Interventions to increase adherence to therapeutic exercise in older adults with low back pain and/or hip/knee osteoarthritis: a systematic review and meta-analysis.

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Keywords: exercise adherence; interventions; osteoarthritis; low back pain; systematic review, meta-analysis

Word Count: 4121

ABSTRACT

Objective: To evaluate whether interventions aimed at increasing adherence to therapeutic exercise increase adherence greater than a contextually equivalent control among older adults with chronic low back pain and/or hip/knee osteoarthritis.

Design: A systematic review and meta-analysis.

Data sources: Five databases (MEDLINE (PubMed), CINAHL, SportDISCUS (EBSCO), Embase (Ovid) and Cochrane Library) were searched until 1 August 2016.

Eligibility criteria for selecting studies: Randomised controlled trials that isolated the effects of interventions aiming to improve adherence to therapeutic exercise among adults ≥45 years of age with chronic low back pain and/or hip/knee osteoarthritis were included.

Results: Of 3899 studies identified, 9 studies (1045 participants) were eligible. Four studies, evaluating strategies that aimed to increase motivation or using behavioural graded exercise, reported significantly better exercise adherence (*d*=0.26 to 1.23). In contrast, behavioural counseling, action coping plans and/or audio/video exercise cues did not improve adherence significantly. Meta-analysis using a random effects model with the two studies evaluating booster sessions with a physiotherapist for people with osteoarthritis revealed a small to medium significant pooled effect in favor of booster sessions (SMD 0.39, 95%CI 0.05 to 0.72, z=2.26 (p=0.02), I^2= 35%).

Conclusions: Meta-analysis provides moderate quality evidence that booster sessions with a physiotherapist assisted people with hip/knee osteoarthritis to better adhere to therapeutic exercise. Individual high quality trials supported the use of motivational strategies in people with chronic low back pain and behavioural graded exercise in people with osteoarthritis to improve adherence to exercise.

What is already known?

- The benefits of exercise for older adults with chronic low back pain and hip/knee osteoarthritis are well established.
- Adherence to exercise programs is important to optimise clinical benefits, and strategies to enhance exercise adherence have been evaluated in clinical trials.
- Previous systematic reviews of the effectiveness of interventions for improving exercise adherence were hampered by a lack of contextual equivalence between control and intervention groups.

What are the new findings?

- Meta-analysis of two studies provides moderate quality evidence that booster sessions with a physiotherapist may improve adherence to exercise in people with hip/knee osteoarthritis.
- Individual clinical trials provide emerging evidence to support the use of patient motivational strategies in people with chronic low back pain and behavioural graded exercise in people with osteoarthritis to improve adherence to exercise.
- Accurate reporting of intervention components and development of a standard, validated measure of exercise adherence are urgent research priorities in order to progress this field of research.

INTRODUCTION

Chronic low back pain and osteoarthritis, typically affecting the hip and/or knee, are the most common causes of musculoskeletal pain in older adults worldwide.[1] Both conditions are debilitating due to chronic pain and physical dysfunction, leading to significant loss of quality-of-life and substantial societal impact.[2, 3] The incidence of both chronic low back pain and osteoarthritis is expected to rise.[4, 5] Management of both conditions focuses on preventing unnecessary disability, minimizing pain and maintaining optimal function, with a combination of pharmacologic and non-pharmacologic therapies.[6, 7] Therapeutic exercise is a core component of self-management of both chronic low back pain and osteoarthritis in older adults.[7-9]

Therapeutic exercise is participation in physical activity that is planned, structured, repetitive and purposeful for the improvement or maintenance of a specific health condition (or disease).[10] This definition encompasses general aerobic exercise, strengthening, flexibility, balance or body-region specific exercises. There is high quality evidence that exercise improves pain and function in older adults with chronic low back pain and lower limb osteoarthritis.[2, 11, 12] Although exercise provides immediate and short-term clinically worthwhile effects,[11, 13-15] adherence to exercise declines significantly over time among older adults with chronic low back pain and those with hip/knee osteoarthritis.[11, 14, 15] Similar barriers to exercise adherence, such as fear of movement and pain aggravation, time management and uncertainty about the benefits of exercise have been reported across these populations.[16-19] As such, increasing adherence to exercise programs is recognised as an important factor for longer-term effectiveness.[20]

Adherence is defined as the extent to which a person's behaviour corresponds with the agreed recommendations from healthcare providers.[21] Various strategies to improve adherence to exercise have been explored among people with chronic musculoskeletal problems, including

education, goal setting, supervision of exercises, and the use of self-monitoring techniques such as an exercise diary. A 2010 Cochrane review[22] evaluated the efficacy of interventions to improve adherence to exercise for people with chronic musculoskeletal pain. Whilst the authors concluded that supervised or individualized exercise therapy and self-management techniques may enhance adherence, they noted uncertainty in the findings as effects were inconsistent across included studies. Similarly, a recent systematic review found limited evidence for interventions to increase exercise adherence among people with osteoarthritis and rheumatoid arthritis.[23] However, both of these systematic reviews are limited by the use of very broad inclusion criteria that included studies that could not isolate the specific effects of adherence strategies included within interventions. To draw accurate conclusions from experimental studies, the only difference between a control and target intervention should be the active ingredients hypothesized to produce benefit.[24] An analysis of the 2010 Cochrane review found that the contextual equivalence of the control and target interventions of the included studies was low, significantly limiting the conclusions that could be drawn about the effects of adherence interventions.[25] A similar limitation also applies to the systematic review by Ezzat at al.[23]

