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ARTIGO DE REVISÂO

EFFECT OF STRENGTH EXERCISES ON THE POSTURAL BALANCE OF THE OLDER ADULTS: A SYSTEMATIC REVIEW

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Resumo

Objetivos: verificar os efeitos de exercícios contrarresistência no equilíbrio postural de idosos e avaliar as características da intervenção neste perfil etário. Métodos: os critérios de elegibilidade dos artigos seguiram a estratégia PICOS, em que: P = Pessoas com 65 anos ou mais não praticantes de atividade física regular; I = Exercícios contrarresistência; C = Grupo controle sem intervenção; O: Equilíbrio postural; S = Ensaios clínicos randomizados. Como fontes de informação, foram consultadas as bases MEDLINE, LILACS, EBSCOhost, SCOPUS, SPORTDiscus e Web of Science. O risco de viés foi analisado pela Escala de Cochrane, enquanto a qualidade metodológica dos trabalhos foi averiguada pela escala PEDRo. Os resultados foram sintetizados quanto às características da amostra pesquisada, da prescrição do treinamento e os resultados relativos ao equilíbrio. Resultados: a estratégia de pesquisa resultou em 787 artigos e incluídos apenas quatro por atenderem aos critérios estabelecidos. Neles, um total de 118 idosos foram avaliados. As intervenções variaram quanto à duração da sessão e da intervenção, e frequência semanal. Também, diferiram quanto ao número de séries, de repetições e intervalos entre séries. Diferentes testes mediram o equilíbrio postural dos participantes. Apesar das divergências metodológicas entre os estudos, da qualidade metodológica (que variou de 3-7) e do risco de viés dos trabalhos (alto ou incerto), houve melhora significativa no desfecho equilíbrio postural. Conclusão: os quatro artigos mostraram diferenças metodológicas na investigação do treinamento contrarresistência no equilíbrio postural de idosos, no entanto, esse tipo de treino foi positivo na variável desfecho analisada (Registro PROSPERO: CRD42020198932).

PALAVRAS-CHAVE

Controle postural. Revisão. Treinamento de força.

Abstract

Objectives: to assess the effects of resistance training on the postural balance of older adults and evaluate the characteristics of the intervention in this age group. Methods: the eligibility criteria of the articles followed the PICOS strategy, in which: P = People aged 65 or over who do not practice regular physical activity; I = Counter-resistance exercises; C = Control group without intervention; O: Postural balance; S = Randomized clinical trials. As information sources, MEDLINE, LILACS, EBSCOhost, SCOPUS, SPORTDiscus, and Web of Science databases were consulted. The risk of bias was analyzed using the Cochrane Scale, while the methodological quality of the studies was assessed using the PEDRo scale. The results were synthesized regarding the characteristics of the researched sample, the prescription of the training, and the results related to the balance. Results: the search strategy yielded 787 articles, with only four being included for meeting the established criteria. Within them, a total of 118 older adults were evaluated. Interventions varied in terms of session duration, overall intervention duration, and weekly frequency. Additionally, they differed in the number of sets, repetitions, and intervals between sets. Various tests were employed to assess participants' postural balance. Despite methodological divergences among the studies, variations in methodological quality (ranging from 3 to 7), and a high or

uncertain bias risk, there was a significant improvement in the postural balance outcome. Conclusion: the four articles showed methodological differences in the investigation of resistance training in the postural balance of the older adults, however, this type of training was positive in the analyzed outcome variable (PROSPERO Registry: CRD42020198932).

KEYWORDS

Postural control. Review. Strength training.

1 Introduction

The number of older adults in the world is growing and is accompanied by an increase in longevity and life expectancy (World Health Organization, 2021), a phenomenon that imposes the necessity of a better understanding of human aging, given its implications on the health and quality of life of the older adults (Copeland et al, 2017).

The aging process is multifactorial and generates changes in the body structure and its functionality, which increases the incidence of chronic-degenerative and/or psychological diseases, the dependence on other people, and compromises the autonomy and quality of life(Küchemann, 2012). Thus, the idea of living longer and better must be taken into account(Fulop et al, 2019).

