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Research article

Specific clinical, functional and quality of life assessment on long term management of chronic low back pain

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Abstract: Low back pain (LBP) remains a major global cause of disability, significantly impairing quality of life and functional capacity. This study aimed to evaluate and compare the effects of two non-pharmacological treatment strategies—physiotherapy alone versus physiotherapy combined with balneotherapy—on pain, disability, psychological well-being, and health-related quality of life. A total of 40 patients diagnosed with LBP were equally divided into two groups: one receiving standard physiotherapy, and the other undergoing a combined protocol including physiotherapy and balneotherapy (mud applications). Clinical assessment included: pain intensity (Visual Analog Scale), functional disability (Oswestry Disability Index, Roland-Morris Disability Questionnaire), pressure pain threshold (digital algometry), depression (Patient Health Questionnaire-9 and Beck Depression Inventory-II), and quality of life (EQ-5D-5L). Results showed that the combined treatment group achieved significant reductions in pain intensity ($p < 0.05$), while both groups showed within-group improvements in functional scores ($p < 0.05$), with no significant between-group differences ($p > 0.05$). Modest improvements in depressive symptoms were observed in both groups ($p < 0.05$), without significant between-group differences ($p > 0.05$). Quality of life improved significantly only in the balneotherapy group ($p < 0.05$), with no change in the control group ($p > 0.05$). These findings suggest that adding balneotherapy to physiotherapy may enhance short-term pain relief and quality of life in patients with chronic LBP. While functional and psychological improvements were observed in both groups, no between-group differences were found in these domains. Further long-term studies are needed to support these findings and optimize multimodal rehabilitation strategies.

Keywords: low back pain, anxiety, depression, balneotherapy, mud therapy, rehabilitation, hydrotherapy, physiotherapy

1. Introduction

Low back pain (LBP) constitutes a major global public health issue, ranking among the foremost causes of disability across all age groups [1]. Beyond its substantial clinical burden, LBP imposes a profound socioeconomic impact, with annual expenditures surpassing 100 billion USD in the United States alone and accounting for up to 2% of the Gross Domestic Product in European countries [2]. These figures underscore the urgency of identifying effective, sustainable, and evidence-based strategies for its management. LBP is reported to affect approximately one in three adults during their lifetime [3].

The management of LBP continues to pose a significant challenge in modern medicine, as conventional treatments—such as analgesics, physiotherapy, and surgical interventions—often fail to provide long-term efficacy and may be associated with considerable adverse effects [4].

Physiotherapy, through therapeutic exercise, manual therapy, and patient education, has proven effective in reducing pain and improving function in cases of chronic low back pain, although the benefits are generally considered to be moderate [5]. Balneotherapy, on the other hand, is a traditional treatment modality that employs mineral waters and therapeutic muds to alleviate musculoskeletal pain. Its mechanisms of action include the reduction of inflammation, enhancement of local circulation, and promotion of muscle relaxation [6].

Balneotherapy and peloid therapy have been used for centuries to relieve musculoskeletal pain, owing to their anti-inflammatory, analgesic, and muscle-relaxant effects [7]. The study compares standard physiotherapy to an integrative approach combining physiotherapy with balneotherapy. This parallel design enables a comparative evaluation of the effectiveness of each intervention, without assuming any synergistic or combined effects.

Physiotherapy and balneotherapy may represent innovative strategies for the management of LBP, providing patients with integrated, and minimally invasive therapeutic approaches [2]. The etiology of LBP is multifactorial, involving biomechanical, genetic, psychosocial, and lifestyle-related factors. The primary causes include ligamentous instability and intervertebral disc degeneration, inflammation and deterioration of musculoskeletal structures, as well as psychosocial elements such as stress and depression, which influence pain perception. Environmental factors, including poor posture and physical inactivity, also play a significant role.

In clinical practice, the management of LBP typically involves a combination of pharmacological therapies: Non-Steroidal Anti-Inflammatory Drugs, opioids, muscle relaxants, non-pharmacological interventions (physiotherapy, exercise, cognitive-behavioral therapy), and surgical procedures in severe cases [4]. However, the overall effectiveness of these treatment strategies remains limited, and a significant proportion of patients continue to experience recurrent chronic pain, underscoring the need for alternative therapeutic approaches [8]. Fioravanti et al. conducted a meta-analysis of studies on balneotherapy in rheumatologic conditions and concluded that this modality may yield long-term benefits in chronic low back pain, including improved quality of life and reduced reliance on analgesic medications [6].

