
Interventions to Improve Long-term Adherence to Physical Rehabilitation Among Those with Hip or Knee Osteoarthritis or Chronic Low Back Pain: A Systematic Review

June 2022

VA



U.S. Department of Veterans Affairs

Veterans Health Administration
Health Services Research & Development Service

Recommended citation: Seidler KJ, Rethorn ZD, Burke C, et al. Interventions to Improve Long-term Adherence to Physical Rehabilitation Among Those with Hip or Knee Osteoarthritis or Chronic Low Back Pain: A Systematic Review. Washington, DC: Evidence Synthesis Program, Health Services Research and Development Service, Office of Research and Development, Department of Veterans Affairs. VA ESP Project #09-101; 2022.

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This report was prepared by the Evidence Synthesis Program Center located at the Durham VA Medical Center, Durham, NC, directed by Jennifer M. Gierisch, PhD, MPH, and Karen M. Goldstein, MD, MSPH, and funded by the Department of Veterans Affairs, Veterans Health Administration, Health Services Research and Development.

The findings and conclusions in this document are those of the author(s) who are responsible for its contents and do not necessarily represent the views of the Department of Veterans Affairs or the United States government. Therefore, no statement in this article should be construed as an official position of the Department of Veterans Affairs. No investigators have any affiliations or financial involvement (eg, employment, consultancies, honoraria, stock ownership or options, expert testimony, grants or patents received or pending, or royalties) that conflict with material presented in the report.

PREFACE

The VA Evidence Synthesis Program (ESP) was established in 2007 to provide timely and accurate syntheses of targeted health care topics of importance to clinicians, managers, and policymakers as they work to improve the health and health care of Veterans. These reports help:

- Develop clinical policies informed by evidence;
- Implement effective services to improve patient outcomes and to support VA clinical practice guidelines and performance measures; and
- Set the direction for future research to address gaps in clinical knowledge.

The program comprises four ESP Centers across the US and a Coordinating Center located in Portland, Oregon. Center Directors are VA clinicians and recognized leaders in the field of evidence synthesis with close ties to the AHRQ Evidence-based Practice Center Program. The Coordinating Center was created to manage program operations, ensure methodological consistency and quality of products, interface with stakeholders, and address urgent evidence needs. To ensure responsiveness to the needs of decision-makers, the program is governed by a Steering Committee composed of health system leadership and researchers. The program solicits nominations for review topics several times a year via the [program website](#).

The present report was developed in response to a request from the Rehabilitation Research & Development Service (RR&D). The scope was further developed with input from Operational Partners (below), the ESP Coordinating Center, the review team, and the technical expert panel (TEP). The ESP consulted several technical and content experts in designing the research questions and review methodology. In seeking broad expertise and perspectives, divergent and conflicting opinions are common and perceived as healthy scientific discourse that results in a thoughtful, relevant systematic review. Ultimately, however, research questions, design, methodologic approaches, and/or conclusions of the review may not necessarily represent the views of individual technical and content experts.

ACKNOWLEDGMENTS

The authors are grateful to Liz Wing and Stacy Lavin for editorial and citation management support, and the following individuals for their contributions to this project:

Operational Partners

Operational partners are system-level stakeholders who help ensure relevance of the review topic to the VA, contribute to the development of and approve final project scope and timeframe for completion, provide feedback on the draft report, and provide consultation on strategies for dissemination of the report to the field and relevant groups.

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ABBREVIATIONS TABLE

Abbreviation	Definition
BCT	Behavior change technique
CBT	Cognitive behavior therapy
CI	Confidence interval
COE	Certainty of evidence
COM-B	Capability, opportunity, and motivation
ESP	Evidence Synthesis Program
GRADE	Grading of Recommendations Assessment, Development, and Evaluation
KOOS	Knee and Osteoarthritis Outcome Score
KQ	Key question
LBP	Low back pain
NRS	Numeric rating scale
OA	Osteoarthritis
OECD	Organisation for Economic Co-operation and Development
OR	Odds ratio
PRESS	Peer Review of Electronic Search Strategies
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta Analyses
PT	Physical therapy
ROB	Risk of bias
RR&D	Rehabilitation Research and Development
SD	Standard deviation
SEE	Self-Efficacy for Exercise Scale
SMD	Standardized mean difference
VHA	Veterans Health Administration
WOMAC	Western Ontario and McMaster Universities Osteoarthritis Index

EXECUTIVE SUMMARY

Key Findings

- We identified 10 studies that evaluated adjunct adherence-enhancing interventions: 6 were delivered concurrent to an index rehabilitation program and 4 were delivered sequentially.
- Most (7) studies targeted patients with knee and/or hip osteoarthritis.
- Of the 3 studies that reported a positive effect on long-term adherence, only 1 was a low risk of bias study.
- Only 1 study described the use of specific behavior change techniques and related theory for the explicit promotion of behavioral maintenance versus initiation of behavior change.
- There was often similarity in the behavior change techniques used in intervention and comparator groups, and no studies provided a rationale for this overlap.
- Identified adjunct adherence interventions do not appear to have a meaningful treatment effect of adjunct adherence interventions on long-term physical function, self-efficacy, or adverse events.

INTRODUCTION

Chronic pain, often caused by musculoskeletal dysfunction, results in billions of dollars in US health care spending annually. In the Veterans Health Administration, 25% of patients with musculoskeletal conditions receive care for low back pain (LBP) annually, and an additional 21% of Veterans receiving musculoskeletal care have osteoarthritis (OA). One approach to managing symptoms for individuals with chronic LBP or OA is physical rehabilitation, which uses clinician-prescribed, tailored exercise and activity. Despite the effectiveness of rehabilitation in reducing pain and disability, adherence to rehabilitation interventions has been measured to be as low as 13%. Poor adherence is a concern especially when the patient is no longer under direct clinical supervision.

Adjunct interventions have been proposed to address low rates of long-term adherence to musculoskeletal rehabilitation by targeting the maintenance of, rather than the initiation of, behavior changes required for long-term success. Examples of adjuncts include psychological interventions (*eg*, cognitive behavioral therapy and motivational interviewing) and performance feedback interventions (*eg*, coaching, peer support, activity tracking). However, it is currently unknown which of these adjunct interventions, and in what combinations, have the greatest impact on patient motivation, long-term adherence to rehabilitation, or ultimate physical function outcomes.

This review aims to evaluate the impact of physical rehabilitation interventions supplemented with 1 or more adherence-enhancing adjunct components, on the following outcomes among adults with hip or knee OA or chronic LBP: (1) adherence, (2) functional improvements, and (3) self-efficacy at ≥ 3 months after completing an index rehabilitation program. As part of our analysis, we seek to provide insights into how future interventions might be optimized through the selection of behavior change techniques (BCTs) that maximize patient benefit.

METHODS

Data Sources and Searches

We conducted a primary search from inception to July 27, 2021 in MEDLINE (via Ovid), CINAHL Complete (via EBSCO), and Embase (via Elsevier). We used database-specific controlled vocabulary as well as relevant keywords to search titles and abstracts.

Study Selection

In brief, eligible studies were randomized and non-randomized trials evaluating adherence-focused intervention components conducted in addition to usual care or usual-care-like physical rehabilitation programs among adults with hip or knee OA or chronic LBP. Studies were required to use a comparator arm featuring the same physical rehabilitation intervention without the adjunct adherence components, and to measure outcomes at least 3 months after the rehabilitation course.

All citations classified for possible inclusion based on title and abstract by at least 1 investigator underwent full-text review. Citations designated for exclusion by 1 investigator at the title-and-abstract level underwent screening by a second investigator. The study was excluded if both investigators agreed on exclusion. All articles reviewed during full-text review were evaluated independently by 2 investigators and all articles meeting eligibility criteria were included for data abstraction.

Data Abstraction and Assessment

Data elements included descriptors to assess applicability, quality elements, intervention details, and outcomes including adverse events. Study risk of bias (ROB) was assessed by the revised Cochrane Risk of Bias for randomized trials and cluster-randomized trials (RoB 2) and the ROBINS-I for non-randomized studies. Quality assessment was completed in duplicate by 2 investigators. Disagreements were resolved by consensus between those 2 investigators or, as needed, with arbitration by a third.

Synthesis

We summarized the following key study characteristics of the included studies: study design, patient demographics, details of the index rehabilitation program, adjunct adherence intervention and comparator, outcomes measures, and timing of outcomes assessment. We considered the feasibility of completing a quantitative synthesis (*ie*, meta-analysis) to estimate summary effects given the volume of relevant literature, conceptual homogeneity of the studies, and completeness of results reporting. We did not conduct a meta-analysis due to incomparability in intervention characteristics, outcome measures, and outcome timing. As an alternative, we report the standardized mean difference for studies reporting similar outcome categories using continuous data. Since meta-analysis was not feasible, we analyzed the data narratively by focusing on identifying patterns in efficacy across included studies by outcome category.

