REVIEW ARTICLE

Rehabilitation of Musculoskeletal Disorders: A Systematic Review of Effective Interventions in Physically Demanding Workplaces

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Abstract

Background: Musculoskeletal disorders have become the most common health issue in physically demanding workplaces, causing severe pain and functional impairments that significantly reduce the affected employees' quality of life. As a result, this systematic review aims to evaluate the workplace interventions implemented for rehabilitating musculoskeletal disorders in this population.

Methods: A systematic literature search was conducted in various databases, including PubMed, Cochrane Library, Scopus, Web of Science, and CINAHL, following the PRISMA guidelines. Only randomized controlled trials involving employees in physically demanding jobs, where workplace rehabilitation interventions were measured, were considered. A standardized form was used to extract data, including study design, sample size, intervention details, and outcomes.

Results: The review included five randomized controlled trials demonstrating various rehabilitation strategies, including ergonomic training, physical therapy, and emerging approaches such as AI-based health programs. Due to these interventions, the study observed significant reductions in pain levels and improvements in functional outcomes among employees with musculoskeletal disorders.

Conclusion: Workplace interventions targeting musculoskeletal disorders in physically demanding jobs have effectively reduced pain and improved functional capacity. Customized approaches that integrate ergonomic strategies with innovative technologies can significantly enhance rehabilitation outcomes.

Keywords

Ergonomics, Musculoskeletal Disorders, Occupational Health, Rehabilitation.

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Introduction

Musculoskeletal disorders (MSDs) are a significant health concern in the workplace, particularly for workers engaged in physical activities[1]. MSDs encompass musculoskeletal conditions, including muscles, bones, tendons, ligaments, and nerves[1,2]. These disorders are often associated with repetitive movements, heavy lifting, awkward postures, or prolonged physical exertion[3]. MSDs can cause pain, discomfort, and loss of function, and they are the leading cause of work absences and reduced productivity[4]. Jobs that involve high physical demands, such as construction work, nursing, factory labor, farming, and other manual labor, pose a higher risk of MSDs due to the repetitive and strenuous nature of the tasks[5]. Workers in these occupations are frequently exposed to heavy lifting, forceful exertions, and awkward body postures, which can strain muscles and joints[6]. Additionally, long work hours with limited recovery time can contribute to the development of chronic MSDs[7]. Effective rehabilitation interventions are urgently needed to relieve symptoms, restore functionality, and improve the quality of life for affected workers[8].

The World Health Organization (WHO) describes MSDs as a significant cause of disability worldwide, affecting millions of workers every year[9]. In industries with high prevalence, MSDs impose a significant burden with personal and economic consequences. From an individual perspective, this could lead to chronic pain, restricted mobility, and impaired functionality, affecting overall quality of life[10]. Economically, it results in loss of productivity, increased healthcare costs, and long-term absenteeism, creating a substantial financial burden for employers and healthcare systems[11].

Rehabilitation of musculoskeletal disorders is crucial for reducing the impact of these conditions on workers. Rehabilitation involves various interventions to restore function, reduce pain, and improve physical health after an injury or the onset of a musculoskeletal condition[12]. This is particularly important in physically demanding workplaces with a high risk of re-injury due to the overall physical requirements of the work[13]. Rehabilitation is typically a multidisciplinary process involving physical therapy, ergonomic modifications, education, and sometimes behavioral or psychological intervention[14]. For example, physical therapy includes exercises to strengthen muscles, improve flexibility, and enhance joint stability. Ergonomic modifications focus on changing the workplace to prevent strain on the body. Education is essential for managing MSDs as it helps workers make informed decisions about their health and avoid behaviors that worsen their condition[15]. Additionally, cognitive behavioral therapy and other psychosocial interventions are sometimes included in rehabilitation programs to help individuals cope with the emotional and psychological challenges of chronic pain and disability[16].

