Systematic Review

The influence of home exercise programs for patients with non-specific or specific neck pain: a systematic review of the literature

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Study design: Systematic review of randomized controlled trials (RCT).
Objectives: To examine the effects of a therapeutic home exercise program (HEP) for patients with neck pain (associated with whiplash, non-specific, or specific neck pain, with or without radiculopathy, or cervicogenic headache) on pain, function, and disability. Our secondary aim was to describe the design, dosage, and adherence of the prescribed HEPs.
Background: Neck pain is a leading cause of disability that affects 22–70% of the population. Different techniques have been found effective for the treatment of neck pain. However, there is conflicting evidence to support the role of a therapeutic HEP to reduce pain, disability, and improve function and quality of life (QOL).
Methods: A systematic review in accordance with the preferred reporting items for systematic reviews and meta-analyses (PRISMA) statement for reporting systematic reviews. The full-text review utilized the Maastricht–Amsterdam assessment tool to assess quality among RCTs.
Results: A total of 1927 subjects included within seven full-text articles met our specific search strategy. It was found that HEPs with a focus on strength and endurance-training exercises, as well as self-mobilization, have a positive effect when used in combination with other conservative treatments or alone.
Conclusions: Home exercise programs that utilize either self-mobilizations within an augmented HEP to address specific spinal levels, or strengthening, and/or endurance exercise are effective at reducing neck pain, function, and disability and improving QOL. The benefit of HEPs in combination with other conservative interventions yields some benefit with a range of effect sizes.

Keywords: Neck pain, Non-specific neck pain, Home exercise program, Outcomes, Systematic review

Introduction

Neck pain is one of the leading causes of disability in the United States.[1,2] Neck pain may be mechanical in nature and associated with degenerative process or other pathology identified during diagnostic imaging.[2] Non-specific neck pain is more common, and the pathoanatomical cause of it is unknown.[2] Neck pain may be present with or without whiplash, radiculopathy, or cervicogenic headache.[3] The lifetime prevalence of this condition ranges between 22 and 70% of the population and increases with age and female gender.[3] The acuity of its clinical presentation may also vary and impact the patient's level of pain, function, and disability. Acute neck pain comprises10–20% of the cases seen in physical therapy clinics.[2,4–6] The literature shows that 54% of the population reports having an incident of neck pain; 37% of those develop chronic neck pain that limits function and reduces work capabilities.[2,4–7]

There are a variety of approaches that have been found to be effective for the treatment of neck pain. These treatment strategies include modalities, manual therapy, strength training, endurance training, and home exercise programs (HEPs).[6,8–10] Home exercise programs have been used to extend clinically based physical therapy approaches with the treatment of neck pain; however, the influence of a home exercise prescription is widely understudied for musculoskeletal conditions. The evidence that exists is mixed regarding the effect of HEPs to reduce disability and improve the patient's function and QOL.[8,9] This discrepancy may result from variations in the HEP design, aim (i.e. Active Range Of Motion (AROM), stretching, strengthening, etc.), and/or dosage.[11] To date, no systematic review has synthesized the impact of HEPs, when used alone or combined with clinical treatment, on specific outcomes such as pain and/or

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disability. Additionally, minimal attention has been given to the HEP design, aim, and dosage for patients with neck pain.

The primary objective of this systematic review is to examine the effects of adding a therapeutic HEP in the management of patients with neck pain (associated with whiplash, non-specific or specific neck pain, with or without radiculopathy, or cervicogenic headache) on pain, function, and disability compared to other conservative treatment measures and/or a placebo. As a secondary purpose, the design, aim, dosage, and adherence to HEPs included in these studies will be described.

Methods

Study design

A systematic review conducted at Walsh University was completed in accordance with the preferred reporting items for systematic reviews and meta-analyses (PRISMA) guidelines for reporting systematic reviews.[12] To improve the 'transparency and scientific merit' of systematic reviews and meta-analyses, PRISMA was followed using a 27-item checklist.[13]

Search strategy

A comprehensive search was performed by two reviewers (HS and MZ) using the following electronic databases: PubMed, Cochrane Central Register of Control Trials, CINAHL, and SPORTDiscus. The search strategy included both MeSH terms (Table 1) and keyword searches, as well as a combination of both, for a sensitive and specific search strategy. An outline of the systematic review process can be viewed in Fig. 1. Filters were utilized in order to refine the search for randomized control trials and articles written in English. Subsequent hand searches were completed and terminated on 4 February 2013.

Table 1 MeSH terms

MeSH terms
Neck pain
Neck pain*
Neck muscle
Neck muscle*
Cervical radiculopathy
Radiculopathy
Cervical vertebrae
Post-traumatic headache
Post-traumatic headache*
Cervicalgia*
Neckache*
Neck muscles* and injury* or pain or ache*
Cervicogenic headache
Home exercise*
Muscle stretching exercise*
Exercise therapy
Exercise movement technique*
Exercise program*
Strength training
Home
Home bas*
Physical activity

*Indicates a truncation character that encompasses all derivations of the word stem.

Inclusion criteria

Inclusion of articles for this systematic review needed to meet the following criteria:

1. it must be a RCT or randomized clinical trial;
2. it must include patients with neck pain for any duration;
3. it must include patients with neck pain with or without headache and/or whiplash and/or radiculopathy;
4. it must provide a HEP with or without co-interventions and/or control;
5. it must give an adequate description of the HEP intervention to allow for analysis;
6. it must provide statistical reporting of the outcome measures;
7. it must be available in English;
8. it must have utilized at least one or more validated outcome measures on the constructs of pain, disability, quality of life (QOL), return to work, and/or sick leave.

