ORIGINAL ARTICLE

Effects of walking and strength training on walking capacity in individuals with claudication: meta-analysis

Efeitos do treinamento de caminhada e força na capacidade de caminhada de claudicantes: meta-análise

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Abstract

Context: Over the past few years, several clinical trials have been performed to analyze the effects of exercise training on walking ability in patients with intermittent claudication (IC). However, it remains unclear which type of physical exercise provides the maximum benefits in terms of walking ability. **Objective:** To analyze, by means of a meta-analysis, the effects of walking and strength training on the walking capacity in patients with IC. **Methods:** Papers analyzing the effects of walking and strength training programs in patients with IC were browsed on the Medline, Lilacs, and Cochrane databases. Randomized clinical trials scoring >4 on the Physiotherapy Evidence Database (PEDro) scale and assessing claudication distance (CD) and total walking distance (TWD) were included in the review. **Results:** Walking and strength training yielded increases in CD and TWD ($P < 0.05$). However, walking training yielded greater increases than strength training ($P = 0.02$). **Conclusion:** Walking and strength training improve walking capacity in patients with IC. However, greater improvements in TWD are obtained with walking training.

Keywords: exercise; vascular diseases; peripheral arterial disease.

Resumo

Contexto: Ao longo dos últimos anos, diversos ensaios clínicos têm sido realizados sobre os efeitos do treinamento físico na capacidade de caminhada de pacientes com claudicação intermitente (CI). No entanto, ainda permanece incerto, qual modalidade de treinamento físico promove maiores aumentos na capacidade de caminhada dos pacientes. **Objetivo**: Analisar, por meio de meta-análise, os efeitos do treinamento de caminhada e de força na capacidade de locomoção de pacientes com CI. **Métodos:** Foi realizada pesquisa bibliográfica de artigos que analisaram os efeitos do treinamento de caminhada e de força em pacientes com CI nas bases de dados Medline, Lilacs e Cochrane. Foram incluídos na revisão estudos clínicos randomizados com escore > 4 na escala de PEDro e que quantificaram a distância de claudicação (DC) e a distância total de caminhada (DTC). **Resultados:** Os treinamentos de caminhada e de força promoveram aumentos na DC e na DTC ($P < 0,05$). No entanto, os aumentos obtidos com o treinamento de caminhada foram superiores aos obtidos com o treinamento de força ($P = 0,02$). **Conclusão**: Os treinamentos de caminhada e de força promovem aumento na capacidade de locomoção de pacientes com CI. No entanto, efeitos na DTC são mais acentuados com o treinamento de caminhada.

Palavras-chave: exercício; doenças vasculares; doença arterial periférica.

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INTRODUCTION

Peripheral artery disease (PAD), one of the main atherosclerotic diseases, is associated with high morbidity rates among the elderly[1]. The main symptom of PAD is intermittent claudication (IC), characterized by pain in the lower limbs, particularly the calf, when walking[2]. The prevalence of PAD is 3% to 10% in the general population and about 20% in the population older than 70 years[3,4].

IC is the cause of limitations to walking, which may compromise the performance of physical activities of daily living[5]. In addition, individuals with IC have muscle atrophy and decreased muscle strength[6], power and resistance in the lower limbs[7]. Supervised physical training combined with changes in life style has proven to be important interventions for the treatment of individuals with IC[8], and significant increases in their walking ability and muscle and skeletal aptitudes have been found[9,10].

Currently, there is evidence that supports the use of walking training in patients with PAD[11]. In fact, improvements in fitness and quality of life have been found, in addition to the fact that training is low cost and easy to perform[12-14]. Recent studies showed that strength training also improves fitness and quality of life of patients with PAD[10,15-18]. However, it is still unclear which of the two modalities of physical training results in greater increases in walking capacity.

This study conducted a meta-analysis to compare the effects of walking and strength training on the walking capacity of individuals with IC.

METHODS

Literature review

The MedLine, Lilacs and Cochrane databases were reviewed. First, studies were selected according to their publication date, which was limited to July 1980 to December 2010.

