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Review of revisions

Efficacy of resisted training in muscle strength and functionality in adult individuals after brain vascular accident: a systematic review of revisions

Eficácia do treinamento resistido na força muscular e funcionalidade em indivíduos adultos após o acidente vascular cerebral: uma revisão sistemática de revisões

Ramon Martins Barbosa[1,2,3], Larissa Gessilda Silva Barbosa[1,2], Hiago Silva Queiroz[1,2], Lais Santos Oliveira[1,2], Marivaldo Nascimento da Silva Júnior[1,2], Bruno Santiago Silva[1,3], Cristiano Oliveira Souza[3], Alan Carlos Nery dos Santos[1,2]

1. Instituto Mover, Centro Especializado em Fisioterapia, Feira de Santana, Bahia, Brazil
2. Universidade Salvador, UNIFACS, Feira de Santana, Bahia, Brazil
3. Hospital Municipal de Serrinha, HMS, Bahia, Brazil

ABSTRACT

Objective: To summarize systematic reviews that analyzed the effectiveness of resistance training on muscle strength and functionality in adult individuals after stroke. **Methods:** Systematic review, PROSPERO (CRD42020208823), performed in the following databases: Pubmed, EBSCO, Lilacs, Medline, Portal BVS, Scielo, Cochrane, SPORTDiscus and PEDro. Descriptors: "Resistance Training", "Stroke" and "Systematic Review". Included: Systematic reviews; composed of randomized clinical trials and/or controlled intervention studies; which tested resistance training interventions; compared to other neuromuscular interventions, conventional treatment, or, simulation or placebo techniques; in adults who have had a stroke, regardless of the stage of the disease; for the outcomes: muscle strength and functionality. Such studies should be available in full. There were no restrictions regarding the language/time of publication of the studies. The risk of bias was assessed using the AMSTAR-2 scale. **Results:** Identified 139 articles, however, after analysis 10 were included. These were meta-analytic reviews, published between 2009 and 2020. Resistance training interventions were statistically significant for increasing upper and lower limb muscle strength, gains in 1RM, and performance on the 6-minute walk test. Resistance training was not statistically significant for increased activity, maximum gait speed and preferred gait speed. The studies were of high/moderate methodological quality. **Conclusion:** Although resistance training is statistically significant for increasing muscle strength and performance in the 6-minute walk test, these results do not seem to be clinically relevant. There was no improvement in preferred walking speed and maximum walking speed.
Keywords: resistance training; stroke; muscle strength.

RESUMO

Objetivo: Sumarizar revisões sistemáticas que analisaram a eficácia do treinamento resistido na força muscular e funcionalidade em indivíduos adultos após o acidente vascular cerebral. **Métodos:** Revisão sistemática, PROSPERO (CRD42020208823), realizada nas bases: Pubmed, EBSCO, Lilacs, Medline, Portal BVS, Scielo, Cochrane, SPORTDiscus e PEDro. Descritores: "Resistance Training", "Stroke" e "Systematic Review". Incluídos: Revisões sistemáticas; compostas por ensaios clínicos randomizados e/ou estudos de intervenção controlados; que testaram intervenções de treinamento resistido; comparado a outras intervenções neuromusculares, tratamento convencional ou técnicas de simulação ou placebo; em adultos que tiveram acidente vascular cerebral, não importando o estágio da doença; para os desfechos: força muscular e funcionalidade. Tais estudos deveriam estar disponíveis na integra. Não foram realizadas restrições quanto ao idioma/tempo de publicação dos estudos. O risco de viés foi avaliado pela escala AMSTAR-2. **Resultados:** Identificados 139 artigos, contudo, após análise 10 foram incluídos. Esses eram revisões com meta-análise, publicados entre 2009 e 2020. As intervenções de treinamento resistido foram estatisticamente significativas para aumentar a força muscular de membros superiores e inferiores, ganhos em 1RM e desempenho no teste de caminhada de 6 minutos. O treinamento resistido não foi estatisticamente significativo para aumento da atividade, velocidade da marcha máxima e velocidade da marcha preferida. Os estudos eram de alta/moderada qualidade metodológica. **Conclusão:** Embora o treinamento resistido seja estatisticamente significativo para o aumento da força muscular e desempenho no teste de caminhada de 6 minutos, esses resultados parecem não ser clinicamente relevantes. Não houve melhora na velocidade de marcha preferida e velocidade de marcha máxima.
Palavras-chave: treinamento resistido; acidente vascular cerebral; força muscular.

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Correspondence: Ramon Martins Barbosa, Instituto Mover, Centro Especializado em Fisioterapia, Avenida Getúlio Vargas, 471 Centro 44075-525 Feira de Santana BA. ramonmartinsbarbosa@hotmail.com

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Introduction

Stroke is considered a global public health problem, with a prevalence of 80.1 million cases worldwide [1-3]. The 2016 Global Burden of Disease Study [3] highlighted that each year, 13.7 million individuals have a stroke in the world and 5.5 million go on to die. This results directly or indirectly in high costs for health care organizations, and its negative impacts on the functional and biopsychosocial aspects of the population affected by this clinical condition should be mentioned [1,2].

Interestingly, 72% of stroke cases are due to metabolic factors, such as systolic blood pressure, and 66% due to behavioral factors, such as smoking and physical inactivity. While this risk attribution information is not new, much of it is modifiable and, when changed, has been shown to reduce the risk of stroke as well as the recurrent event [1]. Another data that draws attention is that stroke and its comorbidities is the second leading cause of disability worldwide, in which 116.4 million individuals persist with disability-adjusted life years [3]. These data are concerning, as 80% of stroke survivors have motor impairment, affecting the face, arm, and leg on one side of the body [4]. Added to this, it is also known that stroke can impact on the reduction of physical fitness, functionality, and functional capacity, thus necessitating strategies aimed at the recovery/rehabilitation of these clinical outcomes [5,6].

With this in mind, some studies have identified that physical rehabilitation is effective in promoting the recovery of function and mobility after stroke [4,7]. In the same sense, aerobic training alone or combined with resistance training (RT) was effective in improving speed and walking ability in stroke survivors, in acute or chronic stage [8]. As for RT, previous reviews found insufficient evidence for RT in rehabilitation after stroke [8-10]. However, some intervention studies have combined RT with other neuromuscular interventions, a fact that makes it difficult to make an accurate statement about its effectiveness. Thus, our study aimed to summarize systematic reviews that analyzed the effectiveness of RT on muscle strength and functionality in adult subjects after stroke, compared to other neuromuscular interventions, to control with placebo interventions or conventional treatment.

Methods

Study type

This is a systematic review composed of systematic reviews, structured and based on the criteria established by the guideline "Preferred Reporting Items for Systematic Reviews and Meta-Analyses" (PRISMA) [11], and the methodological guide proposed by Smith *et al.* [12], to answer the following clinical question: In adult individuals who suffered a stroke, is the RT, when compared to other neuromuscular interventions, conventional treatments or no intervention (simulation/placebo), effective in improving muscle strength and functionality? Study prospectively registered in PROSPERO under opinion CRD420208823.

