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Original Article

Comparative Effects of Graded Activity and Motor Control Exercise on Disability, Pain Intensity, and Kinesiophobia in Adults with Chronic Nonspecific Low Back Pain: A Randomized Controlled Trial

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ABSTRACT

Background: Chronic nonspecific low back pain is associated with functional disability, persistent pain, and kinesiophobia. Graded activity and motor control exercise are commonly used rehabilitation approaches, but their relative effects across these clinical domains require further evaluation. Objective: To compare graded activity and motor control exercise regarding disability, pain intensity, and kinesiophobia among adults with chronic nonspecific low back pain. Methods: A two-arm, parallel-group randomized controlled trial was described at Therapy Plus Clinics, involving 60 adults with nonspecific low back pain persisting for more than three months. Participants were allocated to graded activity (n = 30) or motor control exercise (n = 30). Outcomes were evaluated at baseline and after intervention using the Oswestry Disability Index (ODI), Numeric Pain Rating Scale (NPRS), and 17-item Tampa Scale for Kinesiophobia (TSK-17). Group-level scores and descriptive changes were compared. Results: Mean ODI scores decreased from 42.6 ± 9.2 to 24.2 ± 7.6 in the graded activity group and from 41.8 ± 8.8 to 27.0 ± 7.9 in the motor control exercise group. NPRS scores decreased from 6.8 ± 1.2 to 3.5 ± 1.4 and from 6.7 ± 1.3 to 3.1 ± 1.2, respectively. TSK-17 scores decreased from 44.8 ± 5.7 to 32.4 ± 5.2 and from 44.1 ± 5.9 to 36.0 ± 5.5, respectively. Differences in mean reductions (graded activity minus motor control exercise) were 3.6 ODI percentage points, −0.3 NPRS points, and 4.3 TSK-17 points. Conclusion: Both intervention groups demonstrated descriptive reductions in disability, pain intensity, and kinesiophobia. Graded activity showed larger reductions in disability and kinesiophobia, whereas motor control exercise showed a slightly larger reduction in pain intensity. Comparative superiority cannot be established from descriptive contrasts alone. Keywords: Chronic nonspecific low back pain; graded activity; motor control exercise; disability; pain intensity; kinesiophobia; randomized controlled trial.

INTRODUCTION

Low back pain is among the most prevalent musculoskeletal health conditions and remains the leading contributor to years lived with disability worldwide. According to the Global Burden of Disease Study 2021, approximately 619 million individuals experienced low back pain globally in 2020, with the number projected to reach 843 million by 2050, reflecting population growth and ageing (1). Beyond its substantial epidemiological burden, low back pain contributes to limitations in mobility, reduced occupational participation, impaired quality of life, and considerable healthcare expenditure. Nonspecific low back pain, characterized by symptoms that cannot be attributed to an

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identifiable specific underlying pathology, accounts for the majority of presentations. When symptoms persist beyond three months, the condition is classified as chronic and frequently requires comprehensive rehabilitation addressing functional, physical, and psychosocial dimensions rather than pain intensity alone (2).

The persistence of chronic nonspecific low back pain is increasingly understood through a biopsychosocial framework that acknowledges interactions among physical impairments, psychological responses, behavioral adaptations, and contextual influences. Kinesiophobia, or fear of movement associated with anticipated pain or reinjury, represents an important psychological dimension of chronic musculoskeletal pain. The fear-avoidance model proposes that individuals who interpret pain as threatening may develop protective avoidance behaviors that restrict physical activity, reinforce disability, and contribute to symptom persistence (3). Although pain severity and functional disability are related, changes in these outcomes may not necessarily parallel changes in movement-related fear. A systematic review by Jadhakhan et al. examined 17 studies involving 1,354 participants with chronic nonspecific spine-related pain and found that exercise interventions generally demonstrated favorable effects on kinesiophobia. However, the certainty of evidence was very low because of methodological limitations and risk of bias (4). These findings highlight the importance of evaluating psychological and functional outcomes alongside conventional measures of pain.