In this context, one of the major problems for the health of older adults is falls, as it is a phenomenon that generates changes in the daily life of the individual and can even lead to death (Lesko, 2020). After the first fall, the fear of falling increases and this feeling generates other harmful behavioral changes, such as sedentary lifestyle (Stubbs et al, 2014). Considering that the incidence of falls among the older adults population is high (about 1/3 falls each year, worldwide) (Sherrington et al, 2019), the development of strategies that avoid this first episode and promote the quality of life of older people is important.

As a way of minimizing the situation presented, the regular practice of physical exercises has been indicated as an effective strategy (Lopez et al, 2018; Sherrington et al, 2019). The regular practice of exercise by older adults contributes to minimizing the causes of morbidity, in addition to reducing public costs and acting positively on the quality of life of this population (Yabuuti et al, 2019).

It is noteworthy that, considering the aforementioned particularities of the older adults, the practice of physical exercises should aim at the development of their functional autonomy (Aguirres et al, 2018), including strategies that prevent the occurrence of falls (Osoba et al., 2019). Therefore, it is worth noting that the risk of falls is associated with difficulty in balance, which is provided, among other factors, by changes in body posture that modify the normal curvatures of the spine, causing misalignments over the years lived (Neri et al, 2019).

Among the several types of physical exercises, the literature presents a certain consensus on the benefits of resistance training for the older adults. Lopez et al. (2018), for example, state that this modality is one of the safest and most effective methods for developing pure strength, muscle power, and improving functional capacities, in addition to contributing to reducing the risk of accidental falls.

Even though the literature already presents strong evidence on the benefits of counter-resistance exercises in various aspects of the general health of older adults (Fragala et al, 2019; Lopez et al., 2018), specifically about improving postural control, which is essential to reduce the risk of falls, there are still doubts as to whether this type of training is, in fact, the best option for this outcome (Sherrington et al, 2019).

Given the gap presented, there is a need to gather and synthesize, through a systematic review, the scientific evidence on the topic in question, to better support the proposals for qualified interventions, based

on evidence. Therefore, the purpose of this study was to verify the effects of counter-resistance exercises on the postural balance of older adults and to evaluate the characteristics of the intervention in this age profile.

2 Methods

Protocol and registration

This systematic review was written following the guidelines of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) (PAGE e colab., 2021) and registered in the database of PROSPERO (International Prospective Register Of Systematic Reviews) (CRD42020198932).

Eligibility criteria

The definition of eligibility criteria for the studies followed the PICOS strategy (Pregunta et al., 2007), thus being defined: P: men and women aged 65 years or older who do not practice regular physical activity; I: Intervention - counter-resistance exercises; C: Comparison - with control groups without intervention; O: Outcomes (outcome) - postural balance; S: Study design - randomized controlled trials.

Information sources

A systematic search was carried out in May 2019 and updated on June 22, 2021, in the databases National Library of Medicine (MEDLINE), Latin American and Caribbean Health Sciences Literature (LILACS), EBSCOhost, SCOPUS, SPORTDiscus, and Web of Science.

Search strategy

The descriptors used were elderly, resistance training, postural balance, and their synonyms described in the MeSH dictionary, from Pubmed. The logic operators AND between descriptors and OR between synonyms were applied. Articles published in the years 2017 to 2021 were considered. This sentence was adapted according to the specifics of each database used.

Selection of studies

This phase was performed independently by three reviewers and disagreements were resolved with the evaluation of a fourth reviewer. All studies found in the identification phase went through the selection phase when duplicates were removed. After reading the titles and abstracts, studies that did not meet the eligibility criteria were excluded. When it was not possible to identify their adequacy by titles and abstracts, the full texts of the studies were completely read. Finally, studies that met the eligibility criteria were included in the present review.

Data collection process

Four independent reviewers extracted the following data for analysis: Authors and year of publication; Characteristics of the study samples (n sample, sex, age); Characteristics of the training prescription (total duration of the intervention in weeks, weekly frequency in days, interval between sessions in hours, duration of sessions in minutes, number of sets and repetitions of exercises performed by the study samples, exercise intensity, interval between the series in seconds and exercises performed); and the results of studies concerning the postural balance of older adults.