Eligibility criteria

We included: 1) systematic reviews; 2) composed of randomized clinical trials and/or controlled intervention studies; 3) that tested interventions of RT; 4) compared to other neuromuscular interventions, conventional treatment or simulation techniques or placebo; 5) in adults who had stroke, regardless of the stage of the disease (acute or chronic); 6) for outcomes such as muscle strength and functionality; 7) such studies should be available in full. There were no restrictions regarding the language and publication time of the studies. On the other hand, the following were excluded: 1) systematic reviews on CA that used mixed protocols with other training modalities (aerobic training); 2) systematic reviews on CA that did not describe the comparison groups of the included studies; 3) systematic reviews that only analyzed the principles related to the prescription of CA; and 4) systematic reviews on CA for the respiratory muscles.

Outcome of interest

For the study, muscle strength was considered as the ability of a specific muscle or muscle group to exert force against a given resistance [13]. Strength is associated with the ability to perform vigorous movements, such as pushing or lifting. Functionality was considered based on the International Classification of Functioning (ICF), analyzing the components related to body functions and structures, activity, and social participation [14].

Search strategy

To formulate the search strategies, the PRESS initiative [15] was used, which aims to perform a peer review of the strategies for electronic searches, in order to minimize possible disagreements, increasing sensitivity/specificity. Thus, the searches were performed in the Pubmed/Medline, Cochrane Library, EBSCOhost/SPORTDiscus, PEDro, Portal da BVS/Lilacs and Scielo databases, by two independent authors [R.M.B] and [H.S.Q], between July and September 2020. The descriptors were selected through the Medical Subject Headings (Mesh) and Health Sciences Descriptors (DeCS): “Resistance Training”, “Stroke” and “Systematic Review”, with their respective synonyms. The Boolean operators [AND], [OR] and [NOT] were used for potential crossings, as described in Chart 1.

Chart 1 - Search strategies for the databases

PubMed / Medline	“resistance training”[Title/Abstract] AND “Stroke”[Title/Abstract] AND “systematic review”[Title/Abstract]
	(“training resistance”[Title/Abstract] OR “strength training”[Title/Abstract] OR ((“Weight-Lifting”[MeSH Terms] OR (“weight”[All Fields] AND “lifting”[All Fields]) OR “Weight-Lifting”[All Fields]) AND “strengthening program”[Title/Abstract]) OR “weight lifting exercise program”[Title/Abstract] OR “weight bearing strengthening program”[Title/Abstract]) AND (((“Stroke”[Title/Abstract] OR “cerebrovascular accident”[Title/Abstract] OR (“Stroke”[MeSH Terms] OR “Stroke”[All Fields] OR “cva”[All Fields])) AND (“Stroke”[MeSH Terms] OR “Stroke”[All Fields] OR (“Cerebrovascular”[All Fields] AND “Accident”[All Fields]) OR “cerebrovascular accident”[All Fields])) OR “cerebrovascular apoplexy”[Title/Abstract] OR “vascular accident brain”[Title/Abstract] OR “cerebrovascular stroke”[Title/Abstract] OR “Apoplexy”[Title/Abstract] OR “cerebral stroke”[Title/Abstract] OR “stroke acute”[Title/Abstract] OR “cerebrovascular accident acute”[Title/Abstract]) AND (((((“systematic review”[Title] OR “systematic literature review”[Title] OR “systematic scoping review”[Title] OR “systematic narrative review”[Title] OR “systematic qualitative review”[Title] OR “systematic evidence review”[Title] OR “systematic quantitative review”[Title] OR “systematic meta review”[Title] OR “systematic critical review”[Title] OR “systematic mixed studies review”[Title] OR “systematic mapping review”[Title] OR “systematic cochrane review”[Title] OR “systematic search and review”[Title] OR “systematic integrative review”[Title]) NOT “comment”[Publication Type]) NOT (“protocol”[Title] OR “protocols”[Title])) NOT “MEDLINE”[Filter]) OR (“cochrane database syst rev”[Journal] AND “review”[Publication Type]) OR “systematic review”[Publication Type])
Portal Regional da BVS / Lilacs	(tw:(Resistance Training)) AND (tw:(Stroke)) AND (tw:(Systematic review))
	(tw:(Resistance Training OR Bodybuilding OR Weightlifting Strength Program OR Weightlifting Bodybuilding Program)) AND (tw:(Stroke OR Acute stroke OR Apoplexy OR Cerebral apoplexy OR Cerebral ictus)) AND (tw:(Systematic review))
Scielo	Treinamento de Resistência OR Musculação OR Programa de Fortalecimento por Levantamento de Peso OR Programa de Musculação por Levantamento de Peso [Todos os índices] AND Acidente Vascular Cerebral OR AVC OR AVC Agudo OR AVE OR Acidente Cerebral Vascular OR Acidente Cerebrovascular OR Acidente Vascular Cerebral (AVC) OR Acidente Vascular Cerebral Agudo OR Acidente Vascular Encefálico OR Acidente Vascular do Cérebro OR Acidentes Cerebrais Vasculares OR Acidentes Cerebrovasculares OR Acidentes Vasculares Cerebrais OR Apoplexia OR Apoplexia Cerebral OR Apoplexia Cerebrovascular OR Derrame Cerebral OR Icto Cerebral OR Ictus Cerebral [Todos os índices] AND Revisão Sistemática [Todos os índices]
EBSCOhost/ SPORTDiscus	Resistance Training OR Strength Training OR Weight Training OR Resistance Exercise [Título] AND Stroke OR Cerebrovascular Accident [Título] AND Systematic Review [Título]
PEDro	Resistance Training* Stroke* Systematic Review*
Cochrane Library	“Resistance Training” OR “Strength Training” OR “Weight-Lifting Strengthening Program” OR “Weight Lifting Strengthening Program” OR “Weight-Lifting Exercise Program” OR “Weight-Bearing Strengthening Program” in Title Abstract Keyword AND “Stroke” OR “Cerebrovascular Accident” OR “CVA (Cerebrovascular Accident)” OR “Cerebrovascular Apoplexy” OR “Vascular Accident, Brain” OR “Cerebrovascular Stroke” OR “Apoplexy” OR Stroke, Acute OR Cerebrovascular Accident, Acute in Title Abstract Keyword AND “systematic review” in Title Abstract Keyword
	“resistance training” in Title Abstract Keyword AND “stroke” in Title Abstract Keyword AND “systematic review” in Title Abstract Keyword

