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Evaluation of the effectiveness of workplace exercise in controlling neck, shoulder and low back pain: a systematic review

Efetividade do exercício físico em ambiente ocupacional para controle da dor cervical, lombar e do ombro: uma revisão sistemática

Helenice J. C. G. Coury, Roberta F. C. Moreira, Natália B. Dias

Abstract

Background: Musculoskeletal disorders have been recognized as a worldwide health problem. One of the measures for controlling these disorders is workplace exercise, either at the workstation or in a separate environment within the company. However, there is controversy regarding the effectiveness and means of applying these interventions. **Objectives:** To assess and provide evidence of the effectiveness of workplace exercise in controlling musculoskeletal pain. **Methods:** The following databases were searched: PubMed, MEDLINE, Embase, Cochrane, PEDro and Web of Science. Two independent reviewers selected the elegible studies. Possible disagreements were solved by consensus. All randomized controlled clinical trials that evaluated exercise interventions in the workplace musculoskeletal pain relief were included. The PEDro scale (range=0-10 points) was used to rate the quality of the studies included in this review. **Results and Conclusions:** The electronic search yielded a total of 8680 references published in English. At the end of the selection process, 18 studies were included. Strong evidence was found to support the effectiveness of physical exercise in controlling neck pain among workers who performed sedentary tasks in offices or administrative environments, while moderate evidence was found for low back pain relief among healthcare and industrial workers who performed heavy physical tasks. These positive results were reported when the training periods were longer than 10 weeks, the exercises were performed against some type of resistance and the sessions were supervised. None of the studies evaluating sedentary workers reported positive results for controlling musculoskeletal shoulder pain. Further randomized controlled trials are needed to comparatively evaluate, among other aspects, the effects of light and heavy training for shoulder pain relief.

Key words: training; workplace; work-related musculoskeletal disorder; pain; prevention; ergonomics.

Resumo

Contextualização: As disfunções musculoesqueléticas representam um problema de saúde mundial. Dentre o conjunto de medidas para controle dessas alterações está a prática de exercício físico em ambiente ocupacional que pode ser realizada no próprio setor de trabalho ou em ambientes à parte, mas dentro da empresa. Entretanto, há controvérsias quanto à efetividade e à forma de aplicação desse tipo de intervenção. **Objetivos**: Avaliar a efetividade e fornecer evidências a respeito da prática de exercício físico no ambiente ocupacional para o controle da dor musculoesquelética. **Métodos:** As seguintes bases bibliográficas foram consultadas: PubMed, MEDLINE, Embase, Cochrane, PEDro e Web of Science. Dois revisores independentes selecionaram os estudos pertinentes, e as eventuais discordâncias foram solucionadas por consenso. Foram incluídos no estudo os ensaios clínicos randomizados controlados que realizaram intervenção no local de trabalho envolvendo exercício e avaliaram a dor musculoesquelética. A escala PEDro, que tem pontuação de 0-10, foi utilizada para avaliação da qualidade dos estudos incluídos nesta revisão. **Resultados e Conclusões:** A busca eletrônica resultou em um total de 8680 referências publicadas em inglês. Ao final do processo de seleção, 18 estudos foram incluídos. Forte evidência foi encontrada para a efetividade do exercício físico no controle de dor cervical em trabalhadores que realizavam atividades em escritórios ou setores administrativos, descritos como sedentários enquanto evidência moderada foi encontrada para a região lombar daqueles que realizavam atividades envolvendo manuseio de pacientes ou materiais na indústria, desde que os treinamentos fossem aplicados por períodos superiores a dez semanas, incluíssem exercícios realizados com algum tipo de resistência e fossem supervisionados. Nenhum estudo avaliando trabalhadores sedentários relatou resultados positivos para o controle da dor musculoesquelética em ombros. Novos estudos randomizados controlados (RCTs) são necessários para avaliar, dentre outros aspectos, o efeito comparado de treinos leves e pesados para ombros.

Palavras-chave: treinamento; local de trabalho; distúrbio osteomuscular relacionado ao trabalho; dor; prevenção; ergonomia.

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Department of Physical Therapy, Universidade Federal de São Carlos (UFSCar), São Carlos (SP), Brazil

Correspondence to: Helenice Jane Cote Gil Coury, Universidade Federal de São Carlos, Departamento de Fisioterapia, Rodovia Washington Luis, Km 235, CP 676, CEP 13565-905, São Carlos (SP), Brazil, e-mail: helenice@ufscar.br

Introduction

Musculoskeletal disorders have been associated with individual and biomechanical risk factors in the workplace[1]. These disorders develop gradually, show a chronic course and often go untreated[2]. Although many symptoms are associated with work-related musculoskeletal disorders, one of the most notable symptoms is pain[3,4]. Painful symptoms may worsen gradually and progress to loss of function[4]. Pain and loss of function may persist for years and, in some cases, become intractable[3,5]. Thus, the adoption of measures to control these disorders is essential in social and economic terms.

Westgaard and Winkel[6] observed that the complaints of work-related musculoskeletal pain in the shoulder and neck areas are becoming as frequent as low back pain complaints. Among the measures for controlling these disorders, workplace exercise programs have often been applied in order to increase muscle strength and improve flexibility and cardiovascular conditioning[7]. Potentially, such changes would improve the workers' health, ability for work and quality of life. However, the effects of the workplace exercise in relation pain relief are controversial. A previous review study[8] showed limited evidence for the beneficial effects of exercise to control shoulder and neck pain in workers, whereas for low back symptoms, there is both limited[9] and strong evidence of effectiveness[10]. Although these review studies are relatively recent, they performed a general evaluation of the effects of exercise, without considering that this therapeutic modality has very heterogeneous intervention protocols that vary in relation to the type of exercise, duration of the exercise protocol, frequency and duration of sessions. The protocols also vary in form and body region of application.

Therefore, based on the assessment of high-quality studies, the objectives of this review were: 1) to investigate the effectiveness of workplace physical exercise in controlling neck, shoulder and low back pain; 2) to investigate which specific characteristics of the workplace exercise and work-related activities have positive effects on pain control, and thus provide information that can be applied to clinical practice. Among these characteristics, we analyzed: total duration of the exercise protocol, frequency and duration of training sessions, presence of supervision, exercised body region and type of occupational activity carried out by workers. This study was carried out based on the assumption that the synthesis of evidence from randomized controlled trials (RCTs) on workplace exercise can lead to safer clinical decisions which, in turn, provide more effective intervention results.

