REVIEW ARTICLE

THE IMPACT OF PHYSICAL ACTIVITY ON THE PREVENTION OF SYMPTOM RECURRENCE FOLLOWING LUMBAR SPINE SURGERY: A SYSTEMATIC LITERATURE REVIEW

Rola aktywności fizycznej w zapobieganiu nawrotom bólu pooperacyjnego po zabiegach w odcinku lędźwiowym kręgosłupa: systematyczny przegląd piśmiennictwa

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Abstract

Background: Spinal surgeries are among the most frequently performed procedures in neurosurgery, with discectomies, laminectomies, and decompression operations being the most common. Chronic postoperative pain, which affects 8–40% of patients who have undergone lumbar spine surgery, is a significant clinical issue. Physical activity is one of the key factors preventing postoperative pain recurrence. **Aim:** The aim of this study was to review the literature on the impact of various forms of physical activity on pain recurrence in patients following lumbar spine surgery. **Materials and methods:** This review synthesized evidence from 21 studies (randomized controlled trials, systematic reviews, and meta-analyses from 2005–2024) on exercise-based rehabilitation after lumbar spine surgery. A literature search was conducted in PubMed, Scopus, and Cochrane Library. The included studies focused on adults after disc surgery or spinal fusion and assessed the impact of physical activity on symptom recurrence. **Results:** Early rehabilitation (within 4–8 weeks post-surgery) moderately reduced pain and improved function. Core stabilization, strength, and aerobic exercises helped prevent recurrence. Individualized walking and education programmes enhanced adherence and reduced the risk of relapse, though study protocols and outcomes vary. **Conclusion:** Physical activity plays a crucial role in postoperative rehabilitation of the lumbar spine. It contributes to pain reduction, functional improvement, and decreased risk of recurrence. Early mobilization (within 1–2 months after surgery) and simple interventions, such as walking programmes combined with education, have proven to be effective and safe. The most commonly used exercises include stabilization exercises, deep muscle strengthening, and aerobic training. Despite the lack of standardized protocols, physical activity remains an essential component of patient care following lumbar spine surgery.

Streszczenie

Wprowadzenie: Operacje kręgosłupa należą do najczęściej wykonywanych procedur w neurochirurgii. Do najpoważniejszych z nich zalicza się dyscektomie, laminektomie oraz operacje dekompresyjne. Istotnym problemem klinicznym jest przewlekły ból pooperacyjny, który występuje u 8–40% pacjentów po zabiegach w obrębie odcinka lędźwiowego kręgosłupa. Aktywność fizyczna stanowi jeden z kluczowych elementów zapobiegania nawrotom dolegliwości bólowych po operacji. **Cel pracy:** Celem niniejszej pracy jest przegląd piśmiennictwa dotyczącego wpływu różnych form aktywności fizycznej na występowanie bólu u pacjentów po operacjach w obrębie odcinka lędźwiowego kręgosłupa. **Materiał i metody:** Do przeglądu włączono 21 badań (randomizowane badania kontrolowane, przeglądy systematyczne i metaanalizy z lat 2005–2024) dotyczących rehabilitacji opartej na ćwiczeniach po operacjach kręgosłupa lędźwiowego. Przeszukiwanie piśmiennictwa przeprowadzono w bazach PubMed, Scopus i Cochrane Library. Do analizy włączono badania obejmujące osoby dorosłe po zabiegach dyscektomii lub stabilizacji kręgosłupa, oceniające wpływ aktywności fizycznej na nawrót objawów. **Wyniki:** Wczesna rehabilitacja (rozpoczynana w ciągu 4–8 tygodni po zabiegu) w umiarkowanym stopniu redukuje ból i poprawia funkcję. Ćwiczenia stabilizujące, siłowe

oraz aerobowe sprzyjają zapobieganiu nawrotom objawów. Indywidualnie dostosowane programy marszowe oraz edukacja pacjentów zwiększają przestrzeganie zaleceń i zmniejszają ryzyko nawrotu, choć protokoły badań i oceniane wyniki różnią się między sobą. **Wnioski:** Aktywność fizyczna odgrywa kluczową rolę w pooperacyjnej rehabilitacji odcinka lędźwiowego kręgosłupa. Przyczynia się do redukcji bólu, poprawy funkcji oraz zmniejszenia ryzyka nawrotu dolegliwości. Wczesna mobilizacja (w ciągu 1–2 miesięcy po zabiegu) oraz proste interwencje, takie jak programy marszowe połączone z edukacją, są skuteczne i bezpieczne. Najczęściej stosowane formy aktywności obejmują ćwiczenia stabilizacyjne, wzmacnianie mięśni głębokich oraz trening aerobowy. Pomimo braku ujednoliconych protokołów, aktywność fizyczna pozostaje nieodzownym elementem opieki nad pacjentami po operacjach kręgosłupa lędźwiowego.