Risk of bias and methodological quality of studies

Two independent and experienced evaluators analyzed the methodological assessment and the risk of bias in each study included in the systematic review. Disagreements were decided by a third reviewer.

To assess the quality of the studies, the PEDro Methodological Assessment Scale was used (Oliveira et al, 2017), which consists of the sum of the scores of 11 domains, namely: 1) Eligibility of the participants; 2) Random distribution; 3) Hidden distribution; 4) Comparison of groups at baseline; 5) Blinding of participants; 6) Blinding of therapists; 7) Blinding of evaluators; 8) Measurement of at least one key result in 85% of allocated subjects; 9) Intention-to-treat analysis; 10) Comparison between groups; 11) Measures of precision and variability. If a study met the requirement for a particular domain, it received 1 point, and 0 if it did not. Only domain “1” was not included in the total score. Higher scores are considered indicators of better methodological quality of the study.

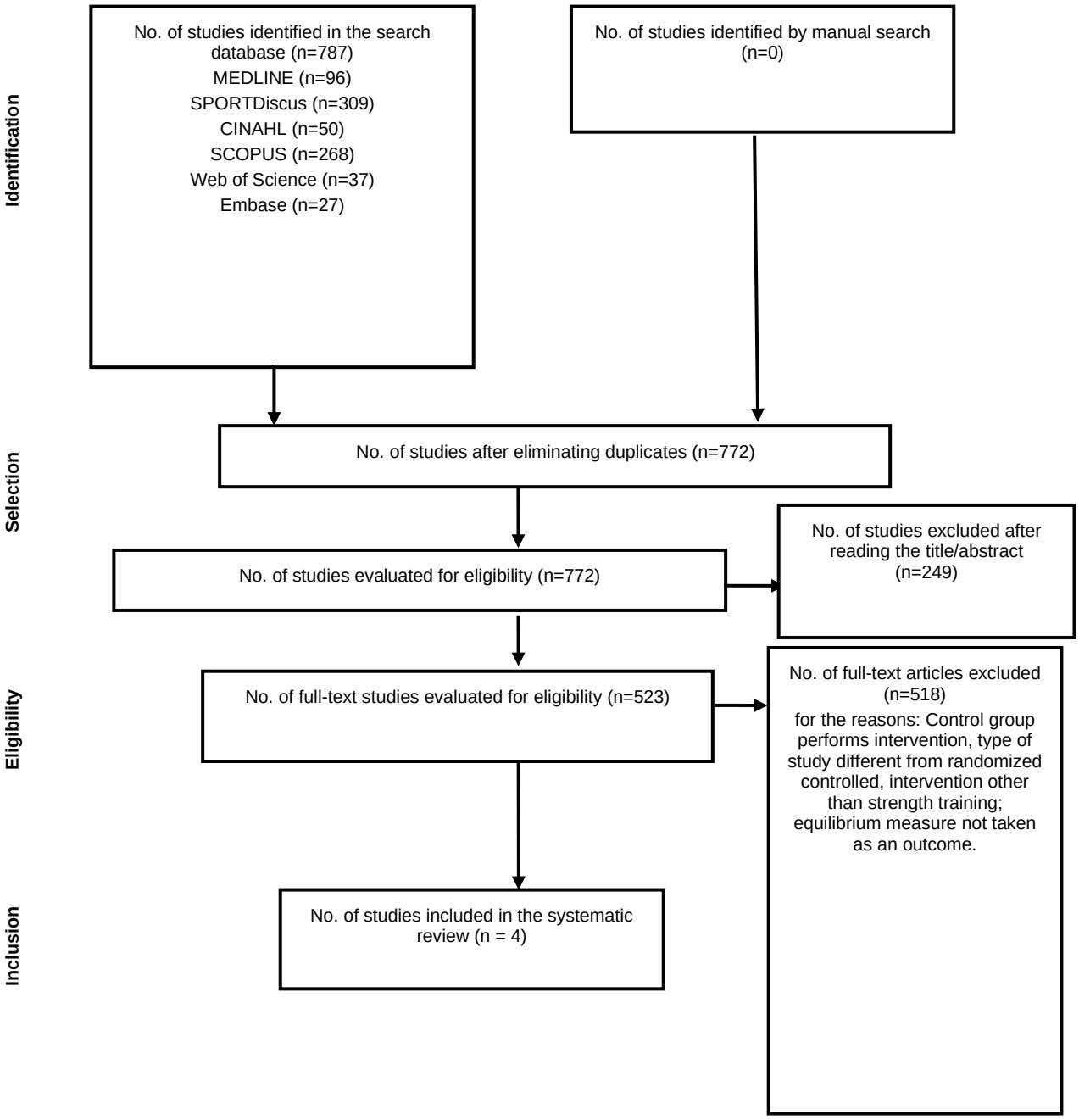
The Cochrane Scale (De Carvalho et al., 2013; Higgins et al, 2011) was used to assess the risk of bias in randomized clinical trials (2005-2007). On this scale, available for download at http://ims.cochrane.org/revman/download or online at http://www.cochrane-handbook.org, seven domains are evaluated, which are classified as HIGH, UNCERTAIN, or LOW risk of bias: 1) Randomization; 2) Allocation concealment; 3) Blinding of participants; 4) Blinding of evaluators; 5) Incomplete results data; 6) Selective report; 7) Other sources of prejudice. For a study to be considered with a low risk of bias, all domains must receive a low-risk assessment. If any domain presents "HIGH risk", the study is classified as "HIGH risk" of bias. In the absence of domains with "HIGH risk", the presence of at least one domain with uncertain risk implies the classification of the study with "UNCERTAIN risk" of bias.