Studies were excluded if they did not meet the inclusion criteria or were determined to have poor methodological quality (below our pre-determined cut-off point of 50% on the Maastricht–Amsterdam checklist).[14]

Study selection and data collection

All of the studies were independently reviewed for their compliance with the inclusion criteria. Two reviewers screened the titles (HS and MZ), abstracts (HS and JN), and full text (JN and MZ). Any disagreements were mediated by the third reviewer not involved in the specific search (HS, JN, or MZ). All three reviewers independently reviewed the full-text articles for quality standards. Kappa values were calculated for agreement measures.

Cohen's *d* effect sizes were calculated in order to determine whether there was a significant difference between two interventions. The calculations of the effect sizes were performed by one author (MZ) through the use of the mean and standard deviations provided in the articles. Two authors (HS and JN) reviewed the completed calculations.

Statistical analysis and quality assessment

Cohen's kappa of agreement is a statistical analysis utilized to measure the inter-rater agreement for qualitative items including review of the titles, abstracts, and full-text articles.[14] The kappa inter-rater agreement was performed between two raters who identified articles as 'yes' or 'no' for acceptance in this review. Overall, results were compared using the kappa formula: $\text{Kappa} = \Pr(a) - \Pr(e)/1 - \Pr(e)$, where $\Pr(a)$ was the relative observed agreement among raters and $\Pr(e)$ equaled the hypothetical probability of chance agreement.[15]

Cohen's *d* effect size measurement was used to determine treatment effect in terms of the interventions' influence on pain, disability, and functional

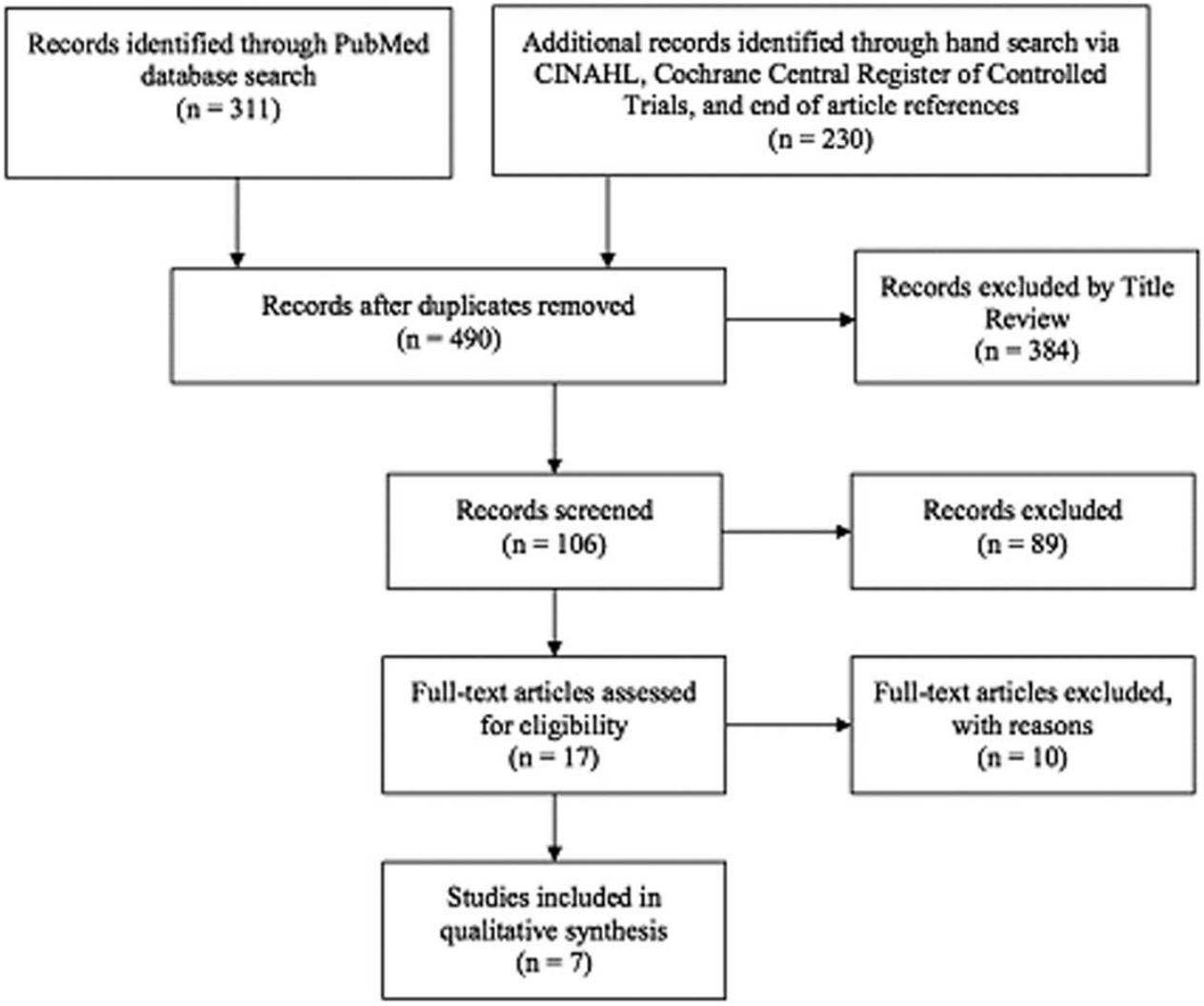

Figure 1 Flow diagram of retrieved, screened, and included studies.

