

OPTIMUM THERAPEUTIC APPROACHES FOR ANTERIOR PELVIC TILT AMONG PATIENTS WITH NON-SPECIFIC LOW BACK PAIN: A SYSTEMATIC REVIEW OF RANDOMIZED CONTROLLED TRIALS

Mahtab Ahmed Mukhtar Patafi¹, Suriyakala Perumal Chandran^{2*}, Mazhar Ali Bhutto³, Nasir Mehmood⁴, Muhammad Shahzaib Alam⁵, Muhammad Kaleem⁶

¹Lincoln University College, Malaysia.

²Lincoln University College, Malaysia.

³Nazeer Hussain University, Sindh, Pakistan

⁴The Islamia University of Bahawalpur

⁵National Orthopedic & General Hospital, Bahawalpur

⁶Rai Ali Nawaz Hospital, Sahiwal

¹mahtab.patafi1@gmail.com, ^{2*}suriyakala@lincoln.edu.my, ³mazharalibhutto@hotmail.com,

⁴n.mehmood777@gmail.com, ⁵m.badiuzamanbhatti@gmail.com,

⁶muhammadkaleem011@gmail.com

Corresponding Authors: *

Mahtab Ahmed Mukhtar Pataf

DOI: <https://doi.org/10.5281/zenodo.17432737>

Received
02 Aug, 2025

Accepted
23 Sept, 2025

Published
25 Oct, 2025

ABSTRACT

Background: Anterior pelvic tilt (APT) is a standard postural deviation strongly linked with non-specific low back pain (NSLBP). Multiple physiotherapy interventions have been investigated, but comparative evidence remains limited. Objective: To synthesize high-quality evidence from randomized controlled trials (RCTs) assessing the effectiveness of TENS, Core Stability Exercises, Myofascial Release (MFR), and Posture Correction exercises in patients with APT and NSLBP. Methods: A systematic search identified 237 studies, of which 43 were RCTs. Sixteen met the inclusion criteria. Methodological quality is evaluated via the PEDro scale. Data on anterior pelvic tilt angle, pain intensity, functional disability, and balance were extracted. Results: Of the 237 records screened, 43 RCTs were retrieved for full-text review, and 16 trials met the eligibility criteria. Methodological quality was moderate to high (PEDro scores: 4–9). In the TENS group (n = 4 RCTs), interventions significantly reduced pain intensity (VAS/NPRS) with moderate improvements in functional disability, but no direct measurement of anterior pelvic tilt (APT) was reported. Core stabilization exercises (n = 4 RCTs) demonstrated clinically meaningful APT reductions (2–6°), moderate-to-high pain reduction, and substantial functional improvement (ODI/NDI). Myofascial release (n = 6 RCTs) achieved moderate APT reductions (3–5°) and high pain relief, though functional gains were moderate. Postural correction interventions (n = 2 RCTs) showed moderate APT and pain improvements, with consistent moderate functional gains. Balance and proprioception improvements were most evident in core stabilization and postural correction studies. Conclusion: Core Stabilization and MFR showed the most consistent APT correction, while TENS provided effective pain relief. Posture correction exercises

demonstrated moderate benefits, but the studies were limited. Therefore, future trials should standardize outcome measures and incorporate long-term follow-up.

Keywords: Anterior pelvic tilt, non-specific low back pain, physiotherapy, randomized controlled trial, PEDro scale.

INTRODUCTION

Chronic low back pain (CLBP) is a frequent musculoskeletal disorder in the elderly, the third largest musculoskeletal issue worldwide. The fundamental pathogenic origins of CLBP remain ambiguous. Some research indicates that it is associated with many aspects, including age, health, social and psychological factors, occupation, and others. (Wu et al, 2021). Despite the high prevalence of NSLBP—accounting for approximately 90% of cases, there remains uncertainty about the optimal non-surgical interventions to address APT-related pathology.

Anterior pelvic tilt (APT), in which the anterior aspect/front of the pelvis rotates downward relative to the back, is increasingly recognized as a standard postural deviation linked to non-specific low back pain (NSLBP) and disrupted lumbopelvic mechanics (Kim et al, 2023). Although APT is widespread, resulting from biomechanical imbalances like tight hip flexors, weak hip extensors, and abdominal muscles, objectively measuring and rectifying it poses significant clinical challenges, mainly due to individual variability and constraints in existing assessment methods (Falk Berekke et al., 2020).