Methods

Search strategy

A survey was carried out in the databases of PubMed, MEDLINE, Embase, Cochrane, PEDro and Web of Science, using the following keywords: ergonomic training, ergonomic program, preventive program, ergonomic intervention, preventive exercise, exercise, rest min, break rest, work pause, efficacy, effectiveness, evaluation, workplace, musculoskeletal diseases, occupational diseases, musculoskeletal complaints, musculoskeletal disorders, prevention, work organization, worksite physical activity, occupational musculoskeletal health, symptoms, warming up, stretching. Initially, two independent reviewers selected the studies based on titles, excluding those clearly unrelated to the theme under review. Then, the abstracts of all the selected titles were reviewed to identify those that met the inclusion criteria. The full texts of the potentially relevant articles were retrieved for final assessment, and their reference lists were checked independently by two reviewers to identify potentially relevant studies not found in the electronic search. The reviewers selected the articles to be included in the review using a standard form adapted from the Cochrane Collaboration[11]. Possible disagreements during the process were solved by consensus.

Inclusion criteria:

Study type

We selected only RCTs that included interventions involving workplace exercise and that investigated musculoskeletal symptoms.

Type of participants

We selected only the studies that reported results about populations of active workers, with or without musculoskeletal complaints, who performed normal work activities during the study.

Intervention type

We selected studies that investigated or compared interventions in the workplace or in reserved areas within the company, involving exercise for primary and/or secondary prevention of musculoskeletal pain.

Types of reported results

We included studies that investigated variables related to musculoskeletal pain as one of the main outcomes.

Assessment of the methodological quality of the selected studies

The methodological quality of the included studies was assessed using the PEDro[12] scale, which is based on the Delphi list[13]. Although this scale has 11 items, only ten are scored, so the score ranges from zero to ten. Each criterion is scored according to its presence or absence in the evaluated study. Each satisfied item (except the first) contributes one point to the total score. Items that are not described in the studies are classified as "not described" are not scored. The final score is obtained by the sum of all the positive answers. The studies indexed in the PEDro database already had a rating, which was maintained, and the non-indexed studies were evaluated independently by two reviewers. In case of disagreement, a third reviewer (senior researcher) was consulted to reach a final decision.

Verhagen et al.[8], van Poppel, Hooftman and Koes[14] and Proper et al.[15] conducted previous systematic review studies to assess the effectiveness of intervention programs carried out in the workplace. They claim that, for a study to be classified as high-quality, it should have a score of more than 50% the maximum possible score. According to Maher[16], due to the impossibility of achieving certain conditions such as blinding of therapist or subjects in the clinical trial studies in the workplace, the maximum score that can be reached by these clinical trials is 8/10. Thus, for this review, all RCTs with a score higher than or equal to five (5/8, 62%) were considered studies of high methodological quality. A minimum score of 3/8 was defined as the cutoff score for inclusion in this review.

Data extraction

All authors worked independently, using a standard form adapted from the Cochrane[11] collaboration model for the data extraction, considering: 1) aspects of the study population, such as occupational activity, mean age and gender; 2) aspects of intervention, such as sample size, type of exercise, presence of supervision, frequency and duration of training sessions; 3) follow-up; 4) follow-up loss; 5) evaluated pain variables and 6) reported results.

Data analysis

A scoring system including five levels of evidence was used to synthesize the evidence in this review. This system considers the number, the methodological quality and the results of studies regarding the variable of interest, and it has been used in previous systematic reviews involving workplace interventions[l8,14,15], as follows:

- Strong evidence: provided by consistent findings in two or more high-quality RCTs;
- Moderate evidence: provided by consistent findings in one high-quality RCT and one or more low-quality RCTs, or by consistent findings in multiple low-quality RCTs;
- Limited evidence: only one high-quality RCT or multiple low-quality RCTs;
- Conflicting evidence: inconsistent findings in multiple RCTs;
- Absent evidence: no RCT.

Results

Search strategy

The literature review included titles published until December 2008. The electronic search resulted in a total of 8680 references published in English. The final selection was defined by consensus and resulted in 19 studies, two[17,18] of which were duplicated. Therefore 18 studies were selected, including six high-quality studies (Figure 1).

Assessment of the quality of the studies

Among the eighteen relevant studies, 17 were indexed in the PEDro database[12], while one non-indexed study[19] was evaluated by consensus of three reviewers, using the PEDro scale. The scores of each one of the included studies are shown in the last column of Table 1. Two[20,21] of the eighteen studies included in this review describe their methods of randomization, but these methods were considered inappropriate by the PEDro raters[12]. This was due to the existence of different specific methods to generate the random allocation sequence. Some methods such as computer randomization, random number tables and randomization cards are considered more suitable, while others are considered less appropriate, such as alternate allocation, or allocation based on medical chart numbers or birth date[22]. Given the difficulty in performing randomization procedures in the workplace[6], the procedures used in study no. 16 (randomization by department into three groups using a spreadsheet) and study no. 17 (randomization by medical chart number) were accepted as valid and included in the present review.

Characteristics of the included studies

Table 1 shows the characteristics of the exercise programs, a summary of the results in relation to the pain outcomes and the PEDro score of the studies included in the review.