outcome measures. This was calculated from the follow-up mean and standard deviation for behavior modifiers (Table 2). Cohen established an effect size of 0.0–0.19 as trivial, 0.20–0.49 as small, 0.50–0.79 as moderate, and more than 0.80 as a large effect size.[22]

The quality of each selected full-text article was assessed using the Maastricht–Amsterdam list (Table 3) for RCTs. This specific tool uses 19 items to collectively produce a total quality score with criteria including patient selection, intervention, outcome measurement, and statistics.[14] In particular, this tool has strong face and content validity, as well as reproducibility (agreement/reliability).[27] Based on the application of this tool in the current literature, previous researchers determined the cut-off percentage values as $<$50% indicating poor quality, 50–80% indicating moderate quality, and $>$80% indicating good quality.[23–26]

Results

Search results

The search strategy (using MeSH terms and keywords) through the large electronic database search yielded a total of 311 viable citations. The hand-search strategy revealed 230 additional studies. After removal of duplicate manuscripts, 490 studies remained for review. Of these, 473 studies were excluded based on the title and abstract review, leaving 17 for full-text review. The full text of the 17 remaining studies was retrieved and reviewed for inclusion. The PRISMA flow chart of this process is shown in Fig. 1. Ten studies were excluded based on the absence of a comparison group, lack of an exercise prescription, exercises not home or work based, and/or a poor quality assessment score. See Table 4 for excluded articles and the rationale for exclusion. The seven studies met all the inclusion criteria. All selected studies compared a HEP to a separate intervention and/or a control group defined by the authors.

Kappa values calculated for the systematic review include 0.62 (95% CI 0.52–0.71) for the titles search, 0.33 (95% CI 0.12–0.54) for abstracts prior to mediation/discussion for inclusion and 1.00 after mediation, and 0.77 (95% CI 0.47–1.06) for full-text inclusion. Within the hand search, the kappa values

for the abstracts were 0.40 (95% CI 0.02–0.78) and 1.00 for full text (full agreement). A population, intervention, comparison, outcomes and study (PICOS) design table was completed to describe the details of the final full-text articles in order to synthesize the information and compare home exercise interventions and their effectiveness (Table 5).

Quality assessment

All studies accepted for inclusion were assessed for their overall quality using the Maastricht–Amsterdam criteria.[23–26]Andersen *et al.*[16] and Bronfort *et al.*[17] scored 'good' (>80%) on the quality assessment, whereas all the remaining studies scored in the moderate range (50–80%) (Table 3).[11,18–21] Blinding throughout the studies was variable. All seven studies were unable to blind the examiner rendering treatment, and only one of the seven studies was able to blind the patients from the intervention.[18] Treatment group allocation was not concealed in four out of the seven studies.[11,19–21] Allocation concealment ensures precise implementation of a random allocation sequence without prior knowledge of treatment assignments.[30] Two of the included studies, Mongini *et al.*[20] and Kujiper *et al*[19], failed to blind the outcome assessor to the intervention.

Study selection and characteristics

There were a total of 1927 subjects included within this systematic review. Subjects were heterogeneous populations with varying geographical location, acuity of symptoms,[28,29] and follow-up periods. Acuity of neck pain was classified and defined in each study as either acute,[19] sub-acute,[17,19] and/or chronic symptom duration.[11,16,18–21] Two of the included studies failed to perform a follow-up;[11,16] others studies performed follow-up at 4 weeks,[18] 14 weeks,[17] 6 months,[19,20] 40 weeks,[17] and 12 months post discharge.[17,18,21]

Home exercise program adherence definition and measurement

Within the seven included studies, one study used the HEP as a co-intervention to clinical treatment,[19] whereas six studies used a HEP only[11,16–18,20,21] Adherence was defined in six of the studies and varied as to what constituted adherence (Table 6). Bronfort *et al.*[17] was the only study to not indicate adherence. Adherence to the prescribed HEP was measured in six of the seven studies using means such as training diaries[11,19–21] and questionnaires.[16,18]

Outcome measures utilized

Various outcome measures were used to quantify the patient's symptoms of neck pain or headache. Outcome reporting on the pain construct (either frequency and/or intensity) occurred on different measures within the included studies: Visual Analog Scale (VAS),[11,16,19] Pain Scale (0–10),[17] Neck/Shoulder Pain Index,[20] headache frequency,[20] and

