

Research

Exercise programs may be effective in preventing a new episode of neck pain: a systematic review and meta-analysis

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KEY WORDS

Neck pain
Prevention
Randomised controlled trial
Systematic review
Meta-analysis



ABSTRACT

Question: What is the effectiveness of interventions that aim to prevent a new episode of neck pain? **Design:** Systematic review and meta-analysis of randomised, controlled trials. **Participants:** People without neck pain at study entry. **Intervention:** Any intervention aiming to prevent a future episode of neck pain. **Outcome measures:** New episode of neck pain. **Results:** Five trials including a total of 3852 individuals met the inclusion criteria. The pooled results from two randomised, controlled trials (500 participants) found moderate-quality evidence that exercise reduces the risk of a new episode of neck pain (OR 0.32, 95% CI 0.12 to 0.86). One of the meta-analysed trials included some co-interventions with the exercise. There was low-quality evidence from three randomised, controlled trials (3352 participants) that ergonomic programs do not reduce the risk of a new neck pain episode (OR 1.00, 95% CI 0.74 to 1.35). **Conclusion:** This review found moderate-quality evidence supporting the effectiveness of an exercise program for reducing the risk of a new episode of neck pain. There is a need for high-quality randomised, controlled trials evaluating interventions to prevent new episodes of neck pain. **Registration:** PROSPERO CRD42017055174. [**de Campos TF, Maher CG, Steffens D, Fuller JT, Hancock MJ (2018) Exercise programs may be effective in preventing a new episode of neck pain: a systematic review. Journal of Physiotherapy 64: 159–165**]

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Introduction

Neck pain is one of the most significant health problems worldwide.¹ It has been ranked the fourth leading cause of years lived with disability, according to the Global Burden of Disease Study.² Mean lifetime prevalence is estimated to be 48.5% and is expected to increase due to the ageing population.^{2,3} The natural course of an episode of neck pain is favourable;⁴ however, recurrence rates are reported to be high,⁵ which contributes to the high global social and economic burden. The Global Burden of Disease studies^{1,2} and Task Forces⁶ worldwide have called for prevention strategies for neck and back pain. Recent clinical practice guidelines for neck pain lack recommendations for prevention.⁷ Consequently, a comprehensive, high-quality systematic review of the literature is required to examine the effectiveness of prevention strategies for neck pain.

A number of systematic reviews that examined the effectiveness of interventions for preventing neck pain have been published.^{8–12} However, these systematic reviews have important limitations. Some were published > 10 years ago,^{8,9} some did not publish a pre-specified study protocol,^{10,12} some included non-randomised studies,^{10–12} and some included studies recruiting symptomatic participants at study entry.^{9,11} There has been no systematic review investigating strategies for prevention of neck pain including only randomised, controlled trials (randomised, controlled trials) and asymptomatic participants at baseline.

Therefore, the research question for this systematic review was:

What is the effectiveness of interventions that aim to prevent a new episode of neck pain?

Method

This systematic review adhered to the statement for reporting systematic reviews and meta-analyses of studies that evaluate healthcare interventions (PRISMA).¹³

Identification and selection of studies

A comprehensive search of five electronic databases (MEDLINE via Ovid, EMBASE via Ovid, CINAHL, Physiotherapy Evidence Database (PEDro), and The Cochrane Central Register of Controlled Trials (CENTRAL) via The Cochrane Library) was conducted from the earliest records published to 27 April, 2018. A sensitive search strategy was used based on the recommendations of the Cochrane Back and Neck Group¹⁴ for 'randomised controlled trials' and 'neck pain', combined with search terms for 'prevention'. The detailed search strategy for each database is presented in Appendix 1 (see eAddenda for Appendix 1). In addition, reference lists of relevant reviews and included randomised, controlled trials were manually searched for additional randomised, controlled trials, and citation tracking of all included trials was performed. Non-English language studies were

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Box 1. Inclusion criteria.**Design**

- Randomised, controlled trials

Participants

- People not meeting the study's definition of an episode of neck pain at study entry

Intervention

- Any intervention aiming to prevent a new episode of neck pain

Outcome measures

- A new episode of neck pain
- A new episode of neck pain leading to care seeking, activity limitation or work loss
- Measures of pain or disability over the follow-up period

Comparisons

- The intervention group must be compared to no intervention/placebo or minimal intervention
- Studies investigating the additional benefit of a treatment (eg, exercise + education versus exercise alone)

included if an appropriate translation could be obtained; otherwise, they were noted but excluded from analyses.