Since the follow-up time points of interest for this review are limited to outcomes ≥ 3 months after completing the rehabilitation program, we estimated the time point of each outcome as the time since the end of the rehabilitation program. In addition, for each included study, we coded the BCTs employed in all experimental and comparator arms using a BCT taxonomy derived

from included studies and any published protocols we identified. The certainty of evidence (COE) was assessed using the approach described by the Grading of Recommendations Assessment, Development, and Evaluation (GRADE) working group. These domains were considered qualitatively, and a summary rating was assigned after discussion as high, moderate, low, or very low COE.

RESULTS

Results of Literature Search

We identified 5,512 citations, of which 81 were reviewed at the full-text stage. Of these, 10 unique studies met eligibility criteria. There were 1 non-randomized trial, 2 cluster-randomized trials, and 7 randomized controlled trials. They were conducted in the United States, Canada, Australia, Europe, and Israel.

Summary of Results for Key Question

Intervention Characteristics

Of the 10 included studies, 6 delivered adjunct interventions concurrently to an index rehabilitation program, and 4 delivered adjunct interventions sequentially. Rehabilitation programs varied in type (eg, submaximal graded exercise program, strength training), duration (1.5–6 months), and number of sessions (median = 5, range = 2–156). Similarly, the adjunct interventions varied in content delivered (eg, mean = 5.5 BCTs, range = 2–15), duration (median = 6 months, range = 1–24), and number of contacts (median = 7, range = 2–42). Of the studies that reported the type of professional who delivered the adjunct intervention, all were physical therapists or similarly trained clinicians. Only 3 studies provided details of clinician training, and they addressed standard of care rather than intervention training. Five studies focused on populations with knee OA alone, 3 focused on LBP, 1 focused on hip OA, and 1 focused on both knee and hip OA.

Behavior Change Techniques

We identified BCTs described by each study across both comparator and intervention arms; none of the included studies commented on clinician knowledge about, familiarity with, or training specifically regarding BCTs. A total of 38 BCTs were identified across the included studies out of the 93 possible BCTs, representing 14 of the 16 BCT clusters. The number of BCTs in index rehabilitation programs ranged from 5 to 11 (mean = 8.8), while adherence interventions included 2 to 15 unique BCTs (mean = 6.2). BCTs included in the index rehabilitation programs generally reflect typical clinical practice using BCTs such as goal setting, instruction on how to perform a behavior, demonstration of the behavior, and behavioral practice/rehearsal. Adjunct interventions varied in complexity with 10 BCT clusters present in ≤ 3 adjunct adherence-enhancing interventions.

Outcomes of Interest

Adherence to prescribed home rehabilitation program

Ten studies reported on long-term adherence outcomes. Six of these studies evaluated the effect of concurrently delivered adjunct components on adherence to home rehabilitation and 4 studies evaluated sequentially delivered components. Overall, there was no evidence of benefit with

concurrently delivered adjunct interventions at 3 to 6 months (SMD range = 0.05–0.06) or 9 months and longer (SMD range = 0.06–0.20) among those studies with continuous outcome measures. Similarly, only 1 sequentially delivered intervention from a low ROB study reported beneficial effects among patients with knee OA at 9 months post-rehabilitation program (SMD = 0.42, 95% CI [0.02, 0.82]). There was no effect of the intervention across the other 4 studies at 3 to 6 months (SMD range = 0.18–0.42) and 9 months and longer (SMD = -0.12). When adherence is reported as percent completion of prescribed home rehabilitation, only 1 study showed a benefit of adjunct interventions (SMD = 0.50, 95% CI [0.09, 0.90]).

Physical function

All but 1 of the 10 included studies reported on function as an outcome to evaluate intervention impact. Five of these studies evaluated the effect of concurrently delivered adjunct components on physical function and 4 studies evaluated sequentially delivered components. Among concurrently delivered interventions, there was no evidence of benefit at 3 to 6 months (SMD range = -0.12– -0.02) or 9 months or longer (SMD range = -0.23–0.20). Similarly, there was no evidence of beneficial effect among sequentially delivered adjunct interventions at 3 to 6 months (SMD range = -0.04–0.02) or 9 months or longer (SMD range = -0.04–0.10). Of note, there was no evidence of intervention effect on function at 6 months for the 1 low-ROB study by Bennell et al that demonstrated improved adherence among participants receiving 24 weeks of sequentially delivered behavior change text messages.

Self-efficacy

Five studies reported self-efficacy for exercise or related constructs as an intermediate outcome of interest due to its role as an important determinant of long-term adherence. The 2 studies reporting validated measures of self-efficacy found no intervention effect.

Adverse events

Four studies reported adverse events associated with interventions to improve long-term adherence to rehabilitation programs. Overall, there was no evidence of increased adverse events among patients receiving adjunct adherence interventions.

DISCUSSION

Key Findings and Strength of Evidence

We found limited evidence of benefit across the included adjunct adherence-enhancing interventions on long-term adherence and no evidence of benefit on functional outcomes. Six adjunct interventions were delivered concurrently to an index rehabilitation program and 4 were delivered sequentially. Some health behavior models (*ie*, Precaution Adoption Process Model, Transtheoretical Model) suggest that initiation of physical therapy (PT) and long-term adherence to PT are conceptually distinct behaviors that require different skills and psychological processes for support. Designing interventions that disentangle behavioral initiation and maintenance (*ie*, sequential interventions) and target distinct content to support these behaviors may lead to improved results. Moreover, the majority of interventions from studies in our review included BCTs from clusters already represented in the comparator arm (such as goal setting, feedback and monitoring, and repetition and substitution). None of the included studies addressed a

rationale for this overlap, though only 1 study (Bennell et al 2020) specifically refers to the BCTs as a part of intervention development.

Of the 10 studies reporting adherence outcomes, 3 had evidence of a positive effect on the primary outcome of long-term adherence to recommended home rehabilitation programs across endpoints within included studies. However, when considering the difference in adherence at follow-up between intervention and comparator arms, only the study by Bennell et al had a beneficial effect on both measures of long-term adherence. Overall, based on GRADE criteria, we found low certainty of evidence that there is no effect of adjunct intervention components on adherence at 3 to 6 months or 9 months across concurrent and sequential intervention types.

All but 1 included study measured functional outcomes, and all used at least 1 established self-report measure of function. To evaluate sustained functional improvement, we considered the difference in change of function from the end of rehabilitation to follow-up. Overall, there was no evidence of intervention effect (low COE) at any time point regardless of the timing of the adjunct components.

Of the 5 studies reporting self-efficacy, only 2 used validated measures specifically related to self-efficacy of any type and found no effect of the intervention. Only 1 high ROB study found a significant difference using a non-validated measure assessing confidence-like attitudes. Four studies reported adverse events, though none found any difference in events by receipt of adjunct adherence interventions and most reported were minor musculoskeletal discomforts.

Applicability

While none of the included studies were conducted in the VA or specifically sought to include Veterans, the identified studies were conducted in settings *similar* to the VA Health Care System, and it is reasonable to expect similar outcomes from the Veteran population. In addition, the participants in the included studies are similar in age and comorbidities to Veterans cared for in the VA.

Future Research

We identified 5 key areas in which future research on this topic could fill existing gaps and/or improve the approach. First, future research seeking to promote long-term adherence to prescribed home rehabilitation programs should leverage theoretical/conceptual approaches to promoting behavioral maintenance (*ie*, beyond the initiation of behavior change) and should more generally be grounded in a sound theoretical/conceptual framework. Second, as current rehabilitation practice employs many behavior change techniques as part of standard of care, adherence-enhancing adjunct interventions should consider the use of different BCTs for promoting adherence to prescribed home exercise regimens and patient long-term outcomes. Third, adherence innovations could target both the rehabilitation provider and patient simultaneously and/or take advantage of the flexibility of virtual and/or asynchronous technology to improve long-term engagement. Fourth, the field would also benefit from well-described usual care comparators that define standards of care and identify any BCTs. Additionally, studies should include objective functional and adherence outcomes and validated measures of self-efficacy. Continued reporting of outcomes at least 6 months after the rehabilitation program would enable comparisons across studies. Lastly, research is needed on important subpopulations, including underrepresented racial and ethnic populations and younger

adults with knee and hip OA and LBP, to ensure that studied approaches are effective despite any distinct challenges and needs for incorporating long-term adherence strategies.

Conclusions

Long-term sustainment of functional improvements gained by short-term rehabilitation programs requires ongoing adherence to recommended home rehabilitation programs well past the end of direct clinical treatment. We found that there is inadequate evidence evaluating rigorously designed adherence-enhancing interventions for the specific promotion of long-term adherence to home rehabilitation programs. As long-term adherence represents a distinct behavioral target (*ie*, behavioral maintenance), future studies may want to consider testing interventions specifically built to target behavioral maintenance of home rehabilitation programs. Future development of interventions to promote long-term or sustained adherence to prescribed home rehabilitation programs could benefit from use of theoretically informed approaches and successful behavioral maintenance interventions for similar conditions. In the meantime, rehabilitation clinicians and referring providers should be aware that long-term commitment to prescribed home rehabilitation programs is necessary to realize ongoing health benefits.