The primary objective of this study was to systematically review and describe randomised controlled trials evaluating interventions to increase adherence to therapeutic exercise, compared to contextually equivalent control interventions, among older adults with chronic low back pain and/or hip/knee osteoarthritis. A secondary aim was to perform meta-analysis on homogeneous randomised controlled trials to determine if interventions are effective at increasing exercise adherence.

METHODS

The review is reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement.[26] The protocol for this systematic review was not registered.

Search strategy

The search strategy was developed in consultation with a research librarian from the University of Melbourne. Three components of the search strategy were developed separately (population, exercise, adherence) then combined using database-specific truncation terms. Both MESH headings and keywords were used for each term. The full MEDLINE (PubMed) search strategy is detailed in Appendix 1. The following electronic databases were searched by one reviewer (PN) from their inception until 1 August 2016: MEDLINE (PubMed), CINAHL, SportDISCUS (EBSCO), Embase (Ovid) and Cochrane Library. The reference lists of any relevant systematic reviews found by the search were screened to identify potentially eligible additional primary studies. Supplementary searches of the reference lists of included studies were also undertaken.

Study selection

Randomised controlled trials (RCTs) involving therapeutic exercise for people 45 years or older with chronic (>3 months) low back pain and/or hip/knee osteoarthritis were considered eligible. Where mixed populations of participants were reported only those with 50% or more meeting the above population criteria were included. Any form of therapeutic exercise was eligible, including aerobic exercise, strengthening exercise, balance exercise etc. Studies were required to test an intervention that aimed to improve adherence to therapeutic exercise. To be eligible, the control arm of included studies was required to receive therapeutic exercise comparable to the intervention arm, such that the only point of difference between control and intervention groups was the specific adherence strategy under investigation. Randomised controlled trials that compared the effectiveness of two or more different adherence strategies

were eligible, as long as all other treatment elements (including the exercise programs) remained similar across trial arms. Studies were required to measure exercise adherence. Any quantitative measure of exercise adherence was deemed eligible, including numerical rating scales and log book/diary measures. Studies not available in English, conducted on animals or published in abstract form only were excluded.

A two-step process was utilised for study screening and selection, using the eligibility criteria outlined above. In the first step, titles and abstracts of all identified studies were independently screened by two reviewers in a standardized manner (AVG and PN). Disagreement regarding potentially eligible studies was resolved independently by a third reviewer (MH). Following title and abstract screening, the full text of all potentially eligible articles was retrieved and each screened independently for final inclusion by the same two reviewers (AVG and PN). Inter-rater agreement was measured by calculating percentage agreement and the kappa (κ) coefficient. Any differences regarding final eligibility were independently resolved by a third reviewer (MH) as required.

Data extraction

A data extraction form was developed by multiple authors, independently piloted by two authors (PN and RH) and subsequently adjusted to ensure all relevant data were captured. Two authors (AVG and PN) independently extracted data from the included study reports using the standardized form. Disagreements were resolved by discussion between the two review authors. If no agreement could be reached it was planned that a third author (RH) would independently adjudicate. Descriptive data extracted from each study included: study location, inclusion criteria, characteristics of study participants (sample size, age, gender), content of adherence and control group interventions (number and length of sessions, exercise type, mode of delivery, any additional intervention components), whether behaviour change theory was

used in developing the adherence intervention, outcomes used to measure exercise adherence and time points of outcome measurement. For each study, data regarding the effects of the adherence intervention on exercise adherence were extracted for each adherence outcome measure at each measured time point. We extracted means (standard deviations) or medians (interquartile range) or odds ratio (95% confidence interval) for adherence outcome measures as appropriate, along with results of relevant between-group statistical comparisons. We contacted authors for data when insufficient information was reported in the study publication.