The rationale for selecting this research topic lies in the pressing need to identify effective and safe therapeutic alternatives for patients with persistent low back pain—approaches that can reduce reliance on analgesic medication while enhancing functional outcomes. To this end, we set out to compare two therapeutic programs: one group undergoing conventional physiotherapy alone, and another receiving a combined intervention of physiotherapy and balneotherapy, to determine whether the addition of balneotherapy provides superior benefits in pain reduction and functional improvement. We hypothesized that the addition of balneotherapy to physiotherapy would result in superior improvements in pain relief, functional status, and quality of life compared to physiotherapy alone.

2. Materials and Methods

2.1. Study Model

Between March and July 2025, 40 patients with LBP were enrolled in this prospective, randomized, controlled, single-blind study at the Balneal and Rehabilitation Sanatorium Techirghiol (BRST) and Ovidius Clinical Hospital (OCH), Romania (23 males, 17 females). The Ethical Committee approved the study (For BRST - approval no. 4902 from 25 March 2025 and for OCH - approval no. 76 from 25 March 2025) and

complied with the revised ethical guidelines of the Declaration of Helsinki. The Balneotherapy group and the Control group were randomly assigned to two groups of patients. This was an exploratory pilot study; therefore, no formal power calculation was conducted. The sample size was based on feasibility and resource constraints.

2.2. Study Population

Inclusion criteria consisted of patients aged 18 to 80 years with clinically and paraclinically diagnosed LBP (lasting more than 3 months), confirmed by imaging: Magnetic Resonance Imaging (MRI) or X-ray; a Visual Analog Scale (VAS) score ≥ 4 for lumbar pain; the ability to follow the study protocol and attend regular evaluations; and provision of informed consent for participation in the study.

Exclusion criteria included patients with disc herniation requiring surgery or severe radiculopathy; active infections, systemic inflammatory diseases, or autoimmune disorders; a history of allergy to substances used in prolotherapy; contraindications to balneotherapy (e.g., severe cardiovascular disease, renal insufficiency, severe dermatological conditions); prior prolotherapy or balneotherapy within the past 6 months; decompensated chronic diseases at the time of enrollment (cardiovascular, hepatic, renal, respiratory, or neurological conditions); pregnancy or breastfeeding; neoplastic diseases; decompensated psychiatric disorders; allergies to natural therapeutic factors that may lead to treatment discontinuation; and refusal to participate in the study.

Data on demographics and clinical conditions were gathered. Demographic data were collected, including age, sex, body mass index (BMI), living environment (urban/rural), physical activity level, educational status, comorbidities, and the chronic medication use.

Also, we collected the following data: pain assessment using the VAS and digital algometry; functional evaluation with the Roland-Morris Disability Questionnaire (RMDQ) and the Oswestry Disability Index (ODI); quality of life measurement using the EQ-5D-5L UK English version; evaluation of depressive symptoms using the Patient Health Questionnaire-9 (PHQ-9), and Beck Depression Inventory (BDI-II); laboratory tests to verify exclusion criteria, included complete blood count, erythrocyte sedimentation rate, aspartate aminotransferase, alanine aminotransferase, alkaline phosphatase, blood glucose, uric acid, urea and creatinine. In addition, imaging investigations (lumbar spine X-ray or MRI) were performed to confirm the diagnosis of LBP.

Digital algometry offers a precise and objective method for quantifying pressure pain thresholds, enabling the detection of subtle changes in pain sensitivity that might not be captured through subjective pain scales alone. Pressure pain sensitivity was assessed using the Medoc AlgoMed digital algometer (Medoc Ltd., Ramat Yishai, Israel). The device applies a steadily increasing pressure through a handheld probe, while the operator maintains a constant application rate guided by real-time visual and auditory feedback from the software interface. For each measurement site, participants were instructed to indicate the point at which the sensation first became painful (Pressure Pain Threshold, PPT) and, if required, the maximum tolerable pressure (Pressure Pain Tolerance, PPTol). These values were automatically recorded by the system's software, ensuring accuracy and reproducibility. The method allows for standardized assessment of mechanical pain sensitivity and has been validated in both clinical and research settings [9].

Patients were randomly assigned to the two groups using a computer-generated randomization list, with allocation concealment ensured by sealed opaque envelopes. Outcome assessors were blinded to group allocation, while patients and therapists were not, due to the nature of the interventions. Both groups underwent a standardized 10-day inpatient rehabilitation program. The physiotherapy protocol included daily sessions of electrotherapy (20 minutes), massage therapy (15 minutes), and kinesiotherapy (30 minutes). In the intervention group, balneotherapy consisted of

daily applications of heated sapropelic mud (40°C) for 20 minutes, followed by immersion in mineral water from Techirghiol Lake for 15 minutes, administered once per day for 10 consecutive days. All 40 participants completed the study, with no dropouts or reported adverse events related to the interventions.