EVIDENCE REPORT

INTRODUCTION

PURPOSE

The Evidence Synthesis Program (ESP) is responding to a request from the Rehabilitation Research and Development Service (RR&D). Findings from this review will be used to inform future research on adjunct interventions to promote long-term adherence to physical rehabilitation recommendations.

BACKGROUND

Chronic pain, with musculoskeletal dysfunction as a common cause, results in over \$600 billion of US health care spending annually—exceeding costs for other highly prevalent conditions like heart disease, cancer, and diabetes.¹ Chronic low back pain (LBP), specifically, fell into the highest category of national health care spending in 2016.² In the Veterans Health Administration (VHA), 25% of patients with musculoskeletal conditions receive care for LBP annually, and an additional 21% of Veterans receiving musculoskeletal care have osteoarthritis (OA). One approach to managing the symptoms of these chronic conditions is physical rehabilitation. Physical rehabilitation interventions use tailored exercise and activity to improve clinical outcomes for individuals with chronic LBP and OA, reducing pain and disability in these populations.^{3,4} Despite the effectiveness of rehabilitation, adherence to rehabilitation interventions has been measured as low as 13%. Poor adherence is a concern especially when the patient is no longer under direct clinical supervision.^{5,6}

Adjunct interventions have been proposed to address low rates of long-term adherence to musculoskeletal rehabilitation by targeting the maintenance of, rather than initiation of, behavior change required for long-term success.⁷ Examples of adjuncts include psychological interventions (*eg*, cognitive behavioral therapy and motivational interviewing) and performance feedback interventions (*eg*, coaching, peer support, activity tracking⁸). However, it is currently unknown which of these adjunct interventions have the greatest impact on patient motivation, long-term adherence to rehabilitation, or ultimate physical function outcomes. This is largely due to a pervasive disconnect between components of behavior change interventions and the underlying mechanisms of behavior change (capability, opportunity, and motivation).⁹ Thus, there is an opportunity to improve long-term patient rehabilitation outcomes by applying current behavior change science—codified in the standardized, evidence-based behavior change technique (BCT) taxonomy¹⁰—to the analysis and design of long-term adherence interventions.

Promoting long-term physical function and quality of life in Veterans through evidence-based practice is a core goal of the VHA, and improving long-term adherence to rehabilitation for those with chronic musculoskeletal conditions has the potential to significantly delay or prevent severe forms of disease and disability.¹¹ Thus, the aim of this review is to evaluate the impact of physical rehabilitation interventions supplemented with 1 or more adherence-focused adjunct components, on the following outcomes among adults with hip or knee OA or chronic LBP: (1) adherence, (2) functional improvements, and (3) self-efficacy at ≥ 3 months after completing an index rehabilitation program. As part of our analysis, we seek to provide insights into how future interventions might be optimized through the selection of BCTs that maximize patient benefit.

METHODS

TOPIC DEVELOPMENT

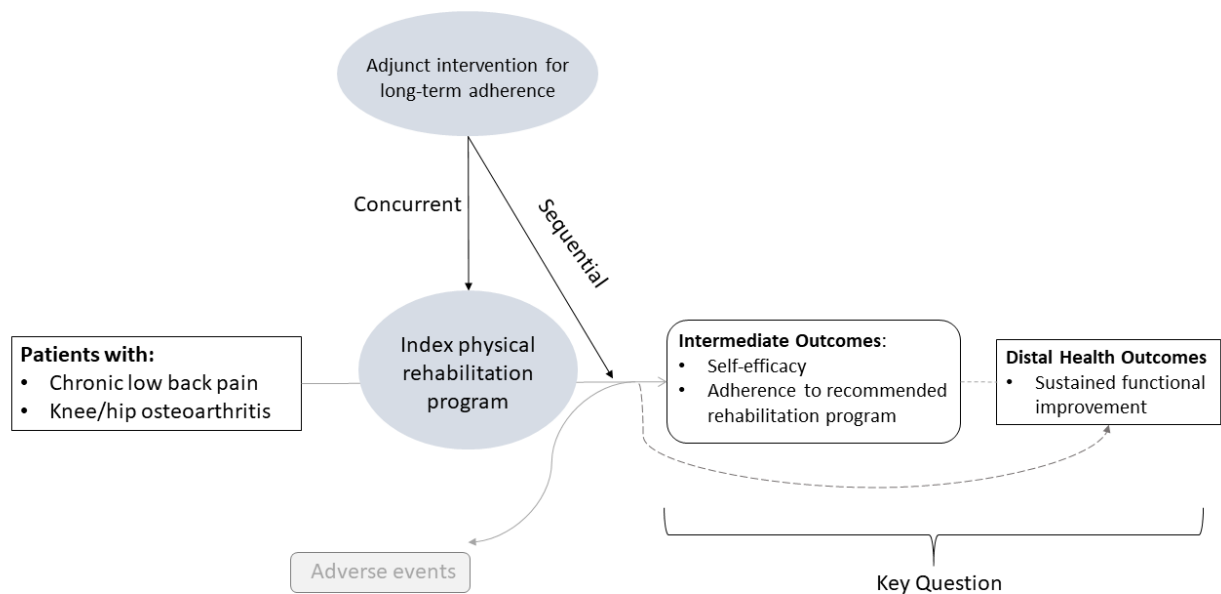
This topic was requested by the VA Rehabilitation Research & Development Service (RR&D). The findings from this review will be used to inform the development of a new request for applications on adjunct interventions that promote long-term adherence to physical rehabilitation recommendations. This review may also inform rehabilitation clinicians and program leadership who seek to improve the long-term outcomes for patients with chronic musculoskeletal pain and functional impairment.

KEY QUESTION

The following key question (KQ) was the focus of this review: *Among adults with hip/knee osteoarthritis or chronic low back pain, do physical rehabilitation interventions, supplemented with 1 or more adjunct components to promote adherence, improve self-efficacy, adherence, or sustained functional improvements at ≥ 3 months after completing the rehabilitation program?*

ANALYTIC FRAMEWORK

The analytic framework shown in Figure 1 provides a conceptual overview of this review. For adults with hip/knee OA or chronic LBP who engage in physical therapy and rehabilitation programs, the goal is to experience sustained functional improvements. It is generally thought that in order to sustain these functional improvements over time, patients need to demonstrate a long-term commitment to the practice of the prescribed home exercise program. However, long-term adherence to prescribed home exercise is often a struggle for many individuals. Thus, there is the potential for interventions that promote long-term adherence to be delivered as an adjunct to a standard rehabilitation program delivered either at the same time as the initial, or index, rehabilitation program (*ie*, concurrently) or after the end of the index program (*ie*, sequentially). An expected intermediate outcome of adjunct interventions that promote long-term adherence is increased self-efficacy to complete the home exercise program as prescribed. We also recognize that it is possible that there could be adverse effects from the addition of adjunct adherence interventions to rehabilitation programs, though we expect such effects to be rare. The analytic framework depicted in Figure 1 is a visual representation of the context for this report and highlights the intermediate and long-term outcomes of interest.

Figure 1. Analytic Framework

DEFINITIONS

To guide our review process and reporting of findings, we established the following definitions:

- Index rehabilitation program is the initial physical rehabilitation care (*ie*, active, structured physical activity or activities designed to reduce impairments and improve movement-related function) that is delivered, supervised, and/or monitored by a health care professional or other trained individual.
- Adjunct adherence-enhancing intervention is the supplemental component provided to the patient in addition to the index rehabilitation program (either concurrent with or sequential to) that is designed to promote long-term adherence to the prescribed home rehabilitation practice.

PROTOCOL

A preregistered protocol for this review can be found on the PROSPERO international prospective register of systematic reviews (<http://www.crd.york.ac.uk/PROSPERO/>; registration number CRD42021276794). There were no significant deviations after submission of this protocol. In addition, we followed the Preferred Reporting Items for Systematic Reviews and Meta Analyses (PRISMA) guideline.¹²

DATA SOURCES AND SEARCHES

To identify primary literature that addresses our key question, we conducted a primary search from inception to July 27, 2021, in MEDLINE (via Ovid), CINAHL Complete (via EBSCO), and Embase (via Elsevier). We used database-specific controlled vocabulary as well as relevant keywords to search titles and abstracts (see Appendix A for complete search strategies). To

ensure completeness, our search strategies were developed by an expert medical librarian (SC) with input on key terms from subject matter experts. We identified exemplar articles to use to test the integrity of our developed search strategy prior to executing across all databases. All search strategies were reviewed by a second medical librarian in accordance with the Peer Review of Electronic Search Strategies (PRESS) guideline.¹³

STUDY SELECTION

Studies identified through our primary search were classified independently by investigators for relevance to the KQ based on our eligibility criteria (Table 1). All citations classified for possible inclusion based on title and abstract by at least 1 investigator underwent full-text review. Citations designated for exclusion by 1 investigator at the title-and-abstract level underwent screening by a second investigator. The study was excluded if both investigators agreed on exclusion. All articles reviewed during full-text review were evaluated independently by 2 investigators, and all articles meeting eligibility criteria were included for data abstraction. All articles were tracked in both DistillerSR, a web-based data synthesis software program (Evidence Partners Inc., Manotick, ON, Canada), and EndNote reference management software (Clarivate).