Exercise-based rehabilitation constitutes a principal component of conservative management for chronic low back pain. The World Health Organization's 2023 guideline recommends structured exercise programs as part of person-centered, nonsurgical management for chronic primary low back pain (2). In a Cochrane systematic review incorporating 249 randomized controlled trials, Hayden et al. reported moderate-certainty evidence that exercise therapy was more effective than no treatment, usual care, or placebo for reducing pain and improving functional limitations, although improvements in functional outcomes were generally modest (5). Similarly, a systematic review conducted to inform WHO recommendations supported the potential benefits of structured exercise programs while identifying uncertainty concerning individual exercise approaches and variation in the underlying quality of evidence (6). Collectively, these findings support exercise as an important treatment strategy but indicate that its effectiveness may depend on the intervention characteristics, selected clinical outcomes, and individual patient factors.

Graded activity is a structured rehabilitation approach that emphasizes progressive participation in functional tasks according to planned activity goals rather than allowing pain intensity alone to determine activity progression. Drawing on operant and behavioral principles, graded activity seeks to improve activity tolerance, support sustained engagement in daily tasks, and reduce activity restriction associated with persistent pain. It differs conceptually from graded exposure, which specifically targets feared movements or activities through systematic exposure.

In a systematic review and meta-analysis of randomized trials, López-de-Uralde-Villanueva et al. found that graded activity improved disability compared with control interventions at short- and long-term follow-up. Nevertheless, its effects relative to other active exercise interventions were less consistent, and graded exposure demonstrated greater benefits for selected psychological and disability outcomes in some comparisons (7). These findings suggest that graded activity may provide functional benefits, although its relative effectiveness against alternative exercise strategies remains an important clinical consideration.

Motor control exercise represents another commonly prescribed rehabilitation strategy for chronic nonspecific low back pain. Unlike interventions primarily focused on increasing activity participation, motor control exercise targets the coordination, activation, and regulation of trunk musculature during progressively challenging movements. Its theoretical basis emphasizes improving control of spinal and trunk movements and integrating neuromuscular coordination into functional activities.

A Cochrane systematic review by Saragiotto et al. indicated that motor control exercise could improve pain and disability in individuals with chronic nonspecific low back pain, but it did not demonstrate consistent superiority over other forms of exercise (8). More recently, Capel-Alcaraz et al. synthesized 18 studies involving 1,356 participants and reported favorable effects of motor control exercise for selected comparisons involving pain intensity and disability. However, the authors emphasized that the observed benefits required cautious interpretation because their magnitude and consistency varied across comparators and assessment periods (9).

Direct comparisons between graded activity and motor control exercise have produced findings that do not establish the universal superiority of either approach. In a randomized controlled trial involving 172 adults with chronic nonspecific low back pain, Macedo et al. compared individualized supervised motor control exercise with graded activity and evaluated pain, functional outcomes, disability, and quality of life across multiple follow-up periods. The investigators reported no statistically significant between-group differences in the investigated outcomes, suggesting broadly comparable effectiveness for the two interventions (10). Although this trial provides important comparative evidence, differences in intervention delivery, patient characteristics, outcome instruments, and follow-up schedules may influence the applicability of its findings to other rehabilitation settings. Moreover, the joint assessment of disability, pain intensity, and kinesiophobia remains clinically relevant because interventions may influence physical and psychological dimensions of recovery differently.

Given the continuing burden of chronic nonspecific low back pain and the need to understand the relative effects of different exercise strategies, further evaluation using complementary measures of disability, pain, and movement-related fear is warranted. Assessing these outcomes together may provide a more comprehensive understanding of treatment-associated changes and contribute to clinical decisions concerning exercise-based rehabilitation. Therefore, the objective of the present randomized controlled trial was to compare the effects of graded activity and motor control exercise on functional disability, pain intensity, and kinesiophobia among adults with chronic nonspecific low back pain.

MATERIALS AND METHODS

Study Design and Setting

This study was designed as a two-arm, parallel-group randomized controlled trial conducted at Therapy Plus Clinics. The trial compared the effects of graded activity and motor control exercise on disability, pain intensity, and kinesiophobia among adults with chronic nonspecific low back pain. A total of 60 participants were included, with 30 allocated to the graded activity group and 30 to the motor control exercise group. Outcome measurements were obtained at baseline and after completion of the intervention.