Table 2 Intervention groups compared with Cohen's *d*

Author	Groups compared	Outcome measure	Group with larger effect at end follow-up	Cohen's *d* at endpoint
Andersen *et al.*[16]	HEP 2 minutes vs control	VAS	HEP	0.67
	HEP 12 minutes vs control	VAS	HEP	0.59
	HEP 12 minutes vs HEP 2 minutes	VAS	Same	0.00
Bronfort *et al.*[17]	HEP vs medication	Pain Scale	HEP	0.11
	HEP vs SMT	Pain Scale	HEP	0.16
Hall *et al.*[18]	Augmented HEP vs sham mobilization	HA Severity Index	Augmented HEP	1.79
Kuijper *et al.*[19]	Physiotherapy (PT) with HEP vs control	VAS	PT with HEP	0.47
		NDI	PT with HEP	0.11
	PT with HEP vs cervical collar	VAS	Cervical collar	0.18
		NDI	Cervical collar	0.10
Mongini *et al.*[20]	HEP vs control	Days with HA (mean)	HEP	0.27
		Headache Index (FxI)	HEP	0.26
		Days with neck/shoulder pain (mean)	HEP	0.29
		Neck/Shoulder Pain Index (FxI)	HEP	0.33
Nikander *et al.*[11]	HEP endurance vs control	VAS	HEP	0.84
		DI	HEP	0.63
	HEP strength vs control	VAS	HEP	1.07
		DI	HEP	0.96
	HEP strength vs HEP endurance	VAS	Strength	0.23
		DI	N/A	0.27
Salo *et al.*[21]	HEP endurance vs control	HRQoL	HEP	N/A
	HEP strength vs control	HRQoL	HEP	N/A
	HEP strength vs HEP endurance	HRQoL	Strength	N/A

HEP=home exercise program, VAS=Visual Analogue Scale, NDI=Neck Disability Index, DI=Disability Index, HRQoL=Health-Related Quality of Life, HA=headache, SMT=Spinal Manipulation Therapy, N/A=not available.
Effect size ranges: 0.0–0.19 (trivial), 0.20–0.49 (small), 0.50–0.79 (moderate), and >0.80 (large).[22]

HA Severity Index.[18] Outcome reporting on the disability construct occurred on two different measures within the included studies: Disability Index[11] and Neck Disability Index (NDI).[11,19] Only one study included the Health-Related Quality of Life (HRQoL) as an outcome measure to examine the QOL construct.[21]

Results and synthesis of individual studies

Andersen *et al.*'s[16] study included 198 subjects (174 females, 24 males) with chronic neck pain, with or without shoulder pain, who worked full time without known major disease or disability. This study had one of the highest quality score (16/19) of the included studies.[16] Their study found that the HEP groups, which included 2-minutes and 12-minutes of resistance training, had a moderate effect on the VAS when compared to the control group, which received no intervention (Cohen's d=0.67, 0.59, respectively).[16] When comparing the two HEP groups, no statistically significant difference on pain was reported on the VAS with an effect size of 0.00.[16]

Bronfort *et al.*'s[17] study included 272 participants, between the ages of 18 and 65 years, who had subacute, non-specific neck pain for 2–12 weeks.[17] Bronfort *et al.*[17] also yielded a high quality score (16/19). They found that the intervention group, which included advice, basic anatomy, postural instructions, demonstrations of daily actions, and a HEP, had a larger effect on the Pain Scale when compared to medication or spinal manipulation (effect sizes of 0.11 and 0.16, respectively).[31]

Both Kuijper *et al.*[19] and Hall *et al.*[18] had moderate quality scores (12/19, 13/19, respectively). Kuijper *et al.*'s[19] study included 205 patients, between the

Table 3 Quality assessment of randomized controlled trials (RCTs)

Criteria	Andersen *et al.*[16]	Bronfort *et al.*[17]	Hall *et al.*[18]	Kuijper *et al.*[19]	Mongini *et al.*[20]	Nikander *et al.*[11]	Salo *et al.*[21]
Patient selection							
A: Were the eligibility criteria specified	Yes	Yes	Yes	Yes	Yes	Yes	Yes
B1: Was a method of randomization performed	Yes	Yes	Yes	Yes	Yes	Yes	Yes
B2: Was the treatment allocation concealed	Yes	Yes	Yes	No	No	No	No
C: Were the groups similar at baseline regarding the most important prognostic indicators	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Intervention							
D: Were the index and control interventions explicitly described	Yes	Yes	Yes	Yes	Yes	Yes	Yes
E: Was the care provider blinded to the intervention	No	No	No	No	No	No	No
F: Were co-interventions avoided or comparable	Yes	No	No	Yes	No	Yes	Yes
G: Was the compliance acceptable in all groups	Yes	Yes	Yes	Yes	Yes	Yes	Yes
H: Was the patient blinded to intervention	No	No	Yes	No	No	No	No
Outcome measurement							
I: Was the outcome assessor blinded to the intervention	Yes	Yes	Yes	No	No	Yes	Yes
J: Were the outcome measures relevant	Yes	Yes	Yes	Yes	Yes	Yes	Yes
K: Were adverse effects described	Yes	Yes	No	No	No	No	No
L: Was the withdrawal/drop-out rate described and acceptable	Yes	Yes	Yes	Yes	No	Yes	Yes
M1: Was a short-term follow-up measurement performed	Yes	Yes	Yes	Yes	Yes	Yes	Yes
M2: Was a long-term follow-up measurement performed	No	Yes	No	No	No	No	Yes
N: Was the timing of the outcome measurement in both groups comparable	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Statistics							
O: Was the sample size for each group described	Yes	Yes	No	Yes	Yes	No	No
P: Did the analysis include an intention-to-treat analysis	Yes	Yes	No	No	No	No	No
Q: Were point estimates and measures of variability presented for the primary outcome measures	Yes	Yes	Yes	Yes	Yes	Yes	No
Total quality score	16/19 (84%)	16/19 (84%)	13/19 (68%)	12/19 (63%)	10/19 (53%)	12/19 (63%)	12/19 (63%)

