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Most systematic reviews of dry needling for musculoskeletal pain have high risk of bias: A systematic review of systematic reviews

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All data are available upon request can be used as needed.

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AV, AN, AM and PS were responsible for Conception and Design; LJ, ES, AV, AN, AM, MO and PS were responsible for data collection, data extraction and the creation of tables; PS were responsible for the creation of the figures; LJ, ES, AV, AN, AM, MO and PS were responsible for data interpretation, drafting the manuscript and reviewing the final version

Abstract

Objective: The primary aim was to evaluate the risk of bias (ROB) of systematic reviews on the effectiveness of dry needling in patients with musculoskeletal conditions. The secondary aim was to summarize findings related to harms.

Design: Systematic review of systematic reviews

Literature search: Five databases were searched until December 2024.

Study selection criteria: Systematic reviews that compared dry needling to any intervention

Data synthesis: ROB was assessed using the ROB in Systematic reviews (ROBIS) tool. The type and frequency of harms reported in primary trials was extracted. A descriptive analysis was performed.

Results: A total of 5190 studies were identified with 38 reviews included. Reviews were published between 2009–2024. One review (3%) had low ROB and 31 reviews (82%) had high ROB. Five (13%) reviews were low risk for 'Eligibility Criteria', four (11%) for 'Identification and Selection of Studies', twelve (32%) for 'Data collection and Appraisal' and two (5%) were low risk for 'Synthesis and Findings'. Twenty-one (55%) reviews reported on harms related to dry needling. When reported, harms were mostly minor and transitory (e.g., post-needling soreness). Moderate harms included syncope (4 patients), presentation to hospital with fever, chills and a systemic upset (1 patient), chest pain (1 patient) and severe pain (1 patient).

Conclusion: Due to the high ROB in most systematic reviews, clear clinical recommendations for dry needling in the management of musculoskeletal pain cannot be confidently made. The inconsistent reporting of harms may result in their underestimation or overestimation.

Keywords: dry needling; pain; function; disability; myofascial trigger points, harms

Background

Globally, musculoskeletal conditions are regarded as the leading burden of disease[148]. Common musculoskeletal conditions include low back pain, neck pain and other joint pain[148]. Treatment for musculoskeletal conditions typically involves a multimodal approach, which may include exercise, physiotherapy, medication, orthoses or other aids, education and behavioural strategies[102]. Clinicians treating musculoskeletal conditions are strongly encouraged to use evidence-based approaches, however several barriers can impede the translation of evidence into practice. These include a lack of confidence in reading and critically appraising literature, limited access to research, difficulty applying evidence to individual patients, uncertainty in implementing interventions due to incomplete reporting and the requirement to integrate evidence with patient preferences and clinical expertise[62,69,88,122]. As a result, some interventions may not be adopted when they should be, incorrectly adopted or adopted prematurely. Ideally, moderate to high certainty evidence showing that an intervention is effective is required before widespread clinical adoption[47]. Dry needling is one widely used intervention where the effects of the intervention are unclear or very unclear due to the certainty of evidence[59,153].

Dry needling is an increasingly popular technique whereby thin filiform needles are directly inserted into myofascial trigger points (MTrPs). The technique has been increasingly reported as being used by physiotherapists worldwide to manage musculoskeletal pain[8,78,83]. It has been proposed that dry needling within MTrPs can help improve or restore function[14,59,70,128]. During dry needling the muscle is penetrated at these hypersensitive locations[38]. The needle is then manipulated within the MTrPs with the intent of mechanically disrupting the tissue and may elicit a local twitch response[152]. The exact physiological mechanisms underpinning dry needling is unclear, however it has been suggested that dry needling targeting MTrPs may disrupt dysfunctional neuromuscular activity in the muscle, decrease muscle tone and normalize the neurochemical properties of muscles[2,152]. One proposed explanation is the pain gate theory, whereby the stimulation of non-nociceptive afferent fibres, through dry needling, inhibits nociceptive fibre transmission at the dorsal horn of the spinal cord[23]. Dry needling is commonly distinguished from acupuncture. Acupuncture is traditionally considered part of Asian or Oriental medicine and involves an intramuscular insertion and manipulation of thin filiform needles into acupoints, with the aim of restoring the flow of Qi or Chi (the healing energy in the

body)[172]. In addition to differing theoretical frameworks, the techniques target different locations: acupuncture involves acupoints, whereas dry needling is generally applied to MTrPs[179].

The use of dry needling remains a topic of debate. One issue is that dry needling is an invasive technique, whereas most physiotherapy techniques are non-invasive. This raises concerns about the potential for harms. Two surveys amongst physiotherapists evaluating the risk of harms associated with dry needling found that minor harms, such as bruising, bleeding and additional pain occur frequently (in 36-40% of treatments), although severe harms are rare[18,58]. There are a growing number of clinical trials and systematic reviews evaluating the effectiveness of dry needling. Most systematic reviews conclude that dry needling is effective, although the underlying evidence is often considered as being at high risk of bias[59,75,104]. Systematic reviews are also susceptible to bias, such as having language restrictions in the eligibility criteria, deviations from protocol, not using duplicate selection, assessment and data extraction procedures, inappropriate risk of bias assessment and insufficient searches[155,165]. Synthesised evidence of high quality is crucial in informing and directing clinical practice guidelines, shaping health care delivery and guiding the education of key interest-holders including policymakers, clinicians, students, and consumers.

A recent overview of reviews aimed to summarise the evidence on the clinical effects of dry needling in musculoskeletal conditions[31]. However, this umbrella review assessed review quality through the AMSTAR-2 (A MeaSurement Tool to Assess systematic Reviews-2), which although has risk of bias components, is not a formal risk of bias assessment. The review also combined aggregated results from systematic reviews without adequate correction for overlap of individual studies and did not aim to provide an overview of harms. Many study designs were eligible, including network meta-analyses[6], reviews that included studies with non-randomised designs[30,91], reviews with interventions that included acupuncture and dry needling [68,103,115,125,134] and trials that combined dry needling with injections[33,68,113,134], electrical stimulation[94,164] or ischemic compression[22]. In addition, the search for that study was conducted in June 2022 and since then 15 reviews[45,49,64,65,70,85,90,95,97,101,111,131,138,143,173] have been published. Therefore, our aim is to evaluate the risk of bias of existing systematic reviews regarding the effectiveness of

dry needling in patients with musculoskeletal complaints, using the Risk of Bias In Systematic reviews (ROBIS) tool. The secondary aim is to evaluate the type and frequency of reported harms.

Methods

Design

This is a systematic review of systematic reviews. The protocol was pre-registered in PROSPERO on September 1, 2022 (CRD42022352856).

Eligibility criteria

Systematic reviews (with or without a meta-analysis) of randomized trials were included if they evaluated the effectiveness of dry needling (intervention) compared to any control intervention in adults (>18 years) with musculoskeletal conditions investigating any outcomes or timepoints. All musculoskeletal conditions were included regardless of whether they were in the acute or chronic phase. For reviews that included populations other than people with musculoskeletal complaints or multiple needling interventions (such as acupuncture), ≥75% of the included trials within the review needed to include the target intervention or population. Reviews were excluded if they contained any non-randomized studies, were network meta-analyses or focused on people with trigger points but no reported musculoskeletal pain condition. Reviews that included comparisons such as dry needling with a co-intervention compared to the same co-intervention were included. Reviews that included dry needling with a co-intervention compared to a different co-intervention, minimal intervention or no intervention were excluded.

Information Sources and search strategy

Databases searched were Medline (Ovid), EMBASE (Ovid), CENTRAL (Wiley), CINAHL (EBSCO), Physiotherapy Evidence Database (PEDro) and Web of Science on December 10, 2024. We combined search terms related to ‘dry needling’, ‘trigger points’ and ‘myofascial pain’, for population as ‘reviews’ and ‘meta-analyses’ for study design. The search strategy for each database is provided in Appendix 1. The search strategies were discussed with an information specialist at the University of Technology Sydney. Backwards and forwards citation

tracking was performed using Web of Science and any other relevant reviews were assessed for potentially eligible reviews.

Study selection

Search results were combined in Endnote and uploaded to Covidence for deduplication and screening. Title and abstracts followed by full texts were screened by two independent reviewers (out of AN, LJ, PS) with disagreements resolved in consultation with a third reviewer (AV).

Data Collection

Data extraction was independently conducted by two reviewers (out of LJ, ES, PS and AV) with disagreements resolved by a third independent reviewer (PS or AV). Data were extracted into a structured extraction form in Microsoft Excel. The following information was collected; first author, publication year, country (corresponding author affiliation), total number of participants, number of included randomized trials, types of comparator interventions, the definition of dry needling and how this was distinguished from acupuncture, condition, body region treated, primary outcomes assessed, follow-up timepoints, potential harms (reported or not reported and if reported the number and type), whether a risk of bias assessment of the included trials was performed (or a methodological quality assessment), whether a meta-analysis was performed and whether any assessment of the certainty of findings (e.g. using the Grading of Recommendations Assessment, Development and Evaluation (GRADE)) was used.

Risk of Bias assessment

Two independent reviewers (LJ, PS) assessed risk of bias using Risk of Bias in Systematic reviews (ROBIS) tool using the provided data extraction form[176]. Disagreements between raters were resolved in consultation with an independent third author (AV). Risk of bias was performed on each systematic review. The domains investigated were; Study Eligibility Criteria (Domain 1), Identification and selection of studies (Domain 2), Data collection and study appraisal (Domain 3), Synthesis and findings (Domain 4). Signaling questions for each domain determined the domain level bias. Domain level bias was classified as ‘low, ‘unclear’, or ‘high’. We then answered three further signaling questions, accounting for the answers in Domains 1–4, to determine the overall risk of bias of the review. The overall risk of bias was scored as ‘low’,

'unclear' or 'high'. Overall risk of bias was determined based on the recommendations of Whiting et al.[176] According to this approach, studies that had domains that were 'high' risk or 'unclear' risk may still be judged as having a 'low' overall risk of bias so long as the concerns for the identified for Domains 1-4 were "*appropriately considered when interpreting the results and drawing conclusions*" [176(p. 231)]. Risk of bias results were plotted using the robvis visualization tool (https://www.riskofbias.info/welcome/robvis-visualization-tool). Agreement in risk of bias ratings were provided as a percentage, measured using Cohen's Kappa (with 95% confidence intervals) and described using the recommendations of Landis and Koch [96].