MSDs have been targeted by various workplace interventions to help rehabilitate employees over the years. These interventions fall into two major categories: individual and workplace. Workplace-level interventions aim to change the physical and organizational environment to prevent and reduce MSDs[17]. These interventions usually involve redesigning workstations, tools, and equipment to better adhere to ergonomic principles. Adjustable workstations, anti-fatigue mats, or lifting aids can reduce physical stress on workers and lower the risk of MSDs. Workplaces with physically demanding jobs may need modifications to minimize the effects of repetitive motions, heavy lifting, and prolonged awkward postures[18-20].

Many workplaces implement comprehensive ergonomic programs that go beyond simple physical modifications[21]. These programs include employee training and management support, aiming to foster a culture of safety and health that enhances productivity and actively identifies and addresses workplace hazards. For example, an ergonomic intervention may involve regular assessments of how employees stand, move, and work to make appropriate changes and prevent injuries. Research indicates that these interventions effectively reduce the frequency and severity of workplace incidents while also boosting employee satisfaction and productivity[22-23].

There is a growing interest in studying the effectiveness of rehabilitation interventions for MSDs in heavy labor. Recent studies on this topic have mainly involved small sample sizes and various methodologies. This indicates the need for a systematic review that can synthesize the existing literature to analyze which interventions are most effective overall. A systematic review can provide a body of evidence for identifying best practices in rehabilitating MSDs in highly physically demanding jobs. By assessing the quality of studies, comparing outcomes for different treatments, and identifying the most successful interventions in specific work settings, this review will offer evidence-based guidance for practitioners, employers, and policymakers.

Methodology

Protocol and Registration

This systematic review followed the guidelines of the PRISMA statement, a Preferred Reporting Item for Systematic Reviews and Meta-Analyses[24]. A protocol was set prior to embarking on the review and published in a relevant database to ensure transparency and replicability of the methods applied for conducting the review.

Research Question

The primary research question that formed the basis of this systematic review was:

- **What are effective workplace interventions for rehabilitating musculoskeletal disorders among employees in physically demanding workplaces?**

Eligibility Criteria

The eligibility criteria that formed the basis of this systematic review aimed to ensure the inclusion of those studies that would provide relevant insights on effective workplace interventions for rehabilitating MSDs among employees in physically demanding jobs.

Studies included controlled randomized trials involving workers whose occupation demands labor, including companies, nursing, and factory work. Interventions concerned the rehabilitation strategies at the workplace, addressing MSDs, ergonomic training, SELMA, Omaha System-based distant intervention, physical therapy and exercise programs, among other proper approaches. Primary outcomes of interest included decreased pain, stress, and posture. Finally, only English papers from 2020-202 were considered for inclusion to ensure a bright focus on the available literature, which is also very current.

Sources of Information

Standardized form data extraction was performed to keep the selection of pertinent information from the selected studies consistent and reliable. Two independent reviewers conducted the extraction, and for this process, they collected the data on aspects such as authorship, publication year, study design, number of participants, characteristics of the participants, particulars about the intervention (type, duration, and frequency), details on the outcomes measured, and summary findings. This helped take a systematic approach toward gathering all the data to enable comprehensive analysis and synthesis of the evidence. Discussions of the data to be extracted or further analysis involving consulting a third reviewer would ensure any discrepancies between reviewers cleared out to give more reliable extracted data.

Study Selection

Two independent reviewers screened the titles and abstracts of identified articles against the inclusion criteria to determine their suitability. Full-text articles of potentially relevant studies were retrieved and assessed against the eligibility criteria. Reviewer disagreements were resolved by discussing or seeking a third reviewer's opinion.

Data Extraction

Standardized forms were used to extract information to standardize the accuracy and consistency with which relevant information from included studies was captured.

Two reviewers did the extraction independently by synthesizing data like authorship, year of publication, study design, sample size, participants' characteristics, details regarding the intervention nature, type, duration, frequency, measurements adopted for the outcomes, and critical findings. This helped in systematic data collection, which allowed data to be comparatively analyzed and synthesized for better understanding. Differences in opinions between reviewers were resolved either by discussion or referring to a third reviewer, which enhanced the reliability of the extracted data. In cases of disagreement, data extraction was done independently by two reviewers, and a consensus was reached.

