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Effectiveness of workplace exercise interventions in the treatment of musculoskeletal disorders in office workers: a systematic review

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ABSTRACT

Objective To determine the effectiveness of workplace exercise interventions in the treatment of musculoskeletal disorders.

Design Systematic review of randomised controlled trials (RCTs).

Data sources The bibliographical databases PubMed, CINAHL Plus, Cochrane, Scopus, ISI WoS and PeDRO were searched, with studies from 1 January 2010 to 31 December 2020 eligible for inclusion.

Eligibility criteria We included RCTs, reported in English or Spanish, with at least an intervention group performing workplace exercises among office workers with musculoskeletal disorders.

Data extraction and synthesis Two independent reviewers extracted data and assessed the risk of bias. A narrative synthesis was carried out with a tabular method specifying the study characteristics following the SWiM (Synthesis Without Meta-Analysis) guideline for synthesis without meta-analysis. The revised Cochrane Risk of Bias (RoB-2) tool was used to analyse the risk of bias of the included studies.

Results Seven studies with a total of 967 participants met the inclusion criteria and were included in this review. Due to heterogeneity in different workplace exercise interventions, outcome measures and statistical analyses, it was not possible to conduct a meta-analysis and a narrative synthesis was performed. The interventions were classified into three categories: multiple body regions, neck and shoulder, and lower back. The seven studies concluded that workplace exercise interventions were effective in reducing musculoskeletal disorders and pain compared with other types of interventions or with control groups with no interventions. The RoB-2 tool found a high risk of bias in six of the seven studies.

Conclusions The findings of the RCTs on workplace exercise interventions suggest that interventions were effective in treating musculoskeletal disorders among office workers. However, due to the high risk of bias of the included studies, no firm conclusions could be drawn and more high-quality studies are needed.

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Strengths and limitations of this study

- ► The search strategy was developed in collaboration with an expert documentalist and included the following databases: PubMed, CINAHL Plus, Cochrane, Scopus, ISI WoS and PeDRO.
- ► We ensured rigorous and consistent sets of inclusion and exclusion criteria.
- ► This is an innovative review as it focuses only on exercise interventions among employees' own workplaces, providing specific data on the most effective workplace exercise interventions (volume, intensity, time).
- ► The review is limited by heterogeneity in study methodologies, interventions and outcome measures.
- ► The risk of bias of the studies was high overall, making it difficult to draw firm conclusions.

INTRODUCTION

The exponential growth of sedentary lifestyle in the society is due to the great technological advances in recent years, increasing the time spent sitting throughout the day.[1 2] Sitting, reclining and lying for a long time are sedentary behaviours with low energy expenditures (<1.5 Metabolic equivalent of tasks [METs]).[3] It is important to note that sedentary behaviour and physical inactivity have different meanings,[4] with the latter the result of performing an insufficient amount of moderate-intensity (3–6 METs) and vigorous-intensity (>6 METs) activity.[3] It is therefore critical for strategies to improve physical activity and reduce sedentary behaviour in order to improve health.

American and Eastern Mediterranean countries have higher rates of physical inactivity, where 43% of the adult population do not reach the recommendations of the WHO physical activity guidelines (at least 150 min of moderate physical activity or 75 min of vigorous physical activity per week)[5]; the worldwide average is lower but surpasses 30%.[6] Moreover, these numbers may be worse due to COVID-19, where home confinement and mobility restrictions are necessary to reduce the spread of the virus, increasing sedentary behaviour.[7]

Even though the association seems obvious, there is limited evidence that physically active individuals have less prevalence of chronic musculoskeletal complaints.[8] More high-quality studies are required to determine the cause/effect of sedentary behaviour and its association with musculoskeletal pain.[9] This condition is one of the leading causes of health problems among the global population, resulting in work disability, absenteeism and work presenteeism.[10]

Because the office workplace is an unfavourable environment in terms of high sedentary behaviour,[11] daily exercise is crucial to prevent pathologies caused by lack of movement and poor posture while spending most of the workday in front of the computer.[12 13] In a study by Kaliniene *et al*[14] on 513 public service sector computer workers in Lithuania, the participants without rest breaks in their schedules had a higher prevalence (8.1%–13%) of musculoskeletal disorders in the elbow, wrist/hand, and upper and lower back than participants with rest breaks every 2 hours. This higher prevalence of pain is also due to working overtime, high quantitative and cognitive demands, and not taking breaks during work hours, increasing the total time spent in a seated position.[14 15]

Since productivity seems to be maintained by taking different standing breaks (from 5 min every 30 min of work to bouts of 50 s every 5 min of work) compared with not taking breaks in 1 hour of work,[16] performing exercise interventions may help reduce the effect of sickness presenteeism on musculoskeletal complaints and work ability.[17]

Having a daily schedule for exercise interventions at work might help reduce the time spent sitting and increase the daily physical activity of employees,[18] preventing cardiovascular and metabolic illnesses and reducing musculoskeletal disorders of the back.[19]

Strength and aerobic exercises that focus on reducing the intensity, disability and duration of neck and shoulder pain can be easily performed in work environments because they do not require equipment and can be performed according to the office worker's own bodyweight.[20] With regard to the type of exercises, the most common interventions are stretching and strength training exercises.[21 22] Additionally, the practice of disciplines such as yoga[23] or qigong[24] has been implemented in the workplace, along with home-based sessions, and could be considered a feasible option in the treatment of musculoskeletal disorders related to job demands.

