Workplace exercise program characteristics associated with musculoskeletal pain reduction in sedentary workers: a systematic review

Características de los programas de ejercicio en el lugar de trabajo asociadas a la reducción del dolor musculoesquelético en trabajadores sedentarios: una revisión sistemática

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Abstract

Introduction: Sedentary office work is associated with an increased risk of musculoskeletal disorders owing to prolonged sitting and insufficient physical activity. Although workplace-based exercise interventions have shown promising results, the programme characteristics associated with favourable outcomes remain unclear.
Objective: To synthesise the evidence on workplace-based exercise interventions for musculoskeletal pain in sedentary workers and identify programme characteristics consistently associated with favourable outcomes.
Methodology: A systematic review was conducted following the PRISMA 2020 guidelines. SCOPUS, Web of Science, PubMed, and EBSCO were searched through January 2024. Studies evaluating workplace-based exercise interventions in sedentary office workers were included. Methodological quality was assessed using the National Institutes of Health Quality Assessment Tools, and findings were synthesised narratively because of substantial heterogeneity.
Results: Thirty-eight publications describing 25 workplace-based exercise interventions conducted in 13 countries met the inclusion criteria. Overall, workplace exercise programmes were associated with reduced musculoskeletal pain, particularly among symptomatic workers. Resistance training showed the most consistent evidence of benefit. Recurring characteristics of successful programmes included progressive resistance exercise, interventions lasting 10–12 weeks, brief sessions performed several times per week, and high participant adherence. Most studies were of moderate to high methodological quality.
Conclusions: Workplace-based exercise programmes appear to be an effective strategy for reducing musculoskeletal pain among sedentary workers. Rather than identifying a single optimal exercise prescription, this review highlights recurring programme characteristics that may guide the design and implementation of evidence-informed workplace interventions.

Keywords

Musculoskeletal pain; occupational health; sedentary workers; systematic review; workplace exercise

Resumen

Introducción: El trabajo sedentario de oficina se asocia con un mayor riesgo de trastornos musculoesqueléticos por la sedestación prolongada y la escasa actividad física. Aunque las intervenciones de ejercicio en el lugar de trabajo han mostrado resultados favorables, las características asociadas siguen sin estar claras.
Objetivo: Sintetizar la evidencia sobre intervenciones de ejercicio en el lugar de trabajo para reducir el dolor musculoesquelético en trabajadores sedentarios e identificar las características vinculadas con resultados favorables.
Metodología: Se realizó una revisión sistemática conforme a PRISMA 2020. Se buscaron estudios en SCOPUS, Web of Science, PubMed y EBSCO hasta enero de 2024. Se incluyeron intervenciones de ejercicio en trabajadores sedentarios. La calidad metodológica se evaluó con las herramientas de los National Institutes of Health y, debido a la heterogeneidad, los resultados se sintetizaron narrativamente.
Resultados: Se incluyeron 38 publicaciones correspondientes a 25 intervenciones desarrolladas en 13 países. En conjunto, las intervenciones se asociaron con reducciones del dolor musculoesquelético, especialmente en trabajadores sintomáticos. El entrenamiento de fuerza mostró la evidencia más consistente. Entre las características recurrentes destacaron el ejercicio progresivo de fuerza, los programas de 10–12 semanas, las sesiones breves varias veces por semana y una elevada adherencia. La mayoría de los estudios presentó una calidad metodológica moderada o alta.
Conclusiones: Las intervenciones de ejercicio en el lugar de trabajo constituyen una estrategia prometedora para reducir el dolor musculoesquelético en trabajadores sedentarios. Esta revisión no identifica una prescripción óptima, sino características recurrentes que pueden orientar el diseño y la implementación de futuros programas.

Palabras clave

ejercicio físico; revisión sistemática; salud laboral; trabajadores de oficina; trastornos musculoesqueléticos.

Introduction

Sedentary behaviour has become a major public health concern owing to its well-established association with chronic diseases, functional decline, and premature mortality (World Health Organization, 2018; Katzmarzyk et al., 2022). Modern occupational environments, particularly office-based workplaces, are characterised by prolonged sitting, low levels of occupational physical activity, and extensive screen exposure (Tudor-Locke et al., 2011; Bennie et al., 2015; Cruz et al., 2021).

For the purposes of this review, sedentary workers were defined as employees whose occupational tasks are predominantly performed in seated postures and involve low levels of occupational physical activity, such as office-based, desk-based, computer-based, and administrative occupations. Occupations combining predominantly sedentary tasks with substantial physical demands were not considered the primary population of interest.

In Europe, a substantial proportion of employees spend more than five hours per day sitting during working hours, reflecting the increasing prevalence of sedentary occupational behaviours (European Commission, 2022).

