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Walking, Cycling, and Swimming for Nonspecific Low Back Pain: A Systematic Review With Meta-analysis

OBJECTIVE: To investigate the effectiveness of walking/running, cycling, or swimming for treating or preventing nonspecific low back pain (LBP).

DESIGN: Intervention systematic review.

LITERATURE SEARCH: Five databases were searched to April 2021.

STUDY SELECTION CRITERIA: Randomized controlled trials evaluating walking/running, cycling, or swimming to treat or prevent LBP were included.

DATA SYNTHESIS: We calculated standardized mean differences (SMDs) and 95% confidence intervals (CIs). Certainty of evidence was evaluated with the Grading of Recommendations Assessment, Development and Evaluation (GRADE) approach.

RESULTS: No trials assessed LBP prevention or addressed acute LBP. Nineteen trials (2362 participants) assessed treatment of chronic/recurrent LBP. Low-certainty evidence suggests that walking/running was less effective than alternate interventions in reducing pain in the short term (8 trials; SMD, 0.81; 95% CI: 0.28, 1.34) and medium term (5 trials; SMD, 0.80; 95% CI: 0.10, 1.49). High-certainty evidence suggests that walking/running was less effective than alternate interventions at reducing disability in the short term (8 trials; SMD, 0.22; 95% CI: 0.06, 0.38) and medium term (4 trials; SMD, 0.28; 95% CI: 0.05, 0.51). There was high-certainty evidence of a small effect in favor of walking/running compared to minimal/no intervention for reducing pain in the short term (10 trials; SMD, −0.23; 95% CI: −0.35, −0.10) and medium term (6 trials; SMD, −0.26; 95% CI: −0.40, −0.13) and disability in the short term (7 trials; SMD, −0.19; 95% CI: −0.33, −0.06). Scarcity of trials meant few conclusions could be drawn regarding cycling and swimming.

CONCLUSION: Although less effective than alternate interventions, walking/running was slightly more effective than minimal/no intervention for treating chronic/recurrent LBP. *J Orthop Sports Phys Ther 2022;52(2):85-99. Epub 16 Nov 2021. doi:10.2519/jospt.2022.10612*

KEY WORDS: *exercise, low back pain, physical activity*

Low back pain (LBP) was responsible for 60.1 million disability-adjusted life-years in 2015.[12] Global estimates suggest that up to 540 million people have LBP at any time.[15] The clinical course of LBP is often favorable, with greater than 80% of people recovering from an episode within 3 months.[45] Despite this favorable recovery pattern, approximately 70% of individuals will experience a recurrence within 12 months following recovery.[6] This indicates the value of identifying strategies to both treat and prevent LBP.

Current guidelines[40] and reviews endorse the use of exercise interventions for treating chronic LBP[30,34] and preventing LBP recurrences.[18,38] Although exercise strategies have benefits across various LBP-related outcomes, limited focus has been given to exercise modes that are easily accessible to individuals. Walking, running, cycling, and swimming are among the most common forms of exercise.[1] They have high participation,[2] are accessible, do not require attendance of scheduled classes, and are relatively inexpensive.

Previous reviews investigated walking as a treatment for chronic LBP, and largely explored walking versus other interventions or walking as a supplement to other interventions.[23,37,43] Walking compared to minimal or no intervention has received little attention; there is no review of the effects of cycling or swimming on LBP. Two previous reviews investigated a wide range of interventions for preventing LBP (eg, exercise, back belts, shoe insoles, etc).[18,38] In these reviews, all forms of exercise were combined, and there is no high-quality review specifically investigating the effectiveness of walking/running, cycling, or swimming for LBP prevention.

Therefore, the primary aim of this systematic review with meta-analysis was to investigate the effectiveness of walking/running, cycling, and swimming for treating or preventing nonspecific LBP and associated disability, compared to alternate interventions (ie, any pharmacological,

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nonpharmacological, active, or passive therapies) or minimal/no intervention.

METHODS

This review was prospectively registered with PROSPERO (registration number CRD42020178896) and adhered to the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) guidelines.[31]

Literature Search

A comprehensive search was conducted of MEDLINE, Embase, CINAHL, PEDro, and the Cochrane Central Register of Controlled Trials databases. The search strategy was based on the recommendations of the Cochrane Back and Neck Group for "randomised controlled trials" and "low back pain,"[10] combined with search terms for the exercise interventions of interest (walking/running, cycling, and swimming). The full search strategy is included in supplemental file 1 (available at www.jospt.org). Development of the search strategy was overseen by a medical librarian and included each database from inception to April 2021. The reference lists of included studies and relevant systematic reviews[18,23,30,35,37,43] were manually searched for potential studies, and forward citation searching of included trials was performed.

Study Selection

We included randomized controlled trials that met the following eligibility criteria:

1. Population: studies including participants with or without current or previous episodes of nonspecific LBP (ie, studies could look at prevention of a first episode, prevention of recurrences, or treatment of a current episode). Nonspecific LBP was defined as pain or discomfort localized in the area of the posterior aspect of the body, from the lower margin of the 12th rib to the lower gluteal folds, with or without pain referred into one or both lower limbs. Low back pain was also sometimes defined as nonspecific by the study authors. We excluded studies that involved participants with a specific cause of LBP (eg, cancer, infection, inflammatory arthritis) and those that included populations with radicular pain or radiculopathy. Participants who had spinal surgery in the last 6 months were also excluded.
2. Intervention: studies that investigated the effectiveness of walking/running, cycling, or swimming were included. No minimum dosage thresholds were set, and if an intervention of interest was delivered with a cointervention, then these were included, provided that the effects of the intervention of interest could be isolated. For example, trials examining walking and education versus education alone were included, as the effects of walking could be determined. Trials examining walking and education versus manipulation were excluded, as the effects of walking could not be isolated due to education being a cointervention.
3. Comparison: studies were included when the intervention was compared to an alternate intervention, minimal intervention, placebo, or no intervention. Alternate interventions could include any pharmacological, nonpharmacological, active, or passive therapies (eg, manual therapies, massage/heat/ultrasound therapies, traction devices, exercises other than walking/running, cycling, or swimming, etc). Minimal or no intervention included situations where the intervention of interest was compared to minimal (eg, advice or hot-pack therapy) or no treatment.
4. Outcomes: studies needed to report on at least 1 outcome of interest. Primary outcomes for this review were pain intensity (eg, a visual analog scale or numeric pain-rating scale) and disability (eg, the Oswestry Disability Index or the Roland-Morris Disability Questionnaire). Secondary outcome measures included other patient-centered outcomes relevant to LBP, such as quality of life, fear-avoidance beliefs, and adverse events.

Data Extraction

Following the search, all records were imported to the reference management software EndNote X9 (Clarivate Analytics, Philadelphia, PA) for removal of duplicates. Two reviewers (N.C.P. and T.F.C.) independently screened the title and abstract of each record and excluded clearly irrelevant studies. For each potentially eligible study, 2 reviewers (N.C.P., T.F.C., or M.J.H.) examined the full-text article and assessed whether the study fulfilled the inclusion criteria. In cases of disagreement, a third reviewer was consulted (either T.F.C. or M.J.H).

Data for each included trial were extracted independently by 2 reviewers (N.C.P., T.F.C., or M.J.H.), using a standardized data-extraction form in Excel (Microsoft Corporation, Redmond, WA), and discrepancies were resolved through discussion. We extracted study characteristics, covering study design (eg, population, sample size, setting, etc), description of interventions (eg, type of intervention and dosage), and the outcomes of interest and corresponding follow-up periods.

Assessing the Risk of Bias

Risk of bias was assessed according to the Cochrane Collaboration's revised domain-based evaluation framework for randomized trials[39] by 2 independent reviewers (N.C.P. and D.M. or A.T. or M.J.H.). The tool provides scoring for each outcome per trial at a selected time point on domains related to bias, focusing on aspects of trial design, conduct, and reporting. Based on the scoring of each domain and consideration of the impact of individual items, each study was independently graded to be of "low risk," "some concerns," or "high risk" by 2 reviewers. In cases of disagreement and when consensus could not be attained, a third reviewer was consulted (D.M. or A.T. or M.J.H.).