Quality of intervention reporting

For each study the Template for Intervention Description and Replication (TIDieR) checklist was applied to assess the quality of description of the interventions evaluated.[27] This checklist consists of 12 items that constitute complete and replicable reporting of interventions (brief name, why, what (materials), what (procedure), who provided, how, where, when and how much, tailoring, modifications, how well (planned) and how well (actual)).[27]

Risk of bias assessment

The degree of bias in included studies was assessed independently by two authors (PN and AVG) using the Cochrane Risk of Bias Tool.[28] This tool rates seven potential sources of bias across six domains (sequence generation, allocation concealment, blinding, incomplete outcome data, selective outcome reporting and 'other sources of bias). Each potential source of bias was rated as low, unclear or high risk. Where there was disagreement between raters, discrepancies were resolved by discussion and consensus with a third author (FD) if necessary. Absolute agreement, and an estimate of level of agreement between reviewers who rated the risk of bias in included studies was assessed by calculating percentage agreement and the kappa (κ) coefficient for the total number of items of the Cochrane Risk of Bias Tool.[11]

Data synthesis

Descriptive characteristics and outcomes of included studies were summarised in tables and synthesized primarily in narrative format. Effect sizes (Cohens *d*) for the difference between adherence and control interventions for adherence outcomes at each time point were calculated using $d = \frac{(mean1 - mean2)}{SD\ pooled}$ (where $SD\ pooled = \sqrt{[(SD1^2 + SD2^2)/2]}$. Effect sizes (*d*) were interpreted as being small ≤ 0.20 ; medium = 0.50 ; large ≥ 0.80.[29] We anticipated there would be limited scope for meta-analyses due to heterogeneity across studies. We did not anticipate included studies would provide sufficient data for subgroup analyses, thus we had no pre-planned subgroup analyses. Studies that were sufficiently homogeneous to allow data pooling were analysed using Review Manager (RevMan, version 5.2) statistical software. We considered studies to be clinically homogenous enough to allow pooling when inclusion criteria, interventions, patients and comparators were deemed similar, and comparable outcome measures were used to assess adherence. Pooled continuous data were expressed as standardized mean difference (SMD) with 95% confidence intervals. Significance was set at $p<0.05$. The random effects model was used for analyses and statistical heterogeneity across pooled studies was quantified using the I^2 statistic. Values >50% were considered to represent substantial heterogeneity, and were deemed unsuitable for pooling.[30]

Following meta-analysis, the strength of the body of evidence was synthesized using the Grading of Recommendations Assessment, Development and Evaluation (GRADE) approach.[31] The quality of evidence was downgraded from high quality by one level for each of the following criteria: presence of one or more high risk domains in the Cochrane Risk of Bias assessment, inconsistent (wide confidence intervals) or unexplained heterogeneity of results.[31] Indirectness was not relevant to this review as search terms encompassed a specific population, outcomes measures of interest and direct comparisons.

RESULTS

Study selection

The process of study selection is shown in Figure 1. The initial search yielded 4741 references. After removal of duplicates, screening of 3899 titles and abstracts yielded 73 references for full text review. Of these, the reviewers agreed on inclusion of seven, exclusion of sixty-three and disagreed about whether three studies should be included (96% absolute agreement, $\kappa = 0.80$), indicating good agreement between the reviewers.[32] Following arbitration by the third reviewer, two articles were included and one excluded. This resulted in a total of nine unique studies, involving 1045 participants, for inclusion in the review.

Study characteristics

Descriptive characteristics of the nine included studies are shown in Table 1.

Table 1 Description of included studies.

Study	Inclusion criteria	Sample characteristics		Intervention content	
		Control group	Adherence intervention group	Control intervention	Adherence intervention
Chronic low back pain studies					
Basler 2007 Germany	Aged ≥65 years. Diagnosis of chronic LBP. Self-reported pain at time of inclusion.	N=84 Age: 70±5 Female: 65.5%	N=86 Age: 70±4 Female: 62.8%	10x 20 minute sessions with physiotherapist over 5 weeks + home exercise program: stretching and tailored exercise (strength, endurance, co-ordination) + 10 minutes of sham ultrasound prior to session.	Control intervention (excluding sham ultrasound) + 10 minutes of counselling at each session, delivered by the physiotherapist, focusing on readiness to change and increasing self-efficacy.
Freidrich 1998 Austria	Aged 20-60 years. Topographic criteria for chronic LBP ± radiation - back pain ≥4 months or ≥3 episodes of LBP in past 6 months with current episode lasting ≥2 months.	N=49 Age: 45±11 Female: 45%	N=44 Age: 43±10 Female: 57%	10x 25 minute exercise sessions over 4-5 weeks. Individual, submaximal, gradually increased exercise program aiming to improve spinal mobility, trunk and lower limb muscles strength and length.	Control intervention + Motivation program delivered by therapist during sessions, consisting of: education about importance of exercise; counselling and positive reinforcement techniques; written exercise contract; exercise diary.
Vong 2011 Hong Kong	Aged 18-65 years. Diagnosis of LBP for >3 months.	N=38 Age: 45±11 Female: 68%	N=38 Age: 45±11 Female: 58%	10x 30 minute sessions over 8 weeks with physiotherapist consisting of 15 minutes of interferential + tailored back exercise program and daily home exercise program.	Control intervention + Motivational Enhancement Therapy (MET) techniques integrated into sessions, including supporting appropriate behaviour change and increasing self-efficacy.

