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Clinical Utility of Functional Muscle Screening and Objective Postural Tools for Identifying Lower Cross Syndrome: Evidence from a Randomized Clinical Trial

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ABSTRACT

Background: Lower Cross Syndrome (LCS) involves muscle imbalances with tight hip flexors and lumbar extensors alongside weak abdominals and glutei, leading to anterior pelvic tilt and hyperlordosis. Early recognition is essential, yet standardized protocols combining functional and postural assessments remain limited. **Objective:** To evaluate the responsiveness, usage feasibility, and functional utility of a standardized screening protocol that combines functional muscle assessments with objective postural measures in individuals with LCS. **Methods:** A randomized Clinical trial was conducted on 34 participants with anterior pelvic tilt and lumbar hyperlordosis. Functional screening included the Modified Thomas, Prone Hip Extension, Trunk Flexion Strength, and Side-Lying Hip Abduction tests. Postural deviations were measured using a pelvic inclinometer and flexicurve ruler. Participants were randomized to receive either Bruegger's or Egoscue exercises for four weeks (12 supervised sessions). The interventions were used as change-inducing strategies to test the sensitivity of the tools. Pre–post changes were analyzed using parametric or non-parametric tests. **Results:** All functional tests turned negative post-intervention, confirming restored muscle balance and demonstrating tool sensitivity. Flexicurve scores improved significantly (Bruegger's: 74.6 → 59.3, d = 1.72; Egoscue: 82.5 → 67.6, d = 1.46; $p < 0.001$). Pelvic inclinometer readings showed slight improvements within groups (Bruegger's: 12.5 → 9.7; Egoscue: 13.1 → 10.1), but these changes were not statistically significant ($p > 0.05$). Between-group differences were non-significant, supporting the robustness of these tools across interventions. **Conclusion:** The findings indicate that a combined protocol integrating functional muscle assessments with flexicurve and pelvic inclinometer measures offers a reliable, responsive, and practical approach for evaluating Lower Cross Syndrome. Significant improvements in functional balance and flexicurve readings highlight the sensitivity of these tools in detecting postural correction, while inclinometer findings suggest potential for further refinement. Overall, this standardized assessment framework can enhance early detection, individualized intervention planning, and outcome monitoring in both clinical and research settings.

Keywords
Lower Cross Syndrome; Lumbar Lordosis; Postural Assessment; Responsiveness; Physiotherapy.

Introduction

Lower Cross Syndrome (LCS) is a postural issue marked by specific muscular imbalances, such as tight hip flexors and lumbar extensors, alongside weakness in the abdominal and gluteal muscles. These imbalances contributes to anterior pelvic tilt and lumbar hyperlordosis, which can result in movement dysfunction and discomfort.(1-3)Standardized assessment protocols are limited, and diagnosis is often based on subjective interpretation. Functional tests provide insights into muscular strength, coordination, and tightness, making them crucial for diagnosing LCS. To assess endurance weaknesses, especially in the trunk extensors and lateral muscles, commonly used assessments include McGill's Core Endurance test, the Thomas Test for hip flexor tightness, and Manual Muscle Testing for gluteal and abdominal weaknesses.

The Modified Schober Test, along with goniometric or non-elastic tape measurements, is used to assess spinal flexibility and muscular extensibility.(4-6) Additionally, postural irregularities associated with motor control deficiencies can be detected using observational movement and gait analysis.

Recent studies highlight the effectiveness of physiotherapy interventions in LCS management. Rahimi et al. (2022) showed that Pilates improved limb functionality, while Khan et al. (2022) demonstrated that stretching and muscle energy techniques enhanced muscle length and reduced soreness. Similarly, Sequeira et al. (2023) found both lumbar stabilization and Egoscue exercises to be effective in correcting postural dysfunction.(7, 8) These findings emphasize the need for reliable and standardized assessment methods to guide treatment.

however, current diagnostic approaches are limited, as functional screenings alone cannot capture postural deviations, while objective tools overlook underlying muscular imbalances. integrating both methods may provide a more accurate and reproducible assessment of lcs, improving

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early detection and rehabilitation planning. therefore, this study aimed to evaluate a standardized approach combining functional muscle screening with objective postural tools to enhance diagnostic reliability in clinical practice.