Eligibility Criteria

Our review included studies that met the criteria shown in Table 1.

Table 1. Study Eligibility

	Inclusion	Exclusion
Populations	Adults (age 18 years+) with: <ul style="list-style-type: none"> • Hip or knee osteoarthritis (self-reported diagnosis, clinical criteria, or radiographic evidence) • Chronic low back pain (lasting ≥12 weeks)¹⁴ 	<ul style="list-style-type: none"> • <75% participants with hip or knee OA and/or chronic low back pain • Patients with OA of hip/knee who are within 12 months before or after joint surgery
Interventions	Physical rehabilitation interventions (<i>ie</i> , active, structured physical activity or activities designed to reduce impairments and improve movement-related function that is delivered, supervised, and/or monitored by a health care professional <i>or other trained individual</i>) that have an adjunct component(s) (embedded within initial physical rehabilitation) or are followed by component(s) (delivered after initial physical rehabilitation) designed to promote long-term adherence to the prescribed rehabilitation home practice including but not limited to the following approaches: <ul style="list-style-type: none"> • Feedback and monitoring (<i>eg</i>, use of activity monitors, automated text messages) • Social support (<i>eg</i>, peer coaches) • Incentives 	Interventions focused on adherence to prescribed activities during initial rehabilitation treatment only Interventions focused on perioperative rehabilitation for knee or hip replacement or other surgery

	Inclusion	Exclusion
	<ul style="list-style-type: none"> Psychologically informed interactions (eg, cognitive behavioral therapy, acceptance and commitment therapy, motivational interviewing) <p>Initial rehabilitation intervention must be delivered by trained individuals (in-person or virtual) with clearly stated profession (eg, PTs, kinesiotherapists, certified exercise physiologist, physiatrist [rehabilitation MD])</p> <p>Adherence-focused sessions/component delivered in addition to the core physical rehabilitation treatment may be delivered by individuals other than those who delivered the original physical rehabilitation treatment</p> <p>Interventions may involve caregiver, but primary target of intervention must be the patient</p>	
Comparators	Same initial physical rehabilitation intervention without the adjunct component or same initial physical rehabilitation with attention control instead of adjunct component	No comparator, other active comparator
Outcome	<p>Any of the following if measured at 3 or more months after the end of the initial rehabilitation intervention:</p> <ul style="list-style-type: none"> Self-efficacy to engage in home practice of physical rehabilitation outside of supervised physical rehabilitation Adherence to prescribed rehabilitation home practice <p>NOTE: <i>If study does not explicitly describe an intent to promote long-term adherence to rehabilitation home practice, it must measure <u>adherence</u> as an outcome.</i></p> <ul style="list-style-type: none"> Measures of physical function (including but not limited to WHO-DAS, FIM + FAM, 6-minute walk test) Adverse events (eg, falls, fractures, ED visits) 	Any outcomes without at least 1 of those listed under inclusion
Setting	<p>Initial physical rehabilitation intervention: clinic or home-based</p> <p>Adjunct component: in-person, home-based, remotely delivered)</p>	Inpatient settings
Timing	At least 2 contacts for initial physical rehabilitation intervention	Not applicable

	Inclusion	Exclusion
Study design	<ul style="list-style-type: none"> • Randomized trials • Non-randomized trials 	<ul style="list-style-type: none"> • Not a clinical study (<i>eg</i>, editorial, letter to an editor) • Uncontrolled clinical study • Qualitative studies • Prospective or retrospective observational studies • Systematic review/meta-analysis • Clinical guidelines • Measurement or validation studies
Countries	OECD ^a	Non-OECD
Publication types	Full publication in a peer-reviewed journal	Letters, editorials, reviews, dissertations, meeting abstracts, protocols without results

Notes. ^a OECD includes Australia, Austria, Belgium, Canada, Chile, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Korea, Latvia, Luxembourg, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Turkey, the United Kingdom, and the United States.

Abbreviations. ED=emergency department; FIM + FAM=Functional Independence Measure and Functional Assessment Measure; OA=osteoarthritis; OECD=Organisation for Economic Co-operation and Development; PT=Physical Therapist; WHO-DAS=World Health Organization Short Disability Assessment Schedule.

DATA ABSTRACTION AND ASSESSMENT

Data from published reports were abstracted into a customized DistillerSR database by 1 reviewer and over-read by a second reviewer. Disagreements were resolved by consensus. Abstracted data elements included participant descriptors (*eg*, age, sex, race/ethnicity, Veteran status), intervention characteristics (*eg*, interventionist profession, duration of index rehabilitation program, content and mode of both index rehabilitation program and adjunct component, whether adjunct component was delivered concurrently or in series to the initial index rehabilitation treatment course), comparator, and outcomes (*eg*, which outcome was identified as the primary outcome of the study). Multiple published reports analyzing data obtained from a single study were treated as a single data point with the most relevant results drawn across reports. When critical data were missing or unclear in published reports, we requested supplemental data from the study authors. For details of study characteristics, see Appendix B. Appendix C presents details of the intervention characteristics. Appendix D lists excluded studies and the reason for exclusion.

Quality assessment was completed in duplicate by 2 investigators (the investigator who abstracted the included article and the investigator who over-read the abstraction data). Disagreements were resolved by consensus between those 2 investigators or, as needed, by arbitration by a third investigator. We used the revised Cochrane Risk of Bias for randomized trials and cluster randomized trials (RoB 2)¹⁵ and the ROBINS-I for non-randomized studies.¹⁶ The domains for the RoB 2 include (1) bias arising from randomization process; (2) deviations from intended intervention; (3) missing outcome data; (4) bias in measurement of the outcome; and (5) bias in selection of the reported results. Overall risk of bias (ROB) judgments included low ROB, some concerns, and high ROB. Cluster-randomized studies were evaluated additionally for bias arising from the timing of identification and recruitment of individual

participants in relation to timing of randomization. The ROBINS-I includes domains for (1) confounding; (2) participant selection; (3) intervention classification; (4) deviations from intended interventions; (5) missing data; (6) outcome measurement; and (7) selective outcome reporting. Overall ROB judgments included low ROB, serious ROB, critical ROB, and no information.

SYNTHESIS

First, we summarized the following key study characteristics of the included studies: study design, patient demographics, details of the index rehabilitation program, adjunct adherence intervention and comparator, outcomes measures, and timing of outcomes assessment. We considered the feasibility of completing a quantitative synthesis (*ie*, meta-analysis) to estimate summary effects. For meta-analyses, feasibility depends on the volume of relevant literature, conceptual homogeneity of the studies, and completeness of results reporting. Because of incomparability in intervention characteristics (*eg*, training for physical therapists in communication skills vs text message exercise reminders to patients) and delivery methods (*eg*, in-person vs automated), as well as inconsistency in outcome measurement, we did not conduct meta-analyses.

As an alternative to meta-analyses, we calculated the standardized mean difference (SMD) for studies reporting similar outcome categories (*eg*, functional status using a validated tool) when possible. Standardized mean differences for functional outcomes were calculated as the difference in mean change from the end of rehabilitation program between arms (intervention minus control) divided by the pooled standard deviation across the arms. When mean change was not reported by a study, we used difference between means at 2 time points and considered 0.5 correlation between measurements at these 2 time points to compute standard deviation of change. When values at the end of the rehabilitation program were not directly provided by a study, we computed these values based on the baseline mean values and reported mean change from baseline. Standardized mean differences for adherence outcomes were calculated as difference between arms (intervention minus control) at the time of follow-up measurement divided by the pooled standard deviation across the arms.

The follow-up timepoints of interest for this review are limited to outcomes at ≥ 3 months after completing the index rehabilitation program. We estimated the time point of each outcome measurement as time since baseline minus the time since end of the rehabilitation program (*eg*, data at 6 months after baseline is the same as data collected 3 months after a 3-month intervention). In cases where the study performed a second round of randomization after the end of the rehabilitation program and before implementation of adjunct adherence components, outcome time points are not changed, as baseline and end of the rehabilitation program are the same.

Because quantitative synthesis was not feasible, we analyzed data narratively through descriptive approaches that identify patterns in key outcomes, comparators, intervention approaches, and other study characteristics. We gave more weight to the evidence from higher quality studies with more precise estimates of effect. The narrative synthesis focused on documenting and identifying patterns in efficacy across included studies by outcome category (*ie*, adherence, functional status, self-efficacy, and adverse events). We analyzed potential reasons for

inconsistency in treatment effects across studies by evaluating differences in the study population, intervention, comparator, and outcome definitions.

In addition, for each included study, we coded BCTs used in all experimental and control arms using a BCT taxonomy (v1)¹⁰ derived from information presented in included studies and any published protocols we identified. Two experienced reviewers (KS and ZR) independently coded each study for BCTs. Any discrepancies were resolved through discussion. A third author (KG) was consulted if needed.