Hip and/or knee osteoarthritis studies					
Bennell 2014 Australia	Aged ≥ 45 years. Knee pain ≥25mm on VAS. Radiographic medial tibiofemoral OA. Pain predominantly medial knee.	N=38 Age: 64±7 Female: 47%	N=40 Age: 61±7 Female: 60%	10-14x 30 minute individual exercise sessions with a physiotherapist over 12 weeks. Advice to continue an unsupervised home exercise program of strengthening or neuromuscular retraining exercises 4x week for 24 weeks (from the end of the original 12 week period).	Control intervention + 2x 30minute individual 'booster' sessions with a physiotherapist over 16 weeks (at weeks 8 and 16 from the end of the original RCT 12 week period). Reviewed and progressed home exercise program content and dose, discussed barriers to exercise adherence and strategies to overcome these.
Brosseau 2012 Canada	Mild-to moderate unilateral/bilateral knee OA according to ACR clinical and radiographic/MRI criteria. Pain >3 months.	N=79 Age: 64±10 Female: 70%	N=69 Age: 64±8 Female: 74%	3x 65 minute group walking sessions supervised by a physical activity specialist per week for 12 months; Monetary compensation for each walking session attended; Educational pamphlet; Log book; Pedometer.	Control intervention + 20x 2 hour group sessions over 20 weeks with a trained instructor including short and long term goal setting, education about physical activity benefits + monthly face-to-face counselling targeting strategies to overcome barriers to adherence for the first 6 months followed by monthly telephone calls 6-12 months.
O'Brien 2013 New Zealand	Aged ≥50 years. Hip or knee OA according to ACR clinical and radiographic criteria.	N=17 Age: 64±11 Female: 80%	N=10 Age: 63±10 Female: 47%	3x class-based exercise sessions per week for 12 weeks supervised by a research assistant: resistance circuit consisting of 8 stations x 60sec each x3	Control intervention + Action and coping plan based on individual functional goal and identified barriers to exercise – when, where, how to perform exercises + coping plan

				circuits; 2x week 20 minute home walking and stretching program.	completed and signed by patient and researcher.
Pisters 2010 The Netherlands	Aged 50 to 80 years. Hip or knee OA according to ACR clinical criteria.	N=103 Age: 65±8 Female: 79%	N=97 Age: 65±7 Female: 75%	18x 30 minute individual sessions over 12 weeks with a physiotherapist consisting of general recommendations and advice, non-individualised exercise program and encouragement of positive attitude.	18x 30 minute individual sessions over 12 weeks with a physiotherapist delivering an individually tailored behavioural graded exercise program directed at a time-effective increase in level of activities + 5-7x booster sessions at weeks 18 (allowed up to 2x sessions), 25 (allowed up to 2x sessions), 34, 42 and 55.
Schoo 2005 Australia	Aged ≥60 years. Pain in one or both knees/hips previous week when climbing stairs, walking, transferring + knee or hip OA confirmed by medical practitioner and verified by a physiotherapist.	N=30 Age: 71 ±7 Female: 63%	Audio group N=30 Age: 71±7 Female: 67% Video group N=30 Age: 69±6 Female: 70%	3x individual sessions with a physiotherapist over 8 weeks (baseline, 4 weeks and 8 weeks) consisting of face to face verbal instruction on the performance of 9 home exercises and a brochure of the exercises.	Audio group: Control intervention + audio tape of verbal cues to prompt correct performance of exercises. Video group: Control intervention + video tape of verbal and visual cues to prompt correct performance of exercises.
Tuzun 2012 Turkey	Aged ≥40 years. OA according to ACR clinical/radiographic criteria.	N=32 Age: 57±9 Female: 97%	N=32 Age: 52±10 Female: 100%	4x individual sessions with the investigator physician over 12 weeks consisting of verbal explanation of 8x home exercises and brochure demonstrating the exercises.	4x individual sessions with investigator physician over 12 weeks consisting of exercise demonstration by physician, coaching of participant performing the exercises and gradual increase in exercise intensity (isometric progressing to isotonic exercises).

N=Number. LBP=Low Back Pain. OA=Osteoarthritis. VAS= Visual Analogue Scale. ACR=American College of Rheumatology. MRI=Magnetic Resonance Imaging.

* Additional data (means, standard deviations) obtained directly from author.

Studies were published between 1998 and 2014, four were conducted in Europe,[33-36] three in Australia/New Zealand,[37-39] one in Canada[40] and one in Hong Kong.[41] Three studies recruited older adults with chronic low back pain (total n=339),[33, 34, 41] three recruited participants with knee osteoarthritis (total n=364)[36, 37, 40] and three recruited participants with either hip or knee osteoarthritis (total n=342).[35, 38, 39] Intervention duration ranged from 3 sessions over 8 weeks to 23 sessions over 55 weeks, with follow-up periods ranging from 8 to 65 weeks. A number (n=4, 44%) of studies assessed adherence at short-term (≤3 months) time points only.[36, 38, 39, 41] Two studies reported mid-term (3-6months) follow-up,[33, 37] and three studies reported long-term (≥12 months) outcome measurement.[34, 35, 40]