2.3. Study Objectives

The general objective was to compare the effectiveness of physiotherapy and balneotherapy in the treatment of LBP by evaluating their impact on pain reduction, improvement in lumbar function, and patients' quality of life. The second aim of the study was to assess the impact of physiotherapy and balneotherapy on mental health and to correlate pain relief with improvements in depressive symptoms using validated assessment scales.

Figure 1. Algometer (https://www.medoc-web.com/algomed)

2.4. Data Analysis

Statistical analysis was performed using IBM SPSS Statistics for Windows, version 26.0 (IBM Corp., Armonk, NY, USA). A p-value of <0.05 was considered statistically significant. Statistical analysis will involve descriptive statistics (mean, standard deviation) for all outcome measures at baseline and after intervention. Paired-samples t-tests will be used to assess within-group differences over time, while independent-samples t-tests will evaluate between-group differences in change scores. The primary outcomes include pain intensity: VAS, digital algometry (Figure 1), functional status: ODI, RMDQ, quality of life: EQ-5D-5L, and mental health: PHQ-9, BDI-II. A p-value of <0.05 will be considered statistically significant.

3. Results

3.1. Study Population

A total of 51 patients were invited to the study. This study was conducted on 40 patients with LBP (Figure 2) and was divided into two groups: a balneotherapy group comprising 20 patients and a control group comprising 20 patients.

The demographic and clinical characteristics (Table 1) of the two study groups show a relatively balanced distribution, with some notable distinctions. The balneotherapy group was composed predominantly of older patients (ages 50–79), most patients were from urban environments and the balneotherapy group had a higher proportion of individuals with normal weight compared to the control group, where cases of grade I obesity were present. Both groups were characterized by a high prevalence of cardiovascular and endocrine-metabolic comorbidities. The level of education was generally high across both groups. While sedentary behavior was more common in the balneotherapy group, the control group included a higher percentage of

physically active individuals. These baseline differences are important to consider when interpreting the effects of the interventions on clinical outcomes.

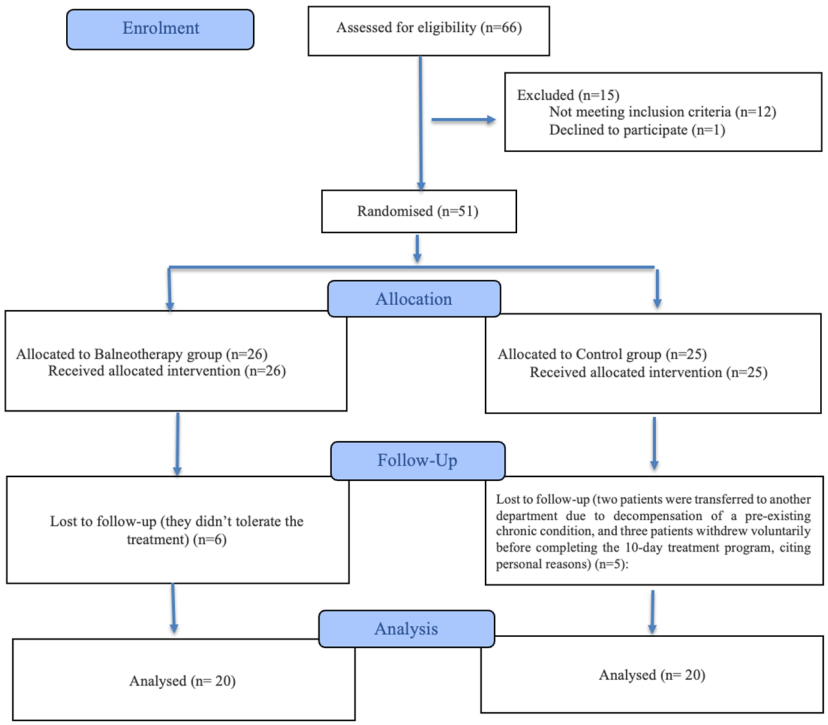


Figure 2. Flowchart of patient's selection

Table 1. Demographic and clinical characteristics of patients

Item	***Group 1 (Balneotherapy) N=20***	***Group 2 (Control) N=20***
Gender (female:male)	9:11	2:3
Age distribution		
30-39 years	0	5
40-49 years	0	3
50-59 years	10	6
60-69 years	5	6
70-79 years	5	0
Environment (urban:rural)	19:1	1:1
Nutritional Status		
Normal	7	4
Overweight	13	12
Obese	0	4
Educational Level		
None	0	1
Secondary	9	7
Higher	11	12
Physical Activity		
Sedentary	7	6
Moderate	10	7
Active	7	7
Comorbidities		
Cardiovascular	14	13
Endocrine-metabolic	11	10
Osteoarticular	5	4
Urological	3	1

