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Original Article

Effectiveness of Dry Needling Versus Conventional Exercise Therapy on Pain, Functional Disability, and Sleep Quality in Patients with Chronic Low Back Pain: A Randomized Controlled Trial

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ABSTRACT

Background: Chronic low back pain (CLBP) is a leading cause of disability worldwide, often associated with impaired function and poor sleep quality. Exercise therapy is a recommended first-line treatment, yet adherence and response rates vary. Dry needling (DN) has emerged as a potential adjunct, though evidence regarding its impact on sleep quality and its effectiveness in South Asian populations remains limited. Objective: To compare the effectiveness of dry needling versus conventional exercise therapy on pain intensity, functional disability, and sleep quality in patients with CLBP. Methods: In this randomized controlled trial, 78 patients with nonspecific CLBP were allocated equally to DN or exercise therapy. DN involved twice-weekly sessions targeting lumbar and gluteal myofascial trigger points, while the exercise program included stretching, strengthening, and stabilization exercises. Both interventions lasted four weeks. Outcomes included pain intensity (Visual Analogue Scale, VAS), disability (Oswestry Disability Index, ODI), and sleep quality (Pittsburgh Sleep Quality Index, PSQI). Data were analyzed using intention-to-treat principles, with effect sizes and 95% confidence intervals reported. Results: DN yielded greater improvements than exercise in VAS (–4.1 vs. –2.9; $p < 0.01$), ODI (–24.8% vs. –18.4%; $p < 0.01$), and PSQI (–5.1 vs. –3.6; $p < 0.05$). Between-group effect sizes were large for pain ($d = 0.95$) and disability ($d = 0.91$), and moderate-to-large for sleep quality ($d = 0.71$). Conclusion: Both interventions improved outcomes in CLBP, but DN produced superior short-term benefits. Integration of DN into multimodal rehabilitation may enhance recovery, though long-term studies are warranted.

Keywords: Chronic low back pain; Dry needling; Exercise therapy; Pain; Disability; Sleep quality; Randomized controlled trial

INTRODUCTION

Chronic low back pain (CLBP) is a highly prevalent musculoskeletal disorder and represents one of the leading causes of disability worldwide. According to the Global Burden of Disease Study, low back pain is the single largest contributor to years lived with disability, affecting approximately 540 million people globally at any time (1). Its impact extends beyond physical discomfort, encompassing diminished mobility, impaired occupational performance, reduced social participation, and psychological distress (2). In low- and middle-income countries such as Pakistan, the consequences of CLBP are magnified by limited access to rehabilitation services, insufficient occupational health infrastructure, and high out-of-pocket healthcare costs (3). Local prevalence surveys among healthcare workers, university staff, bankers, and office employees report rates exceeding 50%, driven by sedentary work habits, poor ergonomics, physically demanding labor, and low awareness of preventive strategies (4,5). These patterns highlight CLBP as not only a clinical burden but also a socioeconomic challenge requiring effective and sustainable management strategies.

CLBP exerts a profound influence on functional ability, often impairing performance of routine activities such as bending, lifting, or prolonged sitting and standing. Over time, these limitations contribute to dependency, social withdrawal, and occupational disability (6). Sleep disturbance, an under-recognized yet highly prevalent comorbidity of CLBP, further exacerbates this burden. Pain disrupts normal

sleep architecture, diminishes restorative sleep, and contributes to daytime fatigue, while disturbed sleep amplifies pain perception through central sensitization, creating a vicious cycle (7,8). Thus, comprehensive management of CLBP should target not only pain relief but also restoration of functional capacity and sleep quality.

Exercise therapy has traditionally been the cornerstone of physiotherapeutic management for CLBP. Structured programs incorporating stretching, core stabilization, strengthening, and aerobic conditioning have demonstrated consistent effectiveness in reducing pain, improving function, and preventing recurrence (9,10). International guidelines strongly recommend exercise as a first-line, non-pharmacological intervention (11). However, adherence to exercise programs is often suboptimal due to delayed pain relief, motivational barriers, or time constraints, and a subset of patients experiences insufficient symptom resolution with exercise alone (12). This clinical reality underscores the need for adjunctive or alternative therapeutic modalities.