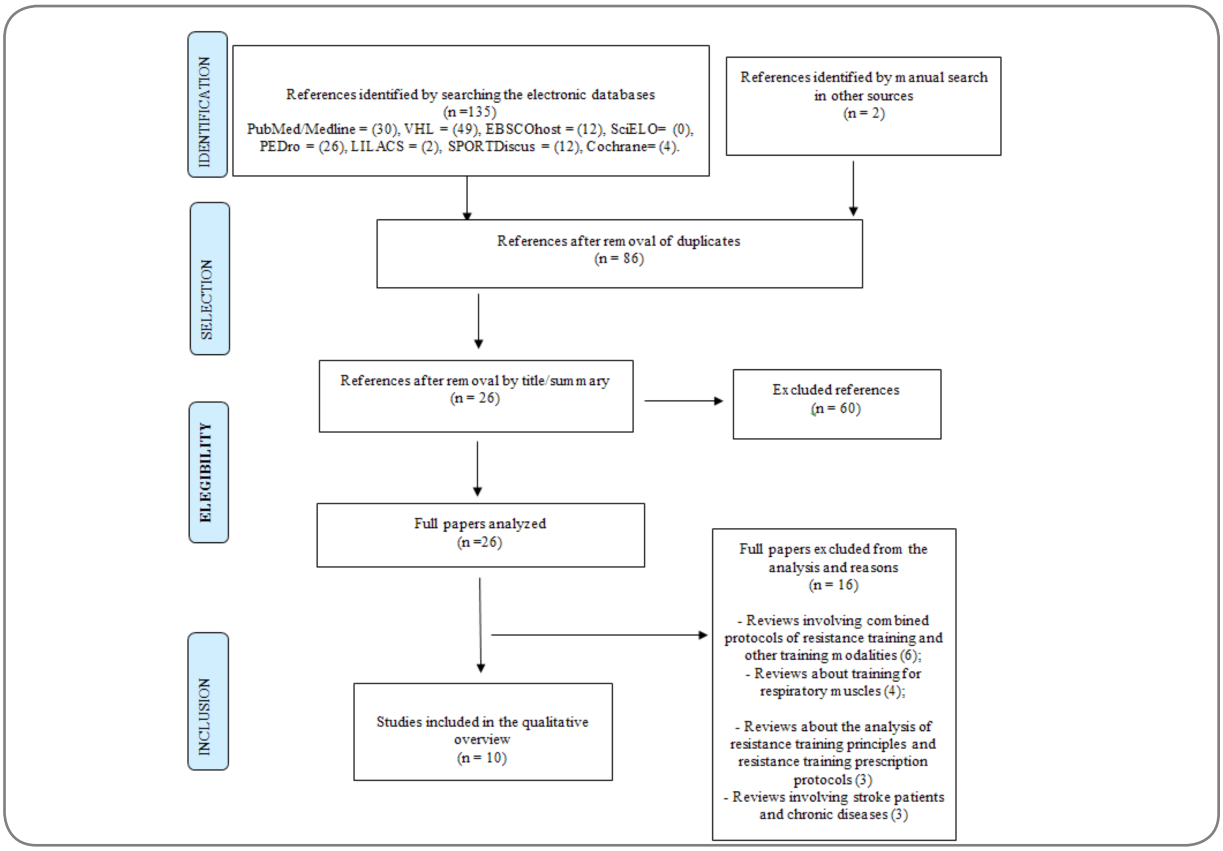
Searching with other resources

In order to identify other published, unpublished, or ongoing studies, we consulted [R.M.B and H.S.Q] the PROSPERO database for prospective registration of systematic reviews. Added to this, we queried the grey literature using Google Scholar. We performed direct citation screening of all included studies (and other relevant studies) using Google Scholar (scholar.google.co.uk/) for additional references to relevant studies.

Study selection and data extraction

The selection of studies was performed by two independent authors [R.M.B] and [H.S.Q], and when there were eventual disagreements, a third reviewer was requested [M.N.S.J]. Thus, titles and abstracts were thoroughly read, so that those that met the above-mentioned eligibility criteria went to the final selection. As shown in Tables I and II, the eligible studies were selected for full-text reading, further evaluation regarding the selection criteria, and data retrieval regarding: 1) author and year of publication of the study; 2) purpose of the study; 3) type of systematic review/quantity of studies included in the review; 4) population (characteristics and exposure); 5) intervention (type of resistance exercise, weekly frequency and duration); 6) control (form of control); 7) methods (measurement of outcomes); 8) outcomes (muscle strength and functionality) and 9) main results obtained by the studies.

The references reviewed and included in this review were analyzed by the second reviewer [H.S.Q], in order to verify the existence of potential studies not identified in the electronic database searches. Figure 1 summarizes the selection strategies of the studies that comprise the scope of this systematic review.



Source: Prepared by the authors

Figure 1 - Flowchart of the selection of studies that comprise the review

Risk of bias

The quality of each review was evaluated by two independent authors [R.M.B and H.S.Q], using the criteria of methodological evaluation proposed by the AMSTAR - 2 scale [16]. It consists of a checklist composed of 16 items, which can be answered with "Yes", "Partial Yes" or "No", but is not intended to generate a final score. It classifies the review as "High Quality" = Zero or a non-critical weakness: The systematic review provides an accurate and comprehensive summary of the results. "Moderate Quality" = More than one non-critical weakness*: The systematic review has more than one weakness, but no critical flaws. "Low Quality" = One critical failure with or without non-critical weaknesses: The review has one critical flaw and may not provide an accurate and comprehensive summary of available studies, and "Critically Low Quality" = More than one critical flaw with or without non-critical weaknesses: The review has more than one critical flaw and should not be considered to provide an accurate and comprehensive summary of the available studies. This is the review of the validated and frequently used AMSTAR scale.

Results

The search strategies devised and the references analyzed by manual search returned a total of 137 articles. However, after reviewer analysis [R.M.B and H.S.Q], 51 were eliminated for duplicity, leaving 86 studies. In another step, after screening based on the eligibility criteria, another 60 studies were excluded. The main reasons for exclusion were: systematic reviews containing protocols of mixed RT, with other training modalities, that did not perform analyses of individual results for each modality, reviews on inspiratory muscle RT, and reviews that aimed to investigate the principles of RT prescription and/or analyze prescription protocols. Finally, ten (10) studies [8-10,17-23] met the eligibility criteria and are summarized in Figure 1.

According to the data presented in Table I, it can be observed that the included studies were published between the years 2009 and 2020, with 100% of the studies being systematic reviews with meta-analysis. In addition, the number of articles included in each review ranged from 5 to 75 studies, totaling 303 primary studies, with more than 90% being RCTs. Of these 303 studies, 121 were specifically about RT, the others were divided into Cardiorespiratory Training (CRT) and Mixed Training (TM). Regarding population characteristics, the sample ranged from 314 to 3,617 adults, totaling 13,828 individuals. Of these 13,828 individuals, 4,555 participated in the studies on RT. Another noteworthy data is the time since stroke, which varied between 8.8 days and 7.7 years, thus the total sample consisted of individuals in acute and chronic stroke stages. In addition, the included studies had the purpose of evaluating the efficacy as well as the effects of RT in individuals who suffered a stroke, based on our outcomes of interest: muscle strength and functionality (upper limb functionality, gait speed, maximum walking speed (MV), preferred walking speed (PWV), total distance walked, and activity of daily living (ADLs).

