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Strengthening Exercise Prescription and Progression in Chronic Neck Pain: A Literature Review of Dosage and Symptom-Response Reporting

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Abstract

Strengthening exercises are commonly used in chronic neck pain rehabilitation. However, incomplete reporting of exercise prescription, progression, and symptom-response monitoring may limit intervention reproducibility. This literature review examined how these components were reported in randomized controlled trials (RCTs) involving adults with chronic nonspecific or mechanical neck pain.

PubMed, the Physiotherapy Evidence Database (PEDro), and Google Scholar were searched for studies published between 2000 and 2026. Eligible trials involved adults with neck pain lasting at least three months and identifiable cervical and/or scapulothoracic strengthening exercises. Data were extracted on exercise dosage, resistance, frequency, progression, individualized advancement criteria, symptom-response monitoring, adherence, and adverse events. Reporting completeness was examined using principles from the Template for Intervention Description and Replication (TIDieR) and Consensus on Exercise Reporting Template (CERT). Risk of bias was assessed using the Cochrane RoB 2 tool.

The search identified 301 records, including 39 duplicates. Of 119 full-text reports assessed, 69 were excluded. Fifty publications representing 45 independent RCTs were included, with five companion publications linked to one original trial. Exercise frequency and program duration were generally reported, whereas initial resistance, individualized progression criteria, and symptom-based modifications were less consistently described. Explicit acceptable-pain thresholds, immediate or next-day symptom-response monitoring, and exercise regression or stopping criteria were frequently unreported. Adherence and adverse-event reporting varied, and participant retention did not consistently establish adherence to prescribed exercise dosage. Overall, 31 trials (68.9%) were judged to have a high risk of bias, 14 (31.1%) raised some concerns, and none were classified as low risk.

Strengthening interventions were generally identifiable, but incomplete reporting of exercise dosage, progression, and symptom-response procedures limited clinical reproducibility and interpretation. More comprehensive reporting of these components, alongside adherence and adverse events, may support individualized physiotherapy practice.

Categories: Therapeutics, Physical Medicine & Rehabilitation, Orthopedics
Keywords: chronic neck pain, exercise prescription, exercise progression, intervention reporting, physiotherapy, resistance training, strengthening exercise, symptom-response monitoring

Introduction And Background

Chronic neck pain is a common musculoskeletal condition associated with functional limitations, reduced physical capacity, and impaired quality of life. Pain persisting or recurring for more than three months is generally classified as chronic, although terminology may differ according to the underlying condition [1]. Chronic nonspecific neck pain refers to persistent neck pain without an identifiable specific underlying pathology and frequently overlaps with conditions described clinically as mechanical neck pain. Adults with chronic nonspecific or mechanical neck pain represent the population of interest in this review. Management requires consideration of physical, psychological, and behavioral factors, with clinical practice guidelines recommending education, active rehabilitation, and individualized therapeutic exercise [2,3].

Strengthening exercise is an important component of physiotherapy management for chronic nonspecific or

mechanical neck pain. Programs may target the cervical flexors, extensors, and scapulothoracic muscles through isometric, dynamic resistance, endurance, and functional exercises [2,3]. However, these interventions differ considerably in exercise selection, intensity, frequency, supervision, and duration. Their clinical interpretation and application therefore depend not only on identifying the exercises performed but also on understanding how training demands were prescribed, adjusted, and progressed.

Exercise prescription involves several variables, including initial resistance, sets, repetitions, contraction duration, rest intervals, and training frequency. Progressive resistance-training principles recommend adjusting these demands to promote physiological adaptation [4]. In patients with chronic nonspecific or mechanical neck pain, decisions regarding exercise progression may also consider pain, irritability, fatigue, movement quality, and individual exercise tolerance. Pain irritability refers to how readily symptoms are provoked and how long they persist following activity, whereas load tolerance describes the ability to tolerate a given exercise demand without unacceptable symptom exacerbation. These concepts may help guide symptom-response monitoring and individualized exercise progression. Progression may follow a predetermined schedule, depend on demonstrated exercise performance, or incorporate the patient's symptom response. These approaches are not interchangeable, and describing an intervention as progressive does not necessarily explain the criteria used to determine when or how training demands were increased.

Incomplete intervention descriptions have long been recognized as a limitation in clinical research [5,6]. The Template for Intervention Description and Replication (TIDieR) was developed to improve reporting of intervention content, dosage, delivery, tailoring, and modifications [7]. Similarly, the Consensus on Exercise Reporting Template (CERT) provides exercise-specific recommendations for documenting prescription, progression, individualization, and adherence [8,9]. These frameworks emphasize the practical information required to reproduce an intervention rather than merely identify its components.

Symptom-response monitoring is another relevant consideration in strengthening rehabilitation. Patients may experience temporary increases in pain, stiffness, or fatigue during or after exercise, which may influence decisions to progress, maintain, or reduce training demands. Evidence from chronic musculoskeletal pain populations suggests that exercise involving some pain may be acceptable in selected circumstances, although no universal acceptable pain threshold has been established specifically for chronic neck pain [10]. Importantly, measuring pain as a treatment outcome differs from monitoring symptoms during exercise or during the subsequent recovery period to guide training decisions. Reporting whether symptoms were monitored, which responses were considered acceptable, and whether these responses informed exercise modification may therefore improve the interpretability and reproducibility of strengthening interventions.

Adherence and adverse-event reporting also influence the interpretation of strengthening interventions. Patient-related, psychological, and practical barriers may affect adherence to physiotherapy programs [11,12]. However, scheduled treatment sessions, participant retention, or provision of home exercises do not necessarily establish completion of the prescribed exercise dose. Similarly, an absence of reported adverse events does not confirm that systematic safety monitoring was undertaken or that no adverse events occurred. Distinguishing between procedures that were explicitly reported and those that were not described is therefore important when evaluating intervention reporting.

Despite the widespread use of strengthening exercises for chronic neck pain, the extent to which randomized controlled trials (RCTs) describe the clinical decisions underlying exercise prescription and progression remains unclear. This literature review therefore examines how trials involving adults with chronic nonspecific or mechanical neck pain report initial exercise dosage, progression methods, individualized advancement criteria, symptom-response monitoring, exercise modification and stopping rules, adherence, and adverse events. The primary aim is to identify gaps in intervention reporting that may affect reproducibility, interpretation, and the application of research findings in physiotherapy practice. The review focuses on the completeness and clarity of intervention descriptions rather than determining the comparative effectiveness of individual strengthening approaches.

Review

Materials and method

Review Design

This literature review used a structured search, predefined eligibility criteria, standardized data extraction, and descriptive synthesis to examine strengthening exercise prescription, progression, symptom-response monitoring, adherence, and adverse-event reporting in RCTs involving adults with chronic nonspecific or mechanical neck pain. The focus was on reporting completeness and intervention reproducibility rather than pooled treatment effects.

Information Sources and Literature Search

PubMed, Physiotherapy Evidence Database (PEDro), and Google Scholar were searched for English-language studies published between 2000 and 2026. PubMed was searched on October 4, 2026, and PEDro and Google Scholar were searched on October 5, 2026.

Search terms included chronic neck pain, cervicalgia, strengthening exercise, and resistance training. Database-specific strategies incorporated Medical Subject Headings (MeSH) and Title/Abstract terms in PubMed and advanced search options in PEDro.

Google Scholar returned approximately 9,050 results for "chronic neck pain" ("strengthening" OR "resistance training"); only the first 200 relevance-ranked results were screened.

The search identified 301 records (PubMed: 45; PEDro: 56; Google Scholar: 200). Detailed strategies, search dates, and record counts are provided in Table *1*.

Database	Search date	Search strategy	Records
PubMed	October 4, 2026	MeSH and Title/Abstract search: ("neck pain"[MeSH Terms] OR "neck pain"[Title/Abstract] OR cervicalgia[Title/Abstract]) AND ("Resistance Training"[MeSH Terms] OR strengthen*[Title/Abstract] OR "resistance training"[Title/Abstract] OR "resistance exercise"[Title/Abstract])	45
PEDro	October 5, 2026	Advanced Search, Abstract & Title Field: Neck Pain Exercise	56
Google Scholar	October 5, 2026	"chronic neck pain" ("strengthening" OR "resistance training"); relevance-ranked results; first 200 records screened	200
Total			301

TABLE 1: Database search strategies used to identify randomized controlled trials (RCTs) of strengthening exercises for chronic neck pain

Searches covered publications from January 2000 to October 2026. The 301 records represent the initial dataset before deduplication. For Google Scholar, 200 refers to the first 200 relevance-ranked records screened, not the total results returned. Publication-date limits and eligibility criteria were applied as database filters only where confirmed in the original search histories.

Eligibility Criteria

Completed RCTs involving adults aged ⩾18 years with chronic nonspecific, idiopathic, or mechanical neck pain lasting ⩾3 months were eligible. Interventions required identifiable resisted strengthening exercises targeting the cervical and/or scapulothoracic muscles. Combined rehabilitation programs were included when the strengthening component was distinguishable, regardless of the comparator.

Studies involving specific cervical pathology, radiculopathy, myelopathy, whiplash-associated disorders, fractures, major trauma, postoperative conditions, or inflammatory or systemic diseases were excluded. Nonrandomized studies, observational studies, case reports, prevention studies, reviews, and protocols without results were also excluded. Studies with unconfirmed chronicity or other essential eligibility criteria were considered ineligible.

Incomplete reporting of exercise dosage, progression, advancement criteria, or symptom-response monitoring was not an exclusion criterion, as these reporting gaps were central to the review.

Study Selection

Records were managed in EndNote Online Classic (Clarivate, Philadelphia, Pennsylvania) for deduplication and screening. MAK and SAS conducted the literature search and eligibility screening. After duplicate removal, titles and abstracts were screened against predefined criteria, followed by full-text assessment. Multiple publications from the same trial were linked, with relevant data extracted without counting companion reports as independent RCTs. Studies were not excluded for incomplete exercise progression or symptom-response reporting. AYA provided methodological guidance and assisted with eligibility decisions when required.

Study selection was documented using a flow diagram adapted from the PRISMA 2020 framework [13], as illustrated in Figure *1*.

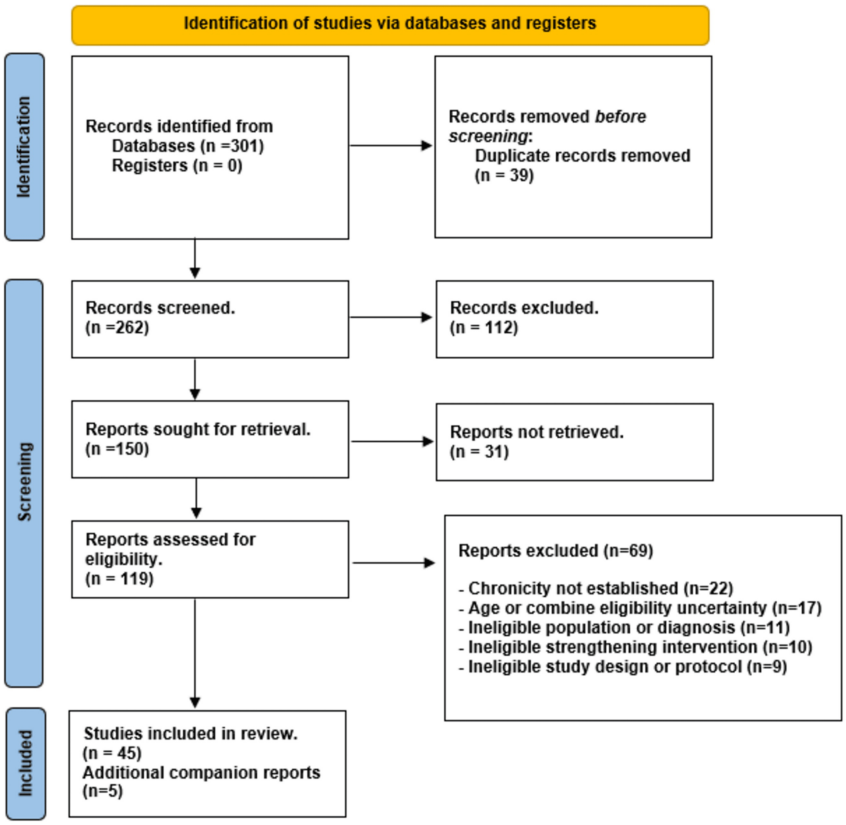


FIGURE 1: PRISMA 2020 flow diagram showing study identification, screening, eligibility assessment, and inclusion of 50 publications representing 45 independent randomized controlled trials

Data Extraction

A structured Microsoft Excel 2010 spreadsheet (Microsoft Corporation, Redmond, Washington) was used for data extraction by MAK and SAS. Data extraction was based on retrieved full-text articles, with supplementary materials and registered trial protocols examined where available. Extracted variables included study characteristics, participant details, intervention type, targeted muscles, initial resistance, sets, repetitions, contraction duration, training frequency, supervision, and program duration.

Progression data included adjusted parameters, progression schedules, and advancement criteria. Symptom-response variables included pain monitoring during exercise, acceptable symptom thresholds, immediate or delayed responses, and modification or stopping rules. Adherence and adverse events were also recorded.

Missing or insufficiently described information was classified as not reported or not verifiable, as appropriate, without assuming that the procedure was not performed. Data were summarized in comparative tables, with AYA providing guidance on clinical interpretation and presentation.

Assessment of Symptom-Response Monitoring, Adherence, and Adverse Events

Symptom-response reporting was assessed for acceptable pain thresholds, immediate and next-day responses, and exercise modification or stopping criteria. Pain measured as a treatment outcome was distinguished from symptom monitoring used to guide exercise decisions.

Adherence reporting was examined through session attendance, home-exercise completion, exercise logs, and other participation measures. Participant retention alone was not considered evidence of exercise adherence.

Adverse-event reporting was assessed for exercise-related complications, symptom exacerbations, and safety monitoring procedures. Absence of reported adverse events was not interpreted as evidence of systematic safety monitoring.

Assessment of Intervention Reporting

Intervention-reporting completeness was evaluated using principles from the Template for Intervention Description and Replication (TIDieR) and Consensus on Exercise Reporting Template (CERT) [7-9]. Domains included exercise dosage, initial loading, progression, individualization, symptom-response monitoring, adherence, and adverse events.

Information was classified as reported, partially reported, not reported, or not applicable. The assessment focused on reporting completeness and intervention reproducibility without assigning an overall numerical quality score.

Risk of Bias Assessment

Two reviewers (MAK and SAS) independently assessed risk of bias in the 45 included RCTs using the revised Cochrane Risk of Bias tool (RoB 2) [14]. Outcome-specific assessments covered five domains: the randomization process (D1), deviations from intended interventions (D2), missing outcome data (D3), outcome measurement (D4), and selection of the reported result (D5). Domain-level and overall judgments were classified as low risk, some concerns, or high risk. Outcomes included pain intensity, neck disability, craniovertebral angle, and deep cervical flexor strength, as applicable. Risk-of-bias assessments were considered separately from intervention-reporting completeness.

Data Synthesis

A descriptive synthesis examined reporting patterns across three domains: (1) exercise prescription and initial dosage, (2) progression methods and advancement criteria, and (3) symptom-response monitoring, adherence, and adverse events.

Findings were summarized in comparative tables, focusing on reporting completeness and intervention reproducibility. No meta-analysis was performed. MAK and SAS conducted the synthesis, with methodological and clinical guidance from AYA.

Results

Study Selection

The search identified 301 records (PubMed: 45; PEDro: 56; and Google Scholar: 200). After removing 39 duplicates, 262 records were screened, of which 112 were excluded. Of the 150 reports sought for retrieval, 31 were unavailable, leaving 119 full-text reports for eligibility assessment. Following the exclusion of 69 reports, 50 publications representing 45 independent RCTs were included.

Characteristics of Included Studies

The 45 independent RCTs investigated cervical and/or scapulothoracic strengthening in adults with chronic nonspecific or mechanical neck pain, either alone or within multimodal rehabilitation programs. Studies varied in participant characteristics, interventions, comparators, and treatment duration. Study characteristics, exercise frequency, and program duration are summarized in Table 2.