Data synthesis and statistical analysis

Risk of bias: Risk of bias was presented overall and for each domain using descriptive statistics (frequencies) and assessed qualitatively.

Reporting of harms: The number or reviews that reported harms were counted (yes/no) and reported descriptively. Following this, the number of unique trials that reported harms and the types of harms were collated. Harms were classified as minor (transient soreness, bruising, skin reactions), moderate (syncope, pneumothorax, brief hospitalisation, admission for a medical procedure related to dry needling) or major (i.e., prolonged hospitalisation, morbidity or death)[26].

Meta-analysis and GRADE used in reviews: Whether the included reviews performed meta-analyses were reported for the immediate-/shortest-term timepoint for pain and disability. In reviews where an immediate term point was not investigated, or combined with a short-term timeframe, the shortest time point in the review was reported. Whether the included reviews assessed certainty of their findings using the GRADE was also counted.

Results

Search results

The PRISMA flow chart (Figure 1) shows the search and identification of reviews. A total of 5190 records were identified, with 1595 duplicates removed. The remaining 3595 unique title and abstracts were screened, leading to the assessment of 135 articles in fulltext. Of these, 38 systematic reviews were included in the study.

<Insert Figure 1 here>

Figure 1: PRISMA flow chart[137] for selection of included studies

Characteristics of included reviews

Reviews were published since 2009. Reviews were conducted in Spain[43,48,65,70,85,97,106,127–130,138,145–147,150,173], USA[19,64,82,93,100], China[75,101,104,111], Brazil[153,175], Australia/New Zealand[59,66], Iran[49,142], Saudi Arabia[90,131], India[143], Poland[95], Greece[45] and United Kingdom[162]. Reviews included between 3 and 42 primary trials (median (IQR): 8 (7 to 13) trials) with between 199 and 3967 participants (median (IQR): 517 (329 to 806) participants).

Dry needling

Thirty-six reviews[19,43,45,49,59,64–66,70,75,82,85,90,93,95,97,100,104,106,111,127–131,138,142,143,145–147,150,153,162,173,175] (95%) defined dry needling either in the introduction and/or the methods section. The definition usually included a procedure where a thin (filiform) needle is inserted in the skin or muscle at a certain location. This location was often referred to as a MTrP.

Participants

Nineteen reviews[48,64,70,90,95,100,101,111,127,129,138,142,146,173,175] (50%) investigated populations with musculoskeletal conditions in the upper extremity. Conditions included neck pain[48,70,128,129,146], headache[90,101,142,173], shoulder pain[64,127,138], lateral epicondylalgia[111,130], orofacial pain[95,175] and multiple upper quarter regions[66,93,100]. Seven reviews[49,75,97,104,106,143,145] (18%) investigated musculoskeletal conditions in the lower back or lower extremities. Conditions included low back pain[75,97,104], knee pain[145], hip pain[49] and plantar heel pain[106] [143]. Twelve reviews[19,43,45,59,65,82,85,131,147,150,153,162] (32%) investigated MTrPs related to body pain[19,43,65,82,147,150,162], musculoskeletal conditions (in any region)[45,59,153], osteoarthritis (any joint)[85] and tendinopathy (any tendon)[131].

Comparator

Comparator interventions varied, with many including multiple comparators. All reviews had at least one comparison that compared dry needling with a comparator (as per our eligibility criteria). Eleven reviews[43,59,75,93,95,128,130,147,150,162,175] (29%) compared dry needling with sham /

placebo / no intervention. Eight reviews[48,64–66,95,97,101,150,162] (21%) isolated the effects of dry needling through combining dry needling with an intervention that was also delivered to the comparator group. Most reviews[19,43,49,59,66,70,75,82,85,90,93,104,106,111,127,128,130,131,138,142,145–147,150,173,175] (67%) compared dry needling to 'other interventions', with comparators that combined trials with multiple interventions (e.g., sham needling, physiotherapy and pharmacological treatments in the same comparator). Eleven reviews[43,45,75,95,97,100,128,129,143,153,162] (29%) compared dry needling with a specific comparisons such as corticosteroid injections[143,153], wet needling[129], pharmacological interventions[43], trigger point manual therapy[100], manual therapy[128], percutaneous needle electrolysis[45], superficial and non MTrP dry needling[162], physiotherapy[97], lidocaine[95], acupuncture[75] and with multiple (1 trial) comparisons[95].

Outcomes and timepoints:

Thirty-four reviews[43,45,48,49,64–66,70,75,82,85,90,93,95,97,101,104,106,111,127–130,138,142,145–147,150,153,162,173,175] (89%) specified one or more primary outcome or did not specify a primary outcome but only had pain intensity and/or disability/function as an outcome. Primary outcomes in reviews were pain intensity only[43,45,65,82,93,95,101,106,146,150,162,173,175] or pain intensity, function and/or disability[48,49,64,66,75,85,97,104,111,127–129,138,142,145,153]. Other reviews used pain and function and/or disability with other outcomes[70,90,130] and pain with other outcomes[147]. Five reviews[19,59,100,131,143] (13%) did not specify primary outcomes. Most reviews investigated outcomes at multiple timepoints however the definitions of short term, medium term and long term were highly variable between reviews (Table 1).

Risk of bias / quality assessment:

All reviews conducted methodological quality or risk of bias assessment of individual trials.

Twelve studies (32%) (assessed study quality only) and used the PEDro scale[19,43,59,66,82,131,143,146,147,173], MacDermid Quality Checklist[93] or an adapted JADAD scale[162]. Thirteen studies (34%) assessed risk of bias only and used the Cochrane Risk of Bias 1.0 tool[49,64,75,95,97,101,129,138,175], a 13-item Cochrane tool[104,142] and the Cochrane Risk of Bias 2.0 tool[90,153]. Thirteen studies (34%) assessed both quality (using the PEDro scale) and Risk of bias using the Cochrane Risk of Bias 1.0 tool[45,48,85,100,106,111,127,128,130,145,150] or the Cochrane Risk of Bias 2.0 tool[65,70].

Meta-analyses and certainty assessment

Twenty-nine reviews[45,48,59,64–66,70,75,85,90,93,95,97,100,101,104,106,111,127–130,138,142,145,147,150,162,175] (76%) used meta-analyses and 9 reviews[19,43,49,82,131,143,146,153,173] (24%) did not. Nineteen reviews[45,48,59,66,85,95,104,106,111,127–130,138,142,145,150,153,175] (50%) provided an estimate of the certainty of findings using GRADE and 19 reviews[19,43,49,64,65,70,75,82,90,93,97,100,101,131,143,146,147,162,173] (50%) did not.

<Insert Table 1 here>

Table 1: Study characteristics and intervention details

Risk of Bias

Thirty-one reviews[19,43,45,49,59,65,66,70,82,85,90,93,95,97,100,101,104,106,111,129–131,138,143,145–147,150,162,173,175] (82%) were of high risk of bias, 6 reviews[48,64,75,127,128,153] (16%) were of unclear risk of bias and 1 review[142] (3%) was low risk of bias (figure 2 and figure 3). Most reviews scored high risk of bias for domain 1 (study eligibility criteria, 68%), domain 2 (identification and selection of studies, 76%) and domain 4 (synthesis of findings, 79%) (Figure 3). Domain 3 (data collection and study approval) had comparable percentages of studies with low (32%), unclear (32%) and high (37%) risk of bias (Figure 3). The kappa values was fair for the total score (κ: 0.38, 95%CI: 0.0 to 1.0, agreement 73%) and slight for domain 1 (κ: 0.13, 95%CI: -0.06 to 0.30, agreement 79%), domain 2 (κ: 0.17, 95%CI: -0.09 to 0.48, agreement 76%), domain 3 (κ: 0.17, 95%CI: -0.01 to 0.35, agreement 42%) and domain 4 (κ: 0.10, 95%CI: -0.12 to 0.41, agreement 76%). Kappa scores were skewed by few response judgments for ‘low’ and ‘some concerns’ for some domains.

<Insert figure 2 here>

Figure 2. Domain level bias (phase 2) and overall bias (phase 3) ROBIS judgement for each study

<Insert figure 3 here>

Figure 3. Domain level bias (phase 2) and overall bias (phase 3) ROBIS judgement for all studies

Harms

Dry needling intervention harms were reported in 19 reviews[48,65,66,70,75,85,95,100,101,106,127–131,142,145,153,173] (50%), incompletely reported in 2 reviews[49,111] (5%) and not reported in 17 reviews[19,43,45,59,64,82,90,93,97,104,138,143,146,147,150,162,175] (45%) (table 1). Two reviews[100,101] reported that none of the included trials reported on harms.

Twenty-two trials[5,15,21,24,27,28,37,40,54,63,81,107,109,110,112,117,135,136,139,156,159,170] from 9 reviews[48,49,65,70,95,128,129,145,153] reported no harms and 1 review[111] did not specify if trials reported no harms or didn't provide information on harms. When overlapping trials were removed 41 unique trials[9–11,28,32,35,36,44,46,53,55,56,61,71,72,76,77,80,84,87,99,105,116,123,126,133,144,149,151,154,157,158,160,163,166–168,171,174,177,178] reported on harms. No major harms were reported. Potentially moderate harms were reported in 4 trials[36,56,76,160], with 2 trials[36,76] reporting that patients experienced syncope (n=2 (4%) in one trial[36] and n=2 (3%) in the other[76]). One trial[76] also reported chest pain (n=1, 7%) and another[160] reported severe pain (n=1, 6%). Another trial[56] reported that 1 patient (5%) presented to the emergency department after treatment with fever, chills and a systemic upset.