Table I - Characteristics of studies and population

Author/ year	Study objective	N°. of studies included	Population characteristics
Saunders *et al.* (2009) [17]	Determine whether TFI (cardiorespiratory, resisted, or mixed) after stroke reduces death, dependence, and disability. Secondary objectives: to determine the effects of TFI on PA, mobility, FF, health status and QoL, mood and incidence of adverse events.	Review with meta-analysis/ 24 RCT/ 4 RCT on RT.	147 individuals of both sexes. Acute and chronic stroke (8.8 days - 7.7 years). (158/1.147 - Participated in the studies on RT)
Harris *et al.* (2010) [18]	Analyze the evidence of the TF of the paretic upper limb in the improvement of strength, function of the upper limb and ADLs. Secondary objective: to examine the effect of injury duration (subacute and chronic) and motor severity (moderate and mild) on upper limb function.	Review with meta-analysis/13 ECR	569 individuals, aged between 35 and 75 years. Acute and chronic stroke (2 months to 5 years).
Brazzelli *et al.* (2011) [19]	Determine the effects of TCR and RT, individually or in combination (TM) compared to no intervention, usual care, or other specific control interventions in stroke survivors.	Review with meta-analysis / 32 RCT. / 14 ECR TCR / 7 ECR RT / 11 ECR TM.	1,414 individuals. With an average age of 64 years. Acute and chronic stroke (8.8 days to 7.7 years). 246/1,414 participated in the RT studies, 651/1,414 in the TCR and 517/1,414 TM.
Metha *et al.* (2012) [10]	To analyze the effectiveness of RT on gait speed and total distance walked in individuals 6 months after stroke.	Review with meta-analysis/10 RCT	381 individuals, aged between 44 and 66 years, in the stage of chronic stroke (20 months to 4.9 years).
Saunders *et al.* (2013) [20]	Determining whether TFI after stroke reduces death, dependency and disability. Secondary objectives were to determine the effects of training on PA, mobility, FF, QoL, mood and incidence of adverse events.	Review with meta-analysis / 45 ECR / 8 ECR on RT.	2,188 individuals of both sexes. Acute and chronic stroke (8.8 days - 7.7 years). 275/ 2188 participated in the study on RT.
Saunders *et al.* (2016) [8]	Determining whether TFI after stroke reduces death, dependency and disability. Secondary objectives: to determine the effects of TFI on adverse events, risk factors, PA, mobility, FF, health status and QoL, mood and cognitive function.	Review with meta-analysis / 58 ECR / 13 ECR on RT	2,797 individuals of both sexes. Acute and chronic stroke (8.8 days - 7.7 years). 432/2797 participated in the RT studies.
Salter *et al.* (2016) [9]	Analyze evidence on the safety and efficacy of TRP for improved activity in the first 3 months after stroke.	Review with meta-analysis / 5 ECR / EPR	350 individuals, 57% were men, with a mean age of 69 ± 10 years. Median time from stroke to start of intervention was 31 days (SD 20 days, range 13-49 days).
Dorsch *et al.* (2018) [21]	Analyze evidence on TRP effects on muscle strength in stroke individuals, and whether this strength is transferred to activity.	Review with meta-analysis / 5 ECR / EPR	314 individuals, aged between 51 and 69 years. Average time since stroke ranged from 16 days - 6 years.
Veldema *et al.* (2020) [23]	Analyze the effects of RT in supporting recovery in stroke patients.	Review with meta-analysis / 30 ECR	1,051 individuals, 626 men, aged between 40 - 92 years. Acute and chronic stroke (2 months - 5.8 years).
Saunders *et al.* (2020) [22]	Determine whether TF reduces death, dependency or disability. Secondary objectives: to determine the effects of TF on adverse events, risk factors, PA, mobility, FF, health status and QoL, mood and cognitive function.	Review with meta-analysis / 75 ECR / 32 TCR / 20 RT / 23 TM.	3,617 individuals after stroke. Average age 62 years. Acute and chronic stroke (8.8 days to 7.7 years). 1,631/3,617 studies on TCR. 1,207/3,617 TM. 779/3,617 studies on RT.

TFI = Physical training; Stroke = Stroke; PA = Physical Fitness; FF = Physical Function; QoL = Quality of Life; RCT = Randomized Clinical Trial; RT = Resistance Training; MMSS= Upper Limb; ADLs = Activity of Daily Living; TCR = Cardiorespiratory Training; TM = Mixed Training; TRP = Progressive Resistance Training; EPR = Randomized Pilot Study

In Table II, it can be observed that in 100% of the studies the participants were exposed to RT interventions with the use of free weights and/or weight-training equipment and/or elastic bands. The programs in the intervention group (IG) were applied in sessions of 15 to 90 minutes, 3 to 5 sets of repetitions, 6 to 15 repetitions, with intensity varying: 50 - 100% of body weight, 25 - 85% of 1RM, 40 - 70% of maximum strength, and 7 - 15 maximum repetitions, 2 to 5 days a week, during a period of 3 to 19 weeks. Furthermore, when the comparison methods were analyzed, the most commonly used were: conventional functional training, stretching, range of motion (ROM) exercises, RCT, TM, usual care, placebo, and no intervention. Outcomes such as muscle strength, and functionality (gait, upper limb function, gait speed, MV, MVP, total distance walked and ADLs) were evaluated, by means of clearly described methods such as: 1RM, dynamometry, 6-minute walk test (6MWT), Timed Up and Go (TUG) and the Fugl-Meyer scale.

Table II - Summary of the evaluation process, intervention, outcomes and main results of the reviewed studies

Author / years	Intervention protocols		Methods	Main outcomes	Results
	EG	CG			
Saunders *et al.* **(2009) [17]**	RT with braces, free weights or elastic bands. Average of 3 sets of 30 - 60 minutes per session, 2 - 5 days a week, 4 to 12 weeks, load ranging from 50% to 100% of body weight, 70% of 1RM.	TFC, AL, usual care, muscle facilitation exercises, TENS, bilateral exercises for ROM and control without any intervention.	LLFDI; 1RM; Dynamometry; MIF; TUG.	A F (F M) ; Mobility	AF: RT was* for ↑ of the FM of the upper and lower limbs (SMD (fixed): 0.58, 95% CI 0.06 to 1.10). / Mobility: The RT was not* VMM (SMD (fixed): -1.17mmin-1 95% CI - 5.53 to 3.19) or VMP (SMD (fixed): -2.16mmin - 1 95% CI - 7.73 to 2.51).
Harris *et al.* **(2010) [18]**	**N= (273)** - RT isotonic and isometric, with elastic bands and free weights. Protocols: average 1h/ session, 2-3 days a week, lasting from 4 to 19 weeks.	**N = (296)** Bobath, TENS, AL, mobility exercises, balance exercises, outpatient treatment as needed, ADLs, lower limb strengthening. Protocols: 3 to 4 times a week, lasting 2 to 4 weeks.	Manual muscle testing; Barthel Index; Southern Motor Assessment; 10-Hole Peg Test; MIF; Box/ Block Test; 9- Hole Peg Test; Rivermead Motor Assessment; Fugl-Meyer Scale; Purdue Pegboard Test; Dynamometry; Wolf Motor Function Test; functional test of the hemiplegic upper extremity.	FM; Function of the MMSS; ADLs.	RT was* for ↑ grip strength (SMD 0.95, P 0.04) and upper limb function (SMD 0.21, P 0.03). Effect* for RT on upper limb function was found in studies including individuals with moderate (SMD 0.45, P 0.03) and mild (SMD 0.26, P 0.01) motor impairment of upper limbs. No treatment effect was found for RT on ADL measurements: random effect model: (SMD 0.26, 95% CI, 0.10 to 0.63, P 0.16, I 2 39%); fixed effect model: (SMD 0.27, 95% CI, 0.01 to 0.54, P 0.06).

