Prevention of Low Back Pain
A Systematic Review and Meta-analysis

Daniel Steffens, PhD; Chris G. Maher, PhD; Leani S. M. Pereira, PhD; Matthew L Stevens, MScMed (Clin Epi); Vinicius C. Oliveira, PhD; Meredith Chapple, BPhty; Luci F. Teixeira-Salmela, PhD; Mark J. Hancock, PhD

**IMPORTANCE** Existing guidelines and systematic reviews lack clear recommendations for prevention of low back pain (LBP).

**OBJECTIVE** To investigate the effectiveness of interventions for prevention of LBP.

**DATA SOURCES** MEDLINE, EMBASE, Physiotherapy Evidence Database Scale, and Cochrane Central Register of Controlled Trials from inception to November 22, 2014.

**STUDY SELECTION** Randomized clinical trials of prevention strategies for nonspecific LBP.

**DATA EXTRACTION AND SYNTHESIS** Two independent reviewers extracted data and assessed the risk of bias. The Physiotherapy Evidence Database Scale was used to evaluate the risk-of-bias. The Grading of Recommendations Assessment, Development, and Evaluation system was used to describe the quality of evidence.

**MAIN OUTCOMES AND MEASURES** The primary outcome measure was an episode of LBP, and the secondary outcome measure was an episode of sick leave associated with LBP. We calculated relative risks (RRs) and 95% CIs using random-effects models.

**RESULTS** The literature search identified 6133 potentially eligible studies; of these, 23 published reports (on 21 different randomized clinical trials including 30 850 unique participants) met the inclusion criteria. With results presented as RRs (95% CIs), there was moderate-quality evidence that exercise combined with education reduces the risk of an episode of LBP (0.55 [0.41-0.74]) and low-quality evidence of no effect on sick leave (0.74 [0.44-1.26]). Low- to very low-quality evidence suggested that exercise alone may reduce the risk of both an LBP episode (0.65 [0.50-0.86]) and use of sick leave (0.22 [0.06-0.76]). For education alone, there was moderate- to very low-quality evidence of no effect on LBP (1.03 [0.83-1.27]) or sick leave (0.87 [0.47-1.60]). There was low- to very low-quality evidence that back belts do not reduce the risk of LBP episodes (1.01 [0.71-1.44]) or sick leave (0.87 [0.47-1.60]). There was low-quality evidence of no protective effect of shoe insoles on LBP (1.01 [0.74-1.40]).

**CONCLUSION AND RELEVANCE** The current evidence suggests that exercise alone or in combination with education is effective for preventing LBP. Other interventions, including education alone, back belts, and shoe insoles, do not appear to prevent LBP. Whether education, training, or ergonomic adjustments prevent sick leave is uncertain because the quality of evidence is low.
Low back pain (LBP) is one of the most burdensome health problems worldwide, generating enormous costs in treatments and time lost from work. The global point prevalence of LBP is 12%; with the aging population, the number of people affected is likely to increase over the coming years. A key contributor to the burden is the high recurrence rate: approximately one-half of patients experience a recurrence of LBP within 1 year after recovering from a previous episode. It is therefore important to know whether it is possible to prevent LBP and, if so, which interventions are most effective.

Although there have been several systematic reviews of strategies to prevent LBP, most have major limitations. Many of the existing reviews are out-of-date, report data from randomized clinical trials (RCTs) of symptomatic participants, do not consider the strength of evidence (eg, using the Grading of Recommendations Assessment, Development, and Evaluation [GRADE] system), are restricted to a particular type of intervention or setting, or do not follow a prespecified, publicly accessible protocol.

Therefore, a comprehensive, high-quality review that includes the most recent publications is needed to provide a current overview of the effectiveness of prevention strategies. The aim of this systematic review was to evaluate the evidence on the effectiveness of interventions for prevention of episodes of LBP and use of sick leave due to LBP.

Methods

Literature Search
The PRISMA Statement was used to guide the conduct and reporting of the study. This study searched the following electronic databases from the earliest record to November 22, 2014: MEDLINE, EMBASE, Physiotherapy Evidence Database (PEDro), and the Cochrane Central Register of Controlled Trials. A sensitive search strategy was used based on the recommendations of the Cochrane Back Review Group for randomized controlled trials and back pain as well as search terms for prevention. The full search strategy is outlined in eTable 1 in the Supplement. The reference lists of relevant reviews and trials were screened for additional studies, and we also used citation tracking of all included trials.

