Medicine®

OPEN

Effects of yoga on patients with chronic nonspecific neck pain
A PRISMA systematic review and meta-analysis

Yunxia Li, MSc, RN[a,b], Siyuan Li, BS[c], Jieqiong Jiang, BS, RN[d], Sue Yuan, PhD, RN[a,b,*]

Abstract

Background: Chronic nonspecific neck pain (CNNP) has a high prevalence and is more common among younger people. Clinical practice suggests that yoga is effective in relieving chronic pain.

Objectives: This meta-analysis aimed to quantitatively summarize the efficacy of yoga for treating CNNP.

Data sources: We searched for trials in the electronic databases from their inception to January 2019. English databases including PubMed, MEDLINE, Cochrane Library, Embase, Scopus, the Cochrane Central Register of Controlled Trials, and Ind Med; Chinese databases including China National Knowledge Infrastructure (CNKI), WanFang Database, and VIP Information. We also conducted a manual search of key journals and the reference lists of eligible papers to identify any potentially relevant studies we may have missed. We placed no limitations on language or date of publication.

Study eligibility criteria: We included only randomized controlled trials (RCTs) and q-RCTs evaluating the effects of yoga on patients with CNNP. The primary outcomes for this review were pain and disability, and the secondary outcomes were cervical range of motion (CROM), quality of life (QoL), and mood.

Participants and interventions: Trails that examined the clinical outcomes of yoga intervention in adults with CNNP compared with those of other therapies except yoga (e.g., exercise, pilates, usual care, et al) were included.

Study appraisal and synthesis methods: Cochrane risk-of-bias criteria were used to assess the methodological quality, and RevMan 5.3 software was used to conduct the meta-analysis.

Results: A total of 10 trials (n=686) comparing yoga and interventions other than yoga were included in the meta-analysis. The results show that yoga had a positive effects on neck pain intensity (total effect: SMD=-1.13, 95% CI [-1.60, -0.66], Z=4.75, $P < .00001$), neck pain-related functional disability (total effect: SMD=-0.92, 95% CI [-1.38, -0.47], Z=3.95, $P < .0001$), CROM (total effect: SMD=1.22, 95% CI [0.87, 1.57], Z=6.83, $P < .00001$), QoL (total effect: MD=3.46, 95% CI [0.75, 6.16], Z=2.51, $P = .01$), and mood (total effect: SMD=-0.61, 95% CI [-0.95, -0.27], Z=3.53, $P = .0004$).

Conclusions and implications of key findings: It was difficult to make a comprehensive summary of all the evidence due to the different session and duration of the yoga interventions, and the different outcome measurement tools in the study, we draw a very cautious conclusion that yoga can relieve neck pain intensity, improve pain-related function disability, increase CROM, improve QoL, and boost mood. This suggests that yoga might be an important alternative in the treatment of CNNP.

Systematic review registration number: Details of the protocol for this systematic review and meta-analysis were registered on PROSPERO and can be accessed at www.crd.york.ac.uk/PROSPERO/display_record.asp?ID=CRD42018108992.

Abbreviations: 95% CI = 95% confidence interval, CAM = complementary and alternative medicine, CNKI = China National Knowledge Infrastructure, CNNP = chronic nonspecific neck pain, CROM = cervical range of motion, M = mean, MeSH = medical subject headings, MSRT = mind sound resonance technique, QoL = quality of life, q-RCTs = quasi-randomized controlled trails, RCTs = randomized controlled trails, SD = standard deviation.

Keywords: chronic, meta-analysis, musculoskeletal, neck pain, nonspecific, systematic review, yoga

1. Introduction

Chronic nonspecific neck pain (CNNP) is a widespread public health problem the modern world,[1] with a reported prevalence of 50% lifetime prevalence[2] and more and more frequent in adolescence.[3] CNNP is considered as persistent neck pain or severe discomfort in the neck for over 3 months,[4] which is caused by poor posture and mechanical and degenerative changes, excluding pain from neck cancer, infections fasciitis, or other areas of the body.[5] The 2018 Burden of Disease Report reported that CNNP was the sixth leading cause of disability in the United States of America in 2016,[6] and contributes to higher costs due to loss of productivity, disability, and increased absenteeism from work, resulting in $77.2 billion in annual medical expenses.[7]

Treatment methods for this chronic health condition are mainly drugs, surgery, and conservative therapies including exercise and acupuncture. There are more specific studies on *tuina*, acupuncture, and manipulation treatments, but the best conservative method is yet to be determined. In recent years, yoga has been recommended as a complementary and integrative medicine therapy for alleviation of various types of pain, including neck-related pain.[8–12]

Rooted in India, yoga has been populated in worldwide, combining physical postures (asana), breathing techniques (pranayama), and meditation (dyana)[13] to promote physical and mental well-being. A variety of different yoga styles have emerged that put varying levels of focus on physical and mental practices.[14] Yoga styles, such as Iyengar yoga and Ashtanga yoga, strongly focus on physical postures, while Kriya yoga, rely on meditation or breathing techniques.[15] In clinical research, all styles seem to be more or less equally effective.[16]

At present, there are a lot of studies have evaluated the efficacy of yoga for neck pain. Whereas the results of most studies are inconsistent.[17–26] So conducting a meta-analysis to explore the synthetical effects seems to be necessary. Only one meta-analysis[15] was found in databases up to now, which concluded that yoga has short-term effects on chronic neck pain, which only searched English-language databases and included 3 eligible studies, resulting in a relatively limited overall sample size. Therefore, the aim of this study was to systematically review published trails, and try to conduct a meta-analysis through a multiple literature search, which may including a larger sample size to investigate the potential effects of yoga on patients with CNNP if there were sufficient studies.

2. Methods

Details of the protocol for this systematic review and meta-analysis was registered on PROSPERO and can be accessed at www.crd.york. ac.uk/PROSPERO/display_record.asp?ID=CRD42018108992. This study was conducted according to the PRISMA statement.[27]

2.1. Ethics statement

As all analyses were based on previously published studies, no ethical approval or patient consent was required.

2.2. Literature search strategies

To identify eligible studies, multiple search strategies, of electronic databases were conducted from their inception to January 2019. English databases including PubMed, Medline, Cochrane Library, Embase, Scopus, the Cochrane Central Register of Controlled Trials, and IndMed. Chinese databases including China National Knowledge Infrastructure (CNKI), WanFang Database, and VIP Information. We also conducted a manual search of key journals: *Journal of Yoga & Physical Therapy* established by USA, Europe, and Asia, as well as *International Journal of Yoga* established by India. Various combinations of Medical Subject Headings (MeSH) and non-MeSH terms were used: "neck pain" OR "chronic neck pain" OR "chronic nonspecific neck pain" OR "neck syndrome" OR "Myofascial Pain Syndrome of neck," AND "yoga" OR "yog" OR "yogic mind sound resonance technique (MSRT)" OR "meditation." Neck pain was defined as cervical spondylosis in Chinese, the same terms in Chinese databases were searched as well. Additionally, reference lists of identified original articles or reviews were also manually searched. We searched the literature without restriction to language and region. Studies were only eligible if they were published as a full article. The main search was screened independently by 2 review authors, and disagreements were resolved by a third author through discussion.