Study Participants

The study population comprised adults with nonspecific low back pain persisting for more than three months. Participants were assigned to either the graded activity or motor control exercise intervention group. Baseline demographic and clinical characteristics included age, sex, body mass index, and duration of low back pain symptoms. These characteristics were summarized separately for the two intervention groups to describe the study population and facilitate interpretation of the comparative findings.

Randomization and Group Allocation

The study employed a randomized, parallel-group design with equal numerical allocation between the two intervention arms. Thirty participants were assigned to graded activity and 30 to motor control exercise. Both groups underwent their respective exercise-based rehabilitation approaches, and the same clinical outcome measures were used for evaluation at baseline and after intervention.

Intervention Procedures

Graded activity group. Participants assigned to the graded activity group received an exercise-based rehabilitation intervention emphasizing progressive participation in functional activities. The intervention incorporated planned activity goals and a graded progression of activity demands. Its central focus was improving engagement in functional movements and daily activities through structured activity progression. Rather than emphasizing isolated trunk muscle coordination as the primary therapeutic target, the graded activity approach prioritized the progressive performance of functional tasks.

Motor control exercise group. Participants assigned to the motor control exercise group received a rehabilitation intervention directed toward improving trunk muscle coordination and movement control. The exercise approach focused on developing control of trunk musculature through progressively challenging exercises. The progression emphasized increasing the complexity of movements requiring coordinated trunk activation and control. This

intervention therefore differed from graded activity in its principal therapeutic emphasis on movement coordination rather than functional activity progression.

Outcome Measures

The clinical outcomes were functional disability, pain intensity, and kinesiophobia, measured using the Oswestry Disability Index (ODI), Numeric Pain Rating Scale (NPRS), and 17-item Tampa Scale for Kinesiophobia (TSK-17), respectively. All three outcomes were evaluated at baseline and after the intervention to quantify changes over the treatment period.

Functional disability. Functional disability was assessed using the Oswestry Disability Index, a widely used condition-specific measure of limitations associated with low back pain. The ODI evaluates difficulties experienced across domains of daily functioning and expresses disability on a standardized scale ranging from 0 to 100, with higher scores indicating greater disability. The instrument has established applications in clinical assessment and research involving spinal disorders (11). In the present study, ODI scores were used to evaluate functional disability at baseline and after intervention, with reductions in scores representing improvement in disability.

Pain intensity. Pain intensity was assessed using the Numeric Pain Rating Scale, an 11-point numerical scale ranging from 0 to 10, where 0 represents no pain and 10 represents the worst imaginable pain. The NPRS is commonly used in clinical research because of its simplicity, responsiveness, and applicability to patients with low back pain. Previous psychometric research has demonstrated its responsiveness to clinical changes among individuals receiving physiotherapy for low back pain (12). Baseline and post-intervention NPRS scores were used to quantify changes in reported pain intensity, with lower values indicating less pain. Kinesiophobia. Kinesiophobia was measured using the 17-item Tampa Scale for Kinesiophobia, which assesses fear of movement and reinjury associated with pain. The TSK-17 comprises 17 statements rated using a four-point response format, producing total scores ranging from 17 to 68 after appropriate item scoring. Higher scores indicate greater movement-related fear. Psychometric investigations have supported the scale's usefulness in evaluating fear of movement among individuals with chronic pain (13). In the present study, TSK-17 scores obtained at baseline and after intervention were used to evaluate treatment-associated changes in kinesiophobia, with reductions indicating lower fear of movement.

Data Collection and Outcome Assessment

Demographic characteristics and clinical information were summarized for participants in each treatment group. Age, body mass index, and duration of low back pain symptoms were reported as continuous variables, while sex was recorded as a categorical characteristic. Disability, pain intensity, and kinesiophobia were measured before and after the exercise interventions using the ODI, NPRS, and TSK-17, respectively. The same outcome scales and scoring ranges were used for both groups to permit direct descriptive comparisons between interventions.

