Dry needling in alleviating pain and enhancing function in neck pain: a scoping review

Isabella Bartalotta [1], Nicola Marotta [2,3], Roberta Zito [1], Maria Sgro [1], Dario Calafiore [4], Francesco Agostini [5], Michele Vecchio [6], Umile Giuseppe Longo [7,8], Antonio Ammendolia [1,2], Alessandro de Sire [1,2]

[1] Department of Medical and Surgical Sciences, University of Catanzaro "Magna Graecia", Catanzaro, Italy; [2] Musculoskeletal Health Research Centre, MusculoSkeletalHealth@UMG, University of Catanzaro "Magna Graecia", Catanzaro, Italy; [3] Physical and Rehabilitation Medicine Division, Department of Experimental and Clinical Medicine, University of Catanzaro "Magna Graecia", Catanzaro, Italy; [4] Physical Medicine and Rehabilitation Unit, Department of Neurosciences, ASST Carlo Poma, Mantua, Italy; [5] Department of Anatomy, Histology, Forensic Medicine and Orthopaedics, "Sapienza" University of Rome, Rome, Italy; [6] Department of Biomedical and Biotechnological Sciences, University of Catania, Physical Medicine and Rehabilitation Unit, "AOU Policlinico G. Rodolico", Catania, Italy; [7] Orthopaedic and Trauma Surgery Research Unit, Department of Medicine and Surgery, University Campus Bio-Medico di Roma, Rome, Italy; [8] Campus Bio-Medico University Hospital Foundation, Via Alvaro del Portillo 200, 00128 Rome, Italy.

ABSTRACT

Neck pain is a common condition that often leads to disability and work absenteeism. This study aimed to review current understanding of the role of dry needling (DN) in reducing disability and pain in individuals with neck pain. A comprehensive literature search of the PubMed, Scopus and Web of Science databases was performed, following the criteria of the Scale for Assessment of Narrative Review Articles (SANRA). Two hundred and thirteen studies related to chronic non-specific neck pain (CNSNP) were identified. All were randomized controlled trials. Overall, the available evidence indicated that DN reduced pain in these patients and contributed to functional improvement in CNSNP. In conclusion, the evidence compiled for this scoping review supports the continued use of DN for the treatment of pain in patients with CNSNP, but does not demonstrate a clear advantage over physical or manual therapy in terms of improving function. Further high-quality studies are necessary to better understand the potential of this minimally-invasive approach for managing neck pain.

KEYWORDS

Chronic non-specific neck pain, dry needling, neck disability, minimally-invasive infiltration technique, absence from work.

Introduction

Chronic non-specific neck pain (CNSNP) is a widespread musculoskeletal disorder that can impair daily functioning and overall well-being, frequently impacting an individual's quality of life and ability to perform daily activities. While neck pain often tends to improve over time, a significant proportion of people report ongoing mild discomfort that may gradually develop into a long-term pain condition [1,2]. In such cases, the disorder is commonly linked to greater physical impairments, increased dependence on medical interventions, and notable financial burdens stemming from decreased work performance and productivity [3].

Certain occupational factors contribute to the persistence of neck pain, with sedentary employees facing a two- to threefold higher risk of developing chronic symptoms compared with the general workforce [4]. Additionally, high work demands have been linked to an increased incidence of neck pain, particularly in office workers [5]. When neck pain arises without a history of trauma, underlying pathology, or neurological involvement, it is commonly classified as "non-specific" [6].

Chronic non-specific neck pain is a leading cause of work-related disability, particularly in individuals exposed to prolonged cervical strain due to ergonomic stressors [7-10]. Despite its prevalence, specific rehabilitation strategies remain diverse, encompassing approaches such as postural training, muscle therapy, spinal manipulation, and infiltration treatments like oxygen-ozone therapy or dry needling (DN) [11-14].

Evidence suggests that physiotherapy interventions, including strengthening and stretching exercises, can alleviate work-related neck pain and enhance functional capacity by improving muscle balance and soft tissue mobility [15,16].

