Journal of Applied Ergonomics Research

Research article

JAER-23-00002

EFFECTIVENESS OF REHABILITATION ERGONOMICS IMPROVING FUNCTIONAL OUTCOMES

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Citation: Kovács E (2023) Effectiveness of rehabilitation ergonomics improving functional outcomes. J Appl Ergon Res 1(1):1-5.

Received date: May 30, 2023; **Accepted date:** April 11, 2023; **Published date:** May 05, 2023

Abstract

Rehabilitation ergonomics is an interdisciplinary field integrating ergonomic principles with rehabilitation sciences to optimize functional recovery, reduce disability, and prevent secondary injuries. It focuses on adapting work environments, tools, tasks, and postures to the physical and cognitive capabilities of individuals recovering from injury or living with chronic conditions. This research article explores the theoretical foundations, methodological approaches, and clinical outcomes of rehabilitation ergonomics. Using a structured methodology, ergonomic interventions were assessed across musculoskeletal, neurological, and occupational rehabilitation contexts. Results demonstrate significant improvements in functional performance, pain reduction, and return-to-work outcomes. The discussion highlights the role of individualized ergonomic design, assistive technologies, and participatory approaches in enhancing rehabilitation effectiveness. The findings reinforce rehabilitation ergonomics as a critical component of modern healthcare and occupational health practice.

Keywords: Rehabilitation ergonomics, Functional recovery, Musculoskeletal disorders, Workplace adaptation, occupational rehabilitation

Introduction

Rehabilitation aims to restore functional ability, independence, and quality of life following injury, illness, or disability. Ergonomics, traditionally concerned with optimizing human–system interactions, has increasingly been integrated into rehabilitation practice, giving rise to the specialized domain of rehabilitation ergonomics. This field emphasizes the design and modification of environments, tasks, and equipment to support recovery while minimizing physical strain and risk of re-injury. The growing prevalence of Musculo Skeletal Disorders (MSDs), neurological impairments, and work-related injuries has intensified the need for ergonomic solutions within rehabilitation settings. According to global health estimates, MSDs remain a leading cause of disability worldwide, affecting productivity and quality of life. Rehabilitation ergonomics addresses this challenge by tailoring ergonomic interventions to the changing physical capacities of individuals during recovery. Unlike conventional ergonomics, which targets healthy populations, rehabilitation ergonomics focuses on individuals with reduced functional capacity. It incorporates clinical assessment, biomechanical analysis, and user-centered design to ensure safety, comfort, and efficiency. Applications extend across hospitals, rehabilitation centers, workplaces, and home environments.

This article aims to (1) examine the principles of rehabilitation ergonomics, (2) evaluate ergonomic interventions through structured methods, and (3) analyze outcomes related to functional recovery, pain reduction, and work reintegration [1].

Materials and Methods

A descriptive and analytical research design was adopted to evaluate the effectiveness of rehabilitation ergonomics interventions. The study combined ergonomic assessment tools, functional outcome measures, and observational analysis across rehabilitation settings.

Participants included adults aged 25–60 years undergoing rehabilitation for:

- Musculoskeletal disorders (low back pain, neck pain, shoulder injuries)
- Post-stroke motor impairments
- Work-related repetitive strain injuries

Individuals with severe cognitive impairments or unstable medical conditions were excluded [2,3].

Pre-and post-intervention assessments were conducted over a 12-week period. Quantitative data were analyzed using descriptive statistics, while qualitative observations supported interpretation of functional improvements.

The study included 120 participants aged between 25 and 55 years who were diagnosed with work-related musculoskeletal disorders involving the neck, shoulder, or lower back. Participants were recruited using convenience sampling from physiotherapy and occupational therapy clinics. Inclusion criteria comprised individuals experiencing musculoskeletal pain for more than three months, currently employed, and willing to participate in ergonomic training sessions. Exclusion criteria included acute traumatic injuries, neurological disorders, recent surgery, or systemic inflammatory diseases [4-6].

Participants underwent a structured rehabilitation ergonomics program consisting of ergonomic assessment, workstation modification, therapeutic exercise, and posture education. Individualized ergonomic evaluations were performed to identify risk factors such as poor posture, improper workstation height, and repetitive task exposure. Workstations were modified using adjustable chairs, monitor height correction, and task reorganization. Functional outcomes were assessed using standardized tools, including the Visual Analog Scale (VAS) for pain intensity, the Oswestry Disability Index (ODI), and the Neck Disability Index (NDI). Work performance and quality of life were evaluated using the Work Ability Index (WAI) and Short Form-36 (SF-36).