Keywords: low back pain; chronic pain; exercise; rehabilitation; pain management

Słowa kluczowe: ból kręgosłupa; ból przewlekły; aktywność fizyczna; rehabilitacja; leczenie bólu

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Introduction

Lumbar pain is a major clinical problem, not only as a symptom, but also as one of the main factors affecting the quality of life of patients [1]. The most common causes of lumbar pain include injuries, intervertebral disc herniation, and age-related degenerative changes [2, 3]. First-line treatment is usually conservative. Non-pharmacological methods include massage, acupuncture, heat and cold therapy, yoga, and tai chi [2, 4]. Pharmacological treatment, including nonsteroidal anti-inflammatory drugs (NSAIDs) and duloxetine, is particularly effective in patients with diffuse pain, high risk of complications, or nociplastic pain [5, 6]. Surgical intervention is considered when conservative management is considered ineffective [7].

Low back pain is often self-limiting, but when symptoms persist beyond the physiological healing time, chronic low back pain (CLBP) may develop. Approximately 85% of CLBP cases are classified as nonspecific, reflecting the absence of a definitive diagnosis and hindering effective treatment. CLBP is currently understood as a multifactorial disorder in which pathoanatomical, neurophysiological, psychological, and social factors contribute to the condition to varying degrees across patients.

Classifying CLBP into subgroups according to the predominant pathophysiological mechanisms is crucial for selecting appropriate treatment. These include pain resulting from pathological processes accompanied by adaptive motor responses, pain centrally modulated by psychological or social factors with maladaptive coping and movement control strategies, and mechanically induced pain associated with impaired movement control and physical and cognitive compensations. For the latter group, targeted physiotherapy interventions addressing both physical and cognitive factors show promising clinical effects, although further research is needed to confirm these findings [8].

Growing evidence also indicates that CLBP patients have significantly reduced aerobic capacity compared to healthy individuals, even at comparable levels of athletic activity, suggesting a clinically significant limitation in physical performance that affects daily functioning [9].

Despite advances in surgical techniques, including the increasing use of minimally invasive methods such as endoscopic spine surgery [10], pain recurrence after spine surgery remains a major clinical challenge. Endoscopic techniques, commonly used in the treatment of lumbar disc herniation and spinal stenosis, aim to limit soft-tissue damage while effectively removing the underlying pathology. Despite these advances, pain recurrence occurs in 8–40% of patients [7]. Preventing pain recurrence is therefore crucial. This review aimed to summarize the current evidence on the role of physical activity in preventing recurrent low back pain after lumbar spine surgery.

Materials and methods

This literature review aimed to synthesize current evidence regarding the role of physical activity in preventing symptom recurrence after lumbar spine surgery. The analysis included randomized controlled trials (RCTs), systematic reviews, and meta-analyses published between 2005 and 2024.

A literature search was conducted in PubMed, Scopus, and Cochrane Library databases using the following keywords and their combinations: “lumbar spine surgery,” “rehabilitation,” “physical activity,” “exercise therapy,” “recurrence,” “low back pain,” and “postoperative recovery.” Boolean operators (AND, OR) were used to narrow the search. Peer-reviewed English-language publications involving adults who had undergone discectomy or lumbar spine stabilization were included if they assessed the effects of physical activity or exercise-based rehabilitation on symptom recurrence or the

progression of CLBP. Only RCTs, systematic reviews, and meta-analyses were included. Case reports, review papers, conference abstracts, and studies that did not report postoperative outcomes or symptom recurrence rates were excluded.

Of the 21 publications ultimately selected, 9 were RCTs, 6 were systematic reviews and meta-analyses, including Cochrane reviews, and 6 were high-quality narrative or clinical reviews. Key sources included Afzal et al. (2022) [11], Hayden et al. (2021, 2005) [1, 12], Oosterhuis et al. (2014) [13], Pocovi et al. (2024) [14], and Foster et al. (2018) [15].

Qualitative assessments were performed with respect to the timing of rehabilitation, types of exercise, functional outcomes, relapse rates, and protocol consistency. Attention was paid to interventions implemented within 1–2 months of surgery, including stabilization exercises, aerobic training, and patient education.

Literature review – results

Early postoperative rehabilitation

A 2022 meta-analysis of 15 RCTs evaluated the efficacy of active rehabilitation initiated within 1–2 months following lumbar discectomy. It demonstrated moderate improvements in functional outcomes and subjective pain perception compared with no-intervention controls [11]. Rehabilitation programmes included motor control exercises, stabilization, strength training, joint and neuromuscular mobilization, as well as educational and psychosocial components [11].