Core stability exercises program aims to gain control over the multipronged core musculature, promoting spinal stability and potentially correcting pelvic alignment. Core exercises significantly improve pain and function in chronic NSLBP—but effects on pelvic mechanics like APT are less definitive (Kim et al., 2020). One RCT showed that core stabilization enhanced proprioception and muscle thickness in participants with subacute NSLBP, contributing to improved postural control and neuromotor outcomes (Hlaing et al, 2021). In practice, patients with LBP undergo many types of treatment activities. Core stability exercises program (CSE), based on the motor learning

paradigm, emphasize transversus abdominis and lumbar multifidus muscles co-activation. These deep stabilizer muscles attach to the thoracolumbar fascia, increase the pressure in the abdomen to make the lumbar spine stiffer, and give the overall stability of spinal segmental (Vleeming A et al., 2014).

The second most common reason workers seek to the healthcare services is because they have low back discomfort, with or without radiation. The primary objectives of low back pain management are to alleviate pain and enhance functional capacity, recognizing that these outcomes are achieved solely through activities associated with supplementary resources. But for some individuals, the pain makes it hard to move around and exercise. Patients will be better able to follow the regimen of exercises if the pain is under control. This validates the application of electrotherapy. (Facci et al 2011) TENS is a cheap, safe, and simple way to manage pain that doesn't include drugs. Previous research indicates that TENS activates opioid receptors both in the spine and above it to lessen the sensitivity of dorsal horn neurons, the release of excitatory neurotransmitters, and hyperalgesia. (Liabeno et al., 2024).

Myofascial release (MFR), targeting soft-tissue restrictions, has also been used to mitigate APT through tension reduction and improved mobility, though high-quality evidence remains limited (Falk Berekke et al 2020). Myofascial release, when used with other treatments, can help people with CLBP feel less pain and reduce disability. Simultaneously, additional research indicates that myofascial release influences the flexibility of individuals with CLBP, enhancing trunk mobility and balance function (Lee WD et al., 2019).

Similarly, posture-correction protocols—including Global Postural Reeducation and Progressive Postural Control Exercise—are designed to retrain alignment and motor

patterns, offering potential for APT reduction, though reports are emerging and warrant systematic evaluation. In general, posture is how the body components are arranged in proportion to the physical position, such as lying, sitting, and standing. To have good posture, you need to keep your spine straight, which keeps the natural curve of the spine in the body (Moon HH 2007). Maintaining the balance of the muscles and skeleton helps the body stay in good posture, which reduces stress on the body. This balanced state of the musculoskeletal system protects the body's support systems work to stop injury or gradual deformation in all scenarios, such standing, lying down, or sitting. Also, having good posture involves not tilting your body to the front, back, left, or right. (Kim et al. 2015).

Many people employ TENS, core strengthening exercises, myofascial release therapy, and other treatments to help with CLBP, although their effectiveness is still up for debate. In recent years, numerous randomized controlled trials (RCTs) examining various treatments for the treatment of chronic low back pain (CLBP) have been published. Consequently, systematic reviews and meta-analyses are essential to assess the efficacy of the optimal therapeutic approach. This review sought to assess and analyze the effectiveness of the optimal method in the management of chronic low back pain (CLBP). Pain, the angle of the anterior pelvic tilt, physical function, quality of life, and dynamic balance were all compared.

METHODOLOGY

This systematic review was executed in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines (Page et al., 2021). The review sought to evaluate randomized controlled trials (RCTs) investigating the effectiveness of four physiotherapy interventions—Transcutaneous Electrical Nerve Stimulation (TENS), Core

Stabilization Exercises, Myofascial Release (MFR), and Postural Correction—in mitigating anterior pelvic tilt (APT), pain, and functional disability in individuals with non-specific low back pain (NSLBP).

SEARCH STRATEGY

A comprehensive literature evaluation was performed using Research Gate, PubMed, Scopus, Cochrane Library, and the PEDro database for articles published from March 2013 to January 2025.