The most common minor harm was soreness due to needling. Twenty-three trials[9,11,28,35,44,46,53,72,77,87,99,105,116,123,126,133,149,154,158,163,166,171,177] reported pain or discomfort during[77,87] or after[9,11,28,35,44,46,53,72,99,105,116,123,126,133,149,154,158,163,166,171,177] needling which occurred in a median 58% (IQR 39% to 86%) of participants. Five trials[28,35,99,158,177] did not specify the number of participants that experienced the event. Eight trials[28,32,116,149,160,166,167,174] reported subcutaneous bleeding, hematoma or hemorrhage which occurred in a median of 5% (IQR 2% to 11%) of patients in trials with 3 trials[28,32,149] not specifying the number of patients. Other common harms were temporary exacerbation or deterioration of symptoms[32,80,116,157], non-specific pain or fear[10,36,61,116], issues with (sticking of or aversion to) needles[80,84,151,167]. For three trials[32,54,178] minor or mild harms are reported without details on the type of event. Table 2 shows the details of the harms reported in each systematic review.

<Insert Table 2 here>

Table 2: Harms reported in each review that reported on harms

Discussion

The risk of bias of 31 (82%) of the systematic reviews investigating dry needling was high, with only 1 (3%) demonstrating low risk of bias. Caution is therefore advised when interpreting systematic review studies of dry needling as many have flaws that affect the interpretation of their effect estimates. In addition, no major harms were reported within this body of literature, although, when reported, minor harms were common. The high risk of bias of most reviews means that findings may not be credible. The presence of minor harms in over half of the reviews underscores the need for careful clinical judgement.

Comparison with other studies

The quality of dry needling reviews has been assessed in an umbrella review using the quality assessment checklist, assessment of multiple systematic reviews-version 2 (AMSTAR-2) checklist[31]. That study found that 2 reviews (6%) were high quality, 19 (53%) were moderate quality, 11 (31%) were low quality and 4 (11%) were critically low quality. These findings broadly align with the present study in terms of overall quality distribution. Although there is a high degree of convergent validity between the AMSTAR-2 and the ROBIS tools[108], and some overlapping items[141], there are distinct conceptual differences between assessments of methodological quality (AMSTAR-2) and risk of bias (ROBIS) [52,89]. Quality assessment has been defined as "the assessment of the inclusion of methodological safeguards within a study" [52] whereas risk of bias "concerns the implication of the inclusion of such safeguards for study results" [52]. Given this, assessing risk of bias provides a better understanding than the assessment of methodological quality to whether the results are trustworthy and clinically relevant.

Harms were reported poorly, and when reported appeared to be minor. However, randomised trials are often not powered to detect harms (especially rare harms), so there might be a risk of rare harms not being encountered [79,161]. A survey of 425 physiotherapists who performed dry needing on 20,464 dry needling sessions reported minor harms in 7,531 (37%) sessions[18]. Minor harms included bleeding, bruising and pain during and after dry needling treatments. However, 20 major harms were reported, although many of these would have been classified as minor or moderate harms in our study (such as syncope, lower extremity weakness) as they were transient. In that study, other harms were difficult to classify as minor, moderate or major as a classification was not provided by the article and there were not enough details to determine

severity. It is estimated that the incidence of moderate to serious harms is low (i.e., pneumothorax incidence approximately 0.01/10,000 interventions) although the low incidence may be due to some needling practitioners abandoning needling treatments over high risk areas (such as the thorax) [169]. Further, as many trials or systematic reviews did not report on harms, it is impossible to ascertain if these were not reported or did not occur.

Dry needling is increasingly being used in clinical practice[8,78,83], and the treatment is associated with potential moderate or minor harms. Given the uncertainty around its effectiveness and the potential for harm, dry needling should be used cautiously. There are few national or international standards for dry needling and inconsistent reporting of harms in clinical practice[14,169]. In Australia, needling by physiotherapists has been recognised as a risky intervention and accounts for the intervention with some of the largest malpractice claims in the profession[12,13]. Reasons for this are multifaceted but could result in discrepancies between the harms that therapists and patients expect[12]. It has been recommended that therapists are appropriately trained in dry needling and that harms are discussed prior to starting the treatment[7,13]. Globally, clinicians using dry needling may not be appropriately trained, which could increase the risk of harm and reduce the likelihood of thorough discussions about the potential risks with patients[12,13]. It has been recommended that professional standards for dry needling are implemented at national and subnational levels, and integrated into standardised educational programs [14,169].

Strengths and limitations

This is the first review evaluating the risk of bias of systematic reviews of dry needling. The review was pre-registered with no deviations from protocol. The use of the ROBIS could be a limitation of our review, as the ROBIS is more difficult, less frequently used, has lower agreement and takes more time to administer than the AMSTAR or AMSTAR-2 [57]. To reduce these issues, raters discussed each ROBIS item prior to grading and then graded and discussed 3 articles to calibrate responses. Further, in the case of disagreement or uncertainty a third author was consulted. Despite this, although overall agreement was generally high, kappa values were still slight or minimal, which is similar or lower than previous studies investigating with kappa values using the ROBIS[108,140]. This was mainly due to low numbers of responses for the 'low' and 'some concerns' judgements. Regardless, given the subjectivity of the ROBIS other review

authors could have scored the ROBIS differently than the authors in the current review. Most reviews did not report harms, or did so incompletely, which means that we cannot be certain regarding the reporting of harms in the trials summarised by these studies.

Implications.

Clinical. Given the litigation and clinically reported harms associated with dry needling as well as the uncertainty of any benefits, performing dry needling should be used cautiously. Our study indicated that systematic reviews were high risk of bias meaning that the findings of the systematic reviews need to be interpreted with caution. Most of the musculoskeletal conditions included in this review have alternative treatments that have higher certainty evidence of benefit (e.g., exercise therapy, manual therapy) [29,67,132]. As recommended by American Physical therapy Association and Australian Physiotherapy Association, physiotherapists using dry needling should act within their scope or practice (attending a course in dry needling), gain and maintain consent ensuring full disclosure on potential harms, minimize needling high risk areas and asking appropriate questions about medications and conditions that could exacerbate harms[7,12,13].

Research. As almost all reviews were high risk of bias and many did not or incompletely reported harms, we recommend that future reviewers better follow reporting guidelines such as PRISMA as well as the PRISMA-harms when reporting their systematic reviews [3,79]. Further, consulting quality or risk of bias tools to assess individual studies may also provide useful information.

Education providers. Physiotherapy degree courses often do not teach dry needling because it is not mandatory as per regulatory guidelines and usually requires additional training that many courses are not willing or able to provide. Nevertheless, many physiotherapists offer dry needling despite it not being formally taught during their university training. Physiotherapy students should, at the very least, be educated on the current evidence for dry needling, given its widespread use in clinical practice. It is essential that students are exposed to discussions around its effectiveness, safety and regulatory risks. This foundational understanding would enable future clinicians to critically appraise the intervention, make informed decisions and communicate appropriately with patients.

Conclusion

Most systematic reviews investigating dry needling were rated as having a high risk of bias, suggesting that their conclusion should be treated with caution. Less than half of the reviews included information on harms, and reporting was often incomplete. Trials and reviews in dry needling require more transparent reporting of adverse events so the risk-benefit of using dry needling as an intervention can be established.

Key points

Findings: Risk of bias is low in one (3%) and high in 31 (82%) systematic reviews of dry needling compared to any other intervention. Harms were poorly reported but, when reported, were mainly minor and transitory

Implications: The results presented in systematic reviews of dry needling should be treated with caution as there are biases that could affect the results and conclusions.

Caution: Dry needling should be used by clinicians with caution with an assessment of the expected benefits and harms.