Among the health consequences associated with sedentary work, musculoskeletal disorders (MSDs) represent one of the leading causes of pain, disability, sickness absence, and productivity loss worldwide (James et al., 2018). These disorders affect muscles, tendons, ligaments, joints, and peripheral nerves, frequently resulting in chronic pain, functional limitations, and impaired quality of life (Shariat et al., 2017). Office workers appear particularly vulnerable because prolonged static postures, repetitive computer-based tasks, and insufficient physical activity during working hours increase mechanical loading on the cervical, shoulder, and lumbar regions (Fortun-Rabadán et al., 2021). In addition, recent evidence suggests that prolonged desk-based work may contribute to postural alterations, particularly forward head posture, which has been associated with impaired postural alignment and may increase the risk of musculoskeletal complaints among office workers (Abd ElHay et al., 2025). Accordingly, neck, shoulder, and low back pain are consistently reported as the most prevalent musculoskeletal complaints among sedentary employees, imposing a considerable clinical, social, and economic burden (Csuhai et al., 2021; Bevan, 2015).

To mitigate these adverse effects, workplace-based exercise interventions have become an increasingly important component of occupational health promotion. International organisations, including the World Health Organization, recommend integrating physical activity into workplace settings to counteract sedentary behaviour and improve workers' health (World Health Organization, 2018). Previous studies have shown that workplace exercise may reduce musculoskeletal pain while also improving physical capacity, work ability, productivity, and psychosocial outcomes, even when delivered through relatively short exercise sessions (Chen et al., 2018; Tudor-Locke et al., 2014).

Despite the growing body of evidence supporting workplace exercise, important uncertainties remain regarding the characteristics of programmes that are most consistently associated with favourable outcomes. Existing interventions differ substantially in exercise modality, training intensity, weekly frequency, session duration, supervision, progression, adherence strategies, and overall programme structure. This considerable heterogeneity complicates comparisons across studies and limits the translation of research findings into practical recommendations for clinicians, employers, and occupational health professionals.

Furthermore, previous systematic reviews have primarily focused on the effectiveness of workplace-based exercise interventions for specific anatomical regions, particularly neck pain, or have evaluated workplace health and wellness programmes from a broader perspective (Moreira-Silva et al., 2016; Chen et al., 2018; Marin-Farrona et al., 2023). Although these reviews confirmed that workplace exercise may reduce musculoskeletal symptoms, they provided limited information regarding dose–response relationships, implementation factors, and the programme characteristics that may explain differences in intervention effectiveness. Consequently, they offer limited guidance on which intervention characteristics are consistently associated with favourable musculoskeletal outcomes across sedentary occupational populations. As a result, clinicians and organisations still lack evidence-informed guidance regarding how workplace exercise programmes should be designed and implemented to maximise their potential benefits.

Addressing this gap is particularly relevant because identifying the characteristics associated with successful interventions may provide greater practical value than simply establishing whether workplace exercise is effective. Understanding how factors such as exercise modality, intensity, weekly frequency, session duration, supervision, adherence, and programme organisation relate to musculoskeletal outcomes may facilitate the design of feasible, evidence-informed workplace exercise strategies that are compatible with organisational constraints while promoting long-term worker health.

Therefore, the aim of this systematic review was to synthesise the available evidence on workplace-based exercise interventions for musculoskeletal pain in sedentary workers and to identify programme characteristics consistently associated with favourable outcomes. Rather than determining the superiority of a particular exercise modality, this review seeks to provide an integrated synthesis of the intervention characteristics that may inform future programme design, implementation, and research in occupational health.

Method

Study Design

This systematic review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA 2020) statement (Page et al., 2021). The review aimed to synthesise the available evidence on workplace-based exercise interventions for musculoskeletal pain in sedentary workers and to identify intervention characteristics associated with favourable outcomes. The review protocol was not prospectively registered (e.g., PROSPERO), which should be recognised as a potential source of methodological bias because prospective registration enhances transparency and reduces the risk of selective reporting. Nevertheless, the review methodology, including the eligibility criteria, search strategy, study selection procedures, data extraction framework, methodological quality assessment, and evidence synthesis, was established *a priori* and applied consistently throughout the review process to maximise methodological transparency and reproducibility.

Search Strategy

A systematic literature search was conducted in SCOPUS, Web of Science, PubMed, and EBSCO from database inception through January 2024. The search strategy was developed to identify studies evaluating workplace-based exercise interventions for musculoskeletal pain in sedentary occupational populations. Search terms combined concepts related to the study population (sedentary office workers), health condition (musculoskeletal disorders and musculoskeletal pain), intervention (workplace-based exercise), and outcomes (pain reduction and related musculoskeletal outcomes). Controlled vocabulary (e.g., MeSH terms where applicable) and free-text keywords were combined using Boolean operators (AND/OR), truncation, and wildcards. Search strategies were adapted to the indexing system and search syntax of each database.