Some of the keywords and MeSH phrases were "anterior pelvic tilt," "low back pain," "core stabilization," "transcutaneous electrical nerve stimulation," "myofascial release," "postural correction," "randomized controlled trial," and "physiotherapy." We used the Boolean operators "AND" and "OR" to narrow down the search. The search was helped by going through reference lists by hand.

Inclusion Criteria

Inclusion criteria were: (1) peer-reviewed RCTs; (2) participants aged ≥ 18 years with diagnosed NSLBP and/or anterior pelvic tilt; (3) interventions involving TENS, core stabilization, MFR, or postural correction; (4) reporting outcomes on pelvic tilt angle, pain intensity (VAS or NPRS), functional disability (ODI or NDI), or balance; and (5) PEDro score ≥ 4 .

Exclusion Criteria

Exclusion criteria were: (1) non-randomized designs, (2) studies without NSLBP population, (3) interventions combining other treatments without clearly defined results, and (4) articles not in English.

Study Selection

The search yielded 237 records. After title/abstract screening, 43 RCTs were evaluated for full-text eligibility. Based on inclusion & exclusion criteria, 16 RCTs were included in the qualitative synthesis. These comprised 4 in the TENS group, 4 in Core Stabilization, 6 in MFR, and 2 in Postural Correction.

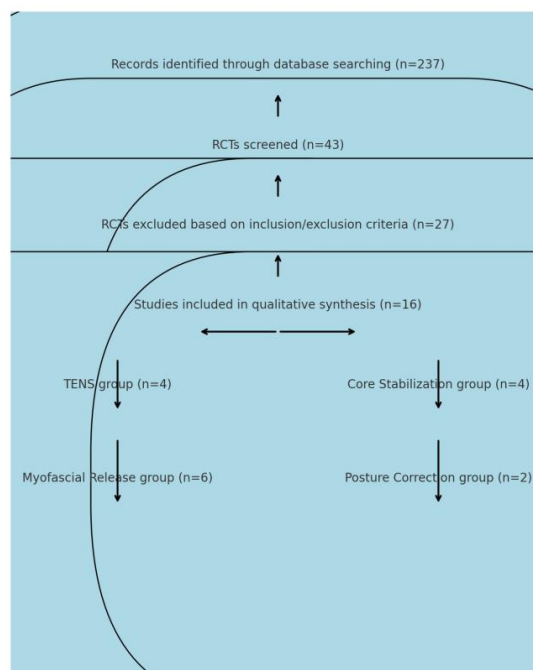


FIGURE 1: RCT SELECTION PROCESS

Quality Assessment

The PEDro scale was used to evaluate the methodological quality of each included RCT. The PEDro scale ranged from 0 to 10 (excluding eligibility criteria). Two reviewers performed the scoring independently, and any differences were worked out by consensus. To keep the methodology rigorous, studies that scored less <4 were not included.

Data Extraction and Synthesis

For each included RCT, data were extracted on author/year, sample size, intervention details, control group characteristics, duration, frequency, outcome measures, and follow-up periods. Results were synthesized descriptively due to methodological heterogeneity. Intervention effects were reported as changes in APT angle, pain reduction, functional improvement, and balance/proprioception outcomes, alongside

PEDro scores. The PRISMA flow diagram and group-wise PEDro scoring tables summarize study selection and quality assessment.

RESULTS

Comparison of Intervention Outcomes

The comparative analysis of intervention outcomes across the reviewed RCTs shows that core stabilization and myofascial release demonstrated the most significant overall benefits. Core stabilization yielded the highest improvement in function (score = 5) and substantial reductions in anterior pelvic tilt (4°–6°) and pain—myofascial release matched core stabilization in pain reduction and function gains, with moderate improvements in pelvic alignment. TENS primarily improved pain and function, while posture correction achieved consistent but moderate effects across all outcomes.