2.3. Criteria for study inclusion and exclusion

Randomized controlled trials (RCTs) and quasi-randomized controlled trials (q-RCTs) that examined the clinical outcomes of yoga intervention in adults with CNNP compared with those of other therapies except yoga (e.g., exercise, pilates, usual care, et al) were included. CNNP may include some people with a traumatic basis for their symptoms, but does not include people for whom pain is specifically stated to have followed sudden acceleration–deceleration injuries to the neck (whiplash).[28] Yoga intervention was required to include any types of yoga, no matter of physical postures, breathing techniques, meditation, or combination one or more of them. Studies on multimodal interventions that include yoga among others were excluded, and studies which reported the data that could not provide or change to the quantitative data such as mean (M), standard deviation (SD), and 95% confidence interval (95% CI) were also excluded.

2.4. Methods of study selection and data extraction

Searches on the aforementioned databases were conducted independently by 2 reviewers. Duplications were removed first by using a document manager (Endnote), and then the titles and abstracts of the obtained articles were scanned. If these initially satisfied the selection criteria, the full articles were reviewed to identified the potential studies. Information from the selected studies were independently extracted by 2 reviewers by using a data extraction form, including first author, publication year, region, design, sample size, age of study participants, comparison, program length, main outcomes and measurements, measure time, and author conclusion. Any disagreements were discussed with a third reviewer and resolved by consensus.

2.5. Quality assessment

The risk of bias of included studies was assessed by using an assessment tool, the "Cochrane Handbook for Systematic Reviews of Interventions version 5.1.0" (updated in 2011 by the Cochrane Organization)[29] by 2 reviewers subjectively. The assessment tool covers 7 domains: random sequence generation (selection bias), allocation concealment (selection bias), blinding of participants and personnel (performance bias), blinding of outcome assessment (detection bias), incomplete outcome data (attrition bias), selective reporting (reporting bias), and other

biases. Bias were assessed as "low risk," "high risk," or "unclear risk." Discrepancies were resolved through discussion and settled by a third reviewer.

2.6. Outcome measures

The primary outcomes of this study were the intensity of neck pain and disability associated with the neck, because these 2 parameters were the most common indicators of clinical outcomes in neck pain. The secondary outcomes were cervical range of motion (CROM), quality of life (QoL), and emotional state, which were also considered important for recovery of CNNP.

2.7. Statistical analyses

The statistical analyses software, Revman 5.3, was used to conduct this meta-analysis. Differences in M, SD, sample size, with 95% CI were measured to compare the yoga group with control group to investigate the changes in neck pain intensity, disability, CROM, QoL, and emotional states. Statistical heterogeneity between studies was tested using I^2 statistics, which presented the percentage of the total variability among the studies that was caused by heterogeneity rather than chance.[30] The percentages of I^2 around 25%, 50%, and 75% indicate low, medium, and high heterogeneity, respectively.[29] The χ^2 test was used to assess whether differences in results were compatible with chance alone, a P-value $\leq.10$ was considered to indicate significant heterogeneity. If $P>.10$ and $I^2<50\%$, statistical heterogeneity was perceived to be acceptable and a fixed effects model was used to conduct the meta-analysis; otherwise, if $P\leq.10$ and $I^2\geq50\%$, statistical heterogeneity was perceived to be relatively high and a random effects model was used to perform the meta-analysis. Subgroup analysis and sensitivity analysis were further conducted to explore the source of such heteroge-

neity. If $P\geq10$ studies with the same outcome were included, a funnel plot was used to assess publication bias of the included studies.

3. Results

3.1. Study selection

A total of 347 studies were identified via a multiple search strategy of electronic databases. Of these 297 were excluded because of duplication, or because they did not meet our inclusion criteria after going through the titles and abstracts. After reading the full text of the remaining 50 studies, 10 studies[17–26] including 686 cases were included in the quantitative synthesis and meta-analysis (Fig. 1).

3.2. Characteristics of eligible studies

The basic characteristics of these 10 studies were represented in Table 1, including 2 q-RCT[19,21] and 8 RCT.[17–18,20,22–26] These articles were from Turkey,[17] India,[18,26] Korea,[19] Sweden,[20] United States,[21] Germany,[22,24,25] and China,[20] were published between 2010 and 2018, cover 686 patients, and sample sizes ranging from 38 to 159. All the studies involved yoga intervention, including both exercise-based and meditation-based, and the program length ranging from 10 days to 12 weeks. Almost all of the studies measured neck pain intensity and associated disability.

3.3. Quality assessment

Fig. 2A presents the quality of the each trials included in this review, and Fig. 2B summarizes the quality of all included studies. As shown in Fig. 2B, all 8 RCTs[17–18,20,22–26] mentioned the method of "random," of which, 6[17,20,22,24–26]
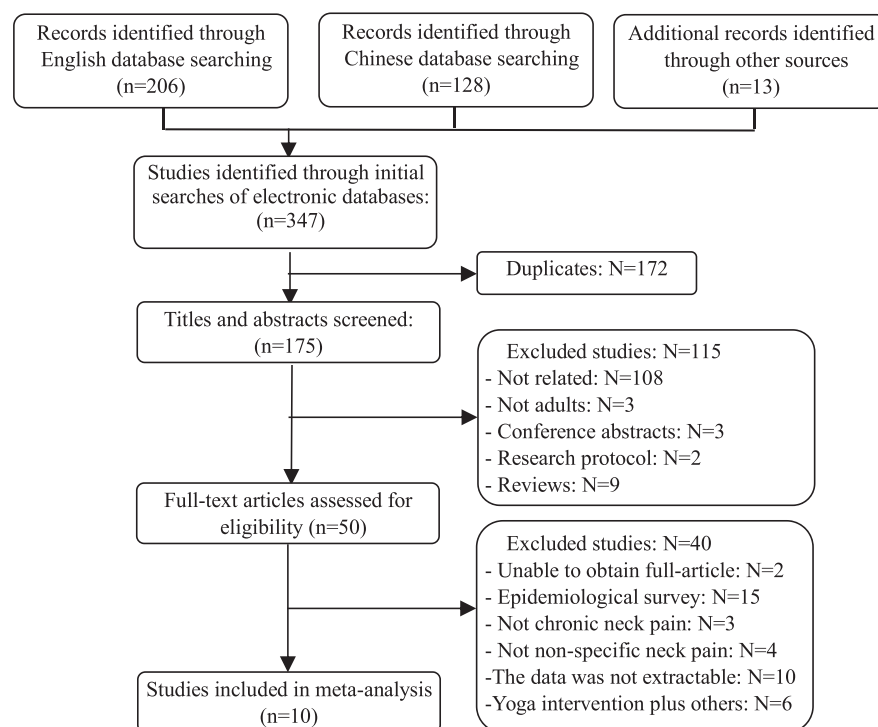

**Figure 1.** Flow diagram of studies identified, included and excluded.

Table 1

Characteristics of the included studies.