Results

In the preliminary search through six database searches, n=5145 articles were retrieved. Nine hundred and thirty original articles were assessed based on their titles and contents. The suitable full-text articles were ranked and chosen after the abstract screening, n=333, and lastly, n=5 studies met the criteria for inclusion and thus were included in the study. A flow chart of the study inclusion is depicted in Figure 1.

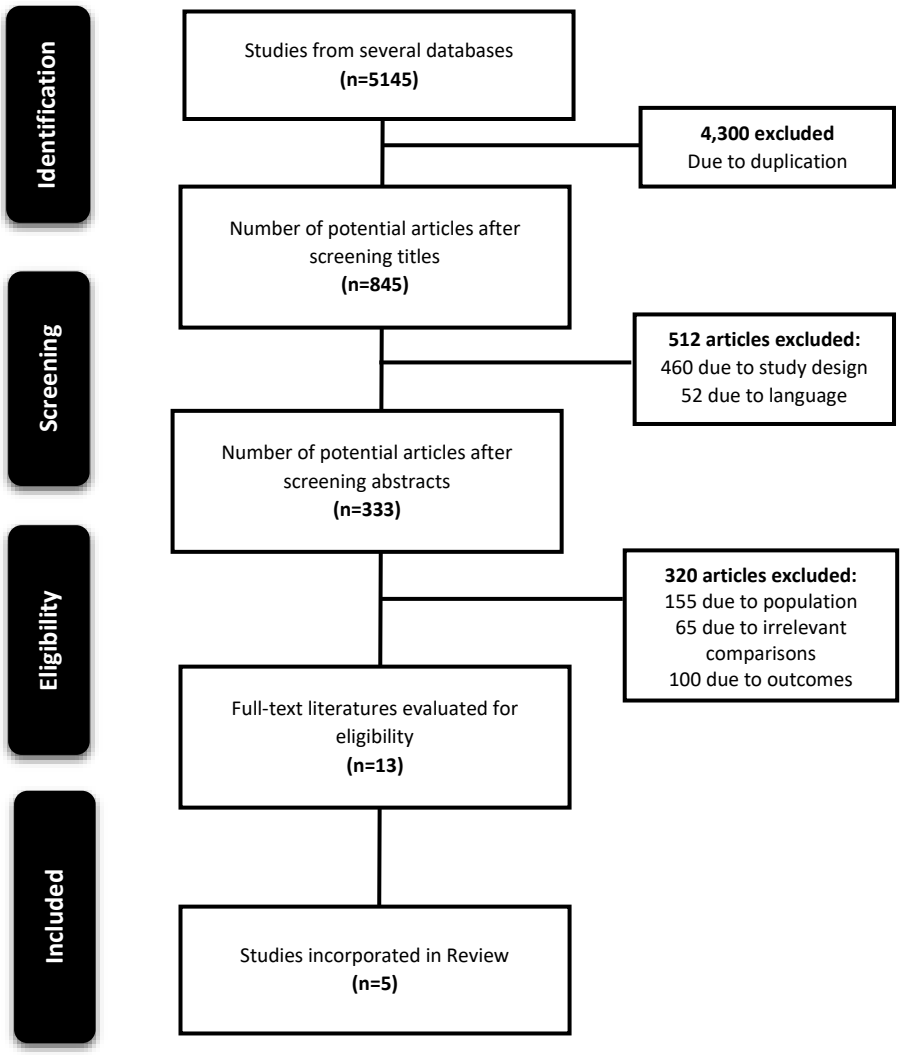

Figure-1 PRISMA Flowchart of Studies Selection

Synthesis of Studies

Studies varied with different workplace interventions used in rehabilitating musculoskeletal disorders among workers in physically demanding professions. Zhang et al.[25] emphasized the

importance of the population of nurses with neck, shoulder, and lower back pain since the intervention group which received an Omaha System-based e-intervention manifested reduced levels of postural stress as well as awkward postures following the intervention compared to the control group after six weeks ($p<0.05$). Hasani et al.[26] reported a study among administrative workers where training significantly reduced pain, especially in the neck, shoulder, and wrist. Significant differences were noted in comparison with the control group concerning the scores on the pain scale. Anan et al.[27] used an AI-assisted health program for electronic company employees, providing physical training orders using a smartphone application for 12 weeks. Notably, there were significant reductions in neck, shoulder, and lower back pain in the intervention group compared with 7% of the controls ($p<0.001$).