Randomised, controlled trials assessing the effectiveness of prevention strategies for neck pain were included if they met the inclusion criteria listed in Box 1. A three-stage screening process was used to select relevant randomised, controlled trials for this review. In the first stage, one reviewer (TFC) screened all titles for eligibility and excluded clearly irrelevant studies. In the second stage, each study title and abstract was independently evaluated by two reviewers (TFC and DS or JTF). In the third stage, the full text for each potentially eligible study was retrieved and assessed against the eligibility criteria by two independent reviewers (TFC and DS or JTF). In cases of disagreement, a third reviewer (MJH or CGM) was consulted.

Assessment of characteristics of studies*Risk of bias*

Risk of bias was assessed using the PEDro Scale^{15,16} by downloading the available scores from the PEDro database. If a study had not been rated on the website, two experienced PEDro raters scored the study. The total score on the PEDro scale is the addition of 'yes' (criterion is clearly satisfied) responses for Items 2 to 11 (Item 1 is not used for calculation of the total PEDro scale score because it is more related to external validity) and range from 0 (high risk of bias) to 10 (low risk of bias). There is evidence that the PEDro scale total score has acceptably high reliability and validity^{15,16} and Rasch analysis has confirmed that it can be used as a continuous scale.¹⁷

Participants

Randomised, controlled trials were included if the participants did not have neck pain at study entry or did not meet all of the study's criteria for an episode of neck pain at baseline. For example, if a small proportion of participants had mild neck pain at study entry but all were working, and the study outcome was a new episode of work absence due to neck pain, then the study would be considered eligible.

Intervention

To be eligible for inclusion, trials had to evaluate an intervention aiming to prevent a future episode of neck pain. The experimental group had to be compared to a group that received no intervention, sham intervention or minimal intervention. Randomised, controlled trials investigating multimodal interventions were also included.

Outcome measures

To be eligible for inclusion, trials had to report an outcome measure of a new episode of neck pain (eg, number of participants experiencing a new episode of neck pain, or number of participants taking sick leave due to a new episode of neck pain), or a measure of neck pain or disability over the follow-up period (pain or disability measures at a single point in time did not satisfy this criterion).

Data extraction and analysis

Data for each included trial were extracted by two independent reviewers (TFC and MJH or JTF) using a standardised data extraction form and discrepancies were resolved by discussion with a third author (CGM). Extracted data included the characteristics of the trial (eg, demographic characteristics of the participants, description of the interventions, duration of treatment, and description of the outcomes) and outcome data. Whenever possible, raw outcome data (number of participants having a new episode of neck pain and total number of participants) in both the intervention group and control group were extracted. Treatment effect estimates were calculated using methods recommended in the Cochrane Handbook for Systematic Review of Interventions.¹⁸ Attempts were made to contact authors of included trials to clarify any relevant information or request additional data, when required.

The overall quality of evidence was assessed for each intervention contrast and rated as high, moderate, low, or very low, as recommended by the Grading of Recommendations Assessment, Development and Evaluation (GRADE) system.¹⁹ The GRADE classification was downgraded one level per study flaw, from high quality, if any of the following flaws were present: design limitation (more than a quarter of participants from studies with high risk of bias, PEDro score < 7); inconsistency of results (substantial heterogeneity, $I^2 > 50%$); and imprecision (based on a threshold of < 400 participants for each pooled outcome, and also observation of the 95% CIs in cases of dichotomous outcomes). This review did not consider the indirectness criterion because the eligibility criteria ensured a specific population with relevant outcomes. In addition, the review did not assess publication bias due to insufficient study numbers. Two reviewers (TFC and MJH or DS or JTF) independently performed GRADE assessments for each treatment contrast.

Trials considered homogeneous were grouped into the same prevention strategy category. Odds ratios (ORs) and 95% CIs were calculated and a random-effects model was used to pool estimates using commercial meta-analysis software^a. For randomised, controlled trials that did not report the sample size at the end of the follow-up period, the OR (95% CI) was calculated using the baseline sample size. Outcome data on short-term follow-up (≤ 12 months) and long-term follow-up (> 12 months) were assessed. Statistical heterogeneity was assessed visually and using the I^2 statistic.