Statistical Analysis

Descriptive statistics were used to summarize participant characteristics and clinical outcome measures. Continuous variables, including age, body mass index, symptom duration, and outcome scores, were expressed as means and standard deviations (SD). Categorical variables were summarized using frequencies and percentages. Baseline and post-intervention ODI, NPRS, and TSK-17 scores were summarized separately for the graded activity and motor control exercise groups. For each outcome, descriptive mean reduction was calculated by subtracting the post-intervention group mean from the corresponding baseline group mean.

Differences in mean reductions between interventions were expressed as graded activity minus motor control exercise. Unadjusted between-group differences in post-intervention mean scores were also calculated in the same direction. Between-group outcome comparisons were described as being evaluated using analysis of covariance (ANCOVA), with the post-intervention score as the dependent variable, intervention group as the grouping factor, and the corresponding baseline outcome score as the covariate. Separate baseline-adjusted comparisons were specified for disability, pain intensity, and kinesiophobia. This analytical approach is intended to compare post-intervention outcomes while accounting for differences in their respective baseline scores.

RESULTS

Participant Characteristics

The available group summaries comprised 60 participants with chronic nonspecific low back pain, with 30 participants represented in the graded activity group and 30 in the motor control exercise group. Baseline demographic and clinical characteristics are presented in Table 1. The mean age was 39.8 ± 8.6 years in the graded activity group and 40.5 ± 9.1 years in the motor control exercise group. The graded activity group included 14 men (46.7%) and 16 women (53.3%), whereas the motor control exercise group included 15 men (50.0%) and 15 women (50.0%). Overall, the study sample contained 29 men and 31 women. Mean body mass index was 26.1 ± 3.4 kg/m^2 in the graded activity group and 25.8 ± 3.6 kg/m^2 in the motor control exercise group. The mean duration of low back pain symptoms was 15.2 ± 6.8 months and 14.7 ± 6.3 months, respectively. The reported baseline characteristics were descriptively similar between groups.

Table 1. Baseline Demographic and Clinical Characteristics

Characteristic	Graded activity (n = 30)	Motor control exercise (n = 30)
Age, years	39.8 ± 8.6	40.5 ± 9.1
Male, n (%)	14 (46.7)	15 (50.0)
Female, n (%)	16 (53.3)	15 (50.0)
BMI, kg/m^2	26.1 ± 3.4	25.8 ± 3.6
Symptom duration, months	15.2 ± 6.8	14.7 ± 6.3

Continuous variables are presented as mean ± standard deviation. BMI, body mass index.

Baseline and Post-intervention Clinical Outcomes

Changes in functional disability, pain intensity, and kinesiophobia were evaluated using the Oswestry Disability Index (ODI), Numeric Pain Rating Scale (NPRS), and 17-item Tampa Scale for Kinesiophobia (TSK-17), respectively. Baseline and post-intervention group means and standard deviations are presented in Table 2. At baseline, the mean ODI score was 42.6 ± 9.2 in the graded activity group and 41.8 ± 8.8 in the motor control exercise group. Following intervention, mean ODI scores decreased to 24.2 ± 7.6 and 27.0 ± 7.9, respectively. Both groups therefore demonstrated descriptive reductions in disability, with a lower post-intervention mean ODI score in the graded activity group.

Baseline pain intensity was also similar between groups. The mean NPRS score was 6.8 ± 1.2 in participants receiving graded activity and 6.7 ± 1.3 in those receiving motor control exercise. Post-intervention NPRS scores were 3.5 ± 1.4 and 3.1 ± 1.2, respectively. Both groups demonstrated lower mean pain intensity following intervention, with a slightly lower post-intervention score in the motor control exercise group. For kinesiophobia, the graded activity group had a baseline TSK-17 score of 44.8 ± 5.7, compared with 44.1 ± 5.9 in the motor control exercise group. Post-intervention mean scores were 32.4 ± 5.2 and 36.0 ± 5.5, respectively. The reductions observed in both groups indicated lower reported fear of movement following the exercise interventions, with a greater descriptive reduction in the graded activity group.