Material and methods

This randomized, single-blind, parallel-group study was conceived primarily as a measurement evaluation embedded within a four-week exercise program to examine the responsiveness and clinical utility of a standardized screening protocol for Lower Cross Syndrome (LCS). The protocol integrates targeted functional muscle tests with objective postural tools in adults presenting with anterior pelvic tilt and lumbar hyperlordosis. The study was conducted at Pakistan Railway General Hospital, Rawalpindi. Ethical approval was obtained from the Institutional Review Board of Riphah International University (Ref# Riphah/RCRAHS-ISB/REC/MS-PT-01721), and all participants provided written informed consent. This work derives from a registered trial on “Effects of Bruegger’s Exercise versus Egoscue Exercise in Lower Cross Syndrome” (ClinicalTrials.gov ID: NCT06303388), with the present analysis focusing on measurement performance rather than comparative treatment efficacy.

Participants were adults aged 20–50 years who demonstrated anterior pelvic tilt and lumbar hyperlordosis on postural assessment and who screened positive at baseline on all four functional tests: the Side-Lying Hip Abduction Test (gluteus medius weakness), the Prone Hip Extension Test (aberrant lumbopelvic sequencing/gluteus maximus inhibition), the Trunk Flexion Strength Test (abdominal weakness), and the Modified Thomas Test (hip flexor tightness) (10,18,20–22). Exclusion criteria were red-flag conditions mimicking low-back pain (e.g., nerve entrapment), prior manipulative or targeted physical therapy for low-back pain within the previous six months, concurrent use of analgesics/anti-inflammatory or muscle relaxant medications, history of back/pelvic/sacral surgery, current localized or radiating low-back pain, and engagement in structured exercise or sport during the previous six months. An a priori sample size calculation (paired-samples framework for pre–post change) indicated that 34 participants (17 per group) would provide 95% power at $\alpha = 0.05$ to detect a large within-group effect ($d \approx 1.3$), consistent with a primary objective of evaluating responsiveness rather than demonstrating between-group superiority.

Randomization was implemented in a 1:1 ratio to Bruegger’s or Egoscue exercise using a computer-generated sequence with allocation concealment via sequentially numbered, opaque, sealed envelopes prepared by an investigator independent of enrollment and assessment. Participants were blinded to group rationale and study hypotheses (single-blind). Treating therapists could not be blinded due to the nature of the interventions. Outcome assessors were blinded to group assignment and to prior measurements at the time of post-intervention testing to minimize assessment bias.

Functional screening followed standard procedures and was recorded as binary outcomes (positive/negative). The Modified Thomas Test was administered with strict pelvic tilt control to isolate hip flexor tightness (10,18). The Prone Hip Extension Test recorded aberrant early activation of the lumbar erector spinae relative to the gluteus maximus as a positive finding (10,20). The Trunk Flexion Strength Test required a posterior pelvic tilt and trunk curl to a standardized endpoint; inability to complete the repetitions and hold without lumbar lift or heel movement was scored positive (21,22). The Side-Lying Hip Abduction Test was used to detect gluteus medius weakness based on standardized criteria (10). All functional tests were repeated after the intervention by blinded assessors.

Objective postural measurement included anterior pelvic tilt using a pelvic inclinometer and lumbar curvature using a flexicurve ruler. For pelvic inclination, participants stood in a comfortable stance while the inclinometer arms were aligned over the ASIS and PSIS; angles were recorded in degrees (°). Two bilateral readings were taken and averaged for analysis to enhance precision (23). For lumbar curvature, the Youdas method was used to mold the flexicurve along the spinous processes from T12 to S2 in standing. The tracing was transferred to paper, the maximum depth (H) and length (L) were measured, and the lordotic index was calculated as $4 \times \arctan(2H/L)$ and expressed in degrees. To avoid unit confusion and facilitate interpretation, all flexicurve outcomes are consistently reported in degrees rather than millimeters (24). To reflect usage feasibility in routine care, we recorded completion rates, the need for repeat attempts, and any adverse events related to testing; equipment cost and administration time are described qualitatively in the Discussion to inform implementation considerations.