Results**Flow of studies through the review**

Overall, the comprehensive database search strategy identified 12 725 records. After screening articles by title and abstract, 114 potentially eligible studies were identified, and their full texts were retrieved. In total, five trials (3852 participants) met the inclusion criteria and were included in the review.^{20–24} The included studies were three randomised, controlled trials^{20,22,24} and two cluster-randomised, controlled trials.^{21,23} An outline of the screening and reviewing process can be seen in Figure 1.

Characteristics of studies*Risk of bias*

Risk of bias scores for four of the randomised, controlled trials^{20,21,23,24} were found on the PEDro database website. The fifth

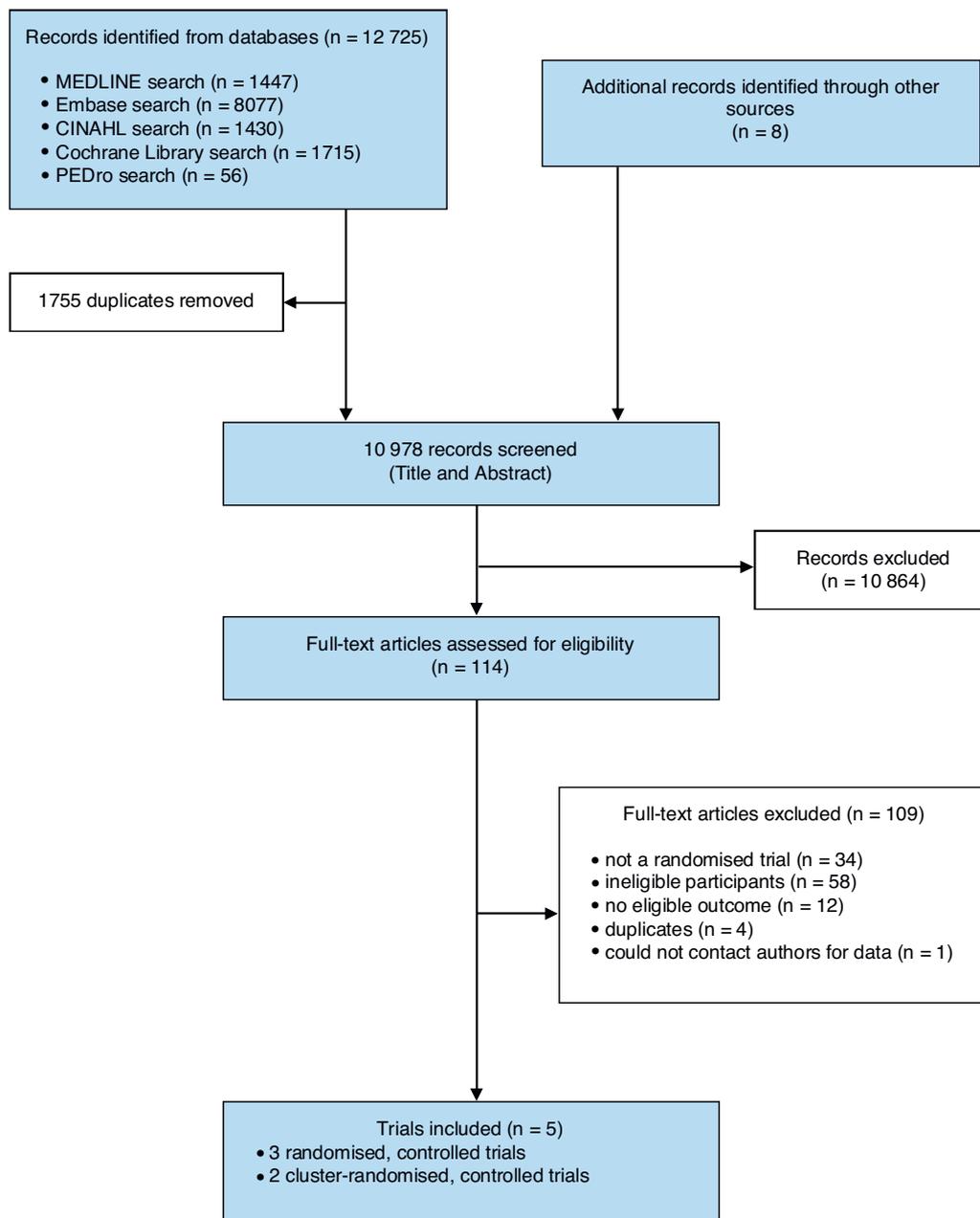


Figure 1. Flow of studies through the review.

