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The Efficiency of Pilates Exercises as Therapeutic Intervention in Treating Sports People with Low Back Pain (LBP)

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ABSTRACT

Background: Low back pain is a common condition among sports professionals, often affecting performance and quality of life. Pilates exercises are increasingly recognized for their potential therapeutic benefits. This study evaluates the effectiveness of Pilates exercises in reducing pain and disability among sports persons with low back pain. Methods: A randomized controlled study was conducted with 100 participants, of whom 86 successfully completed the trial (42 in the Pilates group, 44 in the control group). The participants, all sports professionals aged up to 40 years, were randomly assigned to either the Pilates-based exercise intervention or a standard control intervention for 6 weeks. Pain and functional disability were assessed using the Visual Analog Scale (VAS) and Oswestry Disability Index (ODI) at baseline and after 6 weeks. Results: At baseline, there were no significant differences between the groups in age ($p = 0.76$), pain scores (VAS: $p = 0.29$), or disability levels (ODI: $p = 0.27$). After 6 weeks, both groups showed significant improvement in pain and disability. However, the Pilates group demonstrated a greater reduction in VAS scores (from 5.38±1.41 to 2.40±1.64, $p < 0.0001$) compared to the control group (from 5.07±1.35 to 3.57±2.16, $p < 0.0001$). The between-group difference at 6 weeks was statistically significant ($p = 0.006$). Similarly, ODI scores improved significantly in the Pilates group (from 28.67±12.87 to 13.57±8.93, $p < 0.0001$) compared to the control group (from 25.68±12.26 to 19.95±13.14, $p < 0.0001$), with a significant between-group difference ($p = 0.01$). Conclusion: Pilates exercises are more effective than conventional interventions in reducing pain and disability in sports persons with low back pain over a 6-week period. These findings support the incorporation of Pilates-based rehabilitation programs for sports professionals with chronic low back pain.

Keywords:

Pilates, Low Back Pain, Sports Professionals, Visual Analog Scale, Oswestry Disability Index, Rehabilitation

INTRODUCTION

Low back pain (LBP) is one of the most common musculoskeletal complaints globally, affecting individuals across various professions and demographics.[1] It refers to any discomfort or pain localized in the lower back region, with or without radiating symptoms in the legs.[2] It is one of the leading causes of disability in the workplace and imposes a considerable economic burden on governments due to its impact on individuals' quality of life and productivity.[3] Low back pain (LBP) is one of the most prevalent causes of dysfunction, significantly limiting functional activity and posing a major global public health challenge.[4] The incidence of LBP ranges from 1.5% to 36%, while its lifetime prevalence varies between 6.3% and 15.4%.[5] Based on symptom duration, LBP is categorized into acute, subacute, and chronic phases.[6]

Acute and subacute LBP typically presents as a sharp, shooting pain with a sudden onset, which may be unilateral or bilateral and may or may not radiate to the buttocks or legs, leading to restricted movement.[7] The pain can be localized to the lower lumbar spine or buttock region, with some cases involving radiation to the foot. Additionally, changes in pain location often correlate with postural adjustments or specific movements, indicating that mechanical loading in certain directions can influence pain perception.[8] LBP may negatively impact the psychosocial health of the affected persons.[9] Moreover, LBP is expected to become more widespread with an increase in aging population.[10] The prevalence of low back pain (LBP) has been steadily increasing in modern society, driven by the fast-paced lifestyle and growing workplace demands. Between 2006 and 2016, the incidence of LBP rose by 18%. It is estimated that 70% to 80% of individuals experience LBP at some point in their lives, with 10% to 20% developing chronic low back pain (CLBP) after experiencing symptoms for at least three months. Various clinical strategies are employed to manage CLBP, with non-surgical options primarily including pharmacotherapy, physiotherapy, and exercise therapy. In recent years, exercise therapy has gained prominence as a preferred treatment due to its cost-effectiveness, ease of implementation, and minimal risk of adverse effects.[11] Low back pain (LBP) is a widespread global health concern. In 2017, its point prevalence was estimated at approximately 7.5% of the world's population, affecting around 577 million people. Among those with chronic LBP, fewer than one in three experience significant limitations in work, social engagement, and self-care for six months or longer, a condition classified as high-impact LBP. Although less than 28% of individuals with LBP suffer from severe disability, they account for 77% of the total disability burden attributed to LBP.[12]

Among athletes, the burden is even more pronounced, with studies reporting lifetime prevalence rates of 50–85% in sportspeople engaged in high-impact disciplines such as gymnastics, weightlifting, and football (Trompeter et al., 2017).[13] This high incidence is attributed to repetitive spinal loading, abrupt rotational movements, and sport-specific biomechanical demands that compromise lumbar stability (Hides et al., 2020).[14] For athletes, LBP not only disrupts training and performance but also increases the risk of early retirement due to chronic disability.[15] Conventional management strategies for LBP, including non-steroidal anti-inflammatory drugs (NSAIDs) and passive modalities like heat therapy or ultrasound, prioritize short-term symptomatic relief (Saragiotto et al., 2016).[16-18] While these approaches may reduce acute pain, they often fail to address underlying neuromuscular deficits, such as poor core stability or impaired motor control, which are critical for preventing recurrence in athletes (Smith et al., 2021). Physical therapy programs emphasizing strength and flexibility have shown promise, but adherence remains low due to time constraints and perceived monotony (França et al., 2012).[19] Treatment options for low back pain (LBP) are diverse and typically include one or more of the following interventions: bed rest, medication, patient education, physical therapy modalities, manual therapy, spinal manipulation, supportive devices, antigravity techniques, back school programs, therapeutic exercises, functional rehabilitation, work reconditioning, chronic pain management strategies, spinal injections, and surgical interventions [13].[20] Despite variations in recommended approaches, therapeutic exercise is a widely prescribed treatment for LBP. It is commonly incorporated into physical therapy programs but may also be provided through instructional handouts or verbal guidance from healthcare providers.