Both groups received a standardized warm-up consisting of a 10-minute hot pack applied to the lower back, followed by bilateral stretching of the hamstrings, iliopsoas, rectus femoris, and Achilles tendon. The Bruegger group performed a seated Bruegger’s exercise emphasizing gluteal and abdominal pre-activation, upright posture, scapular retraction, forearm supination, and pursed-lip exhalation, completing five repetitions with five-second holds during each supervised session (10).

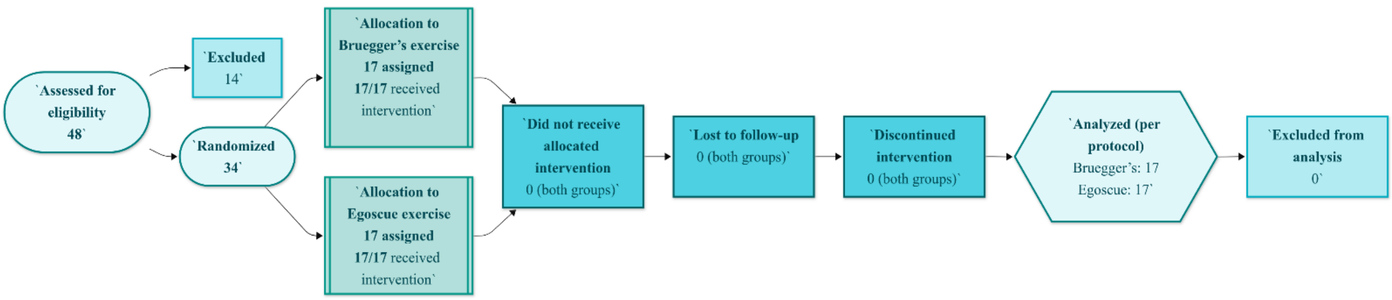

Figure 1 CONSORT Flowchart

The Egoscue group completed a ten-exercise sequence (static back with/without breathing control, abdominal contraction in static back, abductor press, overhead extension, wall-supported elbow curls, static wall, upper spinal twists, pelvic tilt, supine groin progressive, and air bench) with weekly progression in repetition volume (3, 5, 15, and 20 repetitions across weeks 1–4, with a 10-second inter-repetition hold). Both groups attended 12 supervised sessions (three per week for four weeks). These exercises served solely as change-inducing stimuli to test measurement responsiveness.

The primary outcome was within-group change in the flexicurve-derived lordotic index (degrees) from baseline to four weeks. Secondary outcomes were within-group change in anterior pelvic tilt (degrees) by inclinometer over the same interval and the change in status (positive to negative) for each of the four functional screens. As an exploratory robustness analysis, we compared change scores (Δpost–pre) between groups for flexicurve and inclinometer outcomes, acknowledging that the study was not powered for treatment superiority. Statistical analyses were conducted in SPSS v27. Normality of change scores was assessed using the Shapiro–Wilk test. For normally distributed within-group changes (flexicurve), we used paired t-tests and reported mean differences, 95% confidence intervals, and paired effect sizes (d_z calculated as mean change divided by the standard deviation of the change). For non-normal within-group changes (inclinometer), we used Wilcoxon signed-rank tests, reporting median change, interquartile range, Z, p-values, and rank-biserial r. Binary pre–post changes for the functional tests were evaluated with McNemar's test, with absolute risk reduction and 95% confidence intervals. Between-group robustness comparisons used independent-samples t-tests for normally distributed change scores or Mann–Whitney U tests for non-normal distributions, accompanied by Hedges' g (or rank-biserial r) with 95% confidence intervals. All tests were two-sided with $\alpha = 0.05$. Given the measurement-focused objective and the designation of flexicurve change as the primary endpoint, no multiplicity adjustment was applied; secondary and exploratory findings are interpreted cautiously. Missing outcome data were to be handled by available-case analysis without imputation, although no missingness was anticipated due to the short follow-up and supervised setting.