Searches were restricted to articles published in English or Spanish. Grey literature sources, including dissertations, conference proceedings, preprints, and unpublished studies, were not included because the review was designed to synthesise evidence from peer-reviewed scientific publications. No publication date restrictions were applied. In addition, the reference lists of all included studies were manually screened to identify potentially eligible publications not retrieved during the electronic database search.

A summary of the search framework is presented in Table 1, whereas the complete database-specific search strategies are provided in Supplementary Table S1.

Eligibility Criteria

Eligibility criteria were established before study selection and were defined according to the review objective.

Studies were included when they:

- evaluated workplace-based exercise interventions;
- included sedentary office workers aged 18 years or older;
- reported musculoskeletal pain outcomes before and after the intervention; and

- assessed outcomes using validated subjective or objective measures.

Studies were excluded if they:

- involved workers whose occupations required high levels of physical activity;
- focused on non-musculoskeletal conditions;
- evaluated interventions conducted outside the workplace; or
- did not include a physical exercise component.

No restrictions were placed on study design provided that the intervention effects on musculoskeletal pain could be evaluated.

Study Selection

All retrieved records were imported into Zotero (version 6.0.29) for duplicate removal and reference management.
Study selection was performed in two sequential stages. First, two reviewers independently screened titles and abstracts according to the predefined eligibility criteria. Potentially relevant studies subsequently underwent full-text assessment to determine final eligibility.
Any disagreements between reviewers were resolved through discussion until consensus was reached. To maximise the completeness of the review, the reference lists of all included articles were also manually examined for additional eligible studies.
The study selection process was documented according to the PRISMA 2020 recommendations.

Data Extraction

Data extraction was independently performed by two reviewers using a predefined extraction framework to ensure consistency across studies.
The following information was extracted from each study:

- study characteristics (authors, year of publication, and country);
- participant characteristics (sample size, sex, and age);
- intervention characteristics (exercise modality, intensity, frequency, session duration, programme duration, and supervision);
- outcome measures;
- principal findings; and
- study limitations.

Any discrepancies identified during data extraction were resolved through discussion until agreement was achieved.

Outcome Measures

The primary outcome of interest was musculoskeletal pain intensity, regardless of the anatomical region assessed.
Pre- and post-intervention pain outcomes were extracted from all included studies. When studies reported multiple pain-related outcomes or several follow-up assessments, all relevant results were considered during the narrative synthesis. Greater emphasis was placed on the outcome measures most consistently reported across studies to facilitate comparisons between interventions.

Methodological Quality and Risk of Bias Assessment

Methodological quality and risk of bias were assessed using the National Institutes of Health (NIH) Quality Assessment Tools.
These instruments were selected because the included evidence comprised multiple study designs, including randomised controlled trials, cluster-randomised trials, crossover studies, quasi-experimental studies, longitudinal interventions, and process evaluations. Consequently, the NIH tools were considered the most appropriate framework for evaluating methodological quality across heterogeneous intervention designs using consistent assessment criteria.
The assessment considered methodological domains relevant to internal validity, including clarity of the research question, appropriateness of the study design, participant selection, sample size justification,

intervention description, validity and reliability of outcome measures, pre–post assessment procedures, presence of control groups, management of potential confounding factors, and consistency between results and conclusions.
Two reviewers independently assessed the methodological quality of all included studies. Inter-rater agreement was not formally measured using a statistical coefficient (e.g., Cohen's kappa). Instead, any disagreements were resolved through discussion until consensus was reached following the predefined review procedures.
Based on the overall evaluation of these methodological domains, studies were classified as presenting moderate or high methodological quality. The results of the quality assessment were incorporated into the interpretation of the findings and considered during evidence synthesis.

A detailed summary of the methodological quality assessment is provided in Supplementary Table S2.

Data Synthesis

Considerable heterogeneity was observed across studies with respect to participant characteristics, exercise programme characteristics, exercise prescription parameters, outcome measures, and reporting methods. Consequently, statistical pooling of results was considered inappropriate, and a meta-analysis was not performed.

Instead, the findings were synthesised using a structured narrative synthesis. Evidence was organised according to programme characteristics, including exercise modality, training intensity, weekly frequency, session duration, exercise volume, supervision, adherence, and reported pain-related outcomes.

