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Effects of physical exercise on the functional autonomy in the older evaluated by the GDLAM protocol: a systematic review with meta-analysis of randomized clinical trials

Rodrigo Gomes de Souza Vale[1,2], Diego Gama Linhares[1,2], Alex Santos Meireles[1,2], Giullio Cesar Pereira Salustiano Mallen da Silva[1,2], Elirez Bezerra da Silva[1,3]

[1] Postgraduate Program in Exercise & Sport Sciences, Rio de Janeiro State University, Rio de Janeiro, Brazil; [2] Laboratory of Exercise & Sport, Institute of Physical Education & Sports, Rio de Janeiro State University, Rio de Janeiro, Brazil; [3] Research Group on Exercise & Health Science, Institute of Physical Education & Sports, Rio de Janeiro State University, Rio de Janeiro, Brazil

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Correspondence
Alex Santos Meireles
E-mail: alex.meirelesrj@gmail.com

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Aim. To verify the effects of physical exercise on the functional autonomy of the older people evaluated by the GDLAM protocol.

Methods. This systematic review was drafted according to PRISMA recommendations and registered in PROSPERO. Study inclusion criteria considered the PICOS strategy. The search was conducted in the Embase, MEDLINE (via PubMed), Scopus, SPORTDiscus, and Web of Science databases. The RoB 2.0 tool was used for bias risk assessment, and the TESTEX tool for methodological quality. The certainty of evidence level of the meta-analysis was evaluated using the GRADE method.

Results. A total of 1317 publications were found. After applying selection criteria, a total of 10 randomized clinical trials were included in this systematic review, and 16 outcomes were meta-analyzed. The mean age of participants in the control group (CG) was 66.3 ± 20.4 years, and in the experimental group (EG) was 66.3 ± 21.4 years. The 299 older individuals in the experimental group who performed physical exercises significantly decreased the General Index (GI) by -4.72 [-5.75 to -3.78] compared to the 275 older individuals in the control group who did not engage in physical exercises. This decrease in GI of -4.72 signified better functional autonomy for the older individuals who engaged in physical exercises, enabling them to perform activities of daily living such as walking, rising, and dressing more quickly. Conclusions. Studies involving physical exercise as an intervention tend to improve the functional autonomy of the older people.

Key words: independence, functional autonomy, activities of daily living, physical training, aging

INTRODUCTION

The human aging process is influenced by various factors and, as a result, manifests uniquely in each individual. Promoting healthy and active aging is essential to mitigate common health issues among the older people.

These issues can affect the ability to perform daily tasks, impairing the mobility and functional autonomy of older individuals [1].

Functional autonomy (FA) refers to an individual's ability to independently and vigorously perform activities of daily living (ADL), being vital for quality of life in aging [2]. The reduction of FA occurs due to a complex interaction of various factors, including the continuous deterioration of physiological processes. Consequently, it directly impacts the ability to perform everyday activities such as household chores, shopping, and personal care, encompassing tasks like dressing, bathing, feeding, and using the bathroom [3,4].

The importance of physical exercise in aging is widely recognized as one of the most significant factors in promoting quality of life among the older people. In addition to helping preserve functional autonomy and reducing the risk of diseases, it also plays an essential role in maintaining and enhancing physical, physiological, and psychological health in aging [5-7].

Physical exercise can promote improvements in functional capacity and autonomy, reduce the risk of falls, enhance mobility, balance, cardiorespiratory capacity, and muscular strength development. Consequently, it helps attenuate the loss of muscle mass (sarcopenia) and enables improvements in joint mobility [8,9]. Therefore, it contributes to more effective performance in ADL, increased well-being, and self-confidence [1,5].

This study is justified by the absence of meta-analyses that verify the discrepancies in results of functional autonomy in the older people presented by randomized clinical trials that used physical exercise as an intervention and that used a protocol that provides an overall index of functional autonomy at the end, such as the GDLAM protocol [10]. With this, it is possible to obtain an accurate indicator of the overall functional autonomy condition of these individuals. Given the understanding of the potential benefits that physical exercise offers, especially for the older population, it is necessary to analytically comprehend the topic and, therefore, update the literature. Thus, the present systematic review and meta-analysis aimed to verify the effects of physical exercise on the functional autonomy of the older people evaluated by the GDLAM protocol.

METHODS

This systematic review with meta-analysis was drafted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines [11] and registered in the International Prospective Register of Systematic Reviews (PROSPERO) under the protocol: CRD42023478295.

Eligibility criteria

The eligibility criteria for the studies in the present review were based on the PICOS strategy [12] as follows: (P) participants were older individuals aged ≥ 60 years, of both sexes, and not hospitalized; (I) who underwent physical exercise as intervention; (C) compared to a control group (CG); (O) with the outcome being functional autonomy evaluated by the GDLAM protocol; (S) and the study design being randomized clinical trials. Studies that did not report a general functional autonomy index were excluded from this review.

Search strategy

For bibliographic data and materials related to the research, Zotero online 6.0.27 softwares created by George Mason University was utilized. The search was conducted in the Embase, MEDLINE (via PubMed), Scopus, SPORTDiscus, and Web of Science databases in March, 2024, by two independent and experienced researchers, without language or publication date filters. Discrepancies were resolved by a third researcher. The search phrase used was (older) OR (aged) OR (elderly) AND "functional autonomy" OR "activities of daily living" AND exercise (Appendix A). The descriptors related to the topic were selected based on literature review and verified in the Medical Subject Headings (MeSH) metadata system.

Bibliometric analysis by network visualization

The software used for this analysis was VOSviewer 1.6.20, keywords are represented by their label and, by default, also by a circle. The size of a keyword's tag and circle is determined by the weight of the keyword. The higher the weight of a keyword, the larger the keyword label and circle. For some items, the label may not be displayed. This is done to avoid overlapping labels. The color of a keyword is determined by the cluster the keyword belongs to. The lines between items represent links. By default, a maximum of 1,000 lines are displayed, representing the 1,000 strongest links between items. The distance between two journals in the visualization roughly indicates the relatedness of the journals in terms of co-citation links. In general, the closer two journals are to each other, the stronger their relationship. The strongest co-citation links between journals are also represented by lines.