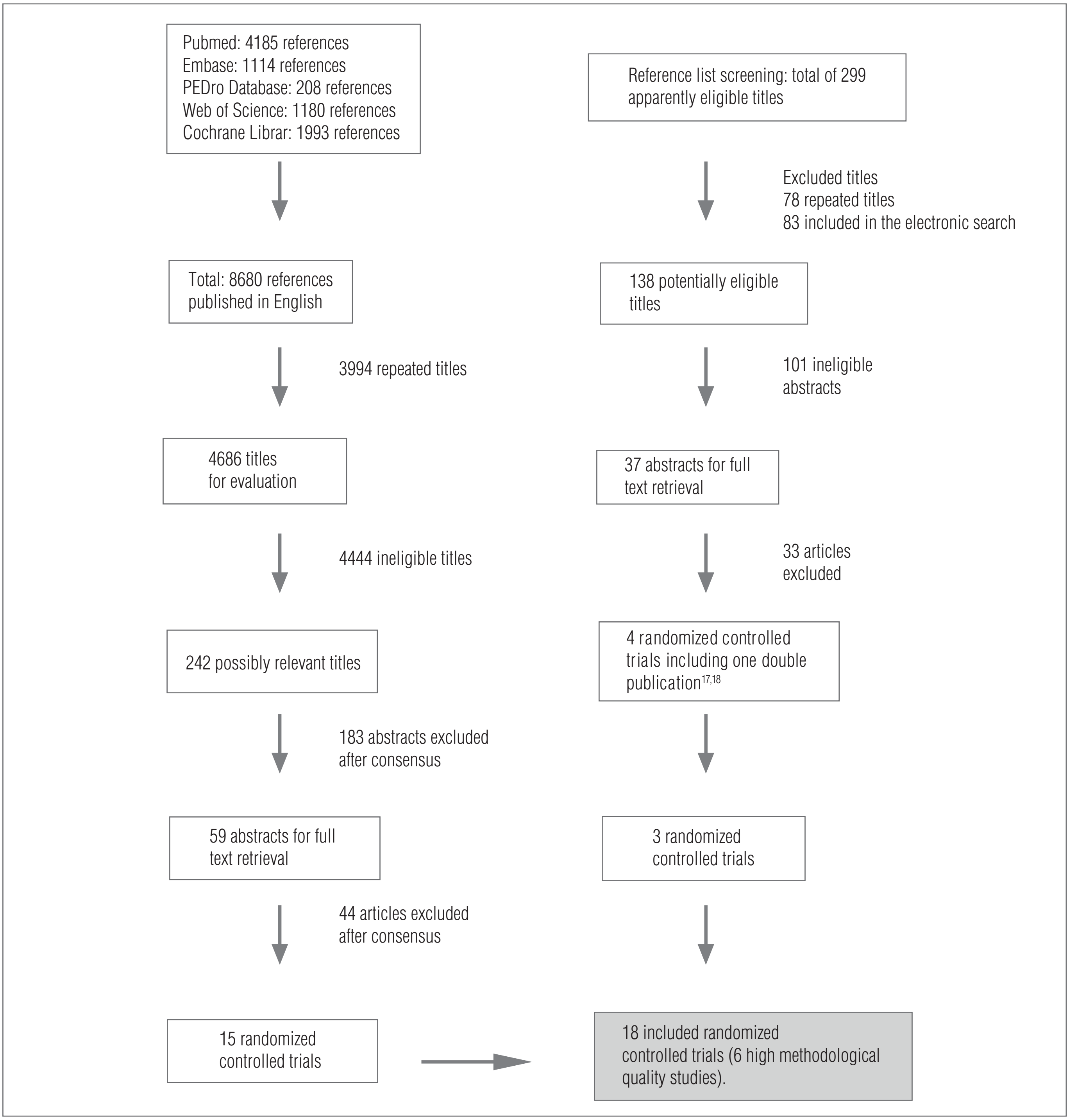

Figura 1. Estágios seguidos durante todo processo da revisão sistemática.

For the interpretation of results, some characteristics of interest were categorized. The results for the effectiveness of exercise were analyzed considering the effects on pain reduction. The studies in which the experimental group demonstrated statistically significant reduction in symptoms compared to the control group were considered positive results. Studies that showed no significant reduction in symptoms after intervention or those in which a significant reduction in symptoms occurred in both groups (experimental and control) were classified as not relevant. The results were not considered if they were described by the authors as positive based on trends or positive interpretations and were not accompanied by numerical values of the pain outcome.

Table 2 demonstrates the numerical results of pain outcomes, the result of the intervention and the statistical

Table 1. Characteristics, pain outcomes and PEDro score for the randomized controlled trials included in the review.

Study	Type of work	Body region	Comparison groups	Type of training	Training duration and frequency	Protocol duration	Supervision	Association of another intervention	Pain outcomes	PEDro score
Takala et al.[23]	Sedentary (printing company employees)	Neck	CG x EG	Light	45min 1x / week	10 weeks	ND	No	Non-effect	**6**
Andersen et al.[24]	Sedentary (bank, post office, administrative office employees)	Neck	CG x SRT x APE	Heavy (SRT) light (APE)	20min 3x / week	10 weeks	Yes	No. CG received instructions on ergonomics; healthy food habits, work organization, stress management and relaxation training.	Positive effect for SST	4
Gronningsater et al.[19]	Sedentary (insurance company employees)	Neck and shoulder	CG x EG x SMT	Heavy	55min 3x / week	10 weeks	Yes	No	Positive effect for neck region (EG) only.	**5**
Lundblad et al.[25]	Sedentary (industrial workers -highly repetitive tasks)	Neck and shoulder	CG x PT x F	Light (F) and heavy (PT)	50min PT: 2x / week F: 1x / week	16 weeks	Yes	Ergonomic program for PT only.	Non-effect	3
Ahlgren et al.[20]	ND	Neck/ shoulder	CG x ST x RT x CT	Heavy	1h 3x / week	10 weeks	Yes	No. CG received instructions on stress management and on relaxation training.	Non-effect	4
van den Heuvel et al.[26]	Sedentary (computer work)	Neck/ shoulder	CG x EB x (EB+E)	Light	5min 1x / 35min	8 weeks	No	No. CG received work station rearrangement.	Non-effect	3
Tsauo et al.[27]	Sedentary (computer work)	Neck and shoulder	CG x E_A x E_{S1} x E_{S2}	Light	15 to 20min E_A: ND, E_{S1}: 1x / day E_{S2}: 2x / day	2 weeks	Just for E_{S1} e E_{S2}	No	Non-effect	3
Sjögren et al.[28]	Sedentary (office workers)	Neck and shoulder	CG x EG	Heavy	6min at the beginning: 1x / day and after: 1 to 2 x / day	15 weeks	No	No	Positive effect for neck region only.	**8**
Andersen et al.[17]	Sedentary (office workers)	Neck and shoulder	CG x SRT x APE	Heavy (SRT) light (APE)	20min 3x / week	12 months	Yes	No. CG received instructions on ergonomics, healthy eating habits, work organization, stress management and relaxation training.	Positive effect for neck region only.	**6**

Table 1. Continued.