Assessing the Certainty of Evidence

The overall certainty of evidence was assessed for each outcome using the Grading of Recommendations Assessment,

Development and Evaluation (GRADE) approach.[13] Two reviewers (N.C.P. and M.J.H.) performed GRADE assessments for each treatment comparison, and disagreements were resolved by discussion. The GRADE classification was downgraded 1 level per study limitation, starting at high certainty, if any of the following were present:

1. Methodological quality: when greater than 50% of included participants in any comparison came from studies rated as having low methodological quality, that is, studies judged as "high risk" of bias
2. Inconsistency of results: based on observation of the variability of point estimates across individual trials and the I^2 statistic
3. Imprecision: based on inspection of the 95% confidence interval (CI) of the pooled estimate (or of individual studies when only 1 or 2 comparisons were available) to see whether it included values that would have different clinical implications (eg, CIs that included trivial effects and clearly important effects)
4. Publication bias: assessed using a funnel plot (conducted when greater than 10 eligible studies were included in the analysis) or other evidence of publication bias, including a majority of small studies with mostly positive results, industry sponsorship, or reported conflicts of interest
5. Indirectness: assessed by determining whether the population, intervention, comparison, and outcome were directly related to the aims of the current review

Statistical Analysis

Raw mean ± SD outcome data for the intervention group and control group were extracted at baseline and follow-up periods; alternatively, between-group change scores were extracted if available. When adequate data were not presented, a maximum of 2 e-mail attempts were made to authors to retrieve additional information, and 1 trial was excluded at full-text review for this reason.[9] A web-based tool (WebPlotDigitizer)[33] was used to accurately extract numerical data from figures when the information was not presented in text or tables.[11,16,29]

If the mean and SD were missing, these were estimated from other measures of effect and variability. If the SD was missing, we calculated this from 95% CIs,[8,19,22,27,28] standard errors,[16] or 25th-75th percentiles.[32] If no measure of variability was presented,[29] we estimated the SD from the most similar trial[7] in the review, based on intervention, outcome measure, and effect size, as recommended by the Cochrane Collaboration.[17]

When possible, we combined results in a meta-analysis where sufficient homogeneity existed in relation to intervention type (walking/running or cycling or swimming), comparison (alternate intervention or minimal/no intervention), outcome type (pain, disability, fear avoidance, or quality of life), and follow-up time point. To enable meta-analysis of the different scales used for study outcomes measuring the same construct (eg, the Roland-Morris Disability Questionnaire and Oswestry Disability Index for the outcome of disability), results were reported as standardized mean difference (SMD). For the outcome of disability, the Roland-Morris Disability Questionnaire and the Oswestry Disability Index were prioritized over other measures of disability and/or function if more than 1 was reported in the same trial. For trials including multiple treatment arms, we extracted data for each comparison that met the inclusion criteria and adjusted the numbers per group (sample size), as recommended in the *Cochrane Handbook for Systematic Reviews of Interventions*.[17]

Outcome assessment data were extracted for 3 time periods: short-term follow-up (collected up to 3 months following randomization), medium-term follow-up (collected from greater than 3 to 12 months), and long-term follow-up (collected greater than 12 months following randomization). In studies presenting multiple follow-up periods within the same category, we used the period closest to 6 weeks for the short-term, closest to 12 months for the medium-term, and the longest time point surpassing 12 months for the long-term follow-up.

Pooled effects using random-effects meta-analyses were expressed as SMD (computed using Cohen's *d* statistic) and 95% CI when more than 5 study comparisons were available. When few studies were available for pooling (ie, from 3 to 5 comparisons), the Knapp-Hartung method for calculating CIs was employed, per recommendations by the Cochrane Collaboration working group.[14] Negative SMD values represent an effect in favor of the experimental group (ie, walking/running, cycling, or swimming). Comprehensive Meta-Analysis Version 2.2.064 (Biostat Inc, Englewood, NJ) was used for all analyses.

To facilitate interpretation of the effect sizes, we re-expressed some of the key findings using a common scale for pain and disability. To do this, we used the most valid, widely used measurement tool of the included trials and multiplied the SMD by the weighted SD of the studies in the review that used that outcome, using the value reported at each follow-up.

Post Hoc Analyses

Many trials examined the effects of the interventions of interest when both intervention and control groups received a cointervention. The effects might have been different had the trials not included a cointervention. Therefore, we conducted post hoc sensitivity analyses excluding studies with a cointervention. This was only explored in the walking/running versus alternate intervention analyses, as too few trials existed to run the sensitivity analyses for the other comparisons.

RESULTS

Of the 7372 identified records, 308 were considered potentially eligible, and those full texts were

reviewed. Of these, 19 published reports, representing 18 different randomized controlled trials, met the inclusion criteria and are reported in this review. **FIGURE 1** outlines the screening and selection process. A list of records that were excluded at full-text review, with reasons for exclusion, can be found in supplemental file 2 (available at www.jospt.org).

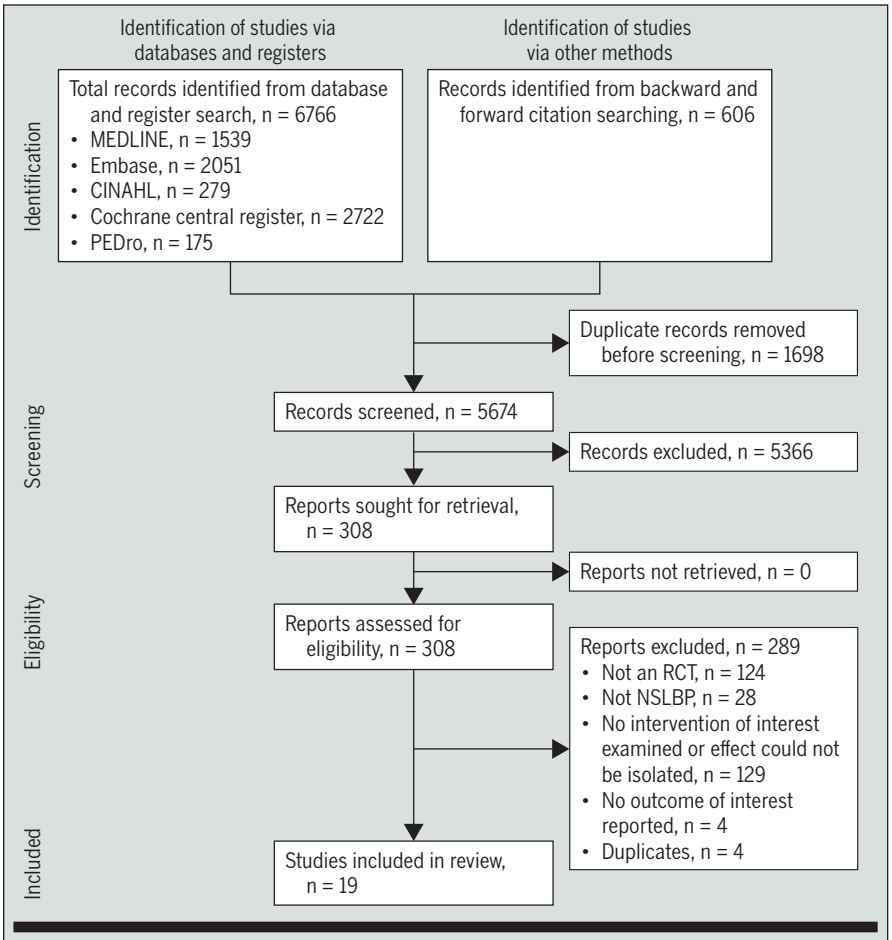


FIGURE 1. Flow diagram of study selection. Abbreviations: NSLBP, nonspecific low back pain; RCT, randomized controlled trial.

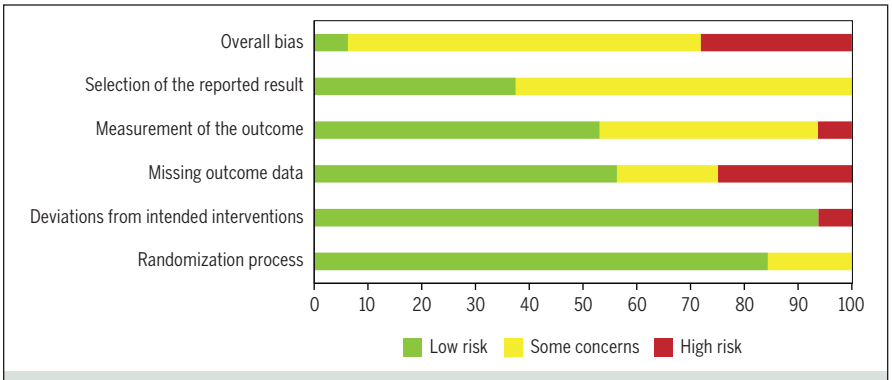


FIGURE 2. Percentage of outcomes with low risk of bias, some concerns, and high risk of bias for each domain of the revised Cochrane risk-of-bias tool.