However, to our knowledge, this is the first systematic review to focus exclusively on workplace exercise interventions for treatment of musculoskeletal disorders among symptomatic office workers from any sector who spend most of their time in a seated position.

This review aims to:

- Determine the effect of workplace exercise interventions on the treatment of musculoskeletal disorders.
- Describe the characteristics of workplace interventions to improve therapeutic exercise programmes for office workers.
- Recommend future lines of research to enhance interventions for a more active lifestyle among sedentary workers.

METHODS

A systematic review of randomised controlled trials (RCTs) published in English and Spanish between 1 January 2010 and 31 December 2020 was conducted according to the standards of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA).[25] The study protocol provides more specific details.[26]

Data sources and search strategy

The search was generated using PubMed Medical Subject Headings (MeSH) terms and keywords related to office workers, musculoskeletal pain and exercise interventions. Subsequently, the search was adapted in the following databases: CINAHL Plus, Cochrane, Scopus, ISI WoS and PeDRO. The full search strategy for all databases is available in online supplemental file 1.

The strategy was reviewed in pairs and followed the criteria of the Peer Review of Electronic Search Strategies (PRESS) tool.[27] Two reviewers (RP-P and CT-M) performed a peer review of all the retrieved records by title and abstract and then by full text using the Covidence tool.[28]

Inclusion criteria and study selection

The selection criteria for the review were as follows:

- RCT articles with at least one intervention through exercise at work.
- Studies with an entire sample carried out on office workers spending the majority of their working hours sitting.
- Evaluation of musculoskeletal disorders or pain in all body regions or specific areas of the body.
- Exercise interventions in the workplace, excluding those with exercises prescribed at home or outside the office setting.
- Studies where the intervention is by means of 'Sit-Stand Workstations' or guidelines of ergonomics and health education without a physical exercise programme have been excluded.

Data extraction

Data extraction was performed by two reviewers (CT-M and CB) based on the recommendations of the Cochrane Handbook for Systematic Reviews of Interventions.[29] Data extraction was carried out in a standardised way, following the characteristics of the studies' methodology, taking into account participants, interventions, outcome measures and the results. Consensus method was used to resolve differences between reviewers, and when differences were not resolved a third reviewer (FR-C) was consulted to reach full consensus.

Risk of bias assessment

The risk of bias of each article was independently assessed by two reviewers (FB, CT-M) using the Cochrane Risk of Bias 2 tool.[30] The sections where there was no coincidence between the two reviewers needed a third opinion (FR-C) to reach a consensus.

Data synthesis

It was not possible to conduct a meta-analysis due to the significant heterogeneity in different workplace exercise interventions, the random-effects model of the outcome measures and the statistical analyses. A narrative synthesis was carried out following the Economic and Social Research Council's guidance on conduct of narrative synthesis[31] and the SWiM (Synthesis Without Meta-Analysis) checklist items.[32] The results of the included studies were summarised and regrouped into three categories according to body regions. A preliminary synthesis was performed, presented in a common rubric through tabulation.

Patient and public involvement

There was no patient or public involvement.

RESULTS

Results of the search

The search results yielded 276 articles after removing duplicates. After screening by title and abstract, 232 articles were excluded, resulting in a total of 44 full-text studies. The search followed the aforementioned specified inclusion and exclusion criteria. In total, seven studies were included. More detailed information is presented in the adapted PRISMA flow chart (figure 1).

Characteristics of the studies

The seven studies that met the inclusion criteria were published from 2010 to 2018: Andersen *et al*[33] and Marangoni[34] in 2010, del Pozo-Cruz *et al*[35] in 2013, Nakphet *et al*[36] and Andersen *et al*[37] in 2014 Kaeding *et al*[38] in 2017, and Shariat *et al*[39] in 2018. A total of 967 participants were included in the seven studies, from the smallest sample of 30 participants[36] to the largest sample of 549.[33] A summary of the different interventions, the statistical analysis of the relevant outcomes and the results of the different studies are shown in table 1.

Interventions varied in each study, from 10 s to 15 s of stretch exercises every 6 min during work hours,[34] to up to 1 hour of strengthening exercises with 2–3 sets of 10–15 repetitions combined with 5 s of static neck exercises once a week.[33] A 3 min break intervention in Nakphet *et al*,[36] with a dynamic contraction group and a stretching group,

