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Effect of strength training on muscle hypertrophy in healthy older adults: a systematic review

Lucas Wilson Miranda da Silva1, Lucas Melo Neves[1,2]

[1]Universidade Santo Amaro (UNISA), São Paulo – SP, Brasil.
2Instituto de Psiquiatria do Hospital das Clínicas da Faculdade de Medicina da Universidade de São Paulo – Ipq – HCUSP, São Paulo – SP, Brasil.

ABSTRACT

OBJECTIVE

To systematically summarize the literature considering studies that address strength training and its effects on muscle hypertrophy in healthy older people.

METHODS

The search was developed on the PubMed platform considering the PICOS strategy. The search date of the selected studies included the last 5 years (01.01.2017 to 07.21.2021). Studies in any language were considered. As eligibility criteria, the studies were required to contain: healthy older people; interventions with strength exercises; outcomes with hypertrophy measures (MRI, ultrasound, etc).

RESULTS

In total, 14 studies were included, totaling 470 older individuals (296 participants in the experimental group and 174 participants in the control group), aged between 60 and 80 years. The strength training interventions took place over between 4 and 30 weeks, with sessions from 1 to 7 times a week. Tests of balance, measurement of muscle temperature, capacity and functional performance, and strength tests were also carried out, with the most common being the 1 repetition maximum test (1RM). For the hypertrophy measurements, dual energy X-ray (DXA), ultrasound, bioelectrical impedance, and computed tomography were used. The analyzed studies showed a significant increase in muscle volume in the intervention groups when compared to control groups (follow-up or comparison). However, studies with comparison groups (another strength training strategy or protocol) also showed increases in muscle volume, with no differences between groups.

CONCLUSIONS

Strength training is effective in promoting improvements in muscle volume in older adults.

DESCRIPTORS

Older adult, Strength training, Muscle mass, Muscle hypertrophy.

Corresponding author:
Lucas Melo Neves.
Docente Mestrado em Ciências da Saúde – Universidade Santo Amaro (UNISA). Pesquisador do Pro-
reproduc- grama de Transtorno Bipolar (PROMAN) do Instituto
credited. de Psiquiatria do Hospital das Clínicas da Faculdade de Medicina da Universidade de São Paulo – Ipq – HCUSP. Rua Professor Enéas de Siqueira Neto, 340. Jardim das Imbuias, São Paulo – SP, Brasil.
E-mail: lmneves@prof.unisa.br
ORCID ID: https://orcid.org/0000-0003-2426-9736.

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INTRODUCTION

Aging is accompanied by several functional and structural alterations, especially the loss of muscle mass1. One of the most effective strategies to attenuate or reverse muscle mass loss in older adults is strength training[2-4], conceptualized as a type of exercise that requires the muscles of the body to move or try to move against an opposing force, usually exerted by some type of equipment (such as machines or dumbbells)[5]. In this way, strength training is an important tool for delaying the loss of muscle mass, which will reflect in a reduction in falls and aid execution of daily functional tasks. Current guidelines recommend at least two weekly strength training sessions involving larger muscle groups.

In fact, muscle tissue has an important role in the health of older adults, as it represents 40-50% of the total mass in individuals with a healthy weight; being a reservoir of proteins in the human body, with functions linked not only to locomotion, but also being fundamental for breathing, feeding, and energy expenditure, as well as for glucose, amino acid, and lipid homeostasis and for maintaining a high quality of life[6]. Muscle loss differs between different muscle groups, that is, within the same catabolic situation, different muscles activate distinct courses related to atrophy and hypertrophy[7].

However, the literature presents several studies referring to the types of interventions used to attenuate muscle mass loss in older adults. Different studies point to the benefit of strength training in older adults to attenuate the loss of muscle mass, however, samples including subjects with a specific disease or multi-comorbidities were included together with older adults without diseases in the most recent systematic reviews carried out[8-11]. In fact, we can highlight recent systematic reviews that summarize the effect of strength training in people with osteoporosis,[10] and long-lived older adults (+75 years)[8, 11]. To the best of our knowledge, a systematic review focusing on healthy older people has not yet been performed. Considering the relevance of the above, the current study summarized the literature on the theme of strength training in healthy older adults, and increased muscle mass.

METHODS

Eligibility criteria

The search was developed considering the PICOS strategy on the *PubMed* platform. The search date for the selected studies was the last 5 years (01.01.2017 to 07.21.2021). Studies in any language were considered.

