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The efficacy of manual therapy and therapeutic exercise for reducing chronic non-specific neck pain: A systematic review and meta-analysis

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Abstract

Background: Chronic non-specific neck pain (CNSNP) is a highly prevalent musculoskeletal disorder associated with significant disability, resulting in growing recourse to healthcare providers, huge cost for society and a great number of workdays lost.
Objective: By this systematic review and metanalysis we aimed to assess the effects of different physical therapy techniques in patients with CNSNP.
Methods: PubMed, Scopus, and Web of Science databases were regularly used to search for articles published from 1st January 2010 until 31st January 2024. All RCTs were assessed for eligibility, including studies on: patients with diagnosis of CNSNP; physical therapy approaches such as manual therapy (MT) and therapeutic exercise (TE); waiting list, sham treatments, as comparison; Visual Analogue Scale, Numerical Rating Scale, Numerical Pain Rating Scale, and Numerical Pain Scale, as outcomes.
Results: At the end of the search, 14025 studies were identified. After the removal of duplicates, 10,852 were considered eligible according to title and abstract screening, while 10,557 papers were excluded after this process. Therefore; a total of 11 RCTs were included in this systematic review. A decrease of pain intensity was observed in all groups, albeit in patients being treated with TE and MT. Besides this, the combination of TE and MT demonstrated a 91% of probability to be the best choice in patients with CNSNP at the first visit. Only the combination of TE plus MT/cognitive behavioral therapy and MT as a single treatment showed a reduction in pain score. Overall, 3 studies (27.2%) showed a low risk of bias, 6 (54.5%) showed some concerns in bias assessment, and 2 (19%) a high risk of bias.
Conclusion: Collectively, the findings of this systematic review showed that MT and TE might be considered as effective rehabilitation approaches for treatment of pain in patients with CNSNP.

Keywords
chronic non-specific neck pain, physical therapy, cognitive behavioral therapy, manual therapy, therapeutic exercise

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Introduction

Neck pain is a highly prevalent musculoskeletal disorder and is one of the major contributors to a poor health-related quality of life.[1] When symptoms persist for more than 12 weeks, the condition is classified as chronic neck pain;[2] albeit neck pain has a favorable prognosis for most of the affected patients, one-third of people show recurrent low-grade discomfort, frequently conducting to a chronic pain syndrome.[3] This latter is commonly associated with great disability and consequent decreased work productivity.[4–7] In 2017, the global prevalence of neck pain was estimated at 288.7 million cases, with approximately 28.6 million people living with disability.[8] Notably, a clear link has been established between intense work effort and neck pain onset in office workers.[9,10]

In this scenario, most patients suffer from chronic non-specific neck pain (CNSNP), which is a pain in the cervical spinal area that arises without trauma, organic disease, or neurological symptomatology.[11] This pain is considered as a leading cause of absenteeism among office employees, affecting their ability to work, prompting medical consultations, and increasing the use of painkillers.[12,13] Notwithstanding the high incidence of this disorder, the existing rehabilitative approaches are highly variable and focused on postural correction; in fact, the techniques range from muscle therapy, adjustments and/or manipulations of the spine, postural re-education, ergonomic modifications, and even corrective pillows.[9–15] The current literature indicates that physical therapy, including exercise and physical agent modalities, might decrease work-related neck pain and functioning disabilities.[16,17] To date, several guidelines[18–22] have recommended conservative interventions, including manual therapy (MT) and therapeutic exercise (TE), for pain relief in individuals with CNSNP. Indeed, MT and TE can restore normal ROM, reduce local ischemia, stimulate proprioception, break fibrous adhesions, stimulate synovial fluid production, and reduce pain.[23,24] In this context, O'Riordan et al.[25] showed that resistance and endurance training could reduce pain and improve quality of life in patients with chronic neck pain. On the other hand, Gross et al.[26] reported no high-quality evidence to support the effectiveness of exercise for treatment of CNSNP in adults. Several systematic reviews have only focused on the comparison of different treatments[27–32] and only few of them have performed multiple interventions simultaneously through a network meta-analysis (NMA), with uncertain results.[33,34] The NMA extends the principles of meta-analysis to the evaluation of multiple interventions in a single analysis, combining both direct and indirect data; more in detail, in a trial comparing "A" and "B" interventions, the direct evidence is the estimation of the relative effects between "A" and "B", whereas the indirect evidence is considered as the one obtained using one or more common comparators.[35–37]

Taking into account the gaps in the scientific literature, this systematic review with NMA aimed to systematically assess the effects of different physical therapy techniques in patients with CNSNP.

Methods

Search strategy

PubMed, Scopus, and Web of Science databases were regularly used to search for articles published from 1st January 2010 until 31st January 2024, according to each specific thesaurus, following the strategy described in Table 1. Furthermore, a manual search of the references of previous systematic reviews on a similar topic was conducted as well.

This systematic review with meta-analysis was conducted according to the guidance of PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses)[38] and the Cochrane Handbook for Systematic Reviews of Interventions.[39] The systematic review protocol has been registered in the International Prospective Register of Systematic Reviews (PROSPERO) with number CRD42024499937.

Eligibility criteria

All RCTs were assessed for eligibility according to the patient, intervention, comparison, and outcome (PICO) model:

P) Patients were selected according to: diagnosis of CNSNP;

I) Intervention was based on: the physical therapy techniques, i.e., MT (cervical spine manipulation and

Table 1. Search strategy.