Quality values: <50% (poor), 50–80% (moderate), and >80% (good).[23–26]

ages of 18 and 75 years, with signs and symptoms of cervical radiculopathy of less than 1 month in duration. Kuijper *et al.*[19] found that physiotherapy, which included graded activity exercises for cervical mobilization and stabilization, combined with a HEP intervention had a greater effect size on the VAS (0.47) and the NDI (0.11) when compared to the control, which was instructed to continue normal daily activities. Interestingly, when the physiotherapy with HEP intervention group was compared to the cervical collar group on the VAS and the NDI, the cervical collar group had a slightly larger effect size on these measures (0.18 VAS and 0.10 NDI). Hall *et al.*'s[18] study included 32 participants, with a mean age of 36 ± 3 years, who complained of chronic cervicogenic headache for the past 3 months, at least once per week.[18] Hall *et al.*[18] found that having a patient self-mobilize a specific spinal level to augment spinal motion within a HEP group had a large effect (1.79) on the HA Severity Index when compared to sham mobilization.

Nikander *et al.*[11] and Salo *et al.*[21] also yielded moderate quality scores (12/19, 12/19, respectively). Nikander *et al.*[11] found improvements, similar to Andersen *et al.*,[16] in pain in both their HEP strength and HEP endurance groups. Their endurance HEP group had a large effect on the VAS (0.84) and moderate effect on the Disability Index (0.63) compared to the control group. The Nikander *et al.*[11] study included 180 female office workers aged 25–53 years old with constant or frequent chronic neck pain and disability occurring greater than 6 months.[11] Nikander *et al.*'s[11] HEP strength group had a strong effect size on the VAS (1.07) and Disability Index (0.96) when compared to the control group, who was advised to perform aerobic and stretching exercises without strengthening.[22,31] Additionally, the strength group had a stronger effect size when compared to the HEP endurance group on the VAS (0.23) and Disability Index (0.27).[22,31] Salo *et al.*'s[21] follow-up study used the participants within the Nikander *et al.*[11] study to qualitatively compare the HRQoL of the strength and endurance groups to a control group. The authors reported that both the strength and endurance HEP groups showed a greater effect than the control group when addressing QOL. Additionally, the strength HEP group had a greater effect when compared to the endurance group. Unfortunately, despite attempts to contact the authors of this study, no effect sizes could be calculated due to insufficient data.

Mongini *et al.*[20] had the lowest quality score on the Maastricht–Amsterdam criteria list (10/19). Despite the low quality score, results of this study are consistent with the results of the higher quality studies. This study included 1040 participants between 43 and 52 years who were municipal workers with chronic headache (including tension-type head-

Table 4 Excluded articles and rationale for exclusion

Author title	Exclusion rationale
Bronfort G, Evans R, Nelson B, Aker PD, Goldsmith CH, Vernon H A randomized controlled trial on the efficacy of exercise for patients with chronic neck pain	No home- or work-based exercises
Marangoni AH Effects of intermittent stretching exercises at work on musculoskeletal pain associated with the use of a personal computer and the influence of media on outcomes	Lack of detail for exercises Poor quality measure
Andersen LL, Mortensen OS, Zebis MK, Jensen RH, Poulsen OM Effect of brief daily exercise on headache among adults – secondary analysis of a randomized controlled trial	No explanation of exercises
Bernaards CM, Ariëns GA, Knol DL, Hildebrandt VH The effectiveness of a work style intervention and a lifestyle physical activity intervention on the recovery from neck and upper limb symptoms in computer workers	No explanation of exercises No formal HEP intervention
Bronfort G, Evans R, Nelson B, Aker PD, Goldsmith CH, Vernon H A randomized clinical trial of exercise and spinal manipulation for patients with chronic neck pain	No explanation of exercises Focus was more on inhouse exercise No control
Dellve L, Ahlstrom L, Jonsson A, Sandsjö L, Forsman M, Lindegård A, Ahlstrand C, Kadefors R, Hagberg M Myofeedback training and intensive muscular strength training to decrease pain and improve work ability among female workers on long-term sick leave with neck pain: a randomized controlled trial	No home or work exercise No explanation of interventions
Häkkinen A, Kautiainen H, Hannonen P, Ylinen J Strength training and stretching verses stretching only in the treatment of patients with chronic neck pain: a randomized one-year follow-up study	No home or work exercise No control group
Maiers MJ, Hartvigsen J, Schulz C, Schulz K, Evans RL, Bronfort G Chiropractic and exercise for seniors with low back pain or neck pain: the design of two randomized clinical trials	No home or work exercise No control group
Martel J, Dugas C, Dubois JD, Descarreaux M A randomised controlled trial of preventive spinal manipulation with and without a home exercise program for patients with chronic neck pain	No description of exercises
Taimela S, Takala EP, Asklöf T, Seppälä K, Parviainen S Active treatment of chronic neck pain	No home or work exercises No description of exercises