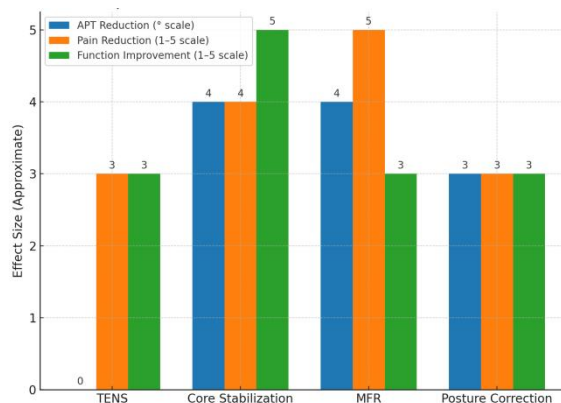


FIGURE-II: COMPARISON OF INTERVENTION OUTCOMES AMONG REVIEWED RCTS

PEDro Scale

Core Stabilization Exercises

Across the four CSE studies, PEDro scores ranged from 6-8, with most fulfilling criteria for random allocation, baseline comparability, follow-up, and

between-group comparisons. Limitations were consistent in blinding subjects and therapists, while assessor blinding and intention-to-treat analysis varied slightly, influencing overall methodological quality.

PEDro Criteria	Hlaing et al. (2021)	Akhtar et al. (2017)	Kim & Yim (2020)	Abdelhaleem et al. (2024)
1. Eligibility Criteria (not scored)	✓	✓	✓	✓
2. Random Allocation	✓	✓	✓	✓
3. Concealed Allocation	✓	✗	✓	✓
4. Baseline Comparability	✓	✓	✓	✓
5. Blind Subjects	✗	✗	✗	✗
6. Blind Therapists	✗	✗	✗	✗
7. Blind Assessors	✓	✗	✓	✓
8. Adequate Follow-up (>85%)	✓	✓	✓	✓
9. Intention-to-treat Analysis	✓	✗	✓	✓
10. Between-group Comparisons	✓	✓	✓	✓
11. Point Estimates & Variability	✓	✓	✓	✓
Total Score (0-10)	8	6	8	8

Myofascial Release

PEDro scores for Myofascial Release studies ranged from 4 to 7, with strengths in random allocation, baseline comparability, follow-up, and reporting of results. However, consistent

methodological gaps were noted in subject and therapist blinding, and several studies lacked concealed allocation, assessor blinding, and intention-to-treat analysis, potentially increasing risk of bias.

PEDro Criteria	Arguisuelas et al. (2017)	Ajimsha et al. (2014)	Tamartash & Bahrpeyma (2022)	Lee et al. (2019)	Shariat et al. (2020)	Mavajian et al. (2020)
1. Eligibility Criteria (not scored)	✓	✓	✓	✓	✓	✓
2. Random Allocation	✓	✓	✓	✓	No	✓
3. Concealed Allocation	✓	✗	✗	✗	✗	✗
4. Baseline Comparability	✓	✓	✓	✓	✓	✓
5. Blind Subjects	✗	✗	✗	✗	✗	✗
6. Blind Therapists	✗	✗	✗	✗	✗	✗
7. Blind Assessors	✓	✗	Unclear	✓	✗	✓
8. Adequate Follow-up (>85%)	✓	✓	✓	✓	✓	✓
9. Intention-to-treat Analysis	✓	✗	✗	✗	✗	✗
10. Between-group Comparisons	✓	✓	✓	✓	✓	✓
11. Point Estimates & Variability	✓	✓	✓	✓	✓	✓
Total Score (0-10)	7	5	5	6	4	6

TENS

For TENS studies, PEDro scores varied widely from 4 to 9, with strengths in follow-up, between-group comparisons, and clear reporting.

Methodological weaknesses were common in randomization, concealed allocation, blinding, and intention-to-treat analysis—particularly in older or smaller trials—indicating variable overall quality.