| Study, year	Region	Design	Sample size (age)	Comparison	Program length	Main Outcomes and measurements	Measure time	Author conclusion
N. Uluğ 2018[17]	Turkey	RCT	56 (18–50)	Yoga Pilates Isometric exercise	6 W	1. The thickness and cross sectional area of neck muscles-ultrasound imaging 2. CROM 3. Pain severity- SF-MPQ 4. Disability-NDI 5. Quality of life-NHP 6. Depression-BDI	1. Baseline 2. After treatment	All 3 types of exercise had favorable effects on pain and functional scores, but no differences were found among the groups
Rajalaxmi V 2018[18]	India	RCT	40 (35–55)	Yogasanas Pilates Tai Chi Isometric exercise	3 W	1. NPQ 2. TSK	1. Pre-test 2. post-test	Yoga is more effective than the Pilates and Tai chi and control group exercise for chronic mechanical neck pain
Sang Dol Kim 2018[19]	Korea	q-RCT	38 (20.8±1.2/ 21.1±1.2)	Yoga Exercise	8 W	Neck pain-100mmVASP	1. Baseline 2. 8W	These findings indicate that yogic exercises could reduce neck pain in university students
Elisabeth 2017[20]	Sweden	RCT	159 (46.9±9.6/ 46.3±9.3/ 43.9±11.7)	kundalini yoga Strength training evidence-based advice	6 W	1. Sickness absenteeism and presenteeism - SMS 2. Pain and disability-CPGS	1. Baseline, 2. 6 W, 3. 6 M 4. 12 M	Kundalini yoga or strength training does not reduce sickness absenteeism more than evidence-based advice alone
Dunleavy 2016[21]	USA	q-RCT	56 (55.6±9.0)	Yoga Pilates Exercise	12 W	1. Disability-NDI 2. Pain ratings-NRS 3. Range of movement-ROM 4. Postural measurements	1. baseline 2. 6 W 3. 12 W 4. 18 W	Pilates and yoga group exercise interventions with appropriate modifications and supervision were safe and equally effective for decreasing disability and pain compared with the control group for individuals with mild- to-moderate CNP.
Michael Jeitler 2015[22]	Germany	RCT	89 (49.7±10.5)	Jyoti meditation home-based exercise	8 W	1. Pain-100 mm VAS 2. Pain at motion-VAS 3. Functional disability-NPDQ 4. Bothersomeness 5. Perceived stress-CPSS 6. Quality of life-SF-36 7. Depression-CES-D 8. Anxiety-STAI	1. baseline 2. 4W 3. 8W	Meditation may support chronic pain patients in pain reduction and pain coping
Chong yuping 2014[23]	China	RCT	60 (38.87±10.41)	Hatha Yoga warm acupuncture	8 W	1. Pain-VAS 2. Disability-NPQ 3. CROM	1. baseline 2. 8W 3. 6 M after therapy	Both Hatha Yoga exercise and warm acupuncture can relieve pain in CNP patients. Hatha Yoga is better than warm acupuncture
Cramer 2013[24]	Germany	RCT	51 (47.8)	Yoga Exercise	9 W	1. Neck pain-100mmVAS 2. Functional disability-NDI 3. Pain at motion-VAS 4. Quality of life-SF-36 5. CROM 6. Proprioceptive acuity-JPE 7. Pressure pain threshold -PPT	1. baseline 2. 9W	Yoga was more effective in relieving chronic nonspecific neck pain than a home-based exercise program
Michalsen 2012[25]	Germany	RCT	77 (47.9±7.9)	Iyengar yoga Exercise	10 W	1. Pain at rest-100 mm VAS 2. Pain at motion-100 mm VAS 3. Functional disability - NDI, NPDS 4. Quality of life-SF-36 5. Psychological outcomes - CES-D, POMS	1. baseline 2. 4W 3. 10W	Yoga appears to be an effective treatment in chronic neck pain with possible additional effects on psychological well-being and quality of life
Yogitha 2010[26]	India	RCT	60 41.03±15.54 42.23±14.30	Physiotherapy + Yogic MSRT Physiotherapy + nonguided supine rest	10 D	1. Pain-VAS 2. Tenderness scoring key 3. Disability-NDS 4. CROM 5. Spinal flexibility 6. State and trait anxiety inventory-Y1 (STAI-Y1)	1. baseline 2. 10D	Yoga relaxation through MSRT adds significant complimentary benefits to conventional physiotherapy for CNP by reducing pain, tenderness, disability and state anxiety and providing improved flexibility

BDI = Beck Depression Inventory, CES-D = Center for Epidemiologic Studies Depression Scale, CNP = chronic neck pain, CPGS = chronic pain grade scale, CPSS = Cohen Perceived Stress Scale, CROM = cervical range of ,motion, D = day, JPE = joint position errors, M = month, MSRT = mind sound resonance technique, NDI = Neck Disability Index, NDS = Neck Disability Score, NHP = Nottingham Health Profile, NPDS = Neck Pain and Disability Scale, NPQ = Northwick Park Questionnaire, NRS = Numeric Rating Scale, PAS = pain analog scale, POMS = profile of mood states, PPT = pressure pain threshold, q-RCT = quasi-randomized controlled trials, RCT = randomized controlled trials, SF-36 = Medical Outcomes Study 36-Item-Short-Form, SF-MPQ = Short-Form McGill Pain Questionnaire, STAI = State-Trait Anxiety Inventory, STAI-Y1 = State Anxiety Inventory, TSK = Tampa Scale for Kinesiophobia, VAS = VASP = visual analog scale for pain, W = week.