Table II - Continuation

Author / years	Intervention protocols EG	CG	Methods	Main outcomes	Results
Brazzelli *et al.* **(2011) [19]**	RT with braces, free weights or elastic bands, during/after usual care. Protocols: 6 to 15 repetitions, with intensities of 50%-100% of maximum weight or 70%-80% of 1RM, lasting 30-90 minutes, 2-4 days a week for 4-12 weeks.	Usual care, AL, TFC and control without intervention. / **TCR** = Ergometry (treadmill/bike), circuit and aquatic training. Protocols: 20 to 60 minutes per session, 2 to 5 days a week, 2 to 12 weeks, with an intensity of 30% to 80% maximum effort, reserve HR ≤ 60% and PSE < 13. / **TM** = walking, RT, treadmill or circuit training. Protocols: 45 to 104 minutes, 2 to 5 days a week, 4 to 14 weeks, with intensity from 50 to 60%1RM, 50 to 80% HR_{max} and PSE=13 to 16.	MIF, Barthel Index, Rivermead Mobility Index, Functional Ambulation Category, Stroke Impact Scale, 6MWT, NHP, Peak VO_2, 1RM.	AF; Mobility;	AF: RT was* for ↑ FM at the end of the intervention, during or after care (SMD 0.58, 95% CI 0.06-1.10). / The TR in knee FM during and after usual care was not* (SMD 12.01 -4.46-28.47), as well as the RT over time (SMD 9.61 -5.01, 24.24). / **Mobility:** RT is not the VMM (MD 1.92, 95% CI -3.50 to 7.35), VMP (MD 2.34, 95% CI -6.77 to 11.45) or CC (MD 3.78, 95% CI -68.56 to 76.11) at the end of the intervention. / **Comparison between trainings:** Only the TCR increased* the VC (MD 4.68 1.40 to 7.96).
Metha *et al.* **(2012) [10]**	**N= (194)** TRP, TF maximal concentric isokinetic, TRP + treadmill training with body weight, TRP + simulated aerobic exercise, TF + functional task practices, circuit exercises, strength feedback program and resistance exercise related to walking . Protocols: 30 - 90 minutes per session, 8 - 36 sessions, lasting 4 - 12 weeks.	**N= (187)** Usual activities without TRP, paretic lower extremity passive ROM, bilateral ROM and flexibility exercises, treadmill training with support + upper limb ergometry, cycling simulation + TRP simulation, upper limb TF + task practice functional, upper extremity functional tasks, education sessions and untrained GC. Protocols: 30 - 90 minutes per session, 8 - 36 sessions, lasting 4 - 12 weeks.	1RM; TC6M	Comfortable VM; total distance traveled	**MV:** A ↑* was observed in MV with a small effect size (0.295 ± 0.118; 95% CI, 0.063 to 0.526; P < 0.013) and an increase of 0.09 m/s for a mean post-clustered velocity of 0 .79 m / s. However, this was not maintained at a mean of 3 months of follow-up (0.134 ± 0.148; 95% CI, -0.156 to 0.425; P = 0.35). **Total distance walked:** A ↑* was observed at post-treatment in the total distance walked (0.247 ± 0.111; 95% CI, 0.030 to 0.465; P = 0.026) with an increase of 28 m with a mean of pooled powders of 271.9 m of total distance covered. This was not maintained at a mean of 3 months of follow-up (0.232 ± 0.183; 95% CI, -0.127 to 0.590; P = 0.205).

Table II - Continuation

Author / years	Intervention protocols EG	Intervention protocols CG	Methods	Main outcomes	Results
Saunders *et al.* **(2013) [20]**	RT with free weights, braces or elastic devices. Protocols: Average 3 sets of 30 - 60 minutes per session, 2 to 5 days a week, 4 to 12 weeks, with intensity between 5 to 15 with 70% to 80% of 1RM.	ADLs, TFC, AL, flexibility exercise, usual care, bobath, TENS, muscle facilitation exercises, bilateral ROM and upper body flexibility exercises, isokinetic dynamometer. / TCR= Ergometry (treadmill/bike), circuit and aquatic training. Protocols: 20 to 60 minutes per session, 2 to 6 days a week, 2 to 24 weeks, with an intensity of 30% to 80% maximum effort, reserve HR ≤ 60% and PSE < 13. / TM = walking, RT, treadmill or circuit training. Protocols: 35 to 104 minutes, 2 to 5 days a week, 4 to 14 weeks, with intensity from 50 to 60%1RM, 50 to 80% HR_{max} and PSE=13 to 16.	**AF:** FM and power. **Mobility:** Walking speed (VMM and VMP); Walking capacity (TC6M).	AF; Mobility;	**AF:** RT was* for ↑ of the upper and lower limb FM (SMD (fixed): 0.58, 95% CI 0.06 to 1.10). / Two studies reported gains* in 1RM in a variety of upper and lower body muscle groups after RT. / **Mobility:** RT was not* for VMM (SMD 1.92 m / min, 95% CI -3.50 to 7.35) or VMP (MD 2.34 m / min, 95% CI -6.77 to 11.45), or 6MWT (SMD 3.78, 95% CI -68.56 to 76.11). / **Comparison (RT/TM/TCR) for mobility** - The RT does not ↑* VMM, VMP and TC6M at the end of the intervention.
Saunders *et al.* **(2016) [8]**	RT with weights, devices or elastic devices. Protocols: Average of 3 sets of 30 - 60 minutes per session, 2 to 5 days a week, between 4 to 12 weeks, with intensity between 8 to 15 repetitions, or 70% - 80% of 1RM	ADLs, TFC, AL, flexibility exercise, usual care, Bobath, TENS, muscle facilitation exercise, motor learning strategies, bilateral ROM and upper body flexibility exercises, isokinetic dynamometer, simulated lower limb training with no resistance and none intervention. TCR = Ergometry (treadmill/bike), circuit training and aquatic. Protocols: 20 to 60 minutes per session, 2 to 6 days a week, from 2 to 24 weeks, with an intensity of 30% to 85% maximum effort, reserve HR from 40 to 70% and PSE < 13. TM = walking, RT, treadmill training or circuits. Protocols: 30 to 104 minutes, 2 to 5 days a week, 4 to 14 weeks, with an intensity of 50 to 80% 1RM, 50 to 80% HR_{max} and PSE=13 to 16.	**AF:** FM and power. **Mobility:** Walking speed (VMM and VMP); walking capacity (TC6M).	AF; Mobility.	**AF:** RT was* for ↑ FM of upper and lower limbs (SMD (fixed): 0.58, 95% CI 0.06 to 1.10) / Two studies reported gains* in 1RM in a variety of upper and lower muscle groups. lower body. / **Mobility:** RT was not* for VMM (SMD 1.92 m / min, 95% CI -3.50 to 7.35), VMP (MD 2.34 m / min, 95% CI -6.77 to 11.45), or 6MWT (SMD 3.78, 95% CI -68.56 to 76.11; level of heterogeneity Chi2 = 0.00, df = 1, P = 0.99;)./ **Comparison (RT /TM/TCR) for mobility** - RTR does not ↑* VMM, VMP and TC6M at the end of the intervention
Salter *et al.* **(2016) [9]**	TRP, TRP + motor control training, isotonic and isometric. Protocol: 1 - 5 sets, 10-15 repetitions, lasting 30 - 60 minutes per session, 3 - 5 days a week, 4 - 6 weeks.	Conventional physiotherapy, Bobath, Exercises without external resistance applied + specific functional training task + standard physiotherapy treatment. Protocol: 1 - 5 sets of 10-15 repetitions, lasting 30 - 60 minutes per session, 3 - 5 days a week, 4 - 6 weeks.	1RM; PSE; Functional Test of the Hemiparetic Upper Extremity; Ashworth scale; Action Research Arm Test; TC2M; MIF; Rivermead Mobility Index.	FM, Função dos MMSS e Mobilidade	**FM:** There was high-level evidence that TRP had little or no effect on FM (SMD 0.17, 95% CI -0.16 to 0.50, I2 = 0%). **Upper limb function and mobility:** There was no effect* for upper limb function (SMD 0.11, 95% CI -0.41 to 0.63, I2 = 0%) and mobility (SMD 0.11, 95% CI - 0.21 to 0.43, I2 = 27%) after TRP.