PubMed: 8934 results
(Neck pain) OR (cervical pain) OR (cervical spine) AND (cervicalgia) OR (chronic neck pain) OR (aspecific neck pain) AND (manual therapy) OR (physical therapy) OR (rehabilitation) OR (physiotherapy) OR (exercise) OR (manipulation) OR (education) OR (pharmacological therapy) OR (placebo) OR (waiting list) OR (cognitive behavioral therapy)
Scopus: 2178 results
TITLE-ABS-KEY(((Neck pain) OR (cervical pain) OR (cervical spine)) AND (cervicalgia) OR (chronic neck pain) OR (aspecific neck pain) AND ((manual therapy) OR (physical therapy) OR (rehabilitation) OR (physiotherapy) OR (exercise) OR (manipulation) OR (education) OR (pharmacological therapy) OR (placebo) OR (waiting list) OR (cognitive behavioral therapy)))
Web of Science: 2913 results
((Neck pain) OR (cervical pain) OR (cervical spine)) AND (cervicalgia) OR (chronic neck pain) OR (aspecific neck pain) AND ((manual therapy) OR (physical therapy) OR (rehabilitation) OR (physiotherapy) OR (exercise) OR (manipulation) OR (education) OR (pharmacological therapy) OR (placebo) OR (waiting list) OR (cognitive behavioral therapy))

mobilization) and TE (stretching exercises, strengthening isometric exercises, cervical stabilization exercises, deep neck flexor exercises, sensory motor exercises), as single treatments or in combination with a Cognitive Behavioral Therapy (CBT);

C) Comparison consisted of: waiting list, sham treatments, conventional physical therapy (non-specific exercise), oral pharmacological drugs.

O) Outcome measures were based on pain intensity, using Visual Analogue Scale (VAS), Numerical Rating Scale (NRS), Numerical Pain Rating Scale (NPRS), Numerical Pain Scale (NPS).

Two reviewers independently screened all potential articles for eligibility after duplication removal. Disagreements were resolved through discussion or, whether necessary, by consulting a third reviewer.

Only RCTs providing full data of the therapy were included. Exclusion criteria were: (1) patients with neck pain due to specific causes (e.g., radicular pain, inflammatory pain etc.); (2) children or adolescents during growth; (3) older adults (>65); (4) history of neck trauma; (5) patients suffering from any inflammatory disorders or rheumatic diseases (e.g., rheumatoid arthritis, psoriatic arthritis); (6) patients with fibromyalgia; (7) patients with headache/migraine; (8) patients with congenital abnormality or neoplastic disease of the cervix; (9) studies including physical agent modalities; (10) proprioceptive exercises or sensorimotor training; (11) cervical-thoracic and thoracic joint manipulations; (12) studies including intra-articular infiltration therapy; (13) studies including only local pressure pain assessment;(14) studies including more than one interventional study; (15) studies published in languages other than English; (16) full-text unavailability (i.e., posters and conference abstracts); (17) studies involving animals.

Data extraction

Two reviewers independently extracted data from the selected studies using a customized data extraction on a Microsoft Excel sheet. Disagreements between reviewers were resolved by consensus of a third independent reviewer.

The following data were extracted: (1) First author; (2) Publication year; (3) Nationality; (4) Age of participants; (5) Type of rehabilitation approach; (6) Type of control (waiting list, sham treatment or placebo, conventional physical therapy, oral pharmacological drugs, or physical therapy approaches in opposition); (7) Population and the number of patients included; (8) Pain intensity as an outcome measure; (9) Main findings.

Data synthesis and analysis

The RCTs were synthesized by describing the extracted data. To evaluate the quality of evidence, we adopted Version 2 of the Cochrane risk-of-bias tool for randomized trials (RoB 2).[37] We assessed the five domains of risk of bias, reporting low, some concern, and high risk. Disagreements on the evaluation were resolved by an independent third reviewer.

Statistical analysis

The statistical analysis was performed on RevMan 5.4 and R 4.3.0 (R foundation, Wien, Austria). The heterogeneity among comparisons was estimated by the Chi-squared and I2 tests. An $I2 > 50\%$ indicated significant heterogeneity across the articles. A random effects model was used to determine the pooled data with 95% confidence intervals (95% CIs). According to previous studies,[39–44] we performed a NMA redirecting all the results measured in each trial to estimate an overall effect, by linking direct head-to-head trials and the indirect comparison from different trials. In this context, it was possible to develop a score of surfaces under the cumulative ranking curves (SUCRA), ranking each intervention by its effectiveness; thus, for each treatment we have a SUCRA score ranging from 0% to 100%. In summary, we obtained a ranking of the interventions based on the SUCRA score, which takes account of every head-to-head and indirect comparison in the NMA. The statistical weight for each class and intervention was estimated using the Markov chain Monte Carlo; the software runs two chains with different initial values simultaneously to evaluate convergence, using the Gelman-Rubin diagnostic trace plots, comparing direct and indirect estimates in each triangular loop. This analysis method minimizes bias and indirectly evaluates the best treatment among multi-arm studies. We also performed a Node-splitting model, assuming consistency across the entire network to highlight inconsistent treatment comparisons within the same network, depicting deviance from NMA model and UME inconsistency model.