clarified how the allocation sequence was randomly generated. Only 4[17,20–24,25] described allocation concealment. Because the practitioners and the participants were directly involved in the treatment, it was impossible for them to be blinded to their allocation. Nevertheless some trials were designed to be unknown for patient allocation to the outcome assessors, there were 4[17,18,20,23] and 5[17,18,20,23,24] reported the "blinding of participants and personnel" and "blinding of outcome assessment," respectively.
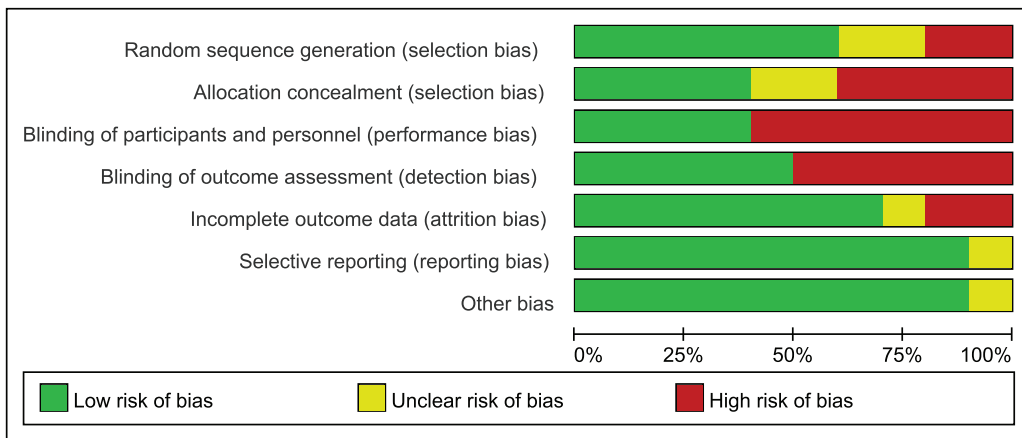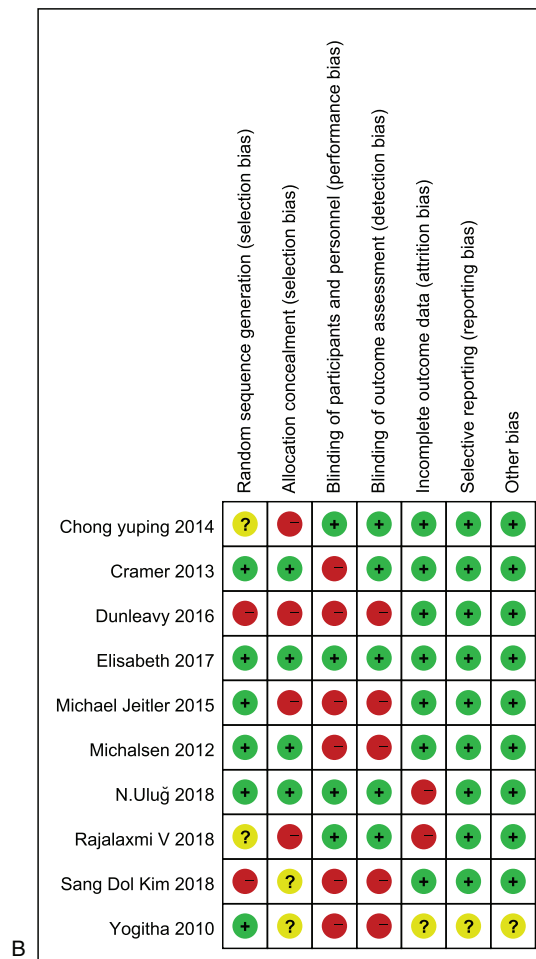
Figure 2. (A) Risk of bias graph. (B) Risk of bias summary.

3.4. Primary outcomes
3.4.1. Neck pain intensity. Pooling the data from 10 studies[17–26] that assessed neck pain intensity showed there were significant difference between the yoga and control groups (total effect: $SMD = -1.13$, 95% CI [-1.60, -0.66], $Z = 4.75$, $P < .00001$). In subgroup analysis, there were also significant difference between the yoga and exercise group (subtotal effect: $SMD = -1.26$, 95% CI [-1.83, -0.68], $Z = 4.31$, $P < .0001$); However, the effects between yoga and pilates group were not significant difference (subtotal

effect: $SMD = -0.18$, 95% CI [-0.76, 0.39], $Z = 0.63$, $P = .53$), either in yoga and complementary and alternative medicine (CAM) group (subtotal effect: $SMD = -2.4$, 95% CI [-5.26, 0.46], $Z = 1.65$, $P = .10$) (Fig. 3A).

3.4.2. Neck pain-related disability. The data from 8 trails[17,18,21–26] were pooled to find the effects of yoga on neck pain-related disability. As shown in Fig. 3B, the effects of yoga were superior to the control group (total effect: $SMD = -0.92$,

95% CI [−1.38, −0.47], Z=3.95, P<.0001). There were significant difference between the yoga and exercise group (subtotal effect: SMD=−0.97, 95% CI [−1.55, −0.38], Z=3.24, P=.001), but no significant difference were found in yoga compares pilates (subtotal effect: SMD=−0.27, 95% CI [−0.88, 0.35], Z=0.85, P=.39), and yoga compares CAM (subtotal effect: SMD=−2.31, 95% CI [−5.35, 0.73], Z=1.49, P=.14).

3.5. Secondary outcomes

3.5.1. CROM. Three studies[23,24,26] compared the CROM changes after treatment between yoga and control groups. The meta analysis found that all the total and subtotal overall effects were statistical significant differences for CROM (total effect: SMD=1.22, 95% CI [0.87, 1.57], Z=6.83, P<.00001), flexion (subtotal effect: SMD=1.46, 95% CI [0.44, 2.48], Z=2.79, P=.005), extension (subtotal effect: SMD=1.27, 95% CI [0.35, 2.20], Z=2.69, P=.007), left lateral flexion (subtotal effect: SMD=0.99, 95% CI [0.12, 1.87], Z=2.22, P=.03), right lateral flexion (subtotal effect: SMD=0.93, 95% CI [0.39, 1.47], Z=3.37, P=.0007), and left rotation (subtotal effect: SMD=1.37, 95% CI [0.09, 2.64], Z=2.10, P=.04), except right rotation (subtotal effect: SMD=1.24, 95% CI [−0.32, 2.80], Z=1.55, P=.12) (Fig. 4A).

3.5.2. QoL. Three studies[22,24,25] pooled the effects of yoga compares exercise for CNNP on QoL. As shown in Fig. 4B, the combined effect size showed a statistical significant difference (total effect: MD=3.46, 95% CI [0.75, 6.16], Z=2.51, P=.01). These 3 studies[22,24,25] stated that QoL improved in yoga group but no statistical significant difference in physical QoL in subgroup (subtotal effect: SMD=2.24, 95% CI [−2.15, 6.64], Z=1.00, P=.32), while significantly different in mental QoL (subtotal effect: SMD=4.82, 95% CI [1.96, 7.69], Z=3.30, P=.001).

3.5.3. Mood. Three studies[17,22,25] evaluated mood improvement and found statistical significance between the yoga and exercise (total effect: SMD=−0.61, 95% CI [−0.95, −0.27], Z=3.53, P=.0004) (Fig. 4C). Subgroup analysis shown that both depression and anxiety improved (subtotal effect: SMD=−0.63, 95% CI [−1.19, −0.07], Z=2.19, P=.03; subtotal effect: SMD=−0.59, 95% CI [−1.09, −0.08], Z=2.27, P=.02, respectively).