During the first screening, 2 reviewers (D.S. or M.J.H. with V.C.O. or M.C.) evaluated the titles and abstracts of each citation and excluded clearly irrelevant studies. For each potentially eligible study, 2 reviewers (D.S. or M.J.H. with V.C.O. or M.C.) examined the full-text article and assessed whether the study fulfilled the inclusion criteria. In cases of disagreement, a decision was made by consensus or, if necessary, a third reviewer (C.G.M.) was consulted.

Study Selection
We included RCTs assessing the effectiveness of prevention strategies for nonspecific LBP. To be eligible, trials needed to meet the following criteria: (1) included participants without LBP at study entry or at least 1 outcome was present at baseline (eg, some participants had mild LBP, but all were working and the study outcome was an episode of work absence due to LBP); (2) aimed to prevent future episodes of LBP; (3) compared intervention group with groups that received no intervention, placebo, or minimal intervention; and (4) reported a measure of a new episode of LBP (eg, episode of LBP or episode of sick leave due to LBP). Studies that used a quasi-randomized design or reported the comparison of 2 prevention strategies (eg, exercise vs lumbar support) were excluded. No restrictions were placed on the setting or context of the included studies, languages, or date of the RCT report.

Data Extraction and Synthesis
We assessed the quality of the trials’ methods using the PEDro scale by either downloading the available scores from the PEDro database (http://www.pedro.org.au) or rating the trial ourselves. Scores on the PEDro scale range from 0 (very low methodological quality) to 10 (high methodological quality); methodologic quality was not an inclusion criterion of this review.

Two independent reviewers (D.S. or M.J.H. with V.C.O. or M.C.) extracted the characteristics and intervention outcomes of each trial using a standardized data extraction form. When possible, we extracted the raw outcomes (number of persons having an episode of LBP) for each group (intervention and control) and calculated the estimates of treatment effect using methods recommended in the Cochrane Handbook for Systematic Reviews of Interventions, Version 5.1.0.

To evaluate the overall quality of the evidence, we used the GRADE system. The GRADE classification was downgraded from high quality by 1 level for each factor that we encountered: (1) design limitation (>25% of participants from studies with low methodologic quality: PEDro score <7), (2) inconsistency of results (wide variance of point estimates across studies or large heterogeneity between trials: I² >50%), and (3) imprecision (<400 participants for each outcome). We did not consider the indirectness criterion in this review because we included a specific population with relevant outcomes and direct comparisons. A GRADE profile was completed for each pooled estimate and for single trials comparing an LBP prevention strategy with controls. When only single RCTs were available, evidence from studies with fewer than 400 participants was downgraded for inconsistency and imprecision (ie, sparse data) and rated as low-quality evidence. These trials could be further downgraded to very low-quality evidence if limitations of study design were found (PEDro score <7). Two reviewers (D.S. or M.J.H. with V.C.O. or M.C.) judged whether these factors were present for each outcome. The quality of evidence was defined as (1) high (further research is unlikely to change our confidence in the estimate of effect and there are no known or suspected reporting biases: all domains are fulfilled); (2) moderate (further research is likely to have an important effect on our confidence in the estimate of effect and might change the estimate: 1 of the domains is not fulfilled); (3) low (further research is likely to have an important effect on our confidence in the estimate of effect and is likely to change the estimate: 2 of the domains are not fulfilled); and (4) very low (we are uncertain about the estimate: 3 of the domains are not fulfilled).
Statistical Analysis
Outcome data were extracted for short-term (follow-up evaluations ≤12 months) and long-term (follow-up evaluations >12 months) follow-up. When multiple time points fell into the same category, we used the longest follow-up period.

Trials considered homogeneous were grouped according to the prevention strategy, comparison group, outcome (LBP episode and sick leave), and outcome assessment time points (short-term and long-term). We calculated relative risks (RRs) and 95% CIs and used the random-effects model to pool estimates for each analysis obtained with Comprehensive Meta-analysis, version 2.2.064 (Biostat). For trials that did not report the sample size at the end of the follow-up period, we calculated the RR using the baseline sample size.

Results
The initial electronic database search identified 6133 potentially eligible studies. After screening citations by title and abstract, we considered 159 potentially eligible studies for inclusion and retrieved full-text articles. Twenty-three published reports (21 different RCTs including 30 850 unique participants) met the inclusion criteria and were included in this review. Two RCTs were reported in 4 articles (2 with 12-month data and 2 with 36-month data). Figure 1 outlines the flow of RCTs through the review.

