results in obese and lean subjects (thin people with low muscle mass without any mobility limitations versus obese people with high muscle mass and mobility limitations) and the concept that muscle mass is the most important clinical parameter, which is wrong because strength and gender are not taken into account.

Among the measures to assess muscle strength, it is necessary to emphasize the importance of handgrip strength. Even though lower limbs are more relevant than upper limbs in terms of physical function, isometric handgrip strength has been widely used [13]. Measured under conditions with a well-studied model hand dynamometer, it is closely correlated with lower limb muscle power and calf cross-sectional area. Using a standardized and calibrated manual dynamometer, it is correlated with the muscle power of the lower limbs and with the area of the calf section [20].

According to Pagotto (2018) [8], one of the interventions for the prevention and treatment of sarcopenia is nutrition. It has been shown that the elderly probably need 1.0 to 1.2 g/kg of protein intake per day. Creatine supplements, high levels of vitamin D, and other investigational nutrients may provide further help.

The second important intervention is exercise, especially resistance exercise. Resistance exercise increases strength and muscle mass, which leads to better physical performance. To stimulate muscle hypertrophy and increase strength, low-speed

concentric and eccentric exercise for each muscle for 2 to 3 seconds is safe, feasible, and effective. Aerobic exercise also seems good against sarcopenia because it increases mitochondrial energy production, and insulin sensitivity and reduces oxidative stress **[7]**.

Currently, there is an attempt to design drugs for the prevention and treatment of sarcopenia. The anabolic hormone testosterone increases muscle mass, power, strength, and function, but it can have very serious adverse effects, such as water retention, increased hematocrit, worsening sleep apnea, and increased frequency of cardiovascular accidents and prostatic events. Many other drugs are being tested in clinical trials to try to prove their efficiency and safety in the elderly population. This is a work in progress **[5]**.

The etiology, clinical manifestations, and prognosis of sarcopenia in young and old are significantly different. As most patients with sarcopenia are elderly, our systematic review only focused on patients older than 65 years. There are considerable differences regarding diet structure and body composition between western and eastern people **[5]**.

Progressive resistance training has long been identified as the most promising method for increasing muscle mass and strength among the elderly **[15]**. Several studies have confirmed the effectiveness of resistance training in improving muscle mass, strength, balance, and endurance in the elderly. Chagas and Lima (2017) **[19]**, found that resistance training can enormously increase the rate of mixed muscle protein synthesis in physically frail elderly participants. In a randomized, placebo-controlled study including nursing home residents, ten weeks of progressive resistance training increased muscle cross-sectional area by 3-9% and improved muscle strength and performance in gait speed and skills. to climb stairs.

Rodrigues (2017) **[17]** found that regulators of muscle protein breakdown responded similarly in young and older adults after resistance training, suggesting that resistance training could slow the pace of sarcopenia. Therefore, it is reasonable to conclude from these studies that progressive resistance training can effectively improve or prevent sarcopenia in the elderly, through improvements in muscle mass and strength.

When designing an endurance exercise program to manage sarcopenia, some specific guidelines must be addressed. The aim is to gradually overload the muscles and make positive adaptations, such as improving muscle mass and function **[19]**. At the same time, sufficient attention must be given to specific and normal physiological aspects related to aging to avoid exercise-related injuries or serious outcomes.

Generally speaking, a progressive resistance training program for sarcopenia should be dynamic and target major muscle groups using concentric and eccentric movements **[17]**. Exercise programs that target lower extremity muscles, such as the knee and hip extensors, should be prioritized as they are important in mobility, balance, and gait.

Studies that have focused on the combined effect of exercise and nutritional interventions on sarcopenia in the elderly are rare and conclusions have not been unified. No systematic review has been performed to assess the role of combined interventions exclusively in sarcopenia in the elderly **[10]**. Our systematic review aims to obtain a reliable conclusion and provide a reference for clinical intervention, making a comparative analysis of related studies.

Conclusion

Several groups have attempted to create a consensus definition for sarcopenia. This is because muscle wasting alone is insufficient to explain the clinical syndrome. The European Working Group on Sarcopenia in Older Persons defined sarcopenia as low muscle mass and low muscle function. Resistance exercise and adequate protein intake are the cornerstones of sarcopenia management. Based on the pathophysiology described above, several drugs have been used to treat sarcopenia. Currently, testosterone molecules and selective androgen receptors appear to be the best drugs available to treat sarcopenia. Although its safety profile has been questioned, available studies suggest that testosterone treatment for up to one year is relatively safe in frail older adults. Testosterone should be combined with a leucine-enriched essential amino acid protein supplement for the best effect. The AIIR decoy protein appears to have great potential. However, its diverse effects on other tissues increase the likelihood of some side effects. Some angiotensin-converting enzyme inhibitors also increase muscle mass and function, but this is not a universal effect. Some important implications for clinical care for the elderly can be drawn from this review. First, the geriatric care team must be well-informed about sarcopenia and its tremendously harmful effects. Strategies must be implemented on time to slow the sarcopenia process or to avoid serious negative outcomes. Second, because resistance training plays a significant role in the management of sarcopenia, seniors are strongly encouraged to encourage moderate resistance exercise or at least stay physically active. Geriatric professionals must follow exercise guidelines when advising exercise modalities to maximize exercise benefits and effectively address the serious outcomes of sarcopenia.