Table 2. Baseline and Post-intervention Disability, Pain Intensity, and Kinesiophobia

Outcome	GA baseline	GA post-intervention	MCE baseline	MCE post-intervention
ODI, 0–100	42.6 ± 9.2	24.2 ± 7.6	41.8 ± 8.8	27.0 ± 7.9
NPRS, 0–10	6.8 ± 1.2	3.5 ± 1.4	6.7 ± 1.3	3.1 ± 1.2
TSK-17, 17–68	44.8 ± 5.7	32.4 ± 5.2	44.1 ± 5.9	36.0 ± 5.5

Values are mean ± standard deviation. GA, graded activity; MCE, motor control exercise; ODI, Oswestry Disability Index; NPRS, Numeric Pain Rating Scale; TSK-17, 17-item Tampa Scale for Kinesiophobia. Lower scores indicate less disability, pain intensity, or kinesiophobia.

Magnitude of Change Within Intervention Groups

The magnitude of change from baseline to post-intervention was calculated descriptively for each outcome. These changes, together with unadjusted between-group contrasts, are summarized in Table 3. For functional disability, mean ODI scores decreased by 18.4 percentage points in the graded activity group and 14.8 percentage points in the motor control exercise group. The difference in mean reductions was 3.6 percentage points in favor of graded activity. The unadjusted post-intervention mean difference between groups was –2.8 percentage points.

Pain intensity decreased by 3.3 NPRS points in the graded activity group and 3.6 points in the motor control exercise group. The difference in mean reductions was –0.3 points, indicating a slightly greater descriptive reduction in pain intensity with motor control exercise. The post-intervention mean difference was +0.4 points. The largest descriptive difference in mean reductions between the two interventions was observed for kinesiophobia. Mean TSK-17 scores decreased by 12.4 points in the graded activity group and 8.1 points in the motor control exercise group. The difference in mean reductions was 4.3 points in favor of graded activity, while the unadjusted post-intervention mean difference was –3.6 points.

Table 3. Descriptive Within-group Changes and Unadjusted Between-group Contrasts

Outcome	GA mean reduction	MCE mean reduction	Difference in reductions (GA – MCE)	Post-intervention mean difference (GA – MCE)
ODI, percentage points	18.4	14.8	+3.6	–2.8
NPRS, points	3.3	3.6	–0.3	+0.4
TSK-17, points	12.4	8.1	+4.3	–3.6

Mean reduction = baseline group mean – post-intervention group mean. Positive differences in reductions favor GA; negative differences favor MCE.

Comparative Patterns Across Outcomes

The descriptive outcome patterns showed reductions from baseline in all three measured domains within both intervention groups. Greater mean reductions in disability and kinesiophobia were observed in the graded activity group, whereas a slightly greater mean reduction in pain intensity was observed in the motor control exercise group. The direction of these descriptive contrasts differed across the evaluated outcomes, illustrating that changes in disability, pain intensity, and movement-related fear were not identical for the two interventions. These findings provide a basis for comparing the observed clinical response patterns across physical and psychological dimensions of chronic nonspecific low back pain.

DISCUSSION

The present study compared graded activity and motor control exercise in adults with chronic nonspecific low back pain, focusing on three complementary clinical outcomes: functional disability, pain intensity, and kinesiophobia. The descriptive findings indicated reductions in all three outcome scores following both interventions, although the magnitude of these changes differed across domains. Graded activity was associated with larger mean reductions in functional disability and kinesiophobia, whereas motor control exercise demonstrated a slightly larger mean reduction in pain intensity. The difference in mean reductions was 3.6 ODI percentage points and 4.3 TSK-17 points in favor of graded activity, while the corresponding difference in NPRS reduction was 0.3 points in favor of motor control exercise. These findings suggest potentially different patterns of response across functional, symptomatic, and psychological outcomes. However, the reported contrasts are descriptive and do not establish statistically significant superiority of either intervention.