No.	Study	Population/design	Intervention and comparator	Program duration/frequency
1	Acikalin et al. (2026) [15]	n = 78 workers with chronic nonspecific neck pain; three-arm RCT	Aerobic exercise vs combined aerobic and cervical-upper-extremity resistance exercise vs education	Single 40-minute supervised session: 5-minute warm-up, 15-minute aerobic exercise, 15-minute resistance exercise, and 5-minute cool-down in the combined group.
2	Zheng et al. (2026) [16]	n = 90; adults with chronic mechanical neck pain ≥3 months; two-arm RCT	Tuina therapy plus cervical resistance exercise vs Tuina therapy alone	Four weeks: home cervical resistance exercises three times/day, six days/week; Tuina therapy twice/week (eight sessions).
3	Ali et al. (2025) [17]	n = 40; adults aged 18-23 years with neck pain >3 months and FHP; two-arm RCT	INIT plus conventional physiotherapy vs conventional physiotherapy alone; both groups received cervical/scapular strengthening and stretching	Four weeks; three supervised sessions/week (12 scheduled sessions).
	Mehmetoğlu et	n = 60 completed; women	Cervical stabilization plus scapular/postural and	Six weeks; three supervised sessions/week (18

4	al. (2025) [18]	with chronic neck pain; two-arm RCT	lumbopelvic stabilization exercises vs cervical stabilization alone	scheduled sessions); follow-up assessment two months after treatment.
5	Lee et al. (2025) [19]	n = 42; adults with chronic neck pain ≥12 weeks; block-randomized trial	Combined lower trapezius strengthening and DCF training vs DCF training alone	Four weeks; two supervised sessions/week (eight scheduled sessions).
6	Bharti et al. (2024) [20]	n = 30; adults with mechanical neck pain lasting 3-12 months; randomized comparative trial	Cervical isometric exercises plus scapular functional exercises vs cervical isometric exercises; both groups received conventional physiotherapy	Four weeks; exercises once daily, five days/week (20 scheduled exercise days); both groups received hot-pack treatment.
7	Amjad et al. (2024) [21]	n = 24 randomized; n = 22 completed; adults with chronic mechanical neck pain >6 months; two-arm RCT	Therapist-resisted cervical isometric strengthening vs elastic-band-resisted isotonic cervical strengthening; both groups received conventional physiotherapy	12 weeks; three supervised sessions/week (36 scheduled sessions).
8	Akhter et al. (2024) [22]	n = 80 (40/group); adults aged 20-50 years with chronic nonspecific neck pain; two-arm RCT	Jaw opening-closing movements combined with active neck exercises vs active neck exercises alone; both groups received cervical isometric strengthening	Six weeks; 16 supervised treatment sessions plus two assessment sessions; home cervical strengthening three times/day.
9	Abd-Eltawab et al. (2024) [23]	n = 60; young women with chronic mechanical neck pain ≥3 months; three-arm RCT	Conventional physiotherapy vs physiotherapy plus mechanical cervical traction vs physiotherapy plus Kinesio taping; cervical isometric strengthening shared across groups	Six weeks; three supervised sessions/week (18 scheduled sessions); approximately 60 minutes/session.
10	Zhang et al. (2024) [24]	n = 70; adults with chronic nonspecific neck pain >3 months; RCT	Cervical extensor strengthening program vs cervical stretching program; both groups received additional conventional treatment	12 months; cervical exercises three times/week; first nine months clinic-supervised, final three months home-based with weekly video supervision.
11	Kumari et al. (2024) [25]	n = 30 desk workers with chronic neck pain >3 months; randomized comparative trial	TheraBand cervical resistance training vs comparator intervention	Six weeks; five exercise sessions/week (30 scheduled sessions).
12	Batool et al. (2023) [26]	n = 52 randomized; n = 45 analyzed; adults with neck pain lasting 3-6 months; RCT	Fasciatherapy vs fascial manipulation; both groups received cervical isometric strengthening	Three weeks; three treatment sessions/week (nine scheduled sessions).
13	Suwaidi et al. (2023) [27]	n = 66; adults aged >60 years with chronic nonspecific neck pain >3 months; RCT	Two exercise-based FHP correction approaches	Six weeks; three treatment sessions/week (18 scheduled sessions).
14	Hamdy et al. (2023) [28]	n = 90; adults aged 18-30 years with chronic nonspecific neck pain ≥3 months; three-arm RCT	IASTM vs INIT vs comparator intervention; conventional physiotherapy shared across groups	Four weeks; three treatment sessions/week (12 scheduled sessions).
15	Hernández-Lucas et al. (2023) [29]	n = 58; adults with chronic nonspecific neck pain ≥3 months; RCT	Back-school-based exercise intervention vs comparator intervention	Eight weeks; two supervised sessions/week (16 scheduled sessions); approximately 45 minutes/session.
16	Gümüşçü et al. (2023) [30]	n = 48 randomized; n = 45 analyzed; adults with chronic mechanical neck pain >3	Three different exercise-training programs	Four weeks; three exercise sessions/week (12 scheduled sessions).

		months; three-arm RCT		
17	Fernandes et al. (2023) [31]	n = 52 randomized; n = 50 completed; women with chronic nonspecific neck pain ≥12 weeks; RCT	GPR vs neck-specific exercise program	Four weeks; two supervised sessions/week (eight scheduled sessions).
18	Hernández-Lucas et al. (2023) [32]	n = 44 randomized; n = 35 analyzed; women with chronic nonspecific neck pain ≥3 months; RCT	Elastic-band resistance exercise program vs comparator intervention	Eight weeks; two supervised sessions/week (16 scheduled sessions).
19	Kang et al. (2022) [33]	n = 41 (exercise n = 21; massage n = 20); adults with chronic neck pain >3 months; two-arm RCT	Cervical and scapular resistance exercise vs trapezius massage	Four weeks; five treatment sessions/week (20 scheduled sessions).
20	Aydoğmuş et al. (2022) [34]	n = 60 randomized; n = 58 completed according to Methods; adults with chronic neck pain ≥3 months; RCT	Neck stabilization exercises plus conventional physiotherapy vs conventional physiotherapy alone	The initial three-week supervised phase included five sessions/week (15 scheduled sessions); subsequent home exercises were prescribed five days/week; and the home-phase duration was not established in the supplied extraction.
21	Arif et al. (2022) [35]	n = 44 randomized; n = 40 completed; adults with chronic neck pain ≥3 months and FHP; RCT	Cervical stabilization exercises plus conventional physiotherapy vs conventional physiotherapy alone	Four weeks; three supervised sessions/week (12 scheduled sessions).
22	Bugti et al. (2022) [36]	n = 180 women aged 24-63 years with chronic nonspecific neck pain >6 months; reported RCT	Intensive cervical strengthening vs dynamic cervical endurance training vs control intervention	Exercises prescribed three times/week; 12-month follow-up reported; exact intervention duration not established in the supplied extraction.
23	Anwar et al. (2022) [37]	n = 30; adults aged 25-50 years with chronic nonspecific neck pain >3 months; RCT	Conventional physiotherapy plus sham breathing vs conventional physiotherapy plus breathing re-education	Eight weeks; five treatment sessions/week (40 scheduled sessions).
24	Shamsi et al. (2021) [38]	n = 100 randomized and analyzed; adults with chronic mechanical neck pain >3 months; RCT	Conventional physiotherapy plus SNAGs vs conventional physiotherapy plus ultrasound	Two weeks; three treatment sessions/week (six scheduled sessions).
25	Javdaneh et al. (2021) [39]	n = 72 randomized; n = 67 analyzed; adults with chronic nonspecific neck pain ≥3 months and scapular downward rotation; three-arm RCT	NET vs NET plus scapular stabilization vs education control	Six weeks; three exercise sessions/week (18 scheduled sessions).
26	Cho et al. (2021) [40]	n = 30 (15/group); adults aged 20-55 years with chronic neck pain and rounded shoulders; two-arm RCT	Selective lower trapezius strengthening plus conventional physiotherapy vs conventional physiotherapy alone	Five weeks; two supervised sessions/week (10 scheduled sessions); the experimental group received 45 minutes of general physiotherapy plus 15 minutes of strengthening/session; the control group received 45 minutes of general physiotherapy/session.
27	Groisman et al. (2020) [41]	n = 90 (45/group); adults with chronic nonspecific neck pain; pragmatic assessor-blinded RCT	Cervical strengthening, stabilization, and stretching plus OMT vs an identical exercise program alone	Four weeks; one supervised exercise session/week (four scheduled sessions, approximately 40-45 minutes each), plus home exercises three times/week; OMT once/week in the combined group.
28	Lytras et al. (2020) [42]	n = 40; adults aged 30-60 years with chronic mechanical neck pain and cervical myofascial trigger points; assessor-blinded RCT	Therapeutic cervical/scapular exercises plus INIT vs therapeutic exercises with additional breathing/stretching	10 weeks; four treatment sessions/week (40 scheduled sessions); approximately 45 minutes of therapeutic exercise/session plus 15 minutes of additional intervention; follow-up six months after treatment.

29	Mehri et al. (2020) [43]	n = 32 women (16/group) with chronic nonspecific neck pain; assessor-blinded RCT	Supervised cervical/scapular corrective exercises vs written postural correction and self-exercise advice	Eight weeks; three supervised exercise sessions/week (24 scheduled sessions); exercise duration described as 30 minutes/day in the abstract and progressing from 30 to 60 minutes/day in Methods.
30	Fathollahnejad et al. (2019) [44]	n = 60 women (20/group), aged 32-42 years, with chronic neck pain, FHP, and rounded shoulders; assessor-blinded three-arm RCT	Stabilization exercises plus manual therapy vs stabilization exercises alone vs home-exercise control	Six-week intervention; manual therapy delivered three times/week (10 minutes/session) in the combined group; one-month post-intervention follow-up. Exercise-session frequency is not established in the supplied Table 1 extraction.
31	Suvarnnato et al. (2019) [45]	n = 54 (18/group); adults aged 18-60 years with chronic mechanical neck pain ≥3 months; assessor-blinded three-arm RCT	Selective semispinalis cervicis strengthening vs CCF training vs usual physiotherapy	Six weeks; cervical strengthening groups supervised twice/week (12 scheduled sessions), with prescribed home exercises. Extensor group: three sets/day; flexor group: home exercises twice/day. Usual-care group: 10-12 appointments. Follow-up at one and three months.
32	Altaf et al. (2017)[46]	n = 40 women (20/group), aged 20-50 years, with chronic nonspecific neck pain ≥3 months; two-arm randomized trial	Cervical isometric strengthening vs cervical endurance exercises; both groups received conventional physiotherapy	Three weeks; cervical strengthening or endurance exercises prescribed once daily; supervised-session frequency not established.
33	Lauche et al. (2016) [47]	n = 114; adults with chronic nonspecific neck pain ≥3 months; three-arm RCT	Tai Chi vs conventional neck exercises incorporating cervical/core strengthening vs waiting-list control	12 weeks; Tai Chi group attended weekly 75-90-minute classes; neck-exercise group attended weekly 60-75-minute classes (12 scheduled classes/group); neck-exercise home program prescribed for at least 15 minutes/day; follow-up at 24 weeks.
34	Javanshir et al. (2015) [48]	n = 60 (30/group); adults with chronic nonspecific neck pain >3 months; assessor-blinded two-arm RCT	Low-load CCF training using pressure biofeedback vs progressive cervical flexor endurance-strength training	10 weeks; three supervised sessions/week (30 scheduled sessions, up to 30 minutes each); home exercises prescribed three times/day.
35	Kang et al. (2015) [49]	n = 64 (32/group); adults with chronic posterior neck pain >3 months; two-arm randomized trial	Forest bathing plus cervical/shoulder strengthening and stretching vs forest bathing alone	Intensive five-day program; both groups participated in approximately two hours of morning forest walking daily; experimental group additionally performed afternoon and evening cervical/shoulder exercise sessions.
36	Rudolfsson et al. (2014) [50]	n = 108 women (36/group), aged 25-65 years, with chronic nonspecific neck pain >3 months; observer-blinded three-arm RCT	Neck coordination exercises vs progressive cervical/shoulder resistance training vs upper-body massage	11 weeks; 22 individually supervised sessions (approximately 30 minutes each), equivalent to two sessions/week.
37	Karlsson et al. (2014) [51]	n = 57 women (strengthening n = 34; stretching n = 23) with chronic neck/shoulder pain >6 months; two-arm RCT	Home-based progressive cervical/shoulder strengthening vs stretching alone	12 months; home strengthening prescribed three times/week; three introductory teaching visits, with telephone/email support approximately every 4-8 weeks.
38	Khan et al. (2014) [52]	n = 68 (34/group); adults aged 20-50 years with nonspecific neck pain lasting three months to three years; two-arm randomized trial	Elastic-band-resisted cervical isometric exercises vs active cervical ROM exercises	12 weeks; three supervised sessions/week (36 scheduled sessions); home exercises prescribed twice daily on at least 5 days/week.
39	Borisut et al. (2013) [53]	n = 100 women (25/group), aged 20-35 years, with work-related chronic neck pain >6 months; four-arm RCT	Cervical strength-endurance training vs CCF training vs combined training vs no-exercise control	12 weeks; cervical strength-endurance and/or CCF exercises prescribed daily; exercise logbooks used to monitor participation.
		n = 14 randomized		

40	Hudson et al. (2010) [54]	(7/group); n = 12 initiated treatment (6/group); adults with chronic/recurrent nonspecific neck pain >3 months; assessor-blinded pilot RCT	Multimodal group physiotherapy incorporating cervical/shoulder strengthening vs individualized usual-care physiotherapy	Six weeks; multimodal group rehabilitation once/week (six scheduled sessions, approximately 60 minutes each), with an additional 40-minute initial assessment; usual-care group received approximately 5-8 visits according to clinical need.
41	Häkkinen et al. (2008) [55]	n = 101; strengthening plus stretching n = 49, stretching alone n = 52; chronic neck pain; RCT	Cervical strength training plus stretching vs stretching alone	12-month follow-up; strengthening prescribed three times/week; reported training frequency approximately 2.1 times/week initially and 1.1 times/week later
42	Falla et al. (2007) [56]	n = 58 women with chronic neck pain >3 months; two-arm randomized exercise trial	CCF motor-control training vs progressive cervical flexor endurance-strength training	Six weeks; therapist supervision once/week (six scheduled sessions, up to 30 minutes each); home exercises twice daily for approximately 10-20 minutes/day.
43	Ylinen et al. (2003) [57]; companion publications [58-62]	n = 180 women (60/group), aged 25-53 years, with chronic nonspecific neck pain >6 months; examiner-blinded three-arm RCT	Intensive cervical isometric strengthening vs cervical endurance training vs stretching/aerobic advice control	12-month intervention; initial 12-day institutional rehabilitation incorporating nine supervised exercise sessions, followed by prescribed home training approximately three times/week and periodic follow-up support.
44	Viljanen et al. (2003) [63]	n = 393 women (dynamic training n = 135; relaxation n = 128; control n = 130), aged 30-60 years, with chronic nonspecific neck pain ≥12 weeks; three-arm RCT	Dynamic cervical/shoulder strengthening vs relaxation training vs ordinary-activity control	12 weeks; supervised 30-minute group sessions three times/week (36 scheduled sessions); one-week reinforcement period at six months; follow-up assessments at 3, 6, and 12 months.
45	Bronfort et al. (2001) [64]	n = 191; adults aged 20-65 years with chronic mechanical neck pain ≥12 weeks; three-arm single-blinded RCT	Spinal manipulation plus supervised progressive strengthening vs MedX cervical resistance exercise vs spinal manipulation alone	11 weeks; 20 scheduled treatment visits (approximately 60 minutes each). Combined group: approximately 15 minutes of manipulation plus 45 minutes of supervised strengthening; follow-up at 3, 6, and 12 months after treatment.

TABLE 2: Characteristics of the included RCTs

CCF: craniocervical flexion; DCF: deep cervical flexors; FHP: forward head posture; IASTM: instrument-assisted soft-tissue mobilization; INIT: integrated neuromuscular inhibition technique; MedX: machine-based cervical resistance exercise system; RCT: randomized controlled trial; ROM: range of motion; SNAGs: sustained natural apophyseal glides.

The RCT by Ylinen et al. (2003) [57] was associated with five companion publications [58-62] reporting additional outcomes, longer-term follow-up findings, or subsequent intervention data. These publications were linked to the original trial and were not counted as independent RCTs.

Risk of Bias Assessment

Of the 45 included RCTs, 31 (68.9%) were judged to have a high overall risk of bias, while 14 (31.1%) raised some concerns; none were classified as low risk.

Outcome measurement (D4) was the most frequently affected high-risk domain (28 trials), particularly for self-reported pain and disability outcomes in trials where participants were aware of treatment allocation. Additional high-risk judgments involved missing outcome data (D3; five trials) and deviations from intended interventions (D2; three trials). Concerns were also identified in the randomization process (D1) and selection of the reported result (D5).

High risk related to missing outcome data was identified in Zhang et al. (2024) [24], Hernández-Lucas et al. (2023) [32], Lauche et al. (2016) [47], Rudolfsson et al. (2014) [50], and Karlsson et al. (2014) [51].

These outcome-specific assessments concern the validity of clinical outcome estimates rather than intervention-reporting completeness. Domain judgments and overall classifications are presented in Table *3*.

								Overall

No	Study	Outcome assessed	D1	D2	D3	D4	D5	RoB
1	Acikalin et al. (2026) [15]	Pain intensity	Some concerns	Low	Low	High	Some concerns	High
2	Zheng et al. (2026) [16]	Pain intensity (four weeks)	Low	Low	Low	High	Some concerns	High
3	Ali et al. (2025) [17]	Craniovertebral angle	Low	Some concerns	Low	Low	Some concerns	Some concerns
4	Mehmetoğlu et al. (2025) [18]	Pain intensity	Some concerns	Some concerns	Some concerns	High	Some concerns	High
5	Lee et al. (2025) [19]	Neck disability	Some concerns	Some concerns	Low	High	Some concerns	High
6	Bharti et al. (2024) [20]	Pain intensity	Some concerns	Some concerns	Low	High	Some concerns	High
7	Amjad et al. (2024) [21]	Pain intensity	Some concerns	Some concerns	Some concerns	High	Some concerns	High
8	Akhter et al. (2024) [22]	Pain intensity	Some concerns	Some concerns	Low	Some concerns	Some concerns	Some concerns
9	Abd-Eltawab et al. (2024) [23]	Pain intensity	Some concerns	Some concerns	Low	High	Some concerns	High
10	Zhang et al. (2024) [24]	Neck disability (12 months)	Some concerns	Some concerns	High	Some concerns	Some concerns	High
11	Kumari et al. (2024) [25]	Pain intensity	Some concerns	Some concerns	Some concerns	High	Some concerns	High
12	Batool et al. (2023) [26]	Pain intensity	Some concerns	Some concerns	Some concerns	Some concerns	Some concerns	Some concerns
13	Suwaidi et al. (2023) [27]	Pain intensity	Low	Some concerns	Low	High	Some concerns	High
14	Hamdy et al. (2023) [28]	Pain intensity	Low	Low	Low	High	Some concerns	High
15	Hernández-Lucas et al. (2023) [29]	Pain intensity	Some concerns	Some concerns	Low	High	Some concerns	High
16	Gümüşçü et al. (2023) [30]	Pain intensity	Some concerns	Some concerns	Some concerns	High	Some concerns	High
17	Fernandes et al. (2023) [31]	Pain intensity	Low	Low	Low	Some concerns	Some concerns	Some concerns
18	Hernández-Lucas et al. (2023) [32]	Pain intensity	Low	High	High	High	Some concerns	High
19	Kang et al. (2022) [33]	Pain intensity	Low	Some concerns	Low	Some concerns	Some concerns	Some concerns
20	Aydoğmuş et al. (2022) [34]	Pain intensity	Low	Some concerns	Low	Some concerns	Some concerns	Some concerns
21	Arif et al. (2022) [35]	Pain intensity	Some concerns	Some concerns	Some concerns	High	Some concerns	High
22	Bugti et al. (2022) [36]	Pain intensity	Some concerns	Some concerns	Some concerns	High	Some concerns	High
23	Anwar et al. (2022) [37]	Deep cervical flexor strength	Some concerns	Low	Low	Some concerns	Some concerns	Some concerns
24	Shamsi et al. (2021) [38]	Pain intensity	Some concerns	Some concerns	Low	Some concerns	Some concerns	Some concerns

25	Javdaneh et al. (2021) [39]	Pain intensity	Low	Some concerns	Low	Some concerns	Some concerns	Some concerns
26	Cho et al. (2021) [40]	Pain intensity	Some concerns	Some concerns	Low	High	Some concerns	High
27	Groisman et al. (2020) [41]	Pain intensity	Low	Some concerns	Some concerns	High	Some concerns	High
28	Lytras et al. (2020) [42]	Pain intensity	Low	Low	Low	High	Some concerns	High
29	Mehri et al. (2020) [43]	Pain intensity	Some concerns	Some concerns	Some concerns	High	Some concerns	High
30	Fathollahnejad et al. (2019) [44]	Pain intensity	Some concerns	Low	Low	High	Some concerns	High
31	Suvarnnato et al. (2019) [45]	Pain intensity	Some concerns	Some concerns	Some concerns	High	Some concerns	High
32	Altaf et al. (2017) [46]	Neck disability	Some concerns	Some concerns	Low	High	Some concerns	High
33	Lauche et al. (2016) [47]	Pain intensity	Low	Low	High	High	Low	High
34	Javanshir et al. (2015) [48]	Pain intensity	Some concerns	Some concerns	Low	Some concerns	Some concerns	Some concerns
35	Kang et al. (2015) [49]	Pain intensity	Some concerns	Some concerns	Low	High	Some concerns	High
36	Rudolfsson et al. (2014) [50]	Pain intensity	Some concerns	High	High	Some concerns	Some concerns	High
37	Karlsson et al. (2014) [51]	Pain intensity	Some concerns	High	High	Some concerns	Some concerns	High
38	Khan et al. (2014) [52]	Pain intensity	Some concerns	Some concerns	Low	Some concerns	Some concerns	Some concerns
39	Borisut et al. (2013) [53]	Pain intensity	Some concerns	Some concerns	Low	High	Some concerns	High
40	Hudson et al. (2010) [54]	Pain intensity	Some concerns	Some concerns	Some concerns	Some concerns	Some concerns	Some concerns
41	Häkkinen et al. (2008) [55]	Pain intensity (12 months)	Low	Some concerns	Some concerns	High	Some concerns	High
42	Falla et al. (2007) [56]	Pain intensity	Low	Some concerns	Low	Some concerns	Some concerns	Some concerns
43	Ylinen et al. (2003) [57]	Pain intensity	Low	Some concerns	Low	High	Some concerns	High
44	Viljanen et al. (2003) [63]	Pain intensity	Low	Some concerns	Some concerns	High	Some concerns	High
45	Bronfort et al. (2001) [64]	Pain intensity	Low	Low	Some concerns	Some concerns	Some concerns	Some concerns

TABLE 3: Outcome-specific risk-of-bias assessment of the 45 included RCTs using the Cochrane Risk of Bias tool (RoB 2)

Risk-of-bias judgments are outcome-specific. Overall judgments follow RoB 2 decision rules and do not reflect the completeness of exercise-intervention reporting.