Table II - Continuation

Author / years	Intervention protocols EG	Intervention protocols CG	Methods	Main outcomes	Results
Dorsch *et al.* **(2018) [21]**	TRP for MMII and MMSS. Protocols: 3 - 4 sets of repetitions, 2 - 4 times a week, with an intensity of 7 to 15 RM or 50-80% of 1RM, with a duration of 4-12 weeks.	No intervention, Usual therapy and Placebo (Arm exercises, passive cycling and AL).	Maximum Isometric Strength, Maximum Dynamic Strength, TUG, Fugl-Meyer, Wolf Motor Function Test, Extremity Functional Test Superior Hemiparetic, comfortable walking speed m/s, TC10m.	FM and Activity	**FM:** The overall effect size of TRP on strength was 0.98 (95% CI 0.67 to 1.29, I 2 = 0%), representing an effect*. **Activity:** The size of the effect of TRP on activity was 0.42 (95% CI −0.08 to 0.91, I 2 = 54%), representing a non-effect*. The overall effect of TRP on late activity after stroke and on the lower limb was 0.40 (95% CI -0.17 to 0.97, I 2 = 63%), which was not statistically*.
Veldema *et al.* **(2020) [23]**	RT X CSI = RT, unilateral and bilateral, for LL and UL, with concentric and eccentric exercises, between 12 and 40 sessions, of 15 - 90 minutes. / RT X CCI= RT, unilateral and bilateral, for LL and UL, with concentric and eccentric exercises, between 6 to 60 sessions. / RT X RT = RT eccentric, concentric and isometric, between 12 and 40 training sessions.	RT X CSI = No intervention, Usual therapy and Placebo. / RT X CCI= Usual therapy and placebo. / RT X RT = Resistance training being eccentric, concentric and isometric, between 12 and 40 training sessions.	**March** = VM; Step length; Length of stride; TUG; TC10M; Up and down stairs; TC6M; Stair Climbing Test. FM = Dynamic strength; Isokinetic strength; Maximum force; Isometric strength; Peak power of extremity muscles; **Mobility, balance and postural control** = Rivermead Mobility Index.	March; FM and motor function; Mobility, Balance and Postural Control.	**RT X CSI=** RT is superior to no intervention in support of recovery after stroke. There were effects* on FM, QoL, independence, reintegration, mobility, balance and postural control. RT X CCI = Collectively, RT is most effective in supporting recovery after stroke. There were effects* FM and motor function, QOL, reintegration and independence. / **RT X RT** = The type of RT protocol may impact* its effect on post-stroke recovery. Generally, the leg-press proves to be more effective than the knee-extension exercise. Exercises for the lower body lead to a ↑ of the parameters evaluated compared to the upper body. High-intensity training supports recovery more effectively than low-intensity training. Eccentric and concentric exercises are more* than isometric training.

Table II - Continuation

Author / years	Intervention protocols EG	Intervention protocols CG	Methods	Main outcomes	Results
Saunders *et al.* (2020) [22]	RT with weights, devices or elastic devices. Protocols: Average 30 - 90 minutes, 2 - 5 days a week, 3 - 12 weeks.	Usual care (hospital care, other standard rehabilitation), no intervention or non-exercise interventions (cognitive tasks, simulated training). **TCR**= Walk on treadmill and/or ground, ergometry, circuit, aquatic training. Protocols: sessions lasting from 7 to 60 minutes, from 2 to 6 days a week, from 2 to 24 weeks, with intensities of 13 on the Borg scale, 40% to 60% of HRreserve, 40% to 80% of HR_{max}, or predicted maximum (220-age). **TM** = walking, treadmill training, RT and circuits. Protocols: sessions with durations of 30 - 120 minutes, 2 - 7 days a week, 4 - 19 weeks, with intensity ranging from 50% to 60% of reserve HR / 50% to 80% of HR_{max} / PSE / 50% a 80% of 1RM.	**AF:** Vo_{2max}, 1RM. **Mobility:** VM (VMM or VMP); walking ability (TC6M); Ambulatory Functional Categories.	AF (FM); Mobility;	**AF: AME:** RT ↑ FM at the end of the intervention (SMD 0.58, 95% CI 0.06 to 1.10; P = 0.03). / The RT can ↑ the knee flexion strength in the affected leg (SMD 0.72, 95% CI 0.10-1.34; P = 0.02), however, there was no ↑ of the FM in the knee extensors of the affected leg (SMD 1.09, 95% CI −0.23 to 2.41; I 2 = 87%). / **Mobility: (VMM)** = not ↑* at the end of the intervention (MD 2.83 m / minute, 95% CI −0.49 to 6.14). / (**VMP**) = RT not ↑* at the end of the intervention (MD 2.15 m / min, 95% CI -3.57 to 7.87). / 6MWT=- there is low certainty in the effect of RT at the end of the intervention (MD 24.98 meters, 95% CI 11.98 to 37.98; P = 0.0002). Comparison (RT/ TM/TCR) for mobility - The RT does not ↑* VMM, VMP and TC6M at the end of the intervention.

RT = Resistance Training; 1RM = 1 repetition maximum; TFC = Conventional Functional Training; AL = Stretching; TENS = Transcutaneous Nerve Electro-Stimulation; ROM = Range of Motion; LLFDI = Late Life Function And Disability Instrument; FIM = Functional Independence Measure; TUG = Timed Up And Go; PA = Physical Fitness; FM = Muscle Strength; *= Significant; ↑= Increase; SSM = Upper Limb; LLM = Lower Limb; MV = Maximum Walking Speed; PT = Preferred Walking Speed; DLA = Activity of Daily Living; RCT = Cardiorespiratory Training; HR = Heart Rate; SB = Subjective Perception of Effort; TM = Mixed Training; HR_{max} = Maximum Heart Rate; TC6M = 6-minute Walk Test; NHP = Nottingham Health Profile; VO_2= Maximal Oxygen Volume; CC = Walking Capacity; VC = Walking Speed; TRP= Progressive Resistance Training; TF = Strength Training; CG = Control Group; EG = Exercise Group; MV = Walking Speed; TC2M = 2-Minute Walk Test; RM = Maximum Repetition; TC10M = 10-Meter Walk Test; CSI = No Intervention Control; CCI = Intervention Control; QL= Quality of Life; SMA = Musculoskeletal Fitness

The main results of the studies analyzed by the present review indicate that the RT interventions were statistically significant for the increase in upper and lower limb muscle strength, gains in 1RM and performance in the 6MWT. RT was not statistically significant for increases in ADLs, MVM and MPV.

Regarding the methodological quality, Table III, it can be seen that 50% of the studies were of high methodological quality. The other 50% were composed of moderate quality studies. The most critical point was with respect to the source of financing of the studies included in the analyzed reviews, only one (1) study declared the information.

