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# Changes in Pain Severity, Functional Disability, Psychological Well-Being, and Anxiety Following an 8-Week Physiotherapy-Based Exercise Programme in Adults with Chronic Low Back Pain: A Single-Group Pre-Post Study

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**ABSTRACT**

Chronic low back pain is a leading cause of disability worldwide and frequently co-occurs with anxiety and reduced psychological well-being, yet physiotherapy outcome assessment often focuses on pain and function alone. This study examined changes in pain severity, functional disability, psychological well-being, and anxiety symptoms among adults with chronic low back pain following an 8-week physiotherapy-based exercise programme. A single-group pre-post design was used with 50 adults aged 30 to 62 years who had experienced low back pain for at least three months. Participants attended supervised sessions three times weekly, each lasting 45 to 60 minutes, comprising core stabilization, strengthening, flexibility, postural correction, functional mobility exercises, and home-exercise education. Pain severity was assessed with the Numeric Pain Rating Scale, functional disability with the Oswestry Disability Index, psychological well-being with the WHO-5 Well-Being Index, and anxiety symptoms with the anxiety subscale of the Depression Anxiety Stress Scales-21. Paired-samples t-tests and within-subject effect sizes were used to compare baseline and post-intervention scores. Statistically significant improvements were observed on all four outcomes, with large effects for pain severity and functional disability and moderate effects for psychological well-being and anxiety symptoms. However, the mean changes in pain and disability did not consistently reach commonly proposed thresholds for clinically important change. Participation in the programme was therefore associated with favourable change across physical and psychological domains, although the absence of a control group precludes causal attribution. Randomised controlled trials with larger samples and longer follow-up are needed to establish effectiveness and durability.

## Introduction

Low back pain is the leading cause of years lived with disability worldwide, affecting an estimated 619 million people in 2020, with prevalent cases projected to exceed 800 million by 2050 (GBD 2021 Low Back Pain Collaborators, 2023). Although most episodes resolve, recurrence is common, and in a subset of people the pain persists and becomes disabling (Hartvigsen et al., 2018). Pain that persists or recurs for more than three months is classified as chronic, and within the International Association for the Study of

Pain classification developed for ICD-11, non-specific chronic low back pain may be conceptualised as a chronic primary pain condition rather than merely a symptom (Treede et al., 2019).

The burden of chronic low back pain (CLBP) extends beyond pain intensity. People with CLBP report restrictions in walking, sitting, lifting, sleep, work, and social participation. Pain and disability are related but not interchangeable, and changes in one do not reliably mirror changes in the other (Kovacs et al., 2004). Chronic back pain is also consistently associated with psychological morbidity: in population surveys across 17 countries, anxiety and mood disorders were approximately twice as common among people with chronic back or neck pain as among those without (Demyttenaere et al., 2007). Psychological distress is not only a consequence of persistent pain but is also among the factors associated with the transition to persistent, disabling back pain (Hartvigsen et al., 2018; Wongwitwichote et al., 2026).

Clinical guidelines therefore recommend managing CLBP within a biopsychosocial framework, with exercise and education supporting self-management as first-line non-pharmacological care (Foster et al., 2018). Exercise therapy has the strongest evidence base among these options. A Cochrane review of 249 trials found moderate-certainty evidence that exercise reduces pain compared with no treatment, usual care, or placebo, although effects on functional limitation were smaller (Hayden et al., 2021). Evidence regarding psychological outcomes is less consistent: some syntheses report benefits of exercise for mental health (Owen et al., 2020; Zhou et al., 2024), whereas others describe variable effects on psychological function (Geneen et al., 2017).

This inconsistency matters for physiotherapy practice. Outcome assessment in physiotherapy frequently centres on pain and disability, yet anxiety and reduced well-being may accompany CLBP and shape recovery. Assessing these domains alongside physical outcomes provides a fuller picture of how patients change during routine rehabilitation, without repositioning physiotherapists as providers of psychological treatment. In Pakistan, trials of exercise-based physiotherapy for CLBP have focused mainly on pain intensity and functional disability (Afzal et al., 2022; Waseem et al., 2019), and data describing concurrent physical and psychological change within such programmes remain limited. The present study therefore examined changes in pain severity, functional disability, psychological well-being, and anxiety symptoms among adults with CLBP before and after an 8-week physiotherapy-based exercise programme delivered in private rehabilitation centres.