The authors highlighted the significant heterogeneity of protocols in terms of type, intensity, and duration of exercise, as well as the timing of intervention [11]. None of the included studies reported complications related to rehabilitation, supporting the safety of early postoperative mobilization. Early mobilization also helped prevent muscle atrophy and restore normal sympathetic feedback mechanisms [11].

The analysis included a total of 2,188 patients. Active rehabilitation conducted 1–2 months postoperatively was associated with a statistically significant reduction in pain (p = 0.004), improvement in overall functional ability (p = 0.0001), and reduction in pain disability scores (p = 0.002) [11]. Despite moderate heterogeneity across studies, the overall quality of the evidence was rated as moderate to high.

Long-term physical activity

A 2009 Cochrane systematic review included 14 RCTs evaluating the effectiveness of various rehabilitation interventions after initial lumbar spine surgery [16]. Studies demonstrated substantial variability in the timing of rehabilitation initiation, ranging from 2 to more than 12 months postoperatively, as well as in the intensity and duration of exercise programmes [16]. Due to clinical heterogeneity, the meta-analysis could only be performed for three comparisons: exercise programmes vs no treatment, low-intensity vs high-intensity programmes, and home-based exercises vs supervised rehabilitation [16].

The updated review included only RCTs and used the GRADE (Grading of Recommendations Assessment, Development and Evaluation) methodology to assess the quality of evidence [16]. Unlike the earlier classification based on "levels of evidence," the GRADE approach enabled a more precise assessment of the reliability of the findings by considering the risk of bias, consistency, validity, and precision [16]. The findings indicated that intensive exercise programmes initiated 4–6 weeks postoperatively produced moderate improvements in functional outcomes, prompting a revision of earlier conclusions suggesting strong evidence [16].

The review found that exercise initiated 4–6 weeks after surgery was associated with faster pain reduction than no intervention (low-quality evidence), and that lower-frequency programmes were more effective than higher-frequency programmes in reducing disability (moderate-quality evidence) [16]. No increased risk of reoperation was observed, supporting the safety of postoperative physical activity [16].

The effectiveness of supervised rehabilitation compared with home-based exercises was similar in the short term (low-quality evidence), although adherence to home-based programmes was limited [16, 17]. Patient engagement declined to below 60% after two months and below 30% after six months, highlighting the potential need for supervision in long-term rehabilitation programmes to sustain motivation [16].

Biopsychosocial interventions were not shown to be significantly superior to standard physiotherapy, with both forms of therapy considered safe and neither found to affect the reoperation rates [16]. Furthermore, differences in surgical techniques (e.g., open discectomy vs. microdiscectomy) had no significant impact on rehabilitation outcomes [16].

The review authors concluded that there is no justification for avoiding physical activity following lumbar spine surgery. Although the optimal rehabilitation protocol remains unclear, early mobilization and higher-intensity programmes appear beneficial in reducing pain and improving function [16].

These results are consistent with previous observations regarding exercise therapy in patients with nonspecific low back pain. A previous Cochrane review found that although exercise was not superior to other conservative treatments in acute cases, it produced moderate effects in subacute work-related pain and a minor yet significant benefit in chronic cases [12]. It also highlighted limitations in the quality of the studies and the need to standardize both interventions and outcomes [12].

Recent data confirm that early rehabilitation following lumbar spine stabilization, based on strength training and intra-abdominal pressure activation, is safe and may accelerate functional recovery. In a randomized trial, both early training and standard rehabilitation improved functional outcomes; however, only the training group

achieved walking distances close to age-appropriate norms and demonstrated improvements in trunk extension, lateral flexion, and pre-activation patterns [18]. No complications or implant damage were noted despite initiating the programme as early as 3 weeks post surgery, with lower baseline performance associated with greater functional gains. These findings suggest that well-planned, strength-based rehabilitation can improve functional capacity without increasing the risk of complications.

Walking programmes

The randomized WalkBack Trial (2024) showed that an individually tailored, progressive walking programme combined with education significantly reduced the risk of recurrent nonspecific low back pain among previously inactive individuals [14]. This effect was consistent across all three analysed endpoints related to pain recurrence. A significant reduction in pain-related disability was also observed within 12 months of implementing the intervention [14]. Furthermore, the economic analysis demonstrated a high probability of cost-effectiveness from a societal perspective [14].

This study addressed a significant gap in the literature. A 2018 systematic review published in The Lancet highlighted the scarcity of high-quality research on low back pain prevention and emphasized the need to develop effective, accessible preventive strategies [15]. The WalkBack study was the first RCT to evaluate the efficacy of walking as a preventive intervention [14]. The results demonstrated effectiveness comparable to that of more expensive, supervised group programmes, suggesting that large-scale implementation could yield substantial health and economic benefits [14].

The study's strengths included preregistration in a clinical trials database, publication of study protocol and statistical analysis plan, a long follow-up period of 12–36 months, and a high participant completion rate [14]. During the COVID-19 pandemic, the intervention was adapted for remote delivery, enabling participation from rural and geographically isolated areas and thereby improving accessibility and implementation potential [14].