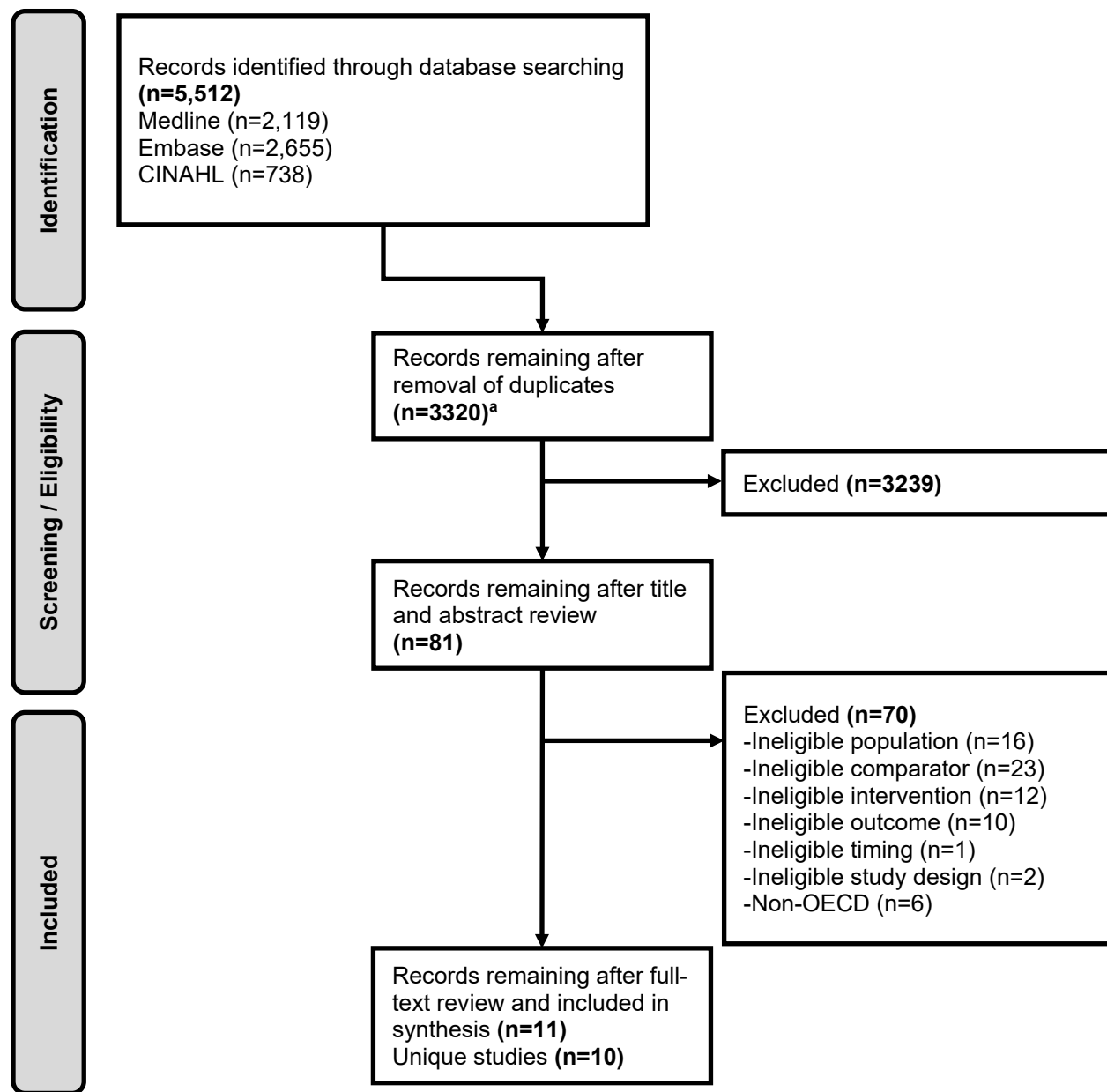
Finally, the certainty of evidence (COE) was assessed using the approach described by the Grading of Recommendations Assessment, Development, and Evaluation (GRADE) working group.¹⁷ GRADE criteria require assessment of 4 domains: risk of bias, consistency, directness, and precision. Additional domains to be used when appropriate are coherence, dose-response association, impact of plausible residual confounders, strength of association (magnitude of effect), and publication bias. These domains were considered qualitatively, and a summary rating was assigned after discussion by a group of investigators (ZR, KS, KG, AG) as high, moderate, low, or very low COE. Randomized and non-randomized designs were not combined per GRADE guidance. Studies reporting dichotomous outcomes were not combined with studies reporting continuous outcomes.

RESULTS

LITERATURE FLOW

The literature flow diagram (Figure 2) summarizes the results of the study selection process (full list of excluded studies available in Appendix D).

Figure 2. Literature Flowchart



Notes. ^a Search results from Medline (2,108), Embase (1,111), and CINAHL (101) were combined.

LITERATURE OVERVIEW

Our search identified 3,320 potentially relevant articles. After removing duplicates, there were a total of 3,320 articles. After applying inclusion and exclusion criteria to titles and abstracts, 81 articles remained for full-text review. Of these, 11 studies (10 unique) were retained for data abstraction, including 1 non-randomized trial, 2 cluster randomized trials, and 7 randomized controlled trials. None were conducted in the VA. The studies were conducted in the United States (1), Canada (1), Australia (3), Europe (4), and Israel (1) (Table 2).

Table 2. Evidence Profile of Included Studies

<p>Number of studies: 11 studies (10 unique interventions)</p> <p>Study Designs: Cluster randomized controlled trial (n=2); Individual randomized controlled trial (n=7); non-randomized controlled trial (n=1)</p> <p>Number of participants: 1,964</p> <p>Countries: Europe (n=4); Australia (n=3); USA (n=1); Canada (n=1); Israel (n=1)</p> <p>Patient demographics (median): age = 62 years old; women (63%); White (74%) (6 studies not reported), Black (2.3%) (9 studies not reported)</p> <p>Conditions: Knee osteoarthritis (n=5); Low back pain (n=3); Hip osteoarthritis (n=1); Knee and Hip osteoarthritis (n=1)</p> <p>BCT components: Mean number of BCTs per index rehabilitation program = 8.8 (range 5 BCTs to 11 BCTs) and mean number of BCTs per adherence adjunct intervention= 6.2 (range 2 BCTs to 15 BCTs)</p> <p>Duration of index rehabilitation program: Median duration was 3 months (range 1 month to 12 months)</p> <p>Duration of adherence adjunct: Median duration was 6 months (range 1 month to 24 months)</p> <p>Intervention timing: Concurrent (n=6); Sequential (n= 4)</p> <p>Risk of bias: Low (n=4); Some concerns (n=2); High (n=4)^a; Serious (n=1)^b</p>
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Notes. ^a One study was evaluated as low risk of bias for objectively measured outcomes and high risk of bias for patient reported outcomes.¹⁸ ^b ROBINS-I tool was used to evaluate the non-randomized controlled trial.¹⁹

Abbreviations. BCT=behavior change technique.

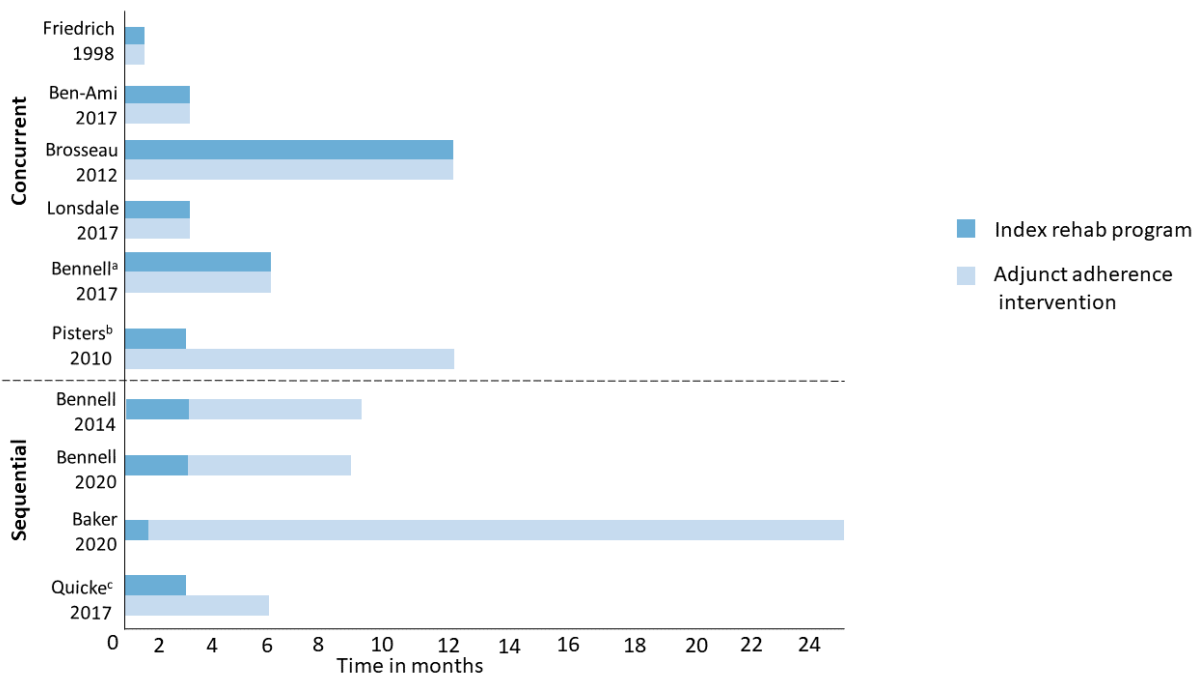
MAIN FINDINGS

Key Points

- We identified 10 studies evaluating adjunct adherence interventions: 6 delivered concurrently to an index rehabilitation program and 4 delivered sequentially.
- Most studies targeted patients with knee and/or hip OA (7 studies).
- There was often similarity in the behavior change techniques used in intervention and comparator groups, and no studies provided a rationale for this overlap.
- Included studies were generally small and only 5 articulated a specific intent to promote long-term adherence.
- Of the 3 studies that reported a positive effect on long-term adherence, only 1 was a low ROB study.
- Included studies with notable limitations showed no meaningful treatment effect on long-term physical function.