TABLE 1 outlines the characteristics of included trials, with an accumulated sample size of 2362 individual participants. Our search yielded no trials investigating LBP prevention. All included trials focused on treating chronic or recurrent episodes of nonspecific LBP, with the shortest defined duration of recurrent LBP included being 3 weeks or longer.[25] All trials recruited adults over 18 years of age, with a mean age ranging from 28.4 to 54.8 years. Participants were primarily recruited from health care settings such as outpatient clinics, hospitals, rehabilitation centers, or primary care. Adherence was reported in very few trials; however, in those in which it was reported, compliance was reasonable, particularly in the short term (see supplemental file 3, available at www.jospt.org).[8,19,27,28,32]

Sixteen trials[3,5,7,8,16,19,20,22,25,28,29,32,36,41,42,44] investigated the effect of walking/running interventions, with walking being investigated by most trials and only 1 trial explicitly assessing the effects of running.[44] Two trials (with 3 published reports)[4,11,27] explored stationary cycling and 1 trial[44] examined swimming. Of the walking/running trials, 5 used a treadmill,[3,5,7,29,36] 1 supplied Nordic walking poles,[16] and the remaining 10 were structured around increasing walking in a community setting, with dosage goals achieved by either set times and frequencies or driven by step count as measured with a pedometer. Interventions were compared to a range of alternate treatments, with alternative exercise approaches (eg, the McGill protocol, Pilates, and trunk conditioning) and usual physical therapy being the most common comparisons. For the minimal or no intervention comparison, education and advice to remain active was most common. More details of the interventions and comparison groups are provided in **TABLE 1**.

The risk-of-bias assessment for each of our primary outcomes (pain and disability) in each study is presented in supplemental file 4 (available at www.jospt.org), with a summary in **FIGURE 2**. Short-, medium-, and long-term follow-ups were con-

TABLE 1 Characteristics of Randomized Controlled Trials Included in the Systematic Review

Study	Participants[a]	Outcome	Follow-up, wk	Intervention, Control	Dosage
		Walking/running-based interventions			
Bello and Adeniyi[3]	n = 53 outpatient clinic attendees with chronic LBP; age, 44.36 ± 12.37; sex NR	LBP intensity: VAS LBP disability: ODI	8	I: treadmill walking C: McGill-based lumbar stabilization exercise	I: 30-40 min, 3 times per week for 8 wk C: 30 min, 3 times per week for 8 wk
Cho et al[5]	n = 20 hospital rehabilitation department attendees with chronic LBP; age, 28.4 ± 4.45; 0% female	LBP intensity: VAS LBP disability: ODI	8	I: treadmill walking and LBP rehabilitation program C: LBP rehabilitation program alone	I: 30 min on treadmill plus 30 min of the LBP rehabilitation program, 3 times per week for 8 wk C: 30 min of the LBP rehabilitation program, 3 times per week for 8 wk
Doğan et al[7]	n = 60 outpatient clinic attendees with chronic LBP; age, 40.2 ± 8.4; 75% female	LBP intensity: VAS LBP disability: RMDQ	6, 10	I: aerobic exercise on a treadmill plus an HEP C1: physical therapy plus an HEP C2: an HEP alone: mobilization and stretching exercise	I: 40-50 min, 3 times per week for 6 wk, plus the HEP C1: heat therapy (15 min), ultrasound (10 min), and TENS (15 min), 3 times per week for 6 wk, plus the HEP C2: 15-20 repetitions of each exercise daily for 6 wk
Eadie et al[8]	n = 60 outpatient clinic attendees with chronic/recurrent LBP; age, 44.93 ± 13.4; 61.7% female	LBP intensity: VAS LBP disability: ODI QoL: SF-36 Fear avoidance: FABQ Adherence Adverse events	12, 26	I: a walking program progressively guided by a physical therapist C1: a group-based exercise class C2: usual physical therapy	I: progressed to 30 min, 5 times per week for 8 wk C1: circuit of 15 progressive exercises, once per week for 8 wk C2: treatment and dosage at the discretion of the treating clinician
Hartvigsen et al[16]	n = 136 outpatient pain clinic attendees with chronic LBP; age, 46.69 ± 11.03; 71.6% female	LBP intensity: LBPRS (pain) LBP disability: LBPRS (function)	11, 26, 52	I1: supervised Nordic walking I2: unsupervised Nordic walking C: advice to stay active	I1: 45 min (3- to 4-km route), twice per week for 8 wk I2: single session to instruct on Nordic walking. Dose was based on participant discretion for 8 wk C: single advice session to remain active
Hurley et al[19]	n = 246 patients, referred to physical therapy by a general practitioner or hospital consultant, with chronic/recurrent LBP; age, 45.4 ± 11.4; 67.9% female	LBP intensity: NPRS LBP disability: ODI QoL: EQ-5D Fear avoidance: FABQ Adherence Adverse events	12, 26, 52	I: a pedometer-based walking program C1: a supervised group exercise class (aerobic/strength based) C2: usual physical therapy	I: progress to 30 min, 5 times per week for 8 wk C1: 60-min class, once per week for 8 wk C2: treatment and dosage at the discretion of the treating clinician
Idowu and Adeniyi[20]	n = 58 medical outpatient and physical therapy attendees with chronic LBP and type 2 DM; age, 48.3 ± 9.4; 64.7% female	LBP intensity: VAS	4, 8, 12	I: a pedometer-based walking program and graded activity program C: a graded activity program alone (aerobic/strength based)	I: recommend 5500 daily steps plus the graded activity program (60 min, twice per week) for 12 wk C: 60 min, twice per week for 12 wk
Lang et al[22]	n = 174 community-based adults with chronic LBP; age, 46.0 ± 16.5; 60.1% female	LBP intensity: MODI-P LBP disability: MODI QoL: EQ-5D Fear avoidance: FABQ Adverse events	12, 26, 52	I: a pedometer-based walking program guided by a physical therapist and education and advice C: education and advice alone	I: an individually tailored step target for 12 wk and a single standard package of education and advice C: a standard package of education and advice alone
Little et al[25]	n = 579 general practice clinic attendees with chronic/recurrent LBP; age, 45.5 ± 10.49; sex NR	LBP intensity: VPS LBP disability: RMDQ QoL: SF-36 Adverse events	12, 52	I: a walking program C: factorial design; no prescribed walking program	I: General practitioner prescription and up to 3 sessions of behavioral counseling with a practice nurse; duration was unclear C: unclear
McDonough et al[28]	n = 57 patients on a primary care referral list of 2 hospital physical therapy departments and local primary care practices with chronic LBP; age: I, 48 ± 5 and C, 51 ± 9; 55.0% female	LBP intensity: NPRS LBP disability: ODI QoL: EQ-5D Fear avoidance: FABQ Adherence Adverse events	9, 26	I: a pedometer-based walking program and education and advice C: education and advice alone	I: individualized dosage for 8 wk, based on previous-week pedometer reading, plus education and advice C: a single 60-min consultation on education and advice to remain active using "The Back Book"

Table continues on page 90.

TABLE 1 Characteristics of Randomized Controlled Trials Included in the Systematic Review (continued)