Risk of bias assessment

For risk of bias assessment, two independent researchers utilized the RoB 2.0 tool for randomized trials, which includes the following bias domains: randomization/allocation process, deviation from intended intervention, missing outcome data, outcome measurement, and selection of the reported result. Any lack of consensus was resolved through the involvement of a third independent researcher using appropriate algorithms [13,14].

Methodological quality assessment

In order to assess the methodological quality of the included studies, the tool for the assessment of study quality and reporting in exercise (TESTEX) was used. TESTEX is applied to studies involving physical exercise in their methodological design, comprising a scale with a total of 15 points used in experimental studies, including criteria for assessing internal validity and the statistical analysis used. Thus, 1 point is attributed to each criterion defined in the scale and present in the study. The scale covers the following criteria: 1) specification of inclusion criteria; 2) random allocation; 3) allocation concealment; 4) similarity of groups at baseline; 5) assessor blinding (for at least one key outcome); 6) measurement of at least one primary outcome in 85% of allocated subjects (up to three points); 7) intention-to-treat analysis; 8) comparison between groups for at least one primary outcome (up to two points); 9) reporting measures of variability for all reported outcome measures; 10) follow-up of control group activities; 11) relative exercise intensity remained constant; 12) characteristics of exercise volume and energy expenditure. Two researchers independently assessed the methodological quality of the included studies, with the presence of a third researcher to resolve potential decision-making divergences during the process [15].

Functional autonomy (GDLAM)

The protocol developed by the Latin American Maturity Development Group (GDLAM) is designed to assess functional autonomy, specifically targeting activities of daily living (ADLs). This protocol includes the following tests: 10-meter walk (W10m), stand from seated position (SSP), rising from the prone position (SPP), putting on and taking off a shirt (PTS), and sitting down and getting up from a chair and moving around the house (SCMA). After administering the tests, the autonomy index (GI) is calculated for a comprehensive analysis of functional autonomy using the formula (GI = [((C10m + LPS + LPDV + VTC) × 2) + LCLC] ÷ 4). This GI indicates a classification (Poor, Regular, Good, and Very Good) [10].

Data extraction

In order to maintain methodological rigor consistency, this process was also carried out by two independent researchers, with potential discrepancies to be resolved by a third researcher. The data extracted from the studies included: authors, year of publication, country of origin, characteristics of the study sample (age, sex, and sample size), intervention details including general and specific exercises, duration of training session (minutes), intervention duration (weeks), training volume (training frequency, times per week), assessment method, and outcomes regarding functional autonomy.

Meta-analysis

The Review Manager 5.4.1 software (RevMan version 5.4.1; The Cochrane Collaboration, Oxford, UK, available at http://tech.cochrane.org/revman) and Jamovi 2.3.21 software was used to perform the meta-analysis of functional autonomy in older adults practicing physical exercise. Functional autonomy was considered a continuous outcome. The statistical method employed was the inverse variance method. The effect measure used was the mean difference, as functional autonomy in all included studies was measured on the same scale. The analysis model utilized was the random-effects model, as there was high and true inconsistency in the meta-analysis. A statistically significant effect was indicated by $p < 0.05$.

RESULTS

A total of 1317 publications were retrieved (Embase = 68; MEDLINE via PubMed = 462; SportDiscus = 196; Scopus = 527; Web of Science = 64). After applying the selection criteria, a total of 10 randomized clinical trials were included in the present systematic review, and 16 outcomes were meta-analyzed due to 6 studies [1,16-20] having more than one experimental group (Fig. 1).

Figure 2 analyzed the results of the bibliometric analysis in relation to the descriptors in the search bases used in this systematic review. Of the 1915 descriptors found, 20 descriptors were selected if they were repeated at least 20 times. The red and green colors represent clusters 1 and 2, respectively. In cluster 1, the descriptor "exercise" and in cluster 2, the descriptor "aged" have greater weight, while the other descriptors are balanced in terms of weight and link strength.

Figure 3 presents the results of the risk of bias assessment using the RoB 2.0 tool, with three studies classified as "low risk" [1,21,22], five studies classified as "some concerns" [17–20,23], and two studies classified as "high risk" [16,24].

Table I presents the assessment of methodological quality using the TESTEX scale. The studies obtained scores ranging from 10 to 15 points on the scale. The domains of assessor blinding (criterion 5) and allocation concealment (criterion 3) were the ones that most reduced the methodological quality of the majority of the studies (50%), although they did not compromise the total score.

Table II displays the studies, sample characteristics, and the protocol used in assessing functional autonomy. The mean age of participants in the control group (CG) was

66.26 ± 20.36 while in the experimental group (EG), it was 66.31 ± 21.36. Regarding the sample's gender, eight studies analyzed women [1,16,18,20-24], and two studies analyzed individuals of both genders [17,19]. Of the 10 studies included, seven were conducted in Brazil [1,16,18,20-22,24], two in Spain [17,19], and one in the United States [23].

Table III presents the data on training volume and the results found in the included studies. Four studies reported a training session duration of 60 minutes [16,17,22,24], two studies utilized 50 minutes [1,23], and four did not provide this information [18-21]. The intervention duration ranged from 8 [22] to 56 [16] weeks, and only one study reported a frequency of 5 sessions per week [23].

Table IV presents the data on the types of intervention and exercises used in the studies included in this systematic review and meta-analysis. Six studies analyzed resistance training as intervention [1,16-18,20,21], two analyzed pilates [17,22], one study analyzed aquatic exercises [23], one studied aerobic exercises [1], one study analyzed functional and balance exercises [24], and one study analyzed circuit resistance exercises [19].