3.2. Clinical–Functional Status

The primary objective was to evaluate and compare the effectiveness of physiotherapy alone versus physiotherapy combined with balneotherapy in managing LBP. The analysis focused on outcomes related to pain reduction, functional improvement, and quality of life. Pain was assessed using the VAS and digital algometry; lumbar function was measured through the RMDQ and the ODI; and quality of life was assessed with the EQ-5D-5L.

We observed a statistically significant reduction in pain intensity measured by the VAS in both groups, with the balneotherapy cohort's mean VAS decreasing from 62.5 ± 13.72 at admission to 34.0 ± 9.95 at discharge and the control groups from 64.25 ± 11.62 to 46.0 ± 10.95, indicating $p < 0.001$ for both paired t-tests in each group. Between-group comparison at discharge revealed that the balneotherapy group had significantly lower VAS scores than the control group, supported by independent-samples t-test ($t \approx -3.63$, $p < 0.001$) and Mann–Whitney U test ($U = 84.0$,$p < 0.001$)

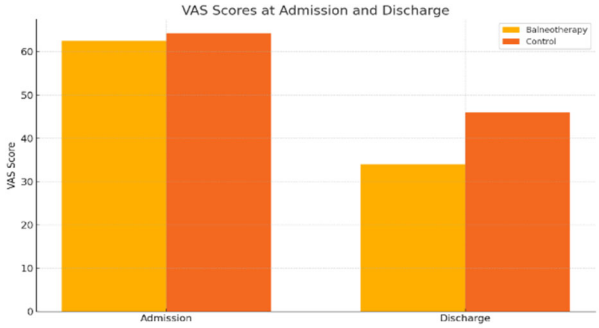


Figure 3. VAS Scores at Admission and Discharge – Comparative Analysis

(Figure 3).

Digital algometry on the right side (Figure 4) showed significant increases in pressure pain threshold in both groups, with the balneotherapy group's mean rising from 468.4 ± 155.8 to 538.4 ± 143.3 and the control groups from 485.8 ± 195.2 to 501.4 ± 188.5 $p < 0.001$. Between-group analysis at discharge (Figure 5) confirmed a significantly higher-pressure pain threshold in the balneotherapy group ($t \approx 3.18$, $p < 0.001$; $U = 96.5$, $p < 0.001$).

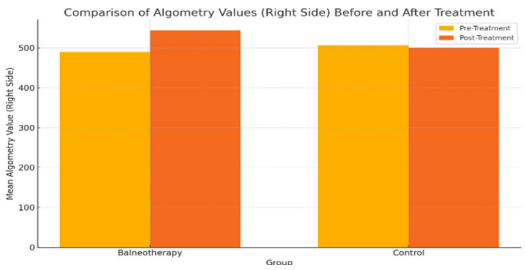


Figure 4. Comparison of Right-Side Algometry Values Before and After Treatment

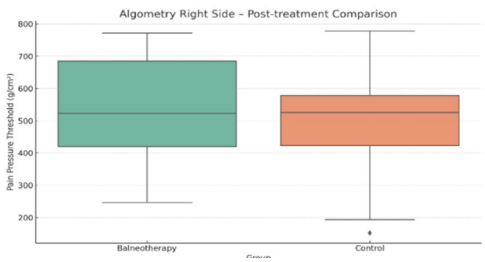


Figure 5. Right-Side Algometry – Post-Treatment Comparison Between

On the left side digital algometry (Figure 6), only the balneotherapy group improved significantly from 403.23 ± 160.28 to 494.70 ± 145.93 (t = –5.18, p = 0.0001), whereas the control group change (454.98 ± 157.36 to 466.20 ± 151.21) was not significant (t = –1.65, p = 0.1162). Between-group comparison for the left side at discharge (Figure 7) showed no statistically significant difference (t ≈ 0.37, p > 0,05; U = 211.5, p > 0,05).