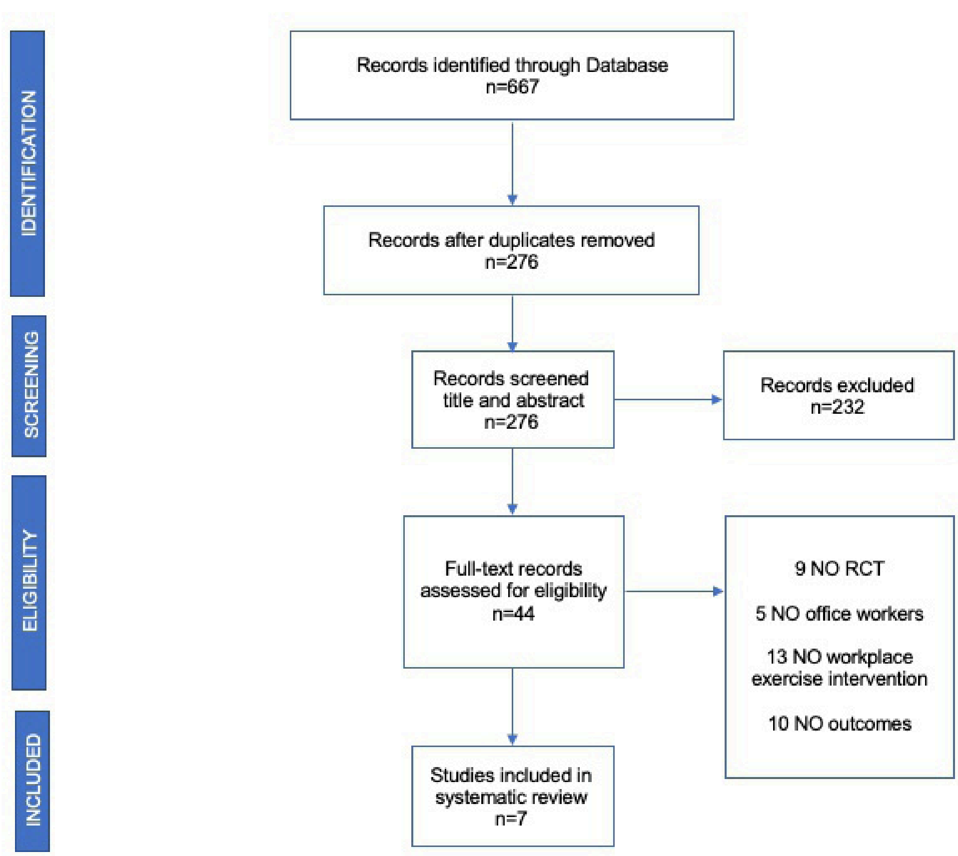

Figure 1 Flow diagram of trial selection, adapted from PRISMA. PRISMA, Preferred Reporting Items for Systematic Reviews and Meta-Analyses; RCT, randomised controlled trial.

Table 1 Summary of the results of the individual studies

Authors	Country	Participants	Intervention group vs control	Relevant outcome	Results	Measurement tools	Adverse effect
Andersen *et al*[33]	Denmark	n=549 (616 participants in the baseline test; 219 male, age: 45.7; 397 female, age: 44.6).	▶ SRT (n=180): consists of neck and shoulder strengthening exercises. ▶ APE (n=187): suggests increasing the level of physical activity during leisure time and at work with physical activities for all-round strength and aerobic fitness. ▶ REF (n=182): tries to improve health and working conditions; however, no changes were implemented at the worksites.	There were main effects for region (*F*=3.04, p<0.0005), group (*F*=2.93, p=0.05) and status (*F*=905, p<0.0001). In relation to pain intensity, there was greater reduction in neck, low back, right elbow and right hand in the SRT and APE groups (p<0.0001–0.05). Also, APE compared with REF had a preventative effect on the development of pain symptoms in the right shoulder (p<0.05). Neck pain decreased in SRT (−0.73±0.36, p<0.05) and APE (−0.91±0.31, p<0.01).	Both SRT and APE for office workers produced better effects than the REF group in several regions of the upper body and in the number of pain regions in individuals with neck pain specifically.	Nordic Musculoskeletal Questionnaire, intensity of pain of 0–9 lasts 3 months.	No.
Andersen *et al*[37]	Denmark	n=47 (10 male, 37 female), age: 44 (12), BMI: 25 (4).	▶ SFT (n=24): 3×20 min training per week for 10 weeks during working hours. It consists of a short warm-up and exercises to activate the serratus anterior and lower trapezius muscles, to a high extent, with a low level of activation of the upper trapezius. ▶ Control (n=23): not offered any physical training.	There was significant difference between groups in terms of pain in the neck/shoulder region (p<0.01). Also, PPT in the lower trapezius had an increase of 129 kPa (95% CI 31 to 227 kPa) (p<0.01). In terms of shoulder elevation and protraction strength, SFT showed an increased shoulder elevation strength of 7.7 kg (95% CI 2.2 to 13.3 kg) (p<0.01) more than the CG.	SFT reduces pain intensity and increases shoulder elevation strength in adults with chronic non-specific pain in the neck/shoulder region.	Self-rated pain intensity (0–9), PPT with algometer, maximal muscle strength with dynamometer, adherence.	No.
Marangoni[34]	USA	n=68 (8 male, 60 female), age: 43 (21–62 years).	▶ CASP subjects (n=22): performed 10–15 s stretch from a computer-assisted stretching programme every 6 min while working on the computer. ▶ FLIP subjects (n=23): performed 10–15 s stretch from a facsimile lesson with instructional pictures.Programme every 6 min while working on the computer. ▶ Control subjects (n=23): non-treatment.	There were significant improvements in reduction of pain in the intervention groups (CASP subjects VAS=−73%, PSA=−70%; FLIP subjects VAS=−64%, PSA=−62%) compared with CG, which slightly increased (VAS=1%, PSA=1%).	Positive effect on the reduction in pain in the intervention groups compared with the CG. No significant differences in the type of media used to prompt stretching exercises.	VAS and PSA, created by the author.	No.
Kaeding *et al*[38]	Germany	n=41 (13 male, 28 female), age: 45.5 (9.1), BMI: 26.6 (5.2).	▶ WBV (n=21): consists of training applying sinusoidal vibrations with 2.5 (30–45 min/week) sessions per week for 3 months. ▶ CG (n=20): received any training.	There were significant differences regarding RMQ and ODI between groups (p=0.027) (*t* test p=0.002, ANCOVA p<0.001). Also the SF-36 physical scale (*t* test p=0.013, ANCOVA p=0.026) and the Freiburg Activity Questionnaire showed significant difference on Wilcoxon test (p=0.022). Sick leave also showed a difference (p=0.008).	WBV training seems to be an effective, safe and suitable intervention for seated working employees with CLBP.	RMQ, ODI, WAI, SF-36, Freiburg Activity Questionnaire, isokinetic performance, sick leave, posturography.	No.