study²² was independently assessed and scored by two experienced PEDro raters. The mean PEDro score was 6.2 (SD 1.3) with blinding, concealed allocation, and adequate follow-up being the main items scored as high risk of bias. The PEDro scale responses for individual items and the total score for each included randomised, controlled trial are available in [Table 1](#).

Participants

All of the included trials (3852 participants) examined a working-age population with the mean age around 40 years, about 42% of whom were female. Four trials investigated prevention strategies in a population of office workers,^{20–23} while one trial investigated a sample of nursing personnel.²⁴ [Table 2](#) provides details about the characteristics of each trial.

Intervention

The included trials investigated the effect of two neck pain prevention strategies: ergonomic programs^{20–22} and exercise programs.^{23,24} The three trials^{20–22} assessing ergonomic programs used multiple prevention strategies: adjustment of workstation,^{20,22} ergonomic redesign or modification,^{20–22} evaluation of participant

posture while performing daily tasks,²² manual handling aids,²¹ and job rotation.²¹ One of the two trials investigating exercise programs²³ evaluated neck muscle stretching and endurance training. This was delivered at work twice a day for each working day and twice a week at home over the 12-month study period. The second trial investigating exercise²⁴ evaluated a generalised aerobic program, including: body awareness and aerobic, strengthening, stabilising and stretching exercises, supplemented by health information/stress management training, and a practical examination of the workplace. The exercise program was delivered in 1-hour sessions, three times per week for 9 months, and the health information/stress management component was delivered in 1-hour sessions, once per week for 4 months.

Outcome measures

Raw data on the number of new events (eg, neck pain episodes) and number of participants were available for four^{20,22–24} of the five trials. For these four studies, ORs (95% CI) were calculated. For the remaining study,²¹ an OR with 95% CI and *p*-value was provided, but raw data on the number of new events were not presented. No eligible trials were identified that reported outcome data on the number of new episodes of neck pain leading to care

Table 1
PEDro scores of included trials.

Study	Eligibility criteria and source	Random allocation	Concealed allocation	Baseline comparability	Blind subjects	Blind therapists	Blind assessors	Adequate follow-up	Intention-to-treat analysis	Between-group comparisons	Point estimates and variability	Total score (0 to 10)
Pillastrini et al (2007) ²²	N	Y	N	Y	N	N	Y	Y	Y	Y	Y	7
Conlon et al (2008) ²⁰	Y	Y	N	Y	N	N	Y	N	Y	Y	Y	6
Tveito et al (2009) ²⁴	N	Y	Y	Y	N	N	N	N	N	Y	Y	5
Driessen et al (2011) ²¹	Y	Y	N	Y	N	N	N	N	Y	Y	Y	5
Sihawong et al (2014) ²³	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	8

N = no, PEDro = Physiotherapy Evidence Database, Y = yes.

Table 2
Characteristics of the included trials.