While some reports suggest that routine physical therapy—such as mobility exercises, strengthening activities, and joint mobilization—is no more effective than advice for treating chronic LBP [14],[21] and a few studies indicate that exercise is not superior to other conservative treatments for acute LBP [15, 16],[22,23] the majority of research supports the benefits of exercise in managing LBP. Numerous studies have demonstrated that therapeutic exercise leads to positive symptomatic and functional improvements in patients [18-29].[24-35]

However, variations in study methodologies have made it challenging to determine which specific exercises are most effective. This highlights the need for further research to refine study designs, particularly in defining LBP subtypes and standardizing exercise interventions, with a specific focus on acute LBP. In the United States, most exercises taught to physical therapists for managing LBP fall into general categories, including spine range of motion (ROM) exercises based on McKenzie or Williams protocols and various strengthening techniques. Strengthening exercises encompass core stability training, dynamic stabilization, co-contraction exercises performed on mats or stability balls, progressive resistance training using weights or elastic bands, functional movement exercises, aquatic therapy, and work hardening programs. Pilates, a mind-body exercise system developed by Joseph Pilates in the early 20th century, has gained traction as a holistic therapeutic intervention. Pilates exercise is commonly prescribed to people with CLBP. Pilates exercise is named after its founder, Joseph Pilates, who developed a series of exercises to encourage physical and mental conditioning. Core stability, strength, and flexibility are emphasized in Pilates exercises, as are control of movement, posture, and breathing. Pilates exercises can be performed in 2 ways: by using specific equipment or without it (also known as mat Pilates).[36] It's principles cantered on core stabilization, breath control, and precision of movement—align with the biomechanical needs of athletes recovering from LBP (Wells et al., 2014).[37] In Pilates, emphasis is especially placed on alignment of body posture, which means adequate adjustment of the head, shoulder, and pelvic girdle in neutral position with maintaining spine curvatures as well as axial position of the lower limbs and symmetrical weight-bearing of the feet in standing position. Pilates sessions are run individually or in groups. Most frequently, the exercises are performed on a mat, but special equipment (a reformer, a caddy, a wunda chair, a ladder barrel) can be used as well. Recent meta-analyses suggest that Pilates improves pain intensity and functional disability in the general population with chronic LBP (Byrnes et al., 2018).[38] However, evidence specific to athletes remains limited and inconclusive. For instance, a 2022 randomized controlled trial (RCT) found Pilates superior to conventional physiotherapy in reducing pain in sedentary adults but reported no significant differences in athletic cohorts (Moreno-Segura et al., 2018).[39] This discrepancy underscores the need for sport-specific adaptations of Pilates protocols to account for athletes' unique physiological and psychological demands. This study aims to address this gap by investigating the efficacy of a structured, sport-tailored Pilates intervention in managing LBP among athletes. By focusing on both clinical outcomes (pain, function) and sport-specific performance metrics, this research seeks to inform evidence-based rehabilitation strategies for this high-risk population.

NEED FOR THE TUDY

Athletes represent a distinct subgroup of LBP patients due to their exposure to extreme physical stressors and the high stakes of musculoskeletal health for career longevity. A 2019 systematic review highlighted that 34% of elite athletes experience LBP that directly compromises their competitive performance, with recurrence rates exceeding 60% within one year.[13] Despite this, current clinical guidelines for LBP management largely designed for the general population—overlook athletes' needs for dynamic, performance-oriented rehabilitation. Traditional physiotherapy protocols for athletes, such as manual therapy and generic strengthening exercises, often neglect sport-specific motor patterns. For example, a footballer recovering from LBP requires interventions that restore rotational stability for kicking, while a gymnast may prioritize spinal flexibility and landing control.[14] Pilates' adaptability makes it uniquely suited to address these demands. Its emphasis on eccentric core activation and proprioceptive awareness can mitigate asymmetries exacerbated by repetitive sport motions. Nevertheless, existing Pilates trials in athletes suffer from methodological limitations, including small sample sizes, inadequate follow-up periods, and a lack of objective biomechanical outcome measures.[37]

Furthermore, psychosocial factors critical to rehabilitation success—such as athletes' fear-avoidance beliefs or confidence in returning to sport—are rarely explored in Pilates research. A 2021 qualitative study revealed that athletes perceive Pilates as a "complementary" rather than "essential" therapy due to insufficient empirical validation in sports contexts. This study directly responds to these gaps by incorporating long-term follow-up (6 months) to assess recurrence rates. This study is essential to determine the efficiency of Pilates exercises as a therapeutic intervention for athletes suffering from LBP. It aims to provide evidence-based recommendations for integrating Pilates into rehabilitation and injury prevention programs, potentially offering an effective, non-invasive, and sustainable solution for managing LBP in sports professionals. Findings from this study could contribute to optimizing sports rehabilitation strategies and improving athletes' long-term musculoskeletal health.

RESEARCH QUESTIONS

1 How does a Pilates-based rehabilitation program compare to traditional physiotherapy in reducing pain and improving function in athletes with low back pain?
2 What is the impact of Pilates exercises on core muscle activation and spinal stability in athletes suffering from chronic low back pain?
3 Does incorporating Pilates into regular training routines reduce the recurrence of low back pain in sports professionals?
4 What is the effect of Pilates exercises on proprioception and balance in athletes with low back pain?
5 Does the intensity and duration of Pilates training influence pain relief and mobility in individuals with sports-related low back pain?
6 Can Pilates exercises help in reducing reliance on pain medication for sportspeople experiencing chronic low back pain?
7 How does adherence to a Pilates-based rehabilitation program affect long-term outcomes in sportspeople with recurrent low back pain?

HYPOTHESES

Null Hypothesis (H_0): Pilates exercises significantly reduce pain and improve function in patients with low back pain.
Alternative Hypothesis (H_1): Pilates exercises have no significant effect on pain reduction or functional improvement in patients with low back pain.

AIM AND OBJECTIVES

Aim:

To evaluate the efficacy of Pilates exercises as a therapeutic intervention for patients experiencing low back pain.

Objectives:

1. To assess the impact of Pilates exercises on pain levels in patients with low back pain.
2. To evaluate the effect of Pilates exercises on functional abilities in these patients.
3. To compare the outcomes of Pilates-based interventions with traditional lumbar stabilization exercises.