4. Discussion

4.1. Main findings

In this meta-analysis, 10 trails consisting of 686 participants were used to evaluate the effects of yoga and control for CNNP. According to the result, yoga had a positive effect on neck pain intensity, pain-related functional disability, CROM, QoL, and mood.
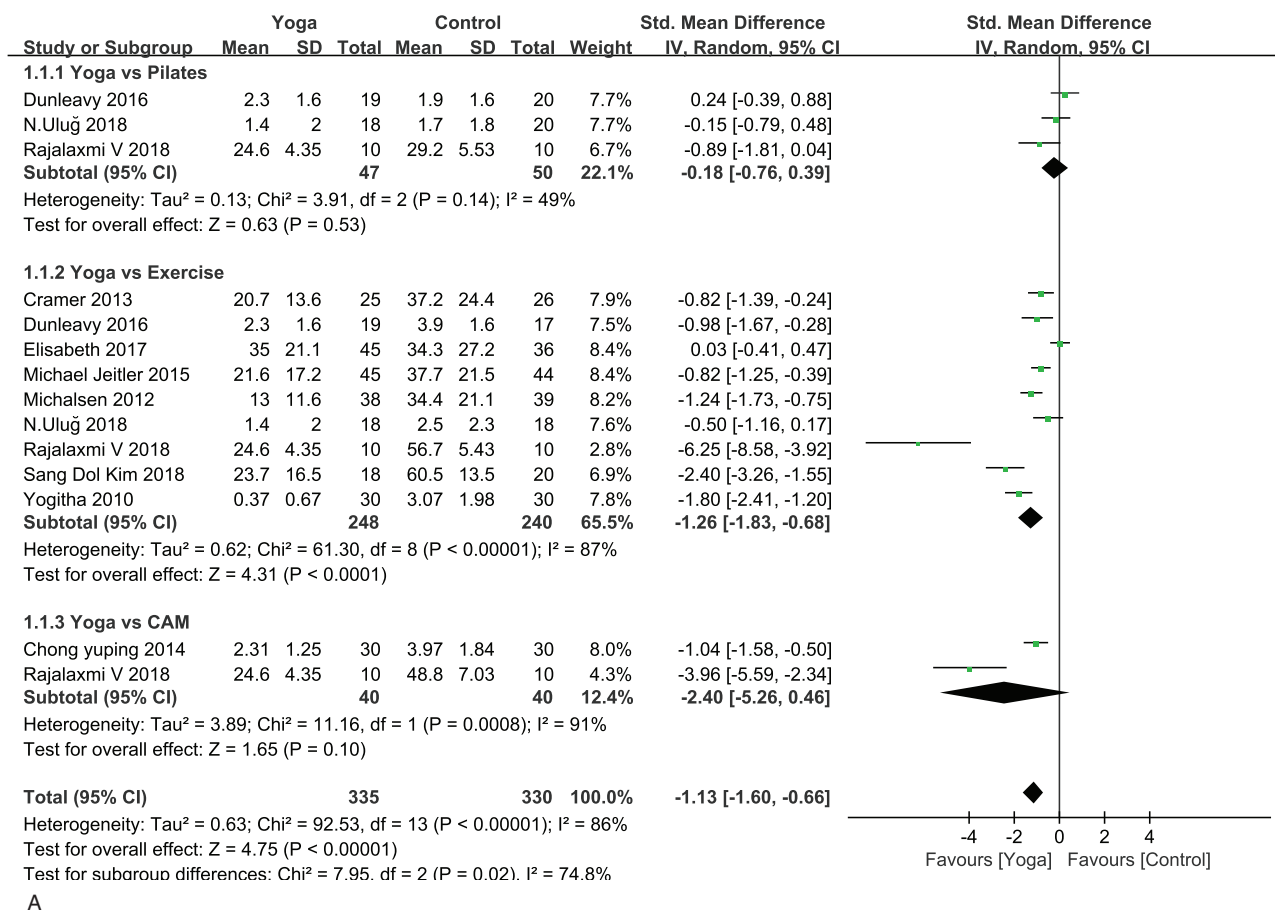

Figure 3. Primary outcomes. (A) The overall effects of yoga and control for neck pain intensity. (B) The overall effects of yoga and control for pain-related disability. CI=confidential interval, M=mean, SD=standard deviation, SMD=standard mean difference.
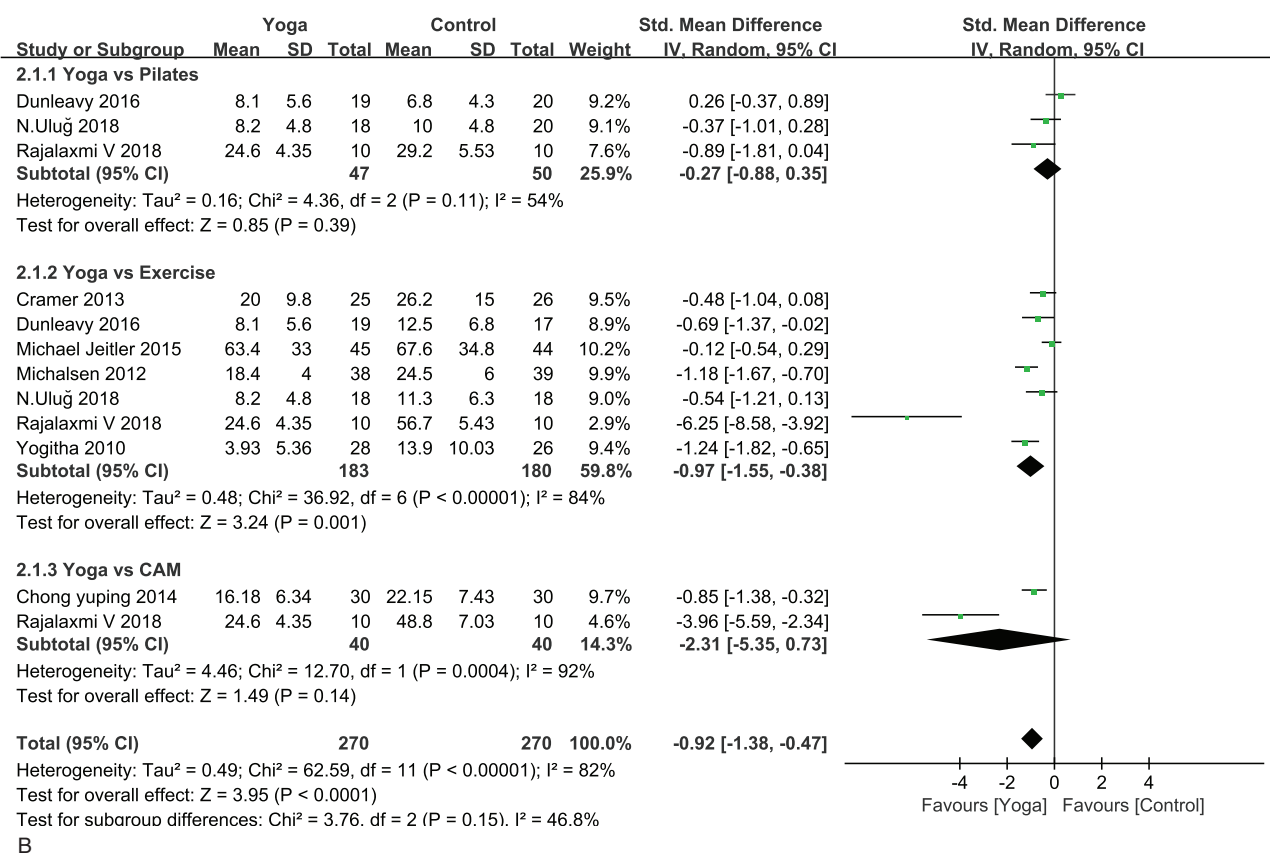
Study or Subgroup	Yoga Mean	SD	Total	Control Mean	SD	Total	Weight	Std. Mean Difference IV, Random, 95% CI
2.1.1 Yoga vs Pilates								
Dunleavy 2016	8.1	5.6	19	6.8	4.3	20	9.2%	0.26 [-0.37, 0.89]
N.Uluğ 2018	8.2	4.8	18	10	4.8	20	9.1%	-0.37 [-1.01, 0.28]
Rajalaxmi V 2018	24.6	4.35	10	29.2	5.53	10	7.6%	-0.89 [-1.81, 0.04]
Subtotal (95% CI)			47			50	25.9%	-0.27 [-0.88, 0.35]
Heterogeneity: Tau² = 0.16; Chi² = 4.36, df = 2 (P = 0.11); I² = 54%								
Test for overall effect: Z = 0.85 (P = 0.39)								
2.1.2 Yoga vs Exercise								
Cramer 2013	20	9.8	25	26.2	15	26	9.5%	-0.48 [-1.04, 0.08]
Dunleavy 2016	8.1	5.6	19	12.5	6.8	17	8.9%	-0.69 [-1.37, -0.02]
Michael Jeitler 2015	63.4	33	45	67.6	34.8	44	10.2%	-0.12 [-0.54, 0.29]
Michalsen 2012	18.4	4	38	24.5	6	39	9.9%	-1.18 [-1.67, -0.70]
N.Uluğ 2018	8.2	4.8	18	11.3	6.3	18	9.0%	-0.54 [-1.21, 0.13]
Rajalaxmi V 2018	24.6	4.35	10	56.7	5.43	10	2.9%	-6.25 [-8.58, -3.92]
Yogitha 2010	3.93	5.36	28	13.9	10.03	26	9.4%	-1.24 [-1.82, -0.65]
Subtotal (95% CI)			183			180	59.8%	-0.97 [-1.55, -0.38]
Heterogeneity: Tau² = 0.48; Chi² = 36.92, df = 6 (P < 0.00001); I² = 84%								
Test for overall effect: Z = 3.24 (P = 0.001)								
2.1.3 Yoga vs CAM								
Chong yuping 2014	16.18	6.34	30	22.15	7.43	30	9.7%	-0.85 [-1.38, -0.32]
Rajalaxmi V 2018	24.6	4.35	10	48.8	7.03	10	4.6%	-3.96 [-5.59, -2.34]
Subtotal (95% CI)			40			40	14.3%	-2.31 [-5.35, 0.73]
Heterogeneity: Tau² = 4.46; Chi² = 12.70, df = 1 (P = 0.0004); I² = 92%								
Test for overall effect: Z = 1.49 (P = 0.14)								
Total (95% CI)			270			270	100.0%	-0.92 [-1.38, -0.47]
Heterogeneity: Tau² = 0.49; Chi² = 62.59, df = 11 (P < 0.00001); I² = 82%								
Test for overall effect: Z = 3.95 (P < 0.0001)								
Test for subgroup differences: Chi² = 3.76, df = 2 (P = 0.15), I² = 46.8%								