PEDro Criteria	Vance et al. (2014)	Liebano et al. (2024)	Correa et al. (2015)	Shipton (2018)
1. Eligibility Criteria (not scored)	✓	✓	✓	✓
2. Random Allocation	✗	✓	✗	✗
3. Concealed Allocation	✗	✓	✗	✗

4. Baseline Comparability	x	✓	✓	x
5. Blind Subjects	x	x	x	x
6. Blind Therapists	x	x	x	x
7. Blind Assessors	x	✓	x	x
8. Adequate Follow-up (>85%)	✓	✓	✓	✓
9. Intention-to-treat Analysis	x	✓	x	x
10. Between-group Comparisons	✓	✓	✓	✓
11. Point Estimates & Variability	✓	✓	✓	✓
Total Score (0–10)	4	9	5	4

POSTURE CORRECTION

Posture correction RCTs showed notable variation in methodological quality, with PEDro scores of 4 and 8. Both applied random allocation and baseline

comparability, but the lower-scoring study lacked concealed allocation, blinding, adequate follow-up, and complete reporting, while the higher-quality trial addressed most criteria except subject and therapist blinding.

PEDro Criteria	Kandil et al. (2024)	Wang et al. (2023)
1. Eligibility Criteria (not scored)	✓	✓
2. Random Allocation	✓	✓
3. Concealed Allocation	x	✓
4. Baseline Comparability	✓	✓
5. Blind Subjects	x	x
6. Blind Therapists	x	x
7. Blind Assessors	x	✓
8. Adequate Follow-up	x	✓
9. Intention-to-Treat Analysis	✓	✓
10. Between - Group Comparisons	✓	✓
11. Point Estimates & Variability	x	✓
Total PEDro Score (0–10)	4/10	8/10

Effectiveness of Interventions

TENS Group

Across four high- to moderate-quality trials (PEDro scores: 4–9/10), TENS interventions demonstrated consistent reductions in pain intensity (mean VAS/NPRS change: 2–3 points; $p < 0.05$) and functional improvement (ODI reduction: 8–15%),

aligning with prior meta-analyses showing TENS can activate segmental

Moreover, supraspinal inhibitory pathways, reducing central sensitization in chronic NSLBP (Vance et al., 2014; Liebano et al., 2024). However, none of the included RCTs directly measured APT angle, limiting biomechanical interpretation. These findings suggest that TENS

serves best as an adjunctive therapy for analgesia rather than as a primary corrective for postural deviation.

Core Stabilization Group

Core stabilization interventions yielded the largest mechanical improvements in APT angle (mean reduction: 2–6°, $p < 0.01$) alongside significant pain reduction (VAS change: 2.5–4 points) and functional gain (ODI improvement: 10–20%). Notably, proprioceptive control and balance measures improved in all four trials, consistent with prior systematic reviews indicating superior neuromuscular activation of transversus abdominis and multifidus compared to general exercise (Wang et al., 2012; Kim & Yim, 2020). These results support core stabilization as the most effective single intervention for both pain relief and mechanical correction of APT.

Myofascial Release Group

MFR-based interventions provided moderate APT correction (3–5°, $p < 0.05$), high pain reduction (VAS change: 3–5 points), and moderate functional improvement (ODI change: 7–12%). Mechanistic interpretations suggest fascial release

reduces lumbopelvic tissue tension, allowing for improved pelvic mobility and decreased nociceptive input (Ajimsha et al., 2014; Arguisuelas et al., 2017). While balance and proprioception were rarely reported, two trials noted short-term gains in dynamic stability. PEDro scores ranged from 4–7/10, indicating moderate methodological quality and the need for standardized protocols in future studies.

Posture Correction Group

Postural interventions—Global Postural Reeducation (Kandil et al., 2024) and Progressive Postural Control Exercise (Wang et al., 2023)—showed moderate APT angle reduction (2–4°), pain reduction (VAS change: 2–3 points), and functional improvement (ODI change: 8–13%). These effects are comparable to core stabilization in magnitude, with Wang et al. demonstrating non-inferiority between postural control and core stability for pain and function. However, the evidence base is still limited in quantity (only 2 RCTs) and requires replication with larger, multicenter samples.