Intervention Characteristics

Of the 10 unique studies included in this review, 4 featured a sequentially delivered adjunct adherence intervention²⁰⁻²³ and 6 were delivered concurrently to the index rehabilitation program^{18,19,24-27} (Figure 3). All but 1 study¹⁸ included some form of traditional physical therapy as the index rehabilitation program, though they varied in duration (1.5 to 6 months) and type (eg, submaximal graded exercise program, strength training). The number of physical rehabilitation sessions (median = 5, range = 2–156) also varied widely across the included studies. The duration of individual sessions and dose actually delivered to patients (eg, sessions attended) were not regularly reported in these studies. Five studies^{18,20,21,24,26} explicitly focused on improving adherence to rehabilitation or home practice or reported adherence as a primary outcome. Five adjunct interventions^{18,20-22,25} were conducted at least partially remotely (eg, telephone, text message). No studies reported using video for adjunct adherence support. The median duration of the adjunct component was 6 months (range = 1–24 months) and the number of sessions ranged from 2 to 42 with a median of 7 sessions. All but 1 study¹⁸ reported the profession of the provider delivering the adjunct adherence intervention, and all were physical therapists or similarly trained clinicians. Little detail was provided about the training or experience of interventions. Below, we describe the concurrent and sequential adjunct interventions in more detail.

Figure 3. Timing of Rehabilitation and Adjunct Interventions

Notes. ^a Participants in the intervention could receive up to 6 extra coaching telephone sessions after the end of the index rehabilitation program. ^b The adjunct components were intentionally different during the same timeframe as the rehabilitation program and determined to be concurrent. ^c The majority of the unique adjunct components were delivered after the rehabilitation program was completed.

Concurrently Delivered Adjunct Adherence Interventions

Three concurrently delivered adjunct interventions targeted chronic LBP, 2 focused on knee OA alone, and 1 studied hip and/or knee OA.^{19,24,27} All 3 studies focused on the treatment of chronic LBP, included specific provider training, or offered treatment approaches as an integrated component of the index rehabilitation program. Specifically, they provided communication training for physical therapists based on self-determination theory²⁴ (a transtheoretical, model-informed rehabilitation counseling intervention¹⁹) and a motivational program co-delivered with a standard rehabilitation program.^{27,28} Two concurrent interventions for patients with hip or knee OA were aligned with more traditional rehabilitation programs. One provided 6 CBT-informed telephone counseling sessions as a supplement during—and then up to an 6 additional sessions after—a standard progressive individualized home rehabilitation program.²⁵ The other provided a behavioral-graded activity intervention with an additional 7 booster sessions beyond the end of the index rehabilitation program.²⁶ Finally, 1 knee OA program consisted of a supervised community walking program supplemented by concurrent group sessions focused on goal setting and support provision.¹⁸

Sequentially Delivered Adjunct Adherence Interventions

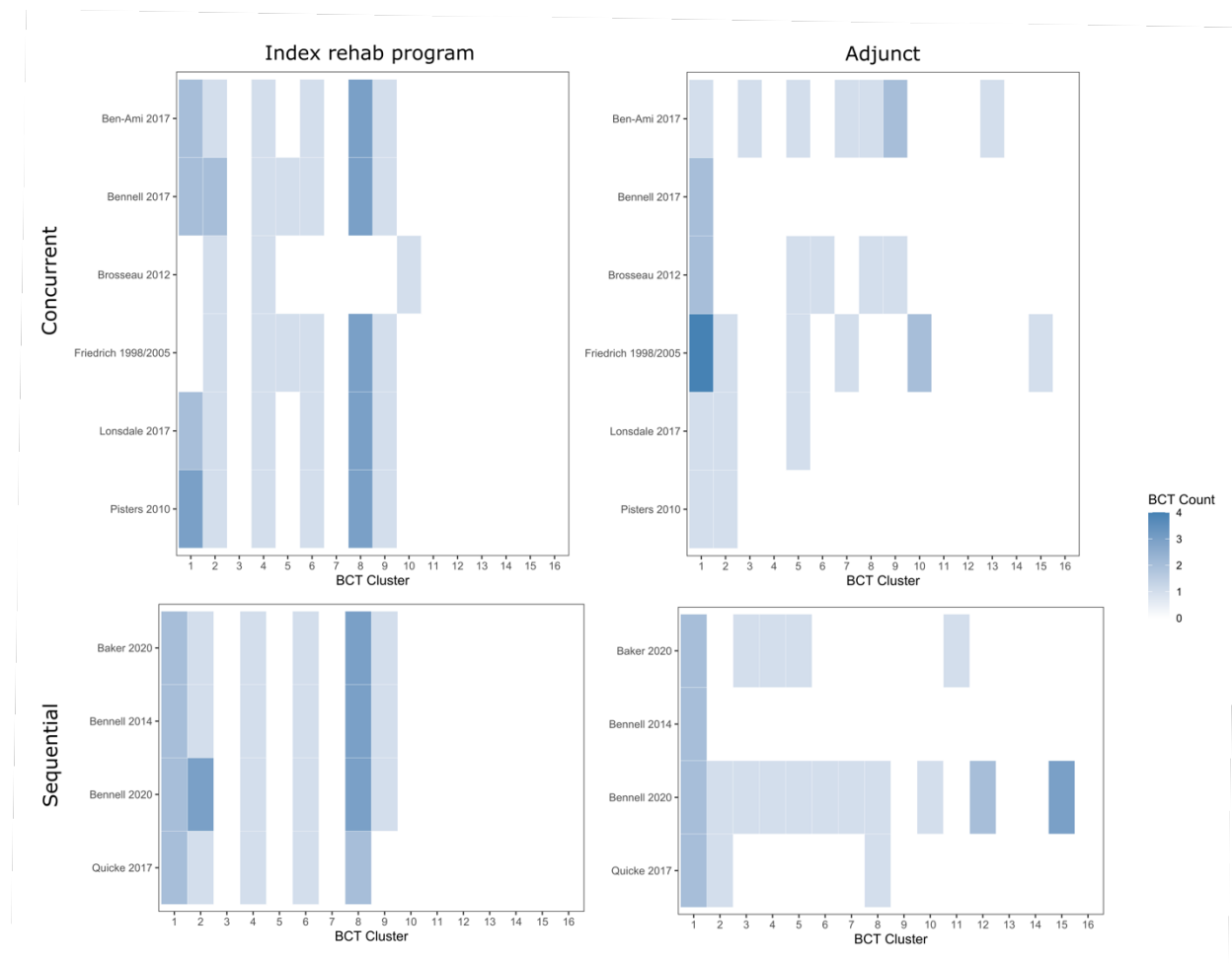
All 4 sequentially delivered adjunct adherence intervention studies targeted patients with knee OA. Two with the same lead author were developed as add-on studies recruiting participants who had completed prior physical therapy trials;^{20,23} the first provided 2 additional booster physical therapy (PT) sessions over the 24 weeks after index rehabilitation,²³ and the second provided 24 weeks of automated, semi-interactive text messages after index rehabilitation.²⁰

Baker et al²¹ provided monthly motivational adherence counseling calls for 18 months after a run-in period of a strength training rehabilitation program, and Quicke et al provided an adherence toolkit including tools for self-monitoring and follow-up adherence sessions.²² See Appendix C for additional intervention details.