On the other hand, an RCT for desk-based office workers with the use of SELMA, which is a CBT-based pain management program, revealed that there was no significant difference in terms of pain-related impairment between the experimental and the control. Finally, Ratzon et al.[29] included nurses with musculoskeletal pain. They reported that the intervention group, which received physiotherapy, showed significant improvements in posture and decreased risk factors of musculoskeletal discomfort measured through the Rapid Entire Body Assessment (REBA) by $p<0.001$. Generally, most interventions were accompanied by positive outcomes, including reduced musculoskeletal pain and improved posture in employees who engage in physically demanding jobs. For example, using ergonomic training, AI-based programs, and physiotherapy resulted in low levels of musculoskeletal pain and improved posture. Other alternatives, like CBT-based pain management, did not witness satisfactory results regarding the management of musculoskeletal pain.

Table-1 Represents features of the included studies

Author	Design	Sample size	Age	Target Population	Intervention	Outcome Measures	Results
Zhang et al., 2024[25]	RCT	94	-	Nurses with self-reported neck, shoulder, and low back pain	**EG:** Omaha System-based remote intervention **CG:** Traditional intervention Both groups received six weeks of intervention	Postural stress and risk assessment	After six weeks, the intervention group showed significantly less stress in the lower back, neck, and shoulder/forearms than the control group ($p<0.05$) Additionally, awkward postures, such as extreme trunk flexion or twisting, were significantly reduced ($p<0.05$)
Hasani et al., 2022[26]	RCT	200	23-58 years	administrative workers from university	EG: The intervention group received active ergonomic training which comprises several intervention packages	Pain	The intervention group experienced a more significant reduction in pain compared to the control group. The mean difference (95% CI) of pain

					CG: The control group was provided with a basic occupational health talk		score was 0.71 (0.30, 1.12) for the neck, 0.49 (0.06, 0.92) for the shoulder, 0.11 (−0.15, 0.37) for the elbow, and 0.69 (0.28, 1.09) for the hand and wrist
Anan et al., 2021[27]	RCT	48	41.8±8.7	Employee of electronic company	**EG:** The intervention group received the AI-assisted health program, in which the chat bot sent messages to users with the exercise instructions at a fixed time every day through the smartphone's chatting app (LINE) for 12 weeks **CG:** The control group continued with their usual care routines	Neck and shoulder pain/stiffness and low back pain	Based on the subjective assessment of pain/stiffness improvement at 12 weeks, 36 out of 48 participants (75%) in the intervention group and 3 out of 46 participants (7%) in the control group showed improvements (improved, slightly improved) (OR 43.00, 95% CI 11.25-164.28; P < .001)
Hauser et al., 2020[28]	RCT	115	43.7±12.7	Desk-based office workers	**EG:** Participants received painSELfMAnagement (SELMA) for 8 weeks either every day or every other day concerning CBT-based pain management, or weekly concerning content not related to pain management	Chronic pain and well being	The intervention group reported no significant change in pain-related impairment (P = .68) compared to the control group post-intervention
Ratzon et al., 2016[29]	RCT	31	30-64 years	Nurses with musculoskeletal pain	**EG:** The intervention program was carried out by one physiotherapist and included four meetings over three months. **CG:** The control group received only instruction sheets.	Nordic Musculoskeletal Questionnaire, Karasek's questionnaire, Rapid Entire Body Assessment and posture	The intervention group improved REBA scores and posture and considered risk factors for work-related musculoskeletal discomfort disorders (p < 0.001)

CG: Control Group, EG: Experimental Group, RCT: Randomized Controlled Trial, SELMA: painSELfMAnagement

Discussion

The study indicated that rehabilitation strategies relating to the condition of interest were very diverse. For example, some studies utilized ergonomic training and physiotherapy, while others were innovative in their suggestion, such as AI-assisted health programs. For instance, Zhang et al.[25] indicated that remote intervention grounded on the Omaha System hugely reduced the postural stress and pain levels among nurses complaining of self-reported pain in their neck, shoulder, and lower back. The reports also echo the result revealed by Hasani et al.[26], who concluded that active ergonomic training for university administrative workers significantly reduced pain scores for different body parts. Both studies demonstrated the effectiveness of targeted interventions specific to workplace demands and showed how ergonomics decreases pain.