Continued

Table 1 Continued

Authors	Country	Participants	Intervention group vs control	Relevant outcome	Results	Measurement tools	Adverse effect
del Pozo-Cruz *et al*[35]	Spain	n=90 (24 male, 66 female), age: CG: 45.5 (7.02) and IG: 46.83 (9.13), with diagnosis of subacute Low Back Pain.	▶ IG(n=46): consists online session daily within postural reminders, stretching, exercises to improve postural stability, muscle strength, flexibility, mobility and finally moderate stretching lasting 9 months. ▶ CG (n=44): had access to usual preventive medicine care only.	In the intervention group, participants were more likely to exhibit improvements in functional disability (ODI clinical change 85%, p=0.001), risk of chronicity (SBST clinical change 75%, p<0.001) and most of the EQ-5D-3L components (VAS 73%, p<0.001; EQ-5D-3L utility score clinical change 78%, p<0.001; mobility 77%, p<0.001; self-care 79%, p=0.003; pain/discomfort 88%, p<0.001; and anxiety/depression 84%, p<0.001).	A web-based occupational intervention in a university administrative office is effective in improving quality of life and reducing the severity of low back pain.	VAS from the EQ-5D-3L, ODI, SBST.	No.
Shariat *et al*[39]	Malaysia	n=142 (47 male, 95 female), age Exercise group: 29.41 (1.16); Ergonomic modification group: 28.31 (0.92); Combined group: 29.64 (0.9); and Control group: 28.74 (0.82).	▶ Exercise group (n=43): consists of stretching and flexibility exercises of muscles of the back, shoulders and neck joints; once a day three times a week lasting 6 months. ▶ Ergonomic modification (n=37): contained modification of workplace. ▶ Combined group (n=34): consists of combining exercise and an ergonomic intervention. ▶ Control group (n=28): no-treatment.	After 6 months, there were significant differences in pain scores for neck,right and left shoulder, and lower back: MD −10.55 (−14.36 to −6.74); MD −12.17 (−16.87 to −7.47); MD −11.1 (−15.1 to −7.09); MD −7.8 (−11.08 to −4.53) between exercise group and control group, and also between the combined group and control group in terms of pain in the neck, right and left shoulder, and lower back: MD −9.99 (−13.63 to −6.36); MD −11.12 (−15.59 to −6.65); MD −10.67 (−14.49 to −6.85); and MD −6.87 (−10 to −3.74).	Exercise modification was more effective in comparison with the ergonomic modification group after 4 months.	CMDQ.	No.
Nakphet *et al*[36]	Thailand	n=30 female (18–40 years); Stretching group (SG): 31.4 (5.9); Dynamic contractions group (DCG): 29.6 (5.9); Reference group (RG): 27.6 (3.0).	▶ SG (n=10): consists of stretching of neck and shoulder muscles during 3 min breaks. ▶ DCG (n=10): consist of performing strength exercises of the neck and shoulders during each 3 min break. ▶ RG (n=10): participants were instructed to take their hands off the computer and relax sitting back on their chairs during the breaks.	There was significant time effect on the myoelectric activity of the upper trapezius between three sessions of a 20 min computer typing task: $F(1.59, 42.81)=5.35$ (p=0.013). However, there were no significant differences between groups.	Positive effect on muscle discomfort in the three groups after the rest break interventions. Rest breaks with a variation in activities did not decrease the level of muscle electrical activity in the neck and shoulder muscles during computer work.	SEMG, Borg's Category- Ratio (CR-10) scale (0–10 scale for muscle discomfort); productivity=total number of correct words/overall time of typing.	No.