Study	Participants ^a	Outcome definition	Experimental group	Control group	Time and frequency of interventions	Follow-up period
Pillastrini et al (2007) ²²	n = 99 Mean age = 42 yrs Gender = 71% females Administrative personnel of the city's Town Hall	Neck pain episode: Indicated the presence of neck pain on a pain drawing. Outcome assessed at 5 months' follow-up.	Ergonomic intervention: workstation evaluation and adjustments, and postural evaluation while performing daily tasks, by a physiotherapist.	No intervention	Exp: One ergonomic intervention session of 30 mins for each operator, with twice a month supervision and consultation of 5 to 10 mins.	5 months
Conlon et al (2008) ²⁰	n = 206 Mean age = 43 yrs Gender = 28% females Office workers (engineers)	Neck pain episode: A neck disorder diagnosed on the physical examination if neck discomfort > 5/10 reported at weekly assessment.	Ergonomic program (implementation of an adapted workstation): (i) an alternative mouse; (ii) a conventional mouse + forearm support board; (iii) an alternative mouse + forearm support board – aimed to prevent musculoskeletal disorders.	Minimal intervention: workstation with a conventional mouse	Exp/Con: Participants were asked to use the workstation while on duty.	12 months
Driessen et al (2011) ²¹	n = 3047 Mean age = 42 yrs Gender = 41% females Participants recruited through four Dutch companies	Neck pain episode: Presence of neck pain at least 3 on a 4-point scale (DMQ). Outcome assessed every 3 months.	Ergonomic program: implementation of Stay@Work participatory ergonomic program (evaluation and prioritise the risk factors and ergonomic measures to prevent neck pain).	Minimal intervention: educational movies about prevention of neck pain	Exp: Participants were asked to use the ergonomic program while on duty (first 3 months to implement the ergonomic measures) Con: 3 × 45 s educational movies.	12 months
Tveito et al (2009) ²⁴	n = 40 Mean age = N/S Gender = 100% females Employees (nursing personnel) in a nursing home for older people in Norway	Neck pain episode: Severity was scored on a 4-point scale (0 = no complaint to 3 = severe complaints); no cut-off point.	Integrated Health Program: physical exercise (based on a standardised aerobic dancing program) to improve physical capacity, strength and flexibility, including: body awareness, aerobic, strength, stabilising and stretching exercises. Supplemented by health information/stress management training and a practical examination of the work place.	No intervention	Exp: Aerobic program 3 × week for 1 hour for 9 months. A total of 15 hours of information (1 hour/week for 3 months) on stress, coping, health and lifestyle and a workplace practical examination.	9 months
Sihawong et al (2014) ²³	n = 567 Mean age = 37 yrs Gender = 50% females Office workers with lower neck flexion range and muscle endurance, from 12 large-scale enterprises in Bangkok	Neck pain episode: An incident episode was defined as having pain > 30 mm on a 100-mm visual analogue scale and had no weakness or numbness in the upper limb. Outcome assessed using a diary.	Exercise program: stretching exercises and endurance exercises for the neck muscles. Included daily reminder messages for the first 3 months.	No intervention	Exp: Neck muscles stretching exercise twice daily for each working day, and muscle endurance training ten times, twice per wk, during the 12-mth study period.	12 months

Con = control group, DMQ = Dutch Musculoskeletal Questionnaire, Exp = experimental group, N/S = not stated.

^a Participants with no neck pain at baseline.

seeking, activity limitation, or days lost from work. All trials followed participants for ≤ 12 months (short-term follow-ups). The number of new events, sample size and ORs (95% CIs) for the included randomised, controlled trials are presented in Figure 2 on the eAddenda. A summary of the findings and quality of evidence assessment (GRADE) are presented in Table 3.

Effect of ergonomic programs on preventing neck pain

Three randomised, controlled trials^{20–22} (3352 participants) were included in the meta-analysis investigating the effect of ergonomic programs compared to no or minimal intervention. One randomised, controlled trial²⁰ had four intervention arms. The minimal intervention arm was used as the control group. Each of

Table 3
Summary of findings and quality of evidence assessment.

Prevention strategy	Summary of findings			Quality of evidence assessment (GRADE)			
	Trials (n)	Participants (n)	OR (95% CI)	Study limitation	Inconsistency	Imprecision	Overall quality
Ergonomic program	3	3352 ²⁰⁻²²	1.00 (0.74 to 1.35)	-1	-1	None	Low
Exercise	2	500 ^{23,24}	0.32 (0.12 to 0.86)	None	None	-1 ^a	Moderate

GRADE= Grading of Recommendations Assessment, Development and Evaluation. The quality of evidence was downgraded one level (-1) if the study did not comply with each GRADE criteria.
^a Downgraded one level (-1) due to wide CI of pooled effect.

three pairwise comparisons were separately included, with the number of events and participants in the control group divided out evenly among the comparisons, as recommended in the Cochrane Handbook for Systematic Reviews.¹⁸ The pooled results for ergonomic programs provided low-quality evidence of no protective effect (OR 1.00, 95% CI 0.74 to 1.35) when compared to no or minimal intervention in preventing new episodes of neck pain (Figure 3, Table 3). See Figure 2 in the eAddenda for a detailed forest plot.