Unlike this study, though, the work by Ratzon et al.[29] claimed that posture improved and musculoskeletal discomfort risk factors of the whole body reduced after multi-session intervention with a physiotherapist. This puts more emphasis on the hands-on methods combined with educational interventions since physical therapy can offer personal, needed feedback and adjustments that a self-directed program may not be able to provide. Similarly, Anan et al.[27] demonstrated the effectiveness of an AI-assisted health program in terms of exercise adherence that eventually led to enhanced pain outcomes in workers of an electronic company. This study captures the potential to involve technology within rehabilitation processes, thus increasing the intervention for more worker involvement and engagement.

Comparative Analysis

Literature studies that had been conducted comparatively also supported the findings of this review. For example, a meta-analysis by Goetzel et al.[30] discusses employee health outcomes and the impact of workplace wellness programs on MSDs. They concluded that ergonomic assessments and employee education programs lead to marked reductions in musculoskeletal symptoms and overall better health. This is consistent with the findings of Zhang et al.[25] and Hasani et al.[26] showing a general trend for ergonomic and education interventions to work across varied workplace conditions.

Another significant similarity is that the favourable findings of this present review had already been discovered in a study by van der Molen et al.[31] on the effects of multi-component interventions on worker's health. The authors concluded that "a multi-component intervention, involving both ergonomination as well as reinforcement and support, showed larger reductions in pain and functionalities than a single intervention." This leads to the conclusion that "the more all-encompassing programs that attend to multiple aspects of workplace health, the better the rehabilitation of MSDs."

Implications for Practice

More implications of this systematic review for workplace health practices are on the considerations organizations should consider in their rehabilitation efforts. Some

recommendations include targeting rehabilitation programs based on the workers' needs in every organization. From the evidence, one-size-fits-all approaches may be less effective than tailored interventions, considering the unique physical demands of different jobs. Ergonomic training, for example, should be part of any workplace wellness program intended to reduce MSD. Technology, such as AI-based health interventions, will also be integrated into rehabilitation practice by enhancing employees' motivation and adherence. According to Anan et al.[27], readily available, ongoing support through digital media may affect behavior change and health outcomes over time.

Limitations and Further Research

Although the results look promising, the review could be better. For example, heterogeneity in study design and probably in interventions and outcomes can limit generalizability. Furthermore, publication bias is a potential solid threat since only studies that show a positive outcome will probably be published. More extensive, multi-center trials should be targeted in future studies to compare better and synthesize evidence.

Future interventions should also focus on workplace interventions' medium- and long-term effects regarding MSDs. Since most studies have evidenced short-term benefits, the sustainability of such benefits in the long term should be understood so that policies and practices can be better guided in the workplace.

Conclusion

This systematic review presents evidence that various workplace interventions may help restore musculoskeletal disorders among employees whose jobs are physically demanding. The findings highlight the need for whole packages designed to address specific occupational needs that embrace ergonomic education, physical therapy, and technological advancement. Organizations can realize healthful work environments, load reduction from MSDs, and appropriate well-being of their employees by developing appropriate rehabilitation strategies. The sheer diversity of different types of workers working and facing challenges from musculoskeletal disorders implies further research to construct more comprehensive evidence bases and optimize intervention strategies.

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Conflict of Interest
None.

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AUTHORS' CONTRIBUTION

The following authors have made substantial contributions to the manuscript as under:

Conception or Design: Sarfraz M, Nizami GN, Ali SA, Imran A

Acquisition, Analysis or Interpretation of Data: Sarfraz M, Azmat SK, Ahmed J

Manuscript Writing & Approval: Sarfraz M, Ali SA, Imran A

All the authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.