ANCOVA, Analysis of covariance; APE, all-round physical exercise; BMI, Body Mass Index; CASP, Computer Assisted Stretching Program; CG, control group; CLBP, chronic low back pain; CMDQ, Cornell Musculoskeletal Disorders Questionnaire; EQ-5D-3L, EuroQol - Five Dimensions Questionnaire - Three Level Version; FLIP, Facsimile Lesson with Instructional Pictures; IG, Intervention Group; MD, Mean deviation; ODI, Oswestry Disability Index; PPT, pressure pain threshold; PSA, pain spot assessment; REF, reference intervention without physical activity; RMQ, Roland-Morris Disability Questionnaire; SBST, STarT Back Screening Tool; SEMG, surface myoelectric activity; SF-36, Short Form 36; SFT, scapular function training; SRT, specific resistance training; VAS, Visual Analogue Scale; WAI, Work Ability Index Questionnaire; WBV, whole-body vibration training.

focused on the neck/shoulder region. Andersen *et al* and Shariat *et al*[37 39] performed a 3-day-a-week intervention: Andersen *et al*[37] with a 10–15 min stretching routine and Shariat *et al*[39] with a 20 min strength routine with scapular training function. While Kaeding *et al*'s,[38] employed whole-body interventions in 2.5 sessions a week of 15 min vibration training, del Pozo-Cruz *et al*[35] performed physical exercise with postural stability strengthening, flexibility, mobility and stretching in 5-day-a-week sessions of 7 min each one.

With regard to the length of the interventions, many studies had medium-term and long-term interventions, except for Nakphet *et al*,[36] where a 1-day intervention was performed to identify the acute effects of two workplace exercise interventions compared with a passive pause, and Marangoni,[34] where a 3-week intervention was performed. The rest of the studies lasted from a 10-week intervention in the case of Andersen *et al*,[37] to a 3-month intervention in Kaeding *et al*,[38] to a 6-month intervention in Shariat *et al*,[39] a 9-month intervention in del Pozo-Cruz *et al*[35] and a 1-year intervention in Andersen *et al*.[33]

There is great variety in the comparison groups that sort from strategies to increase physical activity levels and to improve health and work conditions in Andersen *et al*.[33] Access to standard care in del Pozo-Cruz *et al*.[35] Ergonomic modifications in Shariat et al.[39] A passive pause in Nakphet *et al*.[36] And no-treatment groups in Marangoni *et al*, Andersen *et al*, Kaeding *et al* and Shariat *et al*.[34 37–39]

Risk of bias

All studies, except for Andersen *et al*,[33] had a 'high risk' of bias in terms of 'measurement of the outcome' because the participants and/or the instructors were not blinded. In Andersen *et al*,[33] the participants were blinded through cluster randomisation and replied to internet-based questionnaires.

In Marangoni, Nakphet *et al* and Shariat *et al*,[34 36 39] we found 'some concerns' in the 'selection of the reported results' due to lack of a 'prespecified analysis plan'. Although all studies were randomised, in the study of Nakphet *et al*,[36] the type of randomisation was not specified and the 'randomisation process' was considered 'high risk'. Another section to highlight is evaluating 'missing the outcome data'. Despite finding five articles with low adherence to the intervention only in Andersen et al and Shariat *et al* the cause of the dropout was documented.[37 39] In Andersen *et al*,[33] there was no information on why the participants dropped out of the study, while Marangoni[34] did not specify the number of participants or the reason for dropout, showing a 'high risk' of bias in this aspect. A summary of the risk of bias is shown in figures 2 and 3.

Effectiveness of workplace exercise interventions in reducing musculoskeletal disorders and pain

In Andersen *et al*, Marangoni and Shariat *et al*,[33 34 39] reduction in musculoskeletal pain among office workers was assessed in multiple body parts. Nakphet *et al* and Andersen *et al*[36 37] focused on the neck and shoulder area, while del Pozo-Cruz *et al* and Kaeding *et al*[35 38] assessed workplace interventions in terms of disability caused by lower back pain.

Effectiveness of workplace exercise interventions in reducing musculoskeletal disorders in multiple body regions

As mentioned above, Andersen *et al*, Marangoni and Shariat *et al*[33 34 39] evaluated the effectiveness of workplace exercise interventions in reducing musculoskeletal pain in more than one specific region. In Andersen *et al*,[33] the Nordic Musculoskeletal Questionnaire was used to measure musculoskeletal symptoms, while the Visual Analogue Scale (VAS) was used to measure participants' pain perception. Pain intensity was significantly reduced in the neck, lower back, right elbow and right hand in the two interventions with exercise and physical activity compared with the reference group ($p<0.0001$–0.05) (main effects for region: F=3.04, $p<0.0005$; group: F=2.93, $p=0.05$; and status: F=905, $p<0.0001$). In the feet region, the group where participants were encouraged to perform physical activity on their own showed greater reduction in pain perception than the workplace exercise intervention ($p<0.001$) and the reference group ($p<0.05$).

Marangoni's[34] exercise interventions found a positive effect on reducing pain in both intervention groups, Computer Assisted Stretching Program (CASP) and Facsimile Lesson with Instructional Pictures (FLIP) compared with the control group. VAS (CASP subjects=–73%; FLIP subjects=–64%) and a pain spot assessment created by the author (CASP subjects=–70%; FLIP subjects=–62%) were used to measure pain reduction

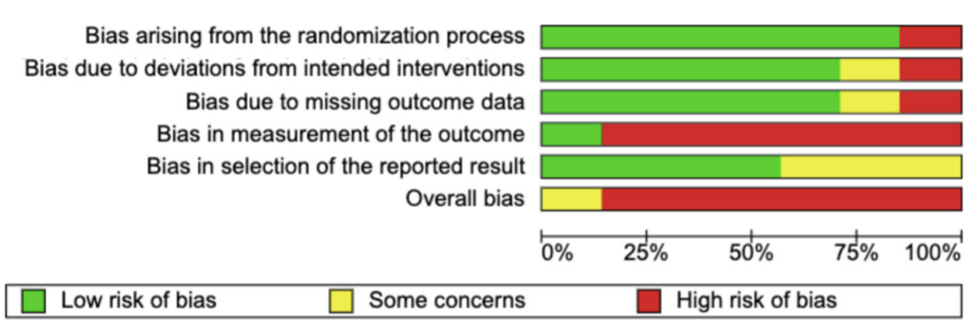

Figure 2 Risk of bias graph. Review authors' judgements of the risk of bias items are presented as percentages across the included randomised controlled trials.