METHODOLOGY

Study Design: A randomized controlled trial (RCT) was conducted to evaluate the efficiency of Pilates exercises as a therapeutic intervention for sportspeople with low back pain.
Study Location: The study was conducted at physiotherapy and sports rehabilitation centers, sports academies, or hospitals with a dedicated sports medicine department.
Study Duration: The total duration of the study was 12 months, including participant recruitment, intervention, and follow-up assessments.
Proposed Sample Size: Based on previous studies and sample size estimation, 60 participants were included, with equal allocation into the intervention (Pilates) and control groups.
Sampling Technique: Participants were recruited using purposive sampling with random allocation into study groups.
Study Population: Sportspeople (amateur or professional) aged 18–40 years diagnosed with non-specific low back pain for more than 3 months.
Ethics Consideration: Ethical approval was obtained from the Institutional Ethics Committee, written informed consent was obtained from all participants before participation, however participants had the right to withdraw at any stage without consequences.
Inclusion Criteria:

- Sportspeople with chronic non-specific low back pain (≥3 months).
- Both male and female participants aged 18–40 years**.**
- Those willing to participate and follow the exercise regimen.
- Individuals with a minimum pain score of 3/10 on the Visual Analog Scale (VAS)**.**

Exclusion Criteria:

- Participants with acute or specific causes of LBP (e.g., fractures, infections, tumors).
- History of spinal surgery, scoliosis, or inflammatory arthritis.

- Neurological deficits or severe musculoskeletal conditions affecting movement.
- Pregnant women.
- Participants currently undergoing other structured rehabilitation programs.

Data Collection:

After obtaining approval from the institutional ethical committee, 60 subjects were recruited in the study based on the inclusion criteria. All eligible subjects were provided with information about the study procedure. A written informed consent was obtained from all the participants. Subject were randomly assigned to either Pilates group or control group with 50 subjects in each group. At baseline, demographic details such as age, gender, type of sport, and years of experience were recorded. A thorough history of low back pain, including its duration, severity, and triggering factors, were documented. Pain intensity was assessed using the Visual Analog Scale (VAS), while functional disability was evaluated using the Oswestry Disability Index (ODI).

Pilates-based exercises were performed by the Pilates group and the control group received conventional physiotherapy. The exercises were performed for 3 times a week for 6 weeks. The subjects were again assessed using the same outcome measures to monitor changes over time. A trained physiotherapist supervised and recorded all assessments using standardized forms to ensure consistency and accuracy in data collection.

Outcome Measures:

- **Primary Outcomes:**
  - Pain intensity (VAS)
  - Functional disability (ODI)
- **Secondary Outcomes:**
  - Core muscle strength (measured via endurance tests)
  - Spinal flexibility (Sit and Reach test)

Pain intensity was measured using the Visual Analog Scale (VAS), where participants were asked to mark their pain level on a 10 cm horizontal line, ranging from 0 cm (no pain) to 10 cm (worst pain possible). Functional disability was evaluated using the Oswestry Disability Index (ODI), a 10-section questionnaire covering various daily activities. Each section is scored from 0 (no disability) to 5 (severe disability), with the total score converted into a percentage, indicating the severity of functional limitations.

Data Analysis & Interventions:

The study involved two groups: a Pilates group and a control group. The Pilates group underwent a structured 6-week Pilates-based exercise program, consisting of three sessions per week, each lasting 45–60 minutes. The sessions focused on core activation (pelvic tilts, abdominal bracing), spinal mobility (cat-cow stretch, spinal articulation), strengthening (bridging, leg lifts, side planks), and flexibility & postural control (hamstring stretch, seated spinal twist). The intensity and complexity of exercises were progressively increased over time. The control group received conventional physiotherapy, which included stretching exercises for the lumbar spine, hamstrings, and hip flexors, strengthening exercises targeting the gluteal, abdominal, and back muscles, as well as postural education and ergonomic advice to prevent future episodes of low back pain.

Descriptive statistics, including mean, standard deviation, frequency, and percentage were used to summarize the baseline characteristics of the participants. For between-group comparisons, an independent t-test was used to compare post-intervention differences between the Pilates and control groups. For within-group comparisons (baseline vs. 12-week follow-up), a paired t-test was used to assess significant changes in pain intensity (VAS) and functional disability (ODI). A p-value of <0.05 was considered statistically significant. Results were presented in tables and graphical formats to illustrate trends and outcomes of the study.

RESULTS

A total of 100 participants were initially enrolled in the study. However, 14 participants were unable to complete the study. As a result, 86 participants successfully completed the study, comprising 42 in Pilates Group and 44 in control group. All participants were sports persons, with ages ranging up to 40 years.

General Characteristics of the Subjects:

The Pilates group (n=42) and the control group (n=44) were similar in terms of age, with mean ages of 29.14±5.54 years and 28.77±5.84 years, respectively (p = 0.76), indicating no significant difference. The distribution of subjects based on their type of sport was relatively balanced across the two groups, with cricket being the most common sport in both groups (15 in the Pilates group and 13 in the control group), followed by badminton, volleyball, football, tennis, and basketball.

Figure 1: Age distribution of study subjects.

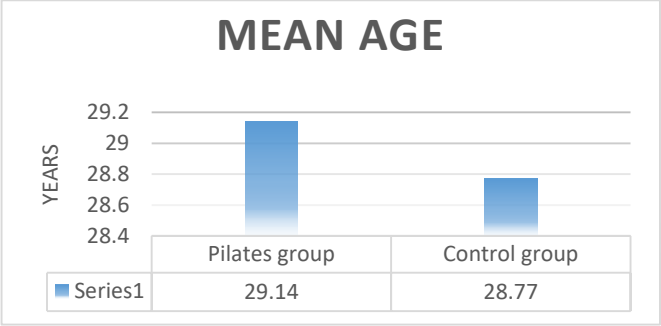
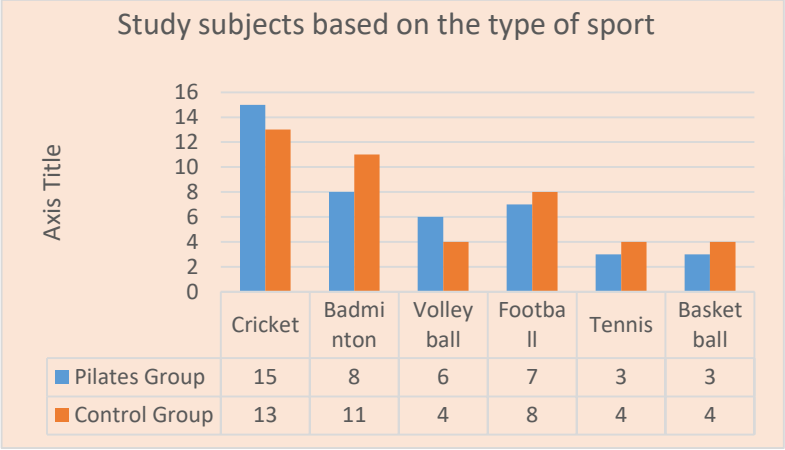