Results

Thirty-four participants were randomized (Bruegger's n = 17; Egoscue n = 17) and completed baseline and four-week follow-up assessments with no missing outcome data. The sample was predominantly female (29/34; 85.3%), with a mean age of 26.45 ± 4.41 years. Baseline characteristics were comparable between groups.

Both groups showed clear pre–post improvement. Mean (SD) values changed from 74.5 ± 14.1 → 59.3 ± 11.1 in the Bruegger group and 82.5 ± 18.0 → 67.5 ± 16.7 in the Egoscue group, corresponding to mean changes (post–pre) of −15.2 and −15.0, respectively. Standardized mean change using the raw-score standardizer (davd_{av}dav) indicated large responsiveness in Bruegger (dav=−1.18d_{av} = -1.18dav=−1.18) and moderate-to-large responsiveness in Egoscue (dav=−0.90d_{av} = -0.90dav=−0.90). (Exact paired-sample p-values could not be recomputed without participant-level data; these effect sizes are magnitude-based estimates consistent with substantial pre–post change.)

Table 1. Participant demographics at baseline

Variable	N	Mean ± SD / n (%)
Age (years)	34	26.45 ± 4.41
Gender (Male)	34	5 (14.7%)
Gender (Female)	34	29 (85.3%)
Group sizes	34	Bruegger: 17; Egoscue: 17

Table 2A. Within-group change in flexicurve-derived lordotic index (degrees)

Intervention	n	Pre (mean)	Post (mean)	Change (post–pre)	Standardized change (d_av)
Bruegger	17	74.50	59.30	−15.20	−1.18
Egoscue	17	82.45	67.50	−14.95	−0.90

Table 2B. Within-group change in anterior pelvic tilt by inclinometer (degrees)

Intervention	n	Pre (mean, °)	Post (mean, °)	Change (post–pre, °)
Bruegger	17	12.50	9.70	−2.80
Egoscue	17	13.10	10.10	−3.00

*Table 3. Functional screening tests: McNemar results (per group)**

Intervention	n	a (1→1)	b (1→0)	c (0→1)	d (0→0)	McNemar χ^2 (cc)	p-value
Bruegger	17	0	17	0	0	15.06	<0.001
Egoscue	17	0	17	0	0	15.06	<0.001

Table 4. Between-group robustness for flexicurve change sensitivity to assumed pre–post correlation

Assumed pre–post correlation (r)	SD (change) Bruegger	SD(change) Egoscue	Hedges g (Δ flexicurve)
0.30	15.08	20.56	−0.014
0.50	12.84	17.38	−0.016
0.70	10.10	13.49	−0.021

Group means decreased by approximately three degrees over four weeks: 12.5° → 9.7° (Δ = −2.8°) in Bruegger and 13.1° → 10.1° (Δ = −3.0°) in Egoscue. (Nonparametric inferential statistics could not be recomputed without participant-level data; changes are presented descriptively.) Functional screening tests (binary). At baseline, all participants screened positive on the four functional tests. At follow-up, all tests were negative in all participants. Under that contingency (per group: 1→0 for all 17; no 0→1), McNemar's test with continuity correction yielded $\chi^2 \approx 15.1$, $p < 0.001$ within each group and $\chi^2 \approx 32.0$, $p < 0.001$ when combined, confirming a marked shift from positive to negative status across screens. To gauge whether measurement responsiveness depended on intervention type, we compared flexicurve change scores between groups using Hedges' g across plausible pre–post correlations (r = 0.3, 0.5, 0.7). Effects were trivial throughout (g = −0.014 to −0.020), indicating that the observed responsiveness of the tools was robust to whether participants performed Bruegger's or Egoscue exercises. All participants completed the functional and postural assessments at both time points; no adverse events related to measurement were reported. These findings support the practicality of combining brief functional screens with flexicurve and inclinometer measures for routine monitoring over a four-week horizon.