3 Results

Selection of studies

In the identification phase, 787 studies were found in the listed databases. After the eligibility phase, four studies were selected for analysis, undergoing quality and risk of bias analysis. The complete selection flow of studies included in this review can be seen in Figure 1.

Figure 1 - Flow diagram of article selection.



Source: The Authors.

Characteristics of the included studies

The characteristics and outcomes of the four studies analyzed are shown in Table 1. In the four studies included a total of 118 individuals, 31 men, and 87 women were involved. In all cases, participants at the start of the experiment exhibited sedentary levels of physical activity and were healthy. In the study of Naczk et al. (2020), the participants were residents of a Long Stay Institution.

Table 1 - Study characteristics and outcomes (n = 4).

Studies	**Sample profile (n, mean ± standard deviation of age)**	**Intervention characteristics**		**Balance tests used and results**
		• **Duration (weeks)** • **Weekly frequency** • **Interval between sessions** • **Duration of sessions**	• **Sets x reps** • **Exercise intensity** • **Interval between sets**	
Ansai et al.[20]	GI= 15 M and 4 H (82.8 ± 2.8 years) CG= 15 M and 4 H (82.6 ± 2.6 years)	• 16 • 3 times • They only report that the sessions were non-consecutive • 1h	• 2 x 12 and 3rd set to fatigue, no more than 10-12 reps • Uninformed • 1'	↑**One-leg standing (right support), s (0–30):** (IG) PRE: 6.0±6.7/ POS: 7.0±7.0 (p<0.001) (CG) PRE: 5.1 ± 6.5 / POS: 4.9 ± 8.0 (p>0.05) *IG vs. GC; p<0.001* ↔ **One-leg standing (left support), s (0–30)**: (IG) PRE: 6.6 ± 7.7 / POS: 7.4 ± 7.1 (p>0.05) (CG) PRE: 5.1 ±6.5/ POS: 5.5±7.1 (p>0.05) *IG vs. GC; p>0.05* ↔**Tandem test, s (0–30):** (IG) PRE: 18.3±11.6/ POS: 20.6±12.2 CG: PRE: 5.1 ±6.5/ POS: 5.5±7.1 (p>0.05) *IG vs. GC; p>0.05*
Hamed et al.[22]	GI=12M and 3H (70.6±3.7 years) CG=9M and 6H (70.8±3.6 years)	• 14 • Twice • Uninformed • 1.5h	• 3 x 5-30* • 20-85%* • Uninformed	↓**The approach of the center of pressure (CoP) to the previous limits of stability (LoS) using a force plate, cm** (IG) PRE: 4.3 ± 1.6 / POS: 4.0 ± 0.9 (p<0.05) *(CG)* PRE: 4.5 ± 1.4 / POS: 5.1 ± 1.2 (p>0.05) *IG vs. GC; p<0.05*