Results

Study characteristics

At the end of the search, 14,025 studies were identified. After the removal of duplicates, 10,852 were considered eligible according to title and abstract screening, and 10,557 papers were excluded after this process, according to the PICO model (see Table 2 for further details). Therefore, a total of 11 RCTs[45–55] were included in this systematic review, as depicted by the PRISMA flow diagram in Figure 1. The selected studies[45–55] have been published in the last 12 years (from 2012 to 2023). Seven[45–47,52–55] (64%) were conducted in Europe (2[50,56] from Spain, 2[48,49] from Turkey, 1[54] from Portugal, 1[55] from Italy, 1[57] from United Kingdom), 3[51–53] (27.2%) from Asia (2[51,52] from South Korea, 1[53] from Hong Kong,) 1[49] (9%) from Brazil. A total of 662 individuals were analyzed, of which 333 were

Table 2. Main characteristics of the randomized controlled trials included in the present systematic review.

Article	Nationality	Study group	Control group	Intervention	Comparison	Outcome measure and time-point assessments	Main findings
Aydoğmus H. et al. Turk J Phys Med Rehab 2022	Turkey	n = 30; 10 M/ 20 F Age: 34.8 ± 9.3 years	n = 29; 11 M/ 18 F Age: 38.8 ± 6.9 years	TE, 5 times per week×3 weeks	CPT, 5 times per week× 3 weeks	0–10 VAS at baseline (T0), after the treatment (T1), 1 (T2) and 3 months (T3)	No significant differences between groups were found in any time-point ($p > 0.05$) . All groups improved VAS score at each time in within analysis ($p < 0.05$).
Celenay ST et al. J Orthop Sports Phys Ther 2016	Turkey	n = 51; 12 M/39 F Age: 47 ± 10 years	n = 51; 16 M/ 35 F Age: 44 ± 13 years	TE + MT, 3 days/ week×4 weeks	MT, 3 days/ week×4 weeks	0–10 VAS at baseline and after the treatment	No differences between groups were found ($p = 0.33$)
Groisman S.. et al. J Bodyw Mov Ther 2020	Brazil	n = 45; 3 M/ 42 F Age: 40.2 ± 12.3 years	n = 45; 13 M/ 32 F Age: 42.8 ± 9.8 years	TE + MT 1 time/ week + 3 times/ week for 4 weeks	TE, 1 times/ week for 4 week	0–100 NPRS at baseline (T0), after treatment (T1), and 15 days after the end (T2)	Intervention Gropus led to greater reductions in NPRS compared with CG ($p = 0.007$; $d = 0.8$)
Hernandez Lucas P. et al. BMC Sports Sci. Med. Rehabilitation 2023	Spain	n = 28; np M/ np F Age: 51 ± 7.6 years	n = 27; np M/ np F Age: 50.7 ± 10 years	TE, 2 times/week for 8 weeks	Nothing	0–100 mm VAS at baseline and after the treatment	Significant differences in VAS score between groups were found in favor of intervention group at 8 weeks ($p < 0.001$; $g = 0.99$)
Kim J.Y. et al. J Phys Ther Sci 2016	South Korea	n = 14; 6 M/ 8 F Age: 46.7 ± 4.2 years	n = 14; 7 M/ 7 F Age: 45.4 ± 5.1 years	TE; 3 times/week for 4 weeks	CPT, 3 times/ week for 4 weeks	0–10 NRS at baseline (T0), at the end of the treatment (T1), and after 8 weeks (T2)	A significant difference in NRS score between groups was observed at 8 weeks in favor of intervention group ($p < 0.05$)
Lee K.S. et al. J Phys Ther Sci 2017	South Korea	n = 9; 0 M/ 9F Age: 59.0 ± 2.4	n = 9; 0 M/ 9 F Age: 58.0 ± 1.6	TE + MT; 3 times/ week for 2 weeks	TE; 3 times/ week for 2 weeks	0–10 VAS at baseline and after the treatment	Significant differences in VAS score between groups were found in favor intervention group ($p < 0.05$)
Lin J.H. et al. Man Ther 2012	Hong Kong	n = 33; 9 M/ 24 F Age: 38.94 ± 11.71 years	n = 30; 8 M/ 22 F Age: 40.90 ± 11.80 years	TE + MT	TE	0–10 NPRS at baseline (T0), at the end of the treatment (T1), and 3 months (T2)	Significant differences in VAS score between groups were found in favor intervention group at the end and at 3 months ($p < 0.001$)
Matias B.A. et al. IJTR 2019	Portugal	n = 25; 3 M/ 22 F Age: 20.7 ± 1.9 years	n = 27; 6 M/ 21 F Age: 21.3 ± 2.1 years	TE + CBT; 1 time/ week for 4 weeks	TE; 1 time/ week for 4 weeks	0–10 VAS at baseline (T0), at the end of treatment (T1), and 3 months (T2)	No significant effect on the intensity of pain was detect at any time of evaluation
Monticone M. et al. Eur Spine J 2012	Italy	n = 40; 10 M/ 30 F Age: 54.97 ± 13.83 years	n = 40; 10 M/ 30 F Age: 44.20 ± 11.44 years	TE + CBT, up to 12 sessions	TE up to 12 sessions	0–10 NRS at baseline (T0), at the end of the treatment (T1), and after 12 months (T2)	No differences between groups were found
Rodríguez-Sanz J. et al. Life 2022	Spain	n = 29; 10 M/ 19 F Age: 48.76 ± 14.5	n = 29; 7 M/ 22 F Age: 49.72 ± 17	TE + MT	TE	0–100 mm VAS at baseline and after the treatment	The intervention group experienced a significant decrease in VAS as compared with the control group ($p < 0.001$, $d = 1.01$)
Thompson D.P. et al. Physiotherapy. 2016	United Kingdom	n = 29; 14 M/ 15 F Age: 49.2 ± 14.5 years	n = 28; 14 M/ 14 F Age: 45.8 ± 12.6 years	TE + CBT, 4 times/week	TE, 4 times/ week	0–10 NRS at baseline and after the treatment	Significant differences in VAS score between groups were found in favor intervention group ($p = 0.04$)

Values are presented as mean ± standard deviation and mean (range). Abbreviations: CBT: Cognitive Behavioral Therapy; CPT: Conventional Physical Therapy; F = Female; GSE: General Strengthening Exercise; M = Male; MT: Manual Therapy; NPRS: Numeric Pain Rating Scale; NPS: Neck Pain Intensity; NRS: Numeric Rating Scale; VAS: Visual Analogue Scale.