Particular attention was given to identifying intervention characteristics that were consistently associated with favourable findings while considering the methodological quality and heterogeneity of the available evidence. Accordingly, the synthesis was intended to identify recurring patterns across studies rather than to establish causal relationships or definitive exercise prescription recommendations.

Results

Study Selection

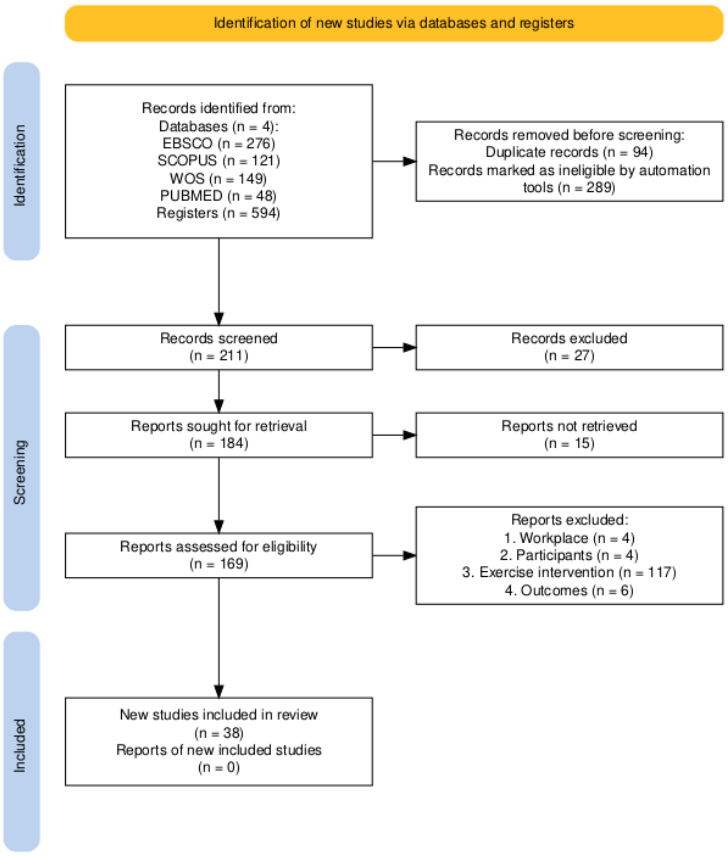
The systematic search identified 594 records across the four electronic databases. After removing duplicates and applying the initial screening procedures, 211 records remained for title and abstract assessment. Full-text evaluation resulted in 38 eligible publications that fulfilled the predefined inclusion criteria.

Among these publications, 19 reported results from interventions already described in other articles, representing follow-up analyses, secondary publications, or multiple reports derived from the same participant cohorts or trial registrations. To avoid overrepresentation of evidence, these publications were grouped according to their corresponding intervention. Consequently, the final narrative synthesis included 25 distinct workplace-based exercise interventions conducted between 2003 and 2023 across 13 countries.

Denmark contributed the largest number of interventions (n = 8), followed by Norway, Portugal, Malaysia, Spain, and Brazil (n = 2 each), while the remaining countries contributed one intervention each.

The complete study selection process is presented in the PRISMA 2020 flow diagram (Figure 1). A detailed description of the exercise programme characteristics, exercise prescription parameters, outcome measures, and principal findings of all included studies is provided in Supplementary Table S3, in which publications derived from the same intervention are identified parenthetically.

Figure 1. PRISMA flow diagram of the study selection process, adapted from Page et al. (2021).



Note. Nineteen publications reported data derived from identical interventions involving the same participant cohorts or trial registrations. Therefore, the final synthesis included 38 publications corresponding to 25 distinct interventions.

Methodological Quality and Risk of Bias

According to the National Institutes of Health (NIH) Quality Assessment Tools, the overall methodological quality of the included studies was moderate to high. Of the 38 included publications, 23 were classified as high methodological quality and 15 as moderate methodological quality. No study was classified as low quality.

Studies rated as high quality were predominantly randomised controlled trials, cluster-randomised trials, and controlled crossover designs. These studies generally incorporated appropriate comparison groups, clearly described intervention protocols, validated outcome measures, pre–post assessments, and methodological procedures aimed at minimising potential sources of bias. Consequently, they were considered to provide the most robust evidence for the present synthesis.

Studies classified as moderate quality fulfilled the essential methodological criteria but presented limitations that reduced the strength of causal inference. The most frequently identified limitations included the absence of control groups, non-randomised or pilot study designs, insufficient sample size justification, partial comparator groups, and incomplete reporting of procedures used to control potential confounding factors. Despite these limitations, these studies contributed valuable evidence regarding the feasibility and implementation of workplace exercise interventions under real-world occupational conditions.