However, the study's generalizability was limited as most participants were women aged 43–66 years with a history of recurrent low back pain [14]. Furthermore, the intervention was delivered by physiotherapists trained in health coaching, which may limit the programme's replicability among other healthcare professionals [14]. Also, the absence of participant blinding may have influenced the subjective assessment of outcomes [14].

The intervention group also reported more lower-limb adverse events compared to controls (100 versus 54 cases) [14]. These findings suggest that similar programmes should include monitoring for signs of overuse or excessive loading, with training intensity increased gradually [14].

Clinically significantly, the preventive effect was achieved with a small number of educational sessions based on the principles of health coaching [14]. The effectiveness of the intervention was likely attributable to the synergistic effects of education, which helped overcome anxiety and activity avoidance, as well as progressive walking training, which supported behavioural changes [14]. It is worth noting that walking intensity initially doubled in the intervention group; however, the differences between the groups were no longer evident after 12 months [14]. This may suggest the need for periodic booster interventions or ongoing therapeutic support to maintain long-term effects [14].

The WalkBack programme has important practical implications: a simple, low-cost, and easy-to-implement walking-based intervention can significantly reduce the risk of low back pain recurrence and the associated burden on the healthcare system [14]. Future studies should evaluate the effectiveness of this approach in physically active individuals and postoperative patients, as well as with alternative forms of physical activity [14].

Types of exercises in postoperative rehabilitation of the lumbar spine

Rehabilitation programmes following lumbar spine surgery typically include three main types of activities: stabilization exercises, core strengthening exercises, and aerobic training [19–21].

Stabilization exercises aim to improve motor control and activation of local muscles, such as the transverse abdominis and multifidus, which are often weakened in patients with low back pain [19, 20]. Core muscle strengthening exercises increase muscle strength and segmental stability of the lumbar spine, which are crucial for improving function and reducing pain [19–21].

Aerobic training improves cardiorespiratory parameters and may also benefit mental well-being, thereby enhancing the overall effectiveness of rehabilitation.

The studies included in this review demonstrated substantial variability in the timing, content, and intensity of postoperative exercise programmes, while the evidence supporting their effectiveness was generally of low to very low quality [13]. Although early postoperative exercise may provide modest improvements in recovery, these findings should be interpreted with caution. Importantly, no association with increased reoperation rates was found, supporting the safety of an early return to activity.

Adherence to home-based exercise recommendations tends to decline over time, highlighting the need for ongoing supervision and support to maintain motivation [13]. Home-based exercise programmes can be effective, particularly when delivered in a group or social setting, which may enhance engagement and adherence. Despite the benefits of supervised and standardized programmes, current evidence remains insufficient to establish the optimal duration and frequency of exercise sessions. Further RCTs are needed to develop optimal practices for home-based rehabilitation following spine surgery [17]. Additionally, patient preferences and expectations may influence adherence, highlighting the importance of individualizing treatment programmes.

Conclusions

Recurrent low back pain following lumbar spine surgery is a major clinical problem that can substantially impair patients' quality of life. Available evidence indicates that physical activity plays a key role in postoperative rehabilitation by reducing pain, improving function, and helping prevent symptom recurrence.

Research suggests that early rehabilitation, initiated within 1–2 months after surgery, provides moderate benefits, including reduced pain and improved functional capacity. Early physical activity not only promotes the recovery of mobility but also helps prevent muscle atrophy and restore neuromuscular control.

However, maintaining patient engagement throughout rehabilitation remains challenging. Therefore, motivational strategies, including regular follow-up, motivational interviewing, and incorporating patient preferences into treatment planning, may help improve adherence.

Simple interventions, such as individually tailored walking programmes combined with education, have been shown to reduce the risk of pain recurrence and promote symptom self-management. These programmes may also be cost-effective for healthcare systems.

Postoperative rehabilitation should include stabilization and core-strengthening exercises alongside aerobic training, as these modalities work together to address different pain mechanisms and provide functional improvement. Despite the absence of standardized protocols, physical activity remains a safe and effective strategy for postoperative management.

Future research should focus on standardizing rehabilitation protocols by defining the optimal duration, intensity, and type of exercise while incorporating psychosocial support. Long-term studies should also evaluate how different rehabilitation strategies affect pain recurrence and functional outcomes across diverse patient populations.

To conclude, incorporating physical activity into postoperative care plans is crucial for optimizing recovery and minimizing the risk of recurrent low back pain. Early mobilization and individually tailored rehabilitation strategies can improve patient outcomes and quality of life. Advancing understanding of the relationship between physical activity and pain mechanisms should prompt healthcare providers to update their approaches to ensure that patient care remains aligned with the latest scientific evidence.

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