

COMPARATIVE EFFECTS OF KINETIC CONTROL AND BALANCE CONTROL TRAINING ON PAIN, FUNCTION AND BALANCE AMONG BUS DRIVERS WITH SACROILIAC JOINT DYSFUNCTION: A RANDOMIZED CLINICAL TRIAL

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Abstract

Background: Sacroiliac joint dysfunction (SIJD) is a significant but often overlooked cause of low back pain, particularly among occupational groups subjected to prolonged sitting and mechanical stress, such as bus drivers. **Aims:** To compare the effects of Kinetic Control and Balance Control Training on Pain, Function and Balance among Bus Drivers with Sacroiliac Joint Dysfunction.

Methodology: Outcomes are evaluated over a 6-week period, focusing on pain levels and functional ability and balance by Berg Balance Scale (BBS), Numeric pain rating scale (NPRS), Oswestry Disability Index (ODI) scores. Data was analyzed using SPSS-27. The significance of this study lies in its potential to enhance current treatment protocols, contributing a more effective and intervention to lessen symptoms and improve the quality of life for that affliction from Sacroiliac joint dysfunction (SIJD). The outcomes could inform clinical practices and lead to personalized rehabilitation approaches that incorporate comparative therapies, ultimately reducing the healthcare load associated with Sacroiliac joint dysfunction (SIJD).

Results: Participants in the kinetic control group reported significantly lower pain scores (2.46 ± 0.97 vs. 3.85 ± 0.90 , $p=0.001$), higher balance scores (53.62 ± 1.45 vs. 50.00 ± 1.29 , $p<0.001$), and lower disability scores (16.38 ± 2.22 vs. 25.54 ± 3.41 , $p<0.001$) compared with the balance control training group.

Conclusion: The results support the integration of kinetic control exercises into routine clinical rehabilitation programs and provide a foundation for future research investigating their long-term effectiveness and application in other populations with lumbopelvic disorders.

INTRODUCTION: Sacroiliac joint dysfunction (SIJD) is a significant yet frequently overlooked source of low back pain, especially among occupational groups exposed to prolonged sitting and mechanical stress such as bus drivers. Low back pain is one of the major causes of disability worldwide, affecting nearly 70–85% of individuals at some point in their lives, and sacroiliac joint dysfunction represents a considerable proportion of these cases.(1) Functional limitations, decreased mobility, and reduced balance are also commonly observed in these individuals.(2) The occurrence rate of sacroiliac joint dysfunction varies globally but is calculated to range between 13% and 30%, contributing to approximately 10–25% of mechanical low back pain cases. Some reports suggest that SIJD may account for up to 15–30% of patients presenting with low back pain, emphasizing its clinical significance.(3) This leads to weakening of stabilizing muscles, ligamentous strain, and impaired neuromuscular coordination, ultimately resulting in joint instability and pain.(4) Over time, chronic inflammation and degenerative changes may develop, further aggravating the condition. Central sensitization may also occur in chronic cases, leading to Elevated pain perception and prolonged symptoms.(5) In bus drivers, prolonged sitting combined with whole-body vibration is a primary contributing factor, as it places continuous stress on the sacroiliac joint and surrounding musculature.(6) Addressing these factors through targeted interventions can significantly improve patient outcomes and prevent reappearance.(7) For occupational groups like bus drivers, WHO guidelines indicate the importance of regular movement breaks, proper seating posture, and workplace ergonomics to lessen the risk of musculoskeletal conditions, including sacroiliac joint dysfunction.(8) Other commonly used interventions include core strengthening exercises, pelvic stabilization, manual therapy techniques such as joint mobilization, and supportive methods like kinesio taping.(9) These rehabilitation approaches offer several benefits, including reduction in pain intensity, improvement in functional ability, increased postural control, and better proprioception.(10) Proper analysis and clinical judgment are