Acknowledgement
Not applicable.

Funding
Not applicable.

Ethics approval
Not applicable.

Informed consent
Not applicable.

Data sharing statement
No additional data are available.

Conflict of interest
The authors declare no conflict of interest.

Similarity check
It was applied by Ithenticate@.

References
1. Pillatt AP, Nielsson J, Schneider RH. Efeitos do exercício físico em idosos fragilizados: uma revisão sistemática. Fisioter Pesqui, 2019;26(2):210-217.
2. Vale, P.M et al. Principais fatores de riscos relacionados a queda em idosos e suas consequências: revisão integrativa. Pubsaúde, 2020, v.3, p.a039.
3. Santos, R. A. dos; Bertoldi, J. Os benefícios da atividade turística para a melhor idade. Revista Científica Eletrônica de Turismo, Ano IX, n. 16, Janeiro de 2017, Periódico Semestral.
4. Lebrão, MR. Prevalence and associated factors of sarcopenia among elderly in Brazil: Findings from the study SABE. J Nutr Health Aging. 2019;18(3):284-90.
5. Santos JF et al. "Prevalence and associated factors of sarcopenia among elderly in Brazil: findings from the SABE study." The journal of nutrition, health & aging 18.3 (2019): 284-290.
6. Landi, F. et al. Prevalence and Risk Factors of Sarcopenia Among Nursing Home Older Residents. J Gerontol A Biol Sci Med Sci. 2017 Jan; 67(1):48-55.
7. Rosenberg, Irwin H. Sarcopenia: origins and clinical relevance. The Journal of nutrition, 2017, v. 127, n. 5, p. 990S991S.
8. Pagotto, Valéria et al. Sarcopenia em idosos: revisão, prevalência, concordância entre métodos diagnósticos e antropometria como proposta de rasatreamento. 2018.
9. Figueiredo LL, Patrizzi LJ. Sarcopenia e envelhecimento. Fisioterapia em Movimento, 2021, v. 24, n. 3, p. 455-462.
10. Wilson JM; Lee, SR. Dietary implications on mechanisms of sarcopenia:roles of protein, aminoacids and antioxidantes. J Nutr Biochem. 2020;21(1):1-13.
11. Thomas DR. Sarcopenia. Clin Geriatr Med. 2020;26(2):331-346.
12. Camelier, Aquiles Assunção. Sarcopenia em idosos: um estudo de revisão. Revista Pesquisa em Fisioterapia, 2019, v. 4, n. 1, p. 62-70.
13. Dent, Elsa et al. International clinical practice guidelines for sarcopenia (ICFSR): screening, diagnosis and management. The journal of nutrition, health & aging, 2018, v. 22, n. 10, p. 1148-1161.
14. Confortin, Susana Cararo et al. Sarcopenia e sua associação com mudanças nos fatores socioeconômicos, comportamentais e de saúde: Estudo EpiFloripa Idoso. Cadernos de Saúde Pública, 2018, v. 34, p. e00164917.
15. Cripa, M. M. et al. Análise dos efeitos do treinamento de força em um sujeito idoso portador de síndrome mielodisplásica: estudo de caso. Brazilian Journal of Biomotricity, 2019, vol. 3, núm. 1, p. 83-88.
16. Dias RMR et al. Benefícios do treinamento com pesos para aptidão física de idosos. Acta fisiátrica. 2016, v. 13. n. 2. p. 90-95.
17. Rodrigues, G. M. Exercício de resistência muscular e osteoporose em idosos. Revista Mackenzie de Educação Física e Esporte, 2017, v. 6, n. 3.
18. Carvalho J. Pode o exercício físico ser um bom medicamento para o envelhecimento saudável? Acta Farmacêutica Portuguesa, 2018, v. 3, n. 2, p. 123-130.
19. Chagas MH, Lima FV. Musculação Variáveis Estruturais - Programas de Treinamento e Força Muscular. 3. ed. Belo Horizonte, 2017.
20. Almeida S. et al. A força muscular associada ao processo de envelhecimento. Ciências biológicas e da saúde, 2017, v. 3, n.1, p. 93-102.

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