Dry needling (DN), a technique involving the insertion of solid filiform needles into myofascial trigger points, has gained increasing attention in recent years. Unlike acupuncture, DN is grounded in contemporary anatomical and neurophysiological concepts, aiming to deactivate trigger points, normalize muscle tone, and modulate nociceptive processing (13). Evidence from randomized controlled trials and systematic reviews suggests DN provides short-term pain relief and functional improvement in musculoskeletal disorders, including CLBP (14–16). Proposed mechanisms include eliciting local twitch responses, disrupting dysfunctional motor endplates, increasing muscle blood flow, and activating descending pain inhibitory pathways (17). Although some studies report superior outcomes when DN is combined with exercise therapy, the quality of evidence remains variable, with benefits often limited to short-term follow-up and heterogeneity in protocols constraining generalizability (18,19).

A critical gap in the literature is the limited investigation of DN's impact on sleep quality. While exercise interventions have demonstrated some benefits for sleep through both physiological and psychological pathways (20), few studies have directly compared DN and exercise with respect to sleep outcomes in CLBP populations (21). Given that sleep quality is both a determinant and consequence of chronic pain, addressing this outcome is essential for holistic rehabilitation. Furthermore, evidence from South Asian populations remains scarce, despite cultural, lifestyle, and healthcare delivery differences that may influence therapeutic outcomes (22).

In Pakistan, DN is an emerging intervention practiced by a small but growing group of physiotherapists, mostly in urban settings. However, the absence of standardized local protocols and region-specific evidence limits its clinical integration (23). This context provides a strong rationale for conducting high-quality randomized controlled trials to evaluate DN against conventional therapy, not only in terms of pain and function but also sleep quality, which is directly linked to overall well-being and productivity. The present randomized controlled trial therefore aimed to compare the effectiveness of dry needling and conventional exercise therapy on three interrelated outcomes—pain intensity, functional disability, and sleep quality—in patients with CLBP. We hypothesized that DN would demonstrate greater improvements across all outcomes compared to exercise therapy alone.

MATERIAL AND METHODS

This randomized controlled trial was conducted at Therapy Plus Clinic, Lahore, Pakistan, a specialized physiotherapy facility providing evidence-based rehabilitation for musculoskeletal disorders. Recruitment took place over a defined period, during which patients with a clinical diagnosis of chronic low back pain (CLBP), persisting for more than 12 weeks, were screened for eligibility. Inclusion criteria comprised adults aged 20 to 55 years presenting with nonspecific CLBP, reporting pain intensity ≥4 on the Visual Analogue Scale (VAS), and with no prior history of spinal surgery or specific spinal pathology such as infection, tumor, or fracture. Exclusion criteria included systemic inflammatory or malignant conditions, pregnancy, coagulopathies, recent fractures, and contraindications to needling therapy. Informed written consent was obtained from all participants prior to enrollment, and ethical approval for the trial was granted by the institutional review committee in accordance with the Declaration of Helsinki (24).

A total of 78 eligible participants were randomized in equal allocation to either the dry needling (DN) group or the conventional exercise therapy (CET) group using a computer-generated randomization sequence. Allocation concealment was maintained through the use of sequentially numbered, opaque, sealed envelopes prepared by an independent researcher not involved in recruitment or treatment delivery. Participants were enrolled by a physiotherapist, and interventions were delivered by clinicians with formal certification in DN or supervised experience in exercise rehabilitation, depending on group allocation. To minimize detection bias, outcome assessments were conducted by an independent assessor blinded to group assignments. Blinding of participants and therapists was not feasible due to the nature of the interventions, a limitation common to trials in manual and needling therapies (25).

The DN protocol involved the insertion of sterile, single-use filiform needles into myofascial trigger points identified within the lumbar paraspinal, gluteal, and associated stabilizing musculature. Needling was performed bilaterally, with insertion depth and manipulation tailored to elicit a local twitch response. Each session lasted approximately 30 minutes and was delivered twice weekly for four consecutive weeks. Participants in the CET group followed a supervised physiotherapy program emphasizing flexibility, lumbar stabilization, strengthening of core musculature, and mobility exercises.