Table III - Methodological quality, AMSTAR-2

Article	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Final Quality
Saunders *et al.* (2009) [17]	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	HIGH
Harris *et al.* (2010) [18]	X		X	/	X		X	X	X		X	X	X			X	MODERATE
Brazzelli *et al.* (2011) [19]	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	HIGH
Metha *et al.* (2012) [10]	X		X	/				X	X		X	X	X			X	MODERATE
Saunders *et al.* (2013) [20]	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	HIGH
Salter *et al.* (2016) [8]	X	/	X	/	X	X	/	/	X		X	X	X			X	MODERATE
Saunders *et al.* (2016) [9]	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	HIGH
Dorsch *et al.* (2018) [21]	X	/	X	/	X	X	X	X	X		X	X	X			X	MODERATE
Veldema *et al.* (2020) [23]	X	/	X	/	/	/	/	/	X		X	X	X			X	MODERATE
Saunders *et al.* (2020) [22]	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	HIGH

X = Yes; / = Partial Yes. **1.** The research questions and inclusion criteria for the review included the components of PICO; **2.** The review report contained an explicit statement that the review methods were established prior to conducting the review and the report justified any significant deviations from the protocol; **3.** The review authors explained their selection of study designs for inclusion in the review; **4.** The review authors used a comprehensive literature search strategy; **5.** The review authors performed duplicate study selection; **6.** The review authors performed duplicate data extraction; **7.** The review authors provided a list of excluded studies and justified the exclusions; **8.** The review authors described the included studies in adequate detail; **9.** The review authors used a satisfactory technique to assess risk of bias (RoB) in individual studies that were included in the review; **10.** The review authors reported the funding sources for the studies included in the review; **11.** If a meta-analysis was performed, the review authors used appropriate methods for statistical combination of results; **12.** If a meta-analysis was performed, the review authors assessed the potential impact of RoB in individual studies on the results of the meta-analysis or other synthesis of evidence; **13.** The review authors took RoB in individual studies into account when interpreting / discussing the review results; **14.** Review authors provided a satisfactory explanation for, and discussion of, any heterogeneity observed in the review results; **15.** If they performed a quantitative synthesis, review authors performed an adequate investigation of publication bias (small study bias) and discussed its likely impact on the review results; **16.** The review authors reported any potential sources of conflict of interest, including any funding they received to conduct the review.

Discussion

In response to the objectives of this systematic review, it was identified that when compared to other neuromuscular interventions, conventional treatment or simulation techniques, or placebo, RT is statistically significant for improvement in upper and lower limb muscle strength, gains in 1RM, and performance on the 6MWT. In addition, RT was not statistically significant for improvement in ADLs, MVM and

MPV. It is also noteworthy that when compared to other interventions such as RCT and MT, RT was not statistically significant for improvement in MVM, MPV and 6MWT performance. The results presented here are reinforced by the high/moderate methodological quality of the included reviews.

Regarding muscle strength and gains in 1RM, the included studies suggest that there was a statistically significant increase in individuals who performed RT [8,18-23]. However, these results may not be clinically important. In fact, Lang *et al.* [24] suggest that a clinically important change in grip muscle strength for upper limbs of stroke survivors was 5.0 kg and 6.2 kg for the dominant and non-dominant affected sides, respectively. In addition, Aguiar *et al.* [25] suggest that for a change in muscle strength to be considered relevant after an intervention assessed by dynamometry, in individuals who have suffered a stroke, one should have variations equal to or greater than 0.96 kg to 6.12 kg. However, although the included studies suggest that RT increases the FM, the data on strength gains are not presented for analysis, a fact that limits the comparison/extrapolation of the data.

Added to the data already presented, the RT was not statistically significant for the improvement of ADLs [18,21]. This result can be justified by the fact that the RT did not incorporate the performance of the specific task at the moment of the exercise execution. Another point is that even though RT promotes a statistically significant gain in strength, it may not be transferred to the performance of activities [21]. Furthermore, a change in strength and activity is related to the amount of baseline strength, and in individuals who have a decrease in strength, any increase in strength produces a large increase in activity. However, in individuals with reasonable strength, an increase in strength does not produce much change in activity.

Moreover, when the gait-related variables were analyzed, the RT benefited only the performance at 6MWT, with no significant improvement for MV and MVP [8,17,19,20,22]. Thus, RT may promote some intramuscular metabolic adaptations, increasing participants' performance tolerance when performing the 6MWT [22,26]. However, there is little certainty of the evidence for this result. Another point is also that although the 6MWT showed a significant effect, these results may not be clinically relevant. In fact, Fulk *et al.* [27] suggested that the minimum clinically important difference for TC6m is +71 to +130 m, based on patients who initially walk fast (≥ 0.4 m/sec). Added to this, Fulk *et al.* [28] concluded that a clinically important increase in MPV after stroke would be 10.5 m / minute. Thus, it is evident that gait speed at baseline will be an important consideration in making judgments about the magnitude of effects related to walking speed outcomes [22].

Another interesting finding is that when compared to RCT and MT, RT was not statistically significant for improvement in MV, MVP, and 6MWT [8,19,20,22]. Thus, the studies suggest that the improvement in these variables when performing RCT and MT can be justified by the fact that these training modalities promote a greater reserve of cardiorespiratory fitness, which can be related to an increased vo_2 peak, considering that, in individuals who suffered a stroke, the cardiorespiratory fitness is reduced by 30-70% when compared to their healthy peers [22,29]. Still, walk-based training interventions dominate the RCT and TM protocols and these are, by definition, task-related and repetitive in nature. Thus, these elements alone may facilitate motor learning and benefit gait performance.

Finally, this study has some limitations that need to be discussed. First, most of the included reviews did not report the percentage of the population in acute or chronic stage of stroke, a fact that limits the interpretation/generalization of the findings for each specific subgroup. Second, not all included studies showed which criteria were used to define what they considered as a RT, a fact that limits the analysis and interpretation of the data. Another point is also in relation to the tools for measuring the outcomes, since they did not always evaluate the same functional domain, and some tools were not validated for individuals who suffered a stroke. In addition, most of the studies included in the reviews were performed with short-term protocols, which limits the interpretation of what the long-term benefits are. Furthermore, with regard to the methodological quality of the studies included in the reviews, the vast majority had moderate/high risk of bias. Finally, the quality of evidence of most studies included in the reviews was of moderate quality, which shows that the true effect is close to the estimated effect, but that there is the possibility of it being substantially different. However, these limitations do not invalidate the data presented, since they are in line with others presented in the literature.

Conclusion

It was concluded that when compared to other neuromuscular interventions, conventional treatment or simulation techniques, or placebo, RT is effective in improving upper and lower limb muscle strength, gains in 1RM, and performance on the 6MWT. However, these findings do not seem to modify clinical practice, since the results were not presented as clinically relevant. Furthermore, RT was not statistically significant for improvement in activity, MVM and MPV. Nor when compared to other interventions such as RCT and MT, for improvement of MVM, MPV and performance on 6MWT.

Potential conflict of interest
No potential conflicts of interest relevant to this article have been reported

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Authors' contribution
Conception and design of research: Barbosa RM, Santos ACN, Barbosa LGS, Queiroz HS. **Acquisition of data:** Barbosa RM, Santos ACN, Queiroz HS, Júnior MNS, Silva BS. **Analysis and interpretation of the data:** Barbosa RM, Santos ACN, Barbosa LGS, Souza CO, Oliveira LS, Queiroz HS. **Statistical analysis:** Barbosa RM, Santos ACN, Souza CO. **Obtaining financing:** Not applicable. **Writing of the manuscript:** Barbosa RM, Santos ACN, Barbosa LGS, Oliveira LS. **Critical revision for intellectual content:** Barbosa RM, Santos ACN, Souza CO, Silva BS, Queiroz BS, Júnior MNS.