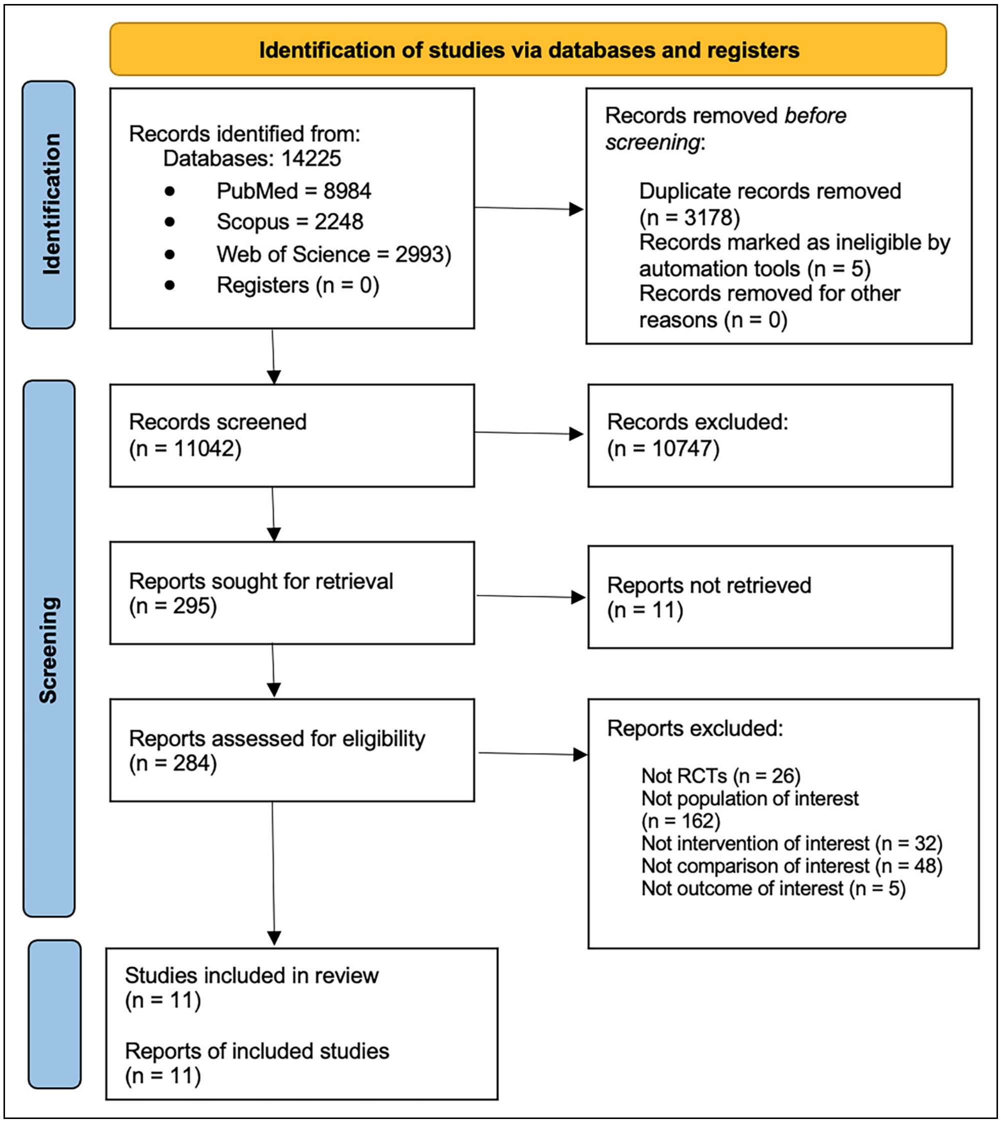

Figure 1. PRISMA flow diagram.

allocated in the intervention group and 329 were included in the control group (undergoing waiting list, sham treatments, conventional physical therapy, or the physical therapy approaches considered as controls). Figure 2 reports the network plot of all studies. Study cohorts of the RCTs included from 18[50] to 102[46] patients, with a mean age ranging from 20.07 years[52] to 59 years.[50] Five RCTs[46,47,50,51,54] investigated the efficacy of TE and MT, three studies[52,53,55] investigated the efficacy of TE in combination with a cognitive behavioral therapy, three RCTs[46,49,50] assessed TE as a single treatment for CNSNP. With reference to the follow-up evaluations, the times were different: two RCTs[51,52] performed a follow-up at 3 months, one RCT[45] performed a follow-up at 1 and 3 months from the first session, one[47] at 15 days, one[49] at 2 months, and one[53] at 12 months. Table 3 summarizes the main characteristics of all the RCTs included in this systematic review.