Study	Type of work	Body region	Comparison groups	Type of training	Training duration and frequency	Protocol duration	Supervision	Association of another intervention	Pain outcomes	PEDro score
Kietrys et al.[29]	Sedentary (computer operators)	Neck and shoulder	Resistance exercise x stretching x CG	Heavy (resistance) and light (stretching)	No fixed timetable 1.5x / day	4 weeks	No	No. CG performed breathing exercises.	Non-effect	5
Donchin et al.[30]	Sedentary and physical (hospital employees)	Low back	CG x CAL x BS	Heavy	45min 2x / week	3 months	Yes	No	Positive effect for CAL group only.	4
Kellett et al.[31]	Physical (employees of a kitchen cabinet manufacturer)	Low back	CG x EG	Heavy	1h 1x / week	18 months	Yes	Extra exercises during the leisure time 1x/ week.	Positive effect	4
Gundewall et al.[32]	Physical (nurses aides)	Low back	CG x EG	Heavy	20min 1 to 2x / week 6 sessions/month	13 months	Yes	No	Positive effect	4
Gerdle et al.[33]	Physical (home care personnel)	Neck, shoulder and low back	CG x EG	Heavy	1h 2x / week	12 months	Yes	No	Non-effect	4
Horneij et al.[34]	Physical (nursing aides, assistant nurses)	Low back	CG x EG x SMT	Heavy	No fixed timetable 2x / week	7 weeks	No	No	Non-effect	4
Larsen et al.[21]	Not categorized (conscripts)	Low back	CG x EG	Heavy	No fixed timetable 2x / day	3 months	Yes (during the first 3 months)	Back school for EG.	Positive effect	4
Maul et al.[35]	Physical (hospital employees)	Low back	CG x EG	Heavy	1h 2 to 3x / week	3 months	Yes	No. CG received back school sessions.	Positive effect	4
Sjögren et al.[36]	Sedentary (office workers)	Low back	CG x EG	Heavy	6min at the beginning: 1x / day and after: 1 to 2 xx / day	15 weeks	No	Instructions for training and lectures on posture and movement control.	Positive effect	**5**

ND=not described; CG=control group; EG=exercise group; SRT=specific resistance training; APE=all round physical exercise; SMT=stress management training; PT=physical therapy intervention; F=Feldenkrais intervention; ST=strength training; RT=resistance training; CT=coordination training; EB=extra break; (EB+E)=extra break+exercise; E_A=self-exercise group; E_{S1}=team-exercise group I; E_{S2}=team-exercise group II; CAL=calisthenics program; BS=back school program; SM=stress management group. Numbers in bold represent the reference number of the high-quality studies (score ≥5 points on the PEDro Scale).

effect as reported by the authors of each study. As noted, most of the studies[19,20,24,25,27,28,31,32,34-36] presented the results as means and standard deviations for the variables related to pain. In one of the studies[23], the authors reported the median values for the Visual Analogue Scale (VAS) at baseline and the decrease in this value in the pos-test, with a confidence interval between the first and the third quartile. In the study by van den Heuvel et al.[26], the mean differences were demonstrated for the frequency of pain complaints, with a confidence interval of 95%. In three other studies[21,27,33], the prevalence of musculoskeletal pain is reported for each of the groups according to body regions of interest. We also identified three studies[26,30,32] in which the variable in question was assessed only in the post-test and two studies[17,29] in which the results were represented only by means of graphs or incomplete description of the results in the text. Therefore, it was not possible to extract accurate numerical data for the post-intervention period from those studies.

In view of the several forms used to present and report results and the different variables and instruments used to assess pain outcomes, it was not possible to conduct a meta-analysis of the present results. The studies by Takala, Viikari-Juntura and Tynkkynen[23] and Sjögren[28,36] are crossover studies in which the experimental and control groups alternated after ten and 15 weeks of intervention, respectively. The results for these groups are demonstrated on the basis of comparison between the same group of subjects in different periods, i.e. between the condition of the control group and at the end of the exercise intervention[28,36].

Based on the analysis of statistical significance, we identified ten studies[17,19,21,24,28,30-32,35,36] that reported positive results for some of the evaluated body regions, and four of them[15,24,31,32] were classified as high-quality studies. Eight studies[20,23,25-27,29,33,34] did not identify statistically significant differences between groups, and two of them were high-quality studies[23,29]. However, a general analysis based only on the methodological quality of the included studies could lead to imprecise interpretations regarding the evidence on the effectiveness of physical exercise practice in the workplace, because it is possible to identify particular trends when the results are analyzed according to the specificities of each protocol. Thus, we opted for a detailed analysis focusing on the exercised body region and the characteristics of the exercise protocols, such as: total duration of training, type of training, presence of supervision, population and duration of the sessions.

The studies by Sjögren et al.[28,36] were conducted with the same group of workers using a similar exercise protocol in terms of the frequency of sessions, duration of training and application of sessions. However, each study focused on different body regions, which were independently evaluated. In order to avoid potentialization of the results of a single exercise program, both studies were evaluated jointly and described in the tables as no. 28 and no. 36.

Effects of the training duration

Table 3 shows the results of exercise per body region and duration of the exercise program over time. The studies that showed effective results, including three[17,19,28,36] high-quality studies, were those in which the time of application of the protocol was equal to or greater than ten weeks, providing strong evidence for the effectiveness of long-term exercise programs. None of the programs lasting less than ten weeks resulted in positive effects for any of the regions studied. Among the ineffective programs, there is one reported in a high-quality[29] study, thus reinforcing the evidence regarding the ineffectiveness of short-term exercise programs.

Considering the body regions, eight studies investigated the low back area, of which six reported positive results after long-term exercise programs and one[28,36] was a high-quality study, indicating moderate evidence of the effectiveness of long-term training to control low back pain. The results for the shoulder region were not positive for the control of symptoms neither after short- or long-term programs. The effectiveness of exercise for the neck region was investigated in eight studies. Of the four studies that showed positive results for interventions lasting ten weeks or more, three[19,17,28,36] were high-quality studies, providing strong evidence of the effectiveness of long-term exercise programs for that region. Among the three studies that applied long-term training programs and were ineffective for neck pain, one[23] was a high-quality study, however the protocol of this study included light training, which may also have contributed to the ineffectiveness of the result as analyzed below.

Effects of types of training

The exercises performed during training sessions were classified into two categories: light or heavy training (Table 4). A protocol was considered light if it involved stretching, relaxation, light aerobic and dynamic exercise, i.e. without resistance. In contrast, a protocol was considered heavy if it included some type of resistance to perform the exercise resulting in increased intensity of the eccentric and concentric contractions, i.e. dumbbells, isokinetic equipment, elastic bands and exercises against gravity.

In general, light training in the workplace was shown to be ineffective for the control of musculoskeletal symptoms[23,25-27,29]. Only one study[17], despite being a high-

Table 2. Numerical results of intervention and statistical effect for pain outcomes.