Figure 4 depicts the meta-analysis of studies investigating the variable functional autonomy by the General Index (GI). Ten studies were included; however, 6 studies [1,16-20] presented more than one EG, resulting in a forest plot with 16 outcomes. The effect size was determined by the mean difference with a 95% confidence interval (CI). In

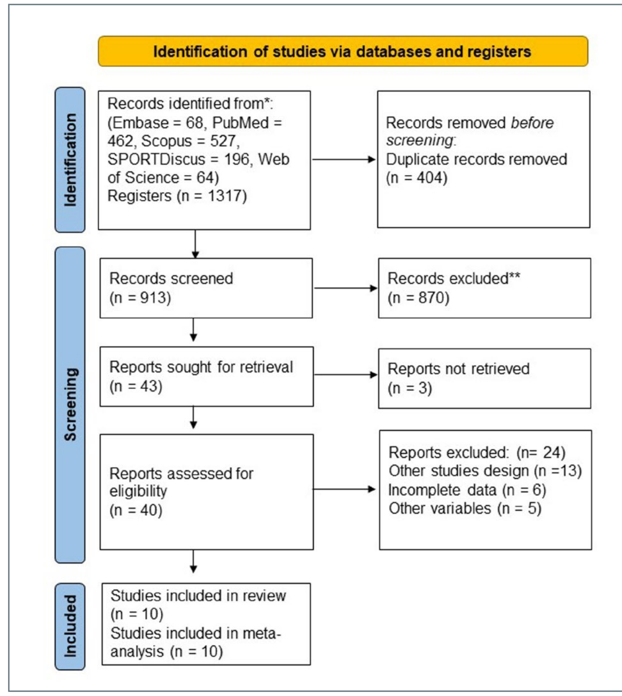

Figure 1. Flow-chart of retrieved, selected, and included studies in the review.

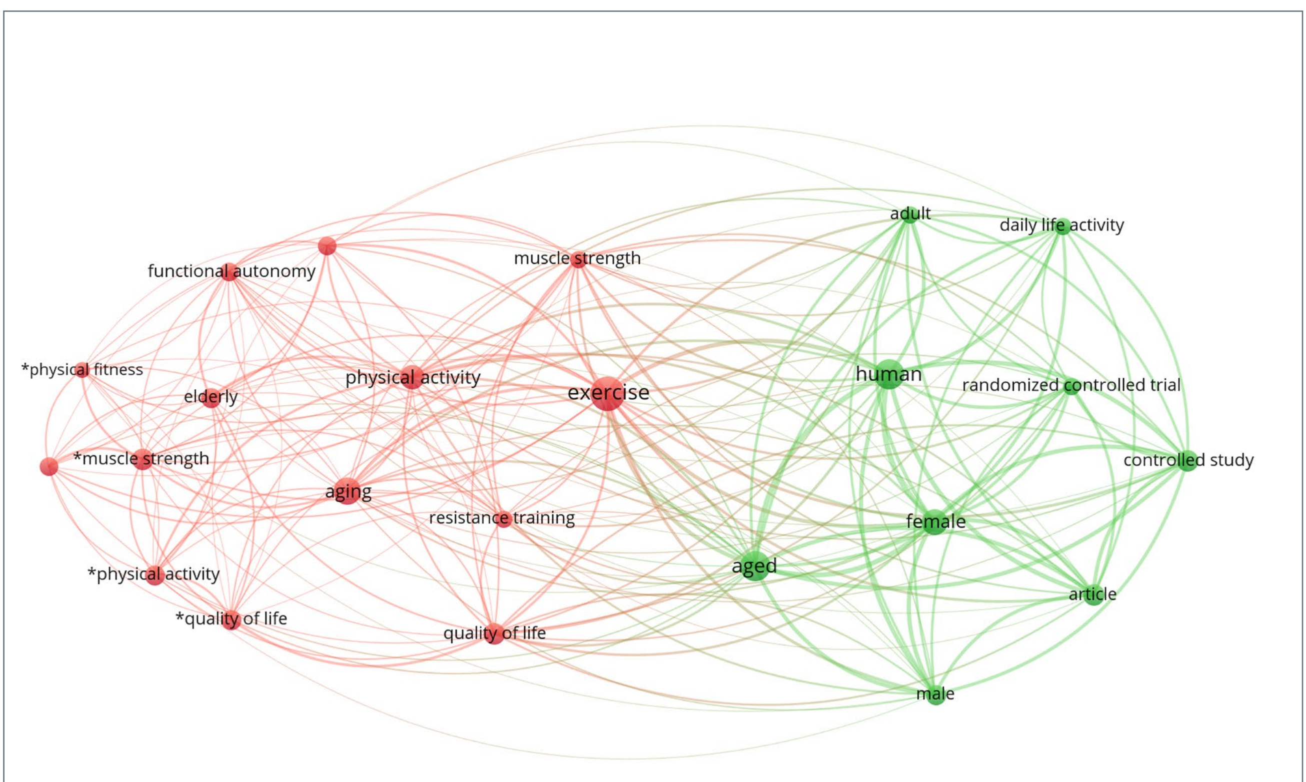

Figure 2. Bibliometric analysis by network visualization.

Table I. Methodological quality assessment using the TESTEX tool.

Studies	Study quality					Subtotal (0 a 5)	Study report										Subtotal (0 a 10)	Total (0 a 15)
	1	2	3	4	5		6ª	6b	6c	7	8a	8b	9	10	11	12		
Borba-Pinheiro et al. [16]	1	1	1	1	0	4	1	1	1	1	1	1	1	1	1	0	9	13
Carrasco-Poyatos et al. [17]	1	1	1	1	1	5	1	1	1	1	1	1	1	1	1	1	10	15
da Silva et al. [18]	1	1	0	1	0	3	1	0	1	1	1	0	1	1	1	1	8	11
Daniel et al. [24]	1	1	0	1	0	3	1	1	1	1	1	0	1	0	1	1	8	11
Marcos-Pardo et al. [19]	1	1	1	0	0	3	1	1	1	1	1	1	1	0	0	0	6	10
Martinez et al. [23]	1	1	0	1	0	3	1	0	1	1	1	0	1	0	1	1	7	10
Pereira et al. [20]	1	1	0	0	0	2	1	0	1	1	1	0	1	1	1	1	8	10
Ramos et al. [1]	1	1	0	1	0	3	1	1	1	1	1	1	1	1	1	1	10	13
Rocha et al. [21]	1	1	0	1	0	3	1	0	1	1	1	1	1	0	1	1	8	11
Siqueira Rodrigues et al. [22]	1	1	0	1	0	3	1	0	1	1	1	1	1	1	1	1	9	12