The included trials investigated 6 different LBP prevention strategies: exercise, education, exercise and education, back belts, shoe insoles, and other prevention strategies. Most of the trials focused largely or completely on working-age populations. The sample size of the trials ranged from 30 to 4325 participants. A comprehensive description of each trial is provided in Table 1.

Methodologic quality assessment was conducted using the PEDro scale. The mean (SD) score was 5.1 (1.5), with the key problem items being blinding, concealed allocation, and loss to follow-up (eTable 2 in the Supplement).

Estimates of the effects of LBP prevention strategies on LBP episode or sick leave due to LBP were calculated for 21 trials. The number of events, sample size, and RRs (95% CIs) for the trials are presented in eTable 3 in the Supplement. Trials were grouped according to the prevention strategy, outcome (episode of LBP or sick leave), and follow-up time point (short- or long-term). Table 2 provides a summary of the findings and GRADE quality ratings.

Exercise vs Control, Minimal Intervention, or Supplement
Four trials reporting data on 898 participants were included in the meta-analysis to estimate the short-term (ie, ≤12 months) efficacy of exercise on incident cases of LBP (presented as RR [95% CI]). The pooled results provide low-quality evidence of a protective effect of exercise (0.65 [0.50–0.86]). In the long-term (ie, >12 months), the pooled results of 2 trials (334 participants) provide very low-quality evidence of no effect of exercise (1.04 [0.73–1.49]) (Figure 2). Two trials presented data from 128 participants and provide very low-quality evidence that exercise reduces the risk of sick leave due to LBP in the long-term (0.22 [0.06–0.76]) (Figure 3).

Exercise and Education vs Control, Minimal Intervention, or Supplement
The effect of exercise and education was investigated in 4 trials (442 participants) at short-term follow-up, and in 2 trials (138 participants) at long-term follow-up (LBP episode). The pooled results (presented as RR [95% CI]) of 4 trials provide moderate-quality evidence that exercise and education reduce the risk of an episode of LBP at short-term follow-up (0.55 [0.41–0.74]). The long-term results are based on 2 trials and provide low-quality evidence of a protective effect (0.73 [0.55–0.96]) (Figure 2).

For prevention of sick leave due to LBP, 3 trials (228 participants) presented short-term data and 2 trials (138 participants) presented long-term data. The pooled results (presented as RR [95% CI]) provide low-quality evidence of no protective effect at short-term follow-up (0.74 [0.44–1.26]) or long-term follow-up (0.72 [0.48–1.08]) (Figure 3).

Education vs Control, Minimal Intervention, or Supplement
The efficacy of education compared with control was investigated in 3 trials (2343 participants) at short-term follow-up and in 2 trials (13242 participants) at long-term follow-up (LBP episode). The pooled results (presented as RR [95% CI]) provide moderate-quality evidence of no protective effect of education at either...
Table 1. Characteristics of the Randomized Clinical Trials Included in Review of Low Back Pain Prevention Strategies