Therapeutic exercise and manual therapy

Five RCTs[46,47,50,51,54] investigated the efficacy of TE and MT in chronic neck pain. Recently, Celenay et al.[46] have demonstrated no differences between MT in association with TE (3.8 ± 2.5 vs 1.7 ± 1.5) and MT alone (4.0 ± 2.9 vs 2.4 ± 2.2; $p = 0.33$) on VAS. Groisman et al.[47] investigated the effect of MT and TE vs TE alone, showing that the intervention group experienced a greater pain reduction (5.7 ± 0.2 vs 2.3 ± 0.2) than the control group at the end of the treatment (5.5 ± 0.2 vs 3.6 ± 0.4; $p = 0.007$; $d = 0.8$). Moreover, Lee et al.[50] reported a decrease in pain intensity on a-10 cm VAS in favor of TE plus MT (4.9 ± 0.3 vs 1.4 ± 0.5) compared to

Table 3. Ranking table. Relative treatment effects in ranked order for all studies.

TEplusMT	−0.50 [−1.78; 0.78]	.	.	−1.53 [−1.88; −1.17]	.
−0.50 [−1.78; 0.78]	MT	.	.	.	.
−0.60 [−1.48; 0.29]	−0.10 [−1.65; 1.46]	TEplusCBT	.	−0.93 [−1.75; −0.12]	.
−1.14 [−2.27; −0.01]	−0.64 [−2.35; 1.06]	−0.55 [−1.89; 0.80]	CPT	−0.39 [−1.46; 0.68]	.
−1.53 [−1.88; −1.17]	−1.03 [−2.36; 0.30]	−0.93 [−1.75; −0.12]	−0.39 [−1.46; 0.68]	TE	−1.10 [−1.74; −0.46]
−2.63 [−3.36; −1.90]	−2.13 [−3.60; −0.65]	−2.03 [−3.07; −1.00]	−1.49 [−2.74; −0.24]	−1.10 [−1.74; −0.46]	Nothing

TE alone after treatment (4.8 ± 0.4 vs 2.7 ± 0.5; p < 0.05). In 2012, Lin et al.[51] reported a significant difference in VAS scores between groups in favor of MT plus TE (5.79 ± 1.96 vs 2.06 ± 1.65) group compared with TE alone (5.63 ± 1.90 vs 4.04 ± 1.59) at the end of the treatment and at 3 months (2.07 ± 1.44 vs 4.54 ± 2.26; p < 0.001). Lastly, similar results have been found by Rodriguez Sanz et al.[54] The authors have compared the combination of TE and MT vs TE as a single treatment, showing a significant improvement in pain on a-100 mm VAS in the intervention group (33.62 ± 19.70 vs 16.05 ± 18.6) compared to the control group (33.62 ± 19.70 vs 16.0 ± 18.6; p < 0.001, d = 1.01).

Therapeutic exercise and cognitive behavioral therapy

Three studies[52,53,55] have investigated the efficacy of TE in combination with a CBT for treatment of CNSNP. Matias et al.[52] indicated no differences between TE and CBT (4.0 ± 2.3 vs 3.0 ± 2.3) and TE alone (4.3 ± 2.9–3.1 ± 2.3) at the end of the treatment at VAS score (p > 0.05) and at three months (3.4 ± 2.3 vs 3.6 ± 2.4; p > 0.05). Similar results were found by Monticone et al.[53] The authors reported no significant differences between the combination of TE and CBT (4.84 ± 2.72 vs 2.32 ± 2.34 vs 2.83 ± 2.14) and TE alone (5.50 ± 2.69 vs 3.78 ± 2.30 vs 4.04 ± 2.11) at any time of evaluation (p > 0.05). On the other hand, Thompson et al.[55] demonstrated that TE plus CBT (5.9 ± 2.1 vs 3.7) was more effective compared to TE alone (5.4 ± 2.1 vs 4.4) on a 0–10 VAS after the treatment (p = 0.04).

Therapeutic exercise (alone)

Three RCTs[45,48,49] assessed TE as a single treatment for CNSNP. Aydoğmuş et al.[45] compared the effect of TE vs conventional physical therapy, showing a pain reduction in the intervention group at any time of evaluation (6.0 ± 1.9 vs 4.2 ± 1.7 vs 3.3 ± 1.9 vs 3.4 ± 1.8; p < 0.001). On the other hand, no differences between groups in VAS after pain treatment and at 1 and 3-month follow-up were found (7.2 ± 1.2 vs 4.8 ± 1.8 vs 4.0 ± 1.4 vs 4.4 ± 1.9; p > 0.005). Recently, Hernandez Lucas et al.[48] investigated the efficacy of TE on pain reduction in patients with CNSNP. The authors claimed that TE was more effective than no treatment in reducing pain on a 100 mm VAS (50 ± 9.7 10 ± 7.3 vs 49.7 ± 10.7 21 ± 13; p < 0.001). Kim et al.[49] reported a significant difference in neck pain between TE (5.2 ± 2.1 vs 3.5 ± 2.0 vs 1.7 ± 1.8, p < 0.05) and CPT (5.1 ± 2.7 vs 3.8 ± 2.0 vs 3.1 ± 1.9) at 4 weeks post-treatment (p < 0.05).

Network meta-analysis

This systematic review with NMA aimed to systematically assess the effects of different techniques of physical therapy in patients with CNSNP. When two interventions are linked, at least with a RCT, we could provide direct evidence for the comparison of the two treatments; however, through a network of similar interventions, we could also allow the combined effects (direct and indirect) to be analyzed, as shown in Figure 3.

Moreover, we considered the group not subjected to the intervention as the control reference of the network, comparing each intervention included, by reformulating a pairwise forest plot, as described in Figure 3.

Therefore, we ranked all the interventions in a net league table, and the treatments were ranked from best to worst along the leading diagonal, as depicted in Table 3. Above the leading diagonal are estimates from pairwise meta-analyses, below the leading diagonal are estimates from NMA.