As eligibility criteria, the studies were required to contain: (I) interventions with humans, (II) older subjects (over 60 years of age), (III) without specific diseases (ex: cancer, HIV, spinal cord injury, etc), (IV) an exclusive intervention with physical exercise in the exercise modality strength training [type of exercise that requires the body musculature to move or try to move against an opposing force, usually exerted by some type of equipment– Fleck & Kraemer, (2017)], (V) outcomes with measures of muscle hypertrophy (magnetic resonance imaging, ultrasound, etc.), (VI) not inversions of strength training.

Duplicate studies, studies in children, adolescents, and adults, animal studies, studies with aerobic protocols, combined or other physical training protocols, studies combined with dietary/nutritional supplementation, review studies, and studies with designs that were not clinical trials were excluded from the present research.

Information sources

We searched for studies in the *PubMed* database.

Search

The search terms used for the study were elderly AND hypertrophy AND exercise. The Clinical trial filter was used.

Selection of studies

The studies resulting from the systematic search were evaluated by two reviewers (LW and LN), if there was disagreement about the selection between these two reviewers, a third reviewer (CJ) applied the inclusion/exclusion criteria to define the selection of the same.

Data collection process

A data extraction spreadsheet (Excel, Microsoft, USA) was used considering: study title, no specific disease, humans or animals, intervention with strength training, older adults, and hypertrophy measurement. Both authors (LW and LN) extracted data from the included studies and verified the extracted data.

Data list

After the aforementioned data collection, details of the studies were extracted as follows: (I) Number of subjects; (II) Subject details; (III) Details of the intervention; (IV) Reported measures; (V) Measurement of hypertrophy; (VI) Main results; (VII) Conclusion.

RESULTS AND DISCUSSION

Selection of studies

Initially, 67 studies were identified (PubMed). After removing non-human studies (1 study) and those which dealt with specific diseases (19 studies), our search identified 47 studies. In the title, abstract, and full text review stage, studies were excluded because they were not related to older adults (6 studies), were not exclusively related to an exercise intervention (19 studies), did not refer to the measure of hypertrophy (2 studies), and did not include a strength training intervention (6 studies). This resulted in 14 studies, read in full and reviewed and evaluated for selection, which met the eligibility criteria and were included in our systematic review12-31. The selection steps are presented in the Flowchart.

Figure 1. Literature search flowchart.

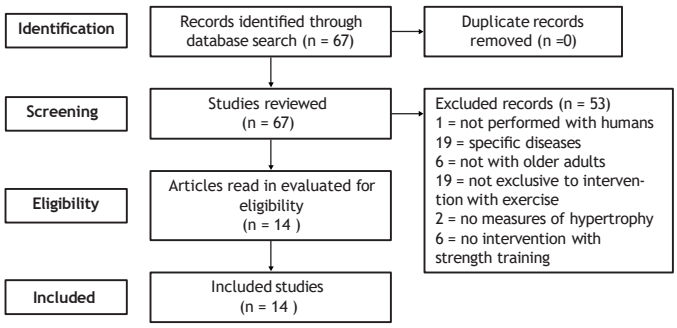

Table 1 presents the details of the selected publications; Number of subjects, Subject details, Intervention time and sessions, other measures reported, Measurement of hypertrophy, and Conclusion.

Table 1. Selected studies and relevant information - (I) Number of subjects (experimental and control); (II) Subject details; (III) Intervention time and sessions; (IV) Other measures reported; (V) Measurement of hypertrophy; (VI) Conclusion.