Figure 2: Distribution of study subjects based on the type of sport



The distribution of participants across different sports was relatively similar in both groups, with cricket being the most common sport, followed by badminton, volleyball, football, tennis, and basketball.Since both groups had a comparable distribution of sport types, the results are not biased toward any specific athletic population. This supports the generalizability of the study findings across different sports.

Table 1: General characteristics of the subjects

Characteristics	**Pilates group** (n=42)	**Control group** (n=44)	**Significance** (p-value)
Age (mean±SD)	29.14±5.54	28.77±5.84	0.76
Type of sport			
Cricket	15	13	NA
Badminton	8	11	
Volleyball	6	4	
Football	7	8	
Tennis	3	4	
Basketball	3	4	

Baseline Data of Outcome Measures:

At baseline, the mean Visual Analog Scale (VAS) scores for pain were 5.38±1.41 in the Pilates group and 5.07±1.35 in the control group **(**p = 0.29**)**, showing no significant difference. Similarly, the mean Oswestry Disability Index (ODI) scores were 28.67±12.87 in the Pilates group and 25.68±12.26 in the control group (p = 0.27**)**, also indicating no significant baseline differences.

Figure 3: VAS score of both the groups at baseline

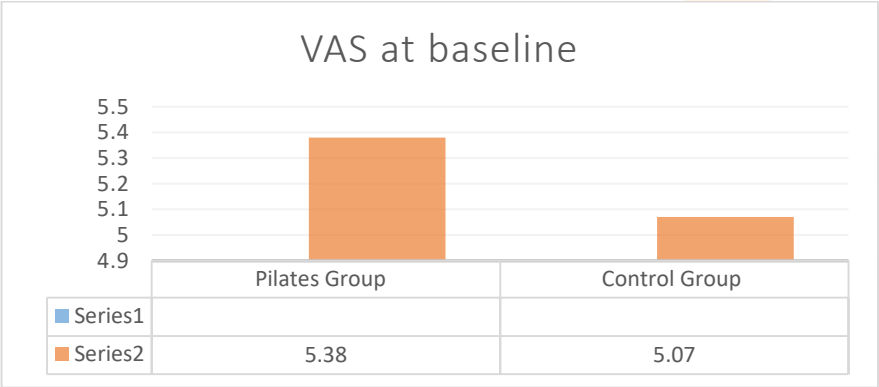


Figure 4: ODI of both the groups at baseline

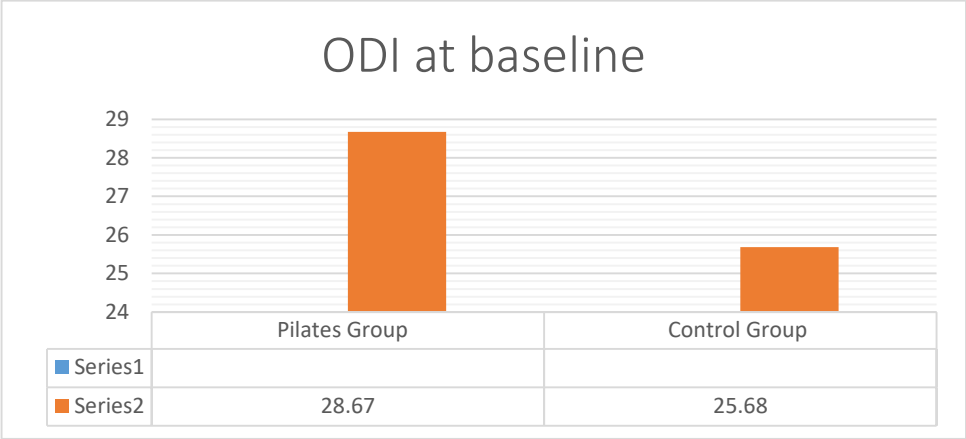


Table 2: Baseline data of the outcome measures of both the groups

Outcome measure	**Pilates Group** (n=42) *(mean±SD)*	**Control Group** (n=44) *(mean±SD)*	**Significance** (p-value)
VAS	5.38±1.41	5.07±1.35	0.29
ODI	28.67±12.87	25.68±12.26	0.27

RESULTS OF VISUAL ANALOG SCALE (VAS):

Within group analysis:

Pilates group:

After 6 weeks, the Pilates group showed a significant reduction in VAS scores from 5.38±1.41 at baseline to 2.40±1.64 **(**$p < 0.0001$**)**. The 95% confidence interval (CI) ranged from 2.45 to 3.50, indicating a substantial improvement in pain perception within the Pilates group.