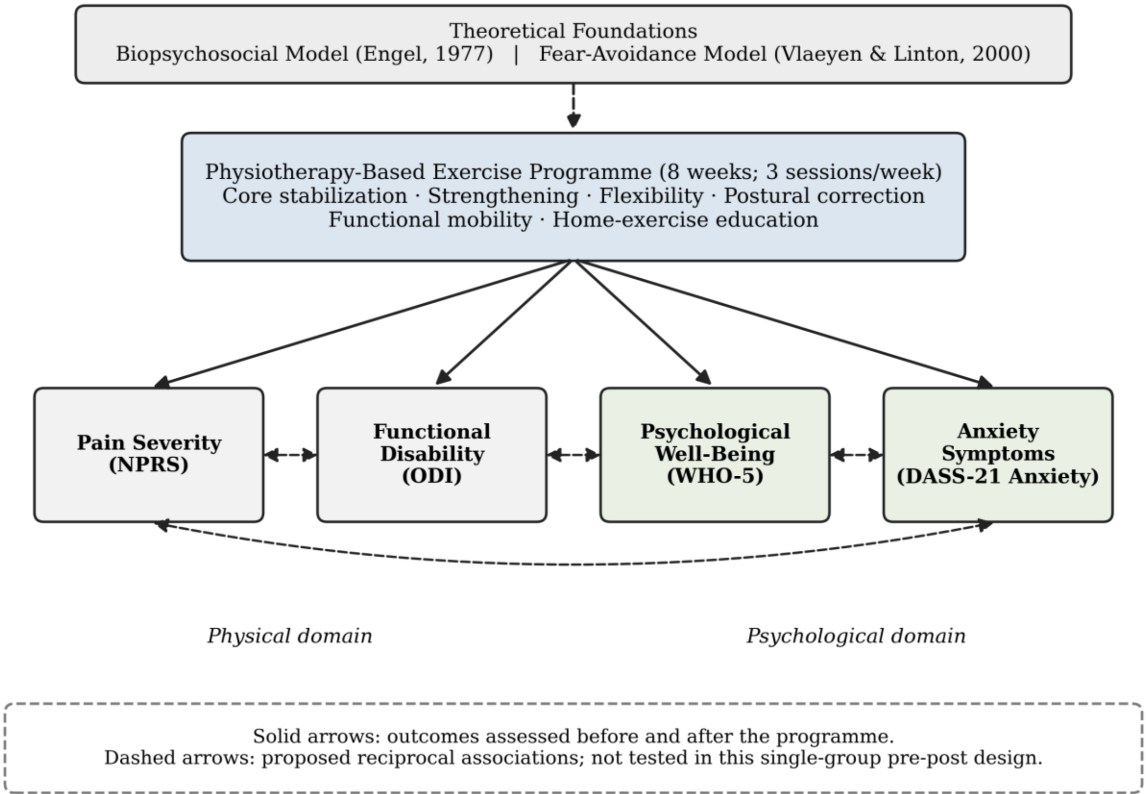
## Theoretical Framework

The study is grounded in the biopsychosocial model (Engel, 1977) and the fear-avoidance model of chronic musculoskeletal pain (Vlaeyen & Linton, 2000). The biopsychosocial model proposes that illness experience arises from interacting biological, psychological, and social factors. Applied to CLBP, it implies that pain, physical function, and emotional state are interdependent and that rehabilitation outcomes should be assessed across these domains rather than through pain intensity alone.

The fear-avoidance model describes how pain appraised as threatening may provoke pain-related fear and anxiety, leading to avoidance of movement, physical deconditioning, and increasing disability, which in turn sustain pain and distress. Graded, supervised movement offers a potential route out of this cycle by exposing patients to activity in a safe context. Within this framework, a structured exercise programme may be associated with change through several complementary pathways, including exercise-related modulation of pain processing (Rice et al., 2019), improved trunk control, strength, and mobility supporting daily function, reduced movement-related fear, and improved mood associated with regained activity.

These pathways are reciprocal rather than strictly sequential: improvement in one domain may accompany, precede, or follow improvement in another. The framework therefore guides outcome selection and interpretation, but the present single-group pre-post design does not test mediation or the temporal ordering of change (Figure 1).

**Figure 1: Conceptual Framework of the Study**




*Note.* NPRS = Numeric Pain Rating Scale; ODI = Oswestry Disability Index; WHO-5 = WHO-5 Well-Being Index; DASS-21 = Depression Anxiety Stress Scales-21. Solid arrows indicate outcomes assessed before and after the programme; dashed arrows indicate theoretically proposed reciprocal associations that were not tested in this design.