Figure 6. Comparison of Left-Side Algometr Values Before and After Treatment

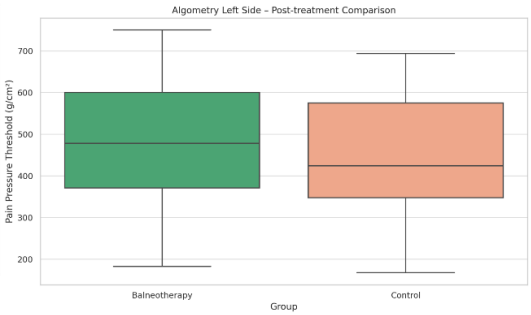


Figure 7. Left-Side Algometry – Post-Treatment Comparison Between Groups

These results support that balneotherapy combined with physiotherapy led to greater reductions in pain intensity and improvements in pressure pain threshold, particularly on the right side, whereas left-side changes were less conclusive.

The ODI was used to assess lumbar functional impairment at both admission and discharge (Figure 8) and the results revealed a statistically significant reduction in disability scores within each group as demonstrated by paired sample t-tests with the balneotherapy group improving from a mean of 26.2 ± 11.91 at baseline to 22.1 ± 11.29 at discharge (t = 17.96, p < 0.001) and the control group showing a reduction from 24.5 ± 8.43 to 21.45 ± 7.69 (t = 4.97, p < 0.001). Despite these improvements, the between-group comparison at discharge did not yield statistically significant differences with an independent samples t-test yielding p = 0.833 and a Mann–Whitney U test confirming this result (p > 0,05), suggesting that while both interventions led to functional improvements, they were comparable in terms of overall ODI outcome at the end of the intervention.

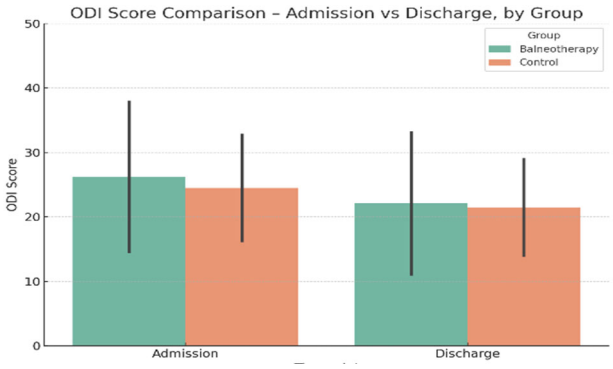


Figure 8. ODI Score – Admission vs Discharge by

The RMDQ was also used to measure perceived functional limitations associated with chronic low back pain and analysis of within-group changes demonstrated statistically significant improvements in both groups with the balneotherapy group (Figure 9) showing a mean reduction from 7.1 ± 4.35 to 6.05 ± 3.66 (t(19) = 5.29, p < 0.001) and the control group improving from 5.95 ± 3.12 to 5.4 ± 2.7 (t(19) = 3.58, p = 0.002). However, the between-group comparison at discharge did not reach statistical significance as evidenced by both the independent t-test (p > 0,05) and Mann–Whitney U test (p > 0,05), indicating that while improvements occurred in both groups,

the difference in RMDQ outcome between the interventions was not meaningful at the group level.

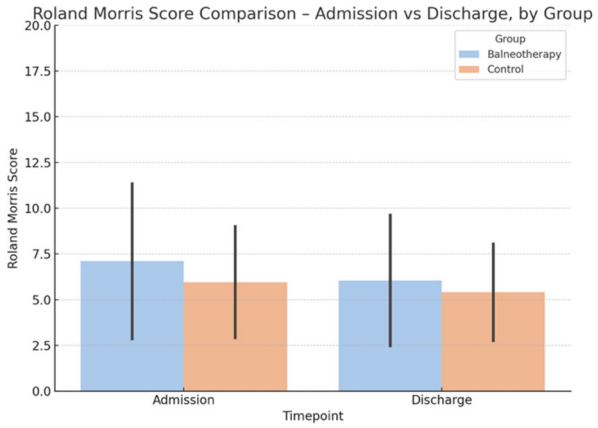


Figure 9. Roland-Morris Disability Score – Admission vs Discharge by Group

Quality of life was assessed using the EQ-5D-5L index (Figure 10) and results showed a statistically significant improvement in the balneotherapy group, with scores increasing from 0.662 ± 0.284 at admission to 0.720 ± 0.270 at discharge ($t = -9.84$, $p < 0.001$), whereas no change was observed in the control group, whose mean scores remained constant at 0.791 ± 0.095 ($t = 0.00$, $p = 1.000$). Despite the within-group improvement in the balneotherapy cohort, the between-group comparison at discharge did not reach statistical significance, as shown by an independent samples t-test ($t = -1.07$, $p > 0.001$), indicating that the final quality-of-life levels were statistically comparable between the two groups.