Comparison With Previous Evidence on Functional Disability

The observed reduction in functional disability following both rehabilitation approaches is consistent with established evidence supporting exercise-based management of chronic low back pain. In the Cochrane review by Hayden et al., exercise therapy demonstrated beneficial effects on pain and functional limitations compared with no treatment, usual care, or placebo, although improvements in disability were generally modest and sometimes below thresholds considered clinically important (5). The findings of the present study follow a similar descriptive direction, with lower post-intervention ODI scores in both intervention groups. Nevertheless, within-group reductions should not be interpreted as the causal effects of treatment in the absence of an untreated comparator, because natural symptom variation, nonspecific therapeutic effects, and other factors may also contribute to change.

The present findings can also be considered in relation to the randomized controlled trial conducted by Macedo et al., which directly compared graded activity and motor control exercise among 172 individuals with chronic nonspecific low back pain. That study found no statistically significant differences between interventions across measures of pain, disability, physical function, and quality of life at the assessed follow-up periods (10). Although the current descriptive results showed a larger reduction in ODI scores in the graded activity group, the unadjusted

post-intervention difference of 2.8 percentage points does not establish an advantage over motor control exercise. Differences in measurement instruments, intervention delivery, treatment duration, and population characteristics could contribute to variation between studies.

Additional evidence comes from Magalhães et al., who randomized 66 participants with chronic nonspecific low back pain to graded activity or a physiotherapy program incorporating strengthening, stretching, and motor control components. Following six weeks of treatment, both interventions produced improvements in pain and disability, without significant differences between groups. The reported between-group mean difference was 0.8 points for disability and 0.1 points for pain intensity, using the study's respective outcome scales (14). Although the comparator was not an isolated motor control exercise program, these findings reinforce the possibility that different active rehabilitation strategies can produce broadly comparable improvements. Consequently, the relative value of graded activity should be assessed according to the magnitude, precision, and clinical importance of comparative outcomes rather than the direction of descriptive change alone.

Potential Functional Benefits of Graded Activity

The comparatively larger ODI reduction observed in the graded activity group may be considered in the context of the intervention's emphasis on planned progression of functional activities. Graded activity encourages patients to engage in progressively demanding tasks according to predetermined activity goals, potentially improving tolerance for daily movements and reducing reliance on pain intensity as the sole determinant of participation. Such an approach is compatible with behavioral models of rehabilitation that prioritize activity restoration and functional independence.

López-de-Uralde-Villanueva et al. reported that graded activity was associated with improvements in disability compared with control interventions at short- and longer-term assessment periods. However, their systematic review did not establish consistent superiority over other active exercise programs. The review also identified differences between graded activity and graded exposure, with the latter demonstrating greater effects on selected psychological outcomes in some comparisons (7). This distinction is important because graded activity and graded exposure are conceptually related but not interchangeable rehabilitation approaches.

The larger disability reduction observed in the current graded activity group may reflect the functional orientation of the intervention. However, the study did not provide measurements of activity exposure, exercise adherence, behavioral adaptation, or functional task performance beyond the ODI. Accordingly, this explanation remains theoretical rather than a demonstrated mechanism of improvement.

Effects on Pain Intensity

Pain intensity decreased descriptively in both intervention groups, with mean NPRS reductions of 3.3 points following graded activity and 3.6 points following motor control exercise. The between-group difference in mean reductions was only 0.3 points, indicating that the observed pain responses were relatively similar.

This finding is compatible with the broader evidence that multiple forms of therapeutic exercise may reduce pain in chronic nonspecific low back pain without consistent superiority of one approach. The Cochrane review by Saragiotto et al. identified motor control exercise as a potentially effective treatment for pain and disability, but found insufficient evidence that it was consistently superior to other exercise interventions (8). Similarly, Capel-Alcaraz et al. reported that motor control exercise produced favorable effects in several comparisons involving pain and disability, although the magnitude of benefit varied according to the comparator and follow-up period (9).

The pain reductions in the current study may also be considered in relation to research on the responsiveness of the NPRS. Childs et al. demonstrated that changes of approximately two points on the NPRS may represent clinically meaningful improvement in some patients receiving physiotherapy for low back pain (12). Although the mean reductions observed in both intervention groups exceeded this approximate benchmark, group-level mean changes do not establish how many individual participants achieved a clinically important response. Moreover, the much smaller between-group difference should not be interpreted using the same criteria as individual improvement.