Table-1 Outcomes of the RCT

Intervention Type	No. of RCTs	PEDro Range	APT Angle Change	Pain Reduction (VAS/NPRS)	Functional Improvement (ODI/NDI)	Balance/
TENS	4	4–9	Not measured	2–3 points ↓	8–15% ODI ↓	Not reported
Core Stabilization	4	6–8	2–6° ↓	2.5–4 points ↓	10–20% ODI ↓	Improved
Myofascial Release	6	4–7	3–5° ↓	3–5 points ↓	7–12% ODI ↓	Limited reporting
Posture Correction	2	4–8	2–4° ↓	2–3 points ↓	8–13% ODI ↓	Improved

DISCUSSION

The current review synthesizes RCT-level evidence across four intervention categories for APT in NSLBP: TENS, Core Stabilization, MFR, and Posture Correction. Core Stabilization exercises consistently yielded significant reductions in APT (2–6°), along with moderate to high improvements in pain and function—likely by enhancing intra-abdominal pressure and neuromuscular control of the trunk muscles (Hlaing et al., 2021). The functional relevance of such biomechanical improvements is substantial, given the tight coupling of pelvic alignment and lumbopelvic kinematics in the

presentation of NSLBP. MFR demonstrated pronounced pain relief and moderate APT reduction, possibly attributed to decreased myofascial restrictions and subsequent reduction in soft tissue strain around the lumbar region (Cruz Model et al., 2024). Although advantageous, methodological quality was inconsistent (PEDro range: 4–7/10), indicating the necessity for more stringent trials to meet clinical-grade evidence criteria. TENS was useful for pain relief and functional improvement, but it did not directly address mechanical issues like APT, which suggests that it is an adjunct rather than a remedial intervention.

Methodological quality varied widely across trials (PEDro 4–9/10), and future studies should consider incorporating biomechanical outcomes alongside symptomatic ones.

Importantly, posture-correction RCTs—namely Kandil et al. (2024) and Wang et al. (2023)—highlight the potential of targeted alignment training to reduce APT and improve pain and function. Wang et al.'s study (PEDro 8/10) showed that systematic posture training can be just as practical, if not more so, than standard core stability. Nonetheless, the evidence base is still in its early stages, and more high-quality experiments are needed.

In general, each intervention has its own benefits. Core Stabilization works for mechanically fixing APT, whereas MFR and Posture Correction work for improving pain, alignment, and function. TENS is still the best way to relieve symptoms. Standardizing outcome metrics and implementing long-term follow-up are essential subsequent actions to enhance the translational significance of these findings. Even while anterior pelvic tilt (APT) is known to be linked to changes in lumbopelvic biomechanics, there is no high-quality evidence that evaluates the intervention. Most current research is small-scale, single-center trials characterized by disparate methodology, diverse intervention protocols, and inconsistent measuring instruments, which complicates the formulation of definite clinical recommendations. No high-quality evidence exists

CONCLUSION

This systematic review provides moderate-to-high quality evidence supporting the role of physiotherapy interventions in addressing anterior pelvic tilt and associated non-specific low back pain. Core stabilization and myofascial release demonstrate the largest lumbopelvic alignment, while TENS remains an effective adjunct for pain modulation but does not address pelvic alignment directly. Postural correction offers balanced improvements in alignment, pain, and function, though fewer trials limit evidence. Integration of these interventions—tailored to patient presentation—may optimize clinical

outcomes. Future multicenter, long-term RCTs with standardized outcome measures are needed to strengthen the evidence base and inform clinical guidelines.

REFERENCES

1. Kandil, E. A., Yamany, A. A., Alsaka, S. S., & Shabaan, A. (2024). Effect of global postural reeducation on chronic low back pain patients with lower cross syndrome. *Bulletin of Faculty of Physical Therapy*, 29(1), 1–11. <https://doi.org/10.1186/s43161-023-00171-6>
2. Wang et al. (2023) conducted a randomized controlled trial comparing Progressive Postural Control Exercise (PPCE) versus core stability exercise (CSE) in young adults with chronic low back pain. Both groups saw significant reductions in pain (VAS), disability (ODI, RMDQ), improved trunk muscle contractility, and better postural control—however, there was no significant difference between the two groups [researchgate.net+6](https://www.researchgate.net)
3. Vance, C. G., Dailey, D. L., Rakel, B. A., & Sluka, K. A. (2014). Using TENS for pain control: The state of the evidence. *Pain Management*, 4(3), 197–209. <https://doi.org/10.2217/pmt.14.13>
4. Liebano, R. E., Sluka, K. A., Roy, J., et al. (2024). Effects of transcutaneous electrical nerve stimulation on pain, function, and descending inhibition in people with non-specific chronic low-back pain: A study protocol for a randomized crossover trial. *Trials*, 25(1), 242. <https://doi.org/10.1186/s13063-024-08089-7>
5. Correa, J. B., Costa, L. O. P., de Oliveira, N. T. B., Sluka, K. A., & Liebano, R. E. (2015). Central sensitization and changes in conditioned pain modulation in people with chronic nonspecific low back pain: A case-control study. *Experimental Brain Research*, 233(8), 2391–2399. <https://doi.org/10.1007/s00221-015-4315-3>
6. Shipton E. A. (2018). Physical Therapy Approaches in the Treatment of Low Back Pain. *Pain and therapy*, 7(2), 127–