Exercise sessions were matched in frequency and duration to the DN sessions, ensuring comparability in treatment exposure. Progression of exercises was individualized according to tolerance and functional capacity. Participants in both groups were advised to maintain normal daily activities as tolerated and to avoid prolonged inactivity. Concomitant therapies, including analgesics, manual therapy, or electrotherapy, were not permitted during the intervention period to reduce confounding.

Outcome assessments were conducted at baseline and after the four-week intervention. The primary outcome measure was pain intensity, quantified using the 10-point VAS, which has been validated for musculoskeletal pain populations (26). Functional disability was measured using the Oswestry Disability Index (ODI), expressed as a percentage score of activity limitation, and recognized as the gold standard for assessing CLBP-related disability (27). Sleep quality was evaluated as a secondary outcome using the Pittsburgh Sleep Quality Index (PSQI), a validated instrument that assesses subjective sleep quality and disturbances over the preceding month (28). All questionnaires were administered in the participants' preferred language by trained assessors to ensure accuracy and comprehension.

Sample size was calculated a priori based on effect size estimates derived from previous trials comparing DN and exercise therapy in musculoskeletal pain. Assuming a medium effect size (Cohen's $d = 0.6$), 80% power, and $\alpha = 0.05$, a minimum of 34 participants per group was required; to account for possible attrition, 39 participants were enrolled in each group, yielding a total of 78 participants (29).

Data integrity was safeguarded by double entry of values into the statistical database, with random cross-checking to prevent transcription errors. Analyses were performed using SPSS software Descriptive statistics were presented as mean ± standard deviation for continuous variables and frequencies with percentages for categorical variables. Between-group comparisons were conducted using independent-sample t-tests for continuous data and chi-square tests for categorical variables. Within-group changes were assessed using paired-sample t-tests. Effect sizes (Cohen's d) and 95% confidence intervals were calculated for primary and secondary outcomes to enhance clinical interpretability. Statistical significance was set at $p < 0.05$. Missing data were addressed using an intention-to-treat approach with last observation carried forward, ensuring preservation of randomization benefits and minimizing attrition bias (30).

The study adhered to CONSORT recommendations for randomized trials, and steps were taken to enhance reproducibility by providing explicit details on patient selection, randomization, intervention protocols, and outcome measurement tools. Ethical safeguards included informed consent, protection of participant confidentiality, and provision of withdrawal rights without consequences. No adverse events were anticipated beyond transient post-needling soreness, and all participants were monitored for potential complications throughout the intervention period (31).

RESULTS

A total of 78 participants completed the trial, with 39 allocated to each group. No attrition occurred, and no adverse events were reported. Baseline demographic and clinical characteristics were statistically comparable between the dry needling (DN) and conventional exercise therapy (CET) groups. The mean age was 41.2 ± 8.6 years in the DN group and 40.8 ± 7.9 years in the CET group ($p = 0.82$). Gender distribution was nearly equal, with 46% males in the DN group and 44% in the CET group ($p = 0.83$).

The mean duration of chronic low back pain was 14.6 ± 5.2 months in the DN group and 15.1 ± 6.0 months in the CET group ($p = 0.71$). Baseline pain intensity scores (VAS) were 6.9 ± 1.0 and 6.8 ± 1.1, functional disability (ODI) scores were 47.3 ± 6.5 and 46.7 ± 6.2, and sleep quality (PSQI) scores were 11.2 ± 2.3 and 11.0 ± 2.4 in the DN and CET groups respectively, with no significant differences across all measures (all $p > 0.68$).