Significant variation existed in the content of the specific adherence interventions evaluated. Five studies involved complex behavioural interventions with multiple components including education, counselling, positive reinforcement techniques and use of an exercise diary.[33-35, 40, 41] Two studies included behavioural graded exercise, alone[36] or in combination with booster sessions supervised by a clinician.[35] One study examined booster sessions supervised by a clinician in isolation,[37] one evaluated action coping plans[39] and one utilised an audio or video tape of exercises in addition to verbal instructions of the exercise program.[38]

Four studies explicitly referred to the use of behaviour change theory or other conceptual frameworks in developing their intervention.[33, 36, 40, 41] Three based their intervention development on the Transtheoretical Model of Behaviour Change,[33, 36, 41] and one on the Knowledge to Action Cycle conceptual framework for knowledge translation.[40]

Table 2 describes the outcomes used to measure exercise adherence, including the time points for follow-up and missing data at each time point. A range of data was captured including ratings of overall adherence, time spent exercising, exercise session attendance and number

of home sessions completed. The most common was self-reported performance of exercise in log-books.[33, 34, 36-38, 41] Some studies included therapist-reported attendance at exercise sessions.[34, 39, 40] The number of adherence outcome measures used in each study ranged from one[33, 35, 36, 40, 41] to four.[34] Most studies utilized custom-developed numerical rating scales for self-rating adherence and only one utilized a specific questionnaire (the Sport Injury Rehabilitation Adherence Scale).[42] A number of studies reported considerable amounts of missing data. One study utilizing self-reported log books had complete data for only 55% of the original cohort at the 12 month follow-up.[34] Another study measuring exercise session attendance reported complete data for only 56% of the original cohort at 12 weeks.[39]

1 **Table 2** Effects of adherence intervention on adherence outcomes reported across included studies.

Study	Adherence measurement method	Measurement time points	Participant retention (% of original cohort)	Results (mean±SD)		Significance (p value)	Effect size (*d*)
				Control group	Adherence intervention group		
Chronic low back pain studies							
Basler, 2007	Self-reported in log book– time per day spent training (minutes).	6 weeks	86%	24.7±16.3	29.2±14.6	NR	0.29
		6 months	86%	25.3±19.7	29.6±24.2	NR	0.19
Freidrich, 1998	Therapist-reported exercise session attendance (n, out of maximum of 10).	4 months	90%	8.6±2.1	9.6±1.1	p=0.0005	0.60
	Self-reported in log book– number of days per week trained (n).	4 months	90%	2.9 ±1.1	3.6±5.0	NR	0.19
		12 months	74%	3.1±2.2	4.0±1.9	p=0.036	0.44
	Self-reported in log book– time per day spent training (minutes).	4 months	90%	16.1±10.2	17.9±8.7	NR	0.19
		12 months	74%	16.4±13.0	15.5±8.6	NR	-0.08
	Self-reported in log book - total training time (minutes).	4 months	90%	748±668	917±656	NR	0.26
		12 months	74%	1516±1397	2024±2026	NR	0.29
Vong, 2011	Self-reported in log book - sessions of home practice completed per week (n).	4 weeks	83%	6.8±3.7	12.8 ±8.1	p=0.002	0.95
		8 weeks	79%	6.2±3.6	13.9±8.1	NR	1.23
		12 weeks	74%	5.8±4.1	12.9±7.2	NR	1.21
Hip and/or knee osteoarthritis studies							
Bennell, 2014	Self-reported in log book – number of exercises completed per day. Values reported as % of prescribed exercises	24 weeks	95%	51±37	56±34	p>0.05	0.14

	performed over 2 x 1 week periods (where 100% indicates all prescribed exercises performed as directed).						
	Self-reported overall adherence to the prescribed exercise program. Values reported as average of ratings given for the previous 8-week period at Weeks 8, 16 & 24. (11 point NRS: 0=not at all, 10=completely as instructed).	24 weeks	95%	5.5±3.5	6.1±3.2	p>0.05	0.18
Brosseau, 2012	Therapist-reported exercise sessions attended (n, out of maximum of 3/week).	3 months	83%	0.770±0.299	0.802±0.290	p=0.514	0.11
		6 months	75%	0.617±0.410	0.636±0.390	p=0.774	0.05
		9 months	67%	0.471±0.418	0.534±0.425	p=0.363	0.15
		12 months	60%	0.446±0.441	0.445±0.433	p=0.989	-0.00
O'Brien, 2013	Therapist-reported class attendance (n, out of maximum of 31).	12 weeks	56%	16±10	17±11	p=0.81	0.10
	Class participation scored by therapist on the Sports Injury Rehabiliation Adherence Scale (3 items scored on a 5 point NRS: exercise intensity, ability to follow instructions and receptiveness to changes to program. Total score out of 15).	12 weeks	56%	4.6±0.9	4.5±0.4	p=0.52	-0.14
	Self-reported adherence to home stretching program. Participants asked whether they performed exercises as prescribed (5 point NRS: 1=not at all, 5=as advised).	12 weeks	56%	3.9±0.2	3.7±1.3	p=0.21	-0.22
	Self-reported adherence to home walking program. Participants asked whether they performed the program as prescribed (5 point NRS: 1=not at all, 5=as advised).	12 weeks	56%	3.5±1.0	3.6 ±1.3	p=0.93	0.09
Pisters, 2010	Self-reported overall adherence. Participants were asked how frequently they performed the exercises as prescribed (5 point NRS: 1=almost never, 5=very often).	13 weeks	96%	59%	75%	OR 4.3 (95%CI 2.1-9.0)	
		65 weeks	90%	34%	44%	OR 3.0	

