

The Effect of High Intensity Laser Therapy on Low Back Pain: A Literature Review

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ABSTRACT

Introduction: Low back pain (LBP) is a highly prevalent musculoskeletal condition that significantly affects quality of life and functional ability across diverse populations. Effective management of LBP remains a clinical challenge, requiring a multidisciplinary approach that may involve patient education, therapeutic exercises, psychological support, and various physical modalities. Recent advancements in non-invasive physiotherapeutic modalities have positioned High-Intensity Laser Therapy (HILT) as a promising option for managing chronic low back pain.

Objective: This literature review aims to discuss the effect of high intensity laser therapy on low back pain.

Methodology: Relevant articles were gathered from several digital databases including PubMed, ScienceDirect, Google Scholar, and the Cochrane Library using keyword combination namely ("High Intensity Laser" AND "Low Back Pain").

Conclusion: HILT demonstrates substantial potential as an effective and non-invasive modality for the treatment of LBP, particularly in chronic cases. HILT has been consistently shown to produce significant improvements in pain reduction, functional mobility, and lumbar range of motion, particularly when combined with therapeutic exercise programs.

KEYWORDS: HILT, laser, therapy, low back pain

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1. INTRODUCTION

Low back pain (LBP) is a highly prevalent musculoskeletal condition that significantly affects quality of life and functional ability across diverse populations. It is characterized by discomfort localized to the lumbar or lumbosacral region, with or without radiating pain to the lower extremities, and may arise from various underlying causes. Chronic low back pain, typically defined as pain persisting for more than 12 weeks, often continues beyond the resolution of the initial tissue injury and is associated with complex biopsychosocial factors, including muscle weakness, limited mobility, and psychological distress.¹

Effective management of LBP remains a clinical challenge, requiring a multidisciplinary approach that may involve patient education, therapeutic exercises, psychological support, and various physical modalities. Physical modalities such as ultrasound therapy are frequently employed for their mechanical and analgesic benefits, enhancing tissue healing and reducing pain perception. More

recently, laser therapy has emerged as a promising non-invasive intervention. It has shown efficacy in alleviating both acute and chronic pain conditions through mechanisms involving enhanced microcirculation, anti-inflammatory activity, neural regeneration, and the stimulation of endogenous opioids like β -endorphins.¹

A novel development in this field is High Intensity Laser Therapy (HILT), which offers deeper tissue penetration and the ability to treat larger areas due to its higher power and specific wavelength. Clinical evidence suggests that HILT possesses potent anti-inflammatory, anti-edematous, and analgesic properties, making it a viable alternative or complement to traditional modalities such as ultrasound.¹

This literature review discusses the effect of High Intensity Laser Therapy (HILT) on low back pain. HILT is a safe, non-invasive method that can treat deeper and broader areas of the body. It has shown positive effects in reducing pain and inflammation, improving movement, and helping patients function better. By reviewing current research, this

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paper aims to show how HILT can be a useful option in the treatment of low back pain.

2. METHODOLOGY

Relevant articles were gathered from several digital databases, including PubMed, ScienceDirect, Google Scholar, and the Cochrane Library. The search strategy involved the use of Boolean operators with the keywords ("High Intensity Laser" AND "Low Back Pain"). Studies were included if they met the following criteria: (1) focused on clinical aspects, diagnosis, or treatment of low back pain, particularly involving high intensity laser therapy; and (2) were published within the last 10 years. Articles were excluded if (1) they were not directly related to the research objectives, (2) full-text versions were unavailable, or (3) were published over 10 years.

3. LOW BACK PAIN

Low back pain (LBP) is characterized by pain, muscle tension, or stiffness localized between the lower rib margin and the gluteal folds, with or without radiation to the thighs or legs. It includes lumbar and lumbosacral pain, radicular pain (dermatomal distribution), and referred pain (non-dermatomal spread). LBP may result from both neural and non-neural tissue damage. Based on duration, LBP is classified as acute (<6 weeks), subacute (6–12 weeks), or chronic (>12 weeks). Chronic LBP may result from unresolved tissue healing or disc degeneration and frequently recurs if not treated appropriately in the acute phase.²

LBP affects more than 80% of individuals during their lifetime. According to the Global Burden of Disease Study 2017, approximately 7.5% of the global population (577 million people) experienced LBP. It ranks as a leading cause of years lived with disability (YLDs), surpassing many chronic conditions. The prevalence increases with age and is higher in women. In Indonesia, local data show that 18.37% of pain clinic patients present with LBP.²

LBP involves damage to neural and/or non-neural structures, including vertebrae, discs, ligaments, and muscles. Pain may be nociceptive (from tissue injury) or neuropathic (from nerve damage). Chronic and recurrent LBP often involve central sensitization, a condition where the central nervous system amplifies pain signals, resulting in heightened pain sensitivity and altered sensory processing.²

Evaluation begins with thorough history-taking and physical examination, including motor, sensory, and reflex testing, along with specific tests like Lasegue's sign. Imaging and advanced diagnostics are reserved for cases with red flags (e.g., trauma, malignancy, infection) or neurological deficits.²

Management of LBP includes both non-pharmacological and pharmacological approaches:²

- Education and activity modification: encouraging patients to maintain mobility and avoid bed rest.
- Physical therapy: stretching, strengthening, and posture training.