Study quality: 1: specific eligibility criteria; 2: specified randomization type; 3: allocation concealment; 4: similar groups at study initiation; 5: assessors blinded (for at least one primary outcome); 6: outcomes assessed in 85% of participants (6a: 1 point if more than 85% completed; 6b: 1 point if adverse events were reported; 6c: if exercise frequency was reported); 7: intention-to-treat statistical analysis; 8: statistical comparison reported between groups (8a: 1 point if between-group comparisons are reported for the primary outcome variable of interest; 8b: 1 point if statistical comparisons between groups are reported for at least one secondary measure); 9: point estimates and measures of variability for all reported outcome measures; 10: monitoring of activities in the control group; 11: relative exercise intensity remained constant; 12: exercise volume and energy expenditure were reported.

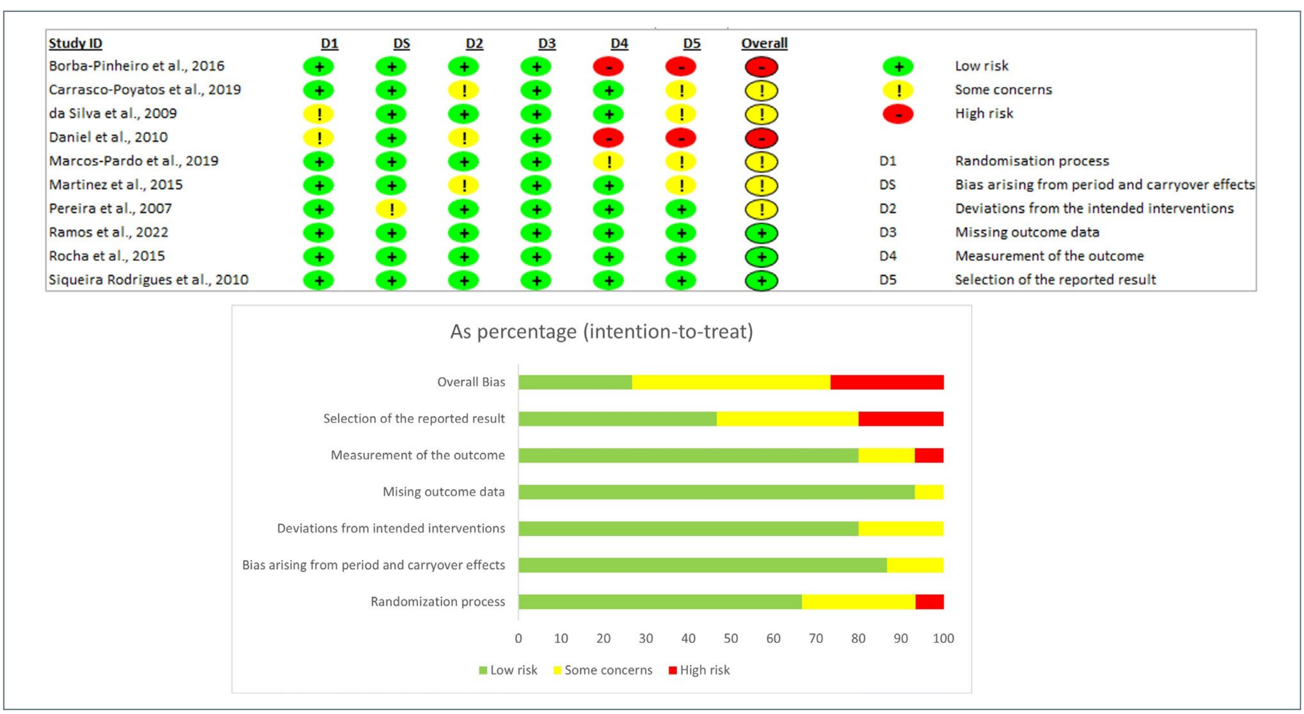

Figure 3. Results of the risk of bias analysis using RoB 2.0.

the calculation of the effect size, a negative sign indicates improvements in older adults functional autonomy. In the comparison between groups (EG *vs* CG), there was a difference in functional autonomy. The values presented in the forest plot were -4.72 (95% CI: -5.75 to -3.78) points with inconsistency I2 = 68% and p-value < 0.0001.

Table II. Sample characteristics and functional autonomy assessment instruments.