Table 5 Characteristics of included studies

Study	Population	Intervention	Comparison	Reported outcomes
Andersen *et al.*[16] RCT	198 participants (174 women, 24 men) Mean age: 2-minute group: 44 (±11) 12 minute group: 42 (±11) control group: 43 (±10) Chronic neck pain with/or without shoulder pain for the previous 3 months lasting at least 30 days within 1 year[28,29]	HEP only: shoulder abduction (lateral raise), exercise to target perceived, 'relevant neck and shoulder muscles' 5 times per week During weeks 1–2, participants used moderate resistance training with elastic tubing. During weeks 2–4, participants progressed to higher level of resistance 12-minute group: Weeks 1–2=5–6 sets of 8–12 repetitions Weeks 2–4=6 sets of 12 repetitions 2-minute group: Weeks 1–2=single set until failure or until 2 minutes Weeks 2–4=increased resistance band	Control group=weekly educational emails containing information including general health and physical activity. Internet links regarding this information were also provided	Clinically relevant reductions in pain and tenderness as well as muscle strength increases were found in approximately half of the participants of the training groups As little as 2 minutes of daily progressive resistance training for 10 weeks results in clinically relevant reductions of pain and tenderness and increased muscles strength in adults with frequent neck/shoulder symptoms
Bronfort *et al.*[17] RCT	272 patients; aged 18–65 years old Mean age: SMT group: 48.3 (±15.2) Med group: 46.8 (±12.2) HEA group: 48.6 (±12.5) Sub-acute non-specific neck pain for 2–12 weeks[28,29]	*Within clinic treatment* of spinal thrust/non-thrust decided by the provider group lasting 15–20 minutes	Home exercise with advice (HEA): instructional 1-hour sessions (×2) placed 1–2 weeks apart for home exercise of 'self-mobilization' of gentle controlled general movements of neck retraction, extension, flexion, rotation, lateral bending motions, and scapular retraction (with no resistance) 5–10 repetitions of each exercise up to 6–8 times per day Medication group: visits lasted 15–20 minutes. Non-steroidal anti-inflammatory drugs, acetaminophen, or both. Participants who did not respond to or could not tolerate drugs received narcotic medications or muscle relaxants	SMT had statistically significant advantage over medication at 26 weeks. No important differences in pain were found between SMT and HEA at any time point
Hall *et al.*[18] RCT	32 subjects, mean±SD age, 36±3 years Chronic cervicogenic headache (CHA) for past 3 months[28,29]	HEP only: The experimental group: C1–C2 self-SNAG. Position held for 3 seconds, 2 repetitions of the exercise, twice daily for 12 months	The control group was involved in a sham self-mobilization at C1–C2 using the cervical self-SNAG strap The strap was positioned in the same way at the experimental group, but the subject did not turn their head when they applied the 3-second sustained forward pressure at C1	C1–C2 self-SNAG reduced cervicogenic headache symptoms on the headache severity index over 1 year compared to the control group

Table 5 Continued

Study	Population	Intervention	Comparison	Reported outcomes
Kuijper *et al.*[19] RCT	205 patients, ages 18–75 years Mean age: collar group: 47 (±9.1) PT: 46.7 (±10.9) control: 47.7 (±10.6) Acute/sub-acute cervical radiculopathy<1 month in duration[28,29]	Cervical collar group: semi-hard collar throughout the day for 3 weeks Weeks 3–6=patients were weaned from the collar until week 6 where they were advised to terminate the use of the collar *Physiotherapy with HEP* Physiotherapy group: clinical treatment of deep and superficial neck muscle exercises twice a week for 6 weeks in duration HEP: isometric and chin retraction exercises, 2 sets of 10 repetitions	Control group: patients were advised to continue daily activities and document their normal routine	Treatment with a cervical collar plus rest or PT plus home exercises resulted in a statistically significant reduction of arm and neck pain compared to the control group With the control group, disability index score improved by 9 points on the neck disability Both the cervical collar and the PT groups disability index score improved by 14 points
Mongini *et al.*[20] RCT	1040 participants between 43 and 52 Mean age: intervention group: 48 control group: 47 Chronic headache, neck/shoulder pain[28,29]	*HEP only* Intervention group: relaxation exercises: concentrated craniofacial-cervical facial relaxation for 1 repetition 2 times daily posture retraining of upright standing, horizontal forward and backward head movements, and isometric extension (counter-pressure): 8–10 repetitions, every 2–3 hours	Control group: one-month diary for daily recording of the presences, severity of their headache and neck/shoulder pain, and their intake of analgesics (by type)	Intervention group showed a higher respondent rate for headache and for neck/shoulder pain, and a larger reduction in the days per month with headache
Nikander *et al.*[11] RCT	180 female office workers aged 25–53 years Mean Age: strength group: 45 (±6) endurance group: 45 (±6) control group: 46 (±5) Constant or frequent chronic neck pain and disability occurring>6 months[28,29]	All three groups were encouraged to perform aerobic exercise 3 times/week for 30 minutes Both training groups exercised 3 times/week and also completed a single series of squats, sit-ups, and back extensor exercises as well as 20 minutes of stretching HEP only: Both groups attended a 12-day rehabilitation period to learn exercises followed by performing exercises for 12 months at home Strength training group targeted neck muscles with rubber band 1 set of 15 repetitions 3 times/week at a resistance level of 80% patient's maximum isometric strength from baseline upper body exercises 1 set of 15 repetitions (4–13 kg gradually increasing the load) with dumbbell including dumbbell shrugs, presses, curls, bent-over rows, flies, and pullovers Endurance-training group: trained neck muscles in supine position by lifting up head in 3 sets of 20 repetitions 3 times/week same upper body exercises as the strength training group with 2 kg dumbbells with 3 sets of 20 repetitions	The control group received written information with the same stretching exercises as the training groups to complete three times/week for 20 minutes	One MET-hour of training per week accounted for an 0.8-mm decrease of neck pain on the Visual Analog Scale (VAS) and a 0.5-mm decrease on the Disability Index; a training dose of 20 MET(hour) per month represented a 16-mm decline in the VAS The effective dose of the specific training program to decrease chronic neck pain was 8.75 MET(hour) per week on a scale of 1.5 (light work) to 10 (extremely heavy work)