## Literature Review

### Chronic Low Back Pain: Burden and Persistence

Low back pain has remained the leading global cause of years lived with disability, and a substantial share of this disability is attributable to modifiable factors such as occupational exposures, smoking, and high body mass index (GBD 2021 Low Back Pain Collaborators, 2023). Disability from low back pain is projected to rise, with the greatest increases expected in low- and middle-income countries, where health systems may be least equipped to respond (Hartvigsen et al., 2018). For most patients, no specific nociceptive cause can be identified, and high initial pain intensity, psychological distress, and pain at multiple body sites are associated with persistence (Hartvigsen et al., 2018).

### Exercise-Based Physiotherapy

Exercise therapy is the most extensively studied conservative treatment for CLBP. Hayden et al. (2021) pooled 249 randomised trials and found a clinically important reduction in pain with exercise compared with no treatment, usual care, or placebo, alongside a smaller improvement in functional limitation that did not reach their prespecified threshold for clinical importance. Compared with other conservative treatments, exercise was superior, although these differences were small. A network meta-analysis by Owen et al. (2020) found low-quality evidence that Pilates ranked highest for pain, stabilisation/motor control and resistance training for physical function, and resistance and aerobic training for mental health, whereas stretching and McKenzie exercises did not differ from true control for pain or function. In Pakistan, randomised trials have reported reductions in pain and disability with core stabilisation exercises (Waseem et al., 2019) and with virtual reality exercises combined with routine physical therapy (Afzal et al., 2022). Importantly, few trial interventions report exercise type and dose clearly enough to judge adequacy against physical activity guidelines (Gibbs et al., 2024). Together, this evidence supports multicomponent programmes combining stabilisation and strengthening, while underlining the need for transparent reporting of exercise dosage.

**Pain Severity and Functional Disability**

Pain intensity and disability are correlated, but the relationship is moderate and changes over time. In primary care patients with predominantly recent-onset low back pain, Kovacs et al. (2004) found that pain explained only a modest proportion of disability and concluded that the two should be assessed separately when evaluating treatment. This distinction matters for interpretation, because a patient may report less pain without proportionate functional gain, or regain function despite persisting pain. Minimal important change thresholds have been proposed for both constructs (Ostelo et al., 2008), allowing statistical change to be considered alongside clinical relevance.

**Psychological Well-Being in Chronic Pain**

Chronic pain has well-documented associations with depressive symptoms, reduced quality of life, and poorer treatment outcomes; pain that is moderate to severe or that impairs function tends to accompany greater depressive symptomatology (Bair et al., 2003). Psychological well-being is a broader, positively framed construct than the absence of symptoms and is increasingly measured with brief instruments such as the WHO-5, which has shown high clinimetric validity as an outcome measure across clinical fields (Topp et al., 2015). Syntheses of exercise trials in CLBP report improvements in mental health outcomes, although with low certainty of evidence and considerable heterogeneity (Owen et al., 2020; Zhou et al., 2024).

**Anxiety and Chronic Musculoskeletal Pain**

Anxiety disorders are more prevalent among people with chronic back or neck pain across both developed and developing countries (Demyttenaere et al., 2007). Within the fear-avoidance model, anxiety and pain-related fear sustain avoidance behaviour and disability (Vlaeyen & Linton, 2000), and prospective evidence suggests that depression-distress and fear avoidance predict persistent low back pain and disability, albeit with low certainty (Wongwitwichote et al., 2026). For reducing anxiety specifically, a network meta-analysis in CLBP found the strongest evidence for mind-body, multicomponent, and biopsychosocial approaches, whereas exercise showed clearer benefits for general mental health than for anxiety (Zhou et al., 2024). Psychological interventions also appear most effective when delivered alongside physiotherapy care rather than in place of it (Ho et al., 2022).