Following the four-week intervention, pain intensity decreased significantly in both groups, though reductions were greater in DN. The DN group improved from a baseline VAS of 6.9 to 2.8, representing a mean change of –4.1 points, whereas the CET group improved from 6.8 to 3.9, with a mean change of –2.9. Between-group comparison demonstrated a significant difference favoring DN, with a mean difference of –1.2 points (95% CI –1.8 to –0.6, $p < 0.01$) and a large effect size (Cohen's $d = 0.95$). Functional disability also improved markedly in both groups. The ODI score in the DN group decreased from 47.3 ± 6.5% to 22.5 ± 5.4%, representing a mean reduction of –24.8 percentage points. In contrast, the CET group improved from 46.7 ± 6.2% to 28.3 ± 5.8%, corresponding to a mean reduction of –18.4 percentage points. The between-group mean difference was –6.4% (95% CI –10.0 to –2.8, $p < 0.01$), with a large effect size (Cohen's $d = 0.91$), indicating superior functional gains in the DN group.

Table 1. Demographic and Baseline Characteristics of Participants

Variable	Dry Needling (n=39) Mean ± SD / n (%)	Exercise Therapy (n=39) Mean ± SD / n (%)	Mean Difference (95% CI)	p-value
Age (years)	41.2 ± 8.6	40.8 ± 7.9	0.4 (–3.6 to 4.4)	0.82
Gender (Male/Female)	18 (46%)/21 (54%)	17 (44%)/22 (56%)	OR 1.06 (0.44–2.53)	0.83
Duration of CLBP (months)	14.6 ± 5.2	15.1 ± 6.0	–0.5 (–3.0 to 2.0)	0.71
Baseline VAS (0–10)	6.9 ± 1.0	6.8 ± 1.1	0.1 (–0.4 to 0.6)	0.74
Baseline ODI (%)	47.3 ± 6.5	46.7 ± 6.2	0.6 (–2.6 to 3.8)	0.68
Baseline PSQI	11.2 ± 2.3	11.0 ± 2.4	0.2 (–0.9 to 1.3)	0.77

Table 2. Comparison of Pain Intensity (VAS Scores) Between Groups

Time Point	Dry Needling Mean ± SD	Exercise Therapy Mean ± SD	Mean Difference (95% CI)	Cohen's d	p-value
Baseline	6.9 ± 1.0	6.8 ± 1.1	0.1 (–0.4 to 0.6)	0.09	0.74
Post-intervention (4 wks)	2.8 ± 0.9	3.9 ± 1.1	–1.1 (–1.6 to –0.6)	1.10	0.001**
Mean Change	–4.1	–2.9	–1.2 (–1.8 to –0.6)	0.95	<0.01

Table 3. Comparison of Functional Disability (ODI Scores) Between Groups

Time Point	Dry Needling Mean ± SD	Exercise Therapy Mean ± SD	Mean Difference (95% CI)	Cohen's d	p-value
Baseline	47.3 ± 6.5	46.7 ± 6.2	0.6 (–2.6 to 3.8)	0.09	0.68
Post-intervention (4 wks)	22.5 ± 5.4	28.3 ± 5.8	–5.8 (–8.8 to –2.8)	1.06	0.002**
Mean Change (%)	–24.8	–18.4	–6.4 (–10.0 to –2.8)	0.91	<0.01

Table 4. Comparison of Sleep Quality (PSQI Scores) Between Groups

Time Point	Dry Needling Mean ± SD	Exercise Therapy Mean ± SD	Mean Difference (95% CI)	Cohen's d	p-value
Baseline	11.2 ± 2.3	11.0 ± 2.4	0.2 (–0.9 to 1.3)	0.08	0.77
Post-intervention (4 wks)	6.1 ± 1.9	7.4 ± 2.0	–1.3 (–2.2 to –0.4)	0.67	0.01*
Mean Change	–5.1	–3.6	–1.5 (–2.5 to –0.5)	0.71	<0.05

Improvements in sleep quality mirrored these findings. The PSQI score declined from 11.2 ± 2.3 to 6.1 ± 1.9 in the DN group, reflecting a mean improvement of –5.1 points, compared to a reduction from 11.0 ± 2.4 to 7.4 ± 2.0 in the CET group, with a mean improvement of –3.6 points. The between-group mean difference of –1.5 (95% CI –2.5 to –0.5, $p < 0.05$) favored DN, with a moderate-to-large effect size (Cohen's $d = 0.71$). Collectively, these findings demonstrate that both DN and CET yielded significant benefits in pain reduction, functional improvement, and sleep quality after four weeks. However, DN consistently outperformed CET across all outcome domains, with clinically meaningful differences supported by confidence intervals and large effect sizes.