Study	Inter-vention Period	Pain variable	Evaluation tool	Results			
				Body region	Results reported by authors		Statistical effect reported by authors
					Pre-test	Post-test	
Takala et al.[23]	10 weeks	Pain intensity and pressure pain threshold	VAS 100mm and algometer Median (Q1-Q3)	Neck	VAS median (Q1-Q3): EG_1=40mm (18-66) CG_2=50mm (16-66)	VAS median decrease: EG_1=-9 (-3-21mm) CG_2=-8 (-2-35mm)	p=ns
					In pressure pain threshold median: EG=45.2N (37.5-53.1) CG=44.8N (32.8-54.8)	In pressure pain threshold median: EG=4 N CG=3.3N	
Andersen et al.[24]	10 weeks	Short- and long-term pain intensity	VAS (100mm)	Neck	GFT=35 (21) SST=28 (15) CG=31 (20)	Post intervention: GFT=33 (12) SST=8 (9) CG=30 (22)	p_{SST}<0.0001
						10 weeks post intervention: GFT=29 (15) SST=16 (14) CG=30 (18)	
Gronningsater et al.[19]	10 weeks	Pain intensity	Pain index (5 scores)	Neck and shoulder	Neck: EG: (♀)=1.9 (2.3); (♂)=0.6 (0.7) SMT: (♀)=2.0 (2.1); (♂)=0.8 (1.9) CG: (♀)=0.7 (2.3); (♂)=0.1 (0.3)	Neck: EG: (♀)=0.7 (1.2); (♂)=0 (0) SMT: (♀)=1.4 (2.0); (♂)=1 (2.7) CG: (♀)=1.1 (1.7); (♂)=0.6 (1.9)	p_{EG}<0.05
					Shoulder: EG:(♀)=1.2 (2.0); (♂)=1.5 (2.8) SMT: (♀)=1.0 (2.2); (♂)=0.1 (0.3) CG: (♀)=1.7 (2.8); (♂)=0.9 (1.8)	Shoulder: EG: (♀)=1.1 (2.0); (♂)=0.7 (1.8) SMT: (♀)=0.4 (0.8); (♂)=1.2 (2.6) CG: (♀)=1.1 (1.9); (♂)=0.9 (2.0)	p=ns
Lundblad et al.[25]	16 weeks	Pain intensity	Neck pain index (0-5) and shoulder pain index (0-7)	Neck and shoulder	Neck: PT=2.0 (1.1) F=2.6 (1.5) CG=2.3 (1.4)	Neck: PT=1.9 (1.1) F=2.1 (1.6) CG=2.6 (1.7)	p=ns
					Shoulder: PT=3.1 (1.9) F=3.3 (1.9) CG=2.4 (2.3)	Shoulder: PT=2.5 (2.0) F=2.5 (2.0) CG=2.5 (2.2)	p=ns

Table 2. Continued.

Study	Intervention Period	Pain variable	Evaluation tool	Results			
				Body region	Results reported by authors		Statistical effect reported by authors
					Pre-test	Post-test	
Ahlgren et al.[20]	10 weeks	Pain intensity	VAS (100mm)	Neck/ shoulder	TF=36 (15) TR=43 (20) TC=40 (15) CG=42 (22)	TF=22 (18) TR=31 (17) TC=30 (17) CG=38 (24)	p=ns
van den Heuvel et al.[26]	8 weeks	Changes in the intensity and severity of complaints	Questionnaires [intensity of complaints (0-7) and pain scale (1-10)]	Neck/ Shoulder	Not applicable	Changes in the intensity of complaints (95% CI): (EB+E)=-0.1 (-0.18 a -0.02) EB=-0.02 (-0.1 a 0.05) CG=-0.09 (-0.17 a -0.02)	p=ns
						Changes in the intensity of complaints (95% CI): (EB+E)=-1.6 (-2.2 a -1.0) EB=-1.2 (-1.7 a -0.6) CG=-1.5 (-2.1 a -1.0)	
Tsauo et al.[27]	2 weeks	Pain and pressure pain threshold	Modified Nordic questionnaire and algometer	Neck and shoulder	Neck pain: -E_A=58.5 % -E_{S1}=33.3% -E_{S2}=14.3% -CG=48.6%	Neck pain: -E_A=33.3% -E_{S1}=32.7% -E_{S2}=25.0% -CG=44.8%	p=ns
					Shoulder pain: -E_A=37.7% -E_{S1}=27.5% -E_{S2}=14.3% -CG=35.1%	Shoulder pain: -E_A=14.6% -E_{S1}=26.9% -E_{S2}=8.3% -CG=48.3%	p=ns
						Pressure pain threshold: mean (SD) -E_A=0.1 (1.2) -E_{S1}=0.3 (1.0) -E_{S2}=0.6 (1.3) -CG=0.1 (1.0)	p=ns

Table 2. Continued.

Study	Intervention Period	Pain variable	Evaluation tool	Results			
				Body region	Results reported by authors		Statistical effect reported by authors
					Pre-test	Post-test	
Sjögren et al.[28]	15 weeks	Pain intensity	Borg CR-10 scale	Neck and Shoulder	Neck: GE_1=2.46 (2.29) GE_2=1.50 (1.68)	Neck: GE_1= 0.67 (1.46) GE_2=0.24 (0.72)	p<0.05
					Shoulder: ND	Shoulder: ND	
Andersen et al.[17]	12 months	Pain intensity	Questionnaires (pain intensity and scale of 0-9)	Neck and Shoulder	Precise data not available. Pain intensity results were only plotted in figures.	-----------	p_{TRE}<0.0001 p_{EFG}<0.0001 p_{CG}=ns
Kietrys et al.[29]	4 weeks	Pain intensity	VAS (1-10cm)	Neck and Shoulder	Mean and SD data not available for individual groups.	-----------	p=0.714
Donchin et al.[30]	3 months	Episodes of low back pain in the last month	Questionnaire	Low back	Episodes of low back pain in the last month: baseline data not available.	LBP episodes CAL=4.5 BS=7.3 CG=7.4	p_{CAL}<0.001
Kellett et al.[31]	18 months	Number of episodes of low back pain	Questionnaire	Low back	EG=0.54 (0.93) CG=0.33 (0.60)	EG=0.27 (0.61) CG=0.52 (1.07)	p<0.05
Gundewall et al.[32]	13 months	Absence from work and days with complaints during the intervention period	Questionnaire	Low back	Baseline data not available	Days absent from work: EG=1 (0.189) CG=4.84 (9.26)	p<0.0044
						Days with complaints: EG=53.9 (4.0) CG=94.3 (9.26)	p<0.018

Table 2. Continued.