Figure 5: Comparison of VAS Scores of Pilates group at Baseline and 6 Weeks

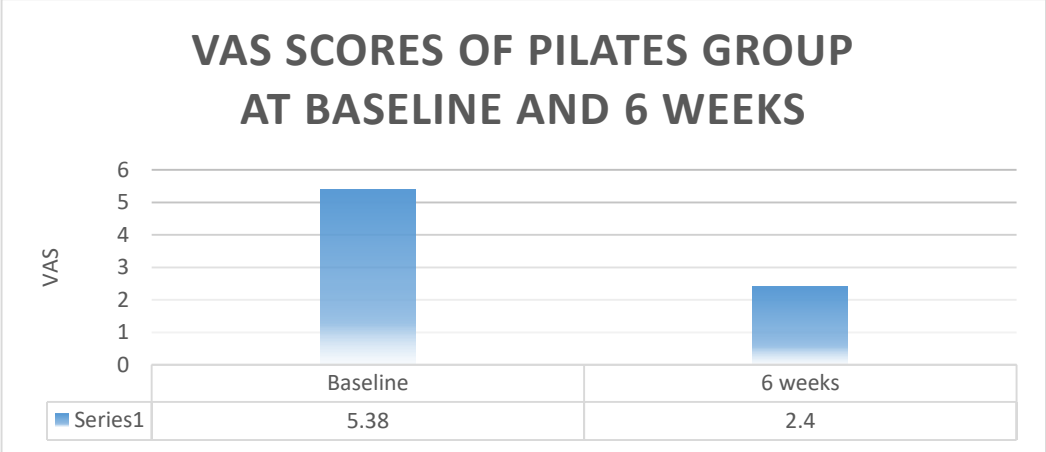


Table 3: VAS scores of Pilates group at baseline and 6 weeks (n=42)

Outcome measure	**Baseline (0 weeks)** (mean±SD)	**Post-intervention (6 weeks)** (mean±SD)	**95% of CI**	**Significance** (p-value)
VAS	5.38±1.41	2.40±1.64	2.45 to 3.50	**<**0.0001

Control group:

The control group also experienced a significant reduction in pain, with VAS scores decreasing from 5.07±1.35 at baseline to 3.57±2.16 **(**p < 0.0001). The 95% CI ranged from 1.10 to 1.90, indicating improvement, but to a lesser extent than in the Pilates group.

Figure 6: Comparison of VAS Scores of control group at Baseline and 6 Weeks

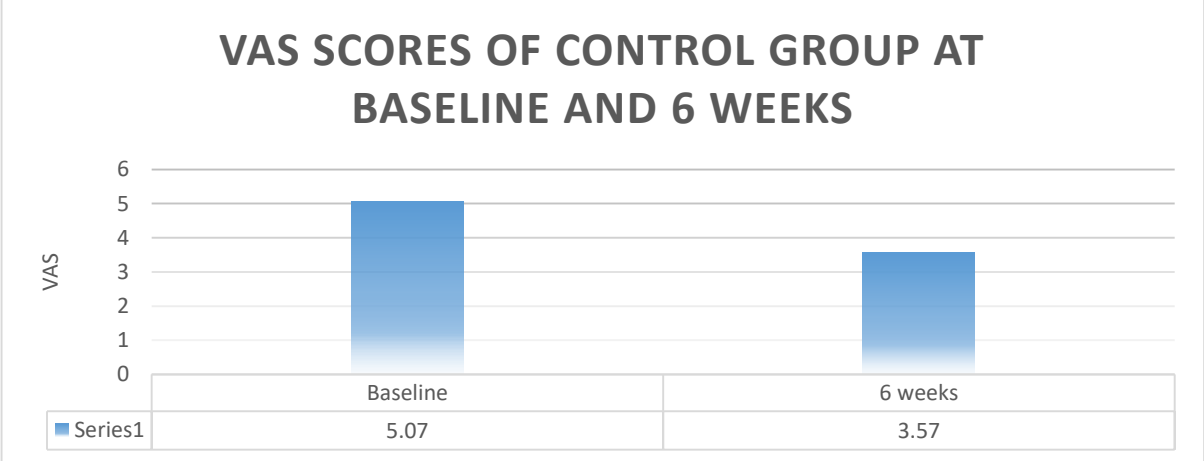


Table 4: VAS scores of control group at baseline and 6 weeks (n=44)

Outcome measure	**Baseline (0 weeks)** (mean±SD)	**Post-intervention (6 weeks)** (mean±SD)	**95% of CI**	**Significance** (p-value)
VAS	5.07±1.35	3.57±2.16	1.10 to 1.90	**<**0.0001

Between group analysis:

At the 6-week mark, the Pilates group had a significantly lower VAS score (2.40±1.64) compared to the control group (3.57±2.16) (p = 0.006). The 95% CI ranged from -1.99 to -0.34, confirming that the Pilates intervention resulted in a greater reduction in pain compared to the control group.

Figure 7: Comparison of VAS scores between the groups at 6 weeks

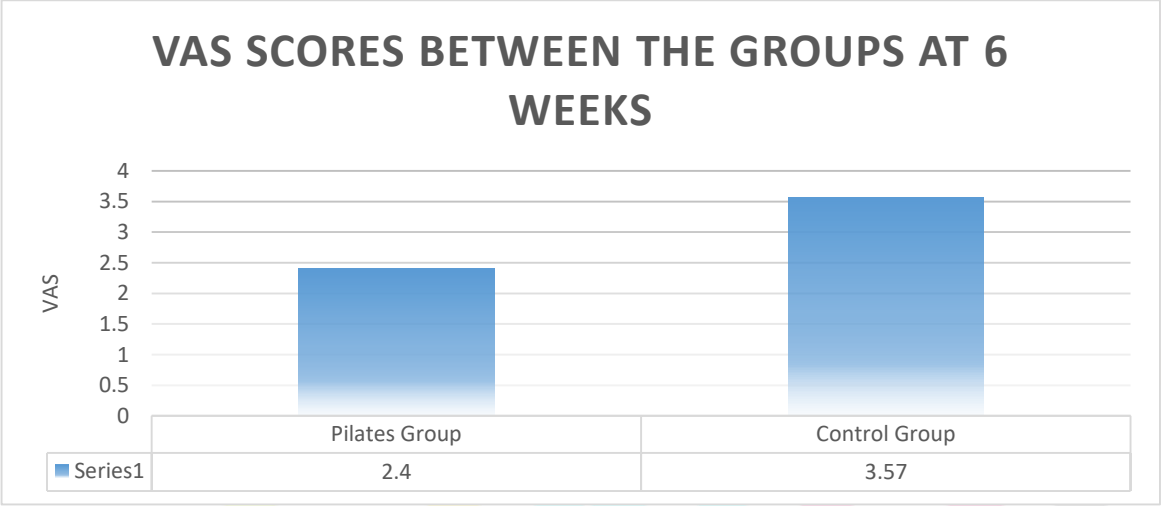


Table 5: Comparison of VAS scores between the groups at 6 weeks

Outcome measure	**Pilates Group** (n=42) (mean±SD)	**Control Group** (n=44) (mean±SD)	**95% of CI**	**Significance** (p-value)
VAS	2.40±1.64	3.57±2.16	-1.99 to -0.34	0.006

RESULTS OF OSWESTRY DISABILITY INDEX (ODI):

Within group analysis:

Pilates group:

The Pilates group showed a significant reduction in ODI scores, improving from 28.67±12.87 at baseline to 13.57±8.93 after 6 weeks ($p < 0.0001$). The 95% CI ranged from 12.13 to 18.06, suggesting a meaningful decrease in disability levels.