<table>
<thead>
<tr>
<th>Source</th>
<th>Participants</th>
<th>Outcome</th>
<th>Intervention and Control</th>
<th>Time of Sessions</th>
<th>Duration of Intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td>George et al, 2011</td>
<td>4325 Army soldiers; mean (SD) age, 22.0 (4.2) y; male (71%)</td>
<td>LBP episode that resulted in the patient seeking of health care</td>
<td>Traditional exercise: traditional lumbar exercises for the rectus abdominis and oblique abdominal muscles</td>
<td>5 Times/wk for 5 min</td>
<td>12 wk</td>
</tr>
<tr>
<td>Helew et al, 1999</td>
<td>402 University employees and students, hospital staff, and London residents; mean (SD) age, 38.4 (9.2) y; male (47%)</td>
<td>LBP episode: continuous or intermittent pain resulting in moderate to severe limitation of function lasting &gt; 2 d</td>
<td>Exercise: abdominal muscle strength exercises</td>
<td>7 Times/wk for 5 min</td>
<td>24 mo</td>
</tr>
<tr>
<td>Lenn et al, 1999</td>
<td>81 Participants recruited through local media advertisement and referral from other health professionals; mean (range) age, 39.4 (12.2-49.8) y; 46% males</td>
<td>LBP episode: recurrences of LBP</td>
<td>Exercise and education: active back school—didactic session included anatomy, biomechanics, pathology, and basic ergonomic principles related to the spinal column and pelvis; practical session included bending the knee and hip joints, while keeping the lumbar segments near midposition and using short-lever arms during functional exercises and obstacle course simulations; strength training of leg muscles and muscles between the upper body and pelvis; stretching exercises for the calf muscles, hamstrings, rectus femoris, and hip flexors</td>
<td>2 Sessions/wk for 7 wk and 1/wk for 6 wk; each session 60 min</td>
<td>20 Sessions (13 wk)</td>
</tr>
<tr>
<td>Mattila et al, 2011</td>
<td>220 Finnish defense forces; mean age 19.0 y; 100% male</td>
<td>LBP episode: requiring a visit to the physician and suspension from duty for at least 1 d</td>
<td>Shoe insoles: customized insoles made from firm-density polyethylene, and the hard plastic shell was three-quarters the length of the foot</td>
<td>Daily service time</td>
<td>6 mo</td>
</tr>
<tr>
<td>Milgrom et al, 2005</td>
<td>404 New recruits beginning elite infantry training; mean (SD), 18.8 (0.7) y; 100% male</td>
<td>LBP episode: presence of LBP</td>
<td>Semirigid shoe insole: semirigid biomechanical orthoses</td>
<td>Unclear</td>
<td>14 wk</td>
</tr>
<tr>
<td>Moore et al, 2012</td>
<td>30 Outpatients of the Brown Cancer Center, University of Louisville; mean (range) age, 49.0 (43-63) y; 23% male</td>
<td>LBP episode: incidence of self-reported LBP</td>
<td>Exercise: 6 calisthenic exercises to strengthen and stretch the pelvis-spine-attached muscles that move lumbar and lumbosacral joints and control upright, 2-legged balance</td>
<td>15 min/d</td>
<td>12 mo</td>
</tr>
<tr>
<td>Sihawong et al, 2014</td>
<td>563 Office workers; mean (SD) age, 37.1 (10.4) y; 31% male</td>
<td>LBP episode: LBP lasting &gt; 24 h during the past month</td>
<td>Exercise: muscle stretching and endurance training (repeatedly contracted each muscle [ie, erector spinae, multifidus, quadratus lumborum, and transversus abdominis] 10 times and rested for 60 s between muscle contractions)</td>
<td>Twice daily (5/d/wk for 30 s each time)</td>
<td>12 mo</td>
</tr>
<tr>
<td>Allen and Wilder, 1996</td>
<td>47 Employees of the Veterans Administration Hospital; age and sex not specified</td>
<td>LBP episode: back injury</td>
<td>Education: training in biomechanics and proper lifting techniques</td>
<td>Volunteers were asked to wear the back support belts while on duty whenever they were lifting patients</td>
<td>6 mo</td>
</tr>
<tr>
<td>Daltroy et al, 1997</td>
<td>3597 US postal workers; mean (SD) age, 42.5 (12.3) y; 66% male</td>
<td>LBP episode: occurrence of LBP injury</td>
<td>Education: safe lifting and handling; posture while sitting, standing, and lying down; pain management; stretching and strengthening exercises; group discussion of barriers to implementation; on-site work-station ergonomic analysis</td>
<td>90 min</td>
<td>2 Sessions</td>
</tr>
<tr>
<td>Driessen et al, 2011</td>
<td>3047 Employees of 4 Dutch companies; mean (SD) age, 42.0 (21.8) y; 59% male</td>
<td>LBP episode: DMQ asked about the presence of LBP in the previous 3 mo (I, no; II, yes, sometimes; III, yes, regularly; IV, yes, always). Prevalence was determined by combining the categories 1 and 2 as “no LBP” and categories 3 and 4 as “LBP”</td>
<td>Ergonomic program: implementation of ergonomic measures aimed to prevent LBP</td>
<td>6 h</td>
<td>1 Session</td>
</tr>
</tbody>
</table>

(continued)
### Table 1. Characteristics of the Randomized Clinical Trials Included in Review of Low Back Pain Prevention Strategies (continued)