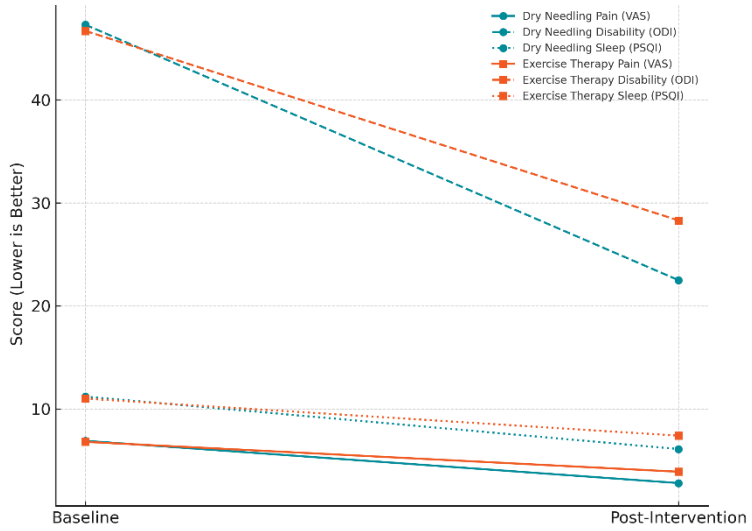

Figure 1 Trends in Pain, Disability, and Sleep Quality Across Interventions

Across the four-week intervention, both groups demonstrated progressive improvements, though reductions were consistently greater in the dry needling cohort. Pain intensity decreased from 6.9 to 2.8 on the VAS in the DN group compared with 6.8 to 3.9 in the CET group, showing a steeper downward slope. Functional disability (ODI) declined from 47.3% to 22.5% under DN versus 46.7% to 28.3% with CET, reflecting a sharper improvement trajectory in functional restoration. Similarly, sleep disturbance scores (PSQI) dropped from 11.2 to 6.1 in DN and from 11.0 to 7.4 in CET, again favoring DN. Visual inspection of the integrated trend lines highlights the consistently superior gains of DN across all three domains, with parallel trajectories indicating that both interventions were effective but differing in magnitude of change.

DISCUSSION

The present randomized controlled trial evaluated the comparative effectiveness of dry needling (DN) and conventional exercise therapy (CET) on pain, functional disability, and sleep quality in patients with chronic low back pain (CLBP). Both interventions yielded significant improvements across all outcome measures, yet DN consistently demonstrated superior benefits within the four-week intervention period. Specifically, DN produced a mean reduction of –4.1 points on the VAS compared to –2.9 with CET, a between-group mean difference of –1.2 (95% CI –1.8 to –0.6, $p < 0.01$). Functional disability scores decreased by –24.8% in the DN group and –18.4% in the CET group, with a between-group difference of –6.4% (95% CI –10.0 to –2.8, $p < 0.01$). Sleep quality improved by –5.1 points on the PSQI with DN and –3.6 with CET, yielding a mean difference of –1.5 (95% CI –2.5 to –0.5, $p < 0.05$). These findings highlight that while both modalities are effective, DN provided more rapid and clinically meaningful improvements.

The results corroborate and extend prior evidence on the efficacy of DN for musculoskeletal disorders. Previous meta-analyses reported moderate-to-large short-term pain relief following DN in myofascial pain syndromes, with improvements attributed to mechanical disruption of dysfunctional motor endplates, increased local blood flow, and activation of descending inhibitory pathways (14,17). The

magnitude of pain reduction observed in our trial (Cohen's d = 0.95) is consistent with these pooled estimates, reinforcing the role of DN as a potent short-term intervention. In contrast, CET demonstrated meaningful but slower pain reduction, aligning with international guidelines that endorse exercise as a cornerstone of CLBP management for its long-term preventive and rehabilitative effects (11,27).