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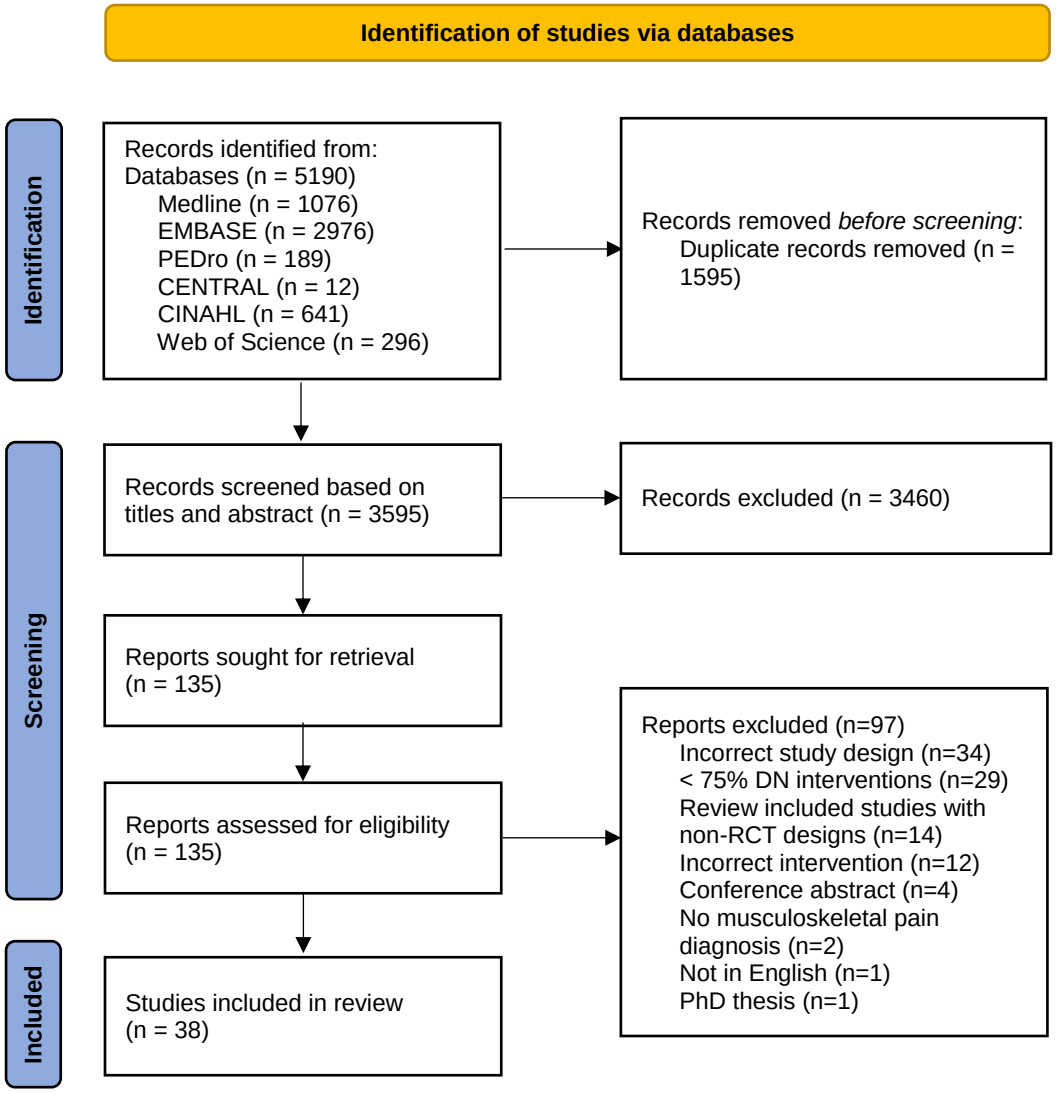

Figure 1: PRISMA flow chart[137] for selection of included studies

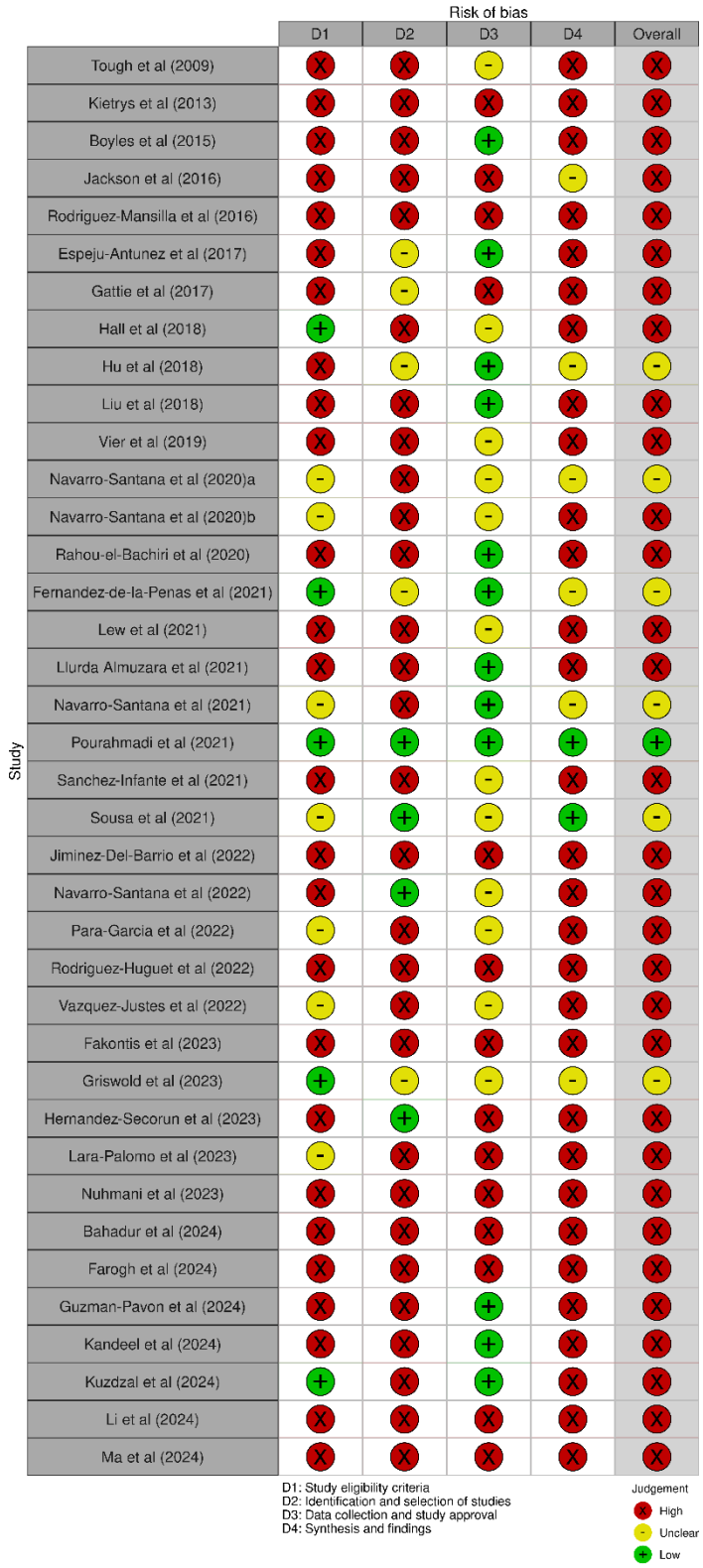

Figure 2. Domain level bias (phase 2) and overall bias (phase 3) ROBIS judgement for each study

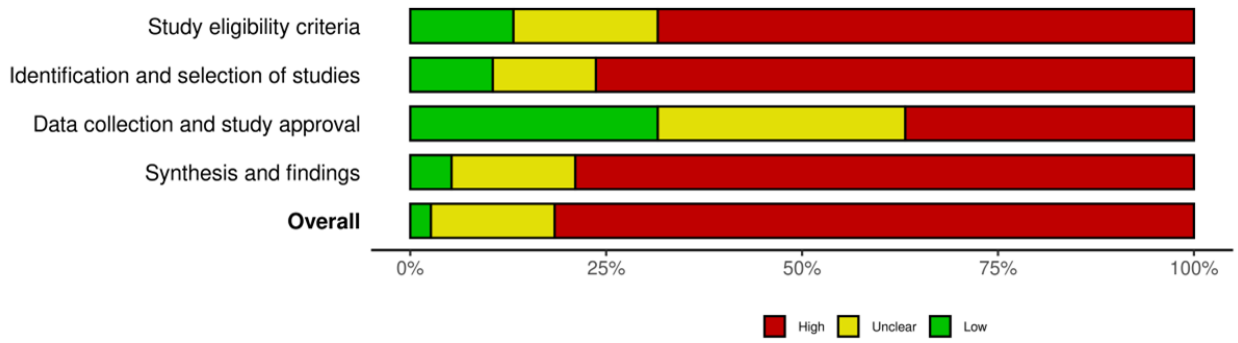

Figure 3. Domain level bias (phase 2) and overall bias (phase 3) ROBIS judgement for all studies

Table 1: Study characteristics and intervention details

Author (Year) Country	Population; Number of included trials (participants)	Definition of dry needling[%]	Interventions and comparisons[&]	Primary outcomes / Timepoints	Quality/ROB, meta-analyses (MA) GRADE conducted	Were harms reported?	Main results*[#]
Neck, shoulder and/or arm pain							
Kietrys et al. 2013 [93] USA	Upper quarter myofascial pain syndrome; 12 trials (n = 696)	"*[DN] is a procedure in which an acupuncture-like needle is inserted into the skin and muscle in the location of an MTrP. Needles are removed once the trigger point is inactivated.* " [93 (p. 621)]. Referenced source(s). [39]	DN vs sham DN vs other treatments	Pain intensity Timepoints: immediately (post-intervention) | short term (≈4 weeks)	Quality: MacDermid Quality Checklist MA: Yes GRADE: No	No	Pain intensity (immediate): • DN vs sham: SMD -1.06 (95%CI -0.05 to -2.06, I^2 86%) • DN vs other treatments: SMD 0.64 (95%CI 1.21 to 0.06, I^2 90%)
Hall et al. 2018 [66] New Zealand	Shoulder or upper extremity pain; 11 trials (n = 496)	"*[DN] is a form of acupuncture where rapid in and out needling is used directly into the [MTrP] to relieve the local tension and reduce pain from the MTP."* [66 (p. 168)] Referenced source(s). None	DN active and latent MTrP vs DN active MTrP DN (including add-on) vs sham/other needling/no treatment DN vs other interventions	Pain intensity and function Timepoints: immediate (post-intervention) | short term (1 week)	Quality: PEDro MA: Yes (pain only) GRADE: Yes	Yes	Pain intensity (immediate): • DN active and latent MTrP vs DN active MTrP: SMD -0.74 (95%CI -1.19 to -0.29, I^2 0%), low certainty
Navarro-Santana et al. 2020 [128] Spain	Neck pain (MTrP); 28 trials (n = 1319)	"*[DN] is defined as a 'skilled intervention using a thin filiform needle to penetrate the skin that stimulates myofascial TrPs, muscles, and connective tissue for the treatment of musculoskeletal pain disorders'"* [128 (p. 2)] Referenced source(s). [7]	DN vs sham / placebo / waiting list / other forms of DN DN vs manual therapy DN vs other interventions (physiotherapy)	Pain intensity and disability Timepoints: immediate (<1 week) | short term (1-12 weeks) | mid-term (12-24 weeks).	Quality: PEDro Risk of bias: Cochrane 1.0 tool MA: Yes GRADE: Yes	Yes	Pain intensity (immediate): • DN vs sham/other forms of DN: MD -1.53 (95%CI -2.29 to -0.76, I^2 58%), low certainty • DN vs manual: MD 0.19 (95%CI -0.61 to 1.00, I^2 0%), low certainty • DN vs other: MD -0.07 (95%CI -0.51 to 0.37, I^2 0%), low certainty Disability (short term) • DN vs sham/other forms of DN: SMD -0.87 (95%CI -1.60 to -0.14, I^2 79%), moderate certainty • DN vs manual: SMD -0.20 (95%CI -0.49 to 0.10, I^2 23%), high certainty • DN vs other: SMD -0.07 (95%CI -0.27 to 0.13, I^2 12%), high certainty
Navarro-Santana et al. 2020 [130] Spain	Lateral epicondylalgia; 7 trials (n = 320)	"*[DN] is defined as a 'intervention using a thin filiform needle that stimulates the skin, trigger points, muscle or connective tissue for the management of*	DN vs sham / placebo / control / no intervention DN vs other interventions	Pain intensity, disability, function, strength and pressure pain threshold. Timepoints:	Quality: PEDro Risk of bias: Cochrane 1.0 tool MA: Yes	Yes	Pain intensity (immediate): • DN vs sham: SMD 0.05, (95%CI -0.63 to 0.74, 1 study), low certainty • DN vs other: SMD -0.21 (95%CI -0.88 to