	Values reported as % that scored 4 or 5/5).					(95%CI 1.5-6.0)	
	Self-reported overall adherence. Participants were asked how frequently they performed the exercises as prescribed (5 point NRS: 1=almost never, 5=very often).	13 weeks	96%	3.47±0.95*	4.23±0.94*	NR	0.80
		65 weeks	90%	3.14±0.99*	3.71±1.15*	NR	0.53
Schoo, 2005	Self-reported in log book. Participants asked if all, some or none of prescribed exercises were performed each day.	4 weeks	NR	93.0%	Audio: 89.0% Video: 92.0%	p=0.690	¥
	Values reported as median % that reported completing all exercises.	8 weeks	78%	89.5%	Audio: 87.0% Video: 81.5%	p=0.538	¥
Tuzun, 2012	Self-reported in log book – number of exercise sessions completed each day. Values reported as % of participants compliant with all exercise sessions as prescribed; median(IQR).	4 weeks	NR	72.5 (55-97.5)	100 (100-100)	p=0.125	¥
		12 weeks	NR	55 (25-85)	100 (90-100)	p=0.036	¥

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2 n=Number. NR=Not reported. NRS=Numeric Rating Scale. OR=Odds ratio. CI=Confidence Interval. QR=Interquartile Range. SD=Standard
3 Deviation.

4 * Additional data (means, standard deviations) obtained directly from author.

5 ¥ Unable to calculate from data provided.

Table 3 shows the TIDieR checklist for included studies. Three studies fulfilled all 12 requirements for complete intervention reporting.[35, 37, 38] Less than half of included studies (n=4, 44%) adequately reported all activities and processes used in the intervention (Item 4). Details of physical and informational materials used in the intervention (Item 3) and details of the intervention provider, including expertise and any specific training give (Item 5) were also poorly described in a number of included studies (n=4, 44 % did not fulfill checklist requirements for these items).

Table 3 TIDieR checklist for reporting of interventions in included studies.

TIDieR Item	1 Brief name	2 Why	3 What (materials)	4 What (procedures)	5 Who provided	6 How	7 Where	8 When and How Much	9 Tailoring	10 Modifications	11 How well (planned)	12 How well (actual)
Chronic low back pain studies												
Basler, 2007	✓	✓	×	×	×	✓	✓	✓	✓	✓	✓	✓
Freidrich, 1998	✓	✓	×	×	×	✓	✓	✓	×	✓	✓	✓
Vong, 2011	✓	✓	×	×	✓	✓	×	✓	✓	✓	✓	✓
Hip and/or knee osteoarthritis studies												
Bennell, 2014	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Brosseau, 2012	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
O'Brien, 2013	✓	✓	✓	✓	×	✓	✓	✓	✓	✓	✓	✓
Pisters, 2010	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Schoo, 2005	✓	✓	✓	×	✓	✓	✓	✓	✓	✓	✓	✓
Tuzun, 2012	✓	✓	×	×	×	×	×	✓	×	✓	✓	×

✓ = Item sufficiently described in the study. × = Inadequately or not described.

Risk of bias assessment

Risk of bias across included studies was scored on 63 items (7 items per study). The two reviewers agreed on the scoring of 58 items (92% absolute agreement, κ=0.85) indicating very good agreement.[32] Consensus was reached on disagreements after discussion. Results of the risk of bias assessment are shown in Figure 2. All studies had at least one domain judged as unclear risk of bias. The main weaknesses of included studies related to reporting bias, where only one study was rated as being at low risk.[37] A number of studies reported pre-specified outcomes incompletely, or in a way that excluded inclusion in a meta-analysis. A high risk of performance bias (lack of blinding of participants and personnel) was evident in two studies,[33, 37] and was unclear in three studies.[34, 36, 38] Four (44%) of the studies were judged to be at low risk of selection bias,[33, 35, 37, 40] and four (44%) at low risk of detection bias.[35, 39-41]

Effects of interventions

Outcomes regarding the effects of adherence interventions on exercise adherence are presented in Table 2. Only two studies (evaluating booster sessions in people with osteoarthritis) were suitable for meta-analysis, as clinical heterogeneity in the other included studies meant no other meta-analyses were considered appropriate.