Study	Participants[a]	Outcome	Follow-up, wk	Intervention, Control	Dosage
Mirovsky et al[29]	n = 84 patients with chronic LBP; age, 48.9; 45% female	LBP intensity: VAS Adverse events	4, 26, 52	I: treadmill walking with a VATD C: VATD alone: a dynamic-frame corset enabling traction between the hip and ribs	I: 15 min (3 km/h), once per day for 12 d, then 8 more sessions on alternating days with the VATD C: 20-30 min, once per day for 12 d, then 8 more sessions on alternating days
Rasmussen-Barr et al[32]	n = 71 private physical therapy clinic attendees with recurrent LBP; age, 38.5 ± 11.06; 50.7% female	LBP intensity: VAS LBP disability: ODI QoL: SF-36 Fear avoidance: FABQ Adherence	8, 26, 52, 156	I: walking at a pace without pain C: graded stabilization and strength exercise	I: two 45-min sessions with a physical therapist at baseline and 8-wk follow-up. Encouragement to walk daily C: 15 min of exercise, performed daily for 8 wk; a 45-min session once per week to progress exercise
Shnayderman and Katz-Leurer[36]	n = 52 outpatient physical therapy clinic attendees with chronic LBP; age, 45.3 ± 11.89; 79% female	LBP disability: ODI Fear avoidance: FABQ	6	I: treadmill walking C: active movement and strength exercise	I: progressed to 40 min, twice per week for 6 wk C: progressed to 40 min, twice per week for 6 wk
Suh et al[41]	n = 60 outpatient rehabilitation clinic attendees with intermittent chronic LBP; age, 54.81 ± 14.66; 68.75% female	LBP intensity: VAS LBP disability: ODI	6, 12	I1: walking alone I2: walking plus stabilization exercise C1: stabilization exercise C2: flexibility exercise	I1: 30 min, 5 times per week for 6 wk I2: 30 min, 5 times per week for 6 wk for stabilization exercise, plus 30 min of walking C1: 30 min, 5 times per week for 6 wk C2: 30 min, 5 times per week for 6 wk
Torstensen et al[42]	n = 208 patients sick listed with chronic LBP; age: I, 39.9 ± 11.4; C1, 42.1 ± 11.2; C2, 43.0 ± 12.0; 50.48% female	LBP intensity: VAS LBP disability: ODI	12, 52	I: walking group C1: progressively graded stabilizing exercises based on symptoms C2: usual physical therapy	I: 60 min, 3 times per week for 12 wk C1: 60 min, 3 times per week for 12 wk C2: treatment type and dosage at the discretion of the treating clinician
Cycling-based intervention					
Brooks et al[4b]	n = 64 patients with chronic LBP; age, 36.25 ± 7.25; 62.5% female	LBP intensity: VAS LBP disability: ODI	8	I: stationary cycle classes C: Pilates-based training	I: a 50- to 60-min session, 3 times per week for 8 wk C: a 50- to 60-min session, 3 times per week for 8 wk
Ganesh et al[11]	n = 60 patients with chronic LBP; age, 39.7 ± 8.3; 40.0% female	LBP disability: ODI	4, 16	I: stationary cycle and diagnostic-specific interventions (exercise, mobilization, traction, etc) C: strength and balance training and diagnostic-specific interventions	I: 15 min of cycling, 5 times per week for 4 wk C: once per day, 5 times per week for 4 wk
Marshall et al[27b]	n = 64 patients with chronic LBP; age, 36.25 ± 7.25; 62.5% female	LBP intensity: VAS LBP disability: ODI Fear avoidance: FABQ	8, 26	I: stationary cycle classes C: Pilates-based training	I: a 50- to 60-min session, 3 times per week for 8 wk C: a 50- to 60-min session, 3 times per week for 8 wk
Swimming-based intervention					
Weifen et al[44]	n = 320 retired athletes with chronic LBP; age, 37.6 ± 5.4; 40.0% female	LBP intensity: VAS	12, 26	I1: swimming plus physical therapy I2: jogging plus physical therapy C1: backward walking plus physical therapy C2: tai chi plus physical therapy C3: no exercise plus physical therapy	I1: 30 min of swimming, 5 times per week for 6 mo I2: 30 min of jogging, 5 times per week for 6 mo C1: 30 min of backward walking, 5 times per week for 6 mo C2: 45 min of tai chi, 5 times per week for 6 mo C3: NR

Abbreviations: C, control; DM, diabetes mellitus; EQ-5D, European Quality of Life-5 Dimensions; FABQ, Fear-Avoidance Beliefs Questionnaire; HEP, home exercise program; I, intervention; LBP, low back pain; LBPRS, Low Back Pain Rating Scale; MODI, Modified Oswestry Disability Index; MODI-P, Modified Oswestry Disability Index-pain question; NPRS, numeric pain-rating scale; NR, not reported; ODI, Oswestry Disability Index; QoL, quality of life; RMDQ, Roland-Morris Disability Questionnaire; SF-36, Medical Outcomes Study 36-Item Short-Form Health Survey; TENS, transcutaneous electrical nerve stimulation; VAS, visual analog scale; VATD, vertical ambulatory traction device; VPS, von Korff pain score.

[a]*Age values are mean or mean ± SD years.*

[b]*The studies by Brooks et al[4] and Marshall et al[27] reflect the same sample of participants. Marshall et al's paper[27] provided long-term data and was used in meta-analyses.*

sidered; however, little variability existed (eg, dropout rates), meaning that judgment did not change across time points for each included trial. Most trials were at low risk of bias regarding the randomization process (84%), deviations from the intended intervention (94%), and missing outcome data (56%). There were some concerns for the domain of measurement of the outcome, due to the inability to blind participants to the intervention received and the use of patient-reported outcomes (41% of trials). There were some concerns for the domain of selective reporting bias (66% of trials), due to the lack of published protocols or project registration of trials on public registries.

A report of all extracted data for both primary and secondary outcomes is included in supplemental files 3 and 5 (available at www.jospt.org).

TABLE 2 Summary of Pooled Effects for the Primary Outcomes of Pain and Disability in the Treatment of Chronic or Recurrent Nonspecific Low Back Pain

Comparison/Outcome/Follow-up[a]	Participants, n	SMD[b]	GRADE
Walking versus alternate treatment			
Pain intensity			
Short term	890[3,7,8,19,32,41,42,44]	0.81 (0.28, 1.34)	Low
Medium term	728[8,19,32,42,44]	0.80 (0.10, 1.49)	Low
Long term	56[32]	0.08 (−0.45, 0.61)[c]	Low
Disability			
Short term	669[3,7,8,19,32,36,41,42]	0.22 (0.06, 0.38)	High
Medium term	467[8,19,32,42]	0.28 (0.05, 0.51)	High
Long term	56[32]	0.36 (−0.18, 0.89)[c]	Low
Walking versus minimal/no treatment			
Pain intensity			
Short term	1025[5,7,16,20,22,25,28,29,41,44]	−0.23 (−0.35, −0.10)	High
Medium term	853[16,22,25,28,29,44]	−0.26 (−0.40, −0.13)	High
Disability			
Short term	869[5,7,16,22,25,28,41]	−0.19 (−0.33, −0.06)	High
Medium term	740[16,22,25,28]	−0.13 (−0.47, 0.21)[d]	High
Cycling versus alternate treatment			
Pain intensity			
Short term	64[27]	0.51 (0.01, 1.01)[c]	Low
Medium term	64[27]	0.19 (−0.30, 0.68)[c]	Low
Disability			
Short term	124[11,27]	NA[e]	Moderate
Medium term	124[11,27]	NA[e]	Moderate
Swimming versus alternate treatment			
Pain intensity			
Short term	265[44f]	−0.76 (−4.00, 2.48)[d]	Low
Medium term	265[44f]	−0.78 (−5.13, 3.57)[d]	Low
Swimming versus minimal/no treatment			
Pain intensity			
Short term	78[44]	−2.07 (−2.62, −1.52)[c]	Low
Medium term	78[44]	−2.36 (−2.94, −1.78)[c]	Low

Abbreviations: NA, not applicable; SMD, standardized mean difference.
[a]*Short term indicates follow-up assessment between 0 and 3 months, medium term indicates follow-up assessment between greater than 3 and 12 months, and long term indicates follow-up assessment greater than 12 months.*
[b]*Values in parentheses are 95% confidence interval. A negative estimate represents an effect in favor of the intervention group.*
[c]*The SMD and 95% confidence interval are representative of a single comparison.*
[d]*The Knapp-Hartung method was used to estimate confidence intervals, due to 3 to 5 comparisons present.*
[e]*Use of the Knapp-Hartung method provides uninformative estimates when 2 comparisons are being pooled; therefore, we did not generate a point estimate or confidence interval.*
[f]*A single trial with 3 comparison arms was available for pooling.*

Walking/Running Versus Alternate Intervention for Treating LBP

Pain Intensity Eight trials (n = 890)[3,7,8,19,32,41,42,44] investigated the short-term effects of walking/running compared to an alternate treatment (eg, stabilization exercises, physical therapy, tai chi, and general exercise programs). There was low-certainty evidence that walking/running was less effective than alternate interventions for reducing pain intensity (SMD, 0.81; 95% CI: 0.28, 1.34; I^2 = 91%) in the short term. This equates to an estimated mean difference of 14.2 points on a 0-to-100-point numeric pain-rating scale, in favor of the alternate intervention.

Five trials (n = 728)[8,19,32,42,44] investigated medium-term effects. There was low-certainty evidence of sustained benefits in favor of the alternate intervention (SMD, 0.80; 95% CI: 0.10, 1.49; I^2 = 94%). This equates to an estimated mean difference of 14.0 points on a 0-to-100-point numeric pain-rating scale, in favor of the alternate intervention. One trial (n = 56)[32] investigated long-term effects and produced low-certainty evidence of no difference in effectiveness between walking/running and an alternate treatment (SMD, 0.08; 95% CI: −0.45, 0.61). A summary of results is provided in **TABLE 2** and **FIGURE 3**.