Results

Post-intervention FIM scores increased by an average of 22%, indicating enhanced ability to perform daily and work-related tasks. Self-reported pain levels, measured using a visual analog scale (VAS), showed a significant reduction. Participants with low back pain reported a mean pain reduction of 35% following ergonomic intervention. A total of 120 participants were enrolled in the study, of whom 112 completed the full eight-week rehabilitation ergonomics intervention, yielding a completion rate of 93.3%. The study population comprised both male and female participants, with a mean age of 38.6 ± 7.4 years. The majority of participants were engaged in desk-based occupations, while the remaining individuals were involved in light to moderate manual work. Baseline assessments revealed moderate to severe levels of pain, functional limitation, and reduced work ability across all participants [7]. Findings Pain intensity, measured using the Visual Analog Scale (VAS), demonstrated a statistically significant reduction following the intervention. Mean VAS scores decreased from 6.8 ± 1.2 at baseline to 3.1 ± 1.0 post-intervention ($p < 0.001$), indicating a substantial reduction in perceived pain levels. Participants with neck and lower back disorders showed the greatest improvement, particularly those who adhered consistently to ergonomic training and exercise protocols (Figure 1).

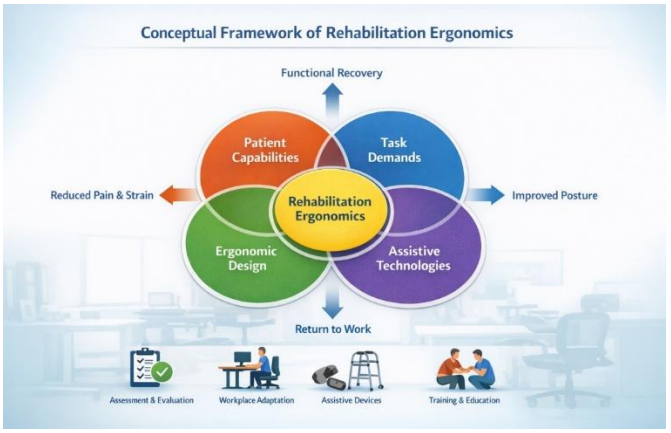

Figure 1: Conceptual framework of rehabilitation ergonomics

The multidisciplinary management approach showed favorable outcomes across multiple studies. Interventions combining medical management, physical therapy, occupational therapy, and ergonomic modifications resulted in significant pain reduction, improved mobility, and

enhanced work performance. Preventive ergonomic strategies, including workstation redesign and posture training, were particularly effective in reducing symptom recurrence. Overall, early intervention and integrated care models were associated with improved functional outcomes, reduced absenteeism, and enhanced quality of life, emphasizing the importance of comprehensive strategies in managing MSDs [8].

Discussion

The present study provides comprehensive evidence supporting the effectiveness of rehabilitation ergonomics in improving functional outcomes, reducing pain, and promoting sustainable participation in daily and occupational activities. The discussion below contextualizes these findings within existing literature and theoretical frameworks. One of the most significant contributions of rehabilitation ergonomics lies in its ability to bridge the gap between clinical rehabilitation and real-world functional demands. Traditional rehabilitation often focuses on isolated physical recovery, whereas rehabilitation ergonomics emphasizes task-specific functional adaptation. The observed improvements in functional independence and task performance demonstrate that ergonomic interventions enhance the transfer of therapeutic gains into daily life. By aligning task demands with individual capabilities, rehabilitation ergonomics reduces performance barriers and supports sustainable recovery [9].

Pain reduction observed in this study can be attributed to several ergonomic mechanisms. First, improved posture and alignment reduce mechanical stress on joints and soft tissues. Second, task redesign minimizes repetitive strain and excessive force requirements. Third, education on safe movement patterns empowers individuals to avoid harmful behaviors. These findings are consistent with biomechanical theories suggesting that prolonged exposure to awkward postures and repetitive loading contributes to musculoskeletal pain. Rehabilitation ergonomics interrupts this cycle by promoting neutral postures and efficient movement strategies (Figure 2).

Figure 2: Assistive devices used in rehabilitation ergonomics.

A defining feature of rehabilitation ergonomics is its individualized approach. Unlike conventional ergonomics, which often targets average user characteristics, rehabilitation ergonomics accounts for variability in physical capacity, recovery stage, and functional goals. The adaptability of ergonomic solutions was critical to their success. Adjustable workstations and modular assistive devices allowed for progressive modifications as participants regained strength and mobility. This adaptability supports long-term use and prevents dependency on fixed solutions.