However, the systematic review conducted by Kay *et al*. [17] showed that the evidence supporting exercise interventions for mechanical neck disorders is limited and of variable quality. Subsequently, a meta-analysis by Miller *et al*. emphasized the need for further randomized controlled trials to clarify the effectiveness of specific exercise programmes in managing chronic neck pain [18].

Among the various rehabilitation approaches, DN has gained attention as a minimally-invasive technique for managing musculoskeletal pain. This method involves the inser-

Article history
Received 17 Mar 2025 – Accepted 10 Jun 2025

Contact
Alessandro de Sire: alessandro.desire@unicz.it
Department of Medical and Surgical Sciences
University of Catanzaro "Magna Graecia", Catanzaro, Italy

tion of fine, filiform needles into specific myofascial trigger points (MTrPs), without the use of pharmacological agents, to induce biomechanical changes that reduce pain and functional impairment. When combined with conventional therapy, DN has shown promise in providing short-term symptom relief in patients with chronic neck pain [19-22] (Figure 1).

While interventions such as active and passive exercise and patient education are widely recognized as standard treatments for mechanical neck pain, evidence supporting the efficacy of minimally-invasive techniques like DN remains limited [23,24].

The aim of this scoping review was to summarize the existing evidence on the role of DN in pain reduction and enhancing function in individuals with CNSNP.

Materials and methods

Given the exploratory nature of the research question, a scoping review design and methodology was selected, with the main databases—PubMed/Medline, Scopus and Web of Science—queried for relevant literature up to 30 October 2024.

To be eligible for inclusion, articles had to be in English and concern randomized controlled trials involving patients with CNSNP who were treated with DN compared with standard physical therapy or manual pressure, and assessed by means of visual analogue scale (VAS) or numerical rating scale (NRS). In addition, only studies that provided post-intervention data with a follow-up period of up to three months were included.

Studies were excluded if they: involved children or individuals who had not reached full maturity, lacked full-text availability (e.g., conference abstracts or posters), concerned research conducted on animal models, used physical agent modalities, involved the use of infiltration techniques other than sham dry needling (SDN), or supplemented the primary treatment with additional therapeutic interventions (with the sole exception of physical therapy).

The search strategy included the keywords "chronic neck pain," "Neck Disability Index" and "dry needling". The eligibility for inclusion of all search results was assessed through title review, followed by abstract analysis and full-text evaluation. Publications that did not meet the inclusion criteria were excluded from the review, and all duplicates were removed. The documents that met the inclusion criteria were further categorised.

The Scale for the Assessment of Narrative Review Articles (SANRA) criteria were followed to ensure greater standardisation of the review process and reporting [25].

Results

Dry needling is a minimally-invasive and cost-effective treatment modality that is relatively easy to learn with appropriate training and carries a low risk of complications [26]. The technique involves inserting fine needles into MTrPs to deactivate them, thereby reducing pain and improving muscle function. One of the key benefits of DN is its ability to inactivate latent trigger points, which can also be addressed through manual pressure techniques. This is clinically relevant because it helps prevent these latent points from becoming active trigger points, which are strongly associated with chronic pain and muscle dysfunction. Additionally, by normalising synaptic efficacy and decreasing both peripheral and central sensitisation within the nervous system, DN may reduce or eliminate nociceptive input—and therefore pain signals—originating from muscles [27]. A hallmark physiological response to DN is the local twitch response (LTR), a brief, involuntary contraction of muscle fibres within the targeted area. Studies have shown that LTRs are associated with a significant decrease in substance P and tachykinins, neuropeptides involved in pain transmission and inflammation.

Their reduction is closely linked to an immediate decrease in pain and local tenderness [28]. Beyond pain modulation, DN contributes to restoring range of motion and improving mus-

Figure 1 Dry needling for neck pain.

cle activation patterns, which enhance muscular coordination and function [29]. Thus, DN not only provides symptom relief but also helps in preventing postural compensations and dysfunctional movement patterns, potentially reducing the risk of recurrent or secondary musculoskeletal issues [30].