For the search, keywords in Portuguese and their corresponding keywords in English were selected using the DECS and the MeSH databases. The keywords selected were: *exercício físico/physical exercise*, *aptidão física/fitness*, *caminhada/walking*, *treinamento de força/strength training* and *claudicação intermitente/intermittent claudication*. For the selection of studies, combinations of keywords were used for the search. As a result, 1947 studies were retrieved, but only eight[15-17,19-23] met inclusion criteria. Figure 1 shows the flowchart of study selection in this meta-analysis.

First, two authors read the study titles to check whether they met the purposes of this meta-analysis. When no decision was reached after reading the title, the abstract and later, if necessary, the whole study was read. This meta-analysis included studies that: (i) were randomized clinical trials; (ii) included a sample of individuals with PAD and symptoms of IC; (iii) analyzed the effects of supervised physical training (walking or strength); (iv) measured claudication distance (CD) or total walking distance (TWD) before and after the intervention; (v) included more than one experimental group; and (vi) had a score equal to or greater than 4 on the Physiotherapy Evidence Database (PEDro) scale, used to measure the quality of methods in clinical studies.

Data extraction

The following data were extracted from the studies that met inclusion criteria: (a) publication year; (b) groups; (c) number of individuals in each group; (d) type of physical exercises; (e) duration of intervention; (f) frequency (times a week); (g) volume of training session; (h) method used to measure intensity; (i) intensity prescribed; (j) initial CD or TWD; (k) final CD or TWD.

Data analysis

Mean and standard deviation values were calculated according to mean values in the studies to describe the characteristics of individuals included in the study. For inferential analysis, mean difference and 95% confidence intervals were calculated; the fixed effects model was used when results were homogeneous ($P \leq 0.10$); and a random effects model was used when results were heterogeneous ($P < 0.10$). The Review Manager 5.1 software was used for all analyses.

RESULTS

Study quality

Mean PEDro score of the studies included was 5.5 ± 0.9, and scores ranged from 4 to 7 (Table 1). The factors that lowered scores in a relevant way were: participant distribution was not blinded[15-17,20,22,23]; participant assignment to intervention groups was not blinded[15-17,19-23]; the individuals that administered the training program were not blinded[15-17,19-23]; and statistical analysis did not follow intention to treat[15-17,19-23].

Study characteristics

Of a total of 424 individuals included, 238 underwent physical training (Table 2). Most participants were men (65%) and elderly (67 ± 4 years). The duration of PAD described in four studies[15,20,22,23] was 3.4 ± 0.8 years. All individuals included in the study had mild to moderate IC, and mean ankle-brachial index (ABI) was 0.64 ± 0.06.

Body mass (BM) was described in four studies[15,19,21,23], and mean BM was 76.0 ± 4.9 kg; body mass index (BMI) was found in three studies[16,19,23], and mean BMI was 28.6 ± 2.0 kg/m^2. The analysis of comorbidities revealed that four studies[15,17,19,22] described the presence of hypertension, five[15,17,19,21,22], heart disease, four[16,17,19,21], diabetes, and two[15,22], dyslipidemia. In addition, most studies[15-17,19-22] reported that individuals were smokers.

Walking ability before intervention

CD was reported in eight studies[15-17,19-23]. Mean CD before intervention was 203 ± 126m and 197 ± 124m in the studies that used walking and strength training. In all studies, CD was similar between experimental and control groups before intervention.

Mean TWD before intervention was 365 ± 182 m and 329 ± 171m in the studies that used walking and strength training. In all studies, TWD was similar between experimental and control groups before intervention.

Training program

Duration ranged from six[23] to 48[19] weeks, and 12 weeks was the most frequent duration[15,17,20,22]. Frequency ranged from two[17] to three times a week[15-17,19-23], whereas session length ranged from 20 to 60 minutes[15-17,19-23].

Walking training was prescribed according to perception of exertion, with Borg scores ranging

Table 1. Quality of studies included in meta-analysis.