Studies	Sample profile (n, mean ± standard deviation of age)	Intervention characteristics		Balance tests used and results
		• **Duration (weeks)** • **Weekly frequency** • **Interval between sessions** • **Duration of sessions**	• **Sets x reps** • **Exercise intensity** • **Interval between sets**	
Barbosa et al.[23]	GI1 (TG5) = 10M (64.6 ± 4.3 years) GI 2 (TG10) = 10M (66.5 ± 6.5 years) GC=10M (66.1 ± 4.5 years)	• 4 • One time • Uninformed • Uninformed	• 5x30” • 5% or 10% CIVM • 30”	**Displacement of the COP in the anteroposterior direction in bipedal support using a force platform (cm)** ↑ GI1 (TG5) PRE: 0.17 ± 0.03/ POST: 0.19 ± 0.04 (p<0.05) ↑ GI2 (TG10) PRE: 0.14 ± 0.04 / POST: 0.16 ± 0.04 (p<0.05) ↔ (GC): PRE: 0.14 ± 0.03 / POST: 0.14 ± 0.03 (p>0.05) *GI1 vs. GI2; p<0.05*
Naczk et al.[19]	GI = 3M and 7H GC=3M and 7H (76.7±8.77 years)	• 6 • Twice • 48 hours • Uninformed	• 3 x 15” • Uninformed • two'	**Tinetti test, points (percentage average change)** ↑ GI PRE: 7.63 ± 2.64 / POST: 9.63 ± 3.08 (p≤0.05) ↔(GC): PRE: 8.13 ± 2.93 / POST: 8.38 ± 2.74 (p>0.05) *GI1 vs. GC, p*≤0.05

GC = Control Group; IG = Intervention Group; TG5 = Group that trained at 5% of the maximum voluntary isometric contraction (MVIC) of the plantar flexor muscles; TG10 = Group that trained at 10% of MVIC of the plantar flexor muscles. *The authors manipulated the variables volume and intensity of the series, according to the course of the weeks.

Source: The Authors.

The resistance training parameters used by the studies included in this review were similar across the four studies analyzed, with some of them showing great variation. In addition, some variables were not clearly described by the authors. Sessions ranged from 60 min to 90 min, 1 to 3 days a week for 4 to 16 weeks. The number of sets per exercise ranged from 2 to 3 between studies (mean 2.7 ± 0.6). Repetitions and intervals between sets were fixed at 12/1' and 10/2' in two experiments (Ansai et al., 2016; Beurskens et al., 2015), while one varied between 5 and 30 repetitions as the training weeks progressed, without informing the interval (Hamed et al., 2018). As for training intensity, of the four studies, only two reported this important variable, indicating that they worked with high loads (Beurskens et al, 2015; Hamed et al, 2018).

The effects of resistance training on postural balance were investigated by different tests and instruments. The force platform was used in two of the four studies; however, the assessment protocols were different. Despite this variation, it was found that the investigated variable improved when evaluated by the one-sided support test (right side, during the 30 s) (Ansai et al., 2016), displacement of the center of pressure (COP) in the limits of the base (Hamed et al., 2018) bipedal support (Barbosa et al., 2020) or Tinetti test (Naczk et al, 2020).

Methodological quality and the risk of bias

The studies methodological quality and risk of bias are presented in Tables 2 and 3, respectively.

Table 2 – Assessment of the methodological quality of the studies included in the review.

Study	1	2	3	4	5	6	7	8	9	10	11	Score
Ansai et al.[20]	1	1	1	1	0	0	0	1	1	1	1	7/10
Hamed et al.[22]	1	1	0	1	0	0	0	0	0	1	1	4/10
Barbosa et al.[23]	1	1	0	0	0	0	0	0	0	1	1	3/10
Naczk et al.[19]	1	1	0	1	0	0	0	0	1	1	1	6/10

Caption: 1) Eligibility of participants; 2) Random distribution; 3) Hidden distribution; 4) Comparison of groups at baseline; 5) Blinding of participants; 6) Blinding of therapists; 7) Blinding of evaluators; 8) Measurement of at least one key result in 85% of allocated subjects; 9) Intent to treat; 10) Comparison between groups; 11) Measures of precision and variability.