Several randomized controlled trials have compared the effects of DN and SDN in patients with CNSNP, yielding mixed results. Gallego-Sendarrubias *et al*. showed that patients treated with DN combined with manual therapy experienced significant reductions in pain intensity and improvements in pressure pain thresholds (PPTs) compared with those treated with SDN plus manual therapy, thereby highlighting potential specific analgesic effects of DN [31].

In contrast, Stieven *et al*. found no statistically significant differences in pain reduction between DN and SDN groups within a multimodal intervention programme. Although DN led to slightly greater improvements in cervical range of motion, overall pain relief was comparable between the two groups [32]. Similarly, Fernández-de-las-Peñas *et al*. observed immediate physiological effects such as decreased mechanical hyperalgesia and altered skin conductance, but reported no significant differences in pain perception between DN and SDN groups, suggesting that short-term subjective pain relief may be largely attributed to placebo effects [33].

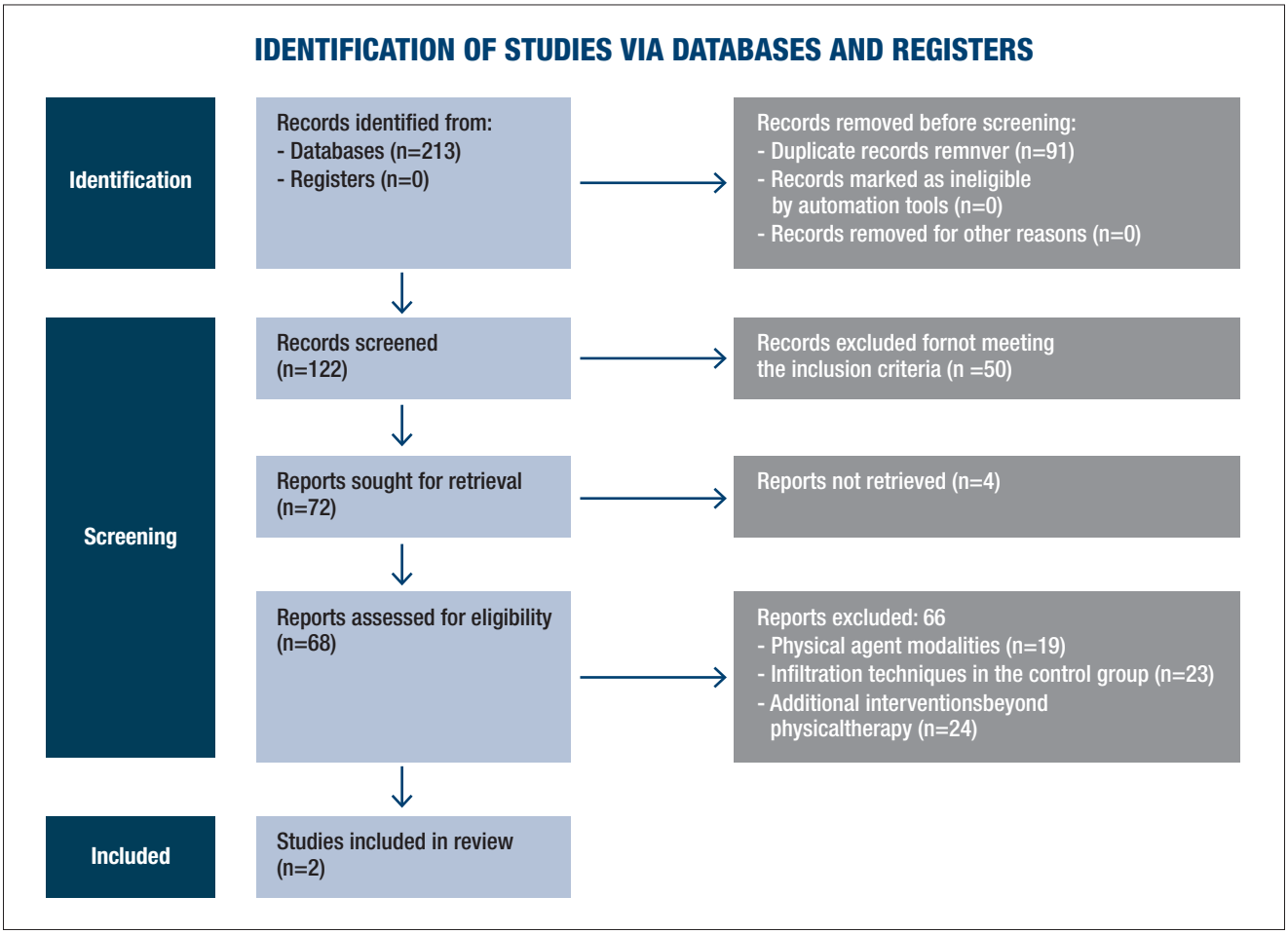
In view of these conflicting findings, we conducted a focused literature review to identify high-quality studies examining the specific effects of DN versus SDN in individuals with CNSNP. Systematic database searching initially identified a total of 213 records. After removal of 91 duplicates, 122 studies were screened by title and abstract. Of these, 50 were excluded for not meeting the inclusion criteria.