Across the included evidence, methodological heterogeneity was observed in sample size, intervention characteristics, programme duration, exercise prescription parameters, and delivery conditions. In addition, most studies relied primarily on self-reported pain measures, participant blinding was rarely feasible because of the nature of the interventions, and several studies reported incomplete adherence data. These factors were considered when interpreting the overall strength and consistency of the evidence.

Risk of bias was interpreted within the overall methodological quality assessment. Studies classified as high quality were considered to present a lower risk of bias owing to the use of randomisation procedures, control conditions, and standardised outcome assessment methods. Conversely, studies rated as moderate quality were considered to present a moderate risk of bias, primarily related to selection, performance, detection, and confounding domains.

A detailed summary of the methodological quality and risk-of-bias assessment is provided in Supplementary Table S2.

Study Characteristics

The final synthesis comprised 25 distinct workplace-based exercise interventions designed to prevent or reduce musculoskeletal pain among sedentary workers. Overall, the evidence was dominated by experimental designs, reflecting the growing emphasis on evaluating the effectiveness of workplace exercise programmes under controlled conditions.

Of the included interventions, 19 were randomised controlled trials, three employed longitudinal or prospective designs, two were quasi-experimental studies, and one used a crossover design. This diversity of study designs contributed to the methodological heterogeneity observed across the available evidence.

Sixteen interventions evaluated a single exercise programme, whereas nine compared two or more intervention arms. Control conditions also varied considerably. Most studies used passive control groups receiving usual practice or no intervention, while others incorporated active comparison groups involving health education, stress management, ergonomic advice, or combined workplace health strategies. These methodological differences were considered during the narrative synthesis and interpretation of intervention effects.

Participants

The 25 workplace-based exercise interventions **i**ncluded a total of 3,771 participants**,** with a mean age of 41.5 years (range: 28–49 years). Participants were predominantly sedentary workers employed **in** office-based occupations, including administrative personnel, educational staff, and healthcare employees.

Among the studies reporting participant sex, women represented the majority of the sample (2,350 women vs. 1,186 men). Five interventions exclusively enrolled women, whereas four studies did not report sex distribution.

The included interventions evaluated both preventive and therapeutic populations. Twelve interventions recruited sedentary workers regardless of musculoskeletal pain status, whereas thirteen specifically included participants presenting musculoskeletal symptoms. Neck and shoulder pain was the most frequently investigated condition, followed by low back pain and multisite musculoskeletal pain.

Across studies, participant eligibility was primarily established using validated self-reported questionnaires, predefined pain intensity and duration criteria, or clinical diagnoses (e.g., chronic trapezius myalgia). Overall, the included populations represent a broad spectrum of sedentary workers commonly targeted by workplace health promotion programmes, thereby enhancing the applicability of the review findings across office-based occupational settings.

Exercise Modalities

Across the 36 intervention groups identified within the 25 workplace-based exercise interventions, strength training was the predominant exercise modality (n = 20 groups), followed by flexibility training (n = 8), aerobic exercise (n = 4), and multicomponent programmes (n = 4), according to the World Health Organization physical activity categories.

Most interventions evaluated a single exercise modality, predominantly strength training, whereas only four interventions combined multiple exercise components. In addition, four studies directly compared strength training with aerobic exercise, providing the main evidence for modality-specific comparisons.

Strength-training programmes were generally characterised by progressive resistance exercise**,** predominantly prescribed at high intensities (≥70% 1RM) using repetition maximum principles. Most protocols targeted the neck, shoulders, and upper limbs through exercises performed with dumbbells, elastic bands, or resistance tubing. Only one intervention implemented resistance exercises without progressive overload, and eccentric contractions were evaluated in a single study.

In contrast, aerobic interventions displayed considerable heterogeneity regarding exercise modality and intensity, including walking, Nordic walking, cycling, and recreational sports performed under different intensity prescriptions. Likewise, flexibility programmes primarily consisted of stretching and mobility exercises targeting the cervical, shoulder, trunk, and lumbar regions, although considerable variability existed in exercise content and programme organisation. Multicomponent interventions combined strength, flexibility, postural control, relaxation, and core stabilisation exercises within integrated workplace exercise programmes.

Overall, the available evidence indicates that strength training was by far the most frequently investigated workplace exercise modality, whereas aerobic, flexibility, and multicomponent interventions were less common and demonstrated substantially greater variability in programme design.

Training Parameters

Despite considerable variability in programme design, several exercise prescription characteristics were consistently observed across the included interventions.

Programme duration ranged from 2 to 52 weeks, although programmes lasting 10–12 weeks were the most frequently implemented. Weekly exercise volume varied between 10 and 150 minutes, with approximately 60 minutes per week representing the most common training workload.