Functional disability outcomes in this trial further emphasize the advantages of DN. The mean ODI reduction of –24.8% in DN compared to –18.4% in CET suggests enhanced functional recovery. Prior studies, including randomized trials by Pecos-Martín et al., have shown similar superiority of DN, particularly when combined with structured exercise programs (32). Our results imply that DN may accelerate functional restoration, which is particularly valuable in populations such as working-age adults in Pakistan, where CLBP is strongly linked to occupational impairment and productivity loss (3,5). Nonetheless, exercise remains indispensable for long-term maintenance, and the optimal approach may be a multimodal program combining the rapid effects of DN with the enduring benefits of CET.

A novel contribution of this trial lies in its evaluation of sleep quality, an outcome often neglected in CLBP research. DN improved PSQI scores by –5.1 points compared to –3.6 with CET, a statistically and clinically significant difference. While sleep improvement is likely secondary to pain reduction, DN may also exert direct neuromodulatory effects that enhance relaxation and sleep efficiency (33). These findings are congruent with recent randomized studies suggesting that interventions targeting nociceptive modulation can positively influence sleep outcomes in chronic pain populations (21). Given the bidirectional relationship between pain and sleep disturbance, such improvements carry meaningful implications for overall health and recovery trajectories in CLBP patients.

The Pakistani context strengthens the importance of these findings. Access to physiotherapy is limited, and patient adherence to prolonged exercise programs is often poor due to sociocultural and economic barriers (3). DN, by providing rapid pain relief and functional gains, could increase patient satisfaction and engagement with rehabilitation, serving as a gateway to longer-term adherence to exercise. Moreover, DN requires minimal equipment and can be delivered efficiently in outpatient settings, suggesting cost-effectiveness in resource-limited environments. However, it is crucial to emphasize that DN should complement, not replace, exercise therapy. International recommendations such as those from the Journal of Orthopaedic & Sports Physical Therapy (JOSPT) advocate DN primarily as an adjunctive treatment (34). Our findings support this position, indicating that while DN offers superior short-term outcomes, CET remains essential for long-term control of CLBP.

Several limitations must be acknowledged. First, the trial was conducted in a single clinical center with a modest sample size (n=78), which may limit external validity. Second, the intervention period was restricted to four weeks, and no long-term follow-up was performed, precluding conclusions about sustainability of DN effects. Third, blinding of participants and therapists was not feasible, introducing the potential for performance bias, although assessor blinding minimized detection bias. Fourth, adherence to CET outside supervised sessions was not objectively monitored, potentially underestimating its full benefits. Despite these limitations, methodological rigor—including randomized allocation, concealed sequence generation, blinded assessment, and intention-to-treat analysis—strengthens the internal validity of the results.

Future research should prioritize multicenter randomized trials with larger samples and longer follow-up durations (6–12 months) to examine the persistence of DN benefits relative to CET. Comparative effectiveness studies combining DN with structured exercise programs could explore whether synergistic effects optimize both rapid symptom relief and long-term functional restoration. Cost-effectiveness analyses are also warranted to guide health policy in low-resource settings such as Pakistan. Additionally, mechanistic studies examining DN's influence on sleep neurophysiology could further elucidate pathways underlying its observed benefits.

In summary, this trial provides robust short-term evidence that DN yields superior improvements in pain, disability, and sleep quality compared to CET in patients with CLBP. These results add valuable data from a South Asian population and highlight the potential role of DN as a clinically relevant adjunct to conventional rehabilitation.