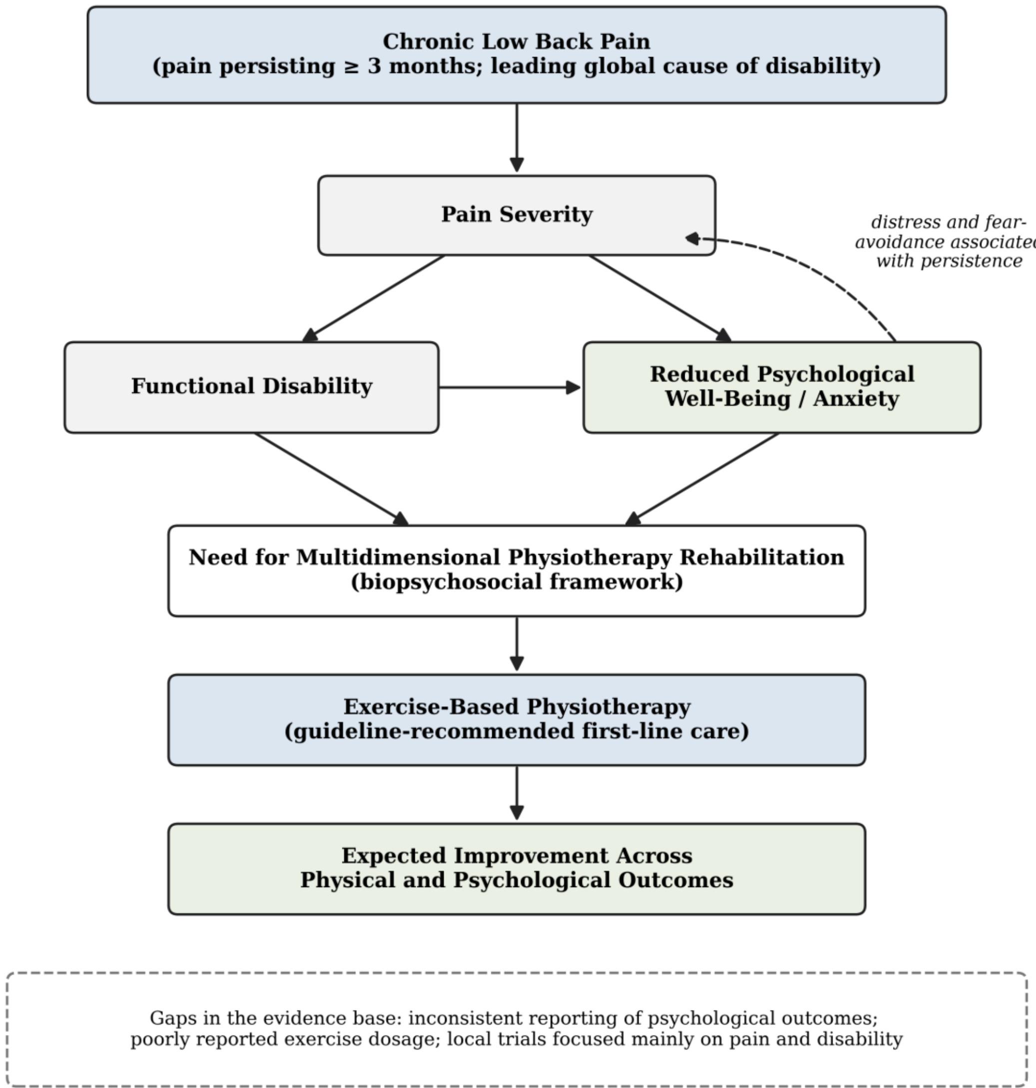
**Integrating Physical and Psychological Outcomes**

Although guidelines advocate a biopsychosocial approach to CLBP management (Foster et al., 2018), overviews of exercise research note that psychological function and quality of life are reported inconsistently and show variable effects (Geneen et al., 2017). Measuring pain, disability, well-being, and anxiety within the same programme allows clinicians to observe whether change is confined to physical outcomes or extends across domains.

**Research Gap**

Evidence on the physical and psychological outcomes of exercise for CLBP derives largely from high-income settings and heterogeneous trial protocols. Psychological outcomes are reported less consistently than pain and disability, and local trials in Pakistan have focused mainly on pain and functional disability (Afzal et al., 2022; Waseem et al., 2019). The present study contributes descriptive data on concurrent pre-post changes across four outcome domains among adults attending physiotherapy in private rehabilitation centres in Pakistan (Figure 2).

**Figure 2: Conceptual Map of the Reviewed Literature**




Note. The map summarises relationships described in the reviewed literature; arrows represent reported associations rather than causal pathways established by the present study.

**Research Objectives**

**General Objective**

To examine changes in physical and psychological outcomes among adults with chronic low back pain following an 8-week physiotherapy-based exercise programme.

**Specific Objectives**

1. To compare pain severity, measured with the Numeric Pain Rating Scale, before and after the programme.
2. To compare functional disability, measured with the Oswestry Disability Index, before and after the programme.
3. To compare psychological well-being, measured with the WHO-5 Well-Being Index, before and after the programme.

4. To compare anxiety symptoms, measured with the DASS-21 anxiety subscale, before and after the programme.

**Research Hypotheses**

- **H1:** Mean pain severity scores will be significantly lower after the 8-week programme than at baseline.
- **H2:** Mean functional disability scores will be significantly lower after the programme than at baseline.
- **H3:** Mean psychological well-being scores will be significantly higher after the programme than at baseline.
- **H4:** Mean anxiety symptom scores will be significantly lower after the programme than at baseline.