Behavior Change Techniques

We identified BCTs targeting adherence to prescribed physical rehabilitation interventions for each study, including for both the intervention and comparator arms (Appendix F). A total of 38 of the total 93 BCTs from the BCT taxonomy (v1)¹⁰ were identified across the included studies, representing 14 of the 16 BCT clusters (see Appendix G). The number of BCTs in comparator arms ranged from 5 to 11 (mean = 8.8 BCTs), while intervention groups included 2 to 15 unique BCTs (mean = 6.2). Bennell et al²⁰ had the most unique BCTs in the adjunct adherence-enhancing intervention (15), followed by Friedrich et al²⁷ (10) (Figure 4). Of note, Bennell et al²⁰ was the only included study that specifically mentioned incorporation of BCTs and related theory during intervention development. BCTs commonly included in index rehabilitation programs reflect typical clinical practice (examples include goal setting, instruction on how to perform a behavior, demonstration of the behavior, and behavioral practice/rehearsal). Though 14 of 16 BCT clusters were represented across all 10 included studies, 10 BCT clusters were present in ≤ 3 adjunct adherence-enhancing interventions. Adjuncts that demonstrated improved long-term adherence tended to have more unique BCTs compared to those that did not improve adherence. Adjuncts that were delivered concurrently likewise tended to have fewer BCTs than those that were delivered sequentially. Across all included studies, little detail was available about how BCTs were operationalized within the clinical encounters.

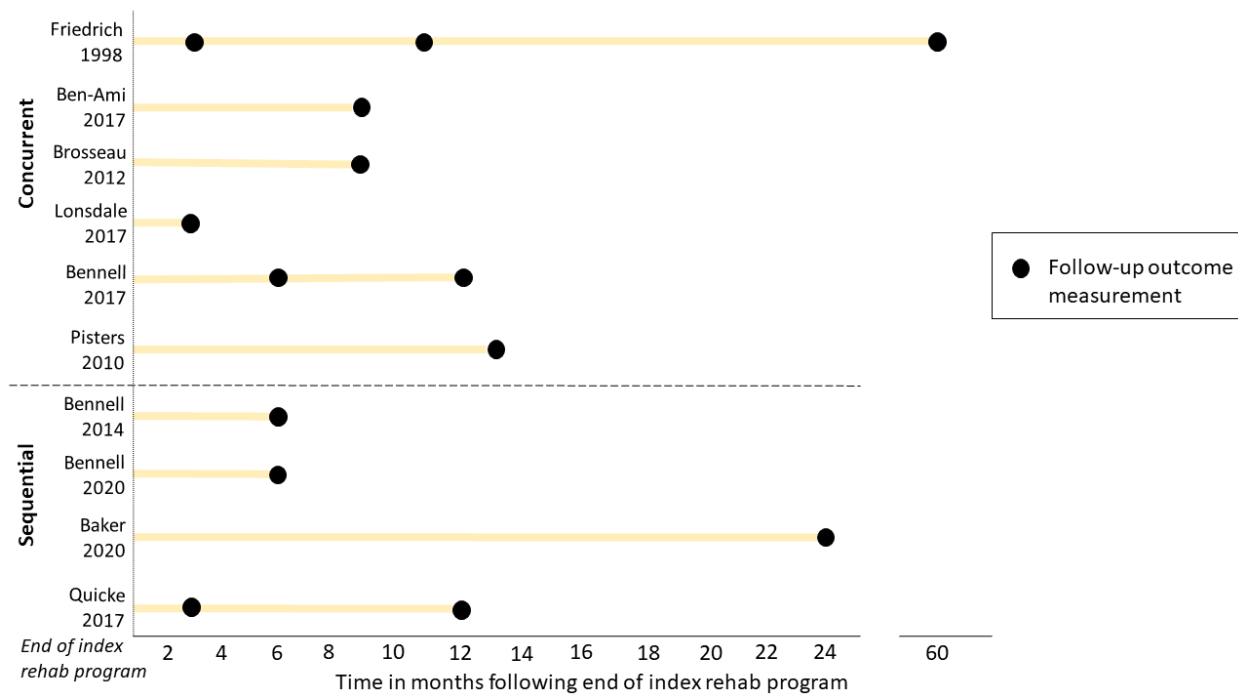
Figure 4. Heatmap of BCTs Identified in Index Rehabilitation Programs and Adjunct Adherence Interventions



Notes. Behavior change techniques (BCTs) were categorized by count in each cluster and are presented in colors ranging from white to blue as shown in the key. BCT domains: 1. Goals and planning, 2. Feedback and monitoring, 3. Social support, 4. Shaping knowledge, 5. Natural consequences, 6. Comparison of behavior, 7. Associations, 8. Repetition and substitution, 9. Comparison of outcomes, 10. Reward and threat, 11. Regulation, 12. Antecedents, 13. Identity, 14. Scheduled consequences, 15. Self-belief, 16. Covert learning.

KEY OUTCOMES OF INTEREST

Included studies measured outcomes at a variety of time points. In Figure 5, we depict the timing of outcomes by study in relationship to the end of the index rehabilitation program in order to emphasize sustainment of outcome effects. For the rest of the results section, we refer to follow-up time points in this manner unless stated otherwise. Note that the primary study publications did not necessarily label assessment time points in this way. One study²³ reported standard deviation (SD) as a direct measure of change. For all other studies, we computed SDs of change from after treatment to follow-up assuming correlation of 0.5 between after-treatment SD and follow-up SD. For 2 studies,^{19,24} we used mean change from baseline to after treatment and the baseline mean (and corresponding SDs) to compute after-treatment mean change and SDs (assuming 0.5 correlation between baseline and after-treatment measurements). For 1 study, we assumed the number of participants after 12 months of follow-up was the same as the number of participants reported at the end of treatment, as the exact number was not specified.²²

Figure 5. Timeline of Outcome Reporting

Adherence to Prescribed Home Rehabilitation Program

Ten studies reported on long-term adherence outcomes.¹⁸⁻²⁷ Adherence to the prescribed home rehabilitation program was measured in multiple ways. Only 2 studies employed validated adherence scales; specifically, Ben-Ami et al used the Baecke PA questionnaire,¹⁹ and Bennell et al 2020 used the Exercise Adherence Rating Scale.²⁰ An additional 6 studies reported adherence using unvalidated numeric rating scales (ranging from 5 to 11 points), though the specific prompt varied (Table 3).²⁰⁻²⁵ Six studies assessed self-reported adherence through variations in percent completion of the prescribed home rehabilitation program or physical activity.^{18,20,22-25} One study reported the proportion of adherent participants per study arm,²⁶ and 1 study reported the number of weeks participants reported being adherent after completion of the index rehabilitation program.²⁷ Adherence was measured at time points ranging from 3 months to 5 years after completion of the index rehabilitation program. Six studies measured adherence at only 1 relevant time point (ranging from 3 to 24 months after the end of the index rehabilitation program).^{18-21,23,24}

Next, we report findings for adherence outcomes across studies that evaluated the effect of concurrent and then sequentially delivered adjunct interventions.

Concurrently Delivered Adjunct Adherence Interventions (N = 6)

Six studies evaluated the effect of concurrently delivered adjunct interventions reported on adherence to prescribed home rehabilitation programs.^{18,19,24-27} Overall, there was no evidence of benefit with concurrently delivered adjunct interventions at 3 to 6 months (SMD range = 0.05–0.06) or 9 months and longer (SMD range = 0.06–0.20) among those studies with continuous outcome measures (Figures 6, 7, 8). The 1 low-ROB study by Bennell et al (2017) evaluated the concurrent delivery of 6 telephone-delivered coaching sessions with up to 6 additional sessions

delivered after index rehab.²⁵ Authors found no significant difference in adherence between intervention and comparator at 6 months post-rehab or 12 months as measured by self-rated adherence by NRS or percent prescribed home exercises completed. Lonsdale et al, the largest (albeit a high ROB) study with 207 participants with chronic LBP, found no effect of communication skills training for physical therapists on adherence at 3 months.²⁴ Finally, another serious-ROB study by Ben-Ami et al reported a mean difference of 0.7 (95% CI [0.07, 1.3]) on the validated Baecke Physical Activity Questionnaire (range = 1–5; higher = greater activity level) from baseline (pre-index rehab program) to 12 months post-baseline for patients with chronic LBP who had received a 3-month enhance transtheoretical model intervention versus usual care PT.¹⁹ However, when the mean difference between arms at 9 months post-index rehabilitation was considered, there was no significant treatment effect (SMD = 0.20, 95% CI [-0.09, 0.48]; Figure 7).