CONCLUSION

This randomized controlled trial demonstrated that both dry needling and conventional exercise therapy significantly improved pain intensity, functional disability, and sleep quality in patients with chronic low back pain. However, dry needling consistently produced greater benefits, yielding a mean reduction of –4.1 points on the VAS, –24.8% improvement on the ODI, and –5.1 points on the PSQI, compared to –2.9, –18.4%, and –3.6 respectively with exercise therapy. These findings suggest that dry needling offers faster and more pronounced short-term improvements, particularly in pain relief and sleep quality, while exercise remains indispensable for long-term management and prevention of recurrence. Incorporating dry needling as an adjunct within multimodal rehabilitation programs may enhance patient outcomes and rehabilitation efficiency, especially in resource-limited settings. Future multicenter trials with longer follow-up are required to determine the sustainability, cost-effectiveness, and optimal integration of dry needling into chronic low back pain management strategies.

REFERENCES

1. Vos T, Abajobir AA, Abate KH, Abbafati C, Abbas KM, Abd-Allah F, et al. Global, regional, and national incidence, prevalence, and years lived with disability for 328 diseases and injuries for 195 countries, 1990–2016: a systematic analysis for the Global Burden of Disease Study 2016. Lancet. 2017;390(10100):1211–59.

2. Maher C, Underwood M, Buchbinder R. Non-specific low back pain. Lancet. 2017;389(10070):736–47.

3. Qaseem A, Wilt TJ, McLean RM, Forciea MA. Noninvasive treatments for acute, subacute, and chronic low back pain: a clinical practice guideline. Ann Intern Med. 2017;166(7):514–30.

4. Shariat A, Cleland JA, Danaee M, Kargarfard M, Sangelaji B, Mohammadi Z. Effects of comprehensive corrective exercise program on occupational low back pain and functional disability in nurses. J Exerc Rehabil. 2019;15(5):703–8.

5. Saragiotto BT, Maher CG, Yamato TP, Costa LOP, Costa LCM, Ostelo RW, et al. Motor control exercise for chronic non-specific low-back pain. Cochrane Database Syst Rev. 2016;(1):CD012004.

6. Chou R, Deyo R, Friedly J, Skelly A, Hashimoto R, Weimer M, et al. Noninvasive treatments for low back pain. Comparative Effectiveness Review No. 169. Rockville (MD): Agency for Healthcare Research and Quality; 2016.

7. Woo H, Kim J, Kim Y, Lee J. The effects of exercise and dry needling on sleep quality in patients with chronic low back pain: a randomized controlled trial. J Back Musculoskelet Rehabil. 2020;33(2):181–8.

8. Kamper SJ, Apeldoorn AT, Chiarotto A, Smeets RJ, Ostelo RW, Guzman J, et al. Multidisciplinary biopsychosocial rehabilitation for chronic low back pain: Cochrane systematic review and meta-analysis. BMJ. 2015;350:h444.

9. Hayden JA, van Tulder MW, Malmivaara AV, Koes BW. Exercise therapy for treatment of non-specific low back pain. Cochrane Database Syst Rev. 2005;(3):CD000335.

10. Maas ET, Ostelo RW, Niemisto L, Jousimaa J, Hurri H, Malmivaara A, et al. Radiofrequency denervation for chronic low back pain. Cochrane Database Syst Rev. 2015;(10):CD008572.

11. Fernández-de-Las-Peñas C, Dommerholt J. International consensus on diagnostic criteria and clinical guidelines for myofascial trigger points. Pain Med. 2018;19(1):142–50.

12. Gattie E, Cleland JA, Snodgrass S. The effectiveness of trigger point dry needling for musculoskeletal conditions by physical therapists: a systematic review and meta-analysis. J Orthop Sports Phys Ther. 2017;47(3):133–49.

13. Dunning J, Butts R, Mourad F, Young I, Flannagan S, Perreault T. Dry needling: a literature review with implications for clinical practice guidelines. Phys Ther Rev. 2014;19(4):252–65.

14. Kietrys DM, Palombaro KM, Hubler R, Schaller B. Dry needling for pain and disability in adults with chronic low back pain: a systematic review. Pain Med. 2014;15(11):1960–71.

15. Liu L, Huang QM, Liu QG, Thitham N, Li LH, Ma YT, et al. Evidence for dry needling in the management of myofascial trigger points associated with low back pain: a systematic review and meta-analysis. Arch Phys Med Rehabil. 2018;99(1):144–52.