Source: The Authors.

Table 3 - Risk of bias in the studies.

Study	1	2	3	4	5	6	7	Risk
Ansai et al.[20]	Low risk	Low risk	Low risk	High risk	Low risk	Low risk	Low risk	High risk
Hamed et al.[22]	Low risk	Uncertain risk	Low risk	uncertain risk	Low risk	Low risk	uncertain risk	uncertain risk
Barbosa et al.[23]	Low	Uncertain	Low	Low	Low	Low	Low	Uncertain
Naczk et al.[19]	Low risk	does not present	Low risk	does not present	Low risk	uncertain risk	uncertain risk	uncertain risk

Caption: 1) Randomization; 2) Allocation concealment; 3) Blinding of participants; 4) Blinding of evaluators; 5) Incomplete results data; 6) Selective report; 7) Other sources of prejudice.

Source: The Authors.

4 Discussion

The present systematic review aimed to verify the effects of resistance exercises on postural balance in older adults and to evaluate the characteristics of the intervention in people over 60 years of age. This study found that very few randomized controlled studies have addressed this issue. Only four randomized trials were included. The methodological quality of these articles ranged from 3 to 7 (on a scale of 10) and is within the average score of articles indexed in PEDRo (Oliveira et al. However, only the study by Ansai et al. (2016) presented a moderate to high methodological quality, with a score of 7. The risk of bias in the studies was also high or uncertain, according to De Carvalho et al. (2013). Therefore, the findings presented here must be carefully analyzed by professionals who seek scientific evidence for decision-making in health.

It is worth mentioning that the four articles analyzed studied older adults people with a mean age of over 65 years, and two had a mean age of over 70 years (Hamed et al., 2018; Naczk et al., 2020), while Ansai et al.

(2016) investigated longer-lived individuals, over 80 years old. This is an indication that the increase in the number of older adults people in society, due to the increase in longevity and life expectancy (World Health Organization, 2021), encourages studies with this population to be carried out, which is important as older adults, despite their benefits, still, show resistance to participating in this type of training (Araújo et al, 2010.)
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Another noteworthy data regarding the sample of the investigated studies is the fact that, of the 118 individuals submitted to resistance training, 87 were women. Although bodybuilding is culturally seen by males and females as a neutral physical exercise modality (Silva et al, 2018), this numerical superiority was expected, since studies indicate, in this population, greater involvement of females in supervised physical activities (Gillette et al, 2015; Goggin;Morrow, 2001; Lemos et al, 2016), among other reasons, due to the phenomenon of feminization of old age (Maximiano-Barreto et al., 2019), a reflection of the difference in life expectancy between genders, which, on average, in Brazil, women live about seven years longer than men (IBGE, 2020).

Despite these facts being able to influence the results of the studies analyzed here, it is important to note that, regardless of the type of evaluation applied, all of them presented positive responses for the postural balance of the older adults submitted to resistance training. To explain these results, it is important to remember the relationship between physical exercise and the most important body systems involved in the control of human balance – the visual, somatosensory, and vestibular systems (Duarte, 2000) – without forgetting that the stability of the body is closely related to the responses of the cardiovascular system (Garg et al, 2014).

The vestibular system plays a key role in the control of posture, coordination of movements, and human balance. It is composed of the semicircular canals, otoliths, and cerebellum, which (Duarte, 2000). Therefore, these organs receive sensory and motor information from the proprioception, motor, and visual systems, which together provide the perception of the individual's position concerning the space around them, allowing safe movement and adequate balance maintenance (Viswanathan;Sudarsky, 2012). In older adults, however, there is a greater possibility of gait alterations, causing uncoordinated movements and inadequate body balance, which can lead to falls and their undesirable consequences (Osoba et al., 2019). This is due to a combination of alterations, such as sensory deficit (polyneuropathies, vestibulopathy, visual impairment due to cataract), degenerative diseases (Parkinson's, cerebellar ataxia, dementia syndromes), vascular encephalopathy, normal pressure hydrocephalus, and intrinsic gait alterations (Osoba et al, 2019).