Moreover, we performed a SUCRA analysis for pain scores to indirectly identify the best therapeutic option for CNSNP.[56] According to the results of this analysis, TE plus MT demonstrated the highest probability of being the best choice available (91% probability), followed by MT alone (68%) and TE plus CBT (65%), as depicted in Figure 4.

The estimates from direct and indirect evidence showed little evidence of inconsistency, as indicated by p-values p > 0.05, as depicted in Figure 5. The plot provided each data points' contribution to the residual deviance for the NMA with consistency (horizontal axis) and the unrelated mean effects (UME) inconsistency models (vertical axis) along with the line of equality. The points on the equality line convey no improvement in model fit when using the inconsistency model, suggesting no evidence of inconsistency. Points above the equality line represent minor residual deviance for the consistency model, indicating a better fit in the NMA consistency model. Points below the equality line mean they have a better fit in the UME inconsistency model.

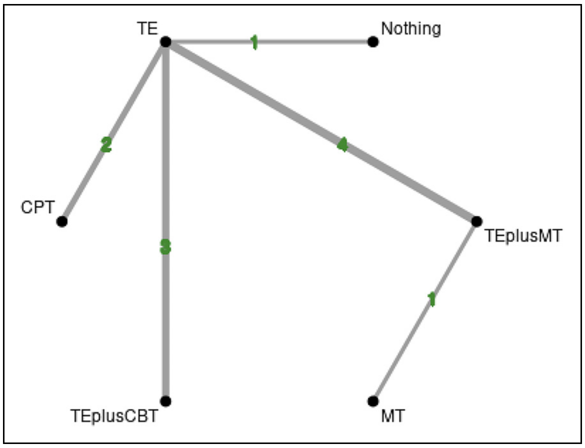

Figure 2. Network plot of all studies.

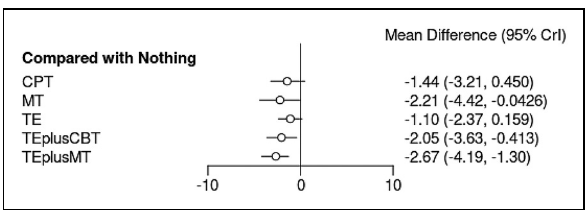

Figure 3. Bayesian random effect consistency model forest plot results.

Risk of bias

According to the above-mentioned RoB 2,[40] the risk of bias among the RCTs analyzed was estimated. With regard to single domain bias, 8 studies (73%) ensured a correct randomization, 5 RCTs (45%) ensured a correct patient and cares blindness, 8 studies ensured (73%) a correct outcome bias, 8 studies (73%) provided guarantees in terms of outcome measurement, and 10 studies (91%) adequately assessed the selection bias. Overall, 3 (27.2%) showed a low risk of bias, 6 (54.5%) showed some concerns in bias assessment, and 2 (19%) a high risk of bias (see Figure 6).

Discussion

This systematic review of RCTs aimed to evaluate the efficacy of different techniques of physical therapy in patients with chronic non-specific neck pain. Interestingly, this study highlighted that different physical therapy approaches have been proposed in the current literature, including TE, MT, and conventional physical therapy. A NMA was performed to assess the efficacy of different physical therapy approaches for treatment of CNSNP, reporting that all conservative approaches showed a reduction of pain intensity against no intervention. More specifically, there was a decrease of pain intensity after the combination of TE and

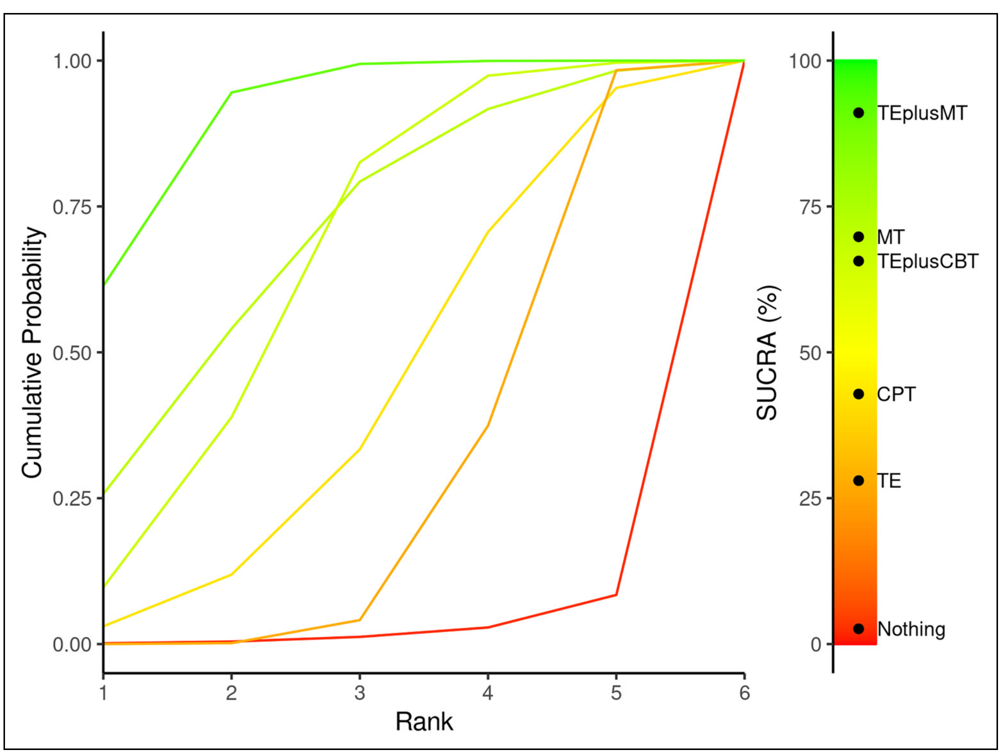

Figure 4. SUCRA analysis.