Author/year	Country	CG	EG	Population	Protocol for measuring functional autonomy
Borba-Pinheiro et al. [16]	Brazil	age: 55.3±6.8; sex: ♀; n: 16; BMI: 28 kg/m²	EG1 (RT2): age: 60.6 ± 7.5; sex: ♀; n: 16; BMI: 29.02 ± 2.9	Older women undergoing pharmacological treatment	GDLAM
			EG2 (RT3): age: 56.3 ± 5.2; sex: ♀; n: 16; BMI: 25.8 ± 3.05		
Carrasco-Poyatos et al. [17]	Spain	n: 12; age: 65.89±4.54; sex: ♂♀; BMI: 31 kg/m²	EG1 (Pilates): age: 67.5 ± 3.87; n: 16; sex: ♂♀; BMI: 32.32 ± 5.24	Isolated older individuals of both sexes	GDLAM
			EG2 (RT): age: 73.36 ± 4.84; n: 19; sex: ♂♀; BMI: 31.95 ± 4.84		
da Silva et al. [18]	Brazil	n: 20; age: 71.45 ± 5.72; sex: ♀; BMI: 26 kg/m²	n: 20; age: 65.62 ± 5.36; sex: ♀; BMI: 26.77 ± 3.72	Older women	GDLAM
Daniel et al. [24]	Brazil	n: 19; age: 64.58 ± 3.40; sex: ♀; BMI: 27 kg/m²	n: 30; age: 66.46 ± 4.35; sex: ♀; BMI: 26.70 ± 4.08	Older women	GDLAM
Marcos-Pardo et al. [19]	Spain	n: ♀ 12/♂ 9; age: 70 ± 4.1; sex: ♂♀; BMI: ♀ 26/ ♂ 27 kg/m²	n: ♀ 15/♂ 9; age: 69 ± 3.2; sex: ♂♀; BMI: ♀ 27.57 ± 4.43 ♀/♂ 27.97 ± 3.74	Older individuals of both sexes	GDLAM
Martinez et al. [23]	USA	n: 10; age: 67.4 ± 4.7 sex: ♀; BMI: NR	EG1 (Water exercise): n: 16; age: 67.5 ± 5.4; sex: ♀; BMI: NR	Healthy older women	GDLAM
			EG2 (Water exercise): n: 28; age: 62.56 ± 2.3; sex: ♀; BMI: 29.29 ± 3.4		
Pereira et al. [20]	Brazil	n: 11; age: 71.4 ± 5.7; sex: ♀; BMI: 25 kg/m²	n: 13; age: 65.6 ± 5.3; sex: ♀; BMI: 27.4 ± 4.2	Healthy older women	GDLAM
Ramos et al. [1]	Brazil	n: 22; age: 64.81 ± 4.34; sex: ♀; BMI: 27 kg/m²	EG1: n: 23; age: 64.70 ± 6.74; sex: ♀; BMI: 26.88 ± 4.43	Healthy older women	GDLAM
			EG2: n: 22; age: 65.56 ± 7.82; sex: ♀; BMI: 28.34 ± 4.72		
Rocha et al. [21]	Brazil	n: 26; age: 68.30 ± 6.34; sex: ♀; BMI: 31 kg/m²	n: 25; age: 69.44 ± 6.82; sex: ♀; BMI: 27.11 ± 5.70	Older women	GDLAM
Siqueira Rodrigues et al. [22]	Brazil	n: 25; age: 66 ± 4; sex: ♀; BMI: 26 kg/m²	n: 27; age: 66 ± 4; sex: ♀; BMI: 25.8 ± 5.64	Sedentary older women	GDLAM

EG: experimental group; CG: control group; ♀: female; ♂: male; N: number of participants; BMI: body mass index; RT: resistance training; NR: not reported; GDLAM: Latin American Maturity Development Group.

Figure 5 assessed publication bias using the Funnel plot. Sixteen outcomes were included in this analysis. The mean difference (X-axis) and standard error (Y-axis) were the coordinates for plotting each outcome. The subjective delineation of the funnel (isosceles triangle) characterized the absence of publication bias suspicion, which was objectively confirmed by Egger's test. Egger's regression test did not indicate any asymmetry in the funnel plot, and there was no suspicion of publication bias (p = 0.604).

In Table V, it is possible to observe the sensitivity analysis based on subgroups, aiming to analyze heterogeneity through categorical variables. The intervention subgroup was analyzed, divided into categories of resistance training, water exercise, pilates, aerobic, and combined circuit (Q = 3.12; I2 = 0%; p = 0.542); and the population subgroup was analyzed, divided into categories of healthy women and men, and unhealthy women (Q = 0.70; I2 = 0%; p = 0.701). Both results demonstrate that neither the intervention category nor the population category confirm the high heterogeneity presented in the meta-analysis results.

Table VI presents the meta-regression analysis, aiming to analyze heterogeneity based on a continuous variable

Table III. Data extracted from the included studies.

Author/year	TV	Results ($p < 0.05$)
Borba-Pinheiro et al. [16]	60 min; 2-3 x/week; 56 weeks	EG: ↑W10m, ↑SSP, ↑SPP, ↑SCMA, ↑PTS, ↑GI
Carrasco-Poyatos et al. [17]	60 min; 2x/week; 36 weeks	EG1 e EG2: ↑W10m, ↔SSP, ↑SPP, ↑SCMA, ↑PTS, ↑GI
		EG1 x EG2 x CG: ↑W10m, ↑SSP, ↑SPP, ↑SCMA, ↑PTS, ↑GI
da Silva et al. [18]	NR; 3x/week; 20 weeks	EG: ↑SSP, ↑SCMA, ↑PTS, ↑W10m, ↑SPP, ↑GI
Daniel et al. [24]	60 min; 2x/week; 12 weeks	EG: ↑W10m, ↑SSP, ↑SPP, ↑SCMA, ↔PTS, ↑GI
		CG: ↔W10m, ↔SSP, ↔SPP, ↔SCMA, ↔PTS, ↔GI
Marcos-Pardo et al. [19]	NR; 3x/week; 12 weeks	EG x CG: ↑W10m, ↔SSP, ↔SPP, ↔SCMA, ↔PTS, ↑GI
Martinez et al. [23]	50 min; 5x/week; 12 weeks	EG x CG: ↑W10m, ↔SSP, ↔SPP, ↔SCMA, ↔PTS, ↑GI
Pereira et al. [20]	NR; NR; 20 weeks	EG x CG: ↑W10m, ↑SSP, ↑SPP, ↑SCMA, ↑PTS, ↑GI
Ramos et al. [1]	50 min; 2x/week; 16 weeks	EG1: ↑W10m, ↑SSP, ↑SPP, ↑SCMA, ↑PTS, ↑GI
		EG2: ↑W10m, ↑SSP, ↔SPP, ↑SCMA, ↑PTS, ↑GI
		EG1 x CG: ↑W10m, ↑SSP, ↑SPP, ↑SCMA, ↑PTS, ↑GI
		EG2 x CG: ↑W10m, ↑SSP, ↔SPP, ↑SCMA, ↔PTS, ↑GI
		EG1 x EG2: ↔W10m, ↑SSP, ↑SPP, ↑SCMA, ↑PTS, ↑GI
Rocha et al. [21]	NR; 3x/week; 20 weeks	EG: ↑W10m, ↑SSP, ↑SPP, ↑SCMA, ↔PTS, ↑GI
		CG: ↔W10m, ↔SSP, ↓SPP, ↔SCMA, ↔PTS, ↔GI
		In the intergroup, there were differences in all variables
Siqueira Rodrigues et al. [22]	60 min; 2x/week; 8 weeks	EG x CG: ↑W10m, ↑SSP, ↑SPP, ↑SCMA, ↑PTS, ↑GI