RoB 2: revised Cochrane Risk of Bias tool; D1: bias arising from the randomization process; D2: bias due to deviations from intended interventions; D3: bias due to missing outcome data; D4: bias in measurement of the outcome; D5: bias in selection of the reported result.

Strengthening Exercise Prescription and Initial Dosage

The 45 included RCTs used various strengthening approaches, including isometric exercises [21,35,46,52], dynamic resistance training [25,33,53,55,57,63], deep cervical flexor training [19,45,48,56], cervical extensor strengthening [16,24], and scapulothoracic exercises [20,39,40]. Interventions were delivered independently or within multimodal rehabilitation programs [17,26,28,41,42]. Although training frequency and program duration were commonly reported, initial resistance, exercise intensity, and individualized loading were inconsistently described.

Initial Exercise Intensity and Resistance

Initial loading varied across trials, including percentage-based prescriptions, repetition-maximum methods, external weights, elastic resistance, and therapist-applied resistance. Ylinen et al. (2003) [57] and Häkkinen et al. (2008) [55] prescribed cervical strengthening at approximately 80% of maximal isometric strength, while Borisut et al. (2013) [53] used repetition-maximum loading. Falla et al. (2007) [56] employed pressure-biofeedback-guided craniocervical flexion training. Rudolfsson et al. (2014) [50] described progression from approximately 60% to 75% of one-repetition maximum, whereas Karlsson et al. (2014) [51] used individualized dumbbell loading. Bronfort et al. (2001) [64] incorporated external resistance and cervical exercise equipment. Elastic and therapist-applied resistance interventions [22,52] did not consistently quantify initial loading. Overall, reporting the resistance method alone was insufficient to establish training intensity, limiting intervention reproducibility.

Sets, Repetitions, and Contraction Duration

Exercise volume was commonly reported through sets, repetitions, or contraction duration, although these parameters were not consistently described together. Falla et al. (2007) [56] and Borisut et al. (2013) [53] reported repetition targets and volume progression. Fathollahnejad et al. (2019) [44] prescribed three sets of 10-15 repetitions, while Karlsson et al. (2014) [51], Häkkinen et al. (2008) [55], and Ylinen et al. (2003) [57] specified sets or repetitions. Akhter et al. (2024) [22] reported contraction holds and exercise volume, whereas Khan et al. (2014) [52] reported repetitions without consistently detailing other loading parameters. Overall, exercise volume was generally identifiable, but resistance intensity, rest intervals, and individualized dosage were less consistently reported, limiting protocol reproducibility.

Training Frequency, Program Duration, and Supervision

Training frequency and program duration were generally better reported than initial loading. Fathollahnejad et al. (2019) [44] prescribed three weekly sessions for six weeks, while Khan et al. (2014) [52] used a 12-week program combining supervised and home exercises. Akhter et al. (2024) [22] used a similar approach over six weeks. Longer interventions included Ylinen et al. (2003) [57], with a 12-month home-based strengthening program, and Häkkinen et al. (2008) [55], with a 12-month program combining home training and periodic supervision. Bronfort et al. (2001) [64] reported 20 treatment visits over approximately 11 weeks. Although prescribed frequency and supervision were commonly described, actual exercise completion was not consistently documented. Prescribed frequency was therefore distinguished from verified adherence.

Completeness and Reproducibility of Initial Exercise Prescription

Exercise-prescription reporting varied across trials. Quantifiable loading methods, including percentage-based intensity and repetition-maximum prescriptions, provided clearer descriptions of training demands [50,53,55,57]. However, initial resistance, exercise volume, contraction duration, rest intervals, frequency, and supervision were not consistently reported together. Some trials described training schedules without adequately specifying starting loads or individualized dosage, limiting intervention reproducibility. Study-specific characteristics are summarized in Table *4*.

Sl. No.	Study	Strengthening intervention	Starting sose (sets/repetitions)	Progression method	Advancement criteria	Program schedule
1	Acikalin et al. (2026) [15]	Cervical and upper-extremity elastic-band resistance exercises: cervical retraction, retraction with extension, scapular retraction, vertical pulling, horizontal shoulder abduction, scapular-plane abduction, and shoulder elevation.	Fifteen minutes of resistance exercise; two sets × 8-10 repetitions per exercise, 30-second rest between sets. Green and blue TheraBand resistance, individually adjusted to Borg RPE 11-14. Exact external resistance is not quantified.	Not applicable: Single-session intervention; authors explicitly stated that no exercise progression was applied.	Not applicable for longitudinal progression. Within-session resistance selection/adjustment was guided by pain-free ROM, correct technique, individual tolerance, and Borg RPE 11-14.	One supervised session: 15 minutes of aerobic exercise + 15 minutes of resistance exercise, with a five-minute warm-up and a five-minute cool-down (40 minutes total).
			Week 1: Five repetitions per		Time-based: Repetitions	Resistance exercise three times daily, six days per

2	Zheng et al. (2026) [16]	Home-based cervical extensor isometric resistance exercise combined with Tuina therapy. Participants interlocked their fingers behind the occiput and pushed their hands forward and their heads backward to generate opposing static resistance.	session, three sessions daily. Each repetition comprised five seconds of maximal voluntary isometric effort followed by two seconds of relaxation. External resistance was not objectively quantified.	Time-based repetition progression: Five repetitions in week 1, 10 in week 2, 15 in week 3, and 20 in week 4.	increased by five at each successive week. No performance-based, strength-based, or pain-based advancement threshold reported.	week for four weeks, alongside Tuina twice weekly for four weeks (eight sessions). Home exercises monitored through video submissions and therapist feedback.
3	Ali et al. (2025) [17]	Scapular retractor and deep cervical flexor strengthening exercises, provided to both experimental and control groups.	three sets × 12 repetitions, with a six-second hold per repetition and 1-2 minutes of rest between sets. External resistance, relative intensity, and initial loading method are not reported.	Not reported. No increase in resistance, repetitions, sets, hold duration, or exercise difficulty described across the intervention period.	Not reported. No symptom-based, performance-based, strength-based, or time-based progression threshold specified.	Three sessions weekly for four weeks (12 scheduled treatment sessions). Strengthening was combined with stretching in both groups; Group A additionally received INIT.
4	Mehmetoğlu et al. (2025) [18]	Both groups: deep cervical flexor training with pressure biofeedback, chin tucks, shoulder shrugs, and lower cervical eccentric control. The SLPS group additionally includes scapular retraction, dynamic stabilization, upward rotation, lower trapezius arm raises, and lumbopelvic stabilization.	Deep cervical flexors: 10 repetitions × 10-second holds, with pressure progression from 20 to 30 mmHg in 2-mmHg increments. Chin tucks and shoulder shrugs: 15 repetitions. Scapular exercises: generally 2 × 15 repetitions with 10-second holds; wall slides and lower trapezius raises: 3 × 10-15 repetitions. Lumbopelvic exercises: 10-15 repetitions with 5-10-second holds and five-second rest.	Reported: Deep cervical flexor pressure increased by 2-mmHg increments; dumbbell resistance added to shoulder shrugs and selected scapular exercises; scapular exercise intensity increased after four weeks.	Partially reported: Time-based advancement after four weeks for scapular exercises. Lumbopelvic stabilization used the ability to maintain constant pressure and pelvic stability to establish the exercise level. No quantified pain-based or strength-based advancement threshold reported.	Supervised physiotherapy three times weekly for six weeks (18 scheduled sessions). Both groups also received stretching and 20-minute hot packs. Follow-up assessment two months after treatment.
5	Lee et al. (2025) [19]	Experimental: modified prone cobra (MPC) targeting the lower trapezius, plus deep cervical flexor (DCF) training. Control: DCF training alone.	MPC: body weight for weeks 1-2, then 0.45-kg (1 lb) dumbbells in each hand during weeks 3-4. DCF: pressure biofeedback starting at 20 mmHg and training targets of 22-30 mmHg. MPC: 3 sets × 10 repetitions, 10-second holds, 20-second rest between sets. DCF: 5 repetitions per stage, 10-second holds, 15-second rests.	MPC: predetermined external-load increase from body weight to 0.45 kg per hand beginning week 3. DCF: five pressure stages, increasing by 2 mmHg from 22 to 30 mmHg.	MPC: time-based progression after two weeks; no individual performance or symptom threshold reported. DCF: advance when participants demonstrate proficient DCF activation without compensatory sternocleidomastoid or scalene recruitment.	Both groups: twice weekly for four weeks (eight sessions). MPC performed only in the experimental group.
6	Bharti et al. (2024) [20]	Cervical isometrics involving flexion, extension, lateral flexion, and rotation, alongside cervical/scapular retraction and shoulder movements. The experimental group additionally performed seated press-ups and push-up plus exercises.	CIE: maximal voluntary isometric contractions within individual discomfort and tolerance. SFE: seated body-weight press-ups and push-ups, initially from knees or feet. No numerical initial external resistance specified. CIE: contraction holds of 3, 5, 7, and 10 seconds, each repeated 10 times, with 30-second rests between contractions. SFE: 10 repetitions per exercise per session, without rest between repetitions. The set and hold duration for SFE is not specified.	CIE: progressive hold duration from 3 to 10 seconds. Press-up: weight plates added to thighs. Push-up plus: progression from knees to feet, followed by iron plates on the upper back.	Partially reported: CIE performed according to discomfort and tolerance. No explicit pain threshold, required performance standard, timing of resistance advancement, or quantitative load-increase rule reported for SFE.	Both groups: Exercises once daily, five days weekly, for four weeks (20 scheduled exercise days). Hot packs: 25-30 minutes per session, five days weekly.
7	Amjad et al. (2024) [21]	Group A: Therapist-resisted isometric cervical strengthening in six directions: flexion, extension, bilateral lateral flexion, and bilateral rotation. Group B: TheraBand-resisted isotonic cervical strengthening in the same six directions. Both groups received hot packs, cervical mobilization, and manual trigger-point treatment.	Isometric: 10 repetitions per direction, three-second holds, with therapist-applied manual resistance. Isotonic: 10 repetitions per direction using TheraBand. Initial resistance magnitude/band color, number of sets, rest intervals, and isotonic	Not reported: No planned increase in resistance, repetitions, sets, hold duration, or exercise difficulty described for either group.	Not reported: No performance-based, symptom-based, or time-based criteria for advancing exercise difficulty described.	12 weeks, three sessions/week (36 scheduled sessions). Exercises performed seated. Both groups received 10-minute hot packs, C2-C7 posteroanterior mobilization, and manual

			movement tempo not specified.			trigger-point release.
8	Akhter et al. (2024) [22]	Both arms: therapist-resisted cervical flexion, extension, and rotation; home self-resisted cervical flexion, extension, and lateral flexion. The experimental arm additionally performed coordinated jaw-neck movements.	Clinic: 3 × 15 repetitions, two-minute rests; resistance intensity and hold duration not reported. Home: 15 repetitions × six-second holds, three times/day.	Not reported; no planned load, volume, or difficulty progression described.	Not reported; no performance- or symptom-based advancement criteria specified.	Six weeks: 16 supervised treatment sessions plus two assessment sessions (18 visits total); home exercises three times/day.
9	Abd-Eltawab et al. (2024) [23]	All three groups received therapist-resisted cervical isometric strengthening of flexors, extensors, rotators, and lateral flexors. Group A: conventional physiotherapy; Group B: conventional physiotherapy plus mechanical cervical traction; Group C: conventional physiotherapy plus Kinesio taping.	Five repetitions per direction; six-second isometric contraction followed by six-second relaxation. Sets and manual resistance intensity are not reported.	Not reported. No progression of resistance, repetition volume, contraction duration, or exercise difficulty described.	Not reported. No performance-based or symptom-based strengthening advancement criteria specified	Six weeks; three supervised sessions/week (18 sessions total); approximately 60 minutes/session.
10	Zhang et al. (2024) [24]	Experimental: cervical extensor isometric training using self-applied manual resistance below the occiput, followed by resistance-band cervical extension in four-point kneeling (described as isokinetic). Control: cervical stretching exercises. Both groups received manual cervical traction and initial analgesic medication.	Isometric: 15-minute, sustained contractions as long as possible, 30-second rest when fatigued. Resistance-band exercise: 4 × 15 repetitions, 30-second rests. Five-minute rest between strengthening components. Initial resistance magnitude and band tension not reported.	Partially reported: Participants could adjust resistance-band tension by changing hand spacing; rest was permitted according to fatigue. No scheduled progression in load, repetitions, or exercise difficulty described.	Not reported: No explicit performance-based or symptom-based advancement threshold. Fatigue-guided rest was described but was not an advancement criterion.	12 months, three sessions/week; first nine months clinic-supervised, final three months home-based with weekly video supervision.
11	Kumari et al. (2024) [25]	Experimental: TheraBand-resisted cervical flexion, extension, bilateral lateral flexion and bilateral rotation using a head harness. Control: cervical isometrics in the same directions, stretching and hot-water fomentation.	Experimental: Two sets × 10-15 repetitions, with mild fatigue during the final set. Initial band color, absolute resistance and rest intervals not reported. Control-group isometric dose not reported.	Reported, but incompletely specified: Elastic resistance was progressively increased when participants achieved the stated repetition criterion. Band color sequence, resistance increments and progression frequency were not reported.	Reported: Ability to complete three sets × 8-12 repetitions was the stated criterion for increasing resistance. However, this differs from the prescribed 2 × 10-15 repetitions and is not reconciled in the article.	Six weeks; five sessions/week (30 planned sessions). Supervision level and session duration not clearly specified.
12	Batool et al. (2023) [26]	Both groups received cervical isometric strengthening targeting flexors, extensors, bilateral lateral flexors and rotators, alongside cervical stretching and hot packs. Group A additionally received DBM fasciatherapy; Group B received fascial manipulation.	Isometric contractions: 5-6 repetitions with 10-second holds in each cervical movement direction. Number of sets, resistance intensity and rest intervals not specified.	Not reported. No changes in contraction duration, repetitions, resistance or exercise difficulty were described over the three weeks.	Not reported. No performance-, fatigue- or symptom-based criteria for increasing strengthening dosage.	Three sessions/week on alternate days for three weeks; 45 minutes per treatment session, including manual therapy, hot packs, stretching and strengthening.
13	Suwaidi et al. (2023) [27]	Standard group: deep cervical flexor chin tucks progressing to head lifts, optional manually resisted cervical flexor work, and scapular retractor strengthening using prone weights and elastic resistance; cervical extensor and pectoral stretching. CBP group: mirror-image cervical postural exercises plus Denneroll traction.	Chin tucks: five repetitions per set, five to seven sets, one-minute interset rest; initial holds two seconds. Scapular retraction: at least six-second contractions; advancement assessed using 3 × 12 accurate repetitions with 2-min rest. CBP mirror-image exercises: 20 repetitions × 10-second holds. Starting resistance magnitude and weights not specified	Reported: Chin-tuck holds progressed through 2, 4, 6, and 8 seconds, with progression from supported chin tucks to head lifts. Scapular strengthening progressed from prone weighted retraction to elastic resistance plus weights, with stages approximately two weeks apart.	Partially reported: Scapular progression required accurate completion of 3 × 12 repetitions. No explicit pain threshold or individualized advancement criterion for cervical flexor progression.	18 sessions over six weeks (3/week), approximately 30 minute/session. No further intervention during the three-month follow-up.
14	Hamdy et al. (2023) [28]	All groups received manually resisted cervical isometric strengthening for cervical flexion, extension and lateral flexion, combined with cervical extensor stretching, active cervical ROM exercises and moist heat. Group A additionally received integrated neuromuscular inhibition technique (INIT); Group B received instrument-assisted soft tissue mobilization (IASTM); Group C received STT alone.	10-15 repetitions with 10-second sustained contractions for cervical isometrics. Manual resistance was applied to the forehead, occiput or lateral head. Number of sets, resistance intensity and inter-repetition rest intervals not reported.	Not reported. No progressive adjustment of manual resistance, repetitions, contraction duration or exercise difficulty described.	Not reported. No performance-, fatigue- or symptom-based strengthening advancement criteria.	Three sessions/week for four weeks (12 planned sessions). Strengthening was delivered as part of supervised traditional therapy; exercise-specific duration not reported.