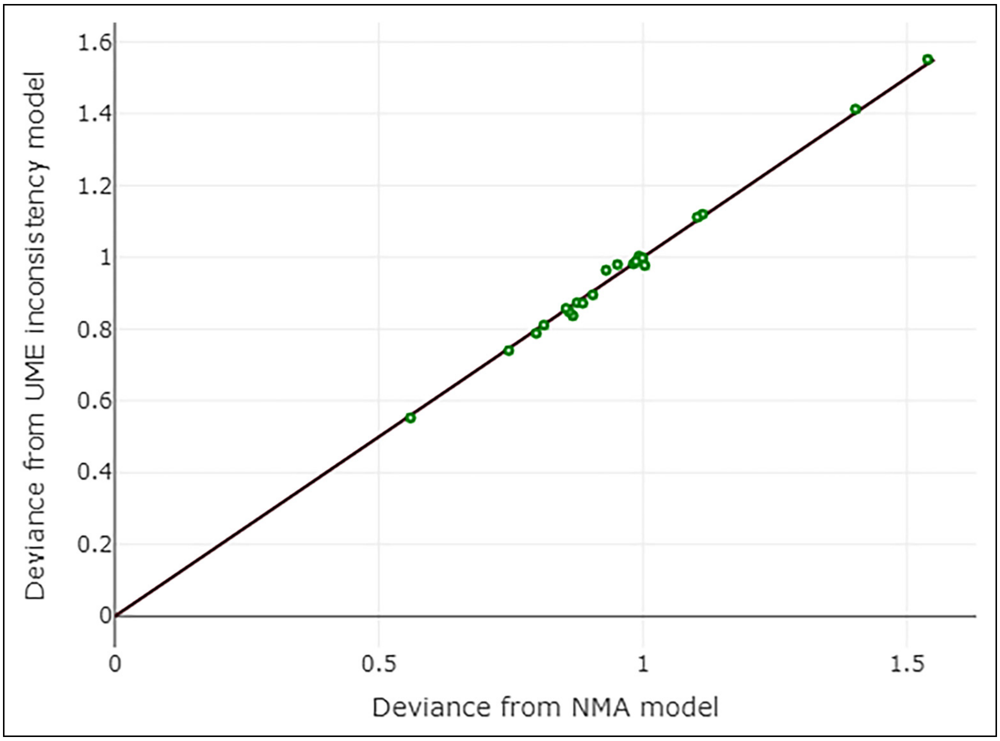

Figure 5. Deviance report plot for residual deviance from NMA model and UME inconsistency model.

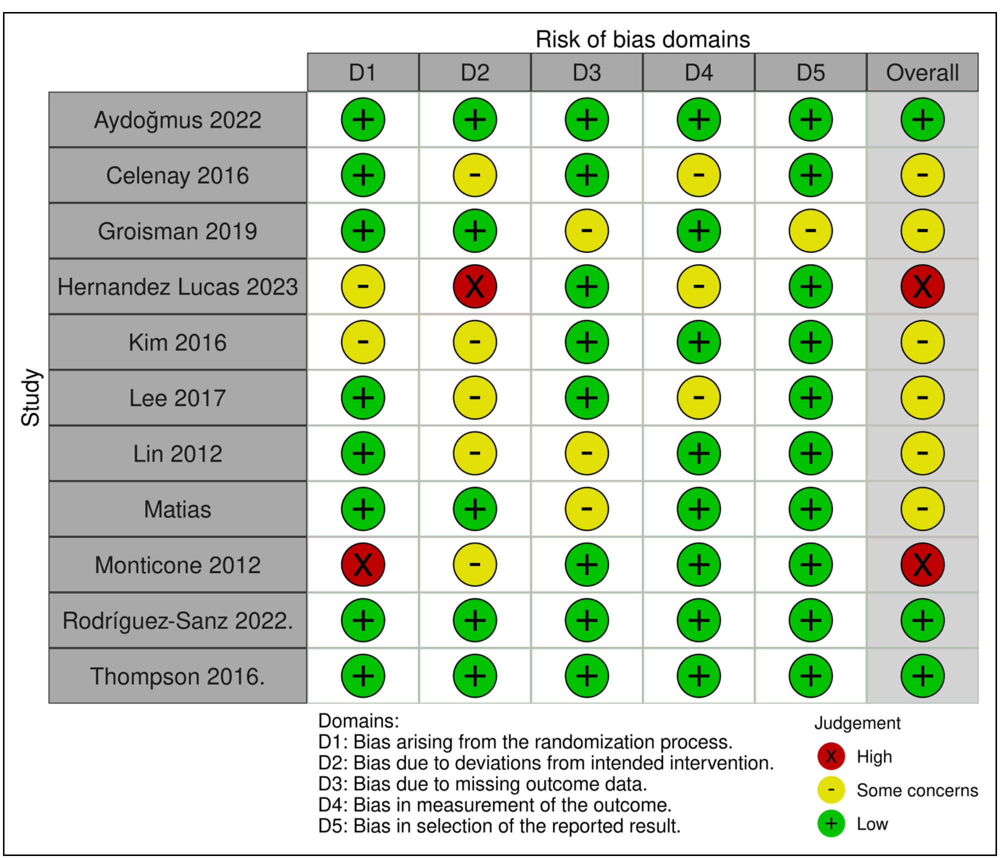

Figure 6. Risk of bias according to RoB 2.