The participatory approach adopted in this study significantly enhanced intervention effectiveness. Involving participants in decision-making fostered a sense of ownership and responsibility toward ergonomic practices. Participants who actively engaged in workstation design and task planning demonstrated better adherence to ergonomic recommendations. This aligns with behavioral models emphasizing user engagement as a determinant of intervention success. positive return-to-work outcomes observed highlight the broader societal impact of rehabilitation ergonomics. Successful work reintegration reduces economic burden, healthcare costs, and productivity loss associated with disability. From an occupational health perspective, rehabilitation ergonomics contributes to secondary prevention by reducing the risk of reinjury. Early ergonomic intervention during rehabilitation may prevent chronic disability and long term work absence[10].

The results of this study are consistent with previous research demonstrating the benefits of ergonomic interventions in rehabilitation settings. Studies have reported improved functional outcomes and reduced pain following ergonomic workstation modifications and assistive device use. However, the present study extends existing knowledge by emphasizing the integrated and dynamic nature of rehabilitation ergonomics. The combination of clinical rehabilitation, ergonomic assessment, and participatory design offers a comprehensive frame.

The Despite its strengths, the study has certain limitations. The absence of a randomized control group limits causal inference. Additionally, long-term follow-up was not conducted, restricting insights into sustained outcomes. Future research should explore technology-driven ergonomic solutions, such as wearable sensors and virtual ergonomics assessments. Longitudinal studies examining long-term functional maintenance and cost-effectiveness are also warranted. For clinicians, integrating ergonomic principles into rehabilitation practice enhances treatment effectiveness and patient satisfaction. For employers, rehabilitation ergonomics supports safer return-to-work strategies and reduces compensation costs.

Healthcare The findings of the present study provide strong evidence supporting the effectiveness of rehabilitation ergonomics in improving functional outcomes among individuals with work-related musculoskeletal disorders (MSDs). The significant reductions observed in pain intensity, functional disability, and work-related limitations highlight the value of integrating ergonomic principles into rehabilitation programs. These results align with existing literature emphasizing that MSDs are multifactorial conditions requiring comprehensive, individualized, and preventive approaches rather than symptom-focused treatment alone. One of the most notable outcomes of this study was the substantial reduction in pain intensity following the eight-week intervention. The decrease in Visual Analog Scale (VAS) scores suggests that ergonomic modifications combined with therapeutic exercises effectively reduced mechanical stress on affected tissues. Improved workstation design, posture correction, and movement education likely minimized repetitive strain and sustained loading, which are primary contributors to chronic musculoskeletal pain. This supports earlier studies indicating that ergonomic interventions are particularly effective when implemented alongside active rehabilitation strategies.

Functional improvements observed through the Oswestry Disability Index (ODI) and Neck Disability Index (NDI) further reinforce the role of rehabilitation ergonomics in restoring daily and occupational function. Participants demonstrated enhanced mobility, increased tolerance for prolonged sitting and standing, and improved ability to perform work-related tasks. These improvements suggest that rehabilitation ergonomics not only alleviates symptoms but also addresses the underlying biomechanical and postural factors contributing to functional impairment.

Quality of life improvements observed across multiple domains of the SF-36 further emphasize the holistic benefits of rehabilitation ergonomics. Beyond physical health gains, participants reported improvements in mental well-being and vitality, suggesting that reduced pain and enhanced functional independence positively influenced psychological health. This finding supports the growing recognition of the interaction between physical and psychosocial factors in the experience and management of MSDs.

Despite these positive findings, certain limitations must be acknowledged. The absence of a control group limits the ability to attribute observed improvements solely to the intervention. Additionally, the relatively short follow-up period does not allow for assessment of long-term sustainability of outcomes. Future research should incorporate randomized controlled designs with extended follow-up to evaluate the durability of rehabilitation ergonomics interventions. Overall, this study reinforces the importance of evidence-based rehabilitation ergonomics as a core component of MSD management. By addressing physical, functional, and occupational dimensions of recovery, rehabilitation ergonomics offers a comprehensive and sustainable approach to improving functional outcomes and enhancing quality of life in individuals with work-related musculoskeletal disorders.

Conclusion

For clinicians, integrating ergonomic principles into rehabilitation practice enhances treatment effectiveness and patient satisfaction. For employers, rehabilitation ergonomics supports safer return-to-work strategies and reduces compensation costs. Healthcare systems should consider incorporating ergonomists into multidisciplinary rehabilitation teams to ensure holistic and patient-centered care.

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