Study	Inter-vention Period	Pain variable	Evaluation tool	Results			
				Body region	Results reported by authors		Statistical effect reported by authors
					Pre-test	Post-test	
Gerdle et al.[33]	12 months	Prevalence of complaints	Questionnaire (musculoskeletal complaints index)	Neck. shoulder and low back	Neck: EG=22 % CG= 42 %	Neck: EG=25% CG=44%	p=ns
					Shoulder: EG=28% CG=38%	Shoulder: EG=25% CG=40%	
					Low back: EG=19% CG=22%	Low back: EG=19% CG=27%	
Horneij et al.[34]	7 weeks	Pain intensity	Pain map (5 scores)	Low back	Low back pain: CG=2.0 (0.9) SMT=2.8 (1.8) EG=1.9 (1.0)	1 year follow-up: CG=0.4 (1.4) SMT=1.4 (2.1) EG=0.7 (1.4)	p=ns
Larsen et al.[21]	3 months	Number of subjects with back problem in the last 3 weeks and in the last year; medical care consulting due to back pain	Questionnaires	Low back	Back problem during the: Last 3 weeks EG=25/101 CG=24/113	7 months after intensive intervention: Back problem during the:	p=0.109
					Last year EG=47/101 CG=46/113	Last 3 weeks EG=22/101 CG=32/113	p=0.009
					Consulted physician due to back pain: EG=18/101 CG=25/113	Consulted physician due to back pain EG=9/101 CG=25/113	p=0.002

Table 2. Continued.

Study	Inter-vention Period	Pain variable	Evaluation tool	Results			
				Body region	Results reported by authors		Statistical effect reported by authors
					Pre-test	Post-test	
Maul et al.[35]	3 months	Pain intensity	VAS (100mm) Pain map	Low back	Current pain: EG=3 (2) CG=3 (2)	Current pain: Post-intervention EG=1 (2) CG=2 (2) 1 year EG=1 (1) CG=1 (2)	p=ns
					Pain map: EG=6 (7) CG=5 (6)	Pain map: Post-intervention EG=3 (3) CG=5 (6) 1 year: EG=3 (3) CG=5 (6)	p=0.02
Sjögren et al.[36]	15 weeks	Pain intensity	Borg CR-10 scale	Low back	EG_1=2.71 (2.01) EG_2=1.68 (2.57)	EG_1=1.44 (2.33) EG_2=0.53 (1.25)	p<0.05

ND=not described; CG=control group; EG=exercise group; SRT=specific resistance training; APE=all round physical exercise; SMT=stress management training; PT=physiotherapy intervention; F=Feldenkrais intervention; ST=strength training; RT=resistance training; CT=coordination training; EB=extra break; (EB+E)=extra break+exercise; E_A=self-exercise group; E_{S1}=team-exercise group I; E_{S2}=team-exercise group II; CAL=calisthenics program; BS=back school program; SM=stress management group.

Table 3. Studies classified by outcomes, body regions and training duration.

Body region	Positive effect		No effect	
	<10 week training	≥10 week training	<10 week training	≥10 week training
Neck	-	**28 and 36**; **19**; **17**; 24	27	**23**; 25; 33
Shoulder	-		27	33; 25; **19**; **28 and 36**; 17
Neck and shoulder	-		26; **29**	20
Low back	-	**28 and 36**; 31; 35; 21; 30; 32	34	33

Numbers in bold represent the reference number of the high-quality studies (score ≥5 points on the PEDro Scale).

Table 4. Studies classified by outcomes, type of training and body regions.

Body region	Positive effect		No effect	
	Light training	Heavy training	Light training	Heavy training
Neck	**17**	24; **19**; **28 and 36**; **17**	**23**; 27; 26	33
Shoulder			25; 27; **17**	**19**; **28 and 36**; **17**; 33
Neck and shoulder			25; **29**	20; **29**
Low back		30; 31; 32; 21; **28 and 36**; 35		33; 34

Numbers in bold represent the reference number of the high-quality studies (score ≥5 points on the PEDro Scale).

Table 5. Studies classified by outcomes and supervision for neck and low back regions.

With Supervision		Without Supervision	
Positive effect	No effect	Positive effect	No effect
19; **17**; 21; 24; 30; 31; 32; 35	20; 25; 27; 33	**28 and 36**	**23**; 26; **29**; 34

Numbers in bold represent the reference number of the high quality studies (score ≥5 points on the PEDro Scale).

quality study, demonstrated positive results for the control of neck pain after light training, indicating conflicting evidence for the effectiveness of light training for the neck region. Conversely, heavy training was effective in controlling symptoms of the neck region, with strong evidence[17,19,28] for this type of training. All eight studies on the low back area applied heavy training. Six of them, including one of high quality[36], were effective in controlling pain. Thus, there is moderate evidence for the effectiveness of heavy training on low back pain. For the shoulder region, despite high-quality studies using both forms of training, none of the programs resulted in symptom control, indicating that light training and especially heavy training were ineffective in that region.

Effects of supervision

The effect of supervision on the training sessions was considered for the neck and low back regions because the studies on the shoulder region did not show any positive results. Of the 12 studies that included supervision, eight were positive, including two[17,19] high-quality studies. In contrast, four of the five studies that investigated unsupervised training were ineffective. Of these, two[23,29] were high-quality studies, and only one[28] obtained a positive result. Thus, the joint analysis of the studies indicated strong evidence of ineffectiveness for unsupervised trainings.

Influence of the type of job

The type of job performed by the participants was classified as sedentary work or physical work. Activities carried out in offices and administrative departments and industrial work involving light physical demand were considered sedentary work. The job was classified as physical work if it was performed by nurses, nursing assistants, home care workers and by the employees of a kitchen cabinet manufacturer who handled heavy loads[31]. One of the studies[30] included hospital employees from administrative and clinical professions who performed both types of activity (sedentary and physical work). The study by Larsen et al.[21] was developed with military conscripts and did not specify the activities they performed, therefore this study was excluded from this part of the analysis.

Table 6 shows that most studies assessed sedentary activities and investigated especially the neck, shoulder and neck/shoulder regions. The studies that evaluated physical work studied mainly the effects of the training on the low back region. Seven studies assessed the neck region with four of them showing positive results, three of which were high-quality studies[17,19,28]. These results indicate strong evidence of the benefits of exercise in the workplace to control the neck symptoms of workers engaged in light or sedentary activities. The shoulder region was evaluated only in workers who performed light or sedentary activities[17,19,25,27,28] and three[17,19,28] of them were high-quality studies, but as already mentioned, there were no positive results for the shoulder region. Thus, there is strong evidence for the ineffectiveness of workplace exercises for the relief of shoulder symptoms. Regarding physical work, four of the six studies showed positive results, but all of them are low-quality RCTs. This result indicates moderate evidence of the importance of exercise in the workplace to control low back symptoms of workers who perform physical work. Only two[30,36] of the ten studies that evaluated sedentary work included the evaluation of low back symptoms, and both reported positive effects after completion of the exercise programs, one[36] being a high-quality study. Thus, there is moderate evidence of the effectiveness of exercise for low back symptoms of workers performing sedentary activities.