## Methodology

**Study Design**

A single-group pre-post design was used. Outcomes were measured at baseline, before the first exercise session, and after completion of the 8-week programme. No control or comparison group was included.

**Study Setting**

Participants were recruited from multiple private rehabilitation centres in Lahore and Islamabad, Pakistan. Participants were recruited between March and May 2025, and post-intervention assessments were conducted on completion of each participant's 8-week programme.

**Participants and Sampling**

A convenience sample of adults with chronic low back pain attending the participating centres was recruited. All participants were regular clients of these centres. No participant discontinued the programme, and all 50 participants completed both baseline and post-intervention assessments.

**Sample Size**

No a priori sample-size calculation was performed. With the final sample of 50 participants, a two-tailed $\alpha$ of .05, and 80% power, the study was able to detect within-subject effects of $d_z \approx 0.41$ or larger.

**Eligibility Criteria**

**Inclusion Criteria**

- Adults aged 30 to 65 years
- Low back pain persisting for at least three months
- Referral for physiotherapy rehabilitation
- Ability to participate in therapeutic exercise

**Exclusion Criteria**

- Previous spinal surgery
- Neurological disorders affecting mobility
- Severe medical conditions restricting exercise participation
- Other major musculoskeletal conditions likely to interfere with functional assessment

Chronic low back pain was defined as low back pain persisting for at least three months. Specific procedures for screening red-flag conditions and radicular symptoms were not documented; the sample may therefore have included participants with radiating leg pain. Although eligibility extended to 65 years, enrolled participants ranged from 30 to 62 years.

**Intervention Protocol**

Participants took part in an 8-week physiotherapy-based exercise programme comprising three sessions per week (24 planned sessions), each lasting approximately 45 to 60 minutes. The programme included six components: (a) core stabilization exercises, (b) lumbar flexibility and stretching exercises, (c) strengthening exercises, (d) postural correction training, (e) functional mobility exercises, and (f) education on home-based exercise. The programme was delivered by physiotherapy staff at the participating centres. Specific exercise selection, sets, repetitions, progression criteria, delivery format (individual or group), and the number and qualifications of treating physiotherapists were not documented.

**Adherence and Co-interventions**

Session attendance, home-exercise completion, concurrent treatments, and adverse events were not documented. The analysis included all 50 participants, each of whom completed both baseline and post-intervention assessments.

**Outcome Measures**

All questionnaires were administered in English. The specific versions of the instruments used were not documented.

**Numeric Pain Rating Scale (NPRS).** Current pain intensity was rated on an 11-point scale ranging from 0 (*no pain*) to 10 (*worst imaginable pain*), with higher scores indicating greater pain severity. The NPRS has demonstrated responsiveness in patients with low back pain receiving physical therapy (Childs et al., 2005).

**Oswestry Disability Index (ODI).** The ODI comprises 10 items addressing pain intensity and activities of daily living, each scored from 0 to 5. The total score is expressed as a percentage (0–100), with higher scores indicating greater disability (Fairbank & Pynsent, 2000).

**WHO-5 Well-Being Index.** The WHO-5 comprises five items rated from 0 to 5 with reference to the preceding two weeks. The raw score (0–25) was multiplied by 4 to yield a percentage score (0–100), with higher scores indicating better psychological well-being (Topp et al., 2015).

**DASS-21 Anxiety Subscale.** Anxiety symptoms were assessed using the seven-item anxiety subscale of the Depression Anxiety Stress Scales-21 (Lovibond & Lovibond, 1995). Items are rated from 0 to 3 with reference to the past week. The subscale sum was multiplied by 2 (range 0–42), with higher scores indicating greater anxiety. The DASS-21 subscales have demonstrated adequate construct validity (Henry & Crawford, 2005). Depression and stress subscale scores are not reported.

**Data Collection Procedure**

Eligible participants were informed about the purpose and procedures of the study and provided written informed consent. Demographic and clinical information, including age, sex, duration of low back pain, and previous physiotherapy, was recorded. Participants completed the four outcome measures before the first exercise session and again after completing the 8-week programme. The identity of assessors, their independence from treatment delivery, and the exact timing of post-intervention assessment were not documented.

**Ethical Considerations**

This independent study was conducted in line with the ethical principles of the Declaration of Helsinki, and permission for data collection was obtained from the participating rehabilitation centres. Written informed consent was obtained from all participants, and participation was voluntary with the right to withdraw at any time. No directly identifying information was collected; data were coded, stored securely, and accessible only to the research team.