15	Hernández-Lucas et al. (2023) [29]	Back School program incorporating resisted cervical flexion, extension and bilateral lateral flexion, shoulder external rotation, scapular stabilization, prone cervical extension, supine cervical flexion and additional cervical/scapular exercises. Combined with mobility, flexibility and educational interventions.	Three 30-second exercise bouts, alternating with three 10-second active-rest periods for each exercise. Initial thin elastic band: 1.3 kg resistance at 100% elongation. Repetition counts and individually applied resistance were not quantified.	Reported: Five predetermined elastic-band resistance levels: 1.3, 1.7, 2.1, 2.6, and 3.3 kg at 100% elongation. Resistance progressed approximately every three practical sessions, corresponding to nominal increases of approximately 25%.	Time-based progression: Band resistance increased according to scheduled sessions. No individualized performance, fatigue, pain-threshold or next-day symptom-response criterion was reported in the supplied protocol.	Eight weeks, twice weekly; 16 sessions (14 practical, two theoretical), each 45 minutes. Practical sessions: three-minute question/review period, seven-minute warm-up, 30-minute main exercise component and five-minute cool-down.
16	Gümüşçü et al. (2023) [30]	All groups: self-resisted cervical isometrics for flexion, extension, rotation and lateral flexion. Group 2 additionally received pressure-biofeedback-guided deep cervical flexor training and progressive cervical stabilization exercises. Group 3 additionally received cervical and core stabilization, including abdominal hollowing, bridging, crunches and progressively challenging limb/trunk exercises.	Conventional: 10 repetitions × 5-second holds per prescribed cervical movement. Group 2: pressure biofeedback initially 20 mmHg, progressed in 2-mmHg steps toward 30 mmHg; 10-second holds, 10 repetitions. Subsequent stabilization exercises: 10 repetitions × 10-second holds, 5-second relaxation. Group 3: lumbar pressure-biofeedback baseline 40 mmHg; stabilization exercises 10 repetitions × 10-second holds, 5-second relaxation	Reported, partially quantified. Group 2: graded pressure-biofeedback targets and progression from supine motor control to prone, quadruped and limb-movement tasks. Group 3: progression through supine, prone, quadruped and ball-supported stabilization exercises. Conventional isometric strengthening progression not described.	Partially reported. Group 2 progressed after deep cervical flexor activation and achievement of cervical motor control. Group 3 progressed after achieving core motor control and maintaining stable pelvic pressure. No explicit pain, fatigue, repetition-quality threshold or standardized advancement test.	Three supervised sessions/week for four weeks (12 sessions); approximately 30 minutes per exercise program.
17	Fernandes et al. (2023) [31]	GPR: Three postural positions incorporating isometric contractions, sustained muscle-chain stretching, postural correction and breathing control. SE: Progressive cervical flexor/extensor and axioscapular motor-control, strength and endurance exercises, including cranio-cervical flexion, cervical extension, scapular retraction/depression and resisted upper-limb movements, with laser-guided sensorimotor training.	GPR: Two supine postures lasting approximately 15-20 minutes each, with intermittent 5-10-second isometric contractions, followed by five minutes standing. SE: Initial cervical extensor exercises: 3 × 5 repetitions; cervical/scapular control exercises: typically 10 repetitions or 10-second holds × 10 repetitions, depending on exercise. Initial external resistance was not quantified.	Reported: SE followed three progressive levels, advancing from low-load motor-control exercises to sustained contractions and strengthening/endurance tasks, including head lifts, loaded cervical extension, and loaded scapular/upper-limb exercises. GPR progressed postural alignment, limb positioning and muscle-chain stretching according to individual tolerance and control. Sensorimotor exercises progressed in complexity.	Partially reported: SE progression included capacity-dependent advancement (e.g., reducing head support and adding light weights according to participant capacity), with the physiotherapist adapting exercise intensity and execution. GPR stretching progressed when participants maintained postural corrections without compensation. No quantified pain threshold or next-day symptom-response rule was specified.	Eight supervised sessions over four weeks (twice weekly), with daily prescribed home exercises. The 2023 trial describes approximately 40 minutes/session; the earlier protocol specifies approximately 35 minutes for SE and 45 minutes for GPR.
18	Hernández-Lucas et al. (2023) [32]	Supervised elastic-band cervical and scapular strengthening/endurance and proprioceptive exercises, combined with joint mobility, flexibility and relaxation. Individual exercises are not specified in the supplied text.	Starting yellow TheraBand, nominal 1.3 kg resistance at 100% elongation. Main exercise component 30 minutes/session; sets, repetitions, contraction durations, rest intervals and actual band elongation not reported.	Explicit schedule-based resistance progression: yellow 1.3 kg (sessions 1-5), red 1.7 kg (6-9), green 2.1 kg (10-13), and blue 2.6 kg (14-16), all nominal forces at 100% elongation.	Not reported. Progression followed predetermined session blocks; no individualized strength, fatigue, movement-quality, or symptom-response threshold.	Eight weeks; two supervised sessions/week; 16 sessions × 45 minutes (10-minute warm-up, 30-minute main exercise, and 5-minute cool-down).
19	Kang et al. (2022) [33]	Green TheraBand cervical and scapular resistance exercises: chin tuck, seated row in long sitting, bent-over row, scapular retraction, standing row, seated row on chair, letting full down (as named by authors), and standing chest press. Exercises targeted deep cervical flexors, serratus anterior, rhomboids and middle/lower trapezius.	Weeks 1-2: 3 sets × 10-15 repetitions/exercise; 30-second rest between sets. Initial green-band resistance; exact tension, elongation, and loading intensity not quantified.	Repetition-based progression: weeks 3-4 increased to 3 sets × 15-20 repetitions. No documented band-resistance or load progression.	Not reported. Progression was scheduled by week, without stated performance, fatigue, pain or movement-quality criteria.	Four weeks, five sessions/week (20 sessions); 30 minutes/session: Five-minute warm-up, 20-minute strengthening, five-minute cool-down.
20	Aydoğmuş et al. (2022) [34]	Both groups: cervical isometrics in flexion, extension, lateral flexion and rotation, plus stretching. Stabilization group additionally received deep cervical flexor/extensor strengthening, cervical rotation/lateral-flexion	Week 1: Ten repetitions/exercise; weeks 2-3: Fifteen repetitions. Stabilization group began with red TheraBand; dumbbell exercises began in week 2 using 1-2 kg.	Scheduled progression: repetitions 10→15; stabilization exercises supine in week 1→standing in weeks 2-3; elastic resistance	Not reported. Progression was time-based; no explicit strength, movement-quality, fatigue, pain, or symptom-	Supervised group exercise five times/week for three weeks, followed by home exercises five times/week. Home program duration

		strengthening, functional/postural exercises, and scapular/upper-extremity strengthening using TheraBands and dumbbells.	Sets, contraction duration, isometric intensity and rest intervals not reported.	red→green→blue, progressing weekly; dumbbells introduced in week 2.	response thresholds.	and total adherence not quantified.
21	Arif et al. (2022) [35]	Both groups: seated self-resisted cervical isometrics in flexion, extension, lateral bending and rotation. Experimental group additionally performed supine cervical stabilization using a pillow beneath the neck, with guided cervical nodding/craniocervical flexion. Both groups received heat and TENS.	Cervical isometrics: 10 repetitions × 10-second holds per prescribed movement. Additional stabilization: 10 repetitions × 10-second holds. Number of sets, rest intervals and resistance intensity not reported.	Not reported. No documented increase in repetitions, contraction duration, resistance or exercise difficulty during the four-week program.	Not reported. No performance-based, fatigue-based or symptom-based advancement criteria.	Four weeks, three sessions/week, 12 planned sessions. Heat 15 minutes and TENS 10 minutes/session; strengthening-session duration not specified.
22	Bugti et al. (2022) [36]	Strength group: intensive cervical isometric resistance exercises. Endurance group: dynamic cervical endurance exercises, including lifting the head from a horizontal position. Both training groups received aerobic exercise, stretching and rehabilitation support.	Not reported. No numerical starting resistance, contraction intensity, sets, repetitions, hold duration or rest intervals provided.	Not reported. No explicit progression in resistance, exercise volume, contraction duration or difficulty.	Not reported. No performance-, fatigue- or symptom-based advancement criteria.	Aerobic exercise and stretching reported three times/week; four physiotherapy sessions mentioned. Exercise-specific frequency, total strengthening sessions and intervention duration are unclear. Outcomes assessed through 12 months
23	Anwar et al. (2022) [37]	Both groups performed supine cervical flexor and extensor isometric strengthening after infrared heat. Group A additionally received sham breathing; Group B received supervised breathing re-education involving slow nasal inhalation and oral exhalation.	Cervical flexor and extensor isometrics: 20 repetitions with 10-second holds for each muscle group. Number of sets, applied resistance, contraction intensity and rest intervals not reported.	Not reported. No increase in resistance, repetitions, contraction duration, exercise difficulty or training volume described.	Not reported. No performance-, fatigue-, pain- or symptom-response-based advancement criteria.	Eight weeks, five sessions/week (40 planned sessions); 30 minutes/session reported. Infrared heat 10 minutes; breathing/sham breathing 15 minutes.
24	Shamsi et al. (2021) [38]	Both groups performed therapist-resisted cervical isometrics targeting flexors, extensors, rotators, and lateral flexors in sitting. The therapist applied manual resistance while the patient attempted movement without producing cervical motion. Additional stretching was performed for upper trapezius and cervical rotators.	10 repetitions × 10-second isometric holds for each cervical movement per session. Number of sets, resistance intensity, contraction effort, and rest intervals for strengthening not reported.	Not reported. No planned progression in resistance, repetitions, contraction duration, or exercise complexity.	Not reported. No strength-, fatigue-, pain-, or movement-quality-based advancement criteria.	Two weeks, three sessions/week (six sessions). Both groups received identical strengthening. Group A additionally received SNAGs (three sets × six repetitions); Group B received ultrasound for 10 minutes.
25	Javdaneh et al. (2021) [39]	Cervical craniocervical flexion, bracing, and resisted isometrics; combined group additionally performed scapular upward-rotation and strengthening exercises using body weight, elastic bands, and dumbbells.	Craniocervical flexion: 5-10 reps × 5-10 s; bracing: 8 × 8 s; cervical isometrics: 5 × 8 s. Scapular strengthening: 3 × 10-15 reps with body weight in weeks 1-2.	Explicit progression: cervical repetitions and hold duration increased weekly; craniocervical flexion progressed through 22-30 mmHg targets; scapular band resistance progressed yellow → red → green → blue; dumbbell loading increased from 30% to 60% 1RM during weeks 3-6.	Partially specified: completion of the preceding craniocervical pressure target was described. Other progression followed predetermined weekly schedules; individualized strength, fatigue, pain or next-day symptom criteria were not reported.	Six weeks, three sessions/week, 18 supervised sessions; 40-60 minutes/session.
26	Cho et al. (2021) [40]	Four lower trapezius-focused exercises: latissimus pull-down, prone V-raise, prone row, and modified prone cobra. Both groups also received cervical extension-flexion-rotation exercises as part of general physiotherapy.	Week 1: 3 sets × 10 repetitions per strengthening exercise, without external resistance. Modified prone cobra included a 10-second hold. Rest: 30-60 seconds between sets.	Week 2: 3 × 10 with yellow TheraBand. Week 3: 3 × 15 using yellow/red TheraBand according to strength. Weeks 4-5: 3-5 × 15 using yellow/red TheraBand according to physical strength.	Partially reported: Band resistance was selected according to participants' strength and fatigue, targeting RPE 12-15 on the Borg 6-20 scale. No explicit repetition-success, pain-response or next-day advancement threshold.	Five weeks, twice weekly (10 sessions). Experimental strengthening: 15 minutes/session in addition to 45 minutes of general physiotherapy.
		Both groups received supervised cervical strengthening, stretching, and stabilization exercises, including cervical flexion,	3 sets × 10 repetitions of low-resistance cervical isometric	Not reported. No planned	Not reported. No objective	Four weeks; One supervised exercise session/week (four

27	Groisman et al. (2020) [41]	extension, rotation, and self-mobilization targeting deep cervical muscles. Exercises involved low-resistance isometric contractions performed in supine and sitting positions. The experimental group additionally received pragmatic OMT.	exercises. Exact contraction duration, resistance magnitude, rest intervals, and muscle-specific dosage not reported.	increase in resistance, repetitions, sets, contraction duration, or exercise complexity was described.	strength, fatigue, movement-quality, or symptom-based advancement criteria.	sessions), approximately 40-45 minutes/session; home exercises prescribed three times/week. Both groups followed the same exercise protocol.
28	Lytras et al. (2020) [42]	Both groups performed cervical and scapular endurance/resistance exercises, including deep cervical flexor retraining, cervical stabilization, neck and upper-limb resistance exercises using elastic bands, and isometric strengthening of cervical flexors, extensors, lateral flexors and rotators.	Elastic-band exercises prescribed at 12-15 repetition maximum (RM); cervical isometrics performed at 20-70% MVC. Exact sets, contraction hold durations, rest intervals, and muscle-specific starting loads not reported in supplied article text.	Not reported in supplied article text. A broad resistance-intensity range was provided, but no explicit weekly progression sequence or loading adjustment schedule.	Not reported in supplied article text. No defined performance, fatigue, pain, or symptom-response threshold for advancing resistance.	10 weeks, four supervised sessions/week, 40 planned sessions; 45 minutes of therapeutic exercise/session. Both groups received identical exercise training.
29	Mehri et al. (2020) [43]	Multicomponent corrective exercise program incorporating cervical flexor strengthening (supine capital flexion with and without head lift), cervical extensor strengthening (prone and quadruped exercises), scapular retraction, trapezius strengthening, wall-supported shoulder abduction/external rotation, shoulder flexion, wall slides, and W-to-Y exercises. Postural alignment and motor-control exercises were also included.	Phase 1: 12-15 repetitions per exercise, beginning with a reference to 12RM and progressing to 15 repetitions; maintained for four weeks. Phase 2: 3 sets × 15 repetitions, with one-minute rest between sets. General exercise holds approximately 30-60 seconds; selected movements held for 2-3 or 5 seconds. Initial external resistance, exercise-specific sets, and actual RM-testing procedures were not clearly quantified.	Three conceptual phases: (1) slow, controlled, low-pain coordination/proprioception exercises; (2) muscular endurance; (3) strengthening. Repetitions progressed from 12 to 15, followed by a reported 3 × 15 prescription. Resistance could be added to selected shoulder exercises using free weights or resistance bands. The precise timing and dosage of the third phase, load increments, and resistance-adjustment intervals were not reported	Not reported: No explicit individualized advancement threshold based on pain, fatigue, repetitions completed, movement quality, or strength reassessment. Pain-free movement and alignment instructions were provided but were not explicitly linked to advancement decisions.	Supervised corrective exercises, three days/week for eight weeks (24 planned sessions). Methods described sessions progressing from 30 to 60 minutes; abstract reported 30 minutes/session. Supervised by a physiotherapist and corrective exercise trainer.
30	Fathollahnejad et al. (2019) [44]	Supervised scapular stabilization and strengthening targeting the periscapular muscles, particularly middle/lower trapezius and serratus anterior. Exercises included Y-to-W, L-to-Y, and scapular protraction in a prone bridge position. The program also incorporated pectoralis stretching, chin tucks, neutral-posture education, and stabilization activities on stable and unstable surfaces. Group 1 additionally received cervical manual therapy; Group 2 performed stabilizing exercises without manual therapy.	Strengthening exercises were described as progressively performed for 3 sets × 10-15 repetitions. The exact starting repetitions, initial number of sets, external resistance, contraction duration for strengthening exercises, and inter-set rest intervals were not specified. Pectoralis flexibility exercises were held for five seconds and repeated 10 times.	Repetition-based progression within a prescribed range of 10-15 repetitions was described. Exercises were performed on stable and unstable surfaces, but their sequencing and use as a progression strategy were not specified. No explicit resistance increments, load progression schedule, or week-by-week progression protocol was provided	Not reported: No explicit individualized advancement criteria based on pain, fatigue, successful repetition completion, perceived exertion, movement quality, or strength testing. Neutral alignment and scapular stabilization were emphasized, but were not explicitly identified as criteria for progression	Six weeks, three supervised sessions/week, 30 minutes/session (18 planned sessions). Groups 1 and 2 received stabilizing exercises; Group 1 additionally received 10 minutes of cervical manual therapy three times weekly. The control group received home-based postural correction exercises three times weekly and occasional educational sessions. One-month post-intervention follow-up.
31	Suvarnnato et al. (2019) [45]	SCT: seated isometric cervical extension against therapist-applied manual resistance at the posterior arch of C2, with shoulder stabilization to minimize compensatory trunk movement; participants resisted maximally without provoking neck pain. (2) DCF: supine low-load CCF training using pressure biofeedback positioned beneath the suboccipital region, emphasizing deep cervical flexor activation without superficial flexor substitution. The control group received usual physiotherapy, potentially including general exercises, upper-limb strengthening, manual therapy, and electrotherapy, but was prohibited from performing the two specific experimental exercises.	SCT: 10-second isometric holds × 10 repetitions/set × 3 sets/session; 30-second rest between sets. Manual resistance was increased gradually during application, but resistance magnitude was not quantified. DCF: Pressure-biofeedback baseline 20 mmHg, with an individually selected training level of 22, 24, 26, 28, or 30 mmHg. Ten repetitions/set with short rests and 30-second inter-set rest; the number of DCF sets and individual hold duration were not explicitly stated in the supplied intervention description	SCT: Therapist-applied resistance was increased gradually during each isometric contraction, but no longitudinal progression schedule, quantified load increments, or systematic resistance reassessment was described. DCF: Initial pressure target was individualized using incremental pressure levels from 22 to 30 mmHg. However, progression between pressure targets over the six-week intervention, reassessment intervals, and subsequent advancement procedures were not reported.	Partially reported: For SCT, resistance was applied according to tolerance without provoking neck pain, while compensatory body movement was monitored. For DCF, the initial pressure target was determined individually as the highest pressure level achievable with correct CCF technique, without superficial flexor activation or neck-pain provocation. These were explicit initial exercise-selection criteria; no separate criteria for longitudinal advancement were reported.	Six weeks. SCT: Supervised by a physical therapist twice weekly, approximately 12 planned sessions. DCF: Supervised twice weekly for six weeks, plus instructed home training twice daily without pressure biofeedback. Usual care: 10-12 physiotherapy appointments over six weeks, 20-30 minutes per appointment. Outcomes assessed after six weeks and at one- and three-month follow-up.