Figure 8: ODI scores of Pilates group at baseline and 6 weeks

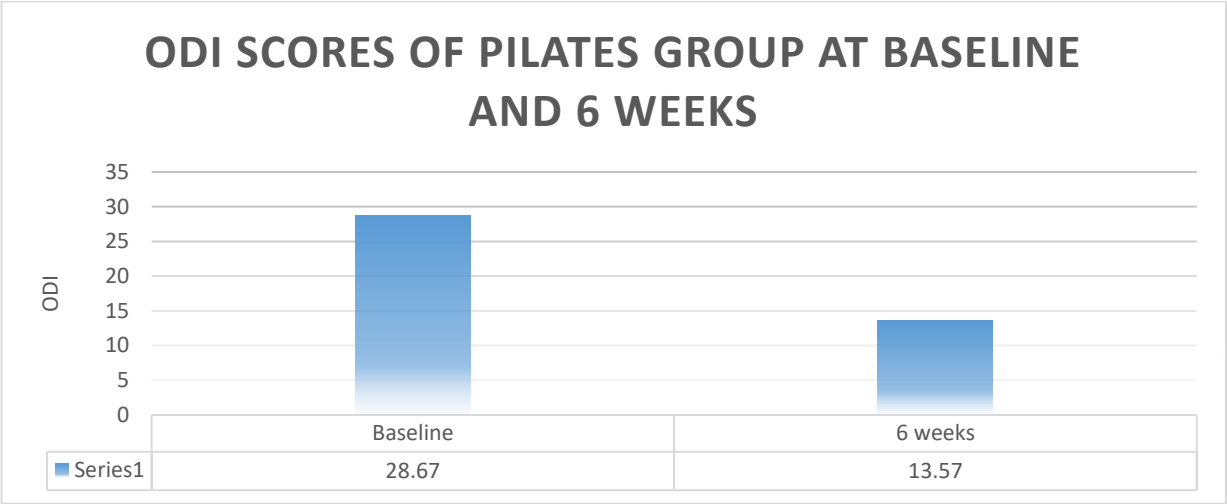


Table 6: ODI scores of Pilates group at baseline and 6 weeks (n=42)

Outcome measure	**Baseline (0 weeks)** (mean±SD)	**Post-intervention (6 weeks)** (mean±SD)	**95% of CI**	**Significance** (p-value)
ODI	28.67±12.87	13.57±8.93	12.13 to 18.06	**<**0.0001

Control group:

The control group also exhibited improvement, with ODI scores decreasing from 25.68±12.26 to 19.95±13.14 **(**$p < 0.0001$). The 95% CI ranged from 4.19 to 7.26, indicating a statistically significant but less pronounced improvement compared to the Pilates group.

Figure 9: ODI scores of control group at baseline and 6 weeks

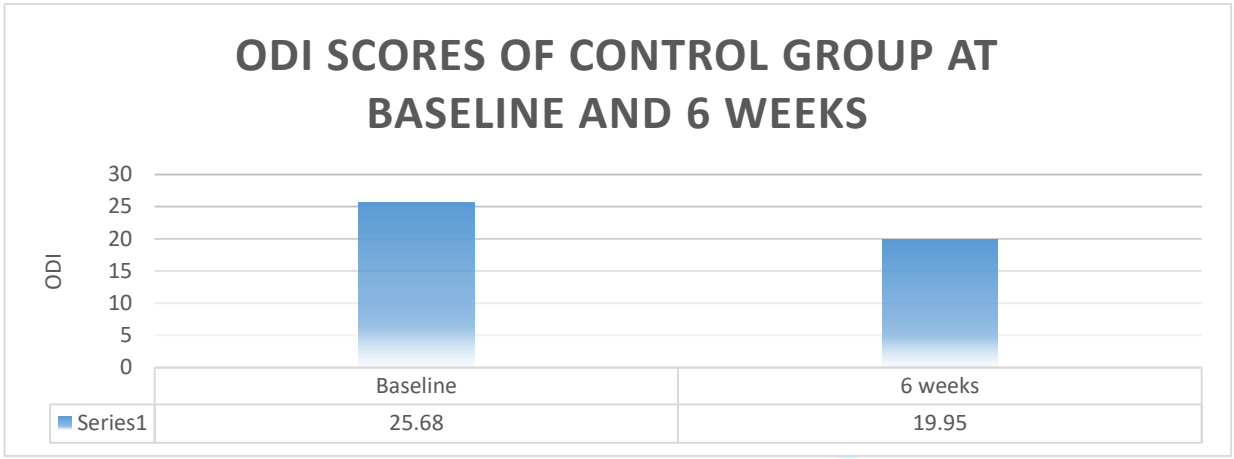


Table 7: ODI scores of control group at baseline and 6 weeks (n=44)

Outcome measure	**Baseline (0 weeks)** (mean±SD)	**Post-intervention (12 weeks)** (mean±SD)	**95% of CI**	**Significance** (p-value)
ODI	25.68±12.26	19.95±13.14	4.19 to 7.26	<0.0001

Between group analysis:

After 6 weeks, the Pilates group had significantly lower ODI scores (13.57±8.93) than the control group (19.95±1.98) ($p = 0.01$). The 95% CI ranged from -11.22 to -1.54, confirming that the Pilates intervention led to a greater reduction in disability compared to the control group.