The remaining 72 full-text articles were assessed for eligibility. Four could not be retrieved. Of the 68 full-text studies reviewed, 66 were excluded due to the use of physical agent modalities (n=19), infiltration techniques in the control group (n=23), or additional interventions beyond physical therapy (n=24). Ultimately, only two studies met all the eligibility criteria and were included in the final review. These findings highlight the scarcity of high-quality, controlled trials isolating the effects of DN versus SDN in CNSNP, and emphasise the need for further research in this area. See Figure 2 for the PRISMA flow diagram.

Two randomised controlled trials met the inclusion criteria for this scoping review, both investigating the effects of DN in individuals with chronic non-specific neck pain associated with active MTrPs.

In the first study, De Meulemeester *et al*. [34] designed a randomized clinical trial to compare the effects of DN and manual pressure therapy in individuals with MTrPs. Participants were divided into two groups, each receiving four treatment sessions

Figure 2 Flow diagram



over the course of four weeks. The researchers aimed to evaluate the short- and medium-term outcomes of both approaches. The results indicated that both treatments were effective in reducing neck-related disability, as measured by the Neck Disability Index (NDI), with significant improvements observed immediately after the intervention and sustained at the three-month follow-up ($p < 0.001$). Pain intensity also decreased significantly after three months, according to a general numerical pain scale ($p = 0.001$). Beyond subjective outcomes, objective changes were found in muscle properties. PPTs increased significantly across all targeted MTrPs, most notably MTrPs 1 and 3 ($p < 0.001$), with smaller but still meaningful effects observed at MTrP 2 ($p = 0.022$) and MTrP 4 ($p = 0.001$). Muscle elasticity improved bilaterally (left: $p= 0.017$; right: $p = 0.030$), and a reduction in muscle stiffness was particularly evident on the right side ($p= 0.012$). Although no clear superiority was found between DN and manual pressure, both methods proved beneficial in enhancing physical function and reducing pain in the studied population.

Korkmaz *et al*. [35] conducted a prospective, randomised, single-blind controlled trial to evaluate the short- and mid-term effects of DN combined with exercise on MTrPs in the upper trapezius muscle (UT). The study enrolled 70 participants (aged 18-45) with chronic neck pain (>3 months) attributed to active MTrPs. Participants were randomised into two groups: DN plus exercise versus exercise only. Both groups followed a home-based cervical exercise programme for three months, while the DN plus exercise group also received three weekly DN sessions targeting the most painful MTrP, identified clinically and confirmed by ultrasonography. Outcomes—pain intensity (VAS score), UT muscle thickness and MTrP diameter (ultrasound), and neck-related disability (NDI)—were assessed at baseline, post-treatment (week 3), and three-month follow-up by a blinded evaluator.