32	Altaf et al. (2017) [46]	Strength group (n = 20): Intensive isometric cervical strengthening exercises. Endurance group (n = 20): Active cervical exercises involving lifting the head from supine and prone positions. Both groups received therapeutic ultrasound, hot packs, dynamic shoulder exercises, and postural education. The specific muscles targeted, exercise positions for isometric strengthening, and method of applying resistance were not described.	Not reported: No initial external resistance, contraction intensity, percentage of maximum voluntary contraction, isometric hold duration, repetitions, sets, or rest intervals were specified for the strength group. The endurance group performed supine and prone head-lifting exercises, but repetitions, sets, hold duration, and starting intensity were not quantified.	Not reported: No scheduled progression in resistance, repetitions, sets, contraction duration, exercise complexity, or training intensity was described. No weekly progression schedule or reassessment procedure was provided.	Not reported: No explicit individualized advancement criteria based on pain, fatigue, movement quality, strength, exercise tolerance, or successful completion of repetitions were described.	Three weeks. Both groups were instructed to repeat their exercise program once daily. The number, frequency, and duration of supervised physiotherapy sessions were not specified. Actual treatment attendance was not quantified.
33	Lauche et al. (2016) [47]	Conventional neck exercise program combining cervical isometric strengthening, mobility, stretching, proprioceptive training, and core exercises. Cervical resistance exercises included hand-resisted isometric flexion (forehead), extension (occiput), lateral flexion (side of head), chin-down pressure, and rotation (temple), with the head maintained stationary. Additional exercises included palm-to-palm pressing, trunk strengthening, and upper- and lower-limb movements. Tai Chi and wait-list groups served as comparators.	Cervical isometrics: 5-15-second holds × 3 repetitions for each direction; lateral flexion performed on each side. Palm-to-palm pressing: 20-30 seconds × 3 repetitions. Core exercises included abdominal crunches, 10-20 repetitions × 3, and various 10-20-second exercises. Initial resistance magnitude, percentage of maximal voluntary contraction, and precise effort level were not quantified.	Not reported: No planned week-by-week increase in cervical isometric resistance, hold duration, repetitions, sets, or exercise difficulty. The 5-15-second hold range describes the prescribed exercise dosage, not a documented progression from 5 to 15 seconds.	Not reported: No individualized criteria for increasing resistance or exercise difficulty based on pain, fatigue, technique, strength, or completion of prescribed exercise were described. Instructor feedback was provided, but no formal advancement algorithm was specified.	12 weeks: One supervised group session weekly. The detailed Methods specify 60-75 minutes per neck-exercise session, although the general study-design description states 75-90 minutes for both active interventions. Home practice was recommended for at least 15 minutes daily. Warm-up lasted 5-10 minutes, followed by neck/core exercises and relaxation.
34	Javanshir et al. (2015) [48]	CCF group (n = 30): Low-load craniocervical flexion using pressure biofeedback to activate deep cervical flexors (longus colli and longus capitis), minimizing superficial flexor recruitment. CF group (n = 30): Supine cervical flexion/head-lifting exercises, progressing to externally resisted training using forehead sandbags.	CCF: Baseline pressure 20 mmHg; individualized starting target from 22 to 30 mmHg. Each target involved 10-second contractions × 10 repetitions, with 10-second rests. CF: Stage 1 (weeks 1-2), individual 12RM progressing to 15 repetitions. Stage 2 (weeks 3-10), 3 sets × 15 repetitions with 1-minute rests. Initial external resistance in kilograms was not reported.	CCF: Progressive advancement through five pressure targets (22, 24, 26, 28, 30 mmHg) in 2-mmHg increments. CF: Repetition progression from 12RM to 15 repetitions, followed by 0.5-kg sandbag increments when exercises became easier. Exercise difficulty could be reduced by elevating the trunk and neck from the horizontal position.	CCF: Advancement required 10 controlled, 10-second contractions at the current pressure level without superficial flexor substitution or jerky movements. CF: Resistance increased when participants could perform exercises easily and reduced when they could not. Both programs required pain-free execution. No numerical pain or RPE threshold was specified.	10 weeks: Both groups received supervised exercise three times/week, with sessions lasting a maximum of 30 minutes. Participants were instructed to perform home exercises three times/day.
35	Kang et al. (2015) [49]	FBE (n = 32): Combined cervical and shoulder stretching and strengthening exercises, alongside forest walking. Each exercise cycle included a 10-minute warm-up, 30-minute main exercise component, and 10-minute cool-down. The main component targeted cervical and shoulder muscles. FBA (n = 32): Forest walking without the additional structured exercise program.	Exercise cycles were described by duration rather than resistance-training dosage. Starting resistance, individual strengthening exercises, sets, repetitions, contraction duration, and rest intervals between strengthening sets were not reported. The program included two exercise cycles per afternoon and two additional cycles after dinner.	Partially reported: The authors stated that exercise intensity was gradually increased during the main exercise component. However, no specific progression in load, repetitions, sets, resistance, or exercise difficulty across the five days was described.	Not reported: No individualized criteria based on pain, fatigue, strength, technique, performance, or symptom response were specified for increasing or reducing exercise intensity.	Five days: Both groups walked in the forest approximately two hours each morning. The FBE group additionally completed approximately four hours/day of structured stretching and strengthening activities, divided between afternoon and evening sessions. FBA participants had free time instead.
36	Rudolfsson et al. (2014) [50]	ST group (n = 36): Six cervical and shoulder strengthening exercises. Three cervical isometric exercises using a head harness/cable pulley and adjustable bench: seated trunk tilting forward and laterally while stabilizing the neck, and supine small head rotations. Three dynamic shoulder exercises: seated dumbbell shoulder press,	Sessions 1-3: Familiarization at Borg RPE 11-13; cervical isometrics 1 × 15 repetitions and dynamic exercises 2 × 15 repetitions. Session 4: 1RM determination using submaximal tests for dynamic exercises and a maximal test for cervical flexors. Sessions 5-11: 60% 1RM, approximately RPE 13; cervical	Clearly reported: Individualized, RPE-guided progressive resistance training. Load increased when perceived effort declined below specified thresholds. A new 1RM determination was performed at session 11 or when 80% of 1RM	Clearly reported: During sessions 5-11, increase load at the next session when RPE fell below 12. During subsequent sessions, increase load when RPE fell below 14. Reassessment of 1RM was	11 weeks: 22 individually supervised sessions, approximately 2/week, 30 minutes/session. Each session included a two-minute warm-up, six strengthening exercises,

		standing chest press, and seated row. Isometric contractions were held for three seconds. Comparators were neck coordination exercise and massage.	isometrics 1 × 12 and dynamic exercises 2 × 12. Remaining sessions: 75% of reassessed 1RM, approximately RPE greater than 16; cervical isometrics 1 × 8 and dynamic exercises 2 × 8.	was attained, followed by progression to 75% of reassessed 1RM with fewer repetitions.	performed at session 11 or on reaching 80% of 1RM. No pain-based advancement criterion was specified.	and a two-minute cool-down. Home strengthening was not described.
37	Karlsson et al. (2014) [51]	STRENGTH (n = 34): Progressive home-based dumbbell exercises targeting neck and shoulder-related musculature: arm abduction, upright row, biceps curls, flys, reverse flys, and pullovers. Supine head lifting against head weight was included. Trunk/leg exercises and stretching followed. STRETCH (n = 23): Neck retraction and stretching of cervical, shoulder, and upper-limb muscles without prescribed strengthening	Weeks 1-8: 2-kg dumbbells, working toward 3 sets × 20 repetitions per exercise; participants initially performed as many repetitions as possible. After week 8: Resistance individually adjusted to the heaviest weight permitting 10 repetitions. Heavy weeks: 3 × 10 initially; light weeks: 2-kg dumbbells, 3 × 20. Head lifting: Initially as many repetitions as possible, targeting 3 × 20, followed by additional repetition progression	Clearly reported: Eight-week familiarization followed by periodized resistance training. Three consecutive heavy weeks alternated with one light week. During heavy weeks, repetitions progressed from 10 toward 15; once 3 × 15 was achieved, dumbbell resistance was increased and repetitions reset to 10. Head-lifting repetitions progressed without additional external resistance.	Clearly reported: Increase dumbbell resistance when the participant could complete 3 sets × 15 repetitions at the current heavy load. The new resistance was the heaviest load allowing 10 repetitions. No numerical pain, RPE, or next-day symptom-response criterion was specified.	12 months: Home exercise prescribed three times/week, preceded by three instructional sessions. Exercise diaries and physiotherapist support every 4-8 weeks. Optional aerobic exercise of 30 minutes, three times/week, was encouraged.
38	Khan et al. (2014) [52]	Isometric group (n = 34): Elastic-band (Theraband) resisted isometric exercises targeting cervical flexors, extensors, bilateral lateral flexors, and rotators. Exercises were performed primarily in sitting, with supine or prone positioning permitted if sitting was difficult. Comparator (n = 34): Active cervical ROM exercises involving the same movement directions, without specified external resistance	20 repetitions per exercise, three supervised sessions/week. The number of sets, isometric contraction duration, rest intervals, initial elastic-band resistance, percentage of maximum voluntary contraction, and target exercise intensity were not reported. The same exercises were prescribed for home performance twice daily, at least five days/week.	Not reported: The intervention maintained a stated repetition prescription throughout 12 weeks. No systematic progression of elastic-band resistance, contraction duration, repetitions, sets, or exercise difficulty was described. Alternative exercise positions were permitted for difficulty with sitting, but were not presented as a progression sequence	Not reported: No criteria based on strength, repetition performance, perceived exertion, exercise tolerance, pain response, or symptom recovery were provided for advancing resistance or dosage.	12 weeks: Three supervised sessions/week (36 planned sessions), plus home exercises twice daily on at least five days/week. Supervision was provided by physiotherapists with at least two years of musculoskeletal clinical experience. Session duration was not reported
39	Borisut et al. (2013) [53]	SE (n = 25): Progressive resisted cervical flexion and extension performed supine and prone, targeting superficial cervical flexors and extensors, including SCM, anterior scalenes, and cervical erector spinae. CCF (n = 25): Low-load craniocervical flexion using pressure biofeedback, targeting longus capitis and longus colli. Combined (n = 25): CCF followed by a five-minute rest and then SE. Control (n = 25): No exercise during the intervention period.	SE phase 1 (weeks 1-4): Initial load corresponding to 12RM; participants performed 12-15 repetitions, progressing toward 15. Number of sets was not specified. SE phase 2 (weeks 5-12): 3 sets × 15 repetitions using the initially determined 12RM load, with one-minute rests. CCF: Pressure sensor baseline 20 mmHg; target pressure 22-30 mmHg; 10-second contractions × 15 repetitions, with 10-second rests. Combined: Both protocols in sequence.	SE: Repetition progression from 12 to 15 during the first four weeks, followed by increased training volume to 3 × 15 during the remaining eight weeks. No subsequent resistance increments were specified. CCF: A target pressure range of 22-30 mmHg was reported, but no explicit pressure-level advancement sequence or week-by-week progression was described. Combined: Followed the respective SE and CCF protocols.	SE: Initial resistance based on individual 12RM capacity; advancement toward 15 repetitions was prescribed, but no explicit criterion for increasing external resistance was reported. CCF: Participants were required to sustain contractions without pain, but criteria for advancing between pressure targets were not described. No RPE threshold, numerical pain threshold, or individualized next-day symptom criterion was specified.	12 weeks: All exercise groups trained daily and maintained exercise logbooks. The combined group completed CCF before SE, separated by five minutes. Session duration and supervision frequency were not specified.
40	Hudson et al. (2010) [54]	Cervical and shoulder strengthening, cervicothoracic stability, postural control/proprioception, and relaxation exercises. Strengthening initially involved isometric resistance exercises for cervical and shoulder regions, progressing to through-range resisted shoulder-girdle exercises using elastic bands (Theraband) and dumbbells. Accompanied by education on pain management, exercise, pacing, ergonomics, and relaxation. Usual care: Individualized physiotherapy potentially involving exercises, education, mobilization, manipulation, electrotherapy, or	Not reported: No initial resistance, elastic-band grade, dumbbell weight, isometric hold duration, sets, repetitions, rest intervals, or target intensity were specified for the multimodal group. Usual-care exercise dosage was not described.	Partially reported: Progression from cervical/shoulder isometric resistance exercises to through-range shoulder-girdle resistance exercises was explicitly described. However, the timing, magnitude, and sequence of load increases were not reported.	Not reported: No individualized criteria based on pain, exercise technique, strength, fatigue, RPE, repetitions completed, or symptom tolerance were provided for progression from isometric to dynamic resistance exercises	Multimodal: Initial 40-minute assessment followed by six weekly, 60-minute supervised group sessions; group size no more than eight. Usual care: Initial 40-minute assessment followed by approximately 5-8 individualized treatments, with 20-minute follow-up appointments; participants actually attended 6-7 treatments. No home

		acupuncture; strengthening content was not standardized.				strengthening schedule was specified.
41	Häkkinen et al. (2008) [55]	Combined cervical isometric strengthening, upper-extremity resistance exercises, trunk and lower-limb exercises, and stretching. Cervical strengthening used elastic resistance bands attached to a head strap, targeting flexors and extensors. Upper-extremity exercises included dumbbell shrugs, presses, curls, bent-over rows, flys, and pullovers. The comparator received stretching exercises without the strengthening program.	Cervical flexors: 3 × 15 repetitions (forward and bilateral oblique directions); cervical extensors: 1 × 15 repetitions. Target resistance was 80% of maximal isometric neck strength. Upper-extremity exercises: 1 × 15 repetitions at the highest achievable load. Abdominal and back exercises: one series each; squats performed until fatigue. Initial resistance was individualized.	Resistance was intended to remain at 80% of maximal isometric neck strength, reassessed at baseline and follow-up. Resistance was checked using handheld digital scales during supervised training. No predetermined weekly progression in sets, repetitions, or external resistance was reported.	Partially reported: Individual maximal isometric strength guided cervical resistance selection and reassessment. Upper-extremity loads were selected according to the highest achievable load. No explicit symptom-response threshold, repetition-completion criterion, or standardized rule for increasing resistance between sessions was reported.	12 months; home exercises prescribed three times weekly. Supervised strengthening was provided weekly for the first six weeks and every second month thereafter, with 10 group meetings reported overall. Mean actual strengthening frequency declined from 2.1 sessions/week during months 1-2 to 1.1 sessions/week during months 3-12. Mean attendance was 8 of 10 group meetings.
42	Falla et al. (2007) [56]	Arm 1 (CCF training): Low-load, pressure-biofeedback-guided craniocervical flexion targeting longus capitis and longus colli, minimizing superficial flexor substitution. Arm 2 (Endurance-strength): Supine cervical flexion/head-lift exercise targeting cervical flexors, with progressive resistance using forehead sandbags when appropriate.	CCF: Pressure baseline 20 mmHg; individualized starting target within 22-30 mmHg, in 2-mmHg increments. Train toward 10-second holds × 10 repetitions at each target. Number of sets not specified. Endurance-strength: Stage 1 (weeks 1-2): initial 12-repetition maximum (12RM) load, progressing from 12 to 15 repetitions; number of sets not specified. Stage 2 (weeks 3-6): 3 sets × 15 repetitions at the initial 12RM load, with one-minute rest between sets	CCF: Increase contraction duration and repetitions at the current pressure target, then progress to the next pressure target in 2-mmHg increments. Endurance-strength: Progress repetitions during the first two weeks; subsequently add forehead sandbag resistance in 0.5-kg increments when repetitions are easily achieved. Reduce mechanical demand by inclining the trunk if the head-lift exercise cannot be completed.	CCF: Advance after maintaining the target pressure for 10 seconds × 10 repetitions with controlled movement and without dominant superficial muscle substitution, retraction, or jerky movement. Endurance-strength: Increase resistance when repetitions are easily achieved. Regress to an inclined trunk position if the participant cannot complete the required head-lift repetitions. No quantified effort threshold was specified.	Both groups received six weekly supervised sessions, each ≤30 minutes, and were instructed to practise their respective exercises twice daily throughout six weeks. The authors specified that the exercises should not provoke neck pain. Stage 2 endurance-strength dosage was described as once daily, creating a frequency inconsistency with the general twice-daily home instruction.
43	Ylinen et al. (2003) [57]	Strength arm: High-intensity isometric cervical strengthening/stabilization using an elastic resistance band, performed in sitting in forward, right-oblique, left-oblique, and backward directions. Additional dynamic shoulder/upper-extremity strengthening using dumbbell shrugs, presses, curls, bent-over rows, flyes, and pullovers. Endurance arm: Dynamic cervical flexor training through supine head lifts, plus the same shoulder/upper-extremity exercises at lighter fixed loads. Both arms also included body-weight trunk/leg exercises, stretching, and multimodal rehabilitation.	Strength: Cervical isometric training: one series of 15 repetitions in each specified direction, targeting 80% of individual maximal isometric neck strength. Shoulder exercises: one set of 15 repetitions using the highest individually tolerable load permitting 15 repetitions. Endurance: Supine head lifts: 3 × 20 repetitions. Shoulder exercises: 3 × 20 repetitions with two 2-kg dumbbells. Trunk/leg exercises: one series of squats, sit-ups and back extensions; repetition counts not specified.	Strength: Resistance intended to remain at 80% of updated maximal isometric neck strength; resistance checked using a handheld force-measuring device during baseline and follow-up training visits. Dumbbell loads individualized to 15-repetition capacity. Endurance: Cervical head-lift resistance was body weight, and dumbbell loads were fixed at 2 kg; no systematic longitudinal load increase was described. Technique and intensity were reviewed at follow-up visits.	Strength: Individual maximal isometric strength was used to determine the target resistance; dumbbell loading was based on ability to complete 15 repetitions. No explicit criterion was provided for advancing resistance based on symptom response, perceived exertion or successful completion of repeated sessions. Endurance: No advancement threshold specified	Initial 12-day institutional rehabilitation, with nine exercise-practice sessions, approximately 45 minutes each, five sessions/week and alternating half-intensity sessions. Subsequently, home training was prescribed three times/week throughout 12 months. Exercise technique/intensity reviewed at 2, 6, and 12 months. Both training groups received stretching and were advised to perform aerobic exercise three times/week.
44	Viljanen et al. (2003) [63]	Dynamic resistance exercises using dumbbells to activate large muscle groups in the neck and shoulder region, followed by stretching after each exercise. Exercises were performed in a standardized sequence. From week 5, participants learned three exercises from the program for independent practice, together with stretching. From week 9, participants performed the program	Dumbbells weighing 1-3 kg each, selected according to performance on a 7.5-kg maximum-repetition test. Exercise-specific movements, starting sets, repetitions, repetition maximum, target exertion, and initial training volume were not reported in the	Authors stated that exercise intensity was increased progressively during the program. However, the increments, timing, loading adjustments, and progression sequence were not quantified. Changes in exercise independence during weeks 5 and 9 represented instructional	Initial dumbbell selection was individualized using maximum-repetition testing. No explicit criteria for subsequent advancement were reported, including repetition achievement, strength reassessment, perceived exertion or acceptable	Supervised group sessions, three times/week for 12 weeks, 30 minutes/session; one reinforcement week at six months. Sessions conducted by experienced physiotherapists in groups