Exercise frequency ranged from one to ten sessions per week. However, three weekly sessions emerged as the predominant prescription across interventions. Session duration varied from 2 to 60 minutes, although sessions lasting 15–20 minutes were implemented most frequently. Consequently, the most common exercise configuration consisted of three supervised sessions of approximately 20 minutes per week, particularly among strength-training programmes.

Most interventions were delivered under direct supervis**ion** by exercise professionals or healthcare practitioners. In contrast, a smaller number of programmes were entirely self-administered or incorporated only initial supervision before participants continued independently. Several studies also compared supervised and unsupervised exercise using identical training protocols, allowing the influence of supervision on programme implementation to be explored.

Overall, although exercise prescription varied substantially across studies, the available evidence revealed a recurring pattern across the included interventions, characterised by moderate-duration interventions (10–12 weeks), distributed weekly training (three sessions), relatively short exercise sessions (15–20 minutes), and a weekly exercise volume of approximately 60 minutes, most commonly delivered under supervised conditions.

Outcome Measures

Musculoskeletal pain was the primary outcome assessed across all included interventions. Pain was predominantly evaluated using validated self-reported instruments, most commonly the Nordic Musculoskeletal Questionnaire, Visual Analogue Scales (VAS), and the Cornell Musculoskeletal Discomfort Questionnaire. Objective assessments were less frequent and primarily consisted of examiner-administered pressure pain threshold measurements.

Beyond pain, several studies evaluated secondary outcomes related to physical function, disability, quality of life, work productivity, psychosocial health, physical performance, exercise self-efficacy, adherence, and programme implementation. Frequently used instruments included the SF-36, EQ-5D-5L, DASH, and the Neck Disability Index (NDI), whereas selected studies incorporated objective measures such as maximal strength, flexibility, range of motion, electromyography, biomarkers, and postural assessments.

Overall, the included studies adopted a multidimensional assessment approach, combining pain-related outcomes with functional, behavioural, and occupational measures to evaluate the broader effects of workplace-based exercise interventions.

Effects of Workplace Exercise Interventions

Overall, most workplace-based exercise interventions reported reductions in musculoskeletal pain among sedentary workers. Although the magnitude of improvement varied across studies owing to differences in participant characteristics, exercise programme characteristics, outcome measures, and follow-up duration, favourable pain-related outcomes were reported across most interventions.

Exercise modality

Among the exercise modalities investigated, strength-training interventions most frequently reported clinically meaningful reductions in musculoskeletal pain. Progressive resistance programmes targeting the neck, shoulders, and upper limbs reported reductions in musculoskeletal pain across multiple occupational populations and intervention settings. Flexibility and mobility programmes also reported positive effects, although improvements were generally smaller and more variable across studies. Likewise, multicomponent interventions combining strength, flexibility, postural control, and stabilisation exercises produced favourable outcomes, particularly in workers with low back pain.

Studies directly comparing exercise modalities generally reported greater improvements following strength-training interventions than aerobic exercise programmes.

Training parameters

No consistent dose–response relationship was identified for exercise frequency or weekly training volume. Interventions prescribing different weekly exercise distributions often reported comparable improvements in pain outcomes despite differences in weekly exercise frequency and volume.

In contrast, interventions incorporating progressive overload and higher cumulative training loads more frequently reported favourable clinical outcomes. This pattern was particularly evident in strength-training programmes in which exercise loads progressively increased throughout the intervention period.

Adherence

Adherence was frequently reported in relation to intervention effectiveness. Several studies reported that participants achieving higher attendance rates experienced greater reductions in musculoskeletal pain, whereas improvements were attenuated among workers with lower programme adherence. In particular, several studies reported that attendance levels of approximately 70% or higher were associated with clinically meaningful improvements.

Adherence varied considerably across interventions. Longer programmes generally reported lower attendance rates than shorter interventions, whereas programmes consisting of brief exercise sessions distributed throughout the working week achieved comparatively higher levels of participation. Psychosocial work environment and exercise self-efficacy were also identified as factors influencing adherence behaviour.

Supervision

Studies reported mixed findings regarding the influence of supervision on clinical outcomes. Although supervised exercise did not always result in greater pain reduction than unsupervised programmes, several studies reported that supervision improved programme adherence, participant engagement, and retention**.** Furthermore, several studies reported comparable outcomes between remote or video-assisted supervision and traditional face-to-face supervision for relatively simple exercise protocols.

Exercise versus ergonomic interventions

Studies directly comparing workplace-based exercise interventions with ergonomic interventions generally reported greater reductions in musculoskeletal pain following exercise-based programmes than following ergonomic interventions alone. Among these studies, interventions centred on structured exercise frequently included progressive resistance training as the principal exercise component.