The descriptive findings therefore suggest reductions in pain intensity under both rehabilitation approaches without demonstrating a clinically meaningful comparative advantage of motor control exercise. Baseline-adjusted effect estimates and their confidence intervals remain necessary for a defensible comparative interpretation.

Kinesiophobia and Movement-related Fear

A particularly relevant finding was the larger descriptive reduction in kinesiophobia following graded activity. Mean TSK-17 scores decreased by 12.4 points in the graded activity group compared with 8.1 points in the motor control exercise group, producing a difference in mean reductions of 4.3 points. The corresponding unadjusted post-intervention mean difference was 3.6 points in favor of graded activity.

Kinesiophobia is clinically relevant because fear of movement may influence participation in physical activity, willingness to perform rehabilitation exercises, and engagement in everyday movements. The fear-avoidance model proposes that threatening interpretations of pain may contribute to activity avoidance and persistent disability (3). Within this theoretical framework, a rehabilitation program that progressively increases participation in functional tasks could plausibly support more confident movement behavior.

The findings can be compared with the systematic review by Jadhakhan et al., which examined exercise and physical activity interventions for movement-related fear among individuals with chronic nonspecific spine-related pain. Most included studies reported a favorable direction of effect on kinesiophobia, although the certainty of evidence was very low because of risk of bias and methodological heterogeneity (4). More recently, Cardellat-González et al. conducted a systematic review and meta-analysis involving eight randomized controlled trials and 854 participants with chronic nonspecific low back pain. Exercise as a standalone intervention was associated with reduced kinesiophobia compared with passive controls or usual care, with a pooled mean difference of –5.38 points. Nevertheless, the authors reported substantial heterogeneity and low certainty of evidence, limiting confidence in the consistency of the pooled effect (16).

The present findings are directionally compatible with literature suggesting that exercise-based rehabilitation may influence movement-related fear. However, a greater reduction in TSK-17 scores following graded activity does not demonstrate that the intervention directly modified fear-avoidance beliefs or that changes in kinesiophobia mediated improvements in disability. Neither movement-related beliefs nor changes in activity avoidance were examined as explanatory mediators. Furthermore, graded activity should not be assumed to have included formal graded exposure unless that component was documented in the intervention protocol.

Interpreting the Different Patterns of Response

The descriptive differences across ODI, NPRS, and TSK-17 suggest that physical and psychological outcomes may not respond identically to exercise-based rehabilitation. Graded activity emphasizes progressive engagement in meaningful tasks, whereas motor control exercise primarily focuses on the coordination and regulation of trunk movements. Although these approaches differ in therapeutic emphasis, both may contribute to functional rehabilitation through overlapping mechanisms involving physical activity, movement confidence, and improved exercise tolerance.

The larger descriptive reductions in disability and kinesiophobia with graded activity are compatible with its functional and behavioral orientation, while the slightly greater reduction in pain with motor control exercise is compatible with its emphasis on movement coordination. These interpretations remain hypotheses because the study did not directly measure neuromuscular adaptations, movement quality, treatment engagement, self-efficacy, or behavioral mediators.

The possibility of differential treatment responses also requires consideration of patient-level characteristics. In a secondary analysis of their randomized trial, Macedo et al. investigated factors potentially modifying responses to graded activity and motor control exercise. They identified self-reported clinical instability as a possible treatment-effect modifier for longer-term function, while most other candidate predictors did not demonstrate useful differential effects (15).

These observations suggest that individual clinical characteristics may influence response to different exercise programs, although the psychometric and generalizability limitations of the modifier assessment warrant caution. In the present study, baseline age, sex distribution, body mass index, and symptom duration were descriptively similar between groups. However, the available results do not permit evaluation of treatment-effect modification by psychological characteristics, physical activity level, symptom severity, or movement-control impairment. Therefore, the findings should not be used to recommend one intervention preferentially for specific clinical subgroups.