Author (Year) Country	Population; Number of included trials (participants)	Definition of dry needling[%]	Interventions and comparisons[&]	Primary outcomes / Timepoints	Quality/ROB, meta-analyses (MA) GRADE conducted	Were harms reported?	Main results*[#]
		musculoskeletal pain disorders' but does not introduce any substance into the tissue." [130] (p. 1328) Referenced source(s). [7]		immediate (< 72 hours) | short term (0-12 weeks) | long term (>24 weeks).	GRADE: Yes		0.45, 1 study), low certainty Disability (short term) • DN vs other: SMD -1.65 (95%CI -2.52 to -0.77, I^2 88%), very low certainty
Fernandez-de-la-Penas et al. 2021 [98] Spain	Neck pain (MTrP); 8 trials (n = 631)	DN not defined	Add-on DN + other interventions vs other interventions	Pain intensity and disability Timepoints: immediate (< 1week post 1 session) | short term (1-12 weeks) | mid-term (12-24 weeks) | long term (>24 weeks)	Quality: PEDro Risk of bias: Cochrane 1.0 tool MA: Yes GRADE: Yes	Yes	Pain intensity (immediate): • MD -0.96 (95%CI -1.61 to -0.31, 1 study), low certainty
Lew et al. 2021 [100] USA	Neck, shoulder, and/or upper back pain; 6 trials (n = 241)	"*DN involves insertion of a fine needle without medication into the skin, subcutaneous tissues, and muscle to mechanically disrupt myofascial trigger points by eliciting local twitch responses*" [100] (p. 136) Referenced source(s). [152]	DN vs Trigger point manual therapy	No primary outcome specified. Outcomes: pain intensity, pressure pain threshold and disability Timepoints: short to mid-term (1 week to 28 days)	Quality: PEDro Risk of bias: Cochrane 1.0 tool MA: Yes GRADE: No	Yes	Pain intensity (short to mid-term) • SMD -0.41 (95%CI -0.99 to 0.18, I^2 35%) Disability (short to mid-term) • SMD 0.66 (95%CI -0.02 to 1.33, I^2 70%)
Navarro-Santana et al. 2021 [127] Spain	Non-traumatic shoulder pain; 6 trials (n = 381)	*"[DN] is defined as a 'skilled intervention using a thin filiform needle to penetrate the skin that stimulates TrPs, muscles, and connective tissue for the management of musculoskeletal disorders.'"* [127] (p. 2) Referenced source(s). [7]	DN vs other interventions (sham / placebo / no intervention / other therapies)	Pain intensity and disability Timepoints[^]: short term (<12 weeks) | mid-term (12–24 weeks) | long term (> 24 weeks).	Quality: PEDro Risk of bias: Cochrane 1.0 tool MA: Yes GRADE: Yes	Yes	Pain intensity (short-term): • SMD -0.34 (95%CI -0.55 to -0.13, I^2 0%), moderate certainty Disability (short-term): • SMD -1.12 (95%CI -2.07 to -0.18, I^2 91%), low certainty
Griswold et al. 2023 [64] USA	Subacromial pain syndrome; 8 trials (n = 538)	*"[DN] is a minimally invasive procedure in which a monofilament or acupuncture needle is used to penetrate symptomatic soft tissue to reduce pain and disability. MTrP DN involves inserting a solid needle into a local focus in the muscle and repeatedly manipulating the needle to elicit and exhaust the local twitch response"* [64] (p. 286) Referenced source(s). [42,86]	Add-on DN + other interventions vs other interventions	Pain intensity and disability Timepoints: short term (1-4 weeks) | mid-term (4 weeks to 3 months) | long term (3-12 months).	Risk of bias: Cochrane 1.0 tool MA: Yes GRADE: No	No	Pain intensity (short term): • SMD -0.57 (95%CI -0.75 to -0.38, I^2 28%) Disability (short term): • SMD -0.69 (95%CI -0.91 to -0.48, I^2 9%)
Navarro-	Neck pain (MTrP);	*"[DN] is a 'skilled intervention using a*	DN vs Wet Needling	Pain intensity and disability	Risk of bias: Cochrane	Yes	Pain intensity (short term):

Author (Year) Country	Population; Number of included trials (participants)	Definition of dry needling[%]	Interventions and comparisons[&]	Primary outcomes / Timepoints	Quality/ROB, meta-analyses (MA) GRADE conducted	Were harms reported?	Main results*[#]
Santana et al. 2022 [129] Spain	7 trials (n = 426)	*thin filiform needle to penetrate the skin that stimulates myofascial TrPs, muscles, and connective tissue for the treatment of musculoskeletal pain disorders'".* [129 (p. 516)]. Referenced source(s). [7]		Timepoints: short term (1-12 weeks) | mid-term (12-24 weeks) | long term (>24 weeks)	1.0 tool MA: Yes GRADE: For some comparisons		• MD 2.13 (95%CI 1.03 to 3.22, I^2 90%), low certainty. Disability (short term): • MD -0.90 (95%CI -4.89 to 3.09, 1 study)
Para-Garcia et al. 2022 [138] Spain	Sub-acromial pain syndrome; 5 trials (n = 315)	*"[DN] is a minimally invasive treatment in which a small needle is inserted throughout the skin. The aim of this method is the stimulation of MTrPs, connective tissue, and muscles in order to reduce pain and functional disability."* [138 (p. 2)] Referenced source(s). None	DN alone or with exercise vs other interventions [+]	Pain intensity and disability Timepoints: short term and mid-term (as defined by individual studies)	Risk of bias: Cochrane 1.0 tool MA: Yes GRADE: Yes	No	Pain intensity (short term): • SMD: -0.27 (95% CI: -0.49 to -0.05, I^2 0%), low certainty Disability (short term): • SMD -0.97 (95%CI -2.04 to 0.11, I^2 93%), very low certainty
Rodriguez-Huguet et al. 2022 [146] Spain	Chronic neck pain; 11 trials (n = 807)	"*[DN] is defined as a minimally invasive physiotherapy technique used in the treatment of neuromusculoskeletal disorders. Needling the most painful point of the muscle…."* [146 (p. 2)] Referenced source(s). [25,120,121]	DN vs other interventions (no treatment / other therapies)	Pain intensity Timepoints: as defined by individual studies	Quality: PEDro MA: No GRADE: No	No	MA not completed
Hernández-Secorún et al. 2023 [70] Spain	Chronic neck pain; 14 trials (n = 1027)	"*The DN procedure consists of inserting a filiform, solid, nonbevelled needle into the MTP, without injecting or extracting any substance. DN is known to have a mechanical effect, provoking the disruption of dysfunctional motor endplates, and it is used to treat different pathologies."* [70 (p.1-2)] Referenced source(s). [119]	DN vs other interventions (e.g., manual therapy / ultrasound / shock wave therapy)	Pain intensity, function and pain sensitivity. Timepoints: short term (immediate - 1 month) | mid-term (1-3 months) | long term (>3 months)	Quality: PEDro Risk of bias: Cochrane 2.0 tool MA: Yes GRADE: No	Yes	Pain intensity (timepoint unclear): • SMD -0.45 (95%CI -0.90 to -0.01, I^2 88%) Disability (timepoint unclear): • SMD -0.20 (95%CI -0.61 to 0.22, I^2 84%)
Ma et al. 2024 [111] China	Lateral epicondylitis; 17 trials (n = 979)	"*Dry needling refers to a physical therapy method that uses fine needles to penetrate the skin and stimulate soft tissues, including muscles, tendons, ligaments, and fasciae, to treat neuromusculoskeletal pain and movement disorders.*" [111 (p. 2185)] Referenced source(s): [7,41]	DN vs other interventions (placebo / other therapies)	Pain intensity and elbow disability Timepoints: immediate (<1 week) | short term (1-12 weeks) | mid-term (12-24 weeks) | long term (>24 weeks)	Quality: PEDro Risk of bias: Cochrane ROB 1.0 tool MA: Yes GRADE: Yes	Incompletely	Pain intensity (immediate): • DN vs other: MD: -0.95 (95%CI -1.88 to -0.02, I^2 95%), very low certainty Disability (immediate): • DN vs other: SMD -1.37 (95%CI -1.88 to -0.86, I^2 89%), very low certainty