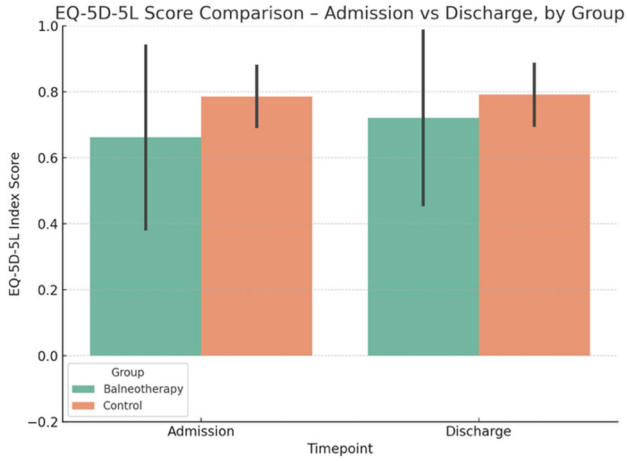
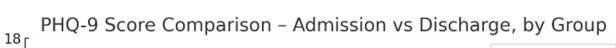


Figure 10. EQ-5D-5L Score – Admission vs Discharge by Group

The secondary objective was to assess the psychological impact of the interventions by evaluating depressive symptoms using validated tools, including the PHQ-9 and the BDI-II.

Depression severity was evaluated using the PHQ-9 questionnaire (Figure 11) and both groups demonstrated statistically significant reductions in depressive symptoms from admission to discharge based on paired samples t-test results the balneotherapy group showed a mean reduction from 4.65 ± 3.84 to 3.40 ± 3.12 ($t = 5.78$, $p < 0.001$) while the control group improved from 4.95 ± 3.65 to 4.45 ± 3.43 ($t = 2.94$, $p = 0.008$). Despite these within-group improvements, the comparison between groups at discharge did not reach statistical significance as indicated by an independent samples t-test ($p < 0,05$) and confirmed by the Mann–Whitney U test ($p < 0,05$) suggesting



that while both interventions contributed to the reduction in depressive symptoms the magnitude of change was not significantly different between the two treatment conditions.

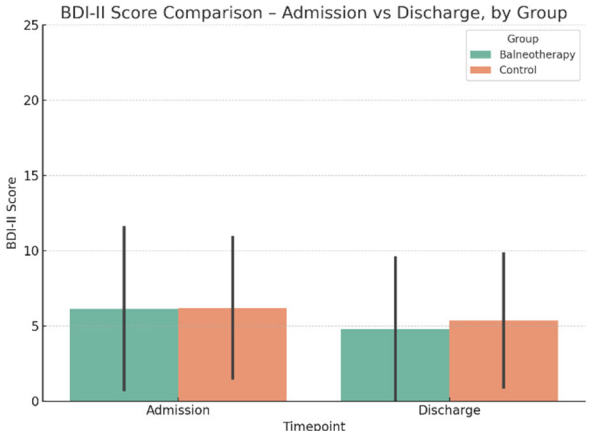


Figure 12. BDI-II Score – Admission vs Discharge by Group

Depressive symptoms were also assessed using the BDI-II (Figure 12) and both groups showed statistically significant reductions from baseline to discharge according to paired sample t-tests the balneotherapy group improved from a mean score of 6.15 ± 5.53 to 4.80 ± 4.84 ($t = 6.11$, $p < 0.001$) while the control group showed a reduction from 6.20 ± 4.80 to 5.35 ± 4.55 ($t = 4.34$, $p < 0.001$). However, statistical comparison of scores at discharge between the two groups did not reveal significant differences with the independent t-test yielding a p-value of 0.713 and the Mann–Whitney U test confirming this result ($p < 0.05$), indicating that both interventions were similarly effective in reducing depression levels as measured by BDI-II.

Only VAS showed a large effect size, supporting clinically meaningful pain reduction in the balneotherapy group. Functional scores (ODI, RMDQ) and depression scales (PHQ-9, BDI-II) had small or negligible effects. EQ-5D-5L improvement had a small to moderate effect—observed only in the balneotherapy group (Table 2).