Discussion

Principal Findings

This systematic review synthesised the available evidence on workplace-based exercise interventions for musculoskeletal pain in sedentary workers and explored the programme characteristics most consistently associated with favourable outcomes. Overall, workplace-based exercise interventions were generally associated with reductions in musculoskeletal pain, particularly among symptomatic workers. Despite considerable heterogeneity across interventions, several characteristics repeatedly emerged among studies reporting favourable outcomes, including progressive resistance training, moderate-duration programmes, exercise sessions distributed throughout the working week, and high participant adherence.

These findings extend previous evidence by indicating that favourable outcomes were reported across different exercise modalities and that several programme characteristics related to exercise prescription and implementation were repeatedly observed among interventions reporting favourable outcomes. Rather than identifying an optimal exercise prescription, this review highlights recurring characteristics that may assist clinicians, occupational health professionals, and researchers in designing evidence-informed workplace exercise programmes for sedentary workers.

Exercise modality

Consistent with previous systematic reviews (Chen et al., 2018; Marin-Farrona et al., 2023), strength-training interventions were the most frequently investigated modality and demonstrated the most consistent reductions in musculoskeletal pain. These findings may be explained by improvements in muscular strength, tissue load tolerance, postural stability, and neuromuscular control (Louw et al., 2017). However, they should not be interpreted as evidence that resistance exercise is inherently superior, as substantial heterogeneity in participant characteristics, exercise programme characteristics, outcome measures, and follow-up periods precludes definitive comparisons.

Flexibility-based interventions also demonstrated favourable effects, supporting previous evidence (Van Eerd et al., 2016; Marin-Farrona et al., 2023). These benefits may reflect improvements in joint mobility, muscular stiffness, and movement quality (Machado-Matos & Arezes, 2016; Andersen et al., 2010). Notably, none of the included studies combined progressive resistance training with structured stretching programmes, highlighting an important gap for future research.

Training parameters

No consistent dose–response relationship was identified between individual training parameters and pain reduction. Among the interventions reporting favourable outcomes, programme durations of approximately 10–12 weeks, weekly exercise volumes close to 60 minutes, and three weekly sessions lasting 15–20 minutes were frequently observed. These programme characteristics should be interpreted as recurring patterns within the available evidence rather than as optimal or prescriptive exercise parameters.

Similarly, progressive overload and moderate-to-high exercise intensities were common among interventions reporting clinically meaningful improvements. Although these observations may help inform the design of future workplace exercise programmes, they should not be interpreted as evidence supporting a single optimal exercise prescription.

Implementation characteristics: adherence, supervision, and programme delivery

Implementation-related factors also appeared to influence the effectiveness of workplace exercise programmes. Participant adherence emerged as one of the characteristics most consistently associated with favourable outcomes, with higher attendance generally accompanying greater reductions in musculoskeletal pain.

Adherence is likely influenced by organisational and individual factors, including time constraints, psychosocial work environment, and exercise self-efficacy (Andersen et al., 2011; Pedersen et al., 2013). The predominance of short sessions distributed across the working week may therefore represent not only an effective exercise strategy but also a practical approach that facilitates participation.

The influence of supervision was less consistent. Although supervised programmes did not invariably produce greater pain reductions, they often improved adherence and reduced dropout (Dalager et al., 2015). Furthermore, remote supervision and video-based instruction achieved comparable outcomes for relatively simple exercise programmes (Jay et al., 2014), suggesting that flexible delivery models may enhance implementation without compromising effectiveness.

Exercise-based interventions generally produced more favourable outcomes than ergonomic interventions alone. However, the limited number of comparative studies prevents firm conclusions regarding potential synergistic effects, highlighting the need for future research integrating structured exercise, ergonomic optimisation, and behavioural strategies.

Finally, relatively few studies evaluated implementation outcomes such as intervention fidelity, organisational support, participant engagement, acceptability, or barriers to participation (Strijk et al., 2011; Driessen et al., 2010; Wierenga et al., 2013). Greater attention to these factors would improve understanding of scalability and facilitate translation into routine occupational practice.

Comparison with Previous Reviews and Contribution of the Present Review

Previous systematic reviews have primarily focused on specific anatomical regions or on the overall effectiveness of workplace health interventions (Moreira-Silva et al., 2016; Chen et al., 2018; Marin-Farrona et al., 2023). In contrast, the present review synthesised evidence from 38 publications describing 25 distinct workplace-based exercise interventions across 13 countries while examining programme characteristics associated with favourable outcomes.