Both groups improved significantly over time, but the DN plus exercise group exhibited greater reductions in VAS scores at rest, during activity and at night ($p < 0.001$), as well as in UT muscle thickness ($p = 0.04$) and MTrP diameter ($p =0.021$) at short-term follow-up. No significant between-group differences were observed in NDI scores. Effect sizes for pain outcomes and MTrP diameter ranged from moderate to large. Ultrasonographic assessments confirmed morphological changes in the UT and MTrPs. These findings support the efficacy of DN as an adjunct to exercise in managing myofascial neck pain, particularly for short-term pain modulation and tissue-level adaptations.

Both DN and manual pressure therapy led to significant improvements in pain, disability and muscle function, with no major differences between the two treatments. Furthermore, comparison of DN plus exercise with exercise alone revealed no significant differences in disability scores. Overall, DN appears beneficial, but its effects may be similar to those of other therapies.

Dry needling may provide significant benefits in terms of pain reduction and muscle function improvement, although no clear superiority over other therapies such as manual therapy was demonstrated. However, the limited number of high-quality studies highlights the need for further research to clarify the specific role of this technique.

Discussion

This scoping review aimed to investigate the efficacy of DN in alleviating pain and enhancing function in individuals affected by CNSNP. DN is a minimally-invasive technique increasingly employed to manage chronic musculoskeletal conditions, including CNSNP, which is the predominant cause of neck discomfort and is frequently associated with postural and mechanical dysfunctions [36]. A prevalent complaint in the primary care setting, neck pain often leads to significant functional impairment and diminished quality of life. Given the heterogeneous aetiologies underlying it, thorough yet efficient clinical assessments are vital. Particular attention to red flags is essential to exclude serious conditions such as trauma, infections, malignancies, vascular emergencies and inflammatory diseases [37].

The burden of neck pain extends beyond physical symptoms, deeply affecting patients' quality of life and daily functioning. De Meulemeester *et al*. [34], for example, found DN to significantly improve scores on both the NDI and the NRS; however, similar improvements were observed in control groups receiving manual therapy, indicating comparable effectiveness between the two modalities. In a meta-analysis by Gattie *et al*. [38], trigger point DN performed by physical therapists significantly reduced pain intensity and improved functional outcomes in patients with musculoskeletal conditions, supporting its use as an effective treatment modality.

Mechanistically, the analgesic effects of DN are thought to arise from complex neurophysiological processes involving both peripheral and central nervous system modulation. Needle insertion into muscle tissue activates peripheral nociceptive fibres, especially Aδ and C fibres, triggering a cascade that releases endogenous neurotransmitters and neuromodulators such as endorphins, serotonin and norepinephrine. These substances are critical in inhibiting nociceptive transmission and enhancing analgesic pathways [36,39]. Additionally, DN may reduce local inflammation by modulating pro-inflammatory cytokines and increasing microcirculation, thereby supporting tissue healing and diminishing nociceptive signalling [39].

A further therapeutic mechanism involves mechanical disruption and inactivation of MTrPs, i.e., localized hyperirritable spots within taut muscle bands that are implicated in chronic pain maintenance and muscle dysfunction. By targeting these trigger points, DN restores muscle length and functional capacity, contributing to pain reduction and improved mobility [39]. Central nervous system effects are also evident; sensory input from DN can attenuate central sensitization, decreasing neuronal hyperexcitability in the spinal cord and modulating pain perception via descending inhibitory pathways [37]. This interplay between the peripheral and central mechanisms underpins the clinical benefits of DN in chronic musculoskeletal pain syndromes.