Effect of exercise programs on preventing neck pain

Two randomised, controlled trials^{23,24} (500 participants) were included in the meta-analysis investigating the effect of exercise programs compared to no intervention control. In one randomised, controlled trial²³ the intervention was restricted to exercise, while in the other randomised, controlled trial²⁴ exercise was the primary intervention, supplemented by health information/stress management training, and a practical examination of the workplace. The pooled results provided moderate-quality evidence of reduced risk of a future neck pain episode (OR 0.32, 95% CI 0.12 to 0.86) (Figure 4, Table 3). See Figure 2 in the eAddenda for a detailed forest plot.

Discussion

Five randomised, controlled trials investigating two intervention strategies to prevent neck pain were deemed eligible to be included in this systematic review. The review found moderate-quality evidence that an exercise program substantially reduces the risk of a new episode of neck pain (OR 0.32, 95% CI 0.12 to 0.86). This evidence was derived from two trials that included 500 participants.^{23,24} Pooled results from three trials²⁰⁻²² with 3352 participants produced low-quality evidence that ergonomic programs do not reduce the risk of a new episode of neck pain (OR 1.00, 95% CI 0.74 to 1.35).

The strengths of this systematic review included the use of a pre-specified protocol registered on PROSPERO, sensitive search strategy using multiple electronic databases with supplementary

hand searching, following the PRISMA recommendations, and the use of the GRADE system to appraise the overall quality of the evidence. The risk of bias of included trials was assessed using the PEDro scale, which has acceptably high reliability and validity,^{15,16} and can be used as a continuous scale for measuring risk of bias in randomised, controlled trials.¹⁷

This systematic review and meta-analysis had some limitations. A small number of trials were included, despite the comprehensive search strategy. The majority of the trials²⁰⁻²³ evaluated the effectiveness of the intervention in office workers; thus, the generalisability of these findings to other populations is unclear. Authors could not be contacted to gather information for one potentially eligible trial.²⁵ Some included trials were not registered,^{20,22,24} and did not present a pre-specified published protocol,^{20,22,24} leading to potential reporting bias. The two trials^{23,24} evaluating exercise had different approaches to exercise: in one trial,²³ the program was confined to neck exercises, whereas the other trial²⁴ evaluated a generalised whole body exercise program, supplemented by health information/stress management training, which means there is uncertainty about which approach to recommend.

It is believed that the current systematic review with meta-analysis is the first to have included only randomised, controlled trials evaluating prevention strategies for neck pain that have included asymptomatic participants at baseline (or at least participants that did not meet all of the study's criteria for an episode of neck pain at baseline). Previous systematic reviews that have investigated the effectiveness of interventions to prevent neck pain have included trials with symptomatic participants at study entry.⁸⁻¹² Some are also out of date,⁸⁻¹⁰ and some include sub-optimal study designs (such as non-randomised trials or quasi-experimental studies).^{9,10}

A recent review¹² investigated the effectiveness of exercise for preventing upper extremity musculoskeletal disorders, including neck pain.¹² That review found evidence of limited to strong quality that exercise could prevent upper extremity symptoms; however, it included studies with symptomatic participants at baseline (ie, the studies evaluated treatment, not prevention), and also included study designs other than randomised, controlled trials. Furthermore, that review did not differentiate neck pain from other body regions (eg, neck/shoulder) when assessing trials for

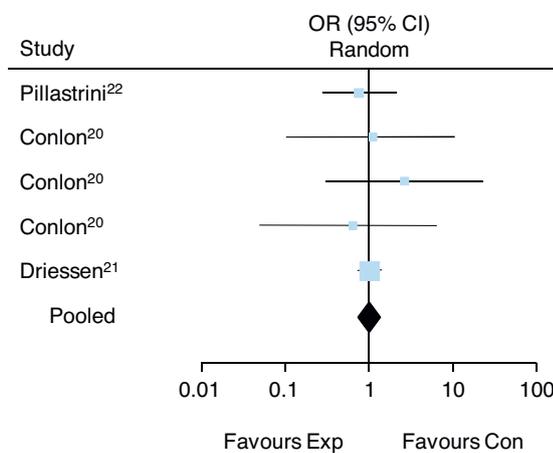


Figure 3. Odds ratio for neck pain episode in trials of ergonomic programs, estimated by pooling data from three trials (n = 3352). Exp = experimental group, Con = control group.