Study	Score
Crowther[19]	5/10
Hiatt[15]	5/10
McDermott[16]	7/10
Mika[20]	6/10
Parr[23]	4/10
Ritti-Dias[17]	6/10
Sanderson[21]	6/10
Tsai[22]	5/10

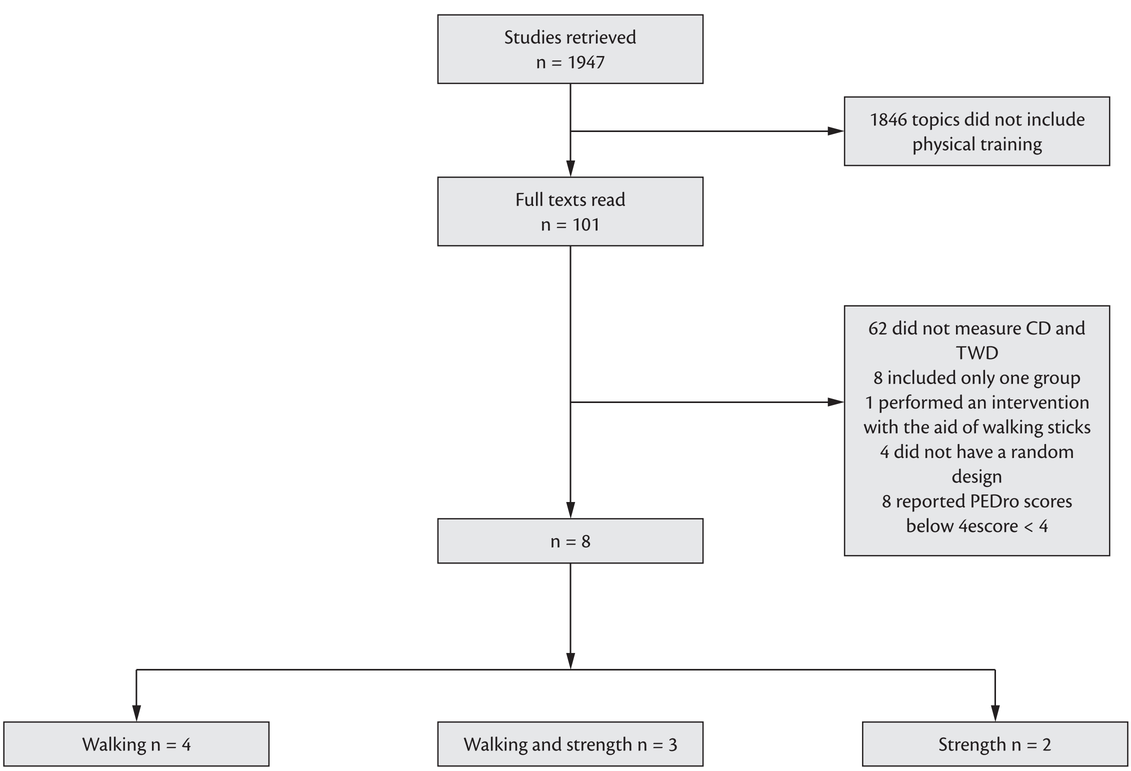


Figure 1. Flowchart of inclusion of studies in the meta-analysis CD – claudication distance; TWD – total walking distance.

Table 2. Characteristics of the studies that met inclusion criteria.

Study	Intervention	Subjects (n)	Duration (weeks)	Frequency (week)
Crowther[19]	Treadmill walking	10	48	3
	Control	11	48	-
Hiatt[15]	Strength	9	12	3
	Treadmill walking	10	12	3
	Control	10	12	-
McDemort[16]	Strength	52	24	3
	Treadmill walking	51	24	3
Mika[20]	Treadmill walking	27	12	3
Control		28	12	-
Parr[23]	Strength	9	6	3
	Control	8	6	-
Ritti-Dias[17]	Strength	15	12	2
	Treadmill walking	15	12	2
Sanderson[21]	Treadmill walking	13	6	3
	Control	14	6	-
Tsai[22]	Treadmill walking	27	12	3
	Control	26	12	-

from 11 to 14[16,17], and perception of claudication pain, with scores ranging from 3 to 4[19]. Peak oxygen consumption (peak VO_2) was used in one study, at an intensity of 80% of peak VO_2[21].