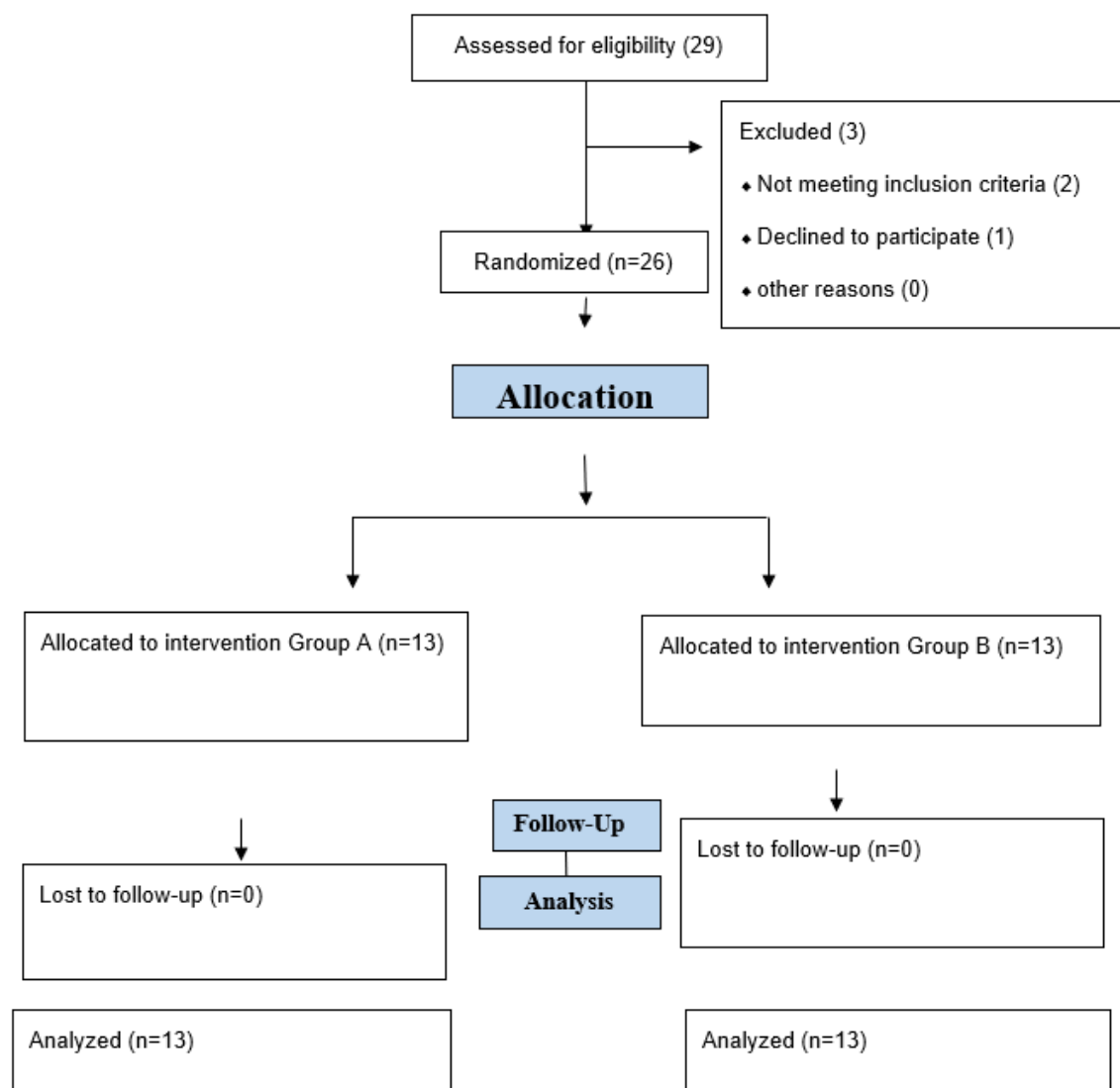
essential to ensure safe and effective treatment.(11) With focused interventions such as kinetic control and balance control training, individuals can achieve significant improvements in pain, function, and balance, supporting them to return to their daily activities and occupational responsibilities.(12) Sacroiliac joint dysfunction is a widespread and limiting condition, especially among bus drivers due to occupational risk factors such as prolonged sitting and exposure to vibration. Its complex mechanism and complex pathophysiology mandate a comprehensive and targeted rehabilitation approach. Exercise-based interventions, particularly kinetic control and balance control training, have shown promising results in addressing neuromuscular impairments and improving functional outcomes. Therefore, comparing the effectiveness of these interventions is important to establish evidence-based practices for the management of SIJD in this high-risk population.(13)