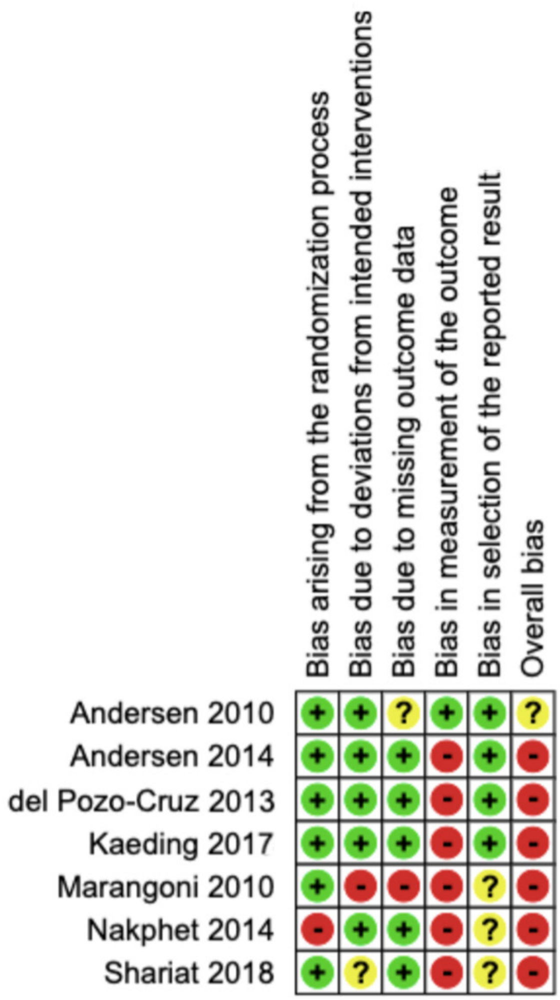

Figure 3 Risk of bias summary: review authors' judgements of each risk of bias item for each included study. Green: low risk; yellow: some concerns; and red: high risk.

among computer workers. There were no significant differences in pain reduction when using stretching exercises prompted by a software program (p<0.001) or a hard copy paper (p<0.001) when compared with the control group, which had a slight increase in pain of 1%.

The Shariat *et al* study[39] found significant differences in pain reduction after 6 months of intervention using the Cornell Musculoskeletal Disorders Questionnaire in the group with exercise sessions compared with the control group without intervention in the neck (Mean Deviation [MD] −10.55; 95%CI −14.36 to −6.74), right shoulder (MD −12.17; 95%CI −16.87 to −7.47), left shoulder (MD −11.1; 95%CI −15.1 to −7.09) and lower back (MD −7.8; 95%CI −11.08 to −4.53). Additionally, significant differences were found between the combined group with exercises and ergonomic modification compared with the control group in the four regions: neck (MD -9.99; 95%CI −13.63 to −6.36), right shoulder (MD −11.12; 95%CI −15.59 to −6.65), left shoulder (MD −10.67; 95%CI −14.49 to −6.85) and lower back (MD −6.87; 95%CI −10 to −3.74). Measures were taken every 2 months, and the most significant improvement in pain reduction was experienced from months 4 to 6 in the exercise group (p<0.05).

Effectiveness of workplace exercise interventions in reducing musculoskeletal disorders and pain in the neck and shoulder region

Nakphet *et al* and Andersen *et al*[36 37] carried out interventions where neck and shoulder pain was assessed. In Andersen *et al*'s study,[37] there was a significant reduction in pain in the neck and shoulder region (p<0.01) and an increase in the lower trapezius pressure pain threshold (129 kPa, 95% CI 31 to 227 kPa, p<0.01) in the active pause group compared with the control group, which did not perform any intervention in the neck/shoulder region. No significant differences in the pressure pain threshold in the other body regions were measured.

In Nakphet *et al*,[36] the Borg Scale for pain perception was used to assess pain, showing a reduction in neck discomfort in the three groups after each pause, without significant differences between the active pauses and the passive pauses intervention groups: neck: $F(6.16, 83.16)=1.41$, p=0.221; right shoulder: $F(4.97, 67.11)=1.30$, p=0.273; left shoulder: $F(6.56, 88.54)=1.15$, p=0.342; right elbow: $F(6.78, 91.76)=0.91$, p=0.500; left elbow: $F(5.29, 71.36)=0.73$, p=0.613; right wrist and hand: $F(5.45, 73.55)=1.14$, p=0.347; and left wrist and hand: $F(4.86, 65.59)=1.39$, p=0.242.