Author (Year) Country	Population; Number of included trials (participants)	Definition of dry needling[%]	Interventions and comparisons[&]	Primary outcomes / Timepoints	Quality/ROB, meta-analyses (MA) GRADE conducted	Were harms reported?	Main results*[#]
Headache							
Pourahmadi et al. 2021 [142] Iran	Headache (TTH, CGH, MH); 11 trials (n = 685)	*"[DN] is a skilled intervention that uses solid filiform needles inserted into muscle trigger points (TrPs) or other soft tissues."* [142 (p. 2)] Referenced source(s). [124]	DN vs other interventions (sham / physiotherapy / pharmacological / injections)	Pain intensity and disability Timepoints: short term (<3 months)	Risk of bias: 13 item Cochrane tool[50] MA: Yes GRADE: Yes	Yes	Pain intensity (short term): • TTH SMD −1.27 (95%CI -3.56 to 1.03, I^2 98%), very low certainty; • CGH SMD −0.41 (95%CI -4.69 to 3.87, I^2 99%), very low certainty; • MH SMD 0.03 (95%CI−0.42 to 0.48, I^2 0%), very low certainty. Disability (short term): • TTH SMD -2.28 (95%CI -2.66 to -1.91, 1 study), very low certainty • CGH SMD −0.72 (95%CI -1.09 to -0.34, I^2 7%), very low certainty
Vazquez-Justes et al. 2022 [173] Spain	Headache (TTH, CGH, MH); 8 trials (n = 577)	*"DN is a technique for managing neuromusculoskeletal pain, in which a solid filiform needle with no bevel is inserted into the skin without injection of any substance. It can be applied at various depths: superficial DN stimulates connective tissue, whereas deep DN reaches [MTrP]"* [173 (p. 807)]. Referenced source(s). [41]	DN vs other interventions (sham / physiotherapy / pharmacological / injections)	Pain intensity Timepoints: As reported by the individual studies.	Quality: PEDro MA: No GRADE: No	Yes	MA not completed
Kandeel et al. 2024 [90] Saudi Arabia	Headache (no specification); 13 trials (n = 857)	*"DN is a therapeutic technique that involves the insertion of fine, monofilament needles into trigger points or tender points within muscles, fascia, or connective tissues, without injecting any substance. DN aims to provoke a localized twitch response, a brief involuntary muscle contraction occurring in the targeted muscle fibers."* [90 (p. 2)] Referenced source(s). [41]	DN vs other interventions (sham / physiotherapy / pharmacological)	Disability, headache frequency, and headache (pain) intensity Timepoints: immediate (<1 week) | short term (1-2 weeks) mid-term (1-3 months) | long term (>3 months)	Risk of bias: Cochrane 2.0 tool MA: Yes GRADE: No	No	Pain intensity (immediate): • SMD -1.70 (95%CI -1.95 to -1.44, I^2 95%) Disability (short term) • SMD -0.23 (95%CI -0.70 to 0.25, I^2 34%)
Li et al. 2024 [101] China	Headache (CGH); 3 trials (n = 263)	DN not defined	DN + manual therapy vs manual therapy	Pain intensity Timepoints: immediate (post-treatment) | short term (< 1 month) |	Risk of bias: Cochrane 1.0 tool MA: Yes GRADE: No	Yes	Pain intensity (immediate): • MD -2.19 (95%CI -3.73 to -0.65, I^2 95%)

Author (Year) Country	**Population; Number of included trials (participants)**	**Definition of dry needling[%]**	**Interventions and comparisons[&]**	**Primary outcomes / Timepoints**	**Quality/ROB, meta-analyses (MA) GRADE conducted**	**Were harms reported?**	**Main results*[#]**
				mid-term (2-3 months)			
Orofacial pain							
Vier et al. 2019 [175] Brazil	Orofacial pain of myofascial origin; 7 trials (n = 199)	*"DN involves applying sterile monofilament needles that penetrate the skin and muscles, stimulating points underlying the TP region in order to regulate neuromuscular pain and movement deficits."* [175] (p. 4) Referenced source(s). [98]	DN vs sham DN vs other interventions (physiotherapy / pharmacological / injections)	Pain intensity Timepoints: short term (< 3 months) | mid-term (3-6 months) | long term (> 6 months)	Risk of bias: Cochrane 1.0 tool MA: Yes GRADE: Yes	No	Pain intensity (short term): • DN vs sham: MD 0.30 (95%CI -0.83 to 1.43, I^2 24%); very low certainty • DN vs other: MD -0.74 (95%CI -1.25 to -0.22, I^2 24%); very low certainty
Kuzdzal et al. 2024 [95] Poland	Orofacial pain of any classification; 24 trials (n = 1318)	*"...(DN) refers to the insertion of monofilament stainless steel needles into muscles, ligaments, tendons, connective tissue, scar tissue, and perineural tissue for the management of neuromusculoskeletal conditions."* [95] (p. 1) Referenced source(s). [40,125]	DN vs sham DN vs lidocaine Add on DN + usual care vs usual care DN vs multiple individual comparisons	Pain intensity Timepoints: Longest follow up timepoint as reported by individual study	Risk of bias: Cochrane 1.0 tool MA: Yes GRADE: Yes	Yes	Pain intensity (longest reported timepoint): • DN vs sham: SMD -1.68 (95%CI -3.16 to -0.20, I^2 92%); very low certainty • DN vs lidocaine: SMD 0.74 (95%CI -1.65 to 3.13, I^2 94%); very low certainty • Add-on DN: SMD -1.89 (95%CI -5.82 to 2.02, I^2 98%); very low certainty
Low back pain							
Hu et al. 2018 [75] China	Low back pain of any duration (MTrP); 16 trials (n = 1233)	*"[DN] involves a minimally invasive procedure in which an acupuncture needle is inserted directly into [MTrPs]. Although an acupuncture needle is used, unlike conventional acupuncture that is based on the theory of traditional Chinese medicine, DN is developed along with the theory of MTrPs."* [75] (p. 1) Reference d source(s). [41]	DN vs sham DN vs acupuncture DN vs other interventions (oral drugs, physiotherapy, behavioral therapy, or massage)	Pain intensity and disability Timepoints: immediate (end of treatment) | follow up timeframes as reported by individual studies	Risk of bias: Cochrane 1.0 tool MA: Yes GRADE: No	Yes	Pain intensity (immediate): • DN vs sham: SMD -2.74 (95%CI, -3.77 to -1.71, I^2 26%) • DN vs acupuncture: SMD -0.96 (95%CI -1.80 to -0.12, I^2 93%) Disability (immediate): • DN vs sham: SMD -1.70 (95%CI -2.59 to -0.81, I^2 34%) • DN vs acupuncture: SMD -0.63 (95%CI -0.99 to -0.26, I^2 0%)
Liu et al. 2018 [104] China	Low back pain of any duration (MTrP); 11 trials (n = 802)	*"In clinical practice, [DN] usually refers to deep dry needling, which is a minimally invasive procedure during which a thin filiform needle is directly inserted into an active [MTrP], with the condition of eliciting a local twitch response."* [104] (p. 144-145) Referenced source(s). [114]	DN vs other interventions (sham / laser therapy / other needling therapies / physiotherapy).	Pain intensity and disability Timepoints: post-intervention (unspecified timepoint) | follow up (timeframes as reported by individual trial)	Risk of bias: 13 item Cochrane tool[50] MA: Yes GRADE: Yes	No	Pain intensity (post intervention): • SMD -1.06 (95%CI -1.77 to -0.36, I^2 94%); moderate certainty Disability (post intervention): • SMD -0.76 (95%CI -1.46 to -0.06, I^2 88%); low certainty
Lara-Palomo	Chronic low back pain;	*"[Introduction] DN is a minimally*	DN vs physiotherapy	Pain intensity and functional	Risk of bias: Cochrane	No	Pain intensity (immediate):

Author (Year) Country	**Population; Number of included trials (participants)**	**Definition of dry needling[%]**	**Interventions and comparisons[&]**	**Primary outcomes / Timepoints**	**Quality/ROB, meta-analyses (MA) GRADE conducted**	**Were harms reported?**	**Main results*[#]**
et al. 2023 [97] Spain	8 trials (n = 414)	*invasive procedure that involves inserting a small monofilament needle into an active or latent trigger point to elicit a local contraction and eliminate a [MTrP] [Methods] DN is defined as a minimally invasive procedure that consists of inserting a needle and moving it using the "sparrow technique," until a local muscle contraction response is obtained."* [97] (p. 110-111) Referenced source(s). [7,72]	Add on DN + physiotherapy vs same physiotherapy	disability Timepoints: immediate (post-intervention) | short term (<3 months)	1.0 tool MA: Yes GRADE: No		• DN vs PT: SMD -0.43 (95%CI -0.97 to 0.11, I^2 76%) • Add on DN: SMD -0.42 (95%CI -0.79 to -0.05, I^2 0%) Disability (immediate): • DN vs PT: SMD 0.11 (95%CI -0.32 to 0.54, I^2 0%) • Add on DN: SMD 0.15 (95%CI -0.67 to 0.97, I^2 75%)
Lower limb							
Rahou-El-Bachiri et al. 2020 [145] Spain	Knee pain; 10 trials (n = 473)	*"[DN] is a 'skilled intervention using a thin filiform needle to penetrate the skin that stimulates [MTrPs], muscles, and connective tissue for the management of musculoskeletal disorders.'"* [145] (p. 2) Referenced source(s). [7]	DN vs other interventions (sham / no intervention / other therapies)	Pain intensity and disability Timepoints: short term (< 10 weeks) | mid-term (10-20 weeks) | long term (> 20 weeks)	Quality: PEDro Risk of bias: Cochrane 1.0 tool MA: Yes GRADE: Yes	Yes	Pain intensity (short term): • SMD -0.53 (95%CI -0.87 to -0.19, I^2 68%), moderate certainty Disability (short term): • SMD -0.58 (95%CI -1.08 to -0.09, I^2 80%), moderate certainty
Llurda-Almuzara et al. 2021 [106] Spain	Plantar heel pain (MTrP); 6 trials (n = 395)	*"[DN] is defined as a 'skilled intervention using a thin filiform needle to penetrate the skin that stimulates TrPs, musculature, and connective tissue for the management of musculoskeletal pain disorders.'"* [106] (p. 1631) Referenced source(s). [7]	DN vs other interventions (sham / no intervention / other therapies)	Pain intensity Timepoints: short term (< 4 weeks) | mid-term (4-12 weeks) | long term (> 12 weeks)	Quality: PEDro Risk of bias: Cochrane 1.0 tool MA: Yes GRADE: Yes	Yes	Pain intensity (short term): • 1 session: SMD 1.44 (95%CI -1.53 to 4.40, I^2 98%), very low certainty; • >3 sessions: SMD -1.28 (95%CI -2.11 to -0.44, I^2 86%), low certainty Disability (short term): • SMD -0.30 (95%CI -0.68 to 0.08, I^2 60%), moderate certainty
Forogh et al. 2024 [49] Iran	Any hip-related disorder; 7 trials (n = 273)	*"(DN) is a therapeutic method capable of reducing chronic musculoskeletal pain… This technique typically stimulates trigger points by the insertion of fine monofilament needles into muscle to reduce pain."* [49] (p. 64) References source(s). [41,91,92]	DN vs other interventions (sham / no intervention / other therapies)	Pain intensity and function Timepoints: As reported by the individual studies.	Risk of bias: Cochrane 1.0 tool MA: No GRADE: No	Incompletely	MA not completed
Prasad et al. 2024 [143] India	Plantar heel pain; 3 trials (n = 214)	*"…(DN), a procedure involving needling stimulation without the use of drugs….it is proposed that the induction of a local twitch response during dry needling may*	DN vs corticosteroid injections	No primary outcome specified Timepoints: As reported by the individual studies.	Quality: PEDro MA: No GRADE: No	No	MA not completed