Chronic neck pain is a widespread public health issue with significant global prevalence, as highlighted in systematic reviews and international epidemiological reports [40]. It not only leads to physical discomfort but also contributes to substantial limitations in daily life, affecting occupational performance, social interaction and general well-being. The Global Burden of

Disease 2010 study confirmed that neck pain is among the leading causes of disability worldwide, highlighting its socioeconomic impact across various populations [41]. Despite this burden, the scarcity of robust randomised controlled trials and the diversity of available therapeutic strategies continue to hinder the formulation of clear, standardised clinical recommendations.

In this scenario, identifying effective strategies to mitigate disability and enhance rehabilitation outcomes is important for reducing absenteeism and its socioeconomic consequences. We acknowledge several limitations in this study. For example, the small number of included studies could potentially undermine the strength of our conclusions; the differences in the frequency and duration of dry needling sessions limits the comparability of results. This heterogeneity hampers the ability to generalize findings and establish standardized clinical protocols for dry needling in chronic non-specific neck pain. Future research with more homogeneous study designs and standardized treatment protocols is necessary to better define the efficacy and optimal application of this intervention. However, the fact that our findings, drawn from such a limited number of studies, represent the best available evidence from three major databases highlights a gap in the current literature.

Conclusions

The findings of this study suggest that DN significantly contributes to pain alleviation, thereby enhancing patients' overall quality of life. However, in terms of functional improvement, it is important to note that DN has not been shown to be more effective than conventional treatments like manual therapy or physical therapy.

Dry needling as a therapeutic intervention should be considered not in isolation but within the context of a broader, multidisciplinary treatment approach. Physical therapy should remain a key part of any comprehensive care plan, with DN acting as a complementary treatment rather than a substitute for other proven therapies. Given the limitations of current research, further investigation is essential to better understand the potential advantages of DN and to explore additional infiltration therapies, as well as other alternative treatment and rehabilitation methods for managing chronic neck pain.

In this scenario, is important to highlight that DN therapy is generally associated with fewer side effects compared with other, more invasive treatments. This makes it a well-tolerated option, particularly for patients who are undergoing polytherapy or have other health conditions that may make them more susceptible to adverse reactions from stronger medications or interventions. Due to its multiple benefits DN has become a recognized and widely used treatment in the fields of pain management and musculoskeletal rehabilitation, particularly in the management of chronic neck pain.

In conclusion, DN emerges as a safe and promising technique for chronic neck pain treatment, although it should not replace conventional therapies. Further well-designed randomized controlled trials are needed to precisely define its benefits and effectively integrate it into multidisciplinary rehabilitation protocols.