Tabel 2. Post-treatment Comparative Analysis with Effect Sizes

Parameter	Balneotherapy Group (Mean ± SD)	Control Group (Mean ± SD)	Mean Difference (ΔM)	95% CI*	Cohen's d	Interpretation	p-values
VAS	34.0 ± 9.95	46.0 ± 10.95	–12.0	(–18.5, –5.4)	1.15	Large	0.00085
Algometry Right	538.4 ± 143.3	501.4 ± 188.5	+37.0	(12.0, 62.0)	0.23	Small	0.003
Algometry Left	494.7 ± 145.9	466.2 ± 151.2	+28.5	(–17.0, 74.0)†	0.19	Small	0.7108
ODI	22.1 ± 11.29	21.45 ± 7.69	+0.65	(–4.7, 6.0)	0.06	Negligible	0.833
RMDQ	6.05 ± 3.66	5.4 ± 2.7	+0.65	(–1.5, 2.8)	0.20	Small	0.527
EQ-5D-5L	0.720 ± 0.270	0.791 ± 0.095	–0.071	(–0.19, 0.05)	0.33	Small–Moderate	0.296
PHQ-9	3.40 ± 3.12	4.45 ± 3.43	–1.05	(–2.6, 0.5)	0.32	Small–Moderate	0.317
BDI-II	4.80 ± 4.84	5.35 ± 4.55	–0.55	(–2.3, 1.2)	0.12	Negligible	0.713

Notes: *CI = 95% confidence interval; calculated for between-group mean differences. Based on independent samples (n = 20 per group). † CI includes 0 → not statistically significant. Cohen's d: small ≈ 0.2; medium ≈ 0.5; large ≥ 0.8.

4. Discussion

Baseline differences—such as older age, lower BMI, and predominantly urban living in the balneotherapy group—may have influenced treatment response or reporting bias. Although randomization was applied, future studies with stratified sampling or adjusted analyses are needed to minimize such confounding effects.

Our study demonstrated a statistically significant reduction in pain intensity measured by VAS in both groups, with the balneotherapy cohort decreasing from 62.5 ± 13.72 at admission to 34.0 ± 9.95 at discharge and the control group from 64.25 ± 11.62 to 46.0 ± 10.95 ($p < 0.001$ for both). The between-group comparison at discharge further revealed significantly lower VAS scores in the balneotherapy group ($t \approx -3.63$, $p = 0.00085$; $U = 84.0$, $p = 0.0012$), indicating an enhanced pain relief effect with balneotherapy.

These results are in line with previous evidence showing that spa therapy and balneotherapy significantly reduce pain intensity on a 100 mm VAS compared to control interventions—the 2006 meta-analysis reported a weighted mean difference of 18.8 mm (95% CI 10.3–27.3, n = 138) [10]. Similarly, Kesiktas et al.'s randomized controlled trial found superior improvements in pain, disability (ODI), spinal flexibility (Schober test), and quality of life in LBP patients treated with balneotherapy plus exercise compared to exercise-only treatment [11].

The objective increase in pressure pain thresholds through digital algometry complements these findings, suggesting not only symptomatic improvement but also measurable sensory changes. This aligns with the recognized reliability and validity of digital algometers in quantifying pressure pain thresholds [12].

Quality of life in the balneotherapy group, assessed via EQ-5D-5L, improved significantly from 0.662 ± 0.284 at admission to 0.720 ± 0.270 at discharge ($t = -9.84$, $p < 0.001$), whereas the control group showed no change, remaining at 0.791 ± 0.095 ($t = 0.00$, $p = 1.000$).

Although the between-group difference at discharge was not statistically significant ($t = -1.07$, $p = 0.296$), the within-group improvement in the balneotherapy cohort supports the therapeutic potential of balneotherapy in enhancing health-related quality of life in LBP. These results align with evidence demonstrating balneotherapy's beneficial effects on quality of life scores. For example, a randomized trial in patients with LBP reported superior enhancements in SF-36 and perceived health status with balneotherapy plus exercise compared to exercise alone [13].

Additional randomized controlled trials (RCTs) in rheumatologic and musculoskeletal conditions have similarly documented clinically meaningful improvements in EQ-5D-5L utility up to six to nine months following spa therapy [14].

Moreover, studies validating EQ-5D-5L for LBP populations confirm its responsiveness in detecting change, reinforcing its suitability as a measure of intervention impact [13].

Taken together, our findings contribute to a growing body of literature supporting the short-term quality-of-life benefits of balneotherapy in LBP, while also highlighting the need for longer follow-up and larger cohorts to demonstrate persistent and between-group differences in utility outcomes.

In contrast, although balneotherapy showed clear benefits in pain reduction, our study found no significant between-group differences in disability measures (ODI, RMDQ) and psychological scales (PHQ-9, BDI-II) at discharge. This suggests that while balneotherapy enhances symptom relief and sensory tolerance, its additional benefit on function and psychological wellbeing may require longer treatment duration or a larger sample to reach statistical significance [15].