Author (Year) Country	Population; Number of included trials (participants)	Definition of dry needling[%]	Interventions and comparisons[&]	Primary outcomes / Timepoints	Quality/ROB, meta-analyses (MA) GRADE conducted	Were harms reported?	Main results*[#]
		generate neural inputs to the brain, potentially interrupting the pain-spasm-pain cycle" [143 (p. 2)] Referenced source(s). [23,41]					
Multiple pain location sites							
Tough et al. 2009 [162] UK	MTrPs [whole body]; 7 trials (n = 564)	*"Although the mechanism of effect is unknown, the practice of inserting needles into points of soft tissue tenderness to alleviate pain is long established, with clinicians commonly adopting either the orthodox approach of injection or the Western medical acupuncture approach of dry needling."* [162 (p. 4)] Referenced source(s). None	DN vs sham Add on DN + rehabilitation vs same rehabilitation DN vs Non-MTrP DN DN vs superficial DN	Pain intensity Timepoints: short term (24 hours to 30 days) | long term (1-6 months)	Quality: modified JADAD scale. MA: Yes GRADE: No	No	Pain intensity (short term): • DN vs sham: MD -14.1 (95%CI -34.0 to 5.8, I^2 88%)
Boyles et al. 2015 [19] USA	MTrPs [whole body]; 19 trials (n = 1102)	*"Trigger point dry needling is a treatment method widely used to treat the aforementioned impairments by targetting and eliminating local MTrPs.…is administered by inserting a thin, solid filiform needle directly into the palpable trigger point."* [19 (p. 5-6)] Referenced source(s). [7,16,39,60,152]	DN vs other interventions (sham / acupuncture / electrotherapy / physiotherapy / pharmacological / injections / other therapies)	No primary outcome specified Timepoints: As reported by the individual studies	Quality: PEDro MA: No GRADE: No	No	MA not completed
Jackson et al. 2016 [82] USA	MTrPs [whole body]; 8 trials (n = 467)	"*Dry needling is an technique involving insertion of a fine needle into specific MTrPs without the use of any medication*" [82 (p. 178)] Referenced source(s). [1]	DN vs other interventions (physiotherapy / other therapies)	Pain intensity Timepoints: As reported by the individual studies	Quality: PEDro MA: No GRADE: No	No	MA not completed
Rodriguez-Mansilla et al. 2016 [147] Spain	Myofascial pain syndrome [whole body]; 19 trials (n = 852)	*"[DN]… is performed by inserting a needle at the [MTrP] at subcutaneous or muscle level. The mechanic stimulus of the needle is used as a physical agent to remove the [MTrP] without injection or extraction of any substance and causing a local spasm response. The needling does not stay in place and it is removed once the [MTrP] has been deactivated."*	DN vs sham DN vs other interventions (needling therapies / physiotherapy / pharmacological / injections / other therapies)	Pain intensity and range of motion Timepoints: immediate | short term (3-4 weeks)	Quality: PEDro MA: Yes GRADE: No	No	Pain intensity (immediate): • DN vs sham: MD -0.49 (95%CI -3.21 to 0.42, I^2 NR) • DN vs other: MD 2.54 (95%CI -0.40 to 5.48, I^2 NR)

Author (Year) Country	Population; Number of included trials (participants)	Definition of dry needling[%]	Interventions and comparisons[&]	Primary outcomes / Timepoints	Quality/ROB, meta-analyses (MA) GRADE conducted	Were harms reported?	Main results*[#]
		[147] (p. 2) Referenced source(s). [51,118]					
Espejo-Antunez et al. 2017 [43] Spain	MTrPs [whole body]; 15 trials (n = 761)	*"[Introduction] [DN] consists of using a needle, as a physical agent, to create a mechanical stimulus with the goal of deactivating the trigger point. It is an invasive procedure, where the needle is inserted through the skin and muscle into the MTrP. Once the MTrP is deactivated, the needle is removed…[Methods] [DN] is an invasive procedure (superficial or deep) consisting of using a needle without any chemical agent inserted into the skin over an active or latent MTrP and that does not follow the principles of the Traditional Chinese Medicine"* [43] (p. 46-47) Referenced source(s). [20,39,93]	DN vs. sham / placebo / no intervention DN vs. pharmacological interventions DN vs. other interventions (manual therapy / needling therapies)	Pain intensity Timepoints: As reported by the individual studies	Quality: PEDro MA: No GRADE: No	No	MA not completed
Cattie et al. 2017 [59] Australia	MSK conditions [whole body]; 13 trials (n = 723)	*"[DN] is a technique in which a fine needle is used to penetrate the skin, subcutaneous tissues, and muscle, with the intent to mechanically disrupt tissue without the use of an anesthetic."* [59] (p. 133) Referenced source(s). [34]	DN vs control/sham DN vs other interventions (manual therapy / other therapies)	No primary outcome specified. Timepoints: short term (0-12 weeks) | long term (6-12 months)	Quality: PEDro MA: Yes GRADE: Yes	No	Pain intensity (short term): • DN vs control/sham: SMD -0.7 (95%CI -1.06 to -0.34, I^2 25%, 6 studies), low certainty • DN vs other: SMD -0.43 (95%CI -0.77 to -0.10, I^2 83%, 6 studies), moderate certainty.
Sanchez-Infante et al. 2021 [150] Spain	MSK conditions with MTrPs [whole body]; 42 trials (n = 3967)	*"[Introduction] DN is a therapeutic procedure, similar to acupuncture, in which a needle is inserted, through the skin without the use of an anesthetic, and one of the most commonly used techniques to inactivate the MTrP within the muscle. The aim of DN in the MTrP is to provoke mechanical tissue stimulation…. [Methods] deep DN using a needle without any chemical or pharmacological agent on an active or latent MTrP and not acupuncture based*	DN vs sham DN vs other interventions (physiotherapy / other therapies) Add-on DN + other interventions vs other interventions	Pain intensity Timepoints: immediate (0-72 hours) | short term (1-3 weeks) | mid-term (4-12 weeks) | long term (13-24 weeks).	Quality: PEDro Risk of bias: Cochrane 1.0 tool MA: Yes GRADE: Yes	No	Pain intensity (immediate): • DN vs sham: SMD -1.89 (95%CI -3.27 to -0.50, I^2 96%), low certainty. • DN vs other: SMD -0.34 (95%CI -0.57 to -0.10, I^2 51%), moderate certainty. • Add-on DN :SMD -0.59 (95%CI -1.28 to 0.10, I^2 92%), low certainty.