B

-4　-2　0　2　4
Favours [Yoga]　Favours [Control]

Figure 3. (Continued).

The results of this review related to pain, disability, QoL, and mood are generally consistent with the previous review.[15] In this study, we grouping the control intervention as pilates, exercise, and CAM (including acupuncture and Tai Chi in this study). The results indicate that all the above outcomes improved in yoga group, and there were significant difference in neck pain intensity between yoga and exercise group, neck pain-related disability between yoga and exercise group, mental QoL, depression, and anxiety. However, the effects of yoga with pilates or CAM for neck pain intensity and neck pain-associated disability were uncertain with a limited studies (3 and 2 studies, respectively). We also assessed the effects of yoga on CROM, which is one of the most basic indicators to evaluate the function of cervical vertebra,

Our results showed that yoga was superior to exercise to improve the CROM with a significant difference in flexion, extension, left lateral flexion, right lateral flexion, and left rotation, while this evidence was limited with only 3 included studies studied CROM.

In this meta-analysis, all of the included studies evaluated the immediate (<1 week) and short-term (1–12 weeks) outcomes, only 2[20,23] followed-up to 6 months, and one[20] followed-up to 12 months, which was not long enough to capture valid data. Thus, the results of this study only represent immediate-term and short-term effects.

Because of the limited studies, we cannot perform further subgroup analysis to explore the effects of different yoga styles, outcome measurements instruments, and follow-up terms, these differences in included studies might contribute to the significant between-study heterogeneity. It also remains unclear whether

there are different effects of yoga on CNNP between countries and cultures, the 10 studies included in this review originated from 7 different countries, we were unable to conduct a meta-analysis to compare the effects. Previous studies have shown, however, that Indian studies on yoga tend to be more positive than those from other countries.[31] Nonetheless, we believe that this study included a representative study of the yoga for CNNP research in global.

There are robust evidences for the effects of yoga on CNNP to help improve mental QoL and mood, this finding is encouraging for certain patient groups, such as high stress-induced neck pain patients.

4.2. Strengths of the study

To the best of our knowledge, this is the first meta-analysis evaluating the effect of yoga on CROM in CNNP, which is important to assess the function of neck vertebrae. Another strength of our study is that we addressed a comprehensive search strategy of MeSH and non-MeSH terms both in Chinese and English databases to identify the overall publications on the subject. Furthermore, the literature search, study selection, quality assessment, and data extraction were all completed independently by 2 reviewers.

4.3. Weaknesses of the study

There are several limitations to this study. First, although we addressed a relatively multiple search strategy, we might still have missed some studies, especially non-English and non-Chinese

studies, in the future meta-analysis, including more trails from India-origin of yoga were recommended. Secondly, the quality of original articles was not high and the sample size was limited. This may affect the reliability of the results to some extent. Thirdly, not being able to blind the participants may affect the validity of these results, since it is generally regarded impossible to blind patients and therapists in trials of behavioral interventions such as yoga.

4.4. Recommendations for future research

The sample size of original articles should be increased and the quality should be enhanced in future research. In this study, only