Influence of frequency and duration of the exercise sessions

Due to variations in the implementation of the workplace exercises, the number of studies in each category was insufficient to show which form of application was the most effective (Table 7), however it is possible to find some trends. The studies that used protocols with daily exercise applied short sessions of 5 to 6 minutes, whereas those with a lower frequency (up to 3 times a week) applied longer exercise sessions (45 to 60 minutes). The high-quality studies investigating the neck region used varied frequencies. The sessions lasting 20 minutes demonstrated positive results for frequencies of up to three times a week. The shoulder region, analyzed alone or with the neck, did not show positive results for any of the exercise protocols. The low back region showed positive results for medium (20 minutes) and long (45 to 60 minutes) sessions with lower frequencies. There was also positive results for the daily short sessions.

Discussion

The reported results suggest that workplace exercise may reduce pain symptoms of the neck and low back regions, but not the shoulder, both for workers who perform light or sedentary activities and heavy or physical activities. However, the effectiveness of such programs depends on the training characteristics.

Type of training

Among the analyzed characteristics, the type of training showed evidence that exercise involving some form of physical resistance, e.g. dumbbells, isokinetic equipment, elastic bands and exercises against gravity, are effective in controlling

Table 6. Studies classified by outcomes, type of job performed and body regions.

Body region	Positive effect		No effect	
	Sedentary work	Physical work	Sedentary work	Physical Work
Neck	**28 and 36; 19; 17**; 24		**23**; 25; 27	**33**
Shoulder			**19**; 25; 27; **28 and 36; 17**	33
Neck shoulder			26; **29**	
Low back	**28 and 36**; 30	30; 31; 32; 35		33; 34

Numbers in bold represent the reference number of the high-quality studies (score ≥5 points on the PEDro Scale).

Table 7. Studies classified by outcomes, body regions, frequency and duration of the exercise sessions.

Frequency	up to 3 times / week						every day					
Duration	45 to 60min		20min		5 to 6min		45 to 60min		20min		5 to 6min	
Body region	+	=	+	=	+	=	+	=	+	=	+	=
Neck	**19**	**23; 25**	24; 17							27	**28 and 36**	
Shoulder		19; 25		**17**						27		**28 and 36**
Neck/shoulder		20										29
Low back	30; 31; 35	33	32								**28 and 36**; 21	

Numbers in bold represent the reference number of the high-quality studies (score ≥5 points on the PEDro Scale) musculoskeletal pain in the low back and neck region. According to the American College of Sports Medicine[37], the most pronounced muscle changes at cellular level are achieved in response to dynamic strength training involving both eccentric and concentric contractions. In a previous review study on strength training for neck pain, Ylinen[38] states that resistance exercises for neck are frequently avoided based on the assumption that they can worsen the painful condition of the neck. However, the results of this review[38] showed that a gain in muscle strength was associated with a decrease in chronic neck pain.

In another review article about low back pain, Pope, Goh and Magnusson[39] also observed that the increase in muscle strength of the spine had a preventive effect on pain. Reviews by Ylinen[38] and Pope, Goh and Magnusson[39] included the evaluation of clinical studies, while the present results evaluated only the effect of exercise in relieving symptoms in the workplace. Thus, the interpretation of the present results, in light of those reviews, must be taken with reservation. Nevertheless, there seems to be a common physiological basis to heavy training programs that influences the pain, as discussed below.

The association of resistance exercise with a reduction in symptoms can be explained, at least in part, by the fact that strong muscle contractions activate the muscle's tension receptors, whose afferents trigger the release of endogenous opioids that stimulate endorphin production by the pituitary gland[40]. Thus, the increased level of endorphins at the end of the training supposedly reduces central and peripheral pain[40]. Another hypothesis, according to Waling et al.[41], is related to the fact that strength and/or resistance training would stimulate the growth of blood capillaries, optimizing oxygen supply, eliminating algogenic metabolic residue and promoting better nutrition of the muscle tissue.

With regard to light training applied in the workplace, the results showed no evidence of effectiveness for any of the evaluated regions. These results support those previously described, suggesting that light training does not provide enough muscle stimulus to promote substantial physiologic changes in the mechanism of chronic neck pain. Light training involving relaxation, socialization, etc. may positively affect productivity and promote healthier habits or even improve moods and the company's standing with employees[42], but it is not sufficient to promote improvement in muscle function[43]. Due to the lack of studies on the effectiveness of light training for the low back region, it was not possible to reach a conclusion about this type of training in the control of low back pain. Thus, further studies are needed to comparatively evaluate the effectiveness of light and heavy training in the workplace.

Duration, intensity and supervision of the exercise programs

The present study found strong evidence that long-term training, lasting ten weeks or more, is effective in reducing musculoskeletal pain in workers. In the literature, there are no studies evaluating this aspect of training in the workplace, but according to Wilmore and Costill[44], studies with athletes have already shown that muscular adaptation to strength training, expressed as increased voluntary strength, starts eight weeks after the beginning of training. Neural factors, which lead to an increase in voluntary muscle activation, seem to be involved in this process[44]. Thus, although the parameters observed for the training of athletes cannot be directly extrapolated to the worker population, it is likely that a minimum time of training for muscle disorders is also necessary for obtaining benefits in the exercises performed in the workplace.

With regard to training intensity, there was lack of evidence related to the specific frequency and duration of sessions needed to provide relief of symptoms. In general, the longer sessions (40 minutes to 1 hour) were associated with lower frequencies (two to three times a week), and shorter sessions (5 to 6 minutes) were associated with higher frequency (daily), with positive results in both cases. Thus, new studies are still needed to obtain more useful results on these aspects of training protocol.

The positive results of the high-quality clinical trials that included supervision and the negative results of the studies that did not include supervision demonstrate evidence of the effectiveness of supervised workplace exercise. This finding may be related to the presence of a professional prepared to provide guidance, monitor the sessions and assist in achieving the correct performance of the exercise.