MT [−2.67 (−4.19, −1.30)], MT as a single treatment [−2.21 (−4.42, −0.0426], combination of TE and CBT [−2.05 (−3.63, −0.413], CPT [−1.44 (−3.21, −0.450], and TE as a single treatment [−1.10 (−2.37, −0.159]. Moreover, the combination of TE and MT demonstrated 91% of probability to be the best choice for patients with CNSNP at the first visit, followed by MT alone and combination of TE and CBT with similar probability (68% and 61%, respectively). Also, it is worth noting that a recent study upholds that the combination of TE plus MT/CBT and MT as a single treatment shows a reduction in pain score above of the minimum clinically important difference in CNSNP (≤1.5 in 0–10 pain score) [52]. Notwithstanding the high incidence of this disorder, the existing rehabilitative approaches are highly variable, and we have only highlighted the most common physical therapy techniques in the clinical practice. Our results are in line with a review of 2017 that did not provide evidence for the superiority of one physical exercise approach in different chronic musculoskeletal pain conditions, including neck pain.[57] On the other hand, several RCTs have demonstrated that a specific exercise program was more effective than only non-specific exercise in a population of patients with CNSNP, not only in terms of pain relief, but also in terms of disability and quality of life.[59–61] Moreover, the combination of different specific approaches may exert a better effect on reducing pain than single or generic approaches.[62] However, there is lack of specificity of the type of exercise, which could be related to the multiple and widespread mechanisms by which exercise works to reduce pain.[63] Although this aspect is not the topic and scope of this systematic review, we would like to elucidate the mechanisms underlying our findings.[64] In our review, we have not detected the superiority of a specific exercise type, and the reason may reside in psychological and/or neurophysiological factors, which are common to all exercise approaches providing beneficial effects on pain.[65] For these empirical reasons, we assume that the addition of CBT (or pain education) can empower the effect and efficacy of the several physical therapy approaches. Our findings are also in line with previous studies involving short CBT-based multidisciplinary interventions, suggesting that treatment of chronic pain requires cognitive modifications closely linked to physical performances in order to achieve effective mental adjustments and guarantee lasting changes.[66,67] Recently, McGirt et al. have showed improvements in different aspects, including pain, anxiety, depression and quality of life in patients with chronic pain, through the adoption of cognitive-behavioral modifications, confirming the need for a comprehensive approach (including new rehabilitative technology), in order to consolidate functional outcomes over time and ensure return to previously fear-avoided activities.[68] If changes in pain and disability occur independent of changes in physical function, then specific modalities of exercises and their dosage may be less relevant in chronic musculoskeletal pain.[57,64] Moreover, it would be desirable to speculate that exercise can exert a desensitization effect of the central nervous system. This hypothesis has recently been supported by several studies based on the current evidence of the central mechanisms underlying exercise-induced pain and analgesia.[69–71] A physical exercise program might elicit a change in various factors and subsequent behaviors; all this can contribute to the overall reduction in back-pain-related disability, also due to fragility fractures.[72,73] On the other hand, the lack of trials investigating the effects of different physical therapy approaches indicates a knowledge gap in literature, where studies on these comparisons are either lacking or include other therapeutic approaches.[74,75] By the way, it is important to stress that all trials in this review have been published since 2010 (according to our inclusion criteria) to only include studies performed with a recent and rigorous methodology. Despite this, more knowledge on this topic could provide practitioners with great advice in their clinical decision-making.[76–78]

This systematic review with NMA is not free from limitations, though. First of all, the low number of studies selected can be a limitation in the meta-analysis and its robustness; second, there are concerns about the risk of bias in all domains, considering that the risk of bias was low-moderate, reporting uncertain results; third, the different time of treatment of the several approaches could have influenced the results; fourth, we did not separate no treatment/waiting list from sham/placebo interventions because too few studies reported a no-intervention or waiting-list control to allow the analyses. Overall, while NMA is an attractive statistical tool, this review emphasizes that the limitations of the evidence base (e.g., trials with small samples, high risk of bias, poor reporting, risk of bias due to missing evidence) may hamper its applicability. In this context, it should be taken into consideration the quality and quantity of primary studies and heterogeneity that we found in our NMA. Lastly, a higher study homogeneity would be desirable in the next future to draw clear conclusions on the use of physical therapy and rehabilitation for treatment of CNSNP, especially in the clinical practice.

Conclusions

The findings of this systematic review collectively showed that MT, TE, and CBT might be considered as effective rehabilitative approaches for pain relief in patients with CNSNP. However, the low quality of the included RCTs should be highlighted, if we consider the difficulties in promoting the scientific literature in this field. Further studies are required to improve knowledge on the effectiveness of MT and physiotherapy as conservative treatment for pain relief in patients with CNSNP.

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Statements and declarations

Author contributions

Study design and conceptualization: DC and AdS; Search strategy: DC, NM, and AdS; Databases searching: DC, NM, and AdS; Data screening: DC, NM, and RZ; Data extraction: DC, NM, and UGL; Data synthesis and interpretation: DC, NM, and MV; Statistical analysis: NM; Manuscript drafting: DC, NM, and UGL; Critical revision: MI, AA, AdS; Visualization: MV, RZ, LL, and FF; Study supervision: AdS. All authors read and approved the final manuscript.

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Data availability statement

The dataset is available from the corresponding author on reasonable request.

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