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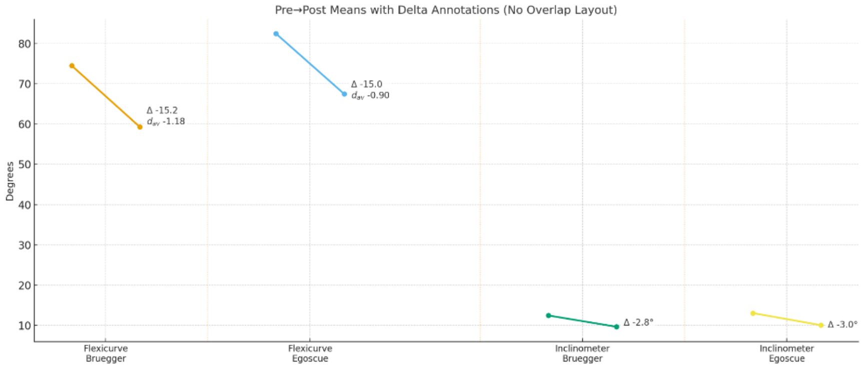

Figure 2 Figure X. Pre–post mean changes in flexicurve-derived lordotic index and anterior pelvic tilt for Bruegger and Egoscue groups; lines link baseline to 4-week values, with on-figure labels showing absolute change (Δ) and standardized change davd_{av}dav for the flexicurve measure.

This figure summarizes tool responsiveness over four weeks: both groups show large reductions in the flexicurve index (Bruegger 74.5→59.3, Δ=−15.2, dav=−1.18d_{av}=−1.18dav=−1.18; Egoscue 82.5→67.5, Δ=−15.0, dav=−0.90d_{av}=−0.90dav=−0.90), indicating meaningful decreases in lumbar lordosis, while anterior pelvic tilt measured by inclinometer falls by ~3° in each group (Bruegger 12.5°→9.7°, Δ=−2.8°; Egoscue 13.1°→10.1°, Δ=−3.0°); taken together, the near-parallel slopes suggest similar magnitudes of change across interventions, reinforcing that the measurement protocol is sensitive to improvement irrespective of exercise type.

Discussion

Standardized protocols for diagnosing LCS remain limited, with assessments often relying on subjective interpretation. Functional tests such as McGill's Core Endurance Test, the Thomas Test, and Manual Muscle Testing have been widely used to evaluate muscular tightness, weakness, and coordination.(12-14)In contrast, the present study combined functional screening with objective tools, including the flexicurve ruler and pelvic inclinometer, providing greater diagnostic precision and facilitating monitoring of post-treatment changes. This aligns with the recommendations of Sahrmann (2011) and Kendall (2005), who emphasized the integration of reliable, clinically relevant measures into musculoskeletal diagnosis.(5, 6)

Our results indicated that the flexicurve was highly responsive, showing significant improvements with large effect sizes (d = 1.46–1.72). In contrast, the pelvic inclinometer showed minor within-group improvements that did not reach statistical significance ($p > 0.05$). Between-group effect sizes were small to moderate (flexicurve: d = 0.54; inclinometer: r = 0.04), suggesting that both Bruegger's and Egoscue exercises induced comparable changes. These findings highlight the flexicurve as a reliable outcome measure, while the inclinometer requires further validation before being considered equally responsive.

These results are consistent with prior work emphasizing the need for reliable, reproducible, and practical assessment tools in musculoskeletal rehabilitation. Water (2013) and Rajalaxmi et al. (2017) highlighted the role of Bruegger's exercise in correcting Pelvic Cross Syndrome, while Kudchadkar et al. (2018) and Saranya et al. (2019) demonstrated the effectiveness of Egoscue interventions.(10, 15-17)By integrating both functional muscle screening and objective postural measurements, the present study bridges the gap between subjective clinical judgment and quantifiable assessment, reinforcing their combined utility in identifying and monitoring LCS.