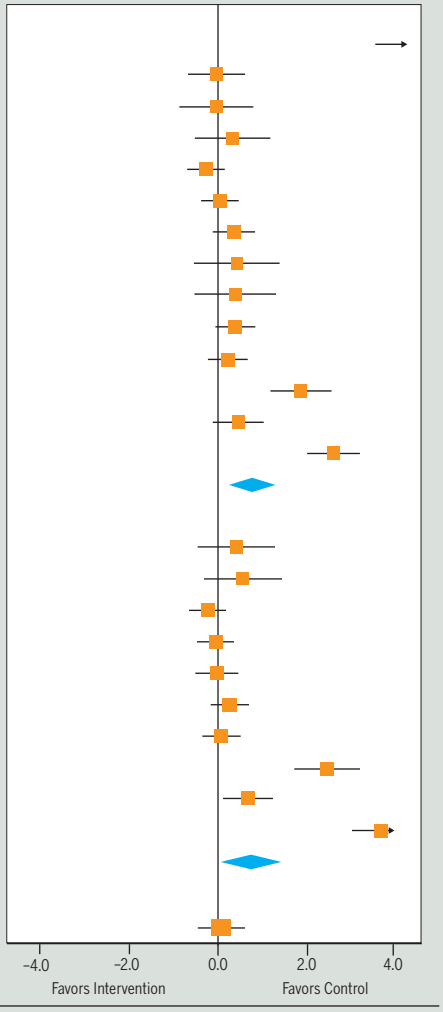
Disability Eight trials (n = 669)[3,7,8,19,32,36,41,42] investigated the short-term effects of walking/running compared to an alternate treatment (eg, stabilization exercises, physical therapy,

and general exercise programs). There was high-certainty evidence that walking/running was less effective than alternate interventions at reducing disability, though the effect size was small (SMD, 0.22; 95% CI: 0.06, 0.38; I^2 = 0%). This equates to an estimated mean difference of 3.8 points on a 0-to-100 Oswestry Disability Index scale, in favor of the alternate intervention.

Four trials (n = 467)[8,19,32,42] investigated medium-term effects. There was high-certainty evidence of sustained, though small, benefits in favor of the alternate intervention (SMD, 0.28; 95% CI: 0.05, 0.51; I^2 = 25%). This equates to an estimated mean difference of 4.1 points on a 0-to-100 Oswestry Disability Index scale, in favor of the alternate intervention. One trial (n = 56)[32] investigated long-term effects and produced low-certainty evidence that walking/running may be inferior to an alternate treatment (SMD, 0.36; 95% CI: −0.18,

Pain

Time Point/Study	Participants, n Intervention	Control	*P* Value	SMD (95% Confidence Interval)
Short term				
Bello and Adeniyi[3]	25	25	<.001	4.57 (3.52, 5.63)
Doğan et al[7]	19	18	.987	0.01 (−0.64, 0.65)
Eadie et al (exercise class)[8]	9[a]	14	1.000	0.00 (−0.84, 0.84)
Eadie et al (physical therapy)[8]	9[a]	13	.392	0.37 (−0.48, 1.23)
Hurley et al (exercise class)[19]	32[a]	66	.276	−0.24 (−0.66, 0.19)
Hurley et al (physical therapy)[19]	32[a]	67	.700	0.08 (−0.34, 0.50)
Rasmussen-Barr et al[32]	35	36	.088	0.41 (−0.06, 0.88)
Suh et al (stability exercise)[41]	7[a]	10	.342	0.47 (−0.51, 1.45)
Suh et al (flexibility exercise)[41]	7[a]	13	.357	0.44 (−0.49, 1.37)
Torstensen et al (exercise class)[42]	29[a]	59	.057	0.44 (−0.01, 0.89)
Torstensen et al (physical therapy)[42]	29[a]	59	.248	0.26 (−0.18, 0.71)
Weifen et al (swimming)[44]	16[a]	38	<.001	1.93 (1.25, 2.62)
Weifen et al (backward walking)[44]	16[a]	47	.086	0.50 (−0.07, 1.08)
Weifen et al (tai chi)[44]	16[a]	132	<.001	2.68 (2.08, 3.29)
Subtotal[b]			.003	0.81 (0.28, 1.34)
Medium term				
Eadie et al (exercise class)[8]	8[a]	13	.332	0.44 (−0.45, 1.33)
Eadie et al (physical therapy)[8]	8[a]	13	.195	0.59 (−0.30, 1.49)
Hurley et al (exercise class)[19]	31[a]	62	.333	−0.21 (−0.65, 0.22)
Hurley et al (physical therapy)[19]	31[a]	60	.889	−0.03 (−0.46, 0.40)
Rasmussen-Barr et al[32]	29	32	1.000	0.00 (−0.50, 0.50)
Torstensen et al (exercise class)[42]	29[a]	59	.193	0.30 (−0.15, 0.74)
Torstensen et al (physical therapy)[42]	29[a]	59	.649	0.10 (−0.34, 0.55)
Weifen et al (swimming)[44]	16[a]	38	<.001	2.52 (1.77, 3.28)
Weifen et al (backward walking)[44]	16[a]	47	.016	0.71 (0.13, 1.29)
Weifen et al (tai chi)[44]	16[a]	132	<.001	3.75 (3.08, 4.42)
Subtotal[c]			.025	0.80 (0.10, 1.49)
Long term[d]				
Rasmussen-Barr et al[32]	25	31	.764	0.08 (−0.45, 0.61)



Abbreviation: SMD, standardized mean difference.
[a]*When trials included more than 1 comparison in the same meta-analysis, the sample size was split in the shared groups, as per Cochrane recommendations, to ensure participants were not double counted.*
[b]*Heterogeneity: τ^2 = 0.95, I^2 = 91%.*
[c]*Heterogeneity: τ^2 = 1.08, I^2 = 94%.*
[d]*No pooled estimate was provided when only 1 or 2 studies were available for the outcome.*

FIGURE 3. Meta-analysis of walking/running versus alternate interventions for the outcome of pain intensity for the treatment of low back pain. All data extracted from each trial can be found in supplemental file 5.

0.89). A summary of results is provided in **TABLE 2** and **FIGURE 4**.

Walking/Running Versus Minimal or No Treatment for LBP

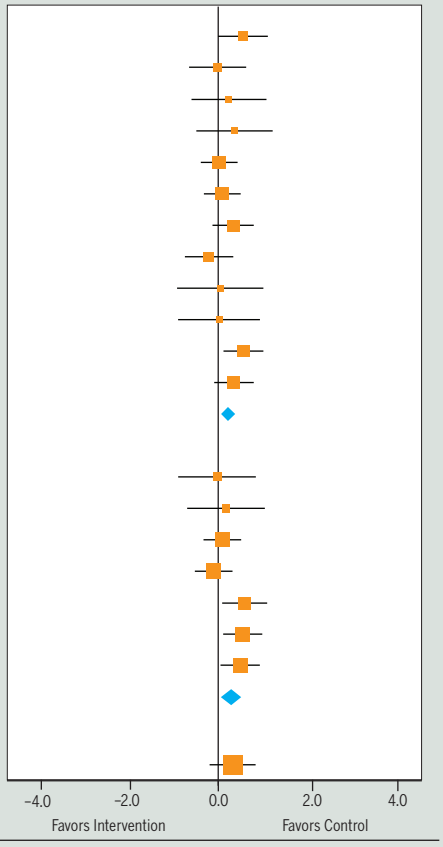
Pain Intensity Ten trials (n = 1025)[5,7,16,20,22,25,28,29,41,44] investigated the short-term effects of walking/running compared to either minimal or no treatment. There was high-certainty evidence that walking/running was more effective than minimal or no treatment for reducing pain intensity, though the effect size was small (SMD, −0.23; 95% CI: −0.35, −0.10; I^2 = 0%). This equates to an estimated mean difference of 4.4 points on a 0-to-100-point numeric pain-rating scale, in favor of walking/running.

Six trials (n = 853)[16,22,25,28,29,44] investigated medium-term effects. There was high-certainty evidence of sustained, though small, benefits in favor of walking/running (SMD, −0.26; 95% CI: −0.40, −0.13; I^2 = 0%). This equates to an estimated mean difference of 5.7 points on a 0-to-100-point numeric pain-rating scale, in favor of walking/running. No trials reported data on pain in the long-term period. A summary of results is provided in **TABLE 2** and **FIGURE 5**.