EG: experimental group; CG: control group; TV: training volume; W10m: Walk 10m; SSP: stand up from sitting position; SPP: stand up from the prone position; SCMA: to sit and get up from the chair and moe around the house; PTS: to put on and take off a T-shirt; GI: GDLAM general index; ↑: improve; ↓: reduction; ↔: without changes; NR: not reported.

Table IV. Characteristics of the included studies.

Author/year	Intervention type	Exercises
Borba-Pinheiro et al. [16]	RT	EG (RT): resistance exercises for upper and lower limbs using equipment
Carrasco-Poyatos et al. [17]	Mat Pilates and RT	EG1: mat pilates: dynamic range of motion exercises
		EG2: pilates or resistance training; static range of motion and breathing exercises
da Silva et al. [18]	RT	EG: resistance exercises for upper and lower limbs using equipment
Daniel et al. [24]	Functional and balance exercises	EG: resistance exercises involving upper and lower limbs using bodyweight
Marcos-Pardo et al. [19]	Circuit resistance training with moderate to high intensities	EG: resistance exercises for upper and lower limbs using equipment
Martinez et al. [23]	Water exercise	EG: water aerobic exercises
		CG: did not perform exercise
Pereira et al. [20]	RT	EG: resistance exercises for upper and lower limbs using equipment
		CG: stretching sessions three times per week
Ramos et al. [1]	RT and aerobic	EG1: resistance exercises for upper and lower limbs using equipment
		EG2: stretching, joint mobility, walking, and relaxation
		CG: did not perform exercise
Rocha et al. [21]	RT	EG: resistance exercises involving upper and lower limbs using equipment
Siqueira Rodrigues et al. [22]	Pilates	EG: resistance exercises involving upper and lower limbs using equipment and bodyweight

EG: experimental group; CG: control group; RT: resistance training.

(mean age of the studies). It can be observed that the mean age found in the studies did not show significant difference ($p = 0.351$).

Two researchers independently assessed the level of evidence of the meta-analysis using the Grading of Recommendations Assessment, Development, and

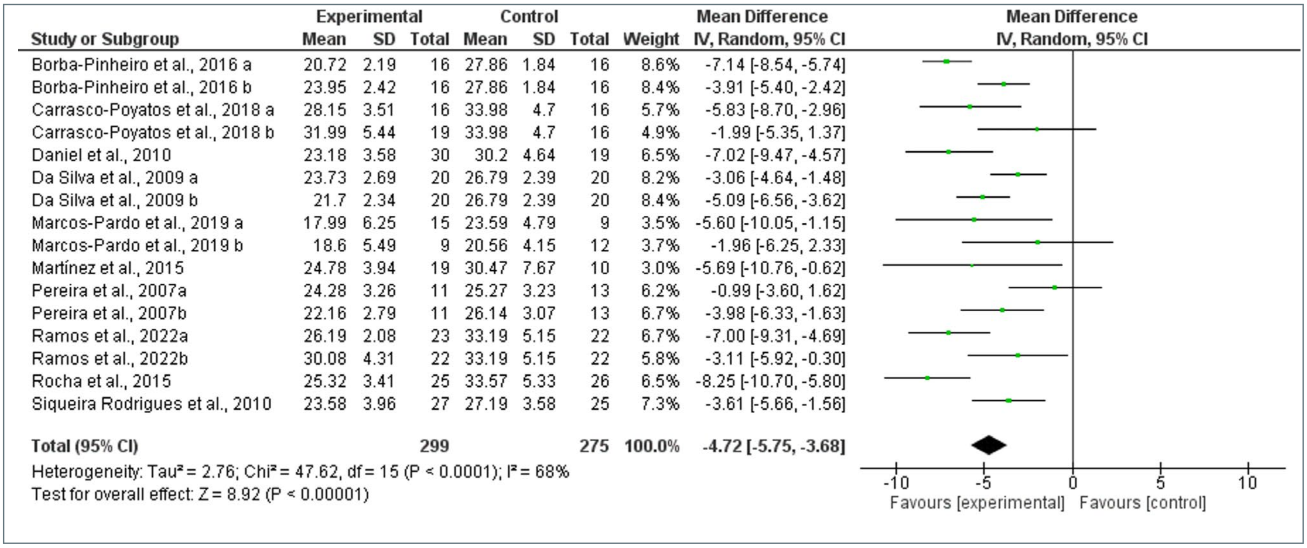

Figure 4. Forest plot of the outcomes of the functional autonomy in points.