METHODOLOGY: The design of this study was Randomized clinical Trial (RCT). Data was collected from physiotherapy department of Advance pain and spine center, Lahore. Sample size is adjusted to 29 participants to maintain the desired power, a 5% margin of error, and 95% power, as calculated by G-Power version 3.1.9.7. (27) Sampling technique used was non probability purposive Sampling technique .The duration of this study was 6 months after BASAR approval. **Inclusion criteria meets** :Male bus drivers aged between 25–55 years(14) Clinically diagnosed with sacroiliac joint dysfunction (SIJD) using provocation tests (FABER, Gaenslen's test, sacral thrust)(14) History of low back or sacroiliac joint pain for more than 3 months (chronic condition)(14) Pain intensity ≥ 3 on Numeric Pain Rating Scale (NPRS)(15) Presence of functional disability as measured by Oswestry Disability Index (ODI)(15) Demonstrated balance impairment on Berg Balance Scale (BBS)(15) **Exclusion Criteria:** History of spinal fractures, tumors, or infections(16) Diagnosed inflammatory conditions (e.g., ankylosing spondylitis)(17). Participants who meet the inclusion criteria are randomly assigned to one

of two groups via computer generated randomization. This was Single blinded (assessors was recruited blinded) RCT. For taking pre and post treatment levels, Outcome assessors was recruited and also blinded to the treatment group allocation. Group A was treated for 30 minutes three times a week for six weeks (18 sessions total). The therapist was stand beside the patient. Group A was receive kinetic control training, which was focus on correcting faulty movement patterns and improving motor control in the lumbopelvic area. The intervention was focus on activating deep stabilizing muscles, particularly the transversus abdominis and multifidus, as well as improving coordination between local and global muscle systems. The exercises was begin with basic awareness and activation techniques, such as pelvic tilting and neutral spine positioning, and progress to lumbar dissociation exercises, in which patients was learn to move the spine independently of the pelvis. Controlled trunk movements such as flexion, extension, and rotation was practiced with a focus on precision and control. Functional movement retraining was also be included, with activities such as sit-to-stand,

bending, and lifting to ensure proper biomechanics are maintained. The exercises was done in 2-3 sets with 8-12 repetitions. (19) Group B was receive balance control training for 30 minutes three times a week for six weeks (18 sessions total). The therapist was stand beside the patient. Participants met three times per week for the duration of the study. Group B was receive balance control training to improve postural stability, proprioception, and neuromuscular coordination. The intervention was start with static balance exercises like single-leg stance and tandem standing on stable surfaces. As the participants progress, dynamic balance exercises such as weight shifting, reaching, and controlled movements was introduced. Unstable surfaces, such as balance boards and foam pads, was also be used during training to challenge the proprioceptive system. To improve sensory integration and postural control, progress was made from stable to unstable environments, as well as from eyes-open to eyes-closed. Gait training and coordination exercises was also be implemented to improve functional balance while moving. Each exercise was done in 2-3 sets of 8-10 repetitions, depending on the activity. (31)

CONSORT DIAGRAM



RESULTS

A total of 26 bus drivers with sacroiliac joint dysfunction completed the randomized clinical trial, with 13 participants allocated to the kinetic control training group and 13 to the balance control training group. Normality testing confirmed that the data were normally distributed, permitting the use of parametric statistical analyses. Within-group analysis showed statistically significant improvements in all measured outcomes following intervention. Pain intensity, assessed using the Numeric Pain Rating Scale (NPRS), decreased from 6.81 ± 1.27 to 3.15 ± 1.16 ($p < 0.001$). Functional disability, measured by the Oswestry Disability Index (ODI), improved from 42.77 ± 3.47 to 20.96 ± 5.45 ($p < 0.001$). Balance performance,

evaluated using the Berg Balance Scale (BBS), increased from 43.54 ± 1.58 to 51.81 ± 2.28 ($p < 0.001$). These findings indicate that both interventions were effective in reducing pain and disability while improving balance. Baseline comparisons revealed no statistically significant differences between the two treatment groups for pain, balance, or disability (all $p > 0.05$), confirming that the groups were comparable before intervention. Post-treatment comparisons demonstrated statistically significant superiority of kinetic control training. Participants in the kinetic control group reported significantly lower pain scores (2.46 ± 0.97 vs. 3.85 ± 0.90 , $p = 0.001$), higher balance scores (53.62 ± 1.45 vs. 50.00 ± 1.29 , $p < 0.001$), and lower disability scores

(16.38±2.22 vs. 25.54±3.41, $p<0.001$) compared with the balance control training group. all outcomes further support the clinical importance of the interventions, with kinetic