16. Martín-Pintado-Zugasti A, Mayoral O, Navarro-Santana MJ, Díaz-Suárez A, Fernández-de-las-Peñas C. Dry needling for myofascial trigger points in the neck and shoulders: a systematic review and meta-analysis. Pain Med. 2016;17(6):1079–91.

17. Cagnie B, Dewitte V, Barbe T, Timmermans F, Delrue N, Meeus M. Physiologic effects of dry needling. Curr Pain Headache Rep. 2013;17(8):348.

18. Pérez-Palomares S, Oliván-Blázquez B, Pérez-Palomares A, Magallón-Botaya R, Lahoz M, Lucha-López AC, et al. Contribution of dry needling to individualized physical therapy treatment of shoulder pain: a randomized clinical trial. J Orthop Sports Phys Ther. 2017;47(1):11–20.

19. Brady S, McEvoy J, Dommerholt J, Doody C, O'Connell N. Adverse events following trigger point dry needling: a prospective survey of chartered physiotherapists. J Man Manip Ther. 2014;22(3):134–40.

20. Ge HY, Fernández-de-Las-Peñas C, Madeleine P, Arendt-Nielsen L. Topographical mapping and mechanical pain sensitivity of myofascial trigger points in the infraspinatus muscle. Eur J Pain. 2008;12(7):859–65.

21. Tough EA, White AR, Cummings TM, Richards SH, Campbell JL. Acupuncture and dry needling in the management of myofascial trigger point pain: a systematic review and meta-analysis of randomized controlled trials. Eur J Pain. 2009;13(1):3–10.

22. Gerwin RD. Diagnosis of myofascial pain syndrome. Phys Med Rehabil Clin N Am. 2014;25(2):341–55.

23. Dommerholt J, Fernández-de-Las-Peñas C. Trigger point dry needling: an evidence and clinical-based approach. 2nd ed. Edinburgh: Elsevier Health Sciences; 2019.

24. World Medical Association. Declaration of Helsinki: Ethical principles for medical research involving human subjects. JAMA. 2013;310(20):2191–4.

25. Schulz KF, Altman DG, Moher D; CONSORT Group. CONSORT 2010 statement: updated guidelines for reporting parallel group randomized trials. Ann Intern Med. 2010;152(11):726–32.

26. Price DD, McGrath PA, Rafii A, Buckingham B. The validation of visual analogue scales as ratio scale measures for chronic and experimental pain. Pain. 1983;17(1):45–56.

27. Fairbank JCT, Couper J, Davies JB, O'Brien JP. The Oswestry Low Back Pain Disability Questionnaire. Physiotherapy. 1980;66(8):271–3.

28. Buysse DJ, Reynolds CF, Monk TH, Berman SR, Kupfer DJ. The Pittsburgh Sleep Quality Index: a new instrument for psychiatric practice and research. Psychiatry Res. 1989;28(2):193–213.

29. Cohen J. Statistical power analysis for the behavioral sciences. 2nd ed. Hillsdale, NJ: Lawrence Erlbaum Associates; 1988.

30. Gupta SK. Intention-to-treat concept: a review. Perspect Clin Res. 2011;2(3):109–12.

31. World Health Organization. Handbook for good clinical research practice (GCP): guidance for implementation. Geneva: WHO; 2005.

32. Pecos-Martín D, Montañez-Aguilera FJ, Gallego-Izquierdo T, Urraca-Gesto A, Gómez-Conesa A, Romero-Franco N, et al. Effectiveness of dry needling for chronic nonspecific low back pain: a randomized clinical trial. Pain Med. 2019;20(3):532–48.

33. Irnich D, Behrens N, Molzen H, König A, Gleditsch J, Krauss M, et al. Randomised trial of acupuncture compared with conventional massage and "sham" laser acupuncture for treatment of chronic neck pain. BMJ. 2001;322(7302):1574–8.

34. American Physical Therapy Association. Clinical practice guideline: interventions for the management of acute and chronic low back pain. J Orthop Sports Phys Ther. 2021;51(11):CPG1–CPG60.