References

1. Gorelick PB. The global burden of stroke: persistent and disabling. Lancet Neurol 2019;18(5):417-8. doi: 10.1016/S1474-4422(19)30030-4

2. Rajsic S, Gothe H, Borba HH, Sroczynski G, Vujicic J, Toell T, *et al.* Economic burden of stroke: a systematic review on post-stroke care. Eur J Heal Econ 2019;20(1):107-34. doi: 10.1007/s10198-018-0984-0

3. Johnson CO, Nguyen M, Roth GA, Nichols E, Alam T, Abate D, *et al.* Global, regional, and national burden of stroke, 1990-2016: a systematic analysis for the Global Burden of Disease Study 2016. Lancet Neurol 2019;18(5):439-58. doi: 10.1016/S1474-4422(19)30034-1

4. Pollock A, Baer G, Campbell P, Choo PL, Forster A, Morris J, *et al.* Physical rehabilitation approaches for the recovery of function and mobility following stroke. Cochrane Database Syst Rev 2014;2014(4):1-447. doi: 10.1002/14651858.CD001920.pub3

5. Smith AC, Saunders DH, Mead G. Cardiorespiratory fitness after stroke: a systematic review. Int J Stroke 2012;7(6):499-510. doi: 10.1111/j.1747-4949.2012.00791.x

6. Gorelick PB. The future of stroke prevention by risk factor modification. Handb Clin Neurol 2008;94(3):1261–76. doi: 10.1016/S0072-9752(08)94063-X

7. Dee M, Lennon O, O'Sullivan C. A systematic review of physical rehabilitation interventions for stroke in low and lower-middle income countries. Disabil Rehabil 2020;42(4):473–501. doi: 10.1080/09638288.2018.1501617

8. Saunders DH, Sanderson M, Hayes S, Kilrane M, Greig CA, Brazzelli M, *et al.* Physical fitness training for stroke patients. Cochrane Database Syst Rev 2016(3):CD003316. doi: 10.1002/14651858.CD003316.pub6

9. Salter K, Musovic A, Taylor NF. In the first 3 months after stroke is progressive resistance training safe and does it improve activity? A systematic review. Top Stroke Rehabil 2016;23(5):366-75. doi: 10.1080/10749357.2016.1160656

10. Mehta S, Pereira S, Viana R, Mays R, McIntyre A, Janzen S, *et al.* Resistance training for gait speed and total distance walked during the chronic stage of stroke: A meta-analysis. Top Stroke Rehabil 2012;19(6):471-8. doi: 10.1310/tsr1906-471

11. Moher D, Liberati A, Tetzlaff J, Altman DG. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. PLoS Med.2009;6(7):e1000097. doi: 10.1371/journal. pmed.1000097

12. Smith V, Devane D, Begley CM, Clarke M. Methodology in conducting a systematic review of systematic reviews of healthcare interventions. BMC Med Res Methodol 2011;11(1):1-6. doi: 10.1186/1471-2288-11-15

13. Cardoso FS, Curtolo M, Natour J, Lombardi Júnior I. Avaliação da qualidade de vida, força muscular e capacidade funcional em mulheres com fibromialgia. Rev Bras Reumatol 2011;51(4):344-50. doi: 10.1590/S0482-50042011000400006

14. Farias N, Buchalla CM. A classificação internacional de funcionalidade, incapacidade e saúde da organização mundial da saúde: conceitos, usos e perspectivas. Rev Bras Epidemiol 2005;8(2):187-93. doi: 10.1590/s1415-790x2005000200011

15. Sampson M, McGowan J, Cogo E, Grimshaw J, Moher D, Lefebvre C. An evidence-based practice guideline for the peer review of electronic search strategies. J Clin Epidemiol 2009;62(9):944-52. doi: 10.1016/j.jclinepi.2008.10.012

16. Shea BJ, Reeves BC, Wells G, Thuku M, Hamel C, Moran J, *et al.* AMSTAR 2: A critical appraisal tool for systematic reviews that include randomised or non-randomised studies of healthcare interventions, or both. BMJ 2017;358:1-9. doi: 10.1136/bmj.j4008

17. Saunders DH, Greig CA, Mead GE, Young A. Physical fitness training for stroke patients. Cochrane Database Syst Rev 2009;(4): CD003316. doi: 10.1002/14651858.CD003316.pub3

18. Harris JE, Eng JJ. Strength training improves upper-limb function in individuals with stroke: A meta-analysis. Stroke 2010;41(1):136-40. doi: 10.1161/STROKEAHA.109.567438

19. Brazzelli M, Saunders DH, Greig CA, Mead GE. Physical fitness training for stroke patients. Cochrane Database Syst Rev 2011;(11): CD003316. doi: 10.1002/14651858.CD003316.pub4

20. Saunders DH, Sanderson M, Brazzelli M, Greig CA, Mead GE. Physical fitness training for stroke patients. Cochrane Database Syst Rev 2013;(10): CD003316. doi: 10.1002/14651858.CD003316.pub5

21. Dorsch S, Ada L, Alloggia D. Progressive resistance training increases strength after stroke but

this may not carry over to activity: a systematic review. J Physiother 2018;64(2):84-90. doi: 10.1016/j.jphys.2018.02.012

22. Saunders DH, Sanderson M, Hayes S, Johnson L, Kramer S, Carter DD, *et al.* Physical fitness training for stroke patients. Cochrane Database Syst Rev 2020;3(3): CD003316. doi: 10.1002/14651858.CD003316.pub7

23. Veldema J, Jansen P. Resistance training in stroke rehabilitation: systematic review and meta-analysis. Clin Rehabil 2020;34(9):1173-97. doi: 10.1177/0269215520932964

24. Lang CE, Edwards DF, Birkenmeier RL, Dromerick AW. Estimating minimal clinically important differences of upper-extremity measures early after stroke. Arch Phys Med Rehabil 2008;89(9):1693-700. doi: 10.1016/j.apmr.2008.02.022

25. Aguiar LT, Martins JC, Lara EM, Albuquerque JA, Teixeira-Salmela LF, Faria CDCM. Dynamometry for the measurement of grip, pinch, and trunk muscles strength in subjects with subacute stroke: reliability and different number of trials. Brazilian J Phys Ther 2016;20(5):395-404. doi: 10.1590/bjpt-rbf.2014.0173

26. Blokland IJ, IJmker T, Houdijk H. Aerobic capacity and aerobic load of activities of daily living after stroke. Handbook of Human Motion. Cham: Springer International Publishing; 2018. p.863-84. doi: 10.1007/978-3-319-14418-4_43

27. Fulk GD, He Y. Minimal clinically important diMerence of the 6- Minute Walk Test in people with stroke. J Neurol Phys Ther 2018;42(4):235-40. doi: 10.1097/NPT.0000000000000236

28. Fulk GD, Ludwig M, Dunning K, Golden S, Boyne P, West T. Estimating clinically important change in gait speed in people with stroke undergoing outpatient rehabilitation. J Neurol Phys Ther 2011;35(2):82-9. doi: 10.1097/NPT.0b013e318218e2f2

29. Smith AC, Saunders DH, Mead G. Cardiorespiratory fitness after stroke: a systematic review. Int J Stroke 2012;7(6):499-510. doi: 10.1111/j.1747-4949.2012.00791.x

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