8 RCTs[17,18,20,22–26] and 2 q-RCTs[19,21] met the criteria and were included in the meta-analysis after quality assessment although we made a comprehensive search strategy of the Chinese and English databases, the average sample size of these studies was only 68.8. The outcome should also be fully reported, all 10 studies[17–26] reported neck pain intensity, 8[17,18,21–26] reported neck pain-related disability, but only 3 studies[23,24,26] reported the CROM, 3[22,24,25] reported QoL, and 3[17,22,25] reported mood. Furthermore, the characteristics, the intervention program, and the outcome measurements instruments of the studies were different, which may increase the heterogeneity of the studies, so a "gold-standard" yoga intervention criteria is also a priority in the future.
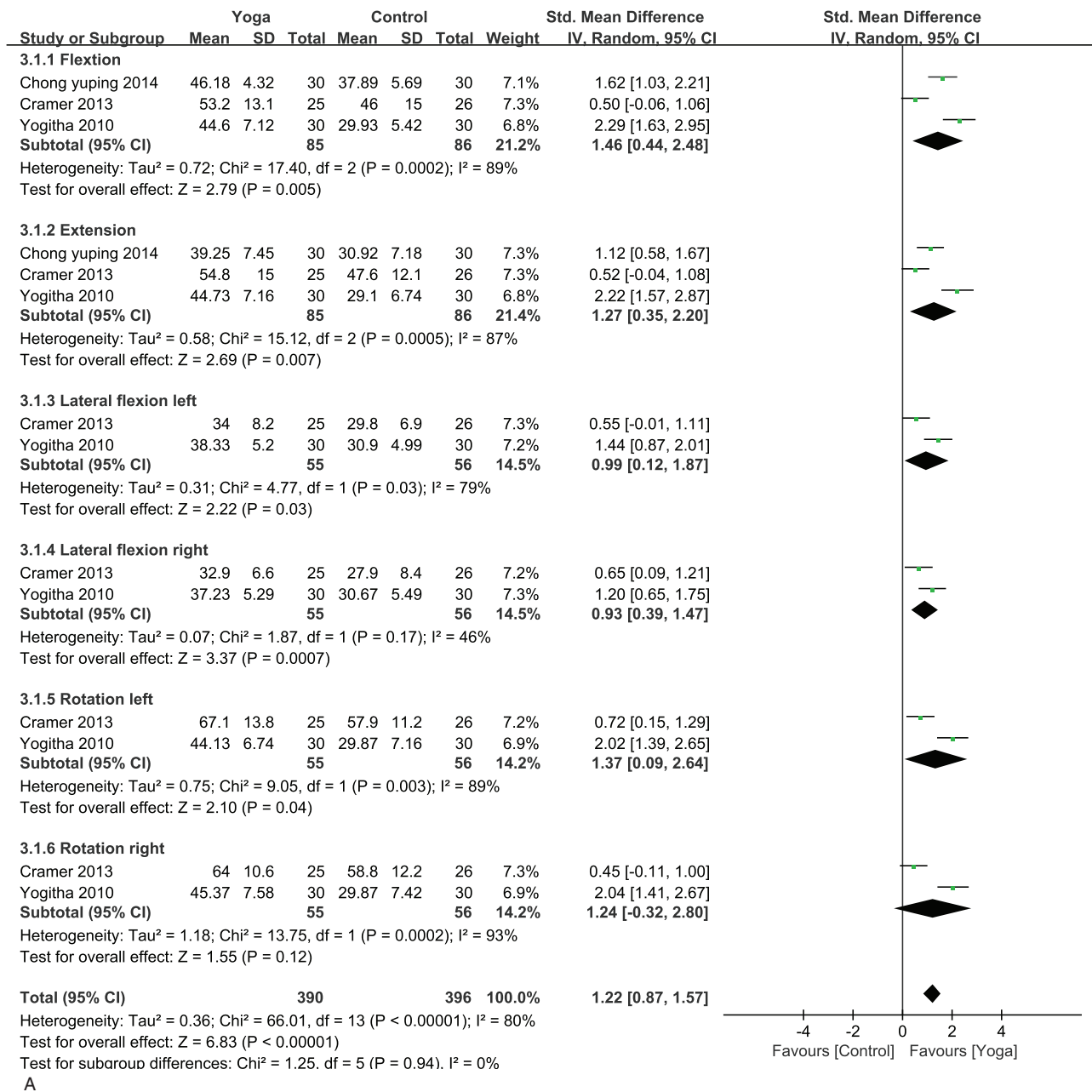

Figure 4. Secondary outcomes. (A) The overall effects of yoga and control for CROM. (B) The overall effects of yoga and control for QoL. (C) The overall effects of yoga and control for mood. CI = confidential interval, CROM = cervical range Of motion, M = mean, SD = standard deviation, SMD = standard mean difference, QoL = quality of life.
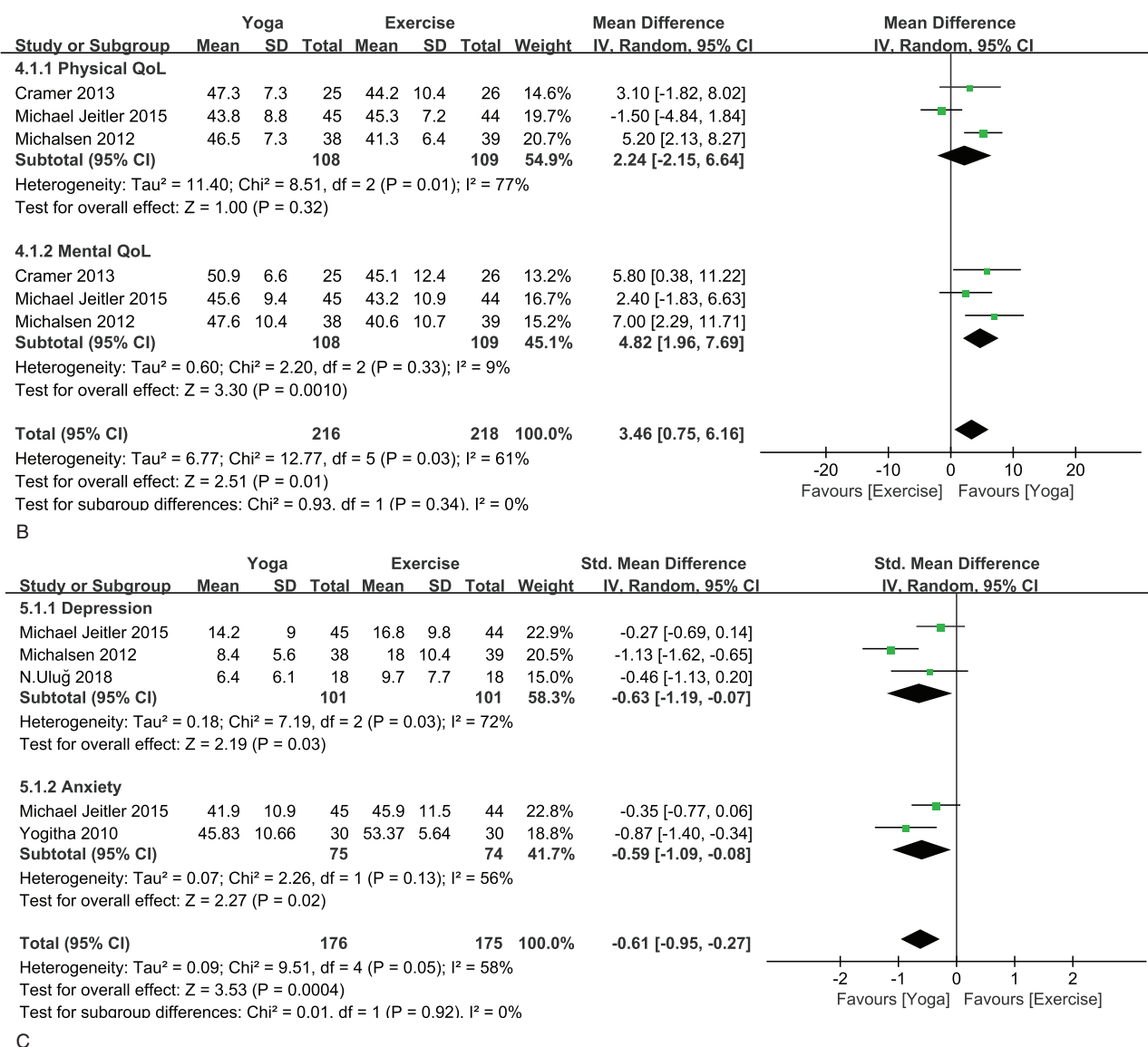
Figure 4. (Continued).