Clinical Implications

The findings support consideration of both graded activity and motor control exercise as active rehabilitation approaches for adults with chronic nonspecific low back pain. The reduction in mean disability, pain intensity, and kinesiophobia scores under both programs indicates that these outcomes are relevant when evaluating rehabilitation progress.

The World Health Organization recommends structured exercise programs within a broader person-centered approach to chronic primary low back pain management (2). Related systematic evidence supports exercise as a potentially beneficial intervention while emphasizing uncertainty about the relative effectiveness of individual exercise types (6). These recommendations are compatible with clinical assessment strategies that consider functional limitations, physical capabilities, psychological responses, patient preferences, and rehabilitation goals rather than pain intensity alone.

The different descriptive outcome patterns observed in the present study also reinforce the value of multidimensional outcome assessment. A treatment may be associated with a meaningful change in one domain without demonstrating an equivalent change in another. Accordingly, rehabilitation assessment should distinguish improvement in pain intensity from improvement in functional participation and movement-related fear.

Nevertheless, the available descriptive contrasts are insufficient to establish whether graded activity should be prioritized for disability or kinesiophobia, or motor control exercise for pain intensity. Such decisions require reliable estimates of comparative treatment effects, their uncertainty, and evidence of clinical importance.

Strengths and Limitations

The study addressed a clinically relevant comparison between two commonly used active exercise interventions for chronic nonspecific low back pain. Its parallel-group structure allowed both approaches to be considered within the same clinical setting. The inclusion of disability, pain intensity, and kinesiophobia provided a broader assessment framework than reliance on pain scores alone. In particular, measurement of kinesiophobia allowed consideration of a psychological domain relevant to rehabilitation participation and persistent activity restriction.

Several limitations affect interpretation. The sample comprised 60 participants from one clinical setting, which may limit statistical precision and generalizability to populations with different demographic, clinical, or healthcare characteristics. The available results represent baseline and post-intervention assessments and therefore do not establish whether the observed changes persisted over longer follow-up periods.

The reported between-group comparisons are descriptive rather than baseline-adjusted estimates. Differences in mean reductions may be influenced by baseline variation and do not replace the ANCOVA treatment contrasts specified in the statistical analysis. Without corresponding confidence intervals and inferential estimates, the precision and statistical compatibility of the observed differences cannot be determined.

Additionally, comprehensive information on randomization implementation, allocation concealment, assessor masking, intervention dosage, treatment adherence, participant flow, missing data, and adverse events is needed for a complete assessment of trial validity. The clinical interpretation of individual improvement is also limited because responder proportions and individual change-score distributions are unavailable.

Finally, the study measured changes in clinical outcomes but did not directly investigate the mechanisms responsible for those changes. Consequently, explanations involving fear reduction, motor coordination, behavioral adaptation, or exercise-related confidence should be regarded as plausible rather than established.

Implications for Future Research

Further adequately powered randomized trials should compare graded activity and motor control exercise using standardized intervention protocols and prespecified primary outcomes. Incorporating baseline-adjusted treatment estimates, confidence intervals, responder analyses, and clinically meaningful change criteria would improve interpretation of comparative effectiveness.

Longer follow-up periods are needed to determine the durability of changes in disability, pain, and kinesiophobia. Future investigations may also assess treatment adherence, physical activity, movement-control performance,

self-efficacy, fear-avoidance beliefs, and patient-level effect modifiers. Such measurements could help clarify whether different exercise approaches act through distinct mechanisms and whether particular patient subgroups are more likely to benefit from one intervention.

CONCLUSION

The reported baseline-to-post-intervention findings showed reductions in functional disability, pain intensity, and kinesiophobia scores in both graded activity and motor control exercise groups among adults with chronic nonspecific low back pain. Graded activity demonstrated larger descriptive reductions in disability and kinesiophobia, whereas motor control exercise showed a slightly greater reduction in pain intensity. These differences indicate variation in observed outcome patterns but do not establish the comparative superiority of either intervention. Baseline-adjusted treatment estimates, confidence intervals, and longer-term outcome data are required to determine the statistical and clinical importance of these findings. Both approaches remain relevant options for exercise-based rehabilitation within a patient-centered management strategy.

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