- Pharmacotherapy: analgesics, NSAIDs, muscle relaxants, and in some cases, antidepressants or anticonvulsants for neuropathic pain.
- Interventional procedures: epidural steroid injections, nerve blocks, or surgery in selected cases (e.g., severe herniation or spinal instability).
- Psychological support: for patients with chronic pain, including cognitive behavioral therapy (CBT).
- Laser therapy: Low-Level Laser Therapy (LLLT) has emerged as a non-invasive treatment option for LBP. It works by reducing inflammation, enhancing blood flow, and modulating pain through photobiomodulation. Clinical evidence suggests that laser therapy may improve function and decrease pain intensity in both acute and chronic LBP, especially when combined with exercise therapy.

Effective LBP management often requires a multidisciplinary approach and should be individualized based on the underlying cause, severity, and duration of symptoms.²

4. HIGH INTENSITY LASER THERAPY

High-Intensity Laser Therapy (HILT) is an emerging modality in laser therapy, specifically developed for managing musculoskeletal disorders (MSDs). Unlike traditional low-level laser therapy (LLLT), HILT utilizes a higher power output up to 3,000 W with a specific wavelength of 1,064 nm, commonly delivered through a pulsed neodymium-doped yttrium aluminum garnet (Nd:YAG) laser. This wavelength falls within the therapeutic window that enables deeper tissue penetration and delivers photothermal, photochemical, and photomechanical effects. HILT can reach areas that are difficult to access with conventional LLLT, making it especially valuable for treating large or deep-seated joints and tissues.³

The mechanism of HILT is centered around its ability to photoactivate cellular systems. During treatment, HILT enhances the concentration of endogenous chromophores, stimulates ATP and RNA synthesis, and activates mitochondrial oxidative responses. These processes promote collagen production in muscle tendons, facilitate tissue regeneration, and improve the overall photobiological effects on damaged tissues. Furthermore, HILT is known to provide pain relief, aid in wound healing, and assist in the recovery of nerve function.⁴

Laser therapy has evolved significantly. Modern laser systems now include class IV lasers with output powers exceeding 500 mW, which are considered high-power or high-intensity lasers used in rehabilitation.⁵

In terms of clinical application, photobiomodulation through lasers has proven to be a safe and effective modality, especially for spinal-origin pain and other chronic musculoskeletal conditions. Studies have demonstrated that HILT effectively reduces pain, improves function, decreases inflammation, and promotes tissue repair. However, inconsistencies in treatment protocols and the lack of detailed

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descriptions of irradiation parameters remain challenges that can affect reproducibility across studies.⁵

Photobiomodulation therapy (PBM), including high-intensity laser therapy (HILT), utilizes specific wavelengths and dosages to achieve therapeutic effects in low back pain (LBP). The choice of wavelength is critical, as it influences tissue penetration and absorption by chromophores such as hemoglobin and melanin. Typically, wavelengths between 780 and 950 nm are preferred for targeting deeper tissues like those involved in LBP, while shorter wavelengths (600–700 nm) are more suitable for superficial tissues. Energy density (dosage) in PBM generally ranges from 1 to 150 J/cm², with effective penetration and therapeutic outcomes depending on this parameter.⁶

Several studies have explored the optimal dosage and wavelength parameters for photobiomodulation in High-Intensity Laser Therapy (HILT) for low back pain. Fiore et al. investigated the use of a 1,064 nm wavelength with a total energy dose of 1,200 J delivered over a 3-week period. Their results showed significant improvements in pain and disability scores, highlighting the efficacy of high-energy photobiomodulation in reducing symptoms of chronic low back pain.⁷

Another study compared the effects of different wavelength combinations, including 650 nm and 810 nm versus 810 nm, 980 nm, and 1,064 nm, both with a constant power of 5 W and a dose of 50 J/cm² over 10 daily sessions. The findings indicated that all tested wavelengths provided significant and sustained improvements in pain and function, with benefits lasting up to four months post-treatment. This reinforces the role of photobiomodulation, particularly with higher wavelengths, in long-term management of low back pain.⁷