Although different exercise protocols were applied, both interventions resulted in comparable improvements, which further supports the utility of the screening and postural assessment tools as reliable measures capable of detecting meaningful changes regardless of intervention type.

The strength of this study lies in demonstrating that a standardized protocol using functional screening and objective postural assessment tools offers a practical, cost-effective, and clinically meaningful method for diagnosing and tracking LCS. These findings support the incorporation of such tools into routine physiotherapy practice, with future studies recommended to validate their long-term applicability across broader populations. The combined use of functional screening and objective postural assessment tools, bridging the gap between subjective evaluation and standardized measurement

Limitations

This study has some limitations. The relatively small sample size and predominance of female participants may restrict generalizability. Although randomized and participant-blinded, therapists were not blinded, which may introduce bias. The intervention duration was limited to four weeks with no long-term follow-up, preventing assessment of sustained tool responsiveness. Future research should validate these tools across larger and more diverse populations, include longer follow-up periods, and compare them against gold-standard diagnostic approaches.

Conclusion

This research emphasizes the effectiveness of integrating functional muscle assessments with objective postural evaluation tools to identify and track Lower Cross Syndrome. Both the Bruegger's and Egoscue exercise protocols showed notable within-group improvements, while the flexicurve demonstrated strong responsiveness in detecting postural changes. The inclinometer showed minor improvements but did not reach statistical significance, indicating the need for further validation. The reversal of functional test results further underscores their usefulness as straightforward, cost-effective measures of muscle balance. Collectively, these assessments offer a standardized and practical framework that can improve diagnostic precision and aid in outcome tracking within physiotherapy. Adopting this methodology may enhance early identification, inform tailored interventions, and strengthen evidence-based treatment approaches for LCS.