References

1. Mendes Fernandes T, Méndez-Sánchez R, Puente-González AS, Martín-Vallejo FJ, Falla D, Vila-Chã C. A randomized controlled trial on the effects of "Global Postural Re-education" versus neck specific exercise on pain, disability, postural control, and neuromuscular features in women with chronic non-specific neck pain. Eur J Phys Rehabil Med. 2023;59(1):42-53.
2. Alshehre YM, Pakkir Mohamed SH, Nambi G, Almutairi SM, Alharazi AA. Effectiveness of physical exercise on pain, disability, job stress, and quality of life in office workers with chronic non-specific neck pain: a randomized controlled trial. Healthcare (Basel). 2023;11(16):2286.
3. Paraskevopoulos E, Koumantakis GA, Papandreou M. A systematic review of the aerobic exercise program variables for patients with non-specific neck pain: effectiveness and clinical applications. Healthcare (Basel). 2023;11(3):339.
4. Green BN. A literature review of neck pain associated with computer use: public health implications. J Can Chiropr Assoc. 2008;52(3):161-7.
5. Tornqvist EW, Hagberg M, Hagman M, Risberg EH, Toomingas A. The influence of working conditions and individual factors on the incidence of neck and upper limb symptoms among professional computer users. Int Arch Occup Environ Health. 2009;82(6):689-702.
6. Hurwitz EL, Randhawa K, Yu H, Côté P, Haldeman S. The Global Spine Care Initiative: a summary of the global burden of low back and neck pain studies. Eur Spine J. 2018;27(Suppl 6):796-801.
7. Ju B, Lee J, Kim HM, Lee CG, Song H. Impact of neck posture and insulating stick use on neck disability in Korean line workers: a cross-sectional study. Ann Occup Environ Med. 2024;36:e11.
8. Ferrillo M, Migliario M, Calafiore D, et al. Effects of a new protocol for the prevention of work-related musculoskeletal disorders in dental hygiene students: a pilot randomized controlled trial. Int J Dent Hyg. 2025;23(1):164-75.
9. Araujo GGC, Pontes-Silva A, Leal PDC, et al. Goniometry and fleximetry measurements to assess cervical range of motion in individuals with chronic neck pain: a validity and reliability study. BMC Musculoskelet Disord. 2024;25(1):651.
10. Ferrillo M, Migliario M, Marotta N, et al. Temporomandibular disorders and neck pain in primary headache patients: a retrospective machine learning study. Acta Odontol Scand. 2023;81(2):151-7.
11. Ruivo RM, Pezarat-Correia P, Carita AI. Effects of a resistance and stretching training program on forward head and protracted shoulder posture in adolescents. J Manipulative Physiol Ther. 2017;40(1):1-10.
12. Oakley PA, Moustafa IM, Harrison DE. Restoration of cervical and lumbar lordosis: CBP® methods overview. In: Bettany-Saltikov J, ed. Spinal Deformities in Adolescents, Adults and Older Adults. London: IntechOpen Publishers, 2019, pp 1-19.
13. Harrison DD, Janik TJ, Harrison GR, Troyanovich S, Harrison DE, Harrison SO. Chiropractic biophysics technique: a linear algebra approach to posture in chiropractic. J Manipulative Physiol Ther. 1996; 19(8):525-35.
14. Im B, Kim Y, Chung Y, Hwang S. Effects of scapular stabilization exercise on neck posture and muscle activation in individuals with neck pain and forward head posture. J Phys Ther Sci. 2016;28(3):951-5.
15. Verhagen AP, Bierma-Zeinstra SM, Burdorf A, Stynes SM, de Vet HC, Koes BW. Conservative interventions for treating work-related complaints of the arm, neck or shoulder in adults. Cochrane Database Syst Rev. 2013;2013(12):CD008742.
16. O'Riordan C, Clifford A, Van De Ven P, Nelson J. Chronic neck pain and exercise interventions: frequency, intensity, time, and type principle. Arch Phys Med Rehabil. 2014;95(4):770-83.
17. Kay TM, Gross A, Goldsmith CH, et al. Exercises for mechanical neck disorders. Cochrane Database Syst Rev. 2012;(8):CD004250.
18. Damgaard P, Bartels EM, Ris I, Christensen R, Juul-Kristensen B. Evidence of physiotherapy interventions for patients with chronic neck pain: a systematic review of randomised controlled trials. ISRN Pain.

2013;2013:567175.