Tomazoni et al. conducted a randomized controlled trial using a protocol that delivered photobiomodulation at multiple lumbar sites, applying a total dose of 220.05 J per session (with cumulative dose of 2,640.6 J over 12 sessions) using cluster probes. The study emphasized the use of multiple irradiation sites to maximize tissue coverage and therapeutic effect. While the study focused on the overall impact of PBM, the protocol illustrates the importance of both dosage and wavelength selection in achieving meaningful clinical outcomes for low back pain.⁸

5. EFFECT OF HIGH INTENSITY LASER THERAPY ON LOW BACK PAIN

Recent advancements in non-invasive physiotherapeutic modalities have positioned High-Intensity Laser Therapy (HILT) as a promising option for managing chronic low back pain (LBP). A study by Taradaj et al. explored the effects of HILT compared to Low-Level Laser Therapy (LLLT) and placebo interventions on postural control in patients with non-specific chronic LBP. Although all groups, including those receiving stabilization exercises, demonstrated improvements in postural stability, HILT did

not show a statistically significant advantage over LLLT or placebo in both short and long-term follow-ups. This suggests that while HILT may provide benefits, it may not outperform other established interventions in terms of postural control outcomes.⁹

In contrast, a systematic review conducted by Chauhan and Sharma emphasized the potential of HILT when used as an adjunct to exercise therapy. Their analysis from 6 high-quality clinical trials revealed that the combination of HILT and therapeutic exercise significantly enhanced clinical outcomes in terms of pain relief and functional disability. HILT was found to stimulate cellular repair mechanisms, promote collagen synthesis, and improve microcirculation, thereby accelerating recovery and improving the efficacy of exercise-based rehabilitation for LBP.⁵

Further supporting these findings, Alayat et al. conducted a meta-analysis of randomized controlled trials to evaluate the therapeutic value of HILT for spinal disorders, including LBP. Their results demonstrated a significant improvement in both pain intensity and functional status among patients treated with HILT compared to those receiving placebo or conventional physiotherapy. However, despite the favorable outcomes, the authors highlighted a low to very low quality of evidence due to methodological limitations and inconsistencies in treatment protocols across the studies, underlining the need for further high-quality research to validate these findings.³

A broader comparison between HILT and LLLT was undertaken by Saleh et al. who reviewed the effectiveness of both laser modalities in various musculoskeletal conditions, including chronic LBP. While no overall statistical superiority was established between HILT and LLLT in terms of pain and disability outcomes, HILT demonstrated enhanced benefits in specific structural parameters, such as increased muscle thickness and improved echogenicity. These findings suggest that HILT may offer deeper tissue penetration and structural advantages that could contribute to long-term recovery.⁴

A clinical study by Gocevska et al. compared the effectiveness of HILT versus therapeutic ultrasound in patients with chronic LBP. The study showed that HILT, combined with exercise therapy, significantly outperformed ultrasound therapy in reducing pain, improving functional mobility, and enhancing lumbar range of motion. These improvements were sustained for up to three months post-treatment, highlighting HILT's potential as a safe, effective, and durable intervention for managing chronic LBP.¹

Abdildin et al. conducted a systematic review and meta-analysis to evaluate the efficacy of HILT in managing low back pain. Their analysis included randomized controlled trials and demonstrated that HILT significantly reduced pain intensity and improved disability outcomes compared to control groups. The study highlighted that HILT could positively impact patient-reported outcomes such as the Oswestry Disability Index and Roland Disability Index.

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These findings suggest that HILT is an effective modality for reducing pain and enhancing functional status in individuals suffering from low back pain.¹⁰

Abdelbasset et al. performed a randomized comparative study investigating the effects of HILT versus LLLT in patients with chronic nonspecific low back pain. Both treatments significantly reduced pain intensity and disability scores while improving lumbar mobility and overall quality of life. Interestingly, there was no statistically significant difference between the two groups, indicating that HILT is as effective as LLLT. The study supports the use of laser therapies, including HILT, as valuable interventions for the conservative management of chronic low back pain.¹¹

Choi et al. explored the effects of HILT on patients with chronic low back pain in a controlled experimental study. Participants were divided into two groups: one receiving conventional physical therapy alone, and the other receiving HILT following physical therapy. The results demonstrated that the group receiving HILT experienced greater reductions in pain intensity and improvements in functional ability compared to the control group. These findings indicate that adding HILT to conventional therapy may provide enhanced pain relief and functional recovery in patients with chronic low back pain.¹²

Finally Chen et al. performed a systematic review and meta-analysis focusing on the effectiveness of laser therapy, including HILT, for chronic low back pain. Their findings confirmed that laser therapies contribute to significant reductions in pain intensity and disability levels among affected patients. However, the study noted that treatment outcomes might vary depending on factors such as laser type, dosage, and duration of therapy. These results reinforce the therapeutic potential of HILT while also emphasizing the need for standardized treatment protocols to optimize its clinical effectiveness.¹³