5. Conclusion

Because it was difficult to make a comprehensive summary of all the evidences due to the different session and duration of the yoga interventions, and the different outcome measurement tools in the study, we draw a very cautious conclusion that yoga can relieve neck pain intensity, improve pain-related function disability, increase CROM, improve quality of life, and boost mood. Therefore, more research on yoga for CNNP, specifically "gold-standard" yoga intervention, large-scale, high-quality RCTs on short-term as well as longer term outcomes, are urgently needed.

Author contributions

Conceptualization: Yunxia Li, Siyuan Li, Jieqiong Jiang.
Data curation: Yunxia Li, Siyuan Li, Jieqiong Jiang.
Formal analysis: Siyuan Li, Jieqiong Jiang.
Funding acquisition: Yunxia Li, Sue Yuan.
Investigation: Yunxia Li, Siyuan Li.
Methodology: Yunxia Li, Siyuan Li, Jieqiong Jiang.
Project administration: Yunxia Li, Sue Yuan.
Resources: Yunxia Li, Siyuan Li, Jieqiong Jiang.
Software: Yunxia Li, Siyuan Li, Jieqiong Jiang.
Supervision: Yunxia Li, Sue Yuan.
Validation: Sue Yuan.

Visualization: Sue Yuan.

Writing – original draft: Yunxia Li, Siyuan Li, Jieqiong Jiang, Sue Yuan.

Writing – review & editing: Yunxia Li, Siyuan Li, Jieqiong Jiang, Sue Yuan.

References

[1] Vassilaki M, Hurwitz EL. Perspectives on pain in the low back and neck: global burden, epidemiology, and management. Hawaii J Med Public Health 2014;73:122–6.

[2] Pacheco J, Raimundo J, Santos F, et al. Forward head posture is associated with pressure pain threshold and neck pain duration in university students with subclinical neck pain. Somatosens Mot Res 2018;35:1–6.

[3] Myrtveit SM, Sivertsen B, Skogen JC, et al. Adolescent neck and shoulder pain—the association with depression, physical activity, screen-based activities, and use of health care services. J Adolesc Health NLM 2014;55:366–72.

[4] Monticone M, Iovine R, De SG, et al. The Italian Society of Physical and Rehabilitation Medicine (SIMFER) recommendations for neck pain. G Ital Med Lav Ergon 2013;35:36–50.

[5] Binder AI. Cervical spondylosis and neck pain. BMJ 2007;334:527–31.

[6] Mokdad AH, Ballestros K, Echko M, et al. The State of US Health, 1990–2016: burden of diseases, injuries, and risk factors among US states. JAMA 2018;319:1444–72.

[7] Dieleman JL, Baral R, Birger M, et al. US spending on personal health care and public health, 1996–2013. JAMA 2016;316:2627–46.

[8] Wallwork SB, Butler DS, Wilson DJ, et al. Are people who do yoga any better at a motor imagery task than those who do not? Br J Sports Med 2015;49:123–7.

[9] Cochrane Library. Cognitive-behavioural treatment for subacute and chronic neck pain. Available at: http://onlinelibrary.wiley.com.proxy.cuk.ac.kr:8080/doi/10.1002/14651858.CD010664.pub2/abstract;jsessionid=8ACE27B704BEF96967F3CA00A8ECAE0F.f04t03. Accessed February 12, 2016.

[10] Cramer H, Lauche R, Haller H, et al. I'm more in balance: a qualitative study of yoga for patients with chronic neck pain. J Altern Complement Med 2013;19:536–42.

[11] Schmid AA, Miller KK, Van Puymbroeck M, et al. Yoga leads to multiple physical improvements after stroke, a pilot study. Complement Ther Med 2014;22:994–1000.

[12] Cramer H, Lauche R, Hohmann C, et al. Yoga for chronic neck pain: a 12-month follow-up. Pain Med 2013;14:541–8.

[13] Feuerstein G. The Yoga Tradition. Prescott: Hohm Press; 1998.

[14] Kim SD. Effects of yoga on chronic neck pain—a systemic review of RCT. J Phys Ther Sci 2016;28:2171–4.

[15] Cramer H, Klose P, Brinkhaus B, et al. Effects of yoga on chronic neck pain: a systematic review and meta-analysis. Clin Rehabil 2017;31:1457–65.

[16] Cramer H, Lauche R, Langhorst J, et al. Is one yoga style better than another? A systematic review of associations of yoga style and conclusions in randomized yoga trials. Complement Ther Med 2016;25:178–87.

[17] Uluğ N, Yilmaz ÖT, Kara M, et al. Effects of Pilates and yoga in patients with chronic neck pain: a sonographic study. J Rehabil Med 2018;50:80–5.

[18] Rajalaxmi V, Jasim A, Sudhakar S, et al. To analyse the effectiveness of yoga, pilates and Tai Chi exercise for chronic mechanical neck pain—a randomized controlled trail. Biomedicine 2018;38:156–60.

[19] Kim SD. Effects of yogic exercise on nonspecific neck pain in university students. Complement Ther Clin Pract 2018;31:338–42.

[20] Brämberg EB, Bergström G, Jensen I, et al. Effects of yoga, strength training and advice on back pain: a randomized controlled trial. BMC Musculoskelet Disord 2017;18:132–42.

[21] Dunleavy K, Kava K, Goldberg A, et al. Comparative effectiveness of pilates and yoga group exercise interventions for chronic mechanical neck pain: quasi-randomised parallel controlled study. Physiotherapy 2016;102:236–42.

[22] Jeitler M, Brunnhuber S, Meier L, et al. Effectiveness of jyoti meditation for patients with chronic neck pain and psychological distress—a randomized controlled clinical trial. J Pain 2015;16:77–86.

[23] Chong Y, Chen X, Xue C. Effect of hatha yoga on rehabilitation of cervical spondylopathy. J Beijing Sport Univ 2014;37:71–5. [In Chinese].

[24] Cramer H, Lauche R, Hohmann C, et al. Randomized-controlled trial comparing yoga and home-based exercise for chronic neck pain. Clin J Pain 2013;29:216–23.

[25] Michalsen A, Traitteur H, Lüdtke R, et al. Yoga for chronic neck pain: a pilot randomized controlled clinical trial. J Pain 2012;13:1122–30.

[26] Yogitha B, Nagarathna R, John E, et al. Complimentary effect of yogic sound resonance relaxation technique in patients with common neck pain. Int J Yoga 2010;3:18–25.

[27] Moher D, Liberati A, Tetzlaff J, et al. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. PLoS Med 2009;6:e1000097.

[28] Binder A. Clinical evidence handbook: neck pain. Am Fam Physician 2005;1:1–34.

[29] Higgins J, Green S. Cochrane Handbook for Systematic Reviews of Interventions Version 5.1.0[M]. 2008;Wiley-Blackwell, 102-108.

[30] Higgins JP, Thompson SG, Deeks JJ, et al. Measuring inconsistency in meta-analyses. BMJ 2003;327:557–60.

[31] Cramer H, Lauche R, Langhorst J, et al. Are Indian yoga trials more likely to be positive than those from other countries? A systematic review of randomized controlled trials. Contemp Clin Trials 2015;41:269–72.