Effectiveness of workplace exercise interventions in reducing musculoskeletal disorders and pain due to disability caused by low back pain

The study of del Pozo-Cruz *et al* and Kaeding *et al* involved reducing disability and intensity of lower back pain.[35 38] In Kaeding *et al*,[38] using a whole-body vibration machine as the intervention, improvements in reducing lower back disability were reported compared with the control group with no intervention. There was a mean difference between the two groups of 1.8 points (95% CI 0.2 to 3.4, p=0.027) on the Roland-Morris Disability Questionnaire (RMQ), with an improvement in the training group of 1.5 (±2.6) RMQ points and with the control group worsening by an average of 0.3 (±2.6) RMQ points. Additionally, the Oswestry Disability Index and changes at the end of the intervention were significantly higher in the training group, with an improvement of 4.5 (±6.6) compared with a worsening of −1.2± (3.2) in the control group (p=0.002).

There was also a reduction in disability due to lower back pain in the del Pozo-Cruz *et al* study[35] among participants who performed a physical exercise intervention, as measured by the Oswestry Disability Index, with a clinical change of 5.420 (1.707 to 17.216; 85%, p=0.001) compared with the control group. Additionally, there was a reduction in the risk of chronicity (STarT Back Screening Tool clinical change 75%, p<0.001) and in the EuroQol - Five Dimensions Questionnaire - Three Level Version (EQ-5D-3L) pain-related and disability-related components (VAS 73%, p<0.001; mobility 77%, p<0.001;

self-care 79%, p=0.003; pain/discomfort 88%, p<0.001). However, the participants in the intervention group did not perceive an improvement in the performance of their daily tasks (p=0.103). Additionally, in the non-physical exercise group, an increase in disability and low back pain episodes was reported at the end of the intervention.

DISCUSSION

Based on the results of the seven RCTs, exercise has significant benefits in treating musculoskeletal disorders of the lower back, neck and general regions of the body. There was a wide variety of exercise routines performed in the different interventions, with supervised or unsupervised programmes, in the different outcome measures, and in the number of participants with musculoskeletal disorders who participated in each study. There has also been found a diversity among control groups with no interventions, other exercise interventions and ergonomic advice. There is also a lack of consistency in the outcomes, which did not allow us to draw firm conclusions with regard to the effectiveness of workplace exercise interventions in treating musculoskeletal disorders.

The risk of bias of the trials was considered high overall, except for Andersen *et al*,[33] which was the only study that blinded the instructor and the participants. The rest of the RCTs did not provide information regarding blinding of their participants or the exercise programme's instructors, which is the most important aspect of quality assessment that can affect the internal validity of the results, despite being very complicated to implement in exercise interventions.[40] With regard to external validity, it should be noted that the interventions were carried out at the workplace, except for the Nakphet *et al* study,[36] where the office setting was simulated in a laboratory to carry out a 1-day intervention to gather data on the surface myoelectric activity of the targeted muscles. This might be a limitation as it is essential to carry out interventions at employees' workspaces so that the results can be easily extrapolated to the population working in an office setting.[41] More significant efforts should be made when carrying out participant recruitment and designing the intervention procedure, considering essential aspects to reduce biases such as blinding and loss to follow-up.[42]

As previously mentioned, one remarkable point of the review is the significant difference in the interventions that workers carried out in the different studies. The duration of the studies with physical exercise in clinical and non-clinical populations commonly ranged between 1 and 3 months, making the performance of the intervention and the economic costs viable.[40]

The reviewed studies showed no difference in exercise physiological adaptations between longer sessions with low weekly frequency and shorter sessions with a high weekly frequency; however, further investigation is required to draw firm conclusions. Mainenti *et al*[12] showed that physical activity in a more extended session is not associated with decreased level of sedentarism. Therefore, using brief sessions with increased frequency each week could result in significant improvements among office workers without prolonged interruption in work activity.[43]

Evidence on workplace exercise interventions in the treatment of musculoskeletal disorders

As the inclusion criteria of the search, one of the key points was that the interventions should be done exclusively at the workplace. It is difficult to determine if the musculoskeletal disorders are work-related or whether there may be other leading causes. However, even in non-work-related musculoskeletal disorders, the implementation of workplace exercise interventions could help reduce symptoms that might worsen by prolonged sitting and working without rest breaks in their schedule.

Three studies that evaluated musculoskeletal pain in multiple body regions[33 34 39] concluded that workplace exercise interventions reduced pain compared with the control groups. Rodrigues *et al*'s systematic review,[44] which also included Marangoni's study,[34] found that with regard to the duration of the exercise programme, performing strength exercises in the workplace three times a week for 20 min could reduce musculoskeletal pain in the different regions of the spine and upper limbs. Another systematic review,[45] which focused on video display terminal workers with musculoskeletal pain, used a rehabilitation programme with exercises, pain education and ergonomic adjustments and found a significant reduction in pain in different body areas, such as the wrist, shoulder and lower back regions.