Disability Seven trials (n = 869)[5,7,16,22,25,28,41] investigated the short-term effects of walking/running compared to either minimal or no treatment. There was high-certainty evidence that walking/running was more effective than minimal or no treatment for reducing disability, though the effect size was small (SMD, −0.19; 95% CI: −0.33, −0.06; I^2 =

Disability

Time Point/Study	Participants, n: Intervention	Participants, n: Control	*P* Value	SMD (95% Confidence Interval)
Short term				
Bello and Adeniyi[3]	25	25	.052	0.56 (−0.01, 1.13)
Doğan et al[7]	19	18	1.000	0.00 (−0.65, 0.65)
Eadie et al (exercise class)[8]	9[a]	14	.555	0.25 (−0.59, 1.09)
Eadie et al (physical therapy)[8]	9[a]	13	.395	0.37 (−0.49, 1.23)
Hurley et al (exercise class)[19]	33[a]	68	.877	0.03 (−0.38, 0.45)
Hurley et al (physical therapy)[19]	33[a]	67	.634	0.10 (−0.32, 0.52)
Rasmussen-Barr et al[32]	35	36	.150	0.34 (−0.12, 0.81)
Shnayderman and Katz-Leurer[36]	26	26	.370	−0.25 (−0.80, 0.30)
Suh et al (stability exercise)[41]	7[a]	10	.910	0.06 (−0.91, 1.02)
Suh et al (flexibility exercise)[41]	7[a]	13	.946	0.03 (−0.89, 0.95)
Torstensen et al (exercise class)[42]	29[a]	59	.013	0.57 (0.12, 1.03)
Torstensen et al (physical therapy)[42]	29[a]	59	.112	0.36 (−0.09, 0.81)
Subtotal[b]			.006	0.22 (0.06, 0.38)
Medium term				
Eadie et al (exercise class)[8]	8[a]	13	.955	−0.03 (−0.91, 0.86)
Eadie et al (physical therapy)[8]	8[a]	13	.697	0.18 (−0.71, 1.06)
Hurley et al (exercise class)[19]	31[a]	64	.671	0.09 (−0.34, 0.52)
Hurley et al (physical therapy)[19]	31[a]	62	.648	−0.10 (−0.53, 0.33)
Rasmussen-Barr et al[32]	29	32	.023	0.60 (0.08, 1.11)
Torstensen et al (exercise class)[42]	29[a]	59	.016	0.55 (0.10, 1.01)
Torstensen et al (physical therapy)[42]	29[a]	59	.032	0.49 (0.04, 0.94)
Subtotal[c]			.015	0.28 (0.05, 0.51)
Long term[d]				
Rasmussen-Barr et al[32]	25	31	.189	0.36 (−0.18, 0.89)



Abbreviation: SMD, standardized mean difference.
[a]*When trials included more than 1 comparison in the same meta-analysis, the sample size was split in the shared groups, as per Cochrane recommendations, to ensure participants were not double counted.*
[b]*Heterogeneity: τ^2 = 0.00, I^2 = 0%.*
[c]*Heterogeneity: τ^2 = 0.15, I^2 = 25%.*
[d]*No pooled estimate was provided when only 1 or 2 studies were available for the outcome.*

FIGURE 4. Meta-analysis of walking/running versus alternate intervention for the outcome of disability for the treatment of low back pain. All data extracted from each trial can be found in supplemental file 5.

0%). This equates to an estimated mean difference of 2.3 points on a 0-to-100 Oswestry Disability Index scale, in favor of walking/running.

Four trials (n = 740)[16,22,25,28] investigated medium-term effects. There was high-certainty evidence that walking/running showed no difference in effect when compared to minimal or no intervention (SMD, −0.13; 95% CI: −0.47, 0.21; I^2 = 38%). This equates to an estimated mean difference of 1.7 points on a 0-to-100 Oswestry Disability Index scale, in favor of walking/running. No trials reported data on disability in the long term. A summary of results is provided in **TABLE 2** and **FIGURE 6**.

Cycling Versus Alternate Intervention for Treating LBP

One trial (n = 64)[27] investigated the effects of cycling compared to an alternate intervention for pain intensity, and 2 trials (n=124)[11,27] investigated disability. There was low-certainty evidence that cycling was less effective than alternate interventions at reducing pain in the short term (SMD, 0.51; 95% CI: 0.01, 1.01) and of no difference in effect in the medium term (SMD, 0.19; 95% CI: −0.30, 0.68). There was moderate-certainty evidence that cycling was less effective than alternate interventions at reducing disability in the short term (SMD, 1.13; 95% CI: 0.59, 1.68[11] and SMD, 0.55; 95% CI: 0.05, 1.05[27]) and medium term (SMD, 1.19; 95% CI: 0.64, 1.74[11] and SMD, 0.41; 95% CI: −0.09, 0.90[27]). A summary of results is provided in **TABLE 2** and **FIGURE 7**.

Cycling Versus Minimal or No Treatment for LBP

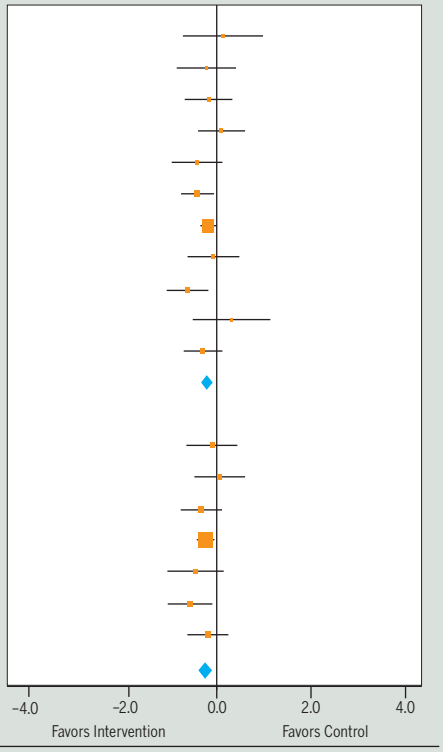
No trials compared the effectiveness of cycling to either minimal or no intervention for treating LBP.

Swimming Versus Alternate Intervention for Treating LBP

Only 1 trial (n = 265)[44] with multiple arms investigated the effects of swimming on pain intensity compared to an

Pain

Time Point/Study	Participants, n: Intervention	Participants, n: Control	*P* Value	SMD (95% Confidence Interval)
Short term				
Cho et al[5]	10	10	.783	0.12 (−0.75, 1.00)
Doğan et al[7]	19	18	.487	−0.23 (−0.88, 0.42)
Hartvigsen et al (supervised NW)[16]	40	22[a]	.501	−0.18 (−0.70, 0.34)
Hartvigsen et al (unsupervised NW)[16]	42	22[a]	.711	0.10 (−0.42, 0.61)
Idowu and Adeniyi[20]	25	26	.130	−0.43 (−0.98, 0.13)
Lang et al[22]	96	42	.025	−0.42 (−0.78, −0.05)
Little et al[25]	206	206	.069	−0.18 (−0.37, 0.01)
McDonough et al[28]	39	17	.786	−0.08 (−0.65, 0.49)
Mirovsky et al[29]	35	41	.008	−0.63 (−1.09, −0.17)
Suh et al (walking and stability exercise)[41]	12	10	.471	0.31 (−0.53, 1.16)
Weifen et al[44]	47	40	.166	−0.30 (−0.72, 0.12)
Subtotal[b]			<.001	−0.23 (−0.35, −0.10)
Medium term				
Hartvigsen et al (supervised NW)[16]	40	22[a]	.654	−0.12 (−0.64, 0.40)
Hartvigsen et al (unsupervised NW)[16]	42	22[a]	.886	0.04 (−0.48, 0.55)
Lang et al[22]	64	32	.132	−0.33 (−0.76, 0.10)
Little et al[25]	206	206	.010	−0.25 (−0.45, −0.06)
McDonough et al[28]	39	17	.128	−0.45 (−1.02, 0.13)
Mirovsky et al[29]	35	41	.018	−0.56 (−1.01, −0.10)
Weifen et al[44]	47	40	.352	−0.20 (−0.62, 0.22)
Subtotal[c]			<.001	−0.26 (−0.40, −0.13)



Abbreviations: NW, Nordic walking; SMD, standardized mean difference.
[a]*When trials included more than 1 comparison in the same meta-analysis, the sample size was split in the shared groups, as per Cochrane recommendations, to ensure participants were not double counted.*
[b]*Heterogeneity: τ^2 = 0.00, I^2 = 0%.*
[c]*Heterogeneity: τ^2 = 0.00, I^2 = 0%.*

FIGURE 5. Meta-analysis of walking/running versus minimal/no intervention for the outcome of pain intensity for the treatment of low back pain. All data extracted from each trial can be found in supplemental file 5.

alternate intervention. There was low-certainty evidence that swimming was no more effective than alternate interventions in the short or medium term (SMD, −0.76; 95% CI: −4.00, 2.48 and SMD, −0.78; 95% CI: −5.13, 3.57). A summary of results is provided in **TABLE 2** and **FIGURE 8**.