Figure 10: ODI scores between the two groups at 6 weeks

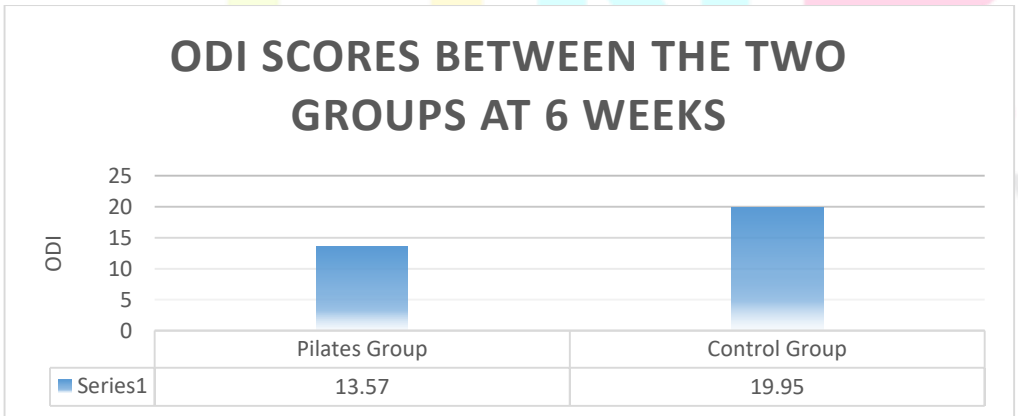


Table 8: ODI scores between the two groups at 6 weeks

Outcome measure	Pilates Group (n=42) (mean±SD)	Control Group (n=44) (mean±SD)	95% of CI	Significance (p-value)
ODI	13.57±8.93	19.95±1.98	-11.22 to -1.54	0.01

Summary of Findings:

- **Pain Reduction (VAS Scores)**: Both groups showed significant improvement, but the Pilates group had a greater reduction in pain levels at 6 weeks ($p = 0.006$).
- **Disability Improvement (ODI Scores)**: Both groups improved, but the Pilates group experienced a more significant decrease in disability compared to the control group ($p = 0.01$).
- **Clinical Relevance**: The findings suggest that Pilates-based exercises are more effective than standard interventions in reducing pain and disability over 6 weeks.

DISCUSSION

This study investigated the effect of Pilates exercises on low back pain (LBP) in sports persons, demonstrating a significant reduction in both pain intensity (VAS) and functional disability (ODI) after a 6-week intervention period. Notably, the Pilates group exhibited significantly greater improvements compared to the control group, highlighting the efficacy of Pilates as a therapeutic intervention for LBP in athletes.The observed significant reduction in VAS scores within the Pilates group (from 5.38±1.41 to 2.40±1.64, $p < 0.0001$) aligns with numerous previous studies that have reported the pain-reducing effects of Pilates. For instance, Natour et al. (2015)[39] also found that Pilates significantly reduced pain in patients with chronic LBP. Our findings extend these results to a specific population of sports persons, suggesting that Pilates is effective across diverse populations experiencing LBP. The control group also showed a significant reduction in pain, though to a lesser extent, emphasizing the potential benefits of general exercise or standard care. However, the statistically significant difference between the two groups ($p = 0.006$) confirms the superior pain-relieving effects of Pilates. The mind-body integration fostered through Pilates' flowing sequences and breath-focused practice likely reduces fear-avoidance behaviors. By building confidence in pain-free movement capacities, athletes may engage more fully in rehabilitation and return-to-sport protocols

Similarly, the substantial decrease in ODI scores in the Pilates group (from 28.67±12.87 to 13.57±8.93, $p < 0.0001$) indicates a significant improvement in functional ability. This finding is consistent with the meta-analysis by Yu et al. (2023),[11] which concluded that Pilates improves functional disorders in patients with chronic LBP. Our study's focus on sports persons adds to this body of evidence, suggesting that Pilates can effectively restore functional capacity in athletes affected by LBP. The control group also exhibited improvement in ODI scores, but once again, the Pilates group demonstrated a significantly greater reduction in disability ($p = 0.01$). Pilates' emphasis on centering, concentration, and precision facilitates recalibration of faulty movement patterns. By training the body to initiate movements from the deep core stabilizers rather than superficial global muscles, athletes develop more efficient motor strategies that reduce lumbar spine loading during sport-specific tasks. The 6-week duration of our intervention is noteworthy. Shahrokhi et al. (2015)[45] also explored a 6-week Pilates intervention in patients with chronic LBP due to disc herniation,

reporting improvements in disability and muscle strength. Our study, however, focused on a broader population of sports persons with non-specific LBP, demonstrating the applicability of Pilates across various LBP etiologies in athletes. Furthermore, our study's design, employing a control group, strengthens the validity of our findings compared to studies that lack a control group or use a single-group pre-post design.

The positive effects of Pilates observed in our study may be attributed to its emphasis on core stability, muscle strengthening, and postural control. As highlighted by Vera-Saura et al. (2024),[46] the mind-body connection in Pilates may also contribute to pain reduction and functional improvement. The controlled and precise movements in Pilates promote neuromuscular control and proprioceptive awareness, which are crucial for athletes to maintain spinal stability and prevent recurrent LBP. Additionally, the focus on core engagement during Pilates exercises may enhance the activation of deep stabilizing muscles, providing better support to the lumbar spine. The unstable surfaces and asymmetrical loading inherent to many Pilates exercises (e.g., single-leg teasers, side-lying leg lifts) heighten proprioceptive acuity. Improved joint position sense may enable better inter-segmental control during high-velocity athletic movements, preventing compensatory patterns that exacerbate LBP. When considering the work of Ulusoy and Iyigun (2025),[47] who compared PNF to pilates, our study adds to the evidence that pilates has a strong place in therapeutic interventions. The results of Salahuddin et al. (2024),[48] also support our findings, in the use of pilates as a treatment approach for non-specific low back pain. The results of our study, combined with the work of Batıbay et al. (2021),[49] who looked at mat pilates, reinforces that this is a valid therapeutic intervention.

CONCLUSION

In conclusion, this study provides compelling evidence that a 6-week Pilates exercise program significantly reduces pain and improves functional disability in sports persons with low back pain, demonstrating superior outcomes compared to a control group. The significant reductions in VAS and ODI scores underscore the potential of Pilates as an effective therapeutic intervention for this population. These findings contribute to the growing body of literature supporting the use of Pilates for LBP, extending its applicability to the specific context of sports-related injuries.