Chronic low back pain

Two studies involving motivation programs targeting increasing self-efficacy through positive reinforcement and education reported statistically significant differences between intervention and control group adherence at one or more time point measured.[34, 41] Effect sizes ranged from large (d = 1.23), short-term[41] to small to medium (d= 0.44) at long-term follow-up.[34] Behavioural counseling, focusing on readiness to change did not improve adherence.[33]

Hip and/or knee osteoarthritis

One study examining the use of behavioural graded activity in people with knee osteoarthritis[36] and one study including a combination of behavioural graded exercise and "booster" sessions in people with hip or knee osteoarthritis[35] reported statistically better adherence at one or more time points compared to control. Effect sizes ranged from large (*d*= 0.80) at mid-term follow-up, to medium (*d*=0.53) at long-term follow-up.[35] Only one study, examining behavioural graded activity and booster sessions, reported significant differences in exercise adherence with the intervention at all measured time points.[35] Among studies that measured adherence at multiple time points in more than one category of short-, mid- and long-term, mean raw adherence scores for both intervention and control groups decreased from short-/mid- to long-term.[35, 40]

The four studies that did not find statistically significant benefits of the intervention on adherence compared to control groups included one study evaluating goal setting and strategies to overcome barriers to adherence,[40] booster sessions with a physiotherapist,[37] action coping plans[39] or audio/video exercise performance cues.[38]

The two studies[35, 37] (229 participants) that evaluated booster sessions were pooled for meta-analysis (Figure 3). The pooled effect of these interventions on improving adherence as measured by a self-reported numeric rating scale was small to medium but significant, compared to control groups (SMD 0.39; 95%CI 0.05 to 0.72; z=2.26; p=0.02; I^2= 35%). As further research could have an impact on the magnitude and confidence in the estimate of this effect and there is a risk of performance bias in one of the two included studies, the current evidence for this type of intervention was graded as "Moderate".[31]

DISCUSSION

This systematic review identified nine unique studies evaluating interventions to increase adherence to therapeutic exercise among older adults with chronic low back pain and/or hip/knee osteoarthritis. Due to significant heterogeneity across studies, we were only able to conduct a limited meta-analysis. We found moderate quality evidence that incorporating booster sessions with a physiotherapist may improve therapeutic exercise adherence in people with osteoarthritis. We also found emerging evidence from individual high quality studies that interventions specifically targeting patient motivation to exercise, or adopting a behavioural graded exercise approach may improve therapeutic exercise adherence in people with chronic low back pain and osteoarthritis respectively. However effect sizes declined to medium (at best) over the long-term. Results of this systematic review and limited meta-analysis suggest that behavioural counseling, use of action coping plans or audio/video exercise performance cues are ineffective at improving exercise adherence in these patient groups.

In contrast to previous systematic reviews,[22, 23] which included studies that could not isolate the specific effects of the adherence strategy under investigation, our review included only studies with contextual equivalence between control and target interventions. Despite this, our findings are largely consistent with those of previous reviews. In people with osteoarthritis and rheumatoid arthritis, Ezzat and colleagues[23] included 19 studies, of which 13 involved participants with osteoarthritis. They did not perform a meta-analysis and concluded there was limited evidence that interventions can improve exercise adherence. Of the 42 studies included in the 2010 Cochrane review[22] of interventions to improve adherence to exercise for chronic musculoskeletal pain in adults, all but two included people with osteoarthritis and spinal pain. Although the authors concluded that supervised or individualized exercise therapy may enhance exercise adherence, this conclusion is questionable given the lack of contextual equivalence between control and intervention arms of the included RCTs.

Our review highlighted some potential strategies that may be effective for increasing exercise adherence and warrant further research. Techniques specifically aimed at increasing patient motivation to exercise appear promising for people with chronic low back pain, based on the positive findings of two individual moderate-high quality studies.[34, 41] These techniques include positive feedback and reinforcement of patient efforts, advice about posting self-reminders at home to complete exercises, the use of an exercise diary and the use of a "treatment contract". Patient motivation to exercise is critical for sustained exercise adherence,[43] and a systematic review of individual and intervention-related factors associated with adherence to home exercise among people with chronic low back pain found incorporating motivational strategies in interventions was associated with increased adherence.[44]

Another intervention with promise is behavioural graded exercise for people with hip or knee osteoarthritis. Behavioural graded exercise uses principles of operant conditioning and self-regulation, and is directed at gradually increasing intensity of exercise and integration of exercises into daily living.[35, 36, 45] Lack of confidence in capability to exercise, lack of time and inability to accommodate exercises in daily life have been recognized as significant barriers to exercise participation among people with knee osteoarthritis.[16, 46, 47] The use of behavioural graded exercise addresses these barriers directly.