		independently within the supervised group while the instructor provided feedback.	supplied article text.	progression, not necessarily resistance progression.	symptom response.	of up to 10 participants.
45	Bronfort et al. (2001) [64]	SMT + exercise: Progressive neck and upper-body strengthening, including push-ups, dumbbell shoulder exercises, and cervical resisted movements using weighted headgear attached to a pulley system. MedX: Dynamic cervical extension and rotation resistance training on MedX machines, with additional upper-body strengthening, stretching and aerobic exercise. All groups received instructions for home-resisted cervical extension, flexion, and rotation using rubber tubing.	SMT + exercise: Upper-body exercises, 2 sets of 15-30 repetitions; dumbbells 2-10 lb (approximately 0.9-4.5 kg); cervical headgear resistance attachments 1.25-10 lb (approximately 0.6-4.5 kg). Cervical-specific sets and repetitions not reported. MedX: Approximately 20 repetitions per cervical exercise; starting resistance, sets, and relative intensity not reported	SMT + exercise: Headgear resistance gradually increased throughout treatment. MedX: Machine resistance increased periodically. Exact increments, reassessment frequency and progression sequence not reported.	Not reported. No explicit repetition-completion threshold, percentage of maximum strength, RPE target, pain ceiling, or performance-based advancement rule.	20 supervised, 60-minute visits over 11 weeks. SMT + exercise: 15 minutes SMT plus 45 minutes exercise. MedX: supervised exercise including stretching, upper-body strengthening and 15-20 minutes aerobic cycling. Home resistance exercises instructed for all groups; home frequency and dose not specified.

TABLE 4: Strengthening exercise prescription and progression across the 45 included RCTs

CCF: craniocervical flexion; DCF: deep cervical flexors; MVC: maximum voluntary contraction; RM: repetition maximum; ROM: range of motion; RPE: rating of perceived exertion; SMT: spinal manipulative therapy; 1RM: one-repetition maximum.

Progression Methods and Advancement Criteria

Progression approaches included predetermined increases in exercise demands [16,19,20], adjustments to external resistance [50,51], increases in exercise volume [33,53], strength- or performance-based progression [48,51,55], and modifications according to exercise tolerance [15]. However, progression methods were not always accompanied by explicit criteria for advancing individual participants.

Time-Based Progression

Time-based progression involved predetermined increases in exercise demands. Zheng et al. (2026) [16] prescribed weekly increases in cervical strengthening repetitions, while Lee et al. (2025) [19] introduced external resistance during a specified treatment phase. Mehmetoğlu et al. (2025) [18] also used staged progression. Although these schedules described when exercise demands changed, individualized advancement criteria based on performance or symptom tolerance were not consistently specified.

Resistance- and Strength-Based Progression

Resistance-based progression involved adjustments to external loading or exercise intensity. Ylinen et al. (2003) [57] and Häkkinen et al. (2008) [55] used cervical strengthening linked to maximal isometric strength, while Borisut et al. (2013) [53] incorporated repetition-maximum loading. Rudolfsson et al. (2014) [50] used one-repetition maximum reassessment, whereas Karlsson et al. (2014) [51] individualized dumbbell loading according to repetition performance. Although these methods identified loading parameters, explicit advancement thresholds and progression schedules were not consistently reported.

Performance-Based and Individualized Progression

Performance-based progression involved increasing exercise demands after achieving specified strength, repetition, endurance, or movement-quality criteria. Ylinen et al. (2003) [57], Häkkinen et al. (2008) [55], Rudolfsson et al. (2014) [50], and Karlsson et al. (2014) [51] reported individualized loading approaches. Rudolfsson et al. used one-repetition maximum reassessment, while Karlsson et al. specified completing three sets of 15 repetitions before increasing dumbbell resistance. However, individualized loading did not necessarily establish explicit advancement criteria, particularly when progression thresholds or adjustment procedures were unspecified.

Symptom- or Tolerance-Guided Progression

Some trials referred to participant comfort or exercise tolerance when selecting or adjusting training demands [20,31,45]. However, these descriptions did not consistently specify acceptable pain thresholds, symptom-response limits, or criteria for delaying progression. Pain measured as a clinical outcome was not considered evidence of symptom-guided progression. General instructions to exercise within tolerance were distinguished from explicit rules for advancing, reducing, or discontinuing exercise.

Explicit Advancement Criteria and Reproducibility

Trials varied in whether they described progressive strengthening or specified explicit advancement criteria. Karlsson et al. (2014) [51] reported increasing resistance after completing prescribed repetitions, while Rudolfsson et al. (2014) [50] and Ylinen et al. (2003) [57] used strength-based loading adjustments. Other trials described scheduled progression [16,18,19] without consistently specifying individualized advancement thresholds. Overall, progression methods were more readily identifiable than the criteria governing individual exercise advancement, limiting protocol reproducibility.

Symptom-Response Monitoring, Adherence, and Adverse Events

Reporting of symptom-response monitoring, exercise modifications, adherence, and adverse events varied across the included trials. Although pain and functional outcomes were commonly assessed, procedures for monitoring exercise-related symptoms and modifying training demands were less consistently reported. Study-specific findings are summarized in Table *5*.

Sl. No.	Study	Pain monitoring during exercise	Post-exercise/next-day response	Modification/stopping rules	Adherence reporting	Adverse events/safety
1	Acikalin et al. (2026) [15]	Reported: Exercises performed within pain-free ROM. Resistance adjusted according to pain-free movement, individual tolerance, technique, and Borg RPE 11-14. Increased pain monitored by the supervising physiotherapist.	Partially reported: Neck pain, generalized body pain, and fatigue were assessed immediately and 20 minutes after the single exercise session. No next-day follow-up was reported; longitudinal symptom-guided progression was not applicable.	Partially reported: Band resistance and exercise execution adjusted according to pain-free ROM, tolerance, technique, and perceived exertion. No explicit numerical pain threshold or stopping criteria reported.	Partially reported: All 78 randomized participants were included in the final analysis. Sessions were supervised; exercise-specific adherence was not quantified.	Reported: The physiotherapist monitored dizziness, excessive fatigue, dyspnea, chest discomfort, and increased pain. Heart rate and oxygen saturation were monitored during exercise, and blood pressure was assessed at specified times. No adverse events were reported.
2	Zheng et al. (2026) [16]	Not reported for resistance exercise. No exercise-specific pain scale, permitted pain threshold, or systematic symptom-monitoring procedure described.	Not reported as an exercise-response rule. Visual Analog Scale (VAS) was assessed weekly, but no next-day symptom check or pain-response criterion governing subsequent exercise was described.	Partially reported: Resistance-exercise technique was monitored using submitted videos, with posture correction and feedback. No exercise-specific pain-based regression, stopping threshold, or symptom-guided progression criterion was reported. Pain-based force adjustments were described for Tuina, not resistance exercise.	Reported: RE compliance was 100.0%, 88.9%, 93.3%, and 97.8% across weeks 1-4. Video submissions, daily check-ins, reminders, and administrator verification were used. Tuina compliance was reported as 100% in both groups.	Reported: Patients and practitioners reported adverse events. Serious events required notification within 24 hours. No adverse events were reported during the trial.
3	Ali et al. (2025) [17]	Not reported. VAS and pressure pain thresholds were measured as outcomes, but no systematic pain monitoring during strengthening was described.	Not reported. Outcomes were measured before and after the four-week treatment period; no immediate post-exercise or next-day symptom-response procedure was described.	Not reported. No explicit exercise modification, regression, progression-with-pain, or stopping criteria described.	Not reported. The treatment schedule was specified, but actual session attendance, exercise completion, and adherence percentages were not provided in the supplied text.	Not reported. No adverse-event monitoring procedure or adverse-event results were identified in the supplied material.
			Not reported as a			

4	Mehmetoğlu et al. (2025) [18]	Not reported. VAS was used for outcome assessment, but no numerical exercise-pain threshold or continuous symptom-monitoring procedure was described.	symptom-response rule. Pain was assessed before treatment, after six weeks, and at two-month follow-up. No immediate post-session or next-day response monitoring described.	Partially reported: Exercise difficulty was adjusted using pressure biofeedback and pelvic control; resistance was increased using dumbbells. No explicit pain-triggered regression, stopping, or exercise-withdrawal rules reported.	Partially reported: Sixty-two participants were randomized, with two reported discontinuations and 60 completing the study. Actual attendance, completed exercise dose, and adherence percentages were not reported in the extracted material.	Not reported in the supplied article text. No structured adverse-event monitoring procedure or explicit adverse-event results were identified.
5	Lee et al. (2025) [19]	Not reported. No numerical pain threshold, symptom-monitoring scale, or acceptable exercise-pain range described.	Not reported. Outcomes were assessed before and after four weeks; no next-day pain or symptom-response procedure was described.	Partially reported for performance: DCF pressure-stage advancement depended on correct muscle activation without superficial-muscle compensation. No pain-triggered exercise modification, load regression, or stopping rule reported.	Not reported quantitatively. Eight sessions were scheduled; attendance, exercise completion, and compliance percentages were not provided.	Not reported. Informed consent and exercise contraindications were described, but no adverse-event monitoring results were provided.
6	Bharti et al. (2024) [20]	Partially reported: Cervical isometric exercises were performed according to individual discomfort and tolerance. No numerical exercise-pain threshold or formal monitoring schedule was described, and no equivalent symptom-response procedure was specified for scapular functional exercises.	Not reported. NPRS assessed present, maximum, and minimum pain over the preceding 24 hours at baseline and four weeks, but it was not described as a next-day exercise-response monitoring procedure.	Partially reported: Exercise intensity was guided by discomfort and tolerance; progression options were described. No explicit criteria for reducing load, stopping exercise, or responding to symptom exacerbation were provided.	Not quantitatively reported. The intervention was observed by physiotherapists, but session attendance, completed repetitions, and compliance percentages were not supplied.	Not reported. Exclusion criteria and informed consent were described, but no systematic adverse-event monitoring or adverse-event results were identified.
7	Amjad et al. (2024) [21]	Not reported: NPRS was used to assess pain as an outcome, but no exercise-specific pain-monitoring procedure or acceptable pain threshold was described.	Not reported: Pain was assessed at baseline and after the 12-week program. No immediate post-exercise, next-day, or symptom-response monitoring procedure was described.	Not reported: No explicit pain-based resistance adjustment, exercise regression, progression-with-pain criterion, or stopping rule was described.	Partially reported: Two participants withdrew, one from each group, after the first week for personal reasons. Twenty-two of 24 enrolled participants completed the study. Actual session attendance and exercise completion were not quantified.	Not reported: No structured adverse-event monitoring procedure or exercise-related adverse-event results were described. The withdrawals were attributed to personal reasons, not documented adverse events.
8	Akhter et al. (2024) [22]	Not reported; NPRS assessed at baseline and week 6 only; no exercise-specific pain threshold.	Not reported; no immediate post-exercise or next-day symptom-response criteria.	Not reported; no pain-based regression, modification, or stopping rules.	Partially reported; home diary provided; all 80 participants completed treatment, but quantitative home adherence was not reported.	Reported (limited); no harmful effects observed; systematic adverse-event monitoring procedures not described.
9	Abd-Eltawab et al. (2024) [23]	Not reported. VAS measured at baseline and six weeks; no exercise-specific pain monitoring or acceptable pain threshold described.	Not reported. No immediate post-exercise or next-day symptom-response assessment described.	Not reported for strengthening. Traction force was modified according to tolerance to avoid fatigue and pain, but no strengthening-specific modification, regression, or stopping criteria were provided.	Partially reported. No participant dropouts were reported (60/60 retained); actual session attendance, exercise completion, and adherence percentages were not reported.	Reported (limited). No adverse reactions reported in any group; systematic adverse-event surveillance procedures not established.

10	Zhang et al. (2024) [24]	Not reported: VAS assessed at baseline and 3, 6, and 12 months; no exercise-specific pain threshold or within-session pain-monitoring protocol.	Not reported: No immediate post-exercise or next-day symptom-response assessment described.	Partially reported: Participants could rest for 30 seconds when fatigued during isometric exercise and adjust band resistance through hand spacing. No explicit pain-triggered regression, exercise suspension, or stopping rule.	Partially reported: Clinic supervision for nine months and weekly video supervision during the final three months; 65/70 assessed at three months, 61/70 at six months, and 48/70 at 12 months. Session attendance and completed exercise dosage are not quantified.	Reported (limited): No adverse effects related to exercise or medication observed at follow-ups; surveillance definitions and systematic event-recording procedures not described.
11	Kumari et al. (2024) [25]	Not reported. NPRS was recorded at baseline, week 3, and week 6, but no exercise-specific pain monitoring or acceptable pain threshold was described.	Not reported. No immediate post-exercise or next-day symptom-response monitoring described.	Partially reported for load progression only. Resistance increased after achieving a repetition criterion. No pain-triggered modification, regression, suspension, or stopping rules were reported.	Not reported. Planned exercise frequency was five times weekly, but actual attendance, completed repetitions, compliance, and dropout information were not clearly provided.	Not reported. No systematic adverse-event monitoring, adverse-event results, or exercise-related safety outcomes were described in the supplied text.
12	Batool et al. (2023) [26]	Not reported. NPRS was measured at baseline and after three weeks; no exercise-specific pain monitoring or acceptable pain threshold was described.	Not reported. No immediate post-exercise or next-day pain-response assessments described.	Not reported. No explicit rules for reducing repetitions, resistance, hold duration or stopping exercise in response to symptoms.	Partially reported. Seven participants withdrew (four in Group A and three in Group B), leaving 45 analyzed. Session attendance, completed exercise dosage and reasons for withdrawal were not reported in the supplied text.	Not reported. No systematic adverse-event monitoring procedure or adverse-event results described.
13	Suwaidi et al. (2023) [27]	Partially reported. Participants were asked during treatment sessions about increased pain or unusual adverse events. No numerical acceptable pain threshold or systematic exercise-specific pain score was reported.	Not reported. No immediate post-exercise or next-day symptom-response protocol. The three-month follow-up was an outcome assessment, not delayed exercise-response monitoring.	Partially reported for tolerance and performance. Denneroll positioning was screened for tolerance; scapular exercise progression required accurate performance. No explicit pain-triggered strengthening regression or stopping rule was reported.	Partially reported. All 66 participants completed the six-week assessment; 62 completed three-month follow-up. Actual session attendance, completed strengthening volume and exercise fidelity were not quantified in the supplied text.	Reported, with limitations. Participants were asked about adverse effects or increased pain during sessions. No formal adverse-event protocol was prespecified. Minimal transient neck discomfort during Denneroll acclimatization was documented; no other adverse events were reported.
14	Hamdy et al. (2023) [28]	Not reported for strengthening. VAS and pressure pain threshold were measured before and after the intervention program. Pain was monitored during the INIT manual technique, but this was not a strengthening-specific monitoring procedure.	Not reported. No immediate post-strengthening or next-day symptom-response assessment described.	Not reported for strengthening. No explicit rules for reducing resistance, repetitions or contraction duration, or stopping strengthening in response to pain. During INIT, manual positioning depended on pain reduction; this was specific to the manual intervention.	Reported at session level. Attendance-based adherence was 97.2% (INIT), 98.6% (IASTM) and 97.8% (STT). Four participants withdrew; 86/90 completed follow-up. Exercise-specific dose completion and fidelity were not reported.	Partially reported. Participants were screened for contraindications and red flags. IASTM participants were advised to apply ice if burning occurred. No systematic adverse-event surveillance or adverse-event results were provided in the supplied text.
15	Hernández-Lucas et al. (2023) [29]	Not reported. Participants could raise questions during practical sessions, but no exercise-specific pain scale, acceptable pain threshold, or structured symptom monitoring was described.	Not reported. VAS assessed pain during the preceding 24 hours at baseline and post-intervention, not immediate or next-day exercise responses.	Not reported. Resistance increased according to the session schedule without described symptom-triggered load reduction, regression, postponement or stopping criteria.	Partially reported. Attendance was monitored, and missing more than two BSP sessions was an exclusion criterion for the per-protocol analysis. One experimental participant was excluded from per-protocol analysis. Exercise-specific completion and resistance fidelity were not reported.	Reported: Authors stated that no participants experienced adverse effects. The method and frequency of adverse-event surveillance were not described.