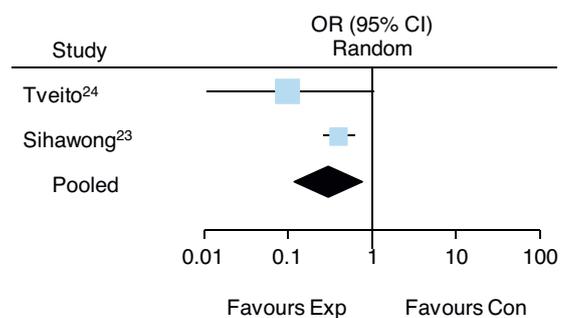


Figure 4. Odds ratio for neck pain episode in trials of exercise, estimated by pooling data from two trials (n = 500). Note that one study²⁴ administered exercise supplemented by health information/stress management training, and a practical examination of the workplace. Exp = experimental group, Con = control group.

the effectiveness of exercise prevention strategies. As a result of the stricter inclusion criteria, the current review identified a substantially smaller number of randomised, controlled trials.

A Cochrane review²⁶ (with 13 randomised, controlled trials involving 2397 workers) reported that most ergonomic interventions were not effective in preventing work-related upper limb and neck musculoskeletal disorders, which is in line with the results from the current review. However, one meta-analysis in the Cochrane review, including two randomised, controlled trials,^{20,27} found moderate-quality evidence that the use of ergonomic equipment may reduce the incidence of neck/shoulder pain. The difference in inclusion criteria, especially the inclusion of studies that did not differentiate neck and shoulder pain, and studies of participants with pain at study entry, may explain the somewhat different conclusions between the Cochrane review and the current systematic review and meta-analysis.

The results of the present systematic review on prevention of neck pain are similar to the results of a recently published systematic review on prevention of low back pain.²⁸ Steffens and colleagues also found that an exercise program alone (RR 0.65, 95% CI 0.50 to 0.86) or in combination with education (RR 0.55, 95% CI 0.41 to 0.74) are effective for preventing low back pain. For a more direct comparison with the result of the Steffens review, the current meta-analysis for the exercise intervention was recalculated as RR (instead of OR as in Figures 2 and 4). Exercise reduced the risk of a new episode of neck pain by 53% (RR 0.47, 95% CI 0.32 to 0.68). The calculation for the pooled RR result for the exercise intervention contrast is presented in Figure 5 on the eAddenda.

Although the current systematic review found that exercise programs are likely to roughly halve the risk of a new episode of neck pain, the quality of the evidence is moderate and further high-quality randomised, controlled trials are needed. One randomised, controlled trial²⁴ evaluating exercise provided participants with health information/stress management training and a workplace assessment as part of the intervention, which means there is uncertainty about the effectiveness of the exercise alone. The durations of the exercise programs were quite long – 9 months²⁴ and 12 months²³ – which needs to be borne in mind when considering this therapy. Additionally, there are no outcomes beyond 12 months, so the long-term effect is unknown. Furthermore, high-quality randomised, controlled trials are needed to investigate the potential benefit of interventions to prevent episodes of neck pain leading to care seeking, activity limitation, and days lost from work.

In conclusion, the results of this review found moderate-quality evidence that an exercise program reduces the risk of a new episode of neck pain. Ergonomic strategies do not appear to prevent neck pain. Additional trials with longer-term follow-up would more clearly establish the public health implications of this result.

What was already known on this topic: Neck pain is common, but clinical practice guidelines lack recommendations regarding prevention. Past systematic reviews of preventive interventions for neck pain have had important flaws such as the inclusion of non-randomised studies.

What this study adds: Exercise programs substantially reduce the risk of a new episode of neck pain. The evidence for this is of moderate quality and one of the included trials included some co-interventions with the exercise. Ergonomic programs do not appear to significantly reduce the risk of a new episode of neck pain, but the evidence for this is of low quality.

Footnote: ^a Comprehensive Meta-analysis, version 2.2.064, Biostat, Englewood, NJ, USA.

eAddenda: Appendix 1, Figures 2 and 5 can be found online at <https://doi.org/10.1016/j.jphys.2018.05.003>

Ethics approval: Not applicable as this is a systematic review.

Conflict of interest: Nil.

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Provenance: Not invited. Peer reviewed.

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