Author (Year) Country	Population; Number of included trials (participants)	Definition of dry needling[%]	Interventions and comparisons[&]	Primary outcomes / Timepoints	Quality/ROB, meta-analyses (MA) GRADE conducted	Were harms reported?	Main results*[#]
		on the principles of traditional Chinese medicine" [150] (p. 2) Referenced source(s). [59,93]					
Sousa Filho et al. 2021 [153] Brazil	Widespread and localized MSK pain [whole body]; 6 trials (n = 384)	*"[DN] consists of a needling stimulation without drugs that can be used in various body areas aiming to reduce pain and disability."* [153] (p. 2) Referenced source(s). [23,41]	DN vs corticosteroid injections	Pain intensity or disability Timepoints: short term (≤6 weeks) | mid-term (7-23 weeks) | long term (≥ 24 weeks)	Risk of bias: Cochrane 2.0 tool MA: No GRADE: Yes	Yes	MA not completed
Jimenez-del-Barrio et al. 2022 [85] Spain	OA in any joint; 7 trials (n = 291)	*"(DN) is the most common invasive technique and consists of the insertion of a single-use acupuncture needle into the MTrP. The Hong's technique is the most investigated procedure and is based on eliciting local twitch responses after repeated needle insertion."* [85] (p. 2) Referenced source(s): [39,72,74]	DN vs other interventions (sham / exercise / no intervention)	Pain intensity or function Timepoints: short term (not specified) | medium term (not specified)| long term (not specified)	Quality: PEDro Risk of bias: Cochrane 1.0 tool MA: Yes GRADE: Yes	Yes	Pain intensity (short term): • SMD -0.76 (95%CI -1.24 to -0.29, I^2 74%), very low certainty Function (short term): • SMD -0.98 (95%CI -1.54 to -0.42, I^2 75%), very low certainty
Fakontis et al. 2023 [45] Greece	MSK pain; 6 trials (n = 293)	*"(DN), which is used to treat [MTrPs]. [MTrPs] have been described by Travell and Simons as painful palpable nodules located along a tense muscle fascicle on the belly of the muscle. Their presence has been found to be greatly increased in patients with musculoskeletal pain."* [45] (p. 1034) Reference(s). [17,59,152]	DN vs percutaneous needle electrolysis	Pain intensity Timepoints: short term (≤ 1 month) | mid term (1-3 months) | long term (3-6 months)	Quality: PEDro Risk of bias: Cochrane 1.0 tool MA: Yes GRADE: Yes	No (only reported for percutaneous needle electrolysis group)	Pain intensity (short term): • MD 0.94 (95%CI -0.33 to 2.21, I^2 83%), moderate certainty
Nuhmani et al. 2023 [131] Saudi Arabia	Tendinopathy in any area; 7 trials (n = 357)	*"[DN] is a relatively new treatment technique in which a solid filament needle is repeatedly used to penetrate the skin, subcutaneous area, tendon and muscles to mechanically disrupt the tissue without using any biological agent."* [131] (p. 128) Reference(s).[4]	DN vs other interventions (sham / no intervention / other therapies)	No primary outcome specified Outcomes: patient-reported outcomes, biological or clinical markers of tendon healing. Timepoints: As reported by the individual studies	Quality: PEDro MA: No GRADE: No	Yes	MA not completed
Guzmán-Pavón et al. 2024 [65] Spain	MTrPs [whole body]; 5 trials (n = 289)	*"[DN] is an invasive procedure in which a needle is inserted into the skin and muscle in the location of an [MTrP]. One of the unique features of [MTrPs] is*	Add on DN + stretching vs stretching	Pain intensity Timepoints: Not described	Quality: PEDro Risk of bias: Cochrane 2.0 tool MA: Yes	Yes	Pain intensity: • SMD -1.73 (95%CI -3.06 to -0.40, I^2 96%)

Author (Year) Country	Population; Number of included trials (participants)	Definition of dry needling[%]	Interventions and comparisons[&]	Primary outcomes / Timepoints	Quality/ROB, meta-analyses (MA) GRADE conducted	Were harms reported?	Main results*[#]
		the local twitch response (LTR), which is an involuntary reflex contraction of the taut band following its needling" [65] (p. 1087) Reference(s). [39,73]			GRADE: No		

ROB – risk of bias, MA – meta-analyses, GRADE - Grading of Recommendations Assessment, Development, and Evaluation, DN – Dry Needling, MTrP – Myofascial Trigger Points, SMD – standardized mean difference, 95%CI – 95% Confidence Intervals, PEDro – Physiotherapy Evidence Database, MD – Mean difference, TTH – Tension type headache, CGH – Cervicogenic type headache, MH - Mixed headache, MSK – Musculoskeletal, OA – osteoarthritis, LTR – Local Twitch Response

*pain and disability outcome for each DN only intervention for the immediate timepoint. When a study did not investigate the immediate timepoint, the next shortest timepoint was used.

[&]Interventions and comparisons that could isolate the effects of dry needling

[%] Sources referenced for definition

^There was differences between the timeframes in the MA and in text. In text, it was obtained at short term (0–1 month), midterm (1–3 months), and long term (3–6 months) from baseline.

+ 4/5 studies were DN only as the intervention and the other study had DN combined with exercise. Therefore, as DN only made up 80% of the treatments it was included.

For the pain and function/disability estimates, negative values favor the DN intervention, and positive values favor the control. Some positive/negative signs were modified to fit this convention.

Table 2: Harms reported in each review that reported on harms

Author	Trials reporting harms, n/total (%)	Description of harms (number of patients, percentage of patients)
Neck, shoulder and/or arm pain		
Hall et al. 2018 [66]	2/11 trials (18%)	Post-needling soreness (n=6, 60%). [11] Syncope (n=2, 4%) | Shoulder soreness (unspecified number) | Regional sympathetic response (n = <10%). [36]
Navarro-Santana et al. 2020 [128]	15/28 trials (46%)	Post-needling soreness (n=5, 29%) | Diffuse muscle fatigue (n=8, 47%). [126] Post-needling soreness (n=9, 88%). [123] Contralateral side pain (n=6, 18%) | Headache (n=4, 12%) | Dizziness (n=1, 3%) | Earache (n=1, 3%) | haematoma (n=1, 3%) | post-needling soreness (n=1, 3%). [116] Post-needling soreness (n=26, 55%). [105] Post-needling soreness (n=76, 91%). [46] Post-needling soreness (unspecified number, 2 trials). [35,158] Post-needling soreness (n=6, 40%). [10] Post-needling soreness (n=37, 90%). [171] Post-needling soreness (n=3, 8%). [133] Aversion to needles (n=2, 17%). [151] No harms (4 trials). [24,37,81,109]
Navarro-Santana et al. 2020 [130]	1/7 trials (14%)	Local haemorrhage (n=1, 2%) | Did not tolerate needling (n=1, 2%). [167]
Fernandez-de-la-Penas et al. 2021 [48]	7/8 trials (88%)	Post-needling soreness (n=16, 80%). [163] Post-needling soreness (n=2, 5%). [154] Temporary exacerbations of neck pain and/or headache symptoms (n=8, 14%). [157] Post-needling soreness (n=37, 90%). [171] Post-needling soreness (unspecified number)[99] Post-needling soreness and local hemorrhage (unspecified number)[28] No harms (1 trial). [54]
Lew et al. 2021 [100]	0/6 trials (0%)	
Navarro-Santana et al. 2021 [127]	1/6 trials (17%)	Muscle soreness (n=5, 25%) [9]
Navarro-Santana et al. 2022 [129]	6/7 trials (71%)	Post-needling soreness (n=15, 100%). [72] Discomfort during needling (n=8, 80%). [87] Post-needling soreness (n=9, 50%). [53] Local transient flare reaction (n=1, 5%). [144] Discomfort during needling (n=12, 60%). [77] No harms (1 trial). [15]
Hernández-Secorún et al. 2023 [70]	8/14 trials (57%)	Mild harms (3 trials)[55,157,178] Post-needling soreness and local hemorrhage (unspecified number)[28] No harms (4 trials)[24,54,156,170]
Ma et al. 2024 [111]	2/17 trials (12%)	Local haemorrhage (n=1, 2%) | Did not tolerate needling (n=1, 2%). [167] Did not tolerate pain (n=1, 2%). [168] It is unclear if the other 15 trials reported '*no adverse events*' or didn't provide any information on harms.
Headache		
Pourahmadi. et al. 2021 [142]	2/11 trials (18%)	Gastrointestinal symptoms (n=2, 5%) | Euphoria (n=1, 3%). [71] Pain and fear during needling (n=5, 6%). [61]
Vazquez-Justes et al. 2022 [173]	2/8 trials (25%)	Gastrointestinal symptoms (n=2, 5%) | Euphoria (n=1, 3%). [71] Pain and fear during needling (n=5, 6%). [61]
Li et al. 2024 [101]	0/3 trials (0%)	

Author	Trials reporting harms, n/total (%)	Description of harms (number of patients, percentage of patients)
Orofacial pain		
Kuzdzal et al. 2024 [95]	6/24 trials (25%)	No harms (6 trials)[5,40,63,107,135,136]
Low back pain		
Hu et al. 2018 [75]	3/16 trials (19%)	Sticking of the needle (n=1, 3%). [84] Deterioration of symptoms (n=1, 8%). [80] Needle-stick with pain (possibly due to intramuscular haematoma) (n=2, 10%) | Presentation to Emergency department with fever, chills and systemic upset (without a physiological explanation) (n=1, 5%).[56]
Lower limb		
Rahou-el-Bachiri et al. 2020 [145]	7/10 trials (70%)	Post needling soreness (n=12, 40%). [44] Hemorrhage (n=3, 14%). [174] Post needling soreness (n = 30, 97%) | Hematoma and bleeding was a 'common side effect (no number provided). [149] Post-needling soreness (unspecified number). [177] No harms (3 trials). [117,139,159]
Llurda-Almuzara et al. 2021 [106]	2/6 trials (33%)	Post-needling soreness (n=19, 38%) | Subcutaneous bleeding (n=6, 12%).[166] Minor temporary harms (n=70, 32%) DN appointments | Delayed harms (most commonly bruising and exacerbation of symptoms) (n= 8, 3%) | No serious harms. [32]
Forogh et al. 2024 [49]	3/7 trials (43%)	Severe pain (n = 1, 6%) | Bleeding (n = 1, 6%).[160] Syncopal responses (n = 2, 7%) | Chest pain (n = 1, 3%) [76] No harms (1 trial). [21] It is unclear if the other 4 trials reported '*no adverse events*' or didn't provide any information on harms.
Multiple pain location sites		
Sousa Filho et al. 2021 [153]	3/6 trials (33%)	Pain during needling (n=1, 2%). [168] Post-needling pain (n=18, 38%) | Subcutaneous bleeding (n=6, 12%). [166] No harms (1 trial). [21]
Jimenez-del-Barrio et al. 2022 [85]	1/7 trials (14%)	Post needling soreness (n = 30, 97%) | Hematoma and bleeding was a common side effect (no numbers provided). [149]
Nuhmani et al. 2023 [131]	1/7 trials (14%)	Local haemorrhage (n=1, 2%) | Did not tolerate needling (n=1, 2%). [167]
Guzmán-Pavón et al. 2024 [65]	5/5 trials (100%)	No harms (5 trials). [27,28,110,112,117]

DN = Dry Needling