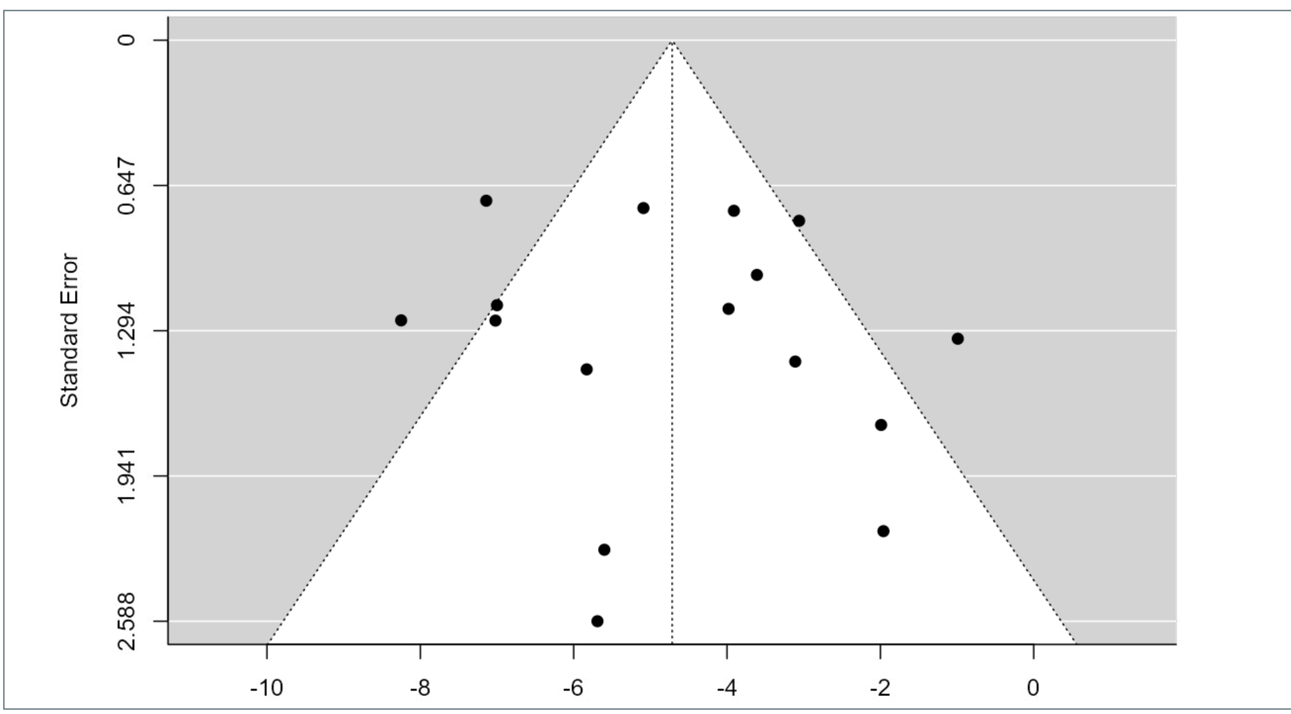

Figure 5. Funnel Plot in assessing publication bias.

Evaluation (GRADE) approach with the GRADE PRO website, available at https://gradepro.org. This tool specifies four levels: "high", "moderate", "low", and "very low". Randomized controlled trials start with "high" evidence. Five aspects can decrease the level of this evidence: methodological limitations, inconsistency, indirect evidence, imprecision, and publication bias [13,25]. A third researcher was responsible for resolving disagreements throughout the process, if necessary (Table VII).

In Table VII, the strength of evidence of the studies included in this systematic review was evaluated. The "risk of bias" domain of the included studies reduced the certainty in the final body of evidence; however, there is moderate confidence in the effect estimate.

Table V. Sensitivity analysis of the EG by subgroup.

Subgroups		Meta-analysis estimation	Heterogeneity/inconsistency	Subgroup difference test
Intervention	RT	-4.69 (-6.09, - 3.30)	Q= 24.75; I^2= 72%; p= 0,0008	Q= 3.12; I^2= 0%; p= 0.542
	WE	-5.69 (-10.76, - 0.62)	Not applicable	
	Pilates	-4.48 (-6.61, -2.36)	Q= 1.52; I^2= 34%; p= 0.22	
	Aerobic	-5.69 (-10.76, -0.62)	Not applicable	
	Combined circuit	-7.02 (-9.47, -4.57)	Not applicable	
Population	Healthy women	-4.72 (-6.05, - 3.40)	Q= 4.30; I^2= 30%; p= 0,23	Q= 0.70; I^2= 0%; p= 0.701
	Healthy women and men	-3.96 (-6.13, - 1.78)	Q= 30.32; I^2= 70%; p= 0,0004	
	Unhealthy women	-5.54 (-8.70, -2.37)	Q= 9.58; I^2= 90%; p= 0.002	

RT: resistance training; WE: water exercise.

Table VI. Meta-regression.

n = 16	B	Std.Err. of b	t(14)	p-value
Intercept	-13.38	8.95	-1.49	0.161
Mean age of the studies	0.13	0.13	0.98	0.351

DISCUSSION

The aim of this systematic review with meta-analysis was to investigate the effects of physical exercise on the functional autonomy of the older people evaluated by the GDLAM protocol. Among the assessment protocols found during the study selection, only the GDLAM Protocol presented a general index of functional autonomy. For this purpose, functional autonomy was assessed by the general index (GI) of the results of five tests: "walk 10m" (W10m), "stand up from sitting position" (SSP), "standing up from the prone position" (SPP), "to sit and get up from the chair and move around the house" (SCMA), and "to put on and take off a T-shirt" (PTS) belonging to an assessment battery (GDLAM). The classification of GI (weak, regular, good, and very good) is determined by the formula (GI = [((W10m + SSP + SPP + PTS) × 2) + SCMA] ÷ 4) [26,27]. The lower the GI value, the greater the functional autonomy of the older adults. The 299 older individuals in the experimental group who performed physical exercises significantly reduced the GI by -4.72 [-5.75 to -3.78] points compared to the 275 older individuals in the control group who did not perform physical exercises. This decrease in GI of -4.72 points indicated improved functional autonomy in the older adults who performed physical exercises, which may ensure the performance of activities of daily living (ADL) such as walking, standing up, and dressing more quickly.

The tests that make up the GDLAM are related to ADL such as walking in different directions, sitting, rising from different positions, and putting on and taking off a shirt. Maintaining the ability to perform these activities in the lives of older individuals is necessary to prevent them from losing their autonomy. Loss of autonomy increases the risk of falls, institutionalization, and dependence on others to carry out basic activities throughout daily life [28].