Strength training was prescribed according to perception of exertion, with Borg scores ranging from 11 to 13[16,17], and tests of 6[15] and 15[23] maximum repetitions.

Effects of training on walking ability

The comparison of the effects of walking training and control intervention on CD (Table 3) revealed that only walking training significantly increased CD (152 m; 95% CI [135, 168], $P < 0.00001$). The comparison of the effects of strength training and control intervention on CD revealed that only strength training significantly increased CD (17 m; 95% CI [–27, 61], $P = 0.03$). The comparison of increases of CD in walking and strength training revealed that the effects of the two trainings were similar ($P = 0.32$).

The comparison of the effects of walking training and control intervention on TWD[15,16,20-22] (Table 4) revealed that only walking training significantly increased TWD (173 m; 95% CI [56, 290], $P < 0.00001$). Also, the comparison of the effects of strength training and control intervention on TWD revealed that only strength training significantly increased TWD (106 m; 95% CI [33, 180] P=0.005). However, the increase in TWD as a result of walking training was greater (P=0.02) than that obtained after strength training.

DISCUSSION

This study compared the effects of walking training and strength training on the walking capacity of individuals with IC using data in the literature. For that purpose, a meta-analysis was conducted. Results showed that: (i) walking and strength training increased the walking capacity of patients with IC; (ii) the effects of strength and walking training on CD are similar; (iii) walking training resulted in greater TWD increases than strength training.

Most studies included in this meta-analysis used walking training[15-17,19-22]. This may be partly explained by the fact that several Vascular Surgery Associations[8,11], in their official guidelines, recommend walking as the most important exercise for patients with PAD. Recent recommendations have included strength training as part of training for individuals with PAD, although only a few studies using strength training have been published. In fact, our analysis included only four studies that evaluated the effects of strength training on the walking ability of patients with PAD[15-17,23]. Furthermore, one of these studies had a weight greater than 70% in the meta-analysis because of the high number of individual included in its sample. Therefore, further studies about this topic should be conducted.

The effects of walking and strength training on CD were similar, but TWD increased more after

Table 3. Effects of walking and strength training on claudication distance.

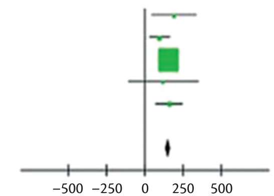
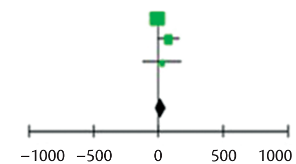
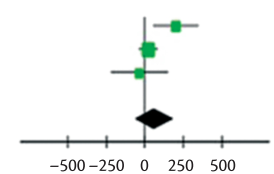
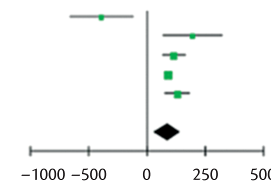
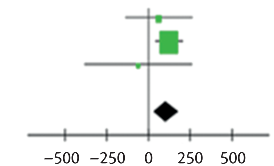
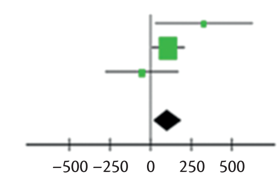
Study	Mean	SD	Total	Mean	SD	Total	Weight	Mean difference IV, fixed, 95%CI	Mean difference IV, fixed, 95% CI
Control vs. walking training									
Hiatt 1994	354	227	10	164	69	10	1.3%	190 [43, 337]	
McDermott 2009	291	170	51	194	169	53	6.7%	97 [32, 162]	
Mika 2006	340	53	41	185	25	39	87.7%	155 [137, 173]	
Sanderson 2006	455	276	13	334	331	14	0.5%	121 [-108, 350]	
Tsai 2002	327	143	27	169	180	26	3.7%	158 [70, 246]	
Total (95%CI)			142			142	100%	152 [135, 168]	
Heterogeneity: X2 = 3.18 df = 4 (P = 0.53); I2 = 0%									
Total effects test: Z = 17.59 (P < 0.00001)									
Control vs. strength training									
Hiatt 1994	153	58	10	163	68	10	63,2%	-10 [-65, 45]	
McDermott 2009	269	138	27	193	169	26	28,0%	76 [-7, 159]	
Parr 2009	202	175	9	175	136	8	8,8%	27 [-121, 175]	
Total (95%CI)			46			44	100%	17 [-27, 61]	
Heterogeneity: X2 = 1.94 df = 4 (P = 0.16); I2 = 48%									
Total effects test: Z = 2.18 (P = 0.03)									
Strength training vs. walking training									
Hiatt 1994	354	227	10	153	58	9	29,9%	201 [55, 347]	
McDermott 2009	291	170	51	269	138	52	46,2%	22 [-38, 82]	
Ritti-Dias 2010	469	237	15	504	276	15	23,9%	-35 [-219, 149]	
Total (95%CI)			76			76	100%	62 [-60, 184]	
Heterogeneity: Tau2 = 7469.79 X2 = 5.67 df = 2 (P = 0.06); I2 = 65%									
Total effects test: Z = 0.99 (P = 0.32)									