Swimming Versus Minimal or No Treatment for LBP

One trial (n = 78)[44] investigated the effect of swimming compared to minimal or no treatment for the outcome of pain intensity. There was low-certainty evidence that swimming was more effective than minimal or no treatment in the short term (SMD, −2.07; 95% CI: −2.62, −1.52) and medium term (SMD, −2.36; 95% CI: −2.94, −1.78). A summary of results is provided in **TABLE 2** and **FIGURE 8**.

Results of Post Hoc Analyses

When we excluded trials with a cointervention (eg, a daily home exercise program[7] or physical therapy[44]) (supplemental file 6, available at www.jospt.org) for the comparison of walking/running versus alternate interventions, there was a small difference in our point estimates for the outcome of pain intensity in the short term (original analysis: SMD, 0.81; 95% CI: 0.28, 1.34 compared to sensitivity analysis: SMD, 0.59; 95% CI: 0.07, 1.12) and disability in the short term (original analysis: SMD, 0.22; 95% CI: 0.06, 0.38 compared to sensitivity analysis: SMD, 0.24; 95% CI: 0.07, 0.40).

For the comparison of walking versus alternate interventions for the outcome of pain intensity in the medium term, removing a trial[44] with multiple comparisons substantially reduced the point estimate, from an SMD of 0.80 (95% CI: 0.10, 1.49) in the original analysis to no apparent difference between groups, with an SMD of 0.07 (95% CI: −0.12, 0.27), in the sensitivity analysis.

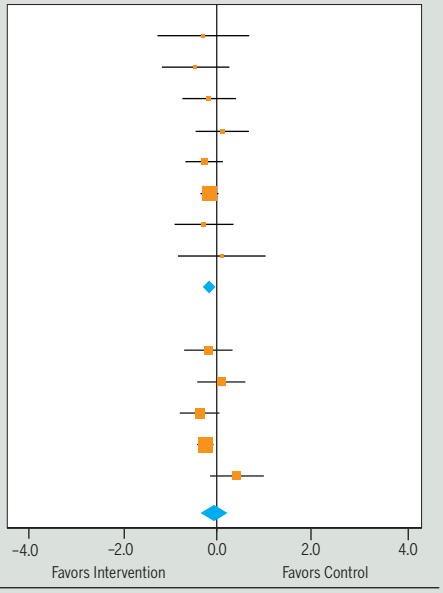
Secondary Outcome Measures

The effects on quality of life were investigated in 6 included trials.[8,19,22,25,28,32] Due to heterogeneity of interventions, comparisons, and outcome measures, meta-analysis was conducted for only 1 measure of quality of life (Medical Outcomes Study 36-Item Short-Form Health Survey [SF-36] role physical). Walking/running was less effective than an alternate intervention for improving quality of life in the short and medium term (SMD, 1.16; 95% CI: −2.15, 4.46; I^2 = 91% and SMD, 0.48; 95% CI: −0.39, 1.35; I^2 = 0%, respectively).

Fear avoidance was investigated in 7 included trials.[8,19,22,27,28,32,36] Due to het-

Disability

Time Point/Study	Participants, n: Intervention	Participants, n: Control	*P* Value	SMD (95% Confidence Interval)
Short term				
Cho et al[5]	10	10	.512	−0.30 (−1.17, 0.59)
Doğan et al[7]	19	18	.179	−0.45 (−1.10, 0.21)
Hartvigsen et al (supervised NW)[16]	40	22[a]	.475	−0.19 (−0.71, 0.33)
Hartvigsen et al (unsupervised NW)[16]	42	22[a]	.811	0.06 (−0.45, 0.58)
Lang et al[22]	96	42	.130	−0.28 (−0.65, 0.08)
Little et al[25]	206	206	.050	−0.18 (−0.36, 0.00)
McDonough et al[28]	39	17	.329	−0.29 (−0.86, 0.29)
Suh et al (walking and stability exercise)[41]	12	10	.901	0.05 (−0.79, 0.89)
Subtotal[b]			<.01	−0.19 (−0.33, −0.06)
Medium term				
Hartvigsen et al (supervised NW)[16]	40	22[a]	.494	−0.18 (−0.70, 0.34)
Hartvigsen et al (unsupervised NW)[16]	42	22[a]	.724	0.09 (−0.42, 0.61)
Lang et al[22]	64	32	.095	−0.36 (−0.79, 0.06)
Little et al[25]	206	206	.008	−0.25 (−0.43, −0.06)
McDonough et al[28]	39	17	.152	0.42 (−0.15, 1.00)
Subtotal[c]			.359	−0.13 (−0.47, 0.21)

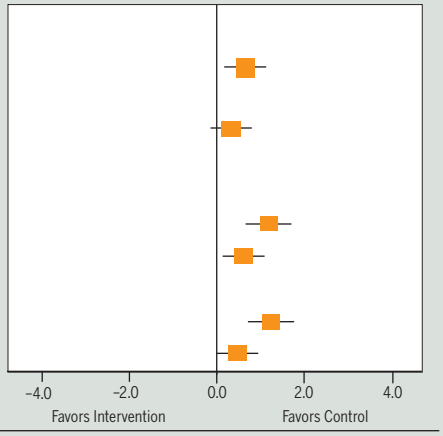


Abbreviations: NW, Nordic walking; SMD, standardized mean difference.
[a]*When trials included more than 1 comparison in the same meta-analysis, the sample size was split in the shared groups, as per Cochrane recommendations, to ensure participants were not double counted.*
[b]*Heterogeneity: τ^2 = 0.00, I^2 = 0%.*
[c]*Heterogeneity: τ^2 = 0.16, I^2 = 38%. The Knapp-Hartung method was used to estimate confidence intervals, due to 3 to 5 comparisons present.*

FIGURE 6. Meta-analysis of walking/running versus minimal/no intervention for the outcome of disability for the treatment of low back pain. All data extracted from each trial can be found in supplemental file 5.

Pain and Disability

Outcome/Time Point/Study	Participants, n: Intervention	Participants, n: Control	*P* Value	SMD (95% Confidence Interval)
Pain				
Short term[a]				
Marshall et al[27]	32	32	.046	0.51 (0.01, 1.01)
Medium term[a]				
Marshall et al[27]	32	32	.445	0.19 (−0.30, 0.68)
Disability				
Short term[a]				
Ganesh et al[11]	30	30	<.01	1.13 (0.59, 1.68)
Marshall et al[27]	32	32	.031	0.55 (0.05, 1.05)
Medium term[a]				
Ganesh et al[11]	30	30	<.01	1.19 (0.64, 1.74)
Marshall et al[27]	32	32	.108	0.41 (−0.09, 0.90)

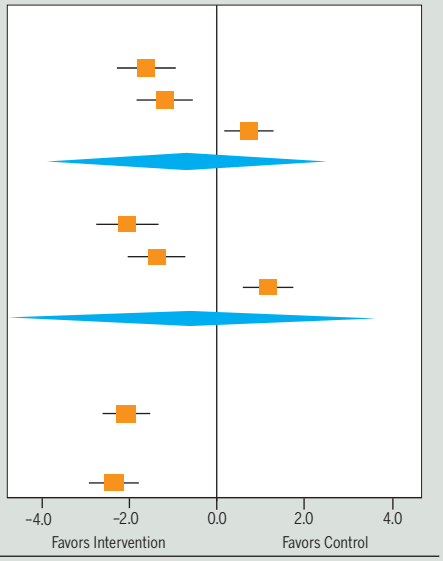


Abbreviation: SMD, standardized mean difference.
[a]*No pooled estimate was provided when only 1 or 2 studies were available for the outcome.*

FIGURE 7. Meta-analysis of cycling versus alternate intervention for the outcomes of pain and disability for the treatment of low back pain. All data extracted from each trial can be found in supplemental file 5.