Type of occupational activity performed by the participants

Strong evidence was observed for the effectiveness of exercise in controlling neck symptoms in workers who performed sedentary or light tasks. Sedentary tasks are usually performed in the sitting position and require concentration and precision. Direct consequences of this condition are anterior flexion of the neck and neck immobility to maintain visual acuity[45]. Over time, the flexed position can lead to weakness of the neck extensors, and static muscle work can lead to fatigue and pain[46]. Strengthening exercises involving dynamic muscle contractions can benefit blood flow and relieve pain in that region, as discussed earlier. Although the risks of the sitting posture for the low back are already known[45], this region was evaluated in only two of ten studies involving sedentary activities, limiting more conclusive interpretation of these results. New methodological quality studies are needed to investigate the effects of exercise on the control of low back pain in sedentary activities.

Most of the studies conducted in physical work environments evaluated the low back region. Exercises for low back symptoms in workers who perform heavy activities showed moderate evidence of effectiveness. In patients, the exercises have been used to relieve low back symptoms due to their physiological effects. Among these effects is the improvement of nutrition of the intervertebral disc, which occurs by diffusion, as a result of increased pumping and mechanical flow generated by exercise[47]. Furthermore, the muscle strength of the low back region reduces lumbar lordosis, intradiscal pressure and the tension in the intervertebral joints. However, muscle strengthening in the workplace should not be seen as a resource to enable the worker to exert more strength at work, because it is always more advisable to reduce the physical demands of the task and the risks of new or recurrent episodes of low back pain[48].

Ineffectiveness of shoulder exercise

None of the workplace exercise programs had positive effects on shoulder symptoms. The authors did not provide a specific explanation for these negative results or an exact clinical diagnosis for the symptomatic workers who participated in the study. The only diagnosis mentioned was trapezius syndrome, and only in one study[16].

The studies included in this review evaluated the shoulder symptoms only in workers who performed sedentary activities. According to Thorn et al.[49], there is a high prevalence of trapezius myalgia among workers who perform sedentary tasks with low levels of muscular activity. According to Westgaard and Winkel[46], epidemiological studies show a clear association between adverse psychosocial factors and muscle pain syndromes, and this association is likely to be permeated by physiological aspects. Although psychological factors may influence the development of painful symptoms in all regions of the spine, the shoulder girdle seems to be particularly susceptible to myalgia caused by psychosocial factors, possibly due to the sensibility of the trapezius muscle to emotional stress[50]. An interesting review also written by Westgaard[51] reported that central and peripheral mechanisms could be involved in the occurrence of psychosocial-induced myalgia associated with sedentary work. According to the author, the mechanisms involved in this occurrence are not clearly known, however it may be possible to break the pattern of continuous muscle activity with variable and dynamic movements, inhibition of involved agonists and the use of contraction strength to promote more phasic patterns of muscle activity in the low-threshold motor units. Thus, considering the issues discussed here, it would be appropriate that future studies evaluate the effect of dynamic exercise and resistance training to control pain in the shoulder region, mainly related to the trapezius muscle pain in sedentary workers.

Furthermore, due to the complexity of the factors that determine the painful symptoms in this region, there is understandable difficulty in achieving positive results through the exclusive application of exercise in the workplace. Thus, it is necessary to carry out further high-quality studies to compare exercise and other measures, such as ergonomic interventions in the physical environment and work organization.

Descriptive and analytical results and clinical meaning

The descriptive and statistical results reported in the analyzed studies (Table 2) indicate that there is general agreement among them, i.e. results describing small differences between groups tend not to show significant differences and vice-versa. The interpretation of the clinical meaning of these results is more complex. The reviewed studies predominantly used pain scales that are considered valid in the therapeutic context[52]. However, when these scales are used in the occupational setting and applied to active individuals, the difficulties are further increased because the level of pain present in these individuals tends to be lower than that reported by patients treated in clinical environments. The positive relationship between initial levels of pain and its reduction after intervention has also been recognized[36]. In other words, when the initial level of pain is small, smaller differences after the intervention are expected.

Another aspect that potentially reduces differences between groups is the condition of high homogeneity between the control and experimental groups required by high-quality studies[53]. Thus, it is suggested for future studies that the clinical meaning of results of pain evaluation in active individuals also be evaluated based on functional outcomes, such as movement limitation, impact on the performed activities, etc.

Methodological quality of the studies

According to Jadad et al.[54] and Guyatt et al.[55], RCTs have a lower risk of methodological bias in the selection of participants and thus provide stronger evidence for planning new interventions. As affirmed by Verhagen et al.[56], the validity of the conclusions of a systematic review is dependent on the quality of the primary studies. Although this recommendation has guided the selection of articles in this review, most of the studies had methodological limitations. The main limitations were inadequate descriptions of randomization procedures, blinding of examiners and absence of intention-to-treat analysis, with studies showing a mean score of 4.5/10.

The most critical points regarding the quality of the studies were related to blinding. Only four studies[17,23,28,33] used blinding of the examiners. Still, in this context, only two studies[20,28] reported concealment allocation of the subjects into the groups and only seven of the 18 studies[17,21,28-30,34,36] provided information about intention-to-treat. Those factors were responsible for reducing the methodological quality of the studies. Given the impossibility of blinding of subjects and therapists in preventive workplace interventions, this condition was accepted and adjustments were made in the PEDro scale. However, there is still a need to conduct new studies that minimize the main methodological faults mentioned here and to provide better evidence to clinical practice. Although the PEDro scale is widely used in evaluations of clinical trials, it has limitations such as lack of evaluation of the external validity of clinical trials and fails to evaluate the magnitude of the effect of the intervention[12], which hinders a more reliable evaluation of the methodological quality of the studies. Another limitation concerns the criterion adopted for synthesis of the evidence, based on the five levels of evidence. Although this criterion has been used in previous reviews[8,14,15], it has not been validated for use in occupational interventions. Thus, there is a need for further high-quality RCTs to better assess the effectiveness of some characteristics of workplace physical activity and control pain in the neck, low back, and especially, the shoulder region.

Conclusions

Workplace exercise can reduce musculoskeletal pain, although this beneficial effect depends on the characteristics of the exercise programs. There is evidence that exercise reduces musculoskeletal pain when it includes resistance, supervision and duration of at least ten weeks. This effectiveness was observed for neck and low back pain control. No high-quality studies on training to reduce shoulder symptoms achieved positive results, although this region was evaluated only in workers who performed sedentary or light activities. Finally, there is strong evidence for the control of neck pain in sedentary work environments and moderate evidence for the control of low back pain in physical work environments.

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