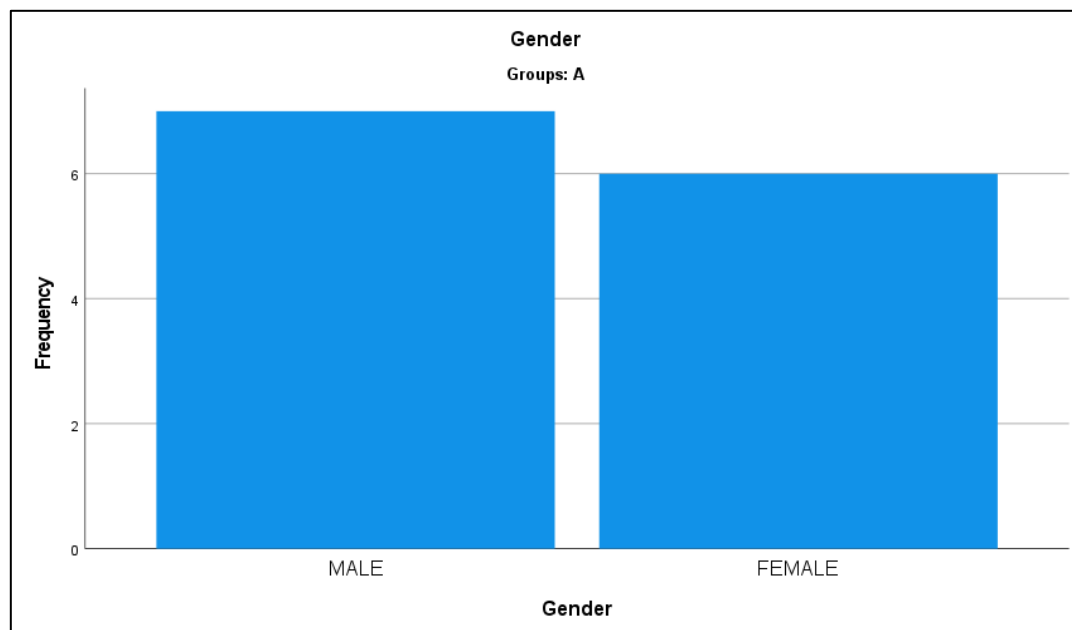
control training producing the greatest improvements in pain reduction, functional recovery, and balance enhancement.

Table 4.1 Demographic Characteristics of Participants

Variable	Kinetic Control Group (n=13)	Balance Control Group (n=13)
Age (years), Mean ± SD	38.54 ± 8.42	39.15 ± 8.38
Gender, n (%)		
Male	7 (53.8%)	11 (84.6%)
Female	6 (46.2%)	2 (15.4%)

Table 4.1 presents the demographic characteristics of the participants. A total of 26 bus drivers with sacroiliac joint dysfunction participated in the study, with 13 participants in the kinetic control group and 13 participants in the balance control group. The mean age was 38.54 ± 8.42 years in the kinetic control group

and 39.15 ± 8.38 years in the balance control group. In the kinetic control group, 53.8% were male and 46.2% were female, whereas the balance control group comprised 84.6% males and 15.4% females. These data describe the demographic profile of the study participants.