<table>
<thead>
<tr>
<th>Source</th>
<th>Participants</th>
<th>Outcome</th>
<th>Intervention and Control</th>
<th>Time of Sessions</th>
<th>Duration of Intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glosnag, et al, 1998</td>
<td>81 Participants recruited from referrals and advertisement; mean (SD) age, 39.8 (6.4) y; 46% male</td>
<td>LBP episode: recurrence of episodes</td>
<td>Exercise and education: active back school didactic session included anatomy, biomechanics, pathology, and basic ergonomic principles related to the spinal column and pelvic; practical session included bending the knee and hip joints, while keeping the lumbar segments near midposition and using short lever arms during functional exercises and obstacle course simulations; strength training of leg muscles and muscles between the upper body and pelvis; stretching exercises for the calf muscles, hamstrings, rectus femoris, and hip flexors</td>
<td>2 Sessions/wk</td>
<td>20 Sessions (20 Sessions)</td>
</tr>
<tr>
<td>Gundewall, et al, 1993</td>
<td>69 Nurses and nurse’s aids; mean (SD) age, 37.5 (10.1) y; 1% male</td>
<td>Sick leave: work absence due to LBP</td>
<td>Exercise: back muscle exercises to increase endurance, isometric strength and functional coordination</td>
<td>6 Times/mo</td>
<td>13 mo</td>
</tr>
<tr>
<td>Ijzenberg, et al, 2002</td>
<td>489 Workers from physically demanding jobs; mean (SD) age, 41.1 (9.7) y; 97% male</td>
<td>Sick leave: absent from work during the past 6 mo and 12 mo due to back pain</td>
<td>Education, training, and ergonomic adjustments: individually tailored education and training, immediate treatment of acute LBP, and advice on ergonomic adjustment of the workplace</td>
<td>Unclear</td>
<td>Unclear</td>
</tr>
<tr>
<td>Kellett, et al, 1991</td>
<td>111 Employees of kitchen unit production; mean (SD) age, 21.0 (1.5) y; 100% male</td>
<td>Sick leave: attributable to LBP</td>
<td>Exercise and education: warm-up, stretching, strengthening, cardiovascular, coordination exercises and cool down; one-third of the classes started with 10 min lecture on theories of back pain prevention, eg, reducing bed rest and increasing activities, eg, swimming</td>
<td>2 Times/wk</td>
<td>20 - 35 min</td>
</tr>
<tr>
<td>Kraus, et al, 2002</td>
<td>12772 Home care attendants; mean (range) age, NS (18-65) y; 5% male</td>
<td>LBP episode: acute-onset, physician-diagnosed injury to the lower back that occurred during a work-related activity</td>
<td>Back belt: stretch nylon back belts</td>
<td>Unclear</td>
<td>28 mo</td>
</tr>
<tr>
<td>Larsen, et al, 2002</td>
<td>314 Military conscripts; mean (SD) age, 21.0 (1.5) y; 100% male</td>
<td>LBP episode: No. of persons who reported having consulted the military medical physician with back problems</td>
<td>Education: back school lesson consisted of the theory based on a booklet43 Exercise: 15 passive prone extensions of the back</td>
<td>Single 40-min session</td>
<td>Single session</td>
</tr>
<tr>
<td>Larsen, et al, 2002</td>
<td>146 Military conscripts; mean (range) age, N5 (18-24 y); 95% male</td>
<td>LBP episode: self-reported back problems</td>
<td>Shoe insoles: custom-made biomechanical shoe orthoses</td>
<td>Whenever wearing their military boots</td>
<td>3 mo</td>
</tr>
<tr>
<td>Lavender, et al, 2007</td>
<td>2144 Workers from distribution centers that require lifting; mean (range) age, 33.5 (18-65) y; 96% male</td>
<td>LBP episode: self-reported back injury</td>
<td>Education: lifting training; participants were instrumented with motion-capture sensors to quantify the dynamic moments (torque) vector acting on lumbar spine (L5/S1) Video training: demonstrating various lifting techniques</td>
<td>5 Sessions</td>
<td>10 mo</td>
</tr>
<tr>
<td>Schwellnus, et al, 1990</td>
<td>1388 New military recruits; mean (SD) age, 18.5 (1.2) y; sex NS</td>
<td>LBP episode: overuse back injury</td>
<td>Shoe insoles: neoprene-impregnated with nitrogen bubbles covered with stretch nylon</td>
<td>Daily</td>
<td>9 wk</td>
</tr>
<tr>
<td>Soukop, et al, 1999</td>
<td>77 Outpatients from medical and physiotherapist practices; mean (SD) age, 37.7 (8.0) y; 47% male</td>
<td>LBP episode: resulting in professional management</td>
<td>Exercise and education: Mensendieck exercises and biomechanical/ergonomic, back anatomy, pain mechanisms, and working posture education</td>
<td>20 Sessions for 60 min</td>
<td>13 wk</td>
</tr>
<tr>
<td>Soukop, et al, 2001</td>
<td>77 Outpatients from medical and physiotherapist practices; mean (SD) age, 37.7 (8.0) y; 47% male</td>
<td>LBP episode: resulting in professional management</td>
<td>Exercise and education: Mensendieck exercises and biomechanical/ergonomic, back anatomy, pain mechanisms and working posture education</td>
<td>20 Sessions for 60 min</td>
<td>13 wk</td>
</tr>
<tr>
<td>van Poppel, et al, 1998</td>
<td>624 Airline employees; mean (SD) age, 35.1 (7.8) y; sex NS</td>
<td>LBP episode: in the past month Sick leave: time lost from work in the past month</td>
<td>Back belts: lumbar support with adjustable elastic side pulls with Velcro fasteners and flexible stays Education: lifting instructions</td>
<td>Wear at all times during work hours</td>
<td>6 mo</td>
</tr>
<tr>
<td>Warming, et al, 2008</td>
<td>181 Hospital nurses Copenhagen; mean (SD) age, 34.8 (9.3) y; sex NS</td>
<td>LBP episode: perceived LBP Sick leave: due to LBP</td>
<td>Education: patient transfer technique based on the law of physics and the natural movement pattern of moving 1 body part at a time Exercise: physical fitness training: aerobic fitness and strength training</td>
<td>Two 6-wk sessions</td>
<td>16 Sessions for 8 wk</td>
</tr>
</tbody>
</table>