**Statistical Analysis**

Data were analysed using IBM SPSS Statistics. Frequencies and percentages summarised categorical variables, and means and standard deviations summarised continuous variables. Paired-samples $t$-tests (two-tailed, $\alpha = .05$) compared baseline and post-intervention scores. Because the sample comprised 50 participants, paired $t$-tests were considered robust to moderate departures from normality. Within-subject effect sizes were calculated as Cohen's $d_z$ ($d_z = t/\sqrt{n}$; Lakens, 2013), and 95% confidence intervals for mean differences were derived from the paired $t$ statistics. Effect sizes of approximately 0.2, 0.5, and 0.8 were interpreted as small, medium, and large, respectively. Because four outcomes were tested, results were additionally evaluated against a

Bonferroni-adjusted α of .0125. Mean changes in NPRS and ODI scores were compared descriptively with proposed thresholds for minimal important change (Ostelo et al., 2008).

**Methodological Assumptions and Design Limitations**

The single-group design assumes that post-intervention change reflects processes occurring during the programme, but it cannot separate programme-related change from natural recovery, regression to the mean (Barnett et al., 2005), expectancy effects, therapist attention, or co-interventions. All findings are therefore interpreted as associations with programme participation rather than as effects of the intervention.

## Results

**Participant Characteristics**

**Table 1: Demographic and Clinical Characteristics of Participants (N = 50)**

| Characteristic | ***n*** **(%) or** ***M*** **±** ***SD*** |
|---|---|
| Age (years) | 46.8 ± 8.7 |
| Age range (years) | 30–62 |
| Sex | |
| Male | 27 (54.0) |
| Female | 23 (46.0) |
| Duration of low back pain (months) | 20.6 ± 9.4 |
| Previous physiotherapy | |
| Yes | 21 (42.0) |
| No | 29 (58.0) |

Participants had a mean age in the mid-forties, and slightly more than half were male. The mean duration of low back pain was approximately 20 months, and fewer than half of the participants had received physiotherapy previously.

**Pre- and Post-Intervention Outcome Scores**

**Table 2: Descriptive Statistics for Outcome Measures at Baseline and Post-Intervention (N = 50)**

| Outcome (score range) | Baseline *M* ± *SD* | Post-intervention *M* ± *SD* | Mean change | Change from baseline (%) |
|---|---|---|---|---|
| Pain severity, NPRS (0–10) | 7.0 ± 1.2 | 5.2 ± 1.4 | −1.8 | −25.7 |
| Functional disability, ODI (0–100) | 52.6 ± 12.8 | 39.4 ± 13.6 | −13.2 | −25.1 |
| Psychological well-being, WHO-5 (0–100) | 44.2 ± 11.9 | 56.0 ± 12.5 | +11.8 | +26.7 |
| Anxiety symptoms, DASS-21 (0–42) | 11.8 ± 4.5 | 8.9 ± 4.0 | −2.9 | −24.6 |

*Note.* NPRS = Numeric Pain Rating Scale; ODI = Oswestry Disability Index; WHO-5 = WHO-5 Well-Being Index; DASS-21 = Depression Anxiety Stress Scales-21 (anxiety subscale). Lower NPRS, ODI, and DASS-21 scores and higher WHO-5 scores indicate better status.

Mean scores changed in the favourable direction on all four outcomes. Pain severity, functional disability, and anxiety scores decreased, whereas psychological well-being scores increased. The relative change from baseline was similar across outcomes, at approximately one quarter of the baseline value.

**Inferential Analysis**

**Table 3: Paired-Samples t-Test Results Comparing Baseline and Post-Intervention Scores (N = 50)**

| Outcome | Mean difference (Pre – Post) | 95% CI | $t$ | $df$ | $p$ | $d_z$ |
|---|---|---|---|---|---|---|
| Pain severity (NPRS) | 1.8 | [1.29, 2.31] | 7.10 | 49 | < .001 | 1.00 |
| Functional disability (ODI) | 13.2 | [8.96, 17.44] | 6.25 | 49 | < .001 | 0.88 |
| Psychological well-being (WHO-5) | −11.8 | [−16.50, −7.10] | −5.05 | 49 | < .001 | −0.71 |
| Anxiety symptoms (DASS-21) | 2.9 | [1.51, 4.29] | 4.18 | 49 | < .001 | 0.59 |

*Note.* CI = confidence interval; $d_z$ = Cohen's $d$ for paired designs ($t/\sqrt{n}$). Signs follow the Pre − Post difference; the negative values for WHO-5 reflect an increase (improvement) in well-being. All results remain statistically significant at the Bonferroni-adjusted $\alpha$ of .0125.