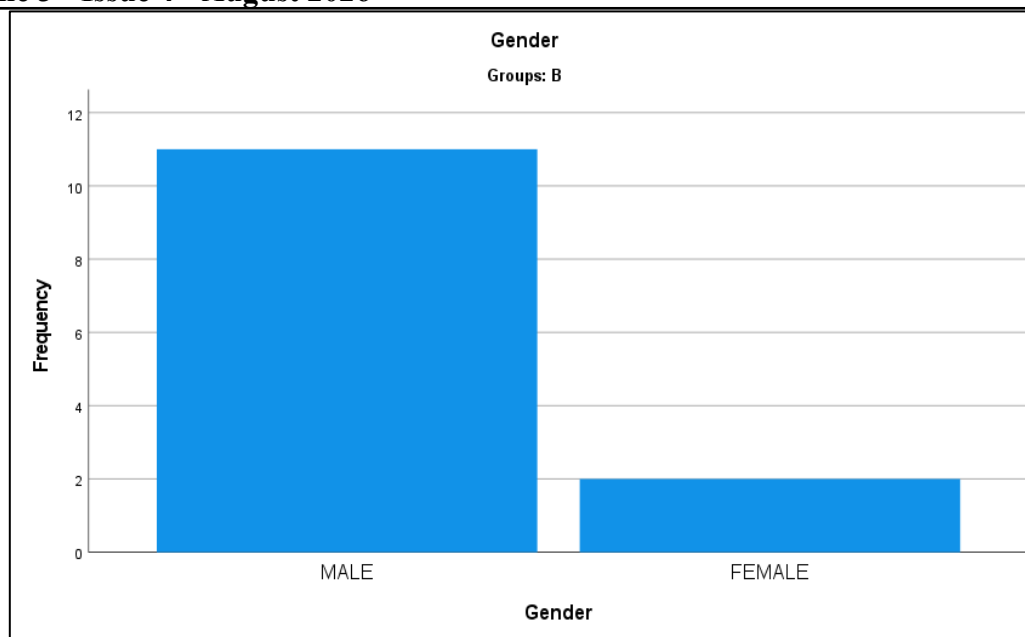


Table 4.2 Normality Test

Variable	Shapiro-Wilk	P value
NPRS Pre	0.927	0.067
BBS Pre	0.930	0.076
ODI Pre	0.928	0.069

Table 4.2 presents the results of the Shapiro-Wilk test used to assess the normality of the study variables before statistical analysis. The Shapiro-Wilk test showed that the p-values for all outcome measures, including the Numeric Pain Rating Scale (NPRS), Berg Balance Scale (BBS), and Oswestry Disability Index (ODI), were greater than 0.05 (NPRS: $p = 0.067$, BBS:

$p = 0.076$, ODI: $p = 0.069$). These findings indicate that the data were normally distributed, and the assumption of normality was satisfied. Therefore, parametric statistical tests, including the paired sample t-test and independent sample t-test, were considered appropriate for analyzing the study data.

Table 4.3 Paired sample t test

Outcome	Pre Mean $\pm$ SD	Post Mean $\pm$ SD	t	p
NPRS	6.81 $\pm$ 1.27	3.15 $\pm$ 1.16	13.75	<0.001
BBS	43.54 $\pm$ 1.58	51.81 $\pm$ 2.28	-22.85	<0.001
ODI	42.77 $\pm$ 3.47	20.96 $\pm$ 5.45	20.69	<0.001

Table 4.3 presents the within-group comparison of the overall study participants before and after the intervention. The results showed a statistically significant reduction in pain intensity, with the mean NPRS score decreasing from 6.81 ± 1.27 at baseline to 3.15 ± 1.16 after treatment ($t = 13.75$, $p < 0.001$). Balance performance also improved significantly, as the mean BBS score increased from 43.54 ± 1.58 to

51.81 ± 2.28 ($t = -22.85$, $p < 0.001$). Similarly, functional disability measured by the ODI showed a significant improvement, with the mean score decreasing from 42.77 ± 3.47 to 20.96 ± 5.45 ($t = 20.69$, $p < 0.001$). These findings indicate that the intervention was highly effective in reducing pain and disability while improving balance among bus drivers with sacroiliac joint dysfunction.

Table 4.4: Independent t test

Outcome Measure	Kinetic Control Group		Balance Control Group		p-value
	Baseline	Post-treatment	Baseline	Post-treatment	
NPRS	7.15 ± 1.14	2.46 ± 0.97	6.46 ± 1.33	3.85 ± 0.90	0.001
BBS	43.62 ± 1.61	53.62 ± 1.45	43.46 ± 1.61	50.00 ± 1.29	<0.001
ODI	43.23 ± 3.40	16.38 ± 2.22	42.31 ± 3.61	25.54 ± 3.41	<0.001

Table 4.4 presents the baseline and post-treatment comparison of pain, balance, and functional disability between the kinetic control and balance control groups. At baseline, both groups had comparable mean scores for the Numeric Pain Rating Scale (NPRS), Berg Balance Scale (BBS), and Oswestry Disability Index (ODI), indicating similar clinical status before the intervention. Following treatment, both groups demonstrated improvements in all outcome measures. However, the kinetic control group achieved greater reductions in pain and functional disability, as well as greater improvements in balance, compared with the balance control group. The post-treatment differences between the two groups were statistically significant for all outcome measures (NPRS: $p = 0.001$; BBS: $p < 0.001$; ODI: $p < 0.001$), indicating that kinetic control training was more effective than balance control training in improving pain, function, and balance among bus drivers with sacroiliac joint dysfunction.