Abbreviations: DMQ, Dutch musculoskeletal questionnaire; LBP, low back pain; NS, not specified.
very low-quality evidence of no protective effect of education on sick leave due to LBP at short-term follow-up (RR, 0.87 [95% CI, 0.47-1.60]) (Figure 3).

**Back Belts vs Control, Minimal Intervention, or Supplement**

The efficacy of back belts over control to prevent LBP episodes (short- and long-term) or sick leave owing to LBP (short-term) was reported in 3 trials. \(^27,34,41\) For episodes of LBP, pooling of 2 trials (329 participants) (presented as RR [95% CI]) provides very low-quality evidence of no short-term effect of back belts over controls (1.01 [0.71-1.44]) (Figure 2). \(^27,41\) At long-term follow-up, a single trial (8472 participants) provides moderate-quality evidence that back belts do not reduce the risk of LBP episodes when compared with controls (0.85 [0.64-1.14]) (Figure 2). \(^34\) For sick leave owing to LBP, a single trial (282 participants) provides low-quality evidence of no effect of back belts compared with controls at short-term follow-up (RR, 1.44 [95% CI, 0.73-2.86]) (Figure 3). \(^41\)

**Shoe Insole vs Control, Minimal Intervention, or Supplement**

Four trials reported data from 1833 participants on the short-term efficacy of shoe insoles compared with controls. \(^23,24,36,38\) For prevention of episodes of LBP, there is low-quality evidence that shoe insoles are not superior to control at short-term follow-up (RR, 1.01 [95% CI, 0.74-1.40]) (Figure 2). One trial reported the efficacy of semiflexible shoe insole vs control and soft shoe insole vs control. \(^24\) Only the group from the semiflexible shoe insole was included in the meta-analysis.

**Other LBP Prevention Strategies**

Two trials reported the short-term effect of other prevention strategies vs control for LBP episode (3047 participants), \(^29\) and sick leave due to LBP (360 participants). \(^32\) An ergonomic program (moderate-quality evidence) was not more effective than control in reducing episodes of LBP at short-term follow-up (odds ratio, 1.23 [95% CI, 0.97-1.57]) (Table 2). It is unclear whether sick leave due to LBP can be prevented by education, training, and ergonomic adjustments since there was very low-quality evidence (RR, 0.95 [95% CI, 0.51-1.76]) (Figure 3).

### Discussion

**Statement of Principal Findings**

The results of this systematic review and meta-analysis indicate that exercise in combination with education is likely to reduce the risk of LBP. Exercise alone may reduce the risk of an episode of LBP and sick leave; however, it is uncertain...
whether the effects persist beyond 1 year. Education alone, back belts, shoe insoles, and ergonomic adjustments probably do not prevent an episode of LBP or sick leave due to LBP. It is uncertain whether education, training, or ergonomic adjustments prevent LBP owing to the very low quality of evidence.