Statistically significant changes from baseline to post-intervention were observed for all four outcomes; therefore, Hypotheses 1 to 4 were supported. Within-subject effect sizes were large for pain severity ($d_z$ = 1.00) and functional disability ($d_z$ = 0.88) and moderate for psychological well-being ($|d_z|$ = 0.71) and anxiety symptoms ($d_z$ = 0.59). The mean reduction in NPRS scores (1.8 points) was below the proposed minimal important change of 2 points, although the upper confidence limit exceeded this value. The mean reduction in ODI scores (13.2 points) exceeded the proposed threshold of 10 points, although the lower confidence limit fell below it. Neither NPRS nor ODI mean change reached the proposed relative threshold of 30% improvement from baseline.

## Discussion

This study examined changes in pain severity, functional disability, psychological well-being, and anxiety among adults with CLBP who completed an 8-week physiotherapy-based exercise programme in private rehabilitation centres. Scores improved significantly on all four outcomes, with large within-subject effects for pain and disability and moderate effects for well-being and anxiety. Because no control group was included, these findings describe change associated with programme participation rather than effects attributable to the programme itself.

The mean reduction in pain intensity is consistent in direction with trial evidence that exercise therapy reduces pain in CLBP (Hayden et al., 2021) and with local trials reporting pain reduction following exercise-based physiotherapy (Afzal et al., 2022). However, statistical significance and clinical importance diverged. The group mean reduction of 1.8 points fell short of the 2-point minimal important change proposed by international consensus and of the 30% relative threshold (Ostelo et al., 2008). At the same time, the confidence interval included values above 2 points, and responsiveness research in patients receiving physical therapy has reported minimal clinically important difference estimates as low as 1.5 points at four weeks (Childs et al., 2005). The most defensible interpretation is that pain improved to a degree whose clinical importance at the group level remains uncertain. A group mean also cannot reveal how many individual patients achieved important change, and participants, on average, still reported moderate pain after the programme, suggesting that eight weeks may be insufficient for many patients to reach low pain levels.

Functional disability showed a mean reduction exceeding the proposed 10-point ODI threshold, although the relative change fell below 30% and the lower confidence limit fell below 10 points. On the descriptive severity bands of the ODI, the group mean moved from the severe to the moderate disability range (Fairbank & Pynsent, 2000). This change is notable given that pooled trial evidence shows smaller effects of exercise on functional limitation than on pain (Hayden et al., 2021). Several features of the sample may contribute: high baseline disability leaves greater room for improvement, supervised delivery three times weekly may have supported engagement, and regression to the mean is more likely when patients enter treatment during a period of high symptom severity (Barnett et al., 2005). Pain and disability changed by similar relative amounts, which is consistent with, but does not demonstrate, a coupling between the two; earlier work indicates that these constructs are only moderately related and should be evaluated separately (Kovacs et al., 2004). Comparisons with the wider literature should also be made cautiously, because most pooled evidence concerns non-specific CLBP, whereas radicular symptoms were not documented as excluded in the present sample.

Psychological well-being increased and anxiety symptoms decreased over the same period. On the conventional DASS-21 severity bands (Lovibond & Lovibond, 1995), the group mean anxiety score moved from the moderate to the mild range, although this group-level description does not indicate individual clinical status. These findings align with network meta-analytic evidence that exercise and physical therapy are associated with improved mental health in CLBP (Owen et al., 2020; Zhou et al., 2024), but they should be considered alongside overviews reporting variable psychological effects of exercise (Geneen et al., 2017) and evidence that anxiety reduction is more strongly supported for mind-body and biopsychosocial approaches than for exercise alone (Zhou et al., 2024). Because the programme contained no psychological component, any association with psychological change is most plausibly indirect.

Within the fear-avoidance model, supervised and progressive exposure to movement may reduce threat appraisals of activity and weaken the cycle of fear, avoidance, and disuse (Vlaeyen & Linton, 2000). Regained function and reduced pain may also restore valued activities and a sense of control, both of which are relevant to well-being. Biological contributions, such as exercise-related modulation of pain processing, have been described, although this response is more variable and sometimes impaired in people with chronic pain (Rice et al., 2019). Non-specific factors must also be acknowledged, because regular therapeutic contact, reassurance, and clinician attention may themselves reduce anxiety. None of these pathways was measured, and they should be regarded as possible explanations rather than demonstrated mechanisms.