DISCUSSION

The present randomized clinical trial evaluated the comparative effects of kinetic control training and balance control training on pain intensity, functional disability, and balance among bus drivers with sacroiliac joint dysfunction (SIJD). Similar baseline comparability has been reported in randomized clinical trials investigating physiotherapy interventions for sacroiliac joint dysfunction and chronic low back pain, allowing post-treatment differences to be attributed primarily to the intervention rather than pre-existing group differences.(18, 19) The present study found that pain intensity measured using the Numeric Pain Rating Scale (NPRS) decreased significantly in both intervention groups, with the kinetic control training group demonstrating significantly greater pain

reduction than the balance control training group.(20) These findings are consistent with the work of Comerford and Mottram (2021), who reported that kinetic control exercises restore optimal movement patterns and reduce excessive mechanical stress on the sacroiliac joint, thereby decreasing pain. Their movement-control approach emphasizes retraining faulty movement patterns and improving neuromuscular coordination, which may explain the superior pain reduction observed in the present study.(21) Similarly, O'Sullivan (2025) demonstrated that movement impairment based rehabilitation significantly reduced pain by correcting abnormal motor (20) control and improving lumbopelvic stability. The current findings support this theory, suggesting that kinetic control training effectively addresses the underlying biomechanical dysfunction associated with SIJD rather than merely reducing symptoms(13). The results are also consistent with Hidalgo et al. (2024), who found that stabilization exercises produced significant reductions in pain among patients with sacroiliac joint dysfunction. The greater improvement observed in the kinetic control group may be attributed to improved activation of the transversus abdominis, multifidus, pelvic floor, and gluteal muscles, resulting in enhanced force closure and stabilization of the sacroiliac joint.(22) In contrast, some previous studies have reported no significant superiority of one exercise program over another for chronic low back pain. These discrepancies may be explained by differences in study populations, intervention duration, treatment intensity, and outcome measures. The present study specifically recruited professional bus drivers, whose prolonged sitting posture and repetitive vibration exposure may particularly benefit from movement-control retraining.(23) The Oswestry Disability Index (ODI) scores decreased significantly in both intervention

groups; however, the kinetic control group demonstrated significantly greater improvement than the balance control group.(24) These findings agree with Richardson, Hodges, and Hides (2024), who concluded that motor control exercises effectively restore functional performance by improving spinal stability and neuromuscular control. (25) Their research demonstrated that retraining deep trunk muscles reduces disability more effectively than conventional exercise.(26) Similarly, Van Dillen et al. (2026) reported that classification-based movement system impairment treatment significantly improved functional outcomes in patients with mechanical low back pain. Their findings support the current study by emphasizing that correcting movement dysfunction leads to meaningful improvements in daily activities. (27) The present results are also comparable to those reported by Stuge et al. (2024), who found that individualized stabilization exercises significantly reduced disability in patients with pelvic girdle pain. The authors suggested that restoring muscle coordination improves load transfer across the pelvis, thereby reducing functional limitations.(28) The greater functional improvement observed in the kinetic control group may be explained by enhanced neuromuscular efficiency, improved trunk muscle coordination, and correction of abnormal movement strategies during occupational activities such as prolonged sitting, repetitive vehicle operation, and transferring in and out of the driver's seat. (29) Similarly, Shumway-Cook and Woollacott (2026) emphasized that improved neuromuscular coordination enhances postural control and balance performance by restoring appropriate muscle activation patterns.(31) Although balance control training directly targets postural stability, kinetic control training likely produced superior improvements because it simultaneously corrected movement dysfunction while enhancing proprioception, core stability, and coordinated muscle activation. This comprehensive approach may have resulted in greater improvements in dynamic balance than balance exercises alone. The principal finding of this randomized clinical trial is that both intervention programs

were clinically effective; however, kinetic control training produced significantly superior improvements in pain reduction, functional disability, and balance performance.(32) The superiority of kinetic control training is consistent with the biomechanical model proposed by Comerford and Mottram, which emphasizes correcting movement impairments rather than focusing solely on muscle strengthening or balance exercises. Restoring normal movement patterns likely reduced repetitive mechanical stress on the sacroiliac joint, improved force closure, optimized muscle recruitment, and enhanced lumbopelvic stability.(33)

Conclusion

The findings of this study provide evidence that both kinetic control training and balance control training are effective rehabilitation approaches for bus drivers with sacroiliac joint dysfunction. But kinetic control training demonstrated superior effectiveness in reducing pain, improving functional ability, and enhancing balance, making it the preferred physiotherapy intervention for this population.

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