Strengths and Weaknesses of the Study
The strengths of this review include the use of a prespecified protocol registered on PROSPERO, inclusion of all prevention strategies from any setting, the use of the GRADE system to evaluate the overall quality of the evidence, and the use of a highly sensitive search strategy to identify LBP prevention trials. We assessed trials’ methodologic quality with the PEDro scale, which has been shown to have acceptable reliability and validity.15,16,44 All scores were available online at the PEDro website. These scores were rated by experienced PEDro researchers, which provided less chance of errors.

This review was designed to be comprehensive with a robust search strategy; however, it is possible that not all studies were identified. Some identified trials did not have the term prevention in either the title or the abstract.27,33,34 For several studies are ordered chronologically within prevention strategies. Short-term indicates follow-up of 12 months or less; long-term, follow-up evaluation of more than 12 months.

<table>
<thead>
<tr>
<th>Source</th>
<th>Intervention vs control (short-term)</th>
<th>Control vs intervention (short-term)</th>
<th>Education vs control (short-term)</th>
<th>Interventions vs control (long-term)</th>
<th>Shoe insoles vs control (short-term)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>RR (95% CI)</td>
<td>RR (95% CI)</td>
<td>RR (95% CI)</td>
<td>RR (95% CI)</td>
<td>RR (95% CI)</td>
</tr>
<tr>
<td>Exercise vs control (short-term)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HELLEWA ET AL, 1999</td>
<td>28</td>
<td>113</td>
<td>37</td>
<td>157</td>
<td>1.05 (0.69-1.61)</td>
</tr>
<tr>
<td>WARMING ET AL, 2008</td>
<td>14</td>
<td>35</td>
<td>22</td>
<td>33</td>
<td>0.60 (0.37-0.96)</td>
</tr>
<tr>
<td>MOORE ET AL, 2012</td>
<td>0</td>
<td>13</td>
<td>10</td>
<td>17</td>
<td>0.06 (0.00-0.96)</td>
</tr>
<tr>
<td>SIHAWONG ET AL, 2014</td>
<td>23</td>
<td>261</td>
<td>53</td>
<td>269</td>
<td>0.45 (0.28-0.71)</td>
</tr>
<tr>
<td>Pooled effect: I² = 67.9%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exercise vs control (long-term)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>KELLIET ET AL, 1991</td>
<td>8</td>
<td>37</td>
<td>14</td>
<td>48</td>
<td>0.74 (0.35-1.58)</td>
</tr>
<tr>
<td>HELLEWA ET AL, 1999</td>
<td>35</td>
<td>101</td>
<td>45</td>
<td>148</td>
<td>1.14 (0.79-1.64)</td>
</tr>
<tr>
<td>Pooled effect: I² = 0%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
prevention strategies, we could identify only a small number of trials; this combined with the quality of the trials means the level of evidence for several prevention strategies is very low or low.

Comparison With Other Studies
To our knowledge, this review is the first to have included a variety of LBP prevention strategies and conducted a meta-analysis of RCTs. Several reviews have investigated the effectiveness of an exercise and/or education program on LBP prevention. All are out-of-date, included at least 1 RCT with symptomatic participants at baseline (ie, the trial evaluated treatment, not prevention), and presented data descriptively.7-9,45-49 The most recent review we know of investigating the effectiveness of exercise for preventing a LBP episode,11 presented data from 3 trials. One was included in the meta-analysis of the current review (ie, exercise vs control),33 one was excluded because the trial included symptomatic participants at baseline,50 and one was included in a different LBP prevention strategy (ie, exercise and education vs control).39 That review by Choi et al11 reported a 50% (2 RCTs with 130 patients) reduction in future LBP episodes when compared with no intervention, which is a larger effect than our estimate of a 35% reduction (4 RCTs with 898 patients).

Previous reviews investigating the efficacy of exercise on the prevention of LBP episodes have not distinguished between studies that included education with the exercise from those just including exercise.31,45,46 In our review, the combination of exercise and education was effective at long-term follow-up (RR, 0.73 [95% CI, 0.55 to 0.96]), while exercise alone was not (RR, 1.04 [95% CI, 0.73 to 1.49]), suggesting that the distinction between exercise alone and exercise combined with education may be important.