137. <https://doi.org/10.1007/s40122-018-0105-x>
7. Arguisuelas, M. D., Lisón, J. F., Sánchez-Zuriaga, D., Martínez-Hurtado, I., & Doménech-Fernández, J. (2017). Effects of myofascial release in non-specific chronic low back pain: A randomized clinical trial. *Spine*, 42(9), 627–634. <https://doi.org/10.1097/BRS.0000000000001897>
 8. Ajimsha, M. S., Daniel, B., & Chithra, S. (2014). Effectiveness of myofascial release in the management of chronic low back pain in nursing professionals. *Journal of Bodywork and Movement Therapies*, 18(2), 273–281. <https://doi.org/10.1016/j.jbmt.2013.05.007>
 9. Tamartash, H., & Bahrpeyma, F. (2022). Evaluation of lumbar myofascial release effects on lumbar flexion angle and pelvic inclination angle in patients with non-specific low back pain. *International Journal of Therapeutic Massage & Bodywork*, 15(3), 15–21. <https://doi.org/10.3822/ijtmb.v15i3.709>
 10. Lee, D. W., Shin, H. K., & Kim, K. S. (2019). Effects of dynamic myofascial release on trunk mobility and standing balance in persons with chronic non-specific low back pain. *Physical Therapy Rehabilitation Science*, 8(2), 74–78. <https://doi.org/10.14474/ptrs.2019.8.2.74>
 11. Shariat, A., Anastasio, A. T., Soheili, S., & Rostad, M. (2020). Home-based fundamental approach to alleviate low back pain using myofascial release, stretching, and spinal musculature strengthening during the COVID-19 pandemic. *Work*, 67(1), 11–19. <https://doi.org/10.3233/WOR-203246>
 12. Mavajian, M., Fakhari, Z., Naghdi, S., Bagheri, H., & Jalaie, S. (2020). A pilot study on the short-term effects of myofascial release and core stability exercises on balance in chronic low back pain. *Auditory and Vestibular Research*, 29(1), 38–44.
 13. Hlaing, S. S., Puntumetakul, R., Khine, E. E., & Boucaut, R. (2021). Effects of core stabilization exercise and strengthening exercise on proprioception, balance, muscle thickness and pain related outcomes in patients with subacute nonspecific low back pain: a randomized controlled trial. *BMC musculoskeletal disorders*, 22(1), 998. <https://doi.org/10.1186/s12891-021-04858-6>
 14. Akhtar, M. W., Karimi, H., & Gilani, S. A. (2017). Effectiveness of core stabilization exercises and routine exercise therapy in management of pain in chronic non-specific low back pain: A randomized controlled clinical trial. *Pakistan journal of medical sciences*, 33(4), 1002–1006. <https://doi.org/10.12669/pjms.334.12664>
 15. Kim, B., & Yim, J. (2020). Core Stability and Hip Exercises Improve Physical Function and Activity in Patients with Non-Specific Low Back Pain: A Randomized Controlled Trial. *The Tohoku journal of experimental medicine*, 251(3), 193–206. <https://doi.org/10.1620/tjem.251.193>
 16. Abdelhaleem, M. D., Aly, S. M., Taha, T. S., & Abdallah, E. A. (2024). Effect of 8 weeks of cognitive behavioral therapy versus 8 weeks core stabilization training in the management of subjects with non-specific low back pain: A randomized controlled trial. *Bulletin of Faculty of Physical Therapy*, 29(1), 1–10. <https://doi.org/10.1186/s43161-024-00198-3>
 17. Kim, W. D., & Shin, D. (2023). Effects of Pelvic-Tilt Imbalance on Disability, Muscle Performance, and Range of Motion in Office Workers with Non-Specific Low-Back Pain. *Healthcare (Basel, Switzerland)*, 11(6), 893. <https://doi.org/10.3390/healthcare11060893>
 18. Falk Brekke, A., Overgaard, S., Hróbjartsson, A., & Holsgaard-Larsen, A. (2020). Non-surgical interventions for excessive anterior pelvic tilt in