16	Gümüşçü et al. (2023) [30]	Not reported as a structured strengthening-specific procedure. Pain was assessed with VNPS before and after four weeks. The physiotherapist asked about possible side effects during each treatment session.	Not reported. No immediate post-exercise or next-day symptom-response monitoring protocol.	Not reported. No pain threshold, symptom-triggered reduction in repetitions or resistance, regression criteria or stopping rule for strengthening exercises.	Partially reported. All programs were supervised. Forty-five of 48 randomized participants completed the study. No session-attendance percentage, exercise-completion rate or home adherence data were provided.	Reported: Physiotherapist questioned participants about possible side effects at every session; no exercise-related side effects were reported.
17	Fernandes et al. (2023) [31]	Not reported. NPRS was measured during research assessments, not as a structured exercise-specific pain-monitoring tool.	Not reported. Post-intervention assessments occurred 48-72 hours after the final session, but no exercise-related next-day symptom-response protocol was described.	Not reported. No explicit pain-related progression, regression, stopping or load-adjustment rules in the supplied extract.	Partially reported. All 50 analyzed participants attended all eight supervised treatment sessions. Daily home exercises were prescribed, but home-exercise completion was not quantified.	Reported: No adverse events were recorded. The specific surveillance procedure, event definitions and severity grading were not described.
18	Hernández-Lucas et al. (2023) [32]	Not reported. VAS was assessed at baseline and post-intervention, not used as a documented within-session monitoring measure.	Not reported. No immediate or next-day pain-response assessment described.	Not reported. No symptom-triggered resistance reduction, repetition modification, regression or stopping criteria.	Partially reported. Three experimental participants withdrew after missing more than two sessions; one withdrew because of bronchitis. Attendance percentages and exercise-specific adherence were not reported.	Participants were informed of study risks, but systematic adverse-event surveillance and exercise-related adverse-event results were not reported. Bronchitis was a withdrawal reason, not identified as an exercise-related adverse event.
19	Kang et al. (2022) [33]	Not reported. VAS was assessed before and after the four-week program; no documented exercise-session pain monitoring.	Not reported. No immediate post-exercise or next-day pain/fatigue response criteria.	Not reported. No pain-based modification, regression, resistance reduction or stopping thresholds.	Training diaries were provided to record sessions, but actual attendance, completion rates and exercise-specific adherence results were not reported in the supplied text.	Warm-up and cool-down stretching were described as injury-prevention measures. Systematic adverse-event monitoring and adverse-event outcomes were not reported.
20	Aydoğmuş et al. (2022) [34]	Not reported. VAS was measured at scheduled follow-up assessments, not documented as an exercise-session monitoring tool.	Not reported. No immediate post-exercise or next-day symptom assessment described.	Not reported. No pain-contingent reduction, exercise regression or stopping thresholds.	Supervised exercise was delivered in groups of 4-5. Home-exercise compliance was described as good based on questioning at follow-up visits, without numerical adherence data.	No structured adverse-event surveillance or adverse-event results reported. One conventional-group participant withdrew after receiving additional physiotherapy for recurrent pain; this is not evidence of an exercise-related adverse event.
21	Arif et al. (2022) [35]	Not reported. NPRS was measured at baseline and four weeks, not documented as an exercise-session monitoring measure.	Not reported. No immediate post-exercise or next-day symptom assessment.	Not reported. No explicit pain thresholds, exercise regression, resistance reduction or stopping rules.	Partially reported. Forty of 44 participants completed the trial (90.9%). Reasons for four withdrawals, attendance rates and exercise-specific adherence were not reported.	Not reported. No systematic adverse-event monitoring or exercise-related adverse-event results described.
22	Bugti et al. (2022) [36]	Not reported. Pain was assessed as an outcome, but no numerical within-session pain-monitoring protocol was described.	Not reported. No immediate post-exercise or next-day symptom-response criteria.	Not reported. No explicit pain thresholds, exercise regression, loading modification or stopping rules.	Partially reported. Exercise programs were reportedly examined through follow-up interviews, with motivational support. No attendance, exercise completion or quantitative adherence results were supplied.	Inadequately reported. The discussion mentions follow-up interviews addressing complications and acknowledges possible exercise-related pain, but provides no structured adverse-event definitions, counts or severity data.
					Partially reported. All 30	Not reported. No systematic

23	Anwar et al. (2022) [37]	Not reported. No exercise-session pain scale or pain-response threshold described.	Not reported. No immediate post-exercise or next-day symptom assessment.	Not reported. No symptom-based exercise regression, dose modification or stopping rules.	participants completed the eight-week intervention and none were lost to follow-up. Actual session attendance, missed sessions and exercise-specific adherence were not quantified.	adverse-event surveillance or adverse-event results described. The authors acknowledged that the intensive five-day-per-week schedule was difficult for patients to comply with.
24	Shamsi et al. (2021) [38]	Not reported for strengthening. Pain limits were mentioned for cervical stretching, but no pain scale or monitoring protocol was described for isometric strengthening.	Not reported. No immediate post-exercise or next-day symptom-response assessment.	Not reported for strengthening. Cervical rotation stretching was performed within pain limits, but no explicit rules for modifying, reducing or stopping strengthening were provided.	Not reported. Six sessions were prescribed; actual attendance, missed sessions and exercise completion rates were not quantified.	Not reported. No systematic adverse-event monitoring, exercise-related complications or adverse-event outcomes described.
25	Javdaneh et al. (2021) [39]	Not reported. Neither appendix specifies pain-monitoring thresholds during strengthening.	Not reported. No post-exercise or next-day symptom-response criteria.	Not reported. No pain-contingent loading modification, regression or stopping criteria.	High adherence described qualitatively; 18 sessions planned; 67/72 participants analyzed. Numerical attendance and completed exercise doses not reported.	No adverse events reported in the main article; monitoring methods not described.
26	Cho et al. (2021) [40]	Partially reported. The common cervical extension-flexion-rotation exercise was performed without pain, and exercise was stopped if pain occurred. No strengthening-specific pain-monitoring scale or threshold was described.	Not reported. No immediate post-strengthening or next-day symptom-response assessment.	Partially reported. An explicit pain-related stopping instruction was provided for the common cervical exercise, but not for the four lower trapezius strengthening exercises. Resistance selection was based on strength and perceived fatigue (RPE 12-15).	Not reported quantitatively. Ten sessions were prescribed and all 30 participants were analyzed. Session attendance, missed sessions and completed exercise dosage were not specified.	Not reported. No adverse-event monitoring procedure or adverse-event findings described.
27	Groisman et al. (2020) [41]	Partially reported. Participants were instructed to perform home exercises without causing pain. No numeric pain threshold, within-session monitoring frequency or formal pain-monitoring procedure was described.	Not reported. No immediate post-exercise or next-day pain-response criteria were specified.	Partially reported. Home exercise was instructed to be pain-free, but explicit strengthening regression, load-adjustment or stopping rules were not provided.	Not reported quantitatively. Four supervised sessions and home exercise 3 times/week were prescribed. Actual attendance, home exercise compliance and completed exercise dosage were not reported in the supplied text.	No adverse events reported. The authors explicitly stated that no adverse events occurred, but did not describe a systematic monitoring procedure.
28	Lytras et al. (2020) [42]	Not reported for strengthening. VAS was assessed at scheduled research visits. During INIT strain-counterstrain treatment, pain ratings guided identification of a position of ease, but this was not an exercise-loading rule.	Not reported. No immediate post-strengthening or next-day pain-response criteria described.	Not reported for strengthening. No explicit load reduction, regression, exercise suspension or symptom-contingent progression rules.	Partially reported. No missed treatment or assessment visits during the 10-week intervention; missed appointments were rescheduled within the same week. Home-exercise adherence after treatment was not quantified.	Not reported. No explicit adverse-event findings or systematic safety-monitoring procedure identified in the supplied text.
		Partially reported: Initial-phase exercises emphasized low-pain movement, and prone cervical extension was instructed within a pain-	Not reported: No explicit post-exercise symptom assessment, next-day pain response, acceptable duration of symptom exacerbation, or	Partially reported: Exercise modifications included assisted or unassisted cervical flexion, supported arm positioning, wall support, postural alignment	Not reported: Sessions were supervised and 24 sessions were scheduled, but actual attendance, completed sessions, adherence	Not reported: No explicit adverse-event monitoring protocol, adverse-event counts, or exercise-related symptom exacerbation data

29	Mehri et al. (2020) [43]	free range. No numerical acceptable pain threshold, systematic within-session pain-monitoring procedure, or pain-guided resistance adjustment was reported.	24-48-hour recovery rule. The assessment 48 hours after completing the program was an outcome measurement, not a longitudinal symptom-response procedure.	corrections, and avoidance of compensatory cervical movements. No explicit symptom-triggered load reduction, repetition regression, temporary suspension, or stopping criteria were reported.	percentages, and exercise-specific compliance were not quantified. Sixteen participants per group were reported in the results; this does not establish full exercise adherence.	were provided. Medication was permitted according to pain intensity; some controls used medication, whereas the intervention group reportedly used none.
30	Fathollahnejad et al. (2019) [44]	Not reported: Baseline clinical assessment included symptom responses to active movements, and pain intensity was assessed using a 0-10 VAS at study assessment points. However, no systematic monitoring of pain during strengthening sessions, numerical acceptable pain threshold, or pain-guided resistance adjustment was described.	Not reported: Pain was assessed at baseline, after six weeks, and at one-month follow-up. These were clinical outcome assessments rather than post-exercise or next-day symptom-response monitoring. No immediate post-session assessment, 24-hour symptom-response rule, acceptable symptom exacerbation, or recovery-based progression criterion was described.	Partially reported: Participants were excluded if they missed three consecutive exercise sessions or more. Neutral posture, scapular stabilization, and correct exercise execution were emphasized. However, no explicit symptom-triggered reduction in resistance, repetitions, or exercise difficulty, and no pain-related stopping or regression criteria were reported. The attendance-based exclusion criterion should not be interpreted as a clinical exercise-stopping rule.	Partially reported: All 60 randomized participants reportedly completed the six-week intervention, with no dropouts. Participants missing three consecutive sessions were subject to exclusion. Actual session attendance, percentage adherence, exercise-specific compliance, and home-exercise completion were not quantified. Completion of follow-up does not establish 100% exercise adherence.	Not reported: No explicit adverse-event monitoring procedure, adverse-event counts, exercise-related symptom exacerbations, or safety-related discontinuations were described. Physician-prescribed pain medication was permitted if needed, but the authors reported no medication use by participants.
31	Suvarnnato et al. (2019) [45]	Reported: Both training protocols explicitly required exercise without provocation of neck pain. SCT resistance was applied gradually and performed according to tolerance. During DCF training, the researcher assessed the highest individually achievable pressure target without pain provocation, monitored superficial neck-flexor activation by palpation, and corrected exercise technique. No numerical acceptable pain threshold or repeated within-session pain scoring was described.	Not reported: Pain intensity was measured at baseline, immediately after six weeks, and at one- and three-month follow-up. These assessments measured treatment outcomes rather than immediate post-exercise or next-day symptom responses. No 24-hour symptom-response threshold, delayed pain monitoring, or recovery-based load-adjustment rule was reported.	Partially reported: SCT resistance was gradually applied and constrained by pain-free tolerance, with compensatory body movements monitored. DCF pressure targets were individualized according to correct technique, absence of superficial flexor substitution, and absence of pain provocation. However, no explicit longitudinal regression procedure, numerical symptom threshold, exercise suspension rule, or criteria for reducing resistance following delayed symptom exacerbation were reported.	Partially reported: The SCT and DCF groups were scheduled for twice-weekly supervised sessions over six weeks. DCF participants were additionally instructed to perform home exercises twice daily. However, actual attendance, completed supervised sessions, home-exercise compliance, and exercise-specific adherence percentages were not reported in the supplied text. The number of randomized participants does not establish full adherence.	Partially reported: Both exercise protocols required avoidance of neck-pain provocation. DCF technique was supervised with palpation to prevent superficial muscle substitution. Participants were asked to discontinue other treatments during study participation. No formal adverse-event surveillance procedure, adverse-event counts, or exercise-related complications were reported.
		Not reported: Pain intensity was assessed using a VAS, but no pain-	Not reported: No immediate post-session assessment, next-	Not reported: No exercise regression criteria, pain-related stopping rules,	Not reported: Participants were advised to repeat exercises once daily for three weeks. No attendance	Not reported: No adverse-event monitoring methods,

32	Altaf et al. (2017) [46]	monitoring procedure during exercise, acceptable pain threshold, or symptom-guided loading protocol was described.	day pain monitoring, delayed symptom-response evaluation, or 24-48-hour recovery rule was described.	reduction in repetitions or intensity, or instructions for managing exercise-induced symptom exacerbation were provided.	records, home-exercise diaries, compliance percentages, or actual completed exercise sessions were provided. Reporting results for 40 participants does not establish full exercise adherence.	adverse-event counts, exercise-related symptom exacerbations, or safety-related withdrawals were documented.
33	Lauche et al. (2016) [47]	Partially reported: Participants recorded neck-pain intensity on a 0-100-mm VAS in daily logs throughout the intervention. Instructors also provided feedback during exercises, emphasizing awareness of bodily sensations. However, no specific during-exercise pain threshold or pain-contingent loading rule was reported.	Partially reported: Daily pain ratings provided longitudinal symptom monitoring and could capture day-to-day fluctuations. However, the study did not explicitly link pain ratings to the preceding exercise session, assess a defined next-day exercise response, or prescribe a 24-hour recovery threshold.	Not reported: No numerical pain ceiling, resistance-reduction algorithm, symptom-triggered regression criteria, or explicit exercise-stopping rules were specified. General instructor feedback was not described as a formal symptom-response modification protocol.	Reported: Neck-exercise participants attended 5.4 ± 4.1 of 12 sessions, compared with 7.6 ± 3.4 in Tai Chi. Nine neck-exercise participants attended no sessions. Fifteen of 37 (40.5%) achieved at least 80% attendance, compared with 26 of 38 (68.4%) in Tai Chi. Reported average home practice was 33.1 ± 9.6 minutes/week for neck exercises and 44.9 ± 10.7 minutes/week for Tai Chi. Adherence was assessed using attendance records and self-reported daily logs.	Reported: Adverse events were actively solicited and recorded. In the neck-exercise group, four upper respiratory infections, one episode of knee pain, and one episode of vertigo were reported as minor events. Four serious events were also recorded: mononucleosis, sudden sensorineural hearing loss before treatment, appendicitis, and dental root infection. The physician considered most events unlikely to be intervention-related; knee pain was among the potentially related events. Adverse events contributed to some withdrawals.
34	Javanshir et al. (2015) [48]	Partially reported: Participants were instructed to perform exercises without pain. CCF training required controlled contractions without superficial muscle substitution; CF head lifting was performed without discomfort or reproduction of symptoms. No numerical pain ceiling, permissible pain increase, or standardized during-exercise pain rating was described.	Not reported: No explicit post-session pain assessment, next-day symptom response, 24-hour recovery criterion, or delayed-symptom monitoring procedure was described. Pain intensity was assessed at baseline and after the 10-week intervention.	Partially reported: CF resistance could be reduced by elevating the trunk and neck when the exercise was too difficult. CCF performance was constrained by correct movement and avoidance of superficial muscle activation. Exercises were instructed to be pain-free. However, explicit stopping rules for symptom exacerbation, delayed pain, or neurological symptoms were not reported.	Partially reported: Supervised and home-exercise frequencies were prescribed, and all 60 participants completed the study. However, actual supervised attendance, home-exercise compliance, percentage of prescribed sessions completed, and exercise diaries were not reported. Trial completion must not be interpreted as exercise adherence.	Not reported: No systematic adverse-event monitoring procedure, exercise-related adverse-event counts, or safety-event classifications were described. The absence of adverse-event reporting does not establish that no adverse events occurred.
35	Kang et al. (2015) [49]	Not reported: Pain intensity was assessed at baseline and at the end of the program, but no during-exercise pain scale, acceptable pain threshold, or exercise-related symptom-monitoring procedure was described.	Not reported: No immediate post-exercise pain response, next-day symptom monitoring, 24-hour recovery criterion, or delayed symptom-exacerbation assessment was described. The previous-week VAS was a retrospective outcome measure, not a specified	Not reported: No symptom-triggered reduction in exercise intensity, regression criteria, temporary exercise suspension, or stopping rules were described.	Not reported: The prescribed program schedule was detailed, but actual session attendance, completion of exercise cycles, individual participation, exercise compliance, and adherence percentages were not provided. The reported group sample sizes do not establish adherence.	Not reported: No adverse-event monitoring procedure, exercise-related adverse events, or systematic safety outcomes were described. Screening exclusions were reported, but these do not constitute adverse-event surveillance.