In addition to neurosensory and visual connections, the musculoskeletal system also plays an important role in maintaining posture, gait, and balance (Osoba et al, 2019). Likewise, in older adults, the presence of osteopenia and osteoporosis, as well as the replacement of skeletal muscle mass by fat (sarcopenia), weakens this body system (Bruijn et al, 2013). The coordinated action of neuromotor stimuli and responses is impaired with advancing age, resulting in more instability, less strength and a prolonged reaction time, especially in the face of obstacles, which end up increasing the chance of falls (Kerrigan et al, 1998).

On the other hand, if such systems are subjected to physical exercises, some adaptations that act against the damage caused by the aging process may occur (Daly et al, 2019; Nascimento et al, 2019). In particular, counter-resistance training has been pointed out as a great ally of this process by stimulating the increase in muscle mass and strength at different ages and clinical conditions (Fragala et al, 2019), preventing sarcopenia and osteoporosis (Daly et al, 2019; Nascimento et al, 2019). Therefore, the practice of exercises can increase body stability (Keating et al, 2021).

In general, physical training may have positive effects on the health of the practitioner if they are submitted to an adequate stimulus in terms of volume and intensity (Filho et al, 2014). In the case of resistance training, the American College of Sports Science (Liguori, 2021) indicates that older adults should perform this type of

training at least two days a week, gradually progress to moderate to vigorous intensities (60%-80% of 1RM), perform 8 to 10 exercises involving large muscle groups, 1 to 3 sets of 8-12 reps each. Based on this assumption, an attempt was made to evaluate the intervention characteristics of the four studies included in this review. The protocols of exercises of the included studies were insufficiently detailed by the authors (frequency, intensity, time, and type) (Table 1). This makes it difficult to understand the real impact of the results obtained and to determine the best prescription for this type of training to achieve the proposed objective.

However, despite the great variation in the interventions proposed by the studies, and the lack of some data, it was found that for some variables the ACSM recommendations (2021) were respected in most studies, with a minimum of 2 weekly sessions (Ansai et al, 2016; Hamedet al., 2018; Naczk et al, 2020) and 1 to 3 series (Ansai et al, 2016; Hamedet al., 2018; Naczk et al, 2020), while only two studies indicated that they worked with high intensity (Barbosa et al, 2020; Hamed et al, 2018), and the others did not provide this information. It is also interesting to note that two studies found their results after only four (Barbosa et al., 2020) and six (Naczk et al, 2020) weeks of training, a time that would be enough to cause an increase in muscle strength by neural adaptations (Gabriel e et al, 2006), but not for muscle mass gains (Reggiani;Schiaffino, 2020). Even the study by Barbosa et al. proposed the shortest time (four weeks) and the smallest number of weekly sessions (one), indicating that positive effects on the body balance variable can be achieved by different combinations of the counter-resistance training variables. A similar conclusion to this was drawn up by Silva et al. (2014). They performed a systematic review with meta-analysis to investigate the impact of resistance training on strength gains in older adults. Regardless of the combination of variables of this type of training, the older adults respond favorably to strength training, which strengthens the relationship of this variable with body balance, as previously presented in the literature (Lopez et al, 2018).

Our results are relevant and have a potential practical implication, as it reinforces the hypothesis that resistance training favors positive adaptations in important systems to preserve body balance, such as neuromotor, favoring important aspects of the functional autonomy of the older adults. However, it is necessary to extrapolate our results with caution, due to the limitations of the included studies, which were presented in the previous sections (the small number of studies, the low level of methodological qualities, and the high risk of bias). To increase the certainty of evidence related to this topic, we suggest that new studies be carried out with better methodological qualities.

4 Conclusion

It is concluded that, although the evidence on the effects of counter-resistance exercises on postural balance in older adults is promising, there is still not enough evidence to support its use in the respective population.

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