6. EFFECT OF HIGH INTENSITY LASER THERAPY REDUCE PAIN

High-intensity laser therapy (HILT), operating at power levels above 500 mW, is a recent innovation for treating musculoskeletal disorders. Utilizing a 1064 nm wavelength, it primarily produces pain relief and reactive vasodilation by stimulating nerve endings in the skin. HILT also promotes tissue repair by acting on various biological levels, including cellular, vascular, interstitial, and immune systems. It stimulates protein synthesis in synovial fluid, boosting regeneration and beta-endorphin release, which contribute to its pain-relieving and anti-inflammatory benefits. The therapy uses a specific waveform with periodic peaks in amplitude and timing to minimize heat buildup while effectively triggering photochemical and photothermal effects deep within tissues. This enhances cellular metabolism, increases blood flow, and improves vascular permeability, leading to fast relief from inflammation and pain.¹⁴

The pain-relieving effects of High-Intensity Laser Therapy (HILT) are believed to result from several mechanisms. In the central nervous system, it boosts the production of natural painkillers like beta-endorphins, which help suppress pain perception. In the peripheral nervous system, HILT reduces the release of substance P—a key chemical involved in pain sensitivity—thereby decreasing hyperalgesia. Additionally, it may slow down the transmission of pain signals by increasing response time and reducing the speed at which sensory nerves (Ae- and C-fibers) conduct impulses. At the tissue level, HILT can also lower the release of inflammatory substances like histamine and bradykinin, helping to raise the pain threshold.¹⁵

HILT delivers a high level of energy to tissues, producing dynamic optical vibrations that trigger photochemical reactions, such as enhanced mitochondrial activity. This boosts ATP production, accelerates metabolism and circulation, and promotes the quick absorption of swelling and removal of fluids. The laser emits very short, rapid pulses that generate pressure waves within the tissue, stimulating free nerve endings. This mechanical stimulation inhibits these nerve terminals, leading to pain relief. HILT offers both immediate and lasting analgesic effects. Its continuous energy emission also induces mild surface heating and blood vessel dilation, improving blood flow in the treated area and helping muscles to relax..¹⁶

7. CLINICAL IMPLICATION

Several studies included in this review provide evidence supporting the clinical applicability of High-Intensity Laser Therapy (HILT) in the management of low back pain (LBP). HILT has been consistently shown to produce significant improvements in pain reduction, functional mobility, and lumbar range of motion, particularly when combined with therapeutic exercise programs. For instance, Gocavska et al. demonstrated that patients treated with HILT in conjunction with exercise experienced greater reductions in pain intensity and disability, as measured by the Numeric Pain Rating Scale and Oswestry Disability Index, compared to those treated with ultrasound therapy. These benefits persisted for up to three months post-treatment, suggesting a sustained therapeutic effect.¹

Similarly, the meta-analysis conducted by Alayat et al. found that HILT, either alone or as an adjunct to conventional physiotherapy, significantly improved both pain and function in patients with spinal disorders, including LBP. The reported effect sizes were large, indicating a strong clinical impact. However, despite these promising results, a notable limitation across studies is the heterogeneity of treatment parameters. Protocols varied in terms of wavelength (typically 1064 nm), dosage (ranging from 50 to 150 J/cm²), session duration (5–15 minutes), frequency (2–5 sessions per week), and overall duration (1–6 weeks), which may affect treatment reproducibility and generalizability in clinical practice.³

8. CONCLUSION

High-Intensity Laser Therapy (HILT) demonstrates substantial potential as an effective and non-invasive modality for the treatment of low back pain (LBP), particularly in chronic cases. Across multiple randomized controlled trials and systematic reviews, HILT was shown to significantly reduce pain intensity, improve functional capacity, and enhance lumbar mobility. Its ability to penetrate deeper tissues, stimulate cellular repair, and promote anti-inflammatory responses makes it a physiologically plausible and therapeutically valuable intervention. Moreover, when combined with therapeutic exercise, HILT enhances clinical outcomes beyond what can be achieved through conventional modalities alone.

Despite these promising findings, the evidence also highlights certain limitations, including heterogeneity in treatment protocols, variability in outcome measures, and generally low to moderate methodological quality across studies. The absence of standardized guidelines and inconsistent reporting of irradiation parameters may limit reproducibility and hinder broader clinical adoption. Nonetheless, HILT appears safe, well-tolerated, and feasible for integration into multidisciplinary rehabilitation programs. Future high-quality research is warranted to establish optimal treatment parameters, assess long-term efficacy, and explore its role in personalized treatment planning for patients with low back pain.

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