The present review’s finding that back belts do not prevent LBP is consistent with results of a previous systematic review.51 There are a few previous systematic reviews10,45,52 investigating the use of shoe insoles in the prevention of an LBP episode. Findings from these reviews are in line with the results of our study: shoe insoles are not effective for the prevention of back pain. The most recent review by Chuter et al10 included 6 trials; our review included 4. We excluded 2 trials because the participants were symptomatic at the time of study entry.53,54

Meaning of the Study
Although our review found evidence for both exercise alone (35% risk reduction for an LBP episode and 78% risk reduction for sick leave) and for exercise and education (45% risk reduction for an LBP episode) for the prevention of LBP up to 1 year, we also found the effect size reduced (exercise and education) or disappeared (exercise alone) in the longer term (>1 year). This finding raises the important issue that, for exercise to remain protective against future LBP, it is likely that ongoing exercise is required. Prevention programs focusing on long-term behavior change in exercise habits seem to be important.
Conclusions

The results of this systematic review and meta-analysis of RCTs indicate that exercise in combination with education is likely to reduce the risk of LBP and that exercise alone may reduce the risk of an episode of LBP and sick leave due to LBP, at least for the short-term. The available evidence suggests that education alone, back belts, shoe insoles, and ergonomics do not prevent LBP. It is uncertain whether education, training, or ergonomic adjustments prevent sick leave due to LBP because the quality of evidence is very low.

ARTICLE INFORMATION

Accepted for Publication: November 9, 2015.
Published Online: January 11, 2016.

Author Contributions: Drs Steffens and Maher had full access to all the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis.

Study design: Steffens, Maher, Stevens, Teixeira-Salma, Hancock.

Acquisition, analysis, or interpretation of data: Steffens, Maher, Pereira, Oliveira, Chapple, Teixeira-Salma, Hancock.

Drafting of the manuscript: Steffens, Maher, Teixeira-Salma, Hancock.

Critical revision of the manuscript for important intellectual content: All authors.

Statistical analysis: Steffens, Maher, Chapple.

Administrative, technical, or material support: Steffens, Oliveira, Teixeira-Salma, Hancock.

Study supervision: Steffens, Maher, Pereira, Teixeira-Salma, Hancock.

Conflict of Interest Disclosures: None reported.

REFERENCES


Exercise and the Prevention of Low Back Pain
Ready for Implementation

Timothy S. Carey, MD, MPH; Janet K. Freburger, PhD

Acute low back pain (LBP) is common, with more than 80% of us experiencing at least one episode in our lives. It is painful, a common cause of time off work, and interferes with our ability to perform daily activities. Fortunately, most episodes of acute LBP are self-limited and improve with time and conservative treatments. However, recurrence is common, with estimates ranging from 24% to 80% in the first year.1

After recovery, patients often query their health care professional on how to avoid future episodes of LBP. The well-conducted systematic review by Steffens and colleagues2 provides us with concrete evidence on the value of exercise. They summarize several low- to moderate-quality trials that examine the benefits of exercise and education on primary and secondary prevention of LBP and sick leave due to LBP. The benefits were fairly consistent across studies, and the effect size was large enough to have clinical and policy importance. Exercise alone or in combination with education is effective for preventing LBP. The authors also assessed other interventions, including education without specific exercise instruction, orthotic insoles, and back belts. These other interventions demonstrated minimal, if any, evidence of benefit. The types of exercise instruction across these studies were variable, encompassing core exercises emphasizing the strengthening of back and abdominal muscles, stretching and spine range-of-motion exercises, and more general instruction in aerobic conditioning. Almost all of the education and exercise regimens assessed were substantial regarding the frequency and duration of the sessions. The effect size of the reduction in risk for subsequent LBP was impressive (approximately 25%-40%), with some evidence of reduced use of sick leave. Long-term benefits were less certain, with several studies showing no effect after 1 year. This diminished benefit may be the result of reduced adherence to continued exercise beyond the intervention period.

If a medication or injection were available that reduced LBP recurrence by such an amount, we would be reading the marketing materials in our journals and viewing them on television. However, formal exercise instruction after an episode of LBP is uncommonly prescribed by physicians. This pattern is, unfortunately, similar to other musculoskeletal problems in which effective but lower-technology and often lower-reimbursed activities are underused. In one study,3 fewer than half of the patients with chronic LBP or neck pain who were surveyed received exercise instruction despite a good evidence base for its effectiveness. Passive treatments (eg, physical modalities) with limited evidence of effectiveness were rela-