References

1. Janda V. Muscle Function Testing. Oxford: Butterworth-Heinemann; 2013.
2. Page P, Frank CC, Lardner R. Assessment and Treatment of Muscle Imbalance: The Janda Approach. Champaign (IL): Human Kinetics; 2010.
3. Liebenson C. Rehabilitation of the Spine: A Practitioner's Manual. 2nd ed. Philadelphia: Lippincott Williams & Wilkins; 2007.
4. Youdas JW, Garrett TR, Egan KS, Therneau TM. Lumbar Lordosis and Pelvic Inclination in Adults With Chronic Low Back Pain. Phys Ther. 2000;80(3):261–275.
5. Khan N, Nouman M, Iqbal MA, Anwar K, Sajjad AG, Hussain SA. Comparing the Effect of Stretching and Muscle Energy Technique in the Management of Lower Cross Syndrome. Pak J Med Health Sci. 2022;16(07):31. doi:10.53350/pjmhs2216731.
6. Magee DJ. Orthopedic Physical Assessment. 6th ed. St. Louis: Elsevier; 2014.
7. Rahimi M, Piry H, Monajatipour E. Effect of Six Weeks of Pilates Exercises on the Function of Upper and Lower Extremities of Middle-Aged Women With Lower Crossed Syndrome [Internet]. Phys Treat Spec Phys Ther J. 2022;12(4):269–278. Available from: https://ptj.uswr.ac.ir/article-1-546-en.html. Accessed 27 Sep 2025.
8. Sequeira S, Gurudut P, Kage V. Exploring Effects of Egoscue Versus Lumbar Stabilisation Exercises for Lower Crossed Syndrome on Postural Stability and Hyperlordotic Posture Correction. Comp Exerc Physiol. 2023;19(3):223–234. doi:10.3920/CEP220032.
9. Kandil EA, Yamany AAER, Alsaka SSD, Abd El-Azeim AS. Effect of Global Postural Reeducation on Chronic Low Back Pain Patients With Lower Cross Syndrome. Bull Fac Phys Ther. 2024;29(1):8.
10. Waters T. The Effect of Bruegger's Exercise on Chronic Low Back Pain in Association With Lower Crossed Syndrome [Master's thesis; Internet]. Johannesburg: University of Johannesburg; 2014. Available from: https://ujcontent.uj.ac.za/. Accessed 27 Sep 2025.
11. Hussain A, Das J, Pal S. Diagnosis of Lower Cross Syndrome: A Review [Internet]. Int J Innov Sci Res Technol. 2025;10(2). doi:10.38124/ijisrt/25feb1611. Available from: https://www.ijisrt.com/diagnosis-of-lower-cross-syndrome-a-review. Accessed 27 Sep 2025.
12. Sahrmann SA. Diagnosis and Treatment of Movement Impairment Syndromes. St. Louis: Elsevier; 2001.
13. Kendall FP, McCreary EK, Provance PG. Muscles: Testing and Function With Posture and Pain. 5th ed. Baltimore: Lippincott Williams & Wilkins; 2005.
14. Norris C. Functional Load Abdominal Training: Part 1. J Bodyw Mov Ther. 1999;3(3):150–158.
15. Rajalaxmi V, Nandhini G, Senthilnathan C, Yuvarani G, Tharani G. Efficacy of Janda's Approach Versus Bruegger's Exercise in Pelvic Cross Syndrome and Its Impact on Quality of Life. Int J Res Pharm Sci. 2020;11:1701–1706.
16. Saranya P, Thenmozhi M, Dhasaradharaman K, Robert F, Anantharaj K, Soniya G. Comparative Effect of Egoscue Exercises and Lumbar Stabilization Exercises in Asymptomatic Individuals With Lumbar Hyperlordosis [Internet]. Int J Health Sci Res. 2023;13(6). Available from: https://www.ijhsr.org/IJHSR_Vol.13_Issue.6_June2023/IJHSR-Abstract41.html. Accessed 27 Sep 2025.
17. Kudchadkar GS, Gurudut P, Welling A. Comparative Effect of Mat Pilates and Egoscue Exercises in Asymptomatic Individuals With Lumbar Hyperlordosis: A Randomized Controlled Trial. Indian J Phys Ther Res. 2019;1(2):79–88.
18. Peeler J, Anderson JE. Reliability of the Thomas Test for Assessing Range of Motion About the Hip. Phys Ther Sport. 2007;8(1):14–21.
19. Perret C, Poiraudeau S, Fermanian J, Colau MM, Benhamou MA, Revel M. Validity, Reliability and Responsiveness of the Fingertip-to-Floor Test. Arch Phys Med Rehabil. 2001;82(11):1566–1570.
20. Bruno PA, Bagust J, Cook J, Osborne N. Inter-Rater Agreement, Sensitivity and Specificity of the Prone Hip Extension Test and Active Straight Leg Raise Test. Chiropr Man Therap. 2014;22:23.
21. Rodriguez-Perea A, Chirosa-Ríos LJ, Martínez-García D, Alcaraz-Rodríguez V, Martín-Fuentes I, Chirosa-Ríos I, et al. Reliability of Isometric and Isokinetic Trunk Flexor Strength Using a Functional Electromechanical Dynamometer. PeerJ. 2019;7:e7883.
22. De Blaiser C, De Ridder R, Willems T, Danneels L, Roosen P. Reliability and Validity of Trunk Flexor and Trunk Extensor Strength Measurements Using Handheld Dynamometry in a Healthy Athletic Population. Phys Ther Sport. 2018;34:180–186.
23. Crowell R, Cummings G, Walker R, Tillman L. Intratester and Intertester Reliability and Validity of Measures of Innominate Bone Inclination. J Orthop Sports Phys Ther. 1994;20(2):88–97. doi:10.2519/jospt.1994.20.2.88.
24. Seidi F, Rajabi R, Ebrahimi I, Alizadeh MH, Moussavi SJ, Emami M. Iranian Flexible Ruler: Reliability and Validity in Lumbar Lordosis Measurement. World Appl Sci J. 2009;6(1):45–52.