Study	(I) Number of subjects (experimental and control)	(II) Subject details	(III) Intervention time and sessions	(IV) Other measures reported	(V) Hypertrophy measure	(VI) Conclusion
Allison SJ, 2018	20+15=35	Older adults aged between 65 and 80 years.	6 months (7x week)	Max isometric strength, balance test	Ultrasound	Significant increase in hypertrophy through the intervention of the training group compared to the control group.
Baggen RJ, 2019	23+20 = 43	Older adults aged over 65 years	12 weeks (3x week)	Functional performance and balance	Computed tomography	Significant increase in hypertrophy through the intervention of the training group compared to the control group.
Conlon JA, 2017	13 +10 = 23	Older adults with a mean age of 70 years	22 weeks (3x week)	Dynamometer, peak torque, vertical jump	Ultrasound	No significant difference between interventions
Conlon JA, 2017	10 + 10 = 20	Older adults with a mean age of 70 years	22 weeks (3x week)	Dynamometer, peak torque, vertical jump	Ultrasound	No significant difference between interventions
Da Silva LXN, 2018	18 + 21= 39	Older adults aged over 66 years	12 weeks	1RM, functional performance	Ultrasound	Significant increase in hypertrophy through the intervention of the training group compared to the control group.
Da Silva LXN, 2018	15 + 21= 36	Older adults aged over 66 years	12 weeks	1RM, functional performance	Ultrasound	Significant increase in hypertrophy through the intervention of the training group compared to the control group.
Dos Santos L, 2018	20 + 19 = 39	Older adults aged over 67 years	8 weeks (3x week)	1RM	Dual energy X-ray (DXA)	There were no significant differences between interventions for hypertrophy
Lopez P, 2020	12+12=24	Older adults aged over 63 years	8 weeks (2x week)	Dynamometer, functional capacity	Ultrasound	Significant increase in hypertrophy through the intervention of the training group compared to the control group..
Moro T, 2019	9+10=19	Older adults aged over 70 years	12 weeks (3x week)	1RM	Dual energy X-ray (DXA)	No significant difference between interventions
Ozaki H, 2017	6+6=12	Older adults aged over 60 years	8 weeks (3x week)	Submaximal and maximal stress test	Ultrasound	No significant difference between interventions
De ResendeNeto AG, 2019	47	aged over 64 years	12 weeks (3x week)	Muscle strength test, 1RM	Bioelectrical impedance	No significant difference between interventions
Ribeiro AS, 2018	16+17=33	Older adults aged over 60 years	12 weeks (3x week)	1RM, stress test	Dual energy X-ray (DXA)	No significant difference between interventions
Soligon SD, 2020	12 + 11= 23	Older adults aged over 62 years	12 weeks (2x week)	Gait, muscle strength test, and functional performance tests	Ultrasound	Significant increase in hypertrophy through the intervention of the training group compared to the control group.
Soligon SD, 2020	11 + 11= 22	Older adults aged over 62 years	12 weeks (2x week)	Gait, muscle strength test, and functional performance tests	Ultrasound	Significant increase in hypertrophy through the intervention of the training group compared to the control group.
Teodoro JL, 2019	9 + 12 + 11= 32	Older adults aged over 68 years	20 weeks (2x week)	1RM, dynamometer and functional performance	Ultrasound	There were no significant differences between interventions for hypertrophy
Tomeleri CM, 2020	15 + 15 = 30	Older adults aged 60 years and over	12 weeks (3x week)	1RM	Dual energy X-ray (DXA)	Significant increase in hypertrophy through the intervention of the training group compared to the control group.
Tomeleri CM, 2020	14 + 15 = 29	Older adults aged 60 years and over	12 weeks (3x week)	1RM	Dual energy X-ray (DXA)	Significant increase in hypertrophy through the intervention of the training group compared to the control group.
Yoon SJ, 2017	8 + 6 + 7 = 21	Older adults aged 65 to 75 years	12 weeks (3x week)	Muscle volume and temperature, 1 RM,	Computed tomography	Significant increase in hypertrophy through the interventions of heat stress training groups.

The selected articles were published between 2017 and 2020. Samples included healthy older people aged between 60 and 80 years, and ranged from 12 to 47 older people, with 296 participants in the experimental group and 174 participants in the control group.

The strength training interventions took place over between 4 and 30 weeks, with sessions from 1 to 7 times a week. Regarding the evaluated outcomes, we verified studies with balance tests, measurement of muscle temperature, functional capacity, and performance and strength tests, of which the most commonly used was the 1RM test. Regarding the measures of hypertrophy used, we verified studies with dual energy X-ray (DXA), ultrasound, bioelectrical impedance, and computed tomography.

Of the 14 articles selected and included in the current study, 7 studies reported a significant increase in hypertrophy and 7 did not obtain a significant increase. However, it was observed that the studies that did not obtain a significant increase included studies with comparisons between variations in strength training (active control group), which justifies the lack of differences.

Regarding the studies with differences between the groups, all included comparisons between the intervention group with strength training and control groups without exercise (only follow-up)[12-31]. We emphasize that in addition to not presenting hypertrophy, in some cases, after the follow-up period, muscle atrophy was observed. Thus, in general, strength training proved to be effective for promoting hypertrophy in older adults.

Considering these facts, it is necessary to highlight the importance of the adoption of strength training in the lifestyle of older adults, since sarcopenia increases the risk of mortality in this population, affecting mobility and balance, and increasing the risk of falls through loss of limb strength, which is harmful to motor and cognitive functionality1. Physical exercise programs have been widely recommended to delay this process and help in the gain in muscle volume in older adults, in addition to improving functional performance and strength, promoting health

and quality of life in this age group[32-34].

However, the current research has certain limitations, since only a single platform (PubMed) was used to search for the studies, and for a short period (last 5 years). Furthermore, despite positive results, there were no specific demonstrations of percentage changes or meta-analyses.

CONCLUSION

The current research aimed to systematically summarize studies on the theme of strength training and muscular hypertrophy, specifically for healthy older people. It is possible to state that strength training programs in healthy older people promote muscle hypertrophy and have positive results.

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