This pattern aligns with existing literature. For instance, Huber et al. reported improvements in pain, disability, and psychological parameters following combined balneotherapy and "green exercise," but also emphasized the need for larger RCTs to confirm effects on mental health [16, 17]. Moreover, Stanciu et al. emphasized the

link between LBP reduced quality of life, and the functional impact of balneal treatment, underscoring the importance of extended follow-up and comprehensive outcome assessment [18, 19]. Together, these findings reinforce our conclusion that while balneotherapy offers notable within-group benefits, demonstrating superiority over standard physiotherapy in psychological domains may require more robust study designs.

Regarding psychological status, analyzing 17 studies across various chronic conditions, the authors found significant reductions in depressive symptoms with a standardized mean difference (SMD) = 0.53 (95% CI: 0.38–0.67) [20].

Importantly, depression improvements were consistent across interventions—even without concurrent therapies—supporting the idea that balneotherapy alone can meaningfully alleviate mood symptoms. In a randomized study involving patients with fibromyalgia (often accompanied by LBP), standard balneotherapy combined with exercise significantly reduced depression scores, supporting the antidepressant effect of mineral-rich water immersion [18]. This comprehensive review of balneotherapy in musculoskeletal conditions concluded that balneotherapy exerts moderate to strong effects on depression and anxiety, although variability in study designs often resulted in within-group effects but mixed results for between-group comparisons [21-24]. Although these findings from fibromyalgia and ankylosing spondylitis provide insight into the physiological impact of spa therapies, their direct applicability to non-specific LBP remains limited. Our interpretation is cautious, and we acknowledge the need for further condition-specific trials. The literature consistently reports improvements in depressive symptoms following balneotherapy, although it does not demonstrate clear superiority over physical therapy alone in controlled comparisons. These findings underscore the need for larger sample sizes, extended follow-up periods, and more targeted assessments of psychological outcomes to determine whether balneotherapy provides a unique and clinically meaningful benefit. This aligns with recent calls from Romanian authors for more comprehensive rehabilitation approaches, integrating both physical and psychosocial dimensions of LBP. [25, 26].

Although balneotherapy led to significant within-group improvements in function and mood, these were not superior to physiotherapy alone. This finding suggests that pain relief may precede, but not necessarily translate into, greater functional or emotional recovery in the short term.

The addition of balneotherapy to physiotherapy demonstrated significantly greater reductions in pain intensity and increased pressure pain thresholds. However, no between-group differences were observed in functional or psychological outcomes. Overall, our findings and the existing literature support the integration of balneotherapy into multidisciplinary rehabilitation programs for LBP, leveraging both objective and subjective benefits in pain modulation. Nevertheless, future studies involving larger cohorts and extended follow-up periods are warranted to assess its long-term impact on functional status and mental health outcomes.

4.1 Study strengths

A notable strength of this study is the use of multiple validated clinical instruments to assess outcomes, including two standardized depression scales (PHQ-9, and BDI-II), which enabled a nuanced evaluation of psychological status. The application of digital algometry provided objective quantification of pressure pain thresholds, adding precision to the assessment of sensory changes. Additionally, the controlled design and balanced group distribution contributed to the methodological robustness of the study.

4.2. Study Limitations

A key limitation of this study is the relatively small sample size, which may limit the generalizability of the results. Additionally, the short-term follow-up does not

allow for conclusions regarding the long-term sustainability of the observed improvements, particularly in psychological outcomes.

4.3. Facts and Perspectives

The findings of this study confirm that both physiotherapy and balneotherapy are effective in reducing pain and improving functional status in patients with LBP, with additional psychological benefits observed in both groups. Although no significant differences were found between groups in mental health outcomes, the consistent within-group improvements suggest that multimodal interventions addressing both physical and emotional domains may offer added value. Future research should explore long-term effects, optimize treatment combinations, and further investigate the role of individualized psychological support in enhancing therapeutic outcomes.

5. Conclusions

This study demonstrates that both physiotherapy and the combined approach of physiotherapy with balneotherapy are effective in reducing pain intensity and improving functional status in patients with LBP. Significant improvements were observed within both groups across all outcome domains, including pain perception, lumbar function, and psychological well-being. Although between-group differences were not statistically significant for depression and anxiety scores, the consistent reduction in symptoms highlights the potential value of integrating physical and psychosocial components in rehabilitation strategies. These results support the use of comprehensive, multidisciplinary approaches for managing LBP and lay the groundwork for future studies with larger samples and longer follow-up periods.

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