However, analysing the best treatment for specific interventions in the neck and shoulder region in Bertozzi *et al*'s systematic review[46 45]has been found a significant overall effect supporting exercise therapies alone on the reduction of pain in the short and intermediate term. The two studies analysed in this review that focused on the neck and shoulder region showed benefits in terms of decreasing pain intensity and associated disability. Nakphet *et al*'s study[36] concluded that taking a break during working hours, either with an exercise intervention or a passive pause, resulted in a reduction in pain perception. In Andersen *et al*,[37] with a 10-week intervention, scapular function training with exercise reduced pain intensity in the neck and shoulder region. A previous systematic review[20] reported a disparity in the results associated with differences between interventions aimed at treating neck disorders, concluding with strong evidence that interventions with strength and endurance programmes were more effective at reducing neck pain.

When focusing on the treatment of lower back pain among office workers, two studies concluded positive effects in reducing musculoskeletal pain; however, there was disparity between the workplace exercise interventions performed. The del Pozo-Cruz *et al* study[35] consisted of a 9 min daily routine of strength, stretching and mobility exercises in a 9-month intervention, while Kaeding *et al*[38] performed 2.5 sessions a week of whole-body vibration training with 10–15 min sessions during a 3-month intervention. These studies agree with the results of the study by Sipaviciene and Kliziene,[47] which showed positive effects of performing stabilisation exercises for the trunk and of performing muscle strength exercise programmes to reduce lower back pain. Additionally, the systematic review by Gordon and Bloxham[48] concluded that a general exercise programme with strength, flexibility and aerobic training would be beneficial in treating non-specific, chronic lower back pain in the adult population.

Adherence to the exercises prescribed using compliance terminology was reported in more than 80% of the total interventions performed in three of the seven studies analysed.[35 37 38] There is no standardised definition of adherence to therapeutic exercises for musculoskeletal pain due to lack of consistency in the literature, finding other terminologies such as compliance or concordance.[49]

A standard definition of therapeutic adherence reported in the studies was noted by Bissonnette[50]: 'Adherence can be defined as the extent to which patients follow the instructions they are given for prescribed treatments'. It is essential to consider the level of therapeutic adherence of participants with musculoskeletal pain when reporting the results of clinical trials.[49] Considering that adherence to exercise is ordinarily low,[51 52] strategies to enhance a higher rate of treatment adherence must be considered when designing intervention procedures. The del Pozo-Cruz *et al*[35] web-based intervention used a log-in system with high compliance reported. Implementation of web-based interventions using customised push reminders via email or phone and regularly updating the content, such as in Edney *et al*'s study,[53] is also effective. Additionally, no differences were found in the study of Gram and collaborators,[54] where both the intervention groups improved in terms of reduced neck pain and headache with or without instructor supervision. A web-based programme with push reminders is likely a feasible option for future interventions.

Ambrose and Golightly[55] conclude that any exercise regimen is better than a sedentary lifestyle as long as there is sustainable progression. Additionally, exercise induces analgesia in healthy people due to the pain inhibition mechanism as a result of endogenous opioids and nociception inhibitory mechanisms. However, in people with chronic pain, these reactions seem to not occur in the same way, and pain relief requires time after the initial increase in pain has been overcome.[56] In Bravo *et al*'s study,[57] where therapeutic exercises were performed among participants with fibromyalgia, a significant reduction in pain did not appear until 2 weeks after the intervention.

Hence, it is essential to consider specific items at the methodological level with a multidimensional approach[58 59] in order to carry out interventions achieving a low dropout rate. With high compliance with exercise preferences, self-management and pain neuroscience education for treatment of musculoskeletal disorders.[60 61]

Study limitations

The present study was limited by the small number of RCTs available that performed workplace exercise interventions to treat musculoskeletal disorders. Only studies published in English and Spanish were analysed. Relevant articles published in other languages could be missed.

The great diversity in the methodological aspects of the different interventions performed in the trials could be a limitation. We found significant heterogeneity in the samples, in the type of interventions and in the period in which the studies' pre/post interventions were carried out. Additionally, heterogeneity was found in the outcomes, which did not allow us to perform a meta-analysis due to the different outcome measures for musculoskeletal disorders and pain used in the studies.

Musculoskeletal conditions are a global concern.[62] More studies are needed to draw firm conclusions in developed and developing countries, where different factors can predict musculoskeletal disorders among office workers.[63] The studies included in the review were conducted in developed countries with high income[33–35 37 38] and in developing countries with middle-upper income.[36 39] Differences could be found when extrapolating results to low-income and middle-income countries, with the prevalence of musculoskeletal disorders rising exponentially.[62]

The review only focused on RCTs, excluding studies with interventions without a control group. There was a disparity in the control groups' interventions among the analysed studies.

The sample size of the participants was low in the majority of the studies[34–38] and some studies used non-validated scales,[33 34 36 37] which could be additional limitations of this review.

CONCLUSIONS

The results of this systematic review suggest that workplace exercise interventions can effectively reduce musculoskeletal disorders in different body regions, such as the neck and shoulder, lower back, and upper limbs, compared with other groups of ergonomic guidelines or control groups without interventions. However, heterogeneity in the intervention characteristics, in the number of participants and in the outcome measures and the low methodological quality of the included studies restricted our ability to draw firm conclusions.

Improvement in the quality of studies is required to strengthen the current evidence on workplace exercise interventions among office workers. There were significant differences between the workplace programmes, such as in the exercises performed, the duration of the session and the weekly frequency. A consensus is needed to find structured therapeutic exercise programmes by following a proper methodological assessment that can be convenient for office workers and other similar sedentary professions.

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