Table 4. Effects of walking and strength training on total walking distance.

Study	Mean	SD	Total	Mean	SD	Total	Weight	Mean difference IV, fixed, 95%CI	Mean difference IV, fixed, 95%CI
Control vs. walking training									
Crowther 2008	650	273	10	1,039	361	11	11.3%	-389 [-661, -117]	
Hiatt 1994	776	385	10	385	142	10	12.3%	391 [137, 645]	
Mc Dermott 2009	612	211	51	380	294	53	24.2%	232 [134, 330]	
Mika 2006	577	69	41	396	67	39	28.7%	181 [151, 211]	
Tsai 2002	660	195	27	401	200	26	23.5%	259 [153, 365]	
Total (95%CI)			139			139	100%	173 [56, 290]	
Heterogeneity: Tau2 = 12207.84 X2 = 22.38 df = 4 (P = 0.0002); I2 = 82%									
Total effects test: Z = 2.90 (P = 0.004)									
Control vs. strength training									
Hiatt 1994	448	275	9	385	143	10	13.5%	63 [-137, 263]	
McDermott 2009	504	214	52	380	212	53	81.3%	124 [43, 205]	
Parr 2009	399	186	9	460	430	8	5.2%	-61 [-383, 261]	
Total (95%CI)			70			71	100%	106 [33, 180]	
Heterogeneity: X2 = 1.40 df = 2 (P = 0.53); I2 = 0%									
Total effects test: Z = 2.83 (P = 0.005)									
Strength training vs. walking training									
Hiatt 1994	776	385	10	448	275	9	8.5%	328 [29, 627]	
McDermott 2009	612	294	51	504	214	52	76.4%	108 [9, 207]	
Ritti-Dias 2010	721	289	15	775	334	15	15.1%	-54 [-278, 170]	
Total (95%CI)			76			76	100%	102 [15, 189]	
Heterogeneity: X2 = 4.08 df = 2 (P = 0.13); I2 = 51%									
Total effects test: Z = 0.99 (P = 0.32)									

walking training. This can be explained by the fact that the mechanisms of increase in walking ability differ between walking and strength training. The increases in walking ability after walking training have been assigned to: angiogenesis[24]; improvement of endothelial function; increase of oxidative enzyme concentrations[13]; and improvement of walking efficiency. In contrast, the increases obtained with strength training have been basically assigned to angiogenesis and improvements on walking efficiency. Therefore, the effects of walking training on oxidative metabolism seem to explain the differences between the effects of walking and strength training on the walking ability of patients with PAD.

One of the limitations of this study was the inclusion of studies only in Portuguese or English. Another important aspect was the fact that, although only studies that measured walking ability using treadmills were included, there was some variation in the protocols used. Therefore, results between studies should be compared cautiously. However, individual studies used the same protocol to measure walking ability, and we were, therefore, able to assess the effects of training between groups.

CONCLUSION

Walking and strength training improve the walking capacity of patients with PAD, but walking training results in greater increases of TWD.

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