19. Butts R, Dunning J, Serafino C. Dry needling strategies for musculoskeletal conditions: do the number of needles and needle retention time matter? A narrative literature review. J Bodyw Mov Ther. 2021;26:353-63.
20. Mengi A, Bulut GT. The effect of combining physiotherapy with dry needling in patients with cervical spondylosis: a randomized controlled trial. J Back Musculoskelet Rehabil. 2024;37(5):1213-21.
21. Medrano-de-la-Fuente R, Hernando-Garijo I, Mingo-Gómez MT, Jiménez-Del-Barrio S, Hernández-Lázaro H, Ceballos-Laita L. Is adding dry needling to a standard care protocol beneficial in patients with chronic neck pain? A randomized placebo-controlled trial. Complement Ther Clin Pract. 2024;55:101842.
22. Pandya J, Puentedura EJ, Koppenhaver S, Cleland J. Dry needling versus manual therapy for patients with mechanical neck pain: a randomized controlled trial. J Orthop Sports Phys Ther. 2024;54(4):267-78.
23. Bier JD, Scholten-Peeters WGM, Staal JB, et al. Clinical practice guideline for physical therapy assessment and treatment in patients with nonspecific neck pain. Phys Ther. 2018;98(3):162-71.
24. Mesregah MK, Feng W, Huang WH, et al. Clinical effectiveness of interlaminar epidural injections of local anesthetic with or without steroids for managing chronic neck pain: a systematic review and meta-analysis. Pain Physician. 2020;23(4):335-48.
25. Baethge C, Goldbeck-Wood S, Mertens S. SANRA-a scale for the quality assessment of narrative review articles. Res Integr Peer Rev. 2019;4:5.
26. Kalichman L, Vulfsons S. Dry needling in the management of musculoskeletal pain. J Am Board Fam Med. 2010;23(5):640-6.
27. Ge HY, Arendt-Nielsen L. Latent myofascial trigger points. Curr Pain Headache Rep. 2011;15(5):386-92.
28. Shah JP, Danoff JV, Desai MJ, et al. Biochemicals associated with pain and inflammation are elevated in sites near to and remote from active myofascial trigger points. Arch Phys Med Rehabil. 2008;89(1):16-23.
29. Fernandez-Carnero J, La Touche R, Ortega-Santiago R, et al. Short-term effects of dry needling of active myofascial trigger points in the masseter muscle in patients with temporomandibular disorders. J Orofac Pain. 2010 Winter;24(1):106-12.
30. Lucas KR, Polus BI, Rich PS. Latent myofascial trigger points: their effects on muscle activation and movement efficiency. J Bodyw Mov Ther. 2004;8(3):160-6.
31. Gallego-Sendarrubias GM, Rodríguez-Sanz D, Calvo-Lobo C, Martín JL. Efficacy of dry needling as an adjunct to manual therapy for patients with chronic mechanical neck pain: a randomised clinical trial. Acupunct Med. 2020;38(4):244-54.
32. Stieven FF, Ferreira GE, Wiebusch M, de Araújo FX, da Rosa LHT, Silva MF. Dry needling combined with guideline-based physical therapy provides no added benefit in the management of chronic neck pain: a randomized controlled trial. J Orthop Sports Phys Ther. 2020;50(8):447-54.
33. Fernández-de-las-Peñas C, Nijs J, Ortega-Santiago R, Ambite-Quesada S, Cleland JA. Immediate effects of dry needling on central pain processing and skin conductance in patients with chronic nonspecific neck pain: a randomized controlled trial. Pain Med. 2022;23(1):34-42.
34. De Meulemeester KE, Castelein B, Coppieters I, Barbe T, Cools A, Cagnie B. Comparing trigger point dry needling and manual pressure technique for the management of myofascial neck/shoulder pain: a randomized clinical trial. J Manipulative Physiol Ther. 2017;40(1):11-20.
35. Korkmaz MD, Medin Ceylan C. Effect of dry-needling and exercise treatment on myofascial trigger point: a single-blind randomized controlled trial. Complement Ther Clin Pract. 2022;47:101571.
36. 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.
37. Kietrys DM, Palombaro KM, Azzaretto E, et al. Effectiveness of dry needling for upper-quarter myofascial pain: a systematic review and meta-analysis. J Orthop Sports Phys Ther. 2013;43(9):620-34.
38. Gattie E, Cleland JA, Snodgrass SJ. 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.
39. Dommerholt J. Dry needling - peripheral and central considerations. J Man Manip Ther. 2011;19(4):223-7.
40. Fejer R, Kyvik KO, Hartvigsen J. The prevalence of neck pain in the world population: a systematic critical review of the literature. Eur Spine J. 2006;15(6):834-48.
41. Hoy D, March L, Woolf A, et al. The global burden of neck pain: estimates from the Global Burden of Disease 2010 study. Ann Rheum Dis. 2014;73(7):1309-15.

Acknowledgements: *This study did not receive external funding. The authors state no conflicts of interest.*

Conflict of interest: *No potential conflict of interest was reported by the authors.*