Pain

Comparison/Time Point/Study	Participants, n: Intervention	Participants, n: Control	*P* Value	SMD (95% Confidence Interval)
Alternate intervention				
Short term				
Weifen et al (jogging)[44]	13[a]	47	<.01	−1.69 (−2.38, −1.01)
Weifen et al (backward walking)[44]	13[a]	47	<.01	−1.28 (−1.93, −0.62)
Weifen et al (tai chi)[44]	13[a]	132	.025	0.66 (0.08, 1.23)
Subtotal[b]			.418	−0.76 (−4.00, 2.48)
Medium term				
Weifen et al (jogging)[44]	13[a]	47	<.01	−2.07 (−2.79, −1.36)
Weifen et al (backward walking)[44]	13[a]	47	<.01	−1.41 (−2.08, −0.75)
Weifen et al (tai chi)[44]	13[a]	132	<.01	1.12 (0.54, 1.70)
Subtotal[c]			.521	−0.78 (−5.13, 3.57)
Minimal/no intervention				
Short term[d]				
Weifen et al[44]	38	40	<.01	−2.07 (−2.62, −1.52)
Medium term[d]				
Weifen et al[44]	38	40	<.01	−2.36 (−2.94, −1.78)



Abbreviation: SMD, standardized mean difference.
[a]*When trials included more than 1 comparison in the same meta-analysis, the sample size was split in the shared groups, as per Cochrane recommendations, to ensure participants were not double counted.*
[b]*Heterogeneity: $\tau^2 = 1.26$, $I^2 = 94\%$. The Knapp-Hartung method was used to estimate confidence intervals, due to 3 to 5 comparisons present.*
[c]*Heterogeneity: $\tau^2 = 1.71$, $I^2 = 96\%$. The Knapp-Hartung method was used to estimate confidence intervals, due to 3 to 5 comparisons present.*
[d]*No pooled estimate was provided when only 1 or 2 studies were available for the outcome.*

FIGURE 8. Meta-analysis of swimming versus alternate or minimal/no intervention for the outcome of pain intensity for the treatment of low back pain. All data extracted from each trial can be found in supplemental file 5.

erogeneity, meta-analysis was conducted for only 1 measure of fear avoidance (the Fear-Avoidance Beliefs Questionnaire physical activity subscale). Walking/running was less effective than an alternate intervention for improving fear avoidance in the short term (SMD, 0.25; 95% CI: 0.04, 0.47; I^2 = 0%), and neither more nor less effective in the medium term (SMD, 0.08; 95% CI: −0.26, 0.42; I^2 = 0%) (supplemental file 3).

Adverse events were reported in 6 walking trials. The numbers of adverse events were low, similar between the walking and control groups, and tended to be minor events that were musculoskeletal in nature, that is, lower-limb or back pain (2 versus 0,[8] 8 versus 0,[28] 7 versus 0,[19] 0 versus 1,[25] 0 versus 0,[29] and 0 versus 0,[22] respectively).

DISCUSSION

Key Findings

We found low- to high-certainty evidence that walking/running was less effective than alternate treatments in reducing pain and disability, but these differences were relatively small. When walking/running was compared to minimal/no intervention, there was high-certainty evidence that walking/running was slightly more effective for reducing pain across all time points and for reducing disability in the short term.

Few studies reported the treatment effects of cycling or swimming, although the findings were not dissimilar to those for walking/running. Results from 2 trials suggested that cycling was less effective than alternate interventions for reducing disability in the short and medium term. Results from a single trial suggested that swimming was no more effective than alternate interventions for reducing pain in the short and medium term, but was substantially superior when compared to minimal/no intervention.

There was an absence of trials investigating walking/running, cycling, or swimming for preventing LBP.

Comparison to Previous Literature and Meaning of the Findings

Two previous systematic reviews with meta-analysis concluded that walking was as effective as other interventions in reducing pain and disability in adults with chronic LBP.[37,43] We found walking/running to be inferior to alternate interventions for reducing pain and disability, although our estimates were imprecise and the CIs include very small differences. The difference between our results and those of previous reviews could be because we ran 2 separate meta-analyses, where we compared our intervention of interest to either alternate interventions or minimal/no intervention. Therefore, some studies that we analyzed in separate meta-analyses were combined in previous reviews.

Our results showing that the effect of walking/running is different when compared to alternate interventions versus minimal or no intervention represent an important new finding. In addition, the systematic reviews of both Sitthipornvorakul et al[37] and Vanti et al[43] included 9[5,7,16,21,24,26,28,36,42] and 5[5,16,19,28,36] walking trials, respectively, while our review included 16.

Characteristics of the included walking/running studies are also an important consideration when interpreting our findings. Across the included studies, there was considerable heterogeneity in the walking/running interventions provided, including variations in dose (15-60 minutes), frequency (2-7 sessions per week), and the type of programs provided (eg, treadmill-based, Nordic pole–assisted, or pedometer-driven programs, etc). At present, there is limited guidance as to whether treatment effects are impacted by these features, and there are too few trials to investigate this further in our review.

An important finding of our review was the scarce evidence for swimming and cycling, despite anecdotal reports by patients and clinicians that these strategies are helpful to treat and prevent LBP. No previous reviews have investigated the effects of cycling or swimming on LBP. We identified only 2 trials (3 articles)[4,11,27] comparing cycling to an alternate intervention and 1 study comparing swimming to an alternate intervention. A previous review identified that aquatic exercise significantly reduced pain and increased physical function in patients with LBP.[35] However, aquatic exercises included any exercise in water, including deep-water running, stretching, strengthening, range of motion, etc. We specifically sought the effects of swimming, thus we excluded all studies in the aquatic therapy review.

Key Messages for Clinicians

Walking/running, cycling, and swimming appear to be slightly less effective than alternate interventions for treating LBP. Walking and possibly swimming provide small benefits when compared to minimal or no intervention for treating chronic or recurrent nonspecific LBP. Some patients may choose walking over alternative interventions, given the accessibility, flexibility, low cost, and general health benefits. However, other patients may choose a slightly more effective intervention, even if it is more costly and less flexible.

Limitations

No trials explored interventions for preventing LBP. We could only include a small number of trials in comparisons for cycling and swimming for treating LBP. These important gaps in the literature warrant further investigation.

Many trials examined the effects of the interventions of interest when both groups received a cointervention. It is possible that the effects could be different when no cointervention is included, and therefore post hoc analyses were conducted, excluding studies with a cointervention for the comparison of walking versus alternate interventions. These are reported in addition to the main results (supplemental files, available at www.jospt.org). Another potential criticism could be our decision to pool all alternate interventions as a com-

parison, despite these potentially having different effects. However, this approach is common and enables us to provide clinicians with the best estimate of the effectiveness of walking/running, cycling, or swimming compared to alternate options. Details regarding the comparison interventions are provided for each study, so readers can make an informed interpretation of the pooled results.

The majority of included studies recruited patients with chronic LBP. However, 1 study[25] included people with chronic and recurrent LBP, and another included only people with recurrent LBP.[32] We do not believe that this substantially impacted our results, as the baseline characteristics of participants in these 2 studies, including the duration of pain, are similar to those of the other included studies.

Despite our efforts to obtain data through contacting authors, some data were unattainable due to the age of the trial,[9] and in other cases SDs were not published and had to either be calculated based on other relevant measures of effect and variability (eg, mean and 95% CI or median and interquartile range) or estimated based on a similar included trial, as recommended by the Cochrane Collaboration. Finally, only 5 of the included trials made comments about adherence to the intervention,[8,19,27,28,32] making it difficult to determine whether compliance levels impacted results.

CONCLUSION

Walking/running was slightly less effective than alternate treatments, and slightly more effective than minimal/no intervention, for improving disability in the short term and pain across all time points. Cycling was slightly less effective than alternate interventions for reducing disability in the short and medium term. There was scarce evidence, but 1 trial indicated that swimming was more effective than minimal/no intervention in reducing pain in the short and medium term.

KEY POINTS

FINDINGS: Accessible and common forms of exercise (walking/running, cycling, and swimming) were inferior to alternate treatments, but slightly superior to minimal/no intervention, for treating low back pain. It is unclear whether walking/running, cycling, and swimming are effective for preventing low back pain.

IMPLICATIONS: Clinicians should discuss these results with patients as part of shared decision making around care plans for low back pain. Some patients may choose walking/running, cycling, or swimming over alternate interventions, given the accessibility, flexibility, low cost, and general health benefits. However, other patients may choose a slightly more effective intervention, despite additional cost and less flexibility.

CAUTION: Certainty of the evidence ranged from high to low, and only a small number of trials investigated cycling and swimming for treating low back pain. Few trials reported on adherence, making it difficult to determine whether this impacted the results.

STUDY DETAILS

AUTHOR CONTRIBUTIONS: Natasha C. Pocovi and Dr de Campos and Prof Hancock had full access to all data in this systematic review and take responsibility for the integrity of the data and the accuracy of the data analysis. Natasha C. Pocovi and Prof Lin and Prof Hancock contributed to study concept and design and provided study supervision. Natasha C. Pocovi and Prof Hancock drafted the manuscript and performed statistical analysis. All authors contributed to the acquisition, analysis, or interpretation of data; provided critical revision of the manuscript for important intellectual content; and provided administrative, technical, or material support.

DATA SHARING: All data relevant to the study are included in the article or are available as supplemental files.

PATIENT AND PUBLIC INVOLVEMENT: No patient and/or public involvement was required for this review.

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