Table 5 Continued

Study	Population	Intervention	Comparison	Reported outcomes
Salo *et al.*[21] RCT	180 female office workers, ages 25–53 years Mean age: strength group: 45 (±6) endurance group: 45 (±6) control group: 46 (±5) Constant or frequent chronic neck pain and disability occurring>6 months[28,29]	HEP only: Both groups attended a 12-day rehabilitation period to learn exercises followed by performing exercises for 12 months at home Strength training group: trained neck muscles with rubber band 1 set of 15 repetitions 3 times/week at a resistance level of 80% patient's maximum isometric strength from baseline upper body exercises 1 set of 15 repetitions (4–13 kg gradually increasing the load) with dumbbell including dumbbell shrugs, presses, curls, bent-over rows, flies, and pullovers Endurance-training group: trained neck muscles in supine position by lifting up head in 3 sets of 20 repetitions 3 times/week same upper body exercises as the strength training group with 2 kg dumbbells with 3 sets of 20 repetitions	The control group received written information with the same stretching exercises as the training groups to complete three times/week for 20 minutes	Both training groups had statistically significant score improvements as shown with the HRQoL 15D measurement tool. There was no change in the control group (P=0.012). The strength training group improved in 5 of 15 dimensions and the endurance-training group improved in 2 dimensions. 12-month follow-up: both the strength or endurance training seemed to moderately enhance the HRQoL of female patients with chronic neck pain

ache or migraine), myogenous neck/shoulder pain, or headache and/or myogenous neck/shoulder pain.[20] Mongini *et al.*[20] showed that the addition of a HEP is more effective for headache pain relief (0.26) measured by Headache Index and neck and/or shoulder pain captured by the Neck/Shoulder Pain Index (0.33) when compared to a control group.

Discussion

Summary of evidence

The purpose of this systematic review was to examine and describe the effects of using a therapeutic HEP for patients with neck pain (associated with whiplash, or non-specific, specific neck pain, with or without radiculopathy, or cervicogenic headache) on pain, function, and disability compared to other conservative treatment measures or a true control. Additionally, as a secondary objective, we synthesized the design/type of HEP programs and reported on measures of adherence. Based on our calculations, evidence suggests that HEP designs have a range of effects when combined with an intervention or when used alone. The HEP designs within these studies included programs that emphasized strength-training exercises, endurance-training exercises, and self-mobilization techniques.

Based on this review, strength-based HEPs, when used alone or in combination with another treatment, yielded the largest effect sizes on pain reduction.[11,16,20] Based on Nikander *et al.*,[11] there may be a relationship regarding the intensity/dosage of the strengthening program and the severity of the neck pain. Therefore, a higher intensity strengthening level may decrease neck pain severity. Specifically, they found that a training dose of more than 8.75 MET hour week^{-1} specifically for the neck, shoulder, and upper extremities will decrease neck pain. One MET is equivalent to the approximate rate of oxygen consumption of a seated individual at rest (3.5 ml kg^{-1} minute^{-1}).[11] The training dose of 8.75 MET hour week^{-1} equates to moderate intensity (i.e. walking briskly or patient rate of perceived exertion of 11–13) for 30 minutes on 5 days, or 2.5 hours/week, of physical activity.[32,33] The level of activity for pain reduction, as indicated in this study, has been further recommended by the American College of Sports Medicine for proper musculoskeletal health.[16,33] Both strength and endurance protocols were found to be effective, but based on Nikander *et al.*'s[11] findings, the effect sizes may be dependent on the dosage of training (MET hour week^{-1}). Strength training was found to have a greater effect size, but this may be due to a larger exercise dosage compared to the endurance group. Salo *et al.*[21] performed a 12-month follow-up of Nikander

Table 6 Description of HEP interventions, adherence rates, and co-interventions

Author	Included in HEP	# of exercises (time)	Adherence rates and definitions	Co-interventions
Andersen *et al.*[16]	Resisted training	1 exercise, 2 minutes, 10 weeks	Control group 90% 2 minutes 65% 12 minutes 66% HEP: number of training sessions completed via Internet-based questionnaire Control group: informational emails read	12% 2-minute group, 12% 12-minute group, 13% control group stated that they received treatment by a doctor or physiotherapist for neck and shoulder complaints
Bronfort *et al.*[17]	'Self-mobilization'/general movements	6 exercises, 5–10 repetitions, 6–8 times daily, 12 weeks	Adherence was not defined	Study does not differentiate between the specific effects of treatment and the contextual (non-specific) effects
Hall *et al.*[18]	Augmented manual	1 exercise, 2 repetitions, 2 times daily, 12 months	Exercise compliance was greater in the C1–C2 self-SNAG group when compared to the placebo. Compliance was assessed by a questionnaire. Subjects were contacted by telephone if they did fill out questionnaire	No co-interventions noted
Kuijper *et al.*[19]	ROM/strength training	10 exercises, 2 sets, 10 repetitions, daily, 6 weeks	Adherence measured through patient diaries Patients wore the collar *First three weeks*: cervical collar: 91%, PT plus HEP: 88% *During weeks three to six*: 14% did not exercise at all	No co-interventions noted
Mongini *et al.*[20]	Relaxation exercises, ROM exercises, posture exercises	Relaxation: 1 repetition, twice a day, 7 months ROM: 8–10 repetitions, every 2–3 hours, 7 months	A question on the frequency of exercise was added to the month seven diary	No co-interventions noted
Nikander *et al.*[11]	Muscle endurance training Muscle strength training	3 sets of 20 reps, 3 times a week, 12 months 1 set, 15 repetitions, 3 times a week, 12 months	86% strength 93% endurance 65% control Adherence was measured with training diaries	No co-interventions noted
Salo *et al.*[21]	Endurance training Strength training	3 sets of 20 reps, 3 times a week, 12 months 1 set, 15 repetitions, 3 times a week, 12 months	86% strength 93% endurance 65% control Adherence was measured with training diaries	No co-interventions noted