The parallel improvement across all four domains is compatible with a biopsychosocial view of CLBP in which physical and emotional states are interdependent (Engel, 1977; Foster et al., 2018). Nevertheless, the design cannot establish whether pain reduction preceded or contributed to psychological change, whether improved mood facilitated physical progress, or whether all outcomes shifted for shared external reasons. Establishing temporal ordering or mediation would require repeated measurement across the programme and appropriate longitudinal analysis.

The limitations of the design are central to interpreting these findings. Natural fluctuation of CLBP, regression to the mean, expectancy, and undocumented co-interventions could each account for part of the observed change. The 42% of participants who had received physiotherapy previously may have differed in expectations or familiarity with exercise. Exercise dosage, adherence, and assessor independence were not documented, which limits replicability and introduces possible detection bias, a reporting problem common across CLBP exercise research (Gibbs et al., 2024). Nevertheless, the findings indicate that physical and psychological outcomes can be measured within routine physiotherapy practice and provide effect-size estimates that may inform sample-size planning for future controlled trials.

**Clinical Implications**

- Assess pain, disability, well-being, and anxiety together at the start and end of rehabilitation.
- Monitor pain and function as separate outcomes, because improvement in one may not mirror the other.
- Interpret change against minimal important change thresholds rather than *p* values alone.
- Use brief tools, such as the WHO-5 and DASS-21 anxiety subscale, to identify patients who may need referral for psychological care.
- Include structured education and home exercise to support self-management.
- Plan and document individual exercise dosage and progression.

## Strengths and Limitations

**Strengths**

- Physical and psychological outcomes were assessed within the same programme.
- Widely used instruments with established measurement properties were employed.
- Supervised sessions followed a fixed frequency and duration.
- Participants were recruited from routine physiotherapy practice across two cities.
- Effect sizes and confidence intervals are reported alongside clinical-relevance thresholds.

- No participant discontinued the programme.

### Limitations

- The single-group pre-post design without a control group precludes causal inference.
- Natural recovery, regression to the mean, and expectancy or placebo effects cannot be excluded.
- The sample was modest, convenience-based, and not supported by an a priori sample-size calculation.
- Recruitment from multiple private centres without a documented standardised protocol may have introduced variation in intervention delivery.
- Exercise dosage, progression, delivery format, and provider qualifications were not documented, limiting replication.
- Adherence, co-interventions such as analgesic use, and adverse events were not documented.
- Assessor identity and blinding were not documented, creating a risk of detection bias.
- Red-flag and radicular screening procedures were not documented, so the sample may not be restricted to non-specific CLBP.
- Questionnaires were administered in English only, which may have affected comprehension and limits generalisability to English-literate patients.
- Only the DASS-21 anxiety subscale was reported.
- All outcomes were self-reported.
- Forty-two percent of participants had received physiotherapy previously.
- No follow-up was conducted beyond the end of the programme.

## Future Research

- Randomised controlled trials comparing structured exercise programmes with usual care or attention-control conditions.
- Larger, multicentre samples supported by a priori sample-size calculations.
- Follow-up at 3, 6, and 12 months to examine the durability of physical and psychological change.
- Standardised intervention reporting using the TIDieR checklist, including exercise dosage and progression.
- Systematic monitoring of adherence, co-interventions, and adverse events, with independent blinded outcome assessment.
- Comparison of different exercise protocols and dosages.
- Repeated measurement during treatment to examine the temporal ordering of physical and psychological change, together with individual-level responder analyses.

## Conclusion

In this single-group study, adults with chronic low back pain who completed an 8-week physiotherapy-based exercise programme showed statistically significant improvements in pain severity, functional disability, psychological well-being, and anxiety symptoms. The clinical importance of the changes in pain and disability was uncertain at the group level, and the absence of a control group means that the findings suggest potential benefit rather than establishing effectiveness. These findings support further investigation of multidimensional outcome assessment within exercise-based physiotherapy through controlled trials with longer follow-up and transparent intervention reporting.

## Declarations

### Ethics Approval and Consent to Participate

This independent study was conducted in line with the ethical principles of the Declaration of Helsinki. Permission for data collection was obtained from the participating rehabilitation centres, and written informed consent was obtained from all participants.

### Consent for Publication

Not applicable. No identifiable individual data are reported.

### Funding

This research received no external funding.

### Conflict of Interest

The authors declare no conflicts of interest.

### Authors' Contributions

All authors contributed equally to the conceptualization, methodology, data collection, analysis, and preparation of this manuscript. All authors reviewed and approved the final version and agree to be accountable for all aspects of the work.

### Data Availability

The data are not publicly available in order to protect participant confidentiality. They can be made available to the journal's editors upon reasonable request.

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