Unlike previous reviews, this synthesis considered exercise modality together with training intensity, duration, frequency, weekly volume, supervision, adherence, and implementation-related factors. Integrating exercise prescription with implementation characteristics provides a broader understanding of why some workplace exercise programmes appear more successful than others.

Importantly, these findings should not be interpreted as identifying a single optimal exercise programme. Instead, they highlight recurring patterns across a heterogeneous evidence base. Collectively, these patterns suggest that interventions incorporating progressive resistance training, moderate-duration programmes, distributed weekly exercise sessions, and high participant adherence are more frequently associated with favourable pain-related outcomes. Although descriptive rather than prescriptive, these observations provide a practical framework to inform future programme design and workplace health research.

Strengths and Limitations

The findings of this review should be interpreted considering several limitations. First, substantial clinical and methodological heterogeneity across interventions—including exercise modality, programme duration, training intensity, participant characteristics, outcome measures, and follow-up—precluded quantitative synthesis and limited the identification of optimal exercise prescription parameters.

Second, most studies relied on self-reported pain measures, participant blinding was rarely feasible, and several investigations included relatively small samples, incomplete adherence reporting, and limited long-term follow-up. Consequently, the certainty of the available evidence is likely to range from low to moderate, and the findings should be interpreted as recurring patterns rather than definitive exercise recommendations. A further limitation is the absence of prospective protocol registration, which may have increased the potential risk of selective reporting. However, the eligibility criteria, search strategy, study selection, data extraction, methodological quality assessment, and evidence synthesis were predefined a priori and applied consistently throughout the review process to minimise this risk and enhance methodological transparency. Publication bias also cannot be excluded.

Despite these limitations, the review has several strengths. It followed the PRISMA 2020 recommendations, included a comprehensive search across four major databases, and systematically assessed methodological quality using the National Institutes of Health (NIH) Quality Assessment Tools. Furthermore, by integrating exercise prescription characteristics with implementation-related factors

such as adherence, supervision, and programme delivery, the review provides a broader perspective on factors associated with successful workplace exercise programmes.

Clinical Implications

The findings of the present review suggest that workplace-based exercise interventions represent a feasible and potentially effective strategy for reducing musculoskeletal pain among sedentary workers when implemented within routine occupational settings.

The review highlights that successful workplace exercise programmes depend not only on exercise prescription, but also on effective implementation. Factors such as supervision, organisational support, behavioural strategies, and flexible delivery models may facilitate participation and long-term adherence, thereby enhancing the feasibility and sustainability of workplace interventions. Likewise, integrated workplace strategies combining structured exercise, ergonomic optimisation, and behavioural support may represent a practical approach for addressing the multifactorial nature of work-related musculoskeletal disorders.

From a practical perspective, many of the interventions included in this review required only minimal equipment, relatively short exercise sessions, and modest organisational resources. Consequently, these programmes appear compatible with the operational constraints of most office-based workplaces and may be implemented without substantial disruption to routine work activities.

Overall, the present findings provide an evidence-informed framework to support clinicians, physiotherapists, exercise professionals, occupational health practitioners, employers, and policy makers in designing and implementing workplace exercise programmes that are both scientifically grounded and feasible within real-world occupational settings.

Conclusions

Workplace-based exercise interventions are generally associated with reductions in musculoskeletal pain among sedentary workers, particularly in symptomatic populations. Although resistance training showed the most consistent evidence of benefit, the heterogeneity of the available evidence prevents definitive conclusions regarding the superiority of any specific exercise modality.

Rather than identifying a single optimal programme, this review highlights recurring characteristics associated with favourable outcomes, including progressive resistance exercise, programmes lasting approximately 10–12 weeks, short distributed exercise sessions, and high participant adherence. It also emphasises the importance of implementation-related factors, such as supervision and organisational support, in facilitating successful workplace interventions.

Future research should prioritise adequately powered randomised controlled trials with longer follow-up, standardised outcome measures, and greater emphasis on implementation processes, long-term adherence, digital delivery models, and integrated workplace strategies combining exercise, ergonomics, and behavioural approaches.

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Conflict of interest

The authors declare that they have no conflicts of interest related to this work.

Ethics Statement

Ethical approval was not required because this study was based exclusively on the analysis of previously published literature and did not involve human participants, personal data, or identifiable information.

Data Availability

The data supporting the findings of this review are contained within the article and its Supplementary Materials. Additional information regarding the search strategy or study selection process is available from the corresponding author upon reasonable request.

Supplementary materials

Supplementary Table S1. Database-specific search strategies.

Supplementary Table S2. Methodological quality and risk-of-bias assessment using the NIH Quality Assessment Tools.

Supplementary Table S3. Detailed characteristics, intervention protocols, training parameters, outcome measures, and principal findings of the included studies.

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