			next-day exercise-response rule.			
36	Rudolfsson et al. (2014) [50]	Partially reported: Borg RPE was used systematically to guide resistance progression in the ST group. However, RPE measures perceived exertion rather than pain. No numerical during-exercise pain threshold or standardized symptom-response monitoring procedure was reported for strengthening.	Not reported for ST: No immediate post-exercise pain rating, next-day pain response, 24-hour recovery criterion, or delayed-symptom monitoring protocol was described.	Partially reported: ST load was adjusted upward according to RPE thresholds, but pain-triggered load reduction, regression, temporary suspension, and stopping criteria were not reported. The NCE protocol contained task-performance stopping rules, but these were not strengthening-specific symptom rules.	Reported for supervised attendance: Of 36 randomized ST participants, 28 completed the intervention, attending a median of 22 sessions (minimum 12). NCE had 29 completers (median 22 sessions, minimum 13); massage had 29 completers (median 21 sessions, minimum 18). No home-training adherence was applicable to the described supervised ST protocol. Individual session attendance among all randomized ST participants was not fully reported.	Partially reported: The authors reported one NCE participant with increased headache and neck pain throughout treatment and ten NCE participants with transient increased neck symptoms or headache on 1-4 occasions. However, adverse-event results specifically for the ST group were not provided in the supplied text. Therefore, no adverse events in ST cannot be assumed.
37	Karlsson et al. (2014) [51]	Not reported: No formal pain-monitoring procedure during strengthening, numerical permissible-pain threshold, or pain-guided load adjustment was described. NRS assessed pain during the previous week at study follow-ups, not specifically during exercise.	Not reported: Exercise diaries documented training frequency and weekly implementation, but no defined immediate post-exercise or next-day pain-response assessment was described. No 24-hour recovery criterion was specified.	Partially reported: Resistance was adjusted according to repetition performance, and the program alternated heavy and light weeks. Participants were advised to prioritize strengthening if unable to complete the full session. However, pain-triggered regression, flare-up management, temporary exercise suspension, and stopping rules were not reported.	Clearly reported: Diaries recorded exercise frequency. A completer performed at least 1.5 sessions/week for eight consecutive weeks before assessment. At 4-6 months, 19/24 assessed STRENGTH participants (79%) and 17/19 STRETCH participants (89%) met this definition. At 12 months, 11/20 STRENGTH (55%) and 10/19 STRETCH (53%) qualified. Exercise frequency declined over time; after 4-6 months, STRENGTH generally averaged approximately 1.5 sessions/week or fewer. Twelve STRENGTH and four STRETCH participants dropped out over 12 months.	Reported: The authors stated that no important harms or unintended effects were found in either group. Detailed adverse-event counts, severity classifications, and surveillance procedures were not provided. This supports no important harms reported, not confirmation that no minor adverse events occurred.
38	Khan et al. (2014) [52]	Not reported: VAS was measured at baseline and 12 weeks, but no exercise-specific pain-monitoring procedure, acceptable pain threshold, or symptom-guided intensity adjustment was described.	Not reported: No immediate post-exercise pain response, next-day assessment, 24-hour recovery criterion, or delayed symptom-exacerbation rule was specified.	Partially reported: Participants unable to exercise comfortably in sitting were permitted to use supine or prone positions. However, this was a positional accommodation rather than a defined pain-based regression protocol. No load-reduction criteria, flare-up management rules, or stopping criteria were reported.	Partially reported: Four participants discontinued the intervention between weeks 5 and 8 but attended the final assessment and were included in the results. The article did not provide supervised-session attendance, home-exercise diaries, compliance percentages, or actual exercise frequency. Final assessment participation must not be equated with treatment adherence.	Not reported: No adverse-event monitoring procedure, exercise-related symptom exacerbations, or adverse-event counts were described. Absence of reporting does not establish absence of adverse events.
39	Borisut et al. (2013) [53]	Partially reported: SE participants were instructed to perform cervical movements while avoiding discomfort or symptom reproduction. CCF contractions were required to be pain-free. However, no	Not reported: No immediate post-exercise pain response, next-day symptom assessment, 24-hour recovery criterion, or delayed symptom-exacerbation	Partially reported: Exercises were instructed to avoid discomfort or pain, but the article did not specify how to modify resistance, repetitions, exercise range, or	Reported: All exercise participants were instructed to exercise daily and maintain logbooks. Authors reported exercise compliance greater than 80% in all groups, without	Not reported: No adverse-event monitoring method, exercise-related adverse events, or safety outcomes were described. Full

		standardized pain-rating procedure, numerical permissible-pain threshold, or repeated during-session symptom assessment was described.	monitoring protocol was described. Baseline and 12-week VAS were study outcomes, not exercise-response monitoring.	frequency if symptoms increased. No formal regression, temporary suspension, or stopping rules were provided.	detailed group-specific percentages or definitions of compliance. All 100 participants completed the 12-week trial.	participant retention does not establish absence of adverse events.
40	Hudson et al. (2010) [54]	Not reported: Pain was assessed using NRS at baseline and post-intervention, but no during-exercise pain-monitoring procedure or acceptable pain threshold was described. General education included pain management and pacing, without a specific symptom-monitoring algorithm.	Not reported: No immediate post-exercise symptom assessment, next-day pain monitoring, 24-hour recovery criterion or delayed symptom-response rule was described.	Not reported: No explicit pain-triggered load reduction, exercise regression, session modification, temporary suspension or stopping criteria were provided.	Partially reported: Multimodal participants attended 5-6 of six scheduled sessions. Usual-care participants attended 6-7 treatment sessions. One participant from each group withdrew before treatment; all 12 who began treatment completed the trial. Attendance was reported, but completion of prescribed exercises, exercise dose achieved and home adherence were not quantified.	Not reported: No systematic adverse-event monitoring procedure or adverse-event results were provided. The two pre-treatment withdrawals were attributed to personal reasons, not reported as intervention-related adverse events.
41	Häkkinen et al. (2008) [55]	Partially reported: Cervical resistance was individualized according to maximal isometric strength, and supervised exercise technique was monitored. However, no standardized during-exercise pain scale, numerical acceptable pain threshold, or systematic symptom-monitoring procedure was established in the available study information.	Not reported: No explicit immediate post-exercise pain assessment, next-day symptom evaluation, 24-hour recovery threshold, or delayed symptom-response rule governing subsequent training was identified.	Partially reported: Cervical resistance was selected and reassessed according to maximal isometric strength, with supervised resistance checks. However, no explicit pain-triggered reduction in resistance or repetitions, symptom-based regression algorithm, temporary exercise suspension, or stopping criteria were identified.	Reported quantitatively: Home strengthening was prescribed three times weekly. Mean actual training frequency declined from 2.1 sessions/week during months 1-2 to 1.1 sessions/week during months 3-12. Participants attended a mean of eight of ten scheduled supervised group meetings. These data indicate that actual training frequency was below the prescribed frequency.	Not established from the available extraction: No verified adverse-event counts, severity classifications, or systematic adverse-event surveillance procedure are available for this entry. This should not be interpreted as confirmation that no adverse events occurred.
42	Falla et al. (2007) [56]	Partially reported: Exercises were instructed to be performed without provoking neck pain. Endurance-strength exercises were performed through the available range without discomfort or symptom reproduction. No numeric pain threshold, structured pain-monitoring scale or assessment frequency was described.	Not reported: No immediate post-exercise pain-response assessment, next-day symptom evaluation, 24-hour recovery criterion or delayed exacerbation rule was specified.	Partially reported: Endurance-strength loading was reduced by inclining the trunk when head-lift repetitions could not be completed. Exercise movements were restricted to a symptom-free range. CCF advancement required correct performance without superficial flexor substitution. However, explicit pain-triggered load reduction, flare-up management and stopping rules were not provided.	Reported: All participants attended all six supervised sessions. Exercise diaries indicated adherence of 91.0% in the endurance-strength group and 94.8% in the CCF group. The authors did not separately quantify the percentage of prescribed repetitions, pressure targets or resistance loads actually achieved.	Reported: The authors explicitly stated that no participants reported adverse events. The method and frequency of adverse-event surveillance were not described.
		Partially reported: Pain and exercise tolerance were addressed during supervised rehabilitation. Participants received education and behavioral	Partially reported: Transient neck pain was sometimes reported for several days after maximal isometric	Partially reported: Every alternate institutional exercise session was performed at half intensity to avoid excessive loading. Massage and mobilization were used during initial rehabilitation	Reported quantitatively: Weekly exercise diaries throughout 12 months. Mean training frequency: strength 1.7 ± 0.6 sessions/week;	Reported: Transient neck pain sometimes occurred for several days after maximal isometric strength testing, without interruption of training. No major

43	Ylinen et al. (2003) [57]	support to manage fear of pain and maintain exercise participation. However, no numerical acceptable pain threshold, formal within-session pain scale or standardized symptom-monitoring frequency was specified.	neck strength testing. No systematic post-exercise or next-day symptom-response assessment was described, and no 24-hour recovery threshold was specified.	to help participants tolerate active exercise. Participants were encouraged to prioritize neck muscle exercises when unable to complete the full program. No explicit pain-triggered regression, load-reduction threshold, flare-up management or stopping algorithm was reported.	endurance 2.0 ± 0.8 sessions/week, compared with three prescribed sessions/week. Stretching averaged 2.0 ± 0.8 sessions/week in both training groups. Diaries were reviewed at follow-up visits.	complications occurred. Approximately 3% of participants in each group reported worsening pain attributed to training. Exercise-related and testing-related symptoms were not fully separated in the safety reporting.
44	Viljanen et al. (2003) [63]	Not reported. Neck pain intensity was assessed as a clinical outcome at baseline and follow-up, but no formal during-exercise pain monitoring, acceptable pain threshold or symptom recording protocol was described.	Not reported. No immediate post-session, evening, 24-hour or next-day symptom-response assessment was described.	Not reported. No explicit pain-triggered load reduction, exercise substitution, temporary cessation, symptom-flare management or stopping criterion was provided.	Reported quantitatively. Instructors recorded supervised attendance. Dynamic training participants completed a mean of 13.6 sessions, reported as 39% of the maximum. At 12 months, participants reported a mean of 31 minutes/week of intervention-specific exercise. Follow-up questionnaires also collected independently performed session frequency, duration and number of weeks.	Not reported in the supplied article. No structured adverse-event monitoring procedure, exercise-related adverse-event frequency or severity classification was provided. This does not establish that no adverse events occurred.
45	Bronfort et al. (2001) [64]	Not reported. Pain intensity was measured as a clinical outcome, but no systematic within-session pain-rating method or acceptable exercise-pain threshold was described.	Not reported. No standardized immediate post-exercise or next-day pain-response assessment was specified.	Not reported. No explicit pain-related resistance reduction, exercise regression, flare-up management or stopping criteria were described.	Partially reported. Overall intervention completion was 93%, but the supplied text does not quantify sessions attended or prescribed exercise volume completed separately for each arm. Follow-up home exercise frequency was categorized as regular (n = 46), occasional (n = 51), or none (n = 62), without arm-specific breakdown.	Reported. Notable increases in neck pain or headache: SMT + exercise 8, MedX 9, SMT alone 6. Additional events: increased radicular pain in one SMT + exercise participant and severe thoracic pain in one SMT participant. Events were self-limited; no permanent injuries reported.

TABLE 5: Symptom-response monitoring, exercise adherence, and adverse-event reporting across the 45 included RCTs

The table summarizes symptom-response monitoring, exercise adherence, and adverse-event reporting across 45 independent RCTs represented by 50 publications. Five companion publications associated with the randomized controlled trial by Ylinen et al. (2003), titled "Active Neck Muscle Training in the Treatment of Chronic Neck Pain in Women: A Randomized Controlled Trial" (Study 43, Reference [57]), were consolidated under the original trial to avoid double-counting. Pain assessments performed solely at baseline or scheduled follow-up were not classified as exercise-specific symptom-response monitoring. Similarly, participant retention, intervention completion, and scheduled treatment sessions were not considered equivalent to verified exercise adherence. “Not reported” indicates that the relevant information was not identified in the available study reports and does not establish that the procedure was not performed or that no adverse events occurred.

CCF: craniocervical flexion; DCF: deep cervical flexors; IASTM: instrument-assisted soft-tissue mobilization; INIT: integrated neuromuscular inhibition technique; NPRS: Numeric Pain Rating Scale; NRS: Numeric Rating Scale; RPE: rating of perceived exertion; SCT: semispinalis cervicis training; ST: strength training; VAS: Visual Analog Scale; RCT: randomized controlled trial.

Pain Monitoring During Exercise

Pain was frequently assessed as a treatment outcome, but exercise-specific symptom monitoring was less consistently described. Some trials referred to participant comfort or exercise tolerance [20,31,45], while Falla et al. (2007) [56] described pain-free exercise performance. However, these instructions did not necessarily establish standardized pain-monitoring procedures or symptom-based progression rules. Improvements in pain intensity were not considered evidence that symptoms were monitored or used to modify exercise demands.

Acceptable Pain Thresholds and Symptom-Response Criteria

Explicit acceptable pain thresholds and symptom-based adjustment criteria were inconsistently reported. Falla et al. (2007) [56] described pain-free exercise, while other trials referred to participant comfort or tolerance [20,31,45]. However, these instructions did not consistently specify numerical pain limits, acceptable symptom aggravation, or corresponding exercise modifications. Consequently, criteria for maintaining, progressing, or reducing exercise demands were often insufficiently defined for clinical reproduction.

Immediate and Delayed Symptom Responses

Immediate post-exercise and next-day symptom responses were inconsistently reported across trials. Although Ylinen et al. (2003) [57] documented transient neck pain following maximal isometric strength testing, this did not establish routine post-exercise symptom monitoring. Most intervention descriptions lacked explicit procedures for assessing delayed symptom aggravation or using recovery responses to adjust subsequent training. Scheduled follow-up pain assessments were not considered evidence of exercise-specific symptom monitoring.

Exercise Modification, Regression, and Stopping Rules

Explicit symptom-based exercise modification and stopping rules were inconsistently reported. Falla et al. (2007) [56] described pain-free exercise performance, while Ylinen et al. (2003) [57] reported supervised adjustments to training intensity. However, these descriptions did not establish standardized symptom-triggered regression or stopping criteria. Across trials, instructions for reducing resistance, repetitions, or exercise intensity in response to symptom aggravation were often insufficiently specified, limiting reproducibility.

Exercise Adherence and Participation

Adherence reporting varied across trials. Ylinen et al. (2003) [57] reported mean training frequencies of 1.7 and 2.0 sessions per week in the strength and endurance groups, respectively, against three prescribed weekly sessions. Häkkinen et al. (2008) [55] reported a decline in home-training frequency from 2.1 to 1.1 sessions per week over the intervention period. Falla et al. (2007) [56] reported diary-based adherence of 91.0-94.8%. Other trials reported attendance or intervention completion without consistently quantifying the exercise dose performed. Participant retention was not considered equivalent to verified adherence.

Adverse Events and Exercise Tolerability

Adverse-event reporting varied across trials. Ylinen et al. (2003) [57] reported transient exercise-related neck pain and worsening symptoms in approximately 3% of participants per group, while Bronfort et al. (2001) [64] documented symptom exacerbations across treatment groups. Falla et al. (2007) [56] reported no adverse events. However, several trials provided insufficient information about adverse-event surveillance. Absence of reported complications was therefore distinguished from documented safety monitoring.

Overall Reporting of Symptom-Guided Exercise Management

Across the 45 RCTs, reporting of symptom monitoring, exercise modification, adherence, and adverse events was inconsistent. Improvements in clinical outcomes did not establish symptom-guided progression, while individualized exercise prescriptions did not necessarily include explicit modification or stopping rules. Similarly, prescribed training frequency was distinguished from verified adherence, and absence of reported adverse events from systematic safety monitoring. These reporting gaps may limit intervention reproducibility. Study-specific findings are summarized in Table *4*.

Discussion

This literature review examined strengthening exercise prescription, progression, and symptom-response reporting across 45 independent RCTs involving adults with chronic nonspecific or mechanical neck pain. Although exercise selection, frequency, and program duration were generally reported, initial resistance, individualized progression criteria, and exercise modification procedures were inconsistently described. Some trials quantified resistance using percentage-based or repetition-maximum methods [50,53,55,57], whereas elastic or therapist-applied resistance interventions often lacked precise starting-load information [22,52]. These findings reflect broader concerns regarding incomplete intervention reporting [5,6] and reinforce the importance of resistance-training principles [4] and the TIDieR and CERT frameworks [7-9] in supporting reproducible exercise prescription.

Progression approaches ranged from predetermined increases in exercise demands [16,18,19] to individualized adjustments based on strength or performance [50,51,55,57]. Rudolfsson et al. (2014) [50] incorporated strength reassessment, while Karlsson et al. (2014) [51] specified repetition-based

advancement criteria. However, individualized loading did not consistently include explicit progression thresholds. Although pain and disability were commonly measured as clinical outcomes, these measures did not establish symptom-guided exercise progression. Evidence suggests that some exercise-related pain may be acceptable in selected chronic musculoskeletal pain populations [10], but no universal acceptable pain threshold was established for chronic neck pain. Reporting of immediate and next-day symptom responses, exercise regression, and stopping criteria remained inconsistent, potentially limiting individualized exercise management.

Adherence and adverse-event reporting also varied. Ylinen et al. (2003) [57] and Häkkinen et al. (2008) [55] documented training frequencies below prescribed levels, emphasizing the distinction between intended dosage and actual exercise participation. Given recognized barriers to physiotherapy adherence [11,12], participant retention or scheduled attendance should not be equated with verified adherence. Similarly, Ylinen et al. (2003) [57] and Bronfort et al. (2001) [64] documented symptom exacerbations, while other trials provided limited information on safety monitoring. The absence of reported adverse events does not confirm systematic surveillance or intervention safety. Future trials should clearly document adherence measures, delivered exercise dosage, and adverse-event monitoring procedures.

Methodological limitations further warrant cautious interpretation. Of the 45 RCTs, 31 (68.9%) were judged to have a high overall risk of bias, 14 (31.1%) raised some concerns, and none were classified as low risk. Outcome measurement was the most frequently affected high-risk domain (28 trials), followed by missing outcome data (five trials) and deviations from intended interventions (three trials). Nevertheless, risk of bias and intervention-reporting completeness are distinct: incomplete descriptions do not necessarily indicate that procedures were not performed. Overall, insufficient reporting of exercise dosage, progression, symptom-response monitoring, adherence, and adverse events may limit intervention reproducibility and clinical application, independently of reported treatment effects.

This review has additional limitations. Restriction to English-language publications may have introduced language bias. Data extraction relied on information available in retrieved full-text reports and accessible supplementary materials, which may not fully reflect actual intervention implementation. Furthermore, 31 reports could not be retrieved for eligibility assessment, potentially resulting in the omission of relevant trials. Google Scholar screening was limited to the first 200 relevance-ranked records, which may have further restricted study identification.

Clinical implications

The findings emphasize the importance of clearly documenting strengthening exercise dosage and progression in chronic neck pain rehabilitation. Clinicians should specify initial resistance, sets, repetitions, contraction duration, frequency, and advancement criteria. When published protocols lack sufficient detail, exercise prescription should be individualized rather than assuming an optimal dosage.

Progression should consider measurable performance, movement quality, strength reassessment, and symptom tolerance. Monitoring during exercise, immediately afterward, and on the following day may inform modifications, although the reviewed trials did not establish universal progression or acceptable pain thresholds. Clinicians should also distinguish prescribed exercise dosage from actual adherence and document adverse responses.

Applying resistance-training principles [4] alongside TIDieR and CERT recommendations [7-9] may improve intervention reproducibility and support individualized clinical decision-making.

Recommendations for future research

Future RCTs should provide reproducible strengthening protocols specifying initial loading, exercise volume, progression schedules, and measurable advancement criteria. Protocols should also describe how immediate and delayed symptom responses guide exercise progression, regression, or discontinuation. Adherence should be measured against prescribed exercise dosage, while adverse-event reporting should include standardized definitions and monitoring procedures. Consistent application of TIDieR and CERT recommendations [7-9], supported by accessible protocols and supplementary materials, may improve reporting transparency, reproducibility, and clinical translation.

Conclusions

This literature review identified inconsistent reporting of strengthening exercise prescription, progression, and symptom-response management across 45 independent RCTs involving adults with chronic nonspecific or mechanical neck pain. Although exercise frequency and program duration were generally reported, initial loading, individualized advancement criteria, symptom-monitoring procedures, and exercise modification rules were less consistently described. Adherence and adverse-event reporting also varied. These findings emphasize the need for reproducible protocols that specify exercise dosage and criteria for modifying training demands according to performance and symptom responses. More complete intervention reporting may improve clinical interpretation, reproducibility, and individualized physiotherapy practice.

Additional Information

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All authors have reviewed the final version to be published and agreed to be accountable for all aspects of the work.

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