Pooled analysis found moderate quality evidence for booster sessions improving mid-long term exercise adherence in people with osteoarthritis. Booster sessions involve returning to a therapist after an initial period of exercise treatment. Content of these sessions may vary. In the two included studies these sessions focused on review and progression of the home exercise program and discussion of progress and barriers to exercise adherence.[35, 37] The use of such sessions provides ongoing contact and reinforcement, both of which are recognized as facilitators to exercise adherence in this population.[16]

Given the vast array of factors known to influence exercise adherence in people with chronic low back pain and/or osteoarthritis, no single strategy will be effective in overcoming all barriers to exercise participation in all people, all of the time.[16, 18, 20, 44, 48] For interventions to effectively facilitate behaviour change, the use of theoretical rationale is imperative when designing interventions.[49] Medical Research Council guidelines recommend including theory within complex intervention study designs,[50] however only four studies in this systematic review explicitly referred to the use of behaviour change theory or other conceptual frameworks in developing their intervention.[33, 36, 40, 41]

Furthermore, it is likely that multi-faceted adherence interventions, that contain multiple behaviour change techniques and address multiple barriers to exercise participation, are required. Previous literature has suggested that complex interventions containing multiple concurrently delivered strategies can improve adherence to exercise more than a single strategy intervention among wider chronic disease populations.[51] Alternate to multi-faceted adherence interventions is an individualized targeted approach to promoting exercise adherence, whereby the unique barriers to exercise participation are established for each patient and a targeted interventional strategy developed collaboratively between the clinician and patient in order to increase exercise adherence.[52] Although an intervention of targeted exercise adherence is promising for improving adherence for longer periods in older adults with knee pain, results to date have been published as conference abstracts only, preventing inclusion in this review.[53, 54]

Strengths and limitations

This review advances previous systematic reviews in comparable populations.[22, 23] Although our review included fewer eligible studies, those that were reviewed demonstrated acceptable contextual equivalence between intervention and control groups, allowing us to

determine whether interventions increase adherence more accurately than previous systematic reviews. We conducted an extensive database review, however it is possible that articles were missed during the search due to publication and selective reporting biases, presenting a potential limitation. In addition, our ability to pool data was limited due to the heterogeneity in interventions and outcomes identified.

It is possible that effectiveness of booster sessions, and indeed other interventions designed to increase adherence, may be influenced by factors such as co-morbidities, age of the patient, cognitive capability and location of intervention delivery, however this has not yet been explored to date.

Improved reporting of interventions is required. Interventions in many of the included studies in this review were poorly described, particularly with respect to physical or informational materials used in the intervention. These deficiencies in reporting preclude clinicians and researchers from reliably replicating or implementing interventions. Previous literature has found this to be common amongst interventions designed to change behaviour,[55, 56] and as a result, the Behaviour Change Technique Taxonomy was developed to provide a clear and replicable method of coding the components of any behaviour change intervention.[57] In addition, the recently published Consensus on Exercise Reporting Template (CERT) was developed to provide guidance specifically in reporting exercise programmes.[58] Future randomized controlled trials should consider utilising these in addition to the TIDieR checklist,[27] both in developing and reporting intervention content.

Finally, the heterogeneity in outcomes used to measure exercise adherence remains an issue, and limited our ability to pool data in this review. This has been previously acknowledged as a limitation to advancing research in this field.[59] A recent systematic review of measures of self-reported adherence to home exercise programmes concluded there is no gold standard

measure.[60] Psychometric evaluation of commonly used self-reported measures of exercise adherence, and development of a validated standard outcome measure for adherence, should be a research priority.

CONCLUSION

In conclusion, this systematic review identified a small number of randomized controlled trials that evaluated whether interventions aimed at increasing adherence to therapeutic exercise increased adherence among older adults with chronic low back pain and/or hip/knee osteoarthritis. Meta-analysis provides moderate quality evidence for booster sessions with a physiotherapist improving patient adherence to therapeutic exercise in people with osteoarthritis. Individual high quality trials provide emerging evidence to support the use of patient motivational strategies and behavioural graded exercise to improve adherence to exercise in people with chronic low back pain and osteoarthritis. However, effect sizes for these interventions declined over time, to medium at best long-term.

Contributors: All authors were involved in study concept and design. PN and FD performed the literature search. PN, AVG and MH screened articles for eligibility. PN, AVG and FD evaluated the quality of included articles. PN wrote the first draft of this article. All authors revised the paper and provided scientific input. All authors approved the final manuscript. RH is the guarantor (the contributor who accepts full responsibility for the finished article, had access to all data and controlled the decision to publish).

Funding: PN is supported by a PhD stipend from the Medibank Health Research Fund. KB is supported by an NHMRC Principal Research Fellowship (#1058440). RH is supported by an Australian Research Council Future Fellowship (FT130100175). AVG is supported by an NHMRC program grant (#061887). MH is supported by the National Institute for Health Research (NIHR) School for Primary Care Research. The views expressed in this publication are those of the authors and not necessarily those of the National Health Service, the NIHR or the Department of Health.

Competing Interests: The authors declare no conflicts of interest.

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Figure legend

Figure 1 Flow chart showing selection of studies

Figure 2 Risk of bias summary showing review authors' judgments about each risk of bias domain of the Cochrane Risk of Bias Tool.

Figure 3 Forest plot of the mid- to long-term effect of booster sessions on self-rated adherence assessed using numeric rating scales.

Appendices

Appendix 1 PubMed search strategy