et al.'s[11] research study and found that the HRQoL scores were better in the strength group compared to the endurance group. Interestingly, Andersen *et al.*[16] found that there was no difference in the effect sizes between the 2-minute and the 12-minute HEP groups. Therefore, the amount of time spent performing the HEP exercises in this study did not correlate to a larger effect size or larger reduction in pain.

Utilization of specific self-mobilizations within a HEP may benefit patients with neck pain and/or headache. Hall *et al.*,[18] whose HEP included a self-mobilization to a specific region/segment, were found to have the highest calculated effect size on neck pain when compared to the sham self-mobilization HEP intervention group (Cohen's d=1.79). The experimental group performed two repetitions of a C1–C2 self-SNAG mobilization, held for 3 seconds, twice daily for 12 months. Therefore, the authors showed that specifically targeting a problematic segment/cervical level may benefit a patient. In contrast to targeting a specific problematic segment/cervical level, Bronfort *et al.*'s[17] study used 'self-mobilization exercises' that involved general non-specific neck motions including retraction. Hall *et al.*'s[18] study yielded a larger effect size compared to Bronfort *et al.*[17] (1.79, 0.16, respectively). Targeting specific dysfunctional cervical segments levels, such as the cervical segments C1–C2, for treatment of cervicogenic headache has been supported in the literature.[34–39]

A finding from Kuijper *et al.*[19] suggested that a passive treatment, such as a cervical collar, may be better than physiotherapy, which included graded activity exercises for cervical mobilization and stabilization, with HEP. However, the effect sizes were trivial when compared on the VAS and the NDI (0.18, 0.10, respectively).[22,31] This is not consistent with the cervical practice guidelines for treatment of neck pain.[2] Additionally, the effects of a cervical collar on whiplash-associated injuries were not found to provide obvious benefits on functional recovery, reduction of pain, or reduction of disability following whiplash injuries.[40] Although there is a difference seen within Kuijper *et al.*'s[19] study, the difference is minimal and further research is necessary to determine whether there is a significant difference.

While adherence was defined in six out of the seven included studies, none of the authors used the same definition. This may influence how their tudies should be interpreted.[11,16,18–21] The most common modes of monitoring adherence were training diaries[11,19–21] and questionnaires.[16,19] None of the studies included in this review used a cut-off percentage to define adherence but did report the rates of adherence (adherent vs non-adherent). It has been found in the literature that rates as low as 50% have been used to define program adherence.[41] Rates of adherence within the included studies ranged from 66 to 93%. The mode of adherence calculations varied from study to study (Table 6).

Implications for clinical practice

After synthesizing the results of our systematic review, the authors would recommend a mixed treatment approach for an effective home exercise prescription. The suggested clinical recommendations for patients with neck pain based on this systematic review include:

- designing a HEP to emphasize both strength- and endurance-training exercises of moderate intensity to improve neck pain and HRQoL measures;
- designing a HEP that uses self-mobilizations to augment spinal motion or cervical ROM for patients with cervicogenic HA may reduce pain.

Specific details regarding these exercises are further described within our PICOS table (Table 5).

Limitations

There were a number of potential limitations to this systematic review. Although classifications are helpful, we wanted to examine the effects of neck HEP across diagnostic sub-classifications.

Another limitation relates to the quality scores assigned to the original studies. As the Maastricht–Amsterdam criteria list was used quantitatively, readers should note that certain criteria are more likely to be important than others in rating the overall quality of a study. Therefore, two studies with the same scores may not have an equivalent level of quality.

Only qualitative conclusions were drawn from Salo *et al.*[21] regarding HRQoL due to insufficient data. With limited data, the authors of this systematic review were unable to calculate effect sizes, which limited subsequent interpretation of the data. In addition, six of the seven studies reported the end point mean and failed to report mean change scores. Resultantly, some of the calculated effect sizes of the interventions may be smaller or larger than could be reported for these studies.

A final limitation included the number of outcome measurements used within the studies. Only three of the seven studies selected more than one outcome measure (Table 2). A greater number of outcome measures allow for greater interpretation of the effectiveness of the interventions used.

Conclusions

According to the results of the studies analyzed in this systematic review, a HEP that emphasizes strengthening and/or endurance is effective at reducing neck pain, function, disability, and improving QOL. The use of a HEP in combination with other conservative interventions, or alone, yields benefits with effect sizes ranging from trivial to moderate. The definitions of patient adherence with standardized cut-off levels

may help research in this topic area become less variable and better evaluated, as it may impact the overall effect of the intervention.

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