Functional autonomy can be influenced by various factors stemming from the aging process that affects individuals' psychophysiological systems. However, examples of these factors such as decline in vascularization and ligament and tendon compliance [29], muscle mass quantity, force production capacity [30], bone mineral density [31], physiological vulnerability, and its debilitating consequences such as chronic disease management, psychological well-being, and perception of quality of life can be influenced and improved through the practice of physical exercises. This improvement may arise from the benefits provided by physiological mechanisms that exercise offers, as well as psychological factors that the environment and interaction with individuals involved in that environment can provide [32,33].

As individuals age, the duration of activities that promote sedentary behavior, such as excessive sitting,

Table VII. Assessment of the strength of evidence of the meta-analysis.

Certainty assessment							N° of patients		Effect		Certainty	Importance
N° of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	EG	CG	Relative (95% CI)	Absolute (95% CI)		
Functional autonomy (GI)												
10	Randomised trials	Serious[a]	Not serious[b]	Not serious	Not serious	None	299	275	-	MD **-4.72 SD lower** (-5.75 lower to -3.68 lower)	⊕⊕⊕◯ Moderate	IMPORTANT

CI: confidence interval; **MD:** mean difference; **a.** The studies by Borba-Pinheiro et al., 2016; Daniel et al., 2010; Minarski et al., 2014; Rezende et al., 2015 presented a high risk of bias in at least one domain; **b.** The high heterogeneity was accounted for in the meta-analysis result by using the random-effects model.

increases. This is associated with deleterious health outcomes, such as increased mortality and abnormal glycolytic metabolism. Therefore, it is necessary to reduce sedentary time and increase time spent in activity, regardless of the physical exercise performed [34]. Despite this, it is recommended that physical exercise should be prescribed based on the individual's goals, abilities, and precautions, and with enough volume and intensity to achieve the maximum benefits [35]. Due to the need for physical exercise as a contribution to the healthy aging process, a well-balanced training program with this goal includes strength, balance, cardiovascular conditioning, and flexibility exercises. Therefore, engaging in a physical exercise program can contribute not only to increased life expectancy but also to healthy life expectancy, which refers to how long an individual can live without dependency or the need for assistance from others to carry out their activities [36]. Based on the exercise programs applied in the studies included in this meta-analysis, it is recommended to have sessions lasting between 30 and 75 minutes, with a frequency of 2 to 5 times per week, and a duration of intervention ranging from 8 to 56 weeks. Different types of exercises were utilized, including resistance training [1,17-20], pilates [17,22], functional training [24], sensorimotor training [24], water exercise [23] and walking [1] (Tabs. III-IV).

This meta-analysis had some limitations. An analysis was conducted solely on the GDLAM Protocol, as it was the only one identified in the searches that provided a final general index of functional autonomy. The high risk of bias or some concerns in the included studies (70% - Figure 3) and the high heterogeneity (Chi2 = 47.62; $p < 0.0001$; I2 = 68%) among the studies included in the meta-analysis (Fig. 4). The high percentage of studies with a high risk of bias indicated the need for future studies with more methodological rigor. The high heterogeneity among the included studies was incorporated into the meta-analysis result by the random-effects model (Fig. 4). A likely explanation for the high heterogeneity among the included studies was the presence of both sexes and older individuals on pharmacological treatment, isolated, healthy, or sedentary (Tab. II). Another likely explanation for the high heterogeneity was the different types of intervention (Tab. IV). However, subgroup analysis (Tab. V) and meta-regression (Tab. VI) could not statistically prove this.

However, as strengths of this meta-analysis, we can highlight the precision of the meta-analysis result due to the large number of participants (n = 574 - Figure 4); the direct evidence manifested by the coherence of the inclusion criteria of the studies with the objective of the meta-analysis; and the absence of suspicion of publication bias (Fig. 5). As a consequence of these limitations and strengths, a moderate level of certainty was attributed to the meta-analysis result (Tab. VII).

CONCLUSIONS

The studies included in this meta-analysis underscore the positive impact evaluated by the GDLAM protocol of physical exercise on the functional autonomy in the older adults, demonstrating a significant improvement in essential activities daily living. Given the increasing aging population, investing in well-structured exercise programs emerges as a important strategy to promote the health and independence of older adults, benefiting both individuals and society.

Conflict of interest statement

The authors declare no conflict of interest.

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Author contributions

We declare that all authors have effectively participated and are aware of the content of the manuscript and in accordance with its submission.

Ethical consideration

Not applicable.

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Appendix A. Search phrases used in the databases.

Embase	((older OR ‘aged’/exp OR aged OR ‘elderly’/exp OR elderly) AND ‘functional autonomy’ OR ‘activities daily living’) AND (‘exercise’/exp OR exercise)
PubMed	Search: ((aged) AND (functional autonomy)) AND (physical activity) (“aged”[MeSH Terms] OR “aged”[All Fields]) AND ((“functional”[All Fields] OR “functional s”[All Fields] OR “functionalities”[All Fields] OR “functionality”[All Fields] OR “functionalization”[All Fields] OR “functionalizations”[All Fields] OR “functionalize”[All Fields] OR “functionalized”[All Fields] OR “functionalizes”[All Fields] OR “functionalizing”[All Fields] OR “functionally”[All Fields] OR “functionals”[All Fields] OR “functioned”[All Fields] OR “functioning”[All Fields] OR “functionings”[All Fields] OR “functions”[All Fields] OR “physiology”[MeSH Subheading] OR “physiology”[All Fields] OR “function”[All Fields] OR “physiology”[MeSH Terms]) AND (“autonomies”[All Fields] OR “autonomy”[All Fields])) AND (“exercise”[MeSH Terms] OR “exercise”[All Fields] OR (“physical”[All Fields] AND “activity”[All Fields]) OR “physical activity”[All Fields])
SPORTDiscus	TX ((older OR aged OR elderly)) AND TX ((“functional autonomy” OR “activities daily living”)) AND TX (exercise)
Scopus	(ALL (aged) AND ALL (“functional autonomy”) AND ALL (“physical activity”))
Web of Science	ALL=((older OR aged OR elderly) AND (“functional autonomy” OR “activities daily living”) AND (exercise))