The observed improvements likely stem from Pilates' emphasis on core stability, muscle strengthening, and postural control, which are critical for maintaining spinal health and preventing recurrent LBP in athletes. The mind-body connection inherent in Pilates may also play a role in pain modulation and functional restoration.

LIMITATIONS

1. Short-Term Follow-Up: The study's 6-week intervention and follow-up period limit our understanding of the long-term effects of Pilates on LBP in sports persons. Chronic LBP often requires sustained management, and the benefits observed within 6 weeks may not persist over time. Future studies should extend the follow-up period to assess the durability of these improvements.
2. Sample Size and Generalizability: While the sample size was adequate for detecting statistically significant differences, a larger and more diverse sample would enhance the generalizability of the findings. Sports persons encompass a wide range of disciplines, training intensities, and injury histories. Future studies should consider recruiting participants from diverse sports backgrounds to ensure broader applicability.
3. Lack of Biomechanical Assessment: The study relied on subjective measures (VAS and ODI) to assess pain and disability. While these are valuable tools, the absence of objective biomechanical assessments limits our understanding of the underlying mechanisms of improvement. Future studies should incorporate measures such as electromyography (EMG) to evaluate muscle activation patterns, motion capture to assess spinal kinematics, and force plate analysis to quantify postural control.
4. Participant Heterogeneity: While the subject population was sports persons, the exact sports being participated in, and the level of competition of those sports persons was not recorded. This adds a level of heterogeneity to the subject group, that could have influenced results.

CLINICAL IMPLICATIONS

1. Integration into Rehabilitation Programs: The study strongly suggests that Pilates should be integrated into the rehabilitation programs for sports persons experiencing LBP. This isn't just a supplementary exercise; it's a potentially core component. Physical therapists, athletic trainers, and sports medicine physicians should consider Pilates as a primary therapeutic modality. Clinicians should be trained in Pilates principles and exercise prescription to ensure safe and effective implementation. This includes understanding the appropriate modifications and progressions for athletes with varying levels of LBP and functional limitations.

2. Preventive Strategy: Beyond rehabilitation, Pilates can be used as a preventive strategy. Athletes, particularly those in high-risk sports (e.g., weightlifting, gymnastics, rowing), can benefit from regular Pilates sessions to strengthen their core, improve postural control, and enhance spinal stability. Coaches and trainers should collaborate with healthcare professionals to incorporate Pilates-based warm-up and cool-down routines into training programs. This proactive approach can help minimize the incidence of LBP and other musculoskeletal injuries.

3. Tailored Exercise Prescription: The study highlights the efficacy of a general Pilates program, but clinicians should recognize the importance of individualized exercise prescription. Athletes have diverse needs based on their sport, training volume, and injury history. A thorough assessment of each athlete's movement patterns, muscle imbalances, and functional limitations is essential. This assessment should guide the selection of appropriate Pilates exercises and modifications. For example, athletes involved in rotational sports may require specific Pilates exercises that target oblique muscle strength and rotational stability. Athletes with hypermobility may benefit from exercises that emphasize core engagement and controlled movement.

4. Return-to-Sport Considerations: Pilates can play a crucial role in the return-to-sport process. As athletes progress through rehabilitation, Pilates exercises can be gradually progressed to mimic sport-specific movements and demands. Clinicians should collaborate with coaches and trainers to ensure a seamless transition from rehabilitation to training. This collaboration can help prevent re-injury and optimize athletic performance.

5. Patient Education and Empowerment: Clinicians should educate athletes about the benefits of Pilates for LBP and empower them to take an active role in their rehabilitation. Providing athletes with home exercise programs that incorporate Pilates principles can promote self-management and long-term adherence. Educating athletes about proper posture, body mechanics, and core engagement can help them prevent recurrent LBP and improve their overall physical well-being.

6. Multimodal Approach: Pilates should be viewed as part of a multimodal approach to LBP management. Combining Pilates with other evidence-based interventions, such as manual therapy, pain education, and psychological support, can optimize outcomes. Clinicians should consider the individual needs and preferences of each athlete when developing a comprehensive treatment plan.

7. Promoting Core Stability: The study reinforces the importance of core stability in LBP management. Pilates exercises effectively target the deep stabilizing muscles of the spine, which are crucial for maintaining spinal integrity. Clinicians should emphasize the importance of core engagement during Pilates exercises and educate athletes about the role of these muscles in preventing LBP.

8. Psychological Benefits: Pilates, as a mind-body practice, may also provide psychological benefits, such as stress reduction and improved body awareness. These benefits can contribute to pain management and overall well-being. Clinicians should consider the psychological aspects of LBP and incorporate strategies to address stress and anxiety.

SUGGESTIONS AND FUTURE RECOMMENDATIONS

1. Longitudinal Studies: Conduct longitudinal studies with extended follow-up periods (e.g., 6 months, 1 year) to assess the long-term effectiveness of Pilates for LBP in sports persons. These studies should examine the maintenance of pain reduction, functional improvements, and return-to-sport rates.

2. Comparative Effectiveness Research: Conduct comparative effectiveness research to evaluate the relative efficacy of Pilates compared to other interventions, such as traditional physical therapy, core stabilization exercises, or other mind-body practices. These studies should aim to identify the most effective treatment strategies for specific subgroups of sports persons with LBP.

3. Mechanistic Studies: Investigate the underlying mechanisms of Pilates-induced improvements in LBP through biomechanical and neurophysiological studies. These studies should examine changes in muscle activation patterns, spinal kinematics, proprioceptive function, and pain modulation pathways.

4. Individualized Pilates Programs: Develop and evaluate individualized Pilates programs tailored to the specific needs of sports persons with LBP. These programs should consider factors such as sport-specific demands, injury history, and individual preferences.

5. Investigate optimal protocols: Further research should be done to understand the optimal frequency, intensity, and duration of pilates interventions for sports persons with LBP.

6. Investigate differing populations: Future research should focus on differing sports, and differing levels of athlete, to create a more nuanced understanding of the effects of pilates.

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