- symptomatic and non-symptomatic adults: a systematic review. *EFORT open reviews*, 5(1), 37-45. <https://doi.org/10.1302/2058-5241.5.190017>
19. Hlaing, S. S., Puntumetakul, R., Khine, E. E., & Boucaut, R. (2021). Effects of core stabilization exercise and strengthening exercise on proprioception, balance, muscle thickness and pain related outcomes in patients with subacute nonspecific low back pain: a randomized controlled trial. *BMC musculoskeletal disorders*, 22(1), 998. <https://doi.org/10.1186/s12891-021-04858-6>
 20. Cruz-Medel, I., Rodrigues-de-Souza, D. P., & Alburquerque-Sendín, F. (2024). Comprehensive Analysis of Pelvic Asymmetries in Low Back Pain, Scoliosis, Post-Traumatic Pelvic Dysfunctions and Obstetric Changes: A Narrative Review Focused on Clinical Relevance. *Symmetry*, 16(10), 1304. <https://doi.org/10.3390/sym16101304>
 21. Wu, Z., Wang, Y., Ye, X., Chen, Z., Zhou, R., Ye, Z., Huang, J., Zhu, Y., Chen, G., & Xu, X. (2021). Myofascial Release for Chronic Low Back Pain: A Systematic Review and Meta-Analysis. *Frontiers in Medicine*, 8, 697986. <https://doi.org/10.3389/fmed.2021.697986>
 22. Lee, D. W., Shin, H. K., & Kim, K. S. (2019). Effects of dynamic myofascial release on trunk mobility and standing balance in persons with chronic nonspecific low back pain. *Physical therapy rehabilitation science*, 8(2), 74-78.
 23. Moon, H. H., & Jang, K. T. (2007). The effect of correction exercise program on primary school students with idiopathic scoliosis. *Journal of sport and leisure studies*, 31, 1033-1041.
 24. Kim, D., Cho, M., Park, Y., & Yang, Y. (2015). Effect of an exercise program for posture correction on musculoskeletal pain. *Journal of Physical Therapy Science*, 27(6), 1791. <https://doi.org/10.1589/jpts.27.1791>
 25. Kim, B., & Yim, J. (2020). Core Stability and Hip Exercises Improve Physical Function and Activity in Patients with Non-Specific Low Back Pain: A Randomized Controlled Trial. *The Tohoku journal of experimental medicine*, 251(3), 193-206. <https://doi.org/10.1620/tjem.251.193>
 26. Vleeming, A., Schuenke, M. D., Danneels, L., & Willard, F. H. (2014). The functional coupling of the deep abdominal and paraspinal muscles: the effects of simulated paraspinal muscle contraction on force transfer to the middle and posterior layer of the thoracolumbar fascia. *Journal of anatomy*, 225(4), 447-462. <https://doi.org/10.1111/joa.12227>
 27. Facci, L. M., Nowotny, J. P., Tormem, F., & Moça Trevisani, V. F. (2011). Effects of transcutaneous electrical nerve stimulation (TENS) and interferential currents (IFC) in patients with nonspecific chronic low back pain: Randomized clinical trial. *São Paulo Medical Journal*, 129(4), 206. <https://doi.org/10.1590/S1516-31802011000400003>
 28. Liebano, R.E., Sluka, K.A., Roy, J. et al. Effects of transcutaneous electrical nerve stimulation on pain, function, and descending inhibition in people with non-specific chronic low-back pain: a study protocol for a randomized crossover trial. *Trials* 25, 242 (2024). <https://doi.org/10.1186/s13063-024-0>
 29. 8089-7