Pisters et al, a study with some concerns for ROB, reported adherence as a dichotomous outcome (*ie*, being adherent to prescribed rehabilitation or not).²⁶ Authors evaluated 18 sessions of a behavioral rehabilitation program followed by 7 booster sessions compared to 18 sessions of usual PT care among 200 patients with hip/knee OA and reported a greater odds of participants being adherent to prescribed rehabilitation in the intervention group compared with usual care at 13 months post-index rehabilitation (OR = 3.0, 95% CI [1.5, 6.0]). The other concurrent studies not included in the forest plot were a high ROB studies.^{18,28} One that reported similar means across study arms for adherence at 3 months, 11 months, and 5 years.²⁷ One reported no evidence of significant benefit at 9 months (Table 3).¹⁸

Sequentially Delivered Adjunct Adherence Interventions (N = 4)

Four studies (2 low, 1 some concerns, and 1 high ROB) with sequentially delivered adherence interventions reported adherence outcomes.²⁰⁻²³ Overall, one low ROB study reported beneficial effects. Bennell et al, evaluated the effect of 24 weeks of automated, semi-interactive text messages delivered after index rehabilitation on adherence as measured by the validated Exercise Adherence Rating Scale (score range = 0–24; higher = better adherence) among 110 patients with knee OA.²⁰ They found higher rates of adherence at 6 months post-index rehabilitation with a mean difference of 3.1 (95% CI [0.8, 5.5]) and a mean difference of 0.6 (95% CI [0.2, 1.0]) additional days that home rehabilitation was completed in the last week. This translated to an SMD of 0.42 (95% CI [0.02, 0.82]). The other low ROB study, Bennell et al (2014), evaluated the sequential delivery of 2 PT booster sessions on 74 participants with knee OA over 24 weeks after index rehabilitation and found no significant effect on adherence (SMD = 0.18, 95% CI [-0.28, 0.63]).²³

Of the other 2 studies with sequentially delivered interventions, 1 had some concerns for ROB,²² and 1 had high ROB.²¹ They reported no evidence of significant benefit at 24 months (Table 3).²¹

Table 3. Adherence to Prescribed Home Rehabilitation Program

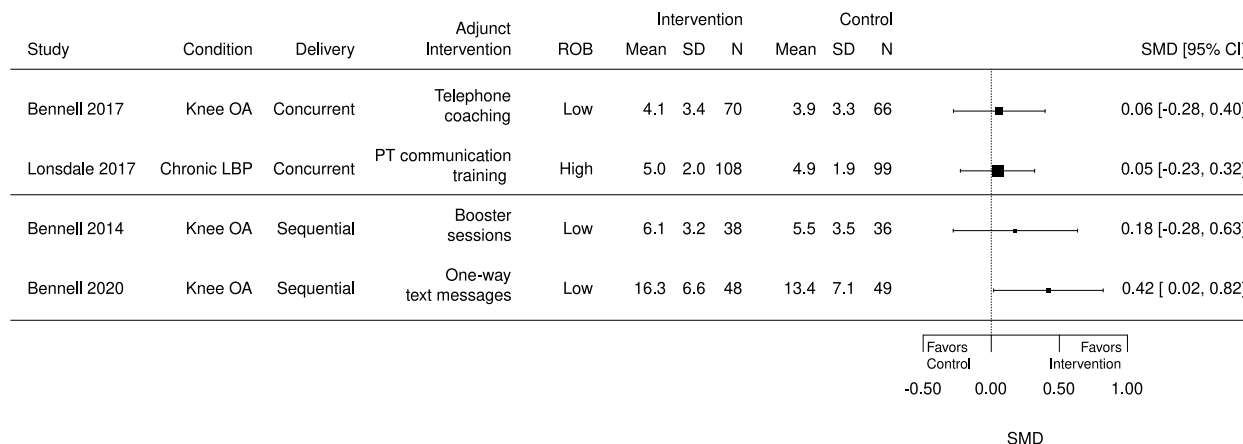
Study Risk of Bias	Time After End of Rehabilitation Program	Outcome
<i>Concurrent</i>		
Bennell, 2017 ²⁵ Low ROB	6 months	<p><i>Home rehabilitation adherence (percentage of prescribed sessions completed)</i></p> <p>Intervention mean = 42% (95% CI [34, 50]) Comparator mean = 39% (95% CI [31, 48]) Mean difference = 2% (95% CI [-10%, 14%])</p> <p><i>Self-rated home rehabilitation adherence into NRS</i></p> <p>Intervention mean = 4.1 (95% CI [3.3, 4.9]) Comparator mean = 3.9 (95% CI [3.1, 4.7]) Mean difference = 0.2 (95% CI [-0.8, 1.3])</p>
	12 months	<p><i>Home rehabilitation adherence (percentage of prescribed sessions completed)</i></p> <p>Intervention mean = 39% (95% CI [31, 46]) Comparator mean = 37% (95% CI [28, 46]) Mean difference = 1% (95% CI [-10, 12])</p> <p><i>Self-rated home rehabilitation adherence into NRS</i></p> <p>Intervention mean = 3.8 (95% CI [3.1, 4.6]) Comparator mean = 3.6 (95% CI [2.9, 4.4]) Mean difference = 0.2 (95% CI [-0.8, 1.2])</p>
Pisters, 2010 ²⁶ Some concerns about ROB	13 months	<p><i>Self-rated questionnaire - adherence to rehabilitation</i></p> <p>Intervention: 46/79 Comparator: 24/72 OR = 3.0 (95% CI [1.5, 6.0])</p> <p><i>Self-rated questionnaire - adherence to activities</i></p> <p>Intervention = 32/71 Control = 17/54 OR = 1.8 (95% CI [0.8, 3.8])</p>
Brosseau, 2012 ¹⁸ High ROB	9 months	<p><i>Number of attended walking sessions/ number of prescribed sessions</i></p> <p>Intervention mean = 0.445 (SD = 0.433) Comparator mean = 0.446 (SD = 0.441) Mean difference = NR, <i>p</i>-value = 0.989</p>

Study Risk of Bias	Time After End of Rehabilitation Program	Outcome
Ben-Ami, 2017 ¹⁹	Estimated at 9 months	Baecke Physical Activity Questionnaire (BPAQ)
Serious ROB		Intervention mean = 0.8 (95% CI [0.4, 1.3]) Comparator mean = 0.1 (95% CI [-0.3, 0.6]) Mean difference = 0.7 (95% CI [0.07, 1.3])
Friedrich, 1998 ²⁷	3 months	<i>Treatment compliance after termination of the treatment program in weeks</i>
Companion: Friedrich 2005 ²⁸		Intervention mean = 10.6 (SD = 2.7) Comparator mean = 10.3 (SD = 2.9) Mean difference = NR
High ROB	11 months	<i>Treatment compliance after termination of the treatment program in weeks</i>
		Intervention mean = 28.8 (SD = 18.5) Comparator mean = 30.1 (SD = 20.5) Mean difference = NR
	5 years	<i>Years that rehabilitation program was performed regularly</i>
		Intervention mean = 3.5 (SD = 2.0) Comparator mean = 4.4 (SD = 2.2) Mean difference = NR
Lonsdale, 2017 ²⁴	3 months	<i>Specific adherence to back rehabilitation at home (percentage of prescribed sessions completed per week)</i>
High ROB		Mean difference = 2.57 (95% CI [-6.05, 11.19])
		<i>Home based adherence (self-reported overall adherence to their physiotherapists' recommendations using 7-point rating scales)</i>
		Mean difference = 0.35 (95% CI [-0.13, 0.83])
<i>Sequential</i>		
Bennell, 2014 ²³	6 months	<i>Self-reported adherence to home rehabilitation</i>
Low ROB		Intervention mean = 6.1 (SD = 3.2) Comparator mean = 5.5 (SD = 3.5) Mean difference = 0.6, <i>p</i> -value > 0.05
		<i>Home rehabilitation sessions completed</i>
		Intervention mean = 56% (SD = 34) Comparator mean = 51% (SD = 37) Mean difference = NR, <i>p</i> -value > 0.05

Study Risk of Bias	Time After End of Rehabilitation Program	Outcome
Bennell, 2020 ²⁰	6 months	<i>Exercise Adherence Rating Scale (EARS)</i>
Low ROB		Intervention mean = 16.3 (SD = 6.6) Comparator mean = 13.4 (SD = 7.1) Mean difference = 3.1 (95% CI [0.8, 5.5]) <i>Number of days home rehabilitation completed in the past week</i> SMS Intervention mean = 1.9 (SD = 1.2) Comparator mean = 1.3 (SD = 1.2) Mean difference = 0.6 (95% CI [0.2, 1.0])
Quicke, 2017 ²²	3 months	<i>"Been doing exercises as often as advised" (n (%))</i>
Some concerns about ROB		Targeted rehabilitation adherence arm: Strongly agree = 22 (17%); Agree = 72 (57%); Not sure = 14 (11%); Disagree = 17 (13%); Strongly disagree = 2 (2%) Usual care arm: Strongly agree = 15 (11%); Agree = 48 (36%); Not sure = 23 (17%); Disagree = 36 (27%); Strongly disagree = 11 (8%)
	12 months	<i>"Been doing exercises as often as advised" (n (%))</i>
		Targeted rehabilitation adherence arm: Strongly agree = 18 (15%); Agree = 42 (36%); Not sure = 22 (19%); Disagree = 25 (21%); Strongly disagree = 10 (9%) Usual care arm: Strongly agree = 12 (9%); Agree = 50 (37%); Not sure = 17 (13%); Disagree = 42 (31%); Strongly disagree = 13 (10%)
Baker, 2020 ²¹	24 months	<i>"How would you rate your level of adherence to the prescribed BOOST exercise program over the last 3 months?"</i>
High ROB		Intervention mean = 3.63 (95% CI [2.70, 4.56]) Control mean = 4.01 (95% CI [3.03, 4.99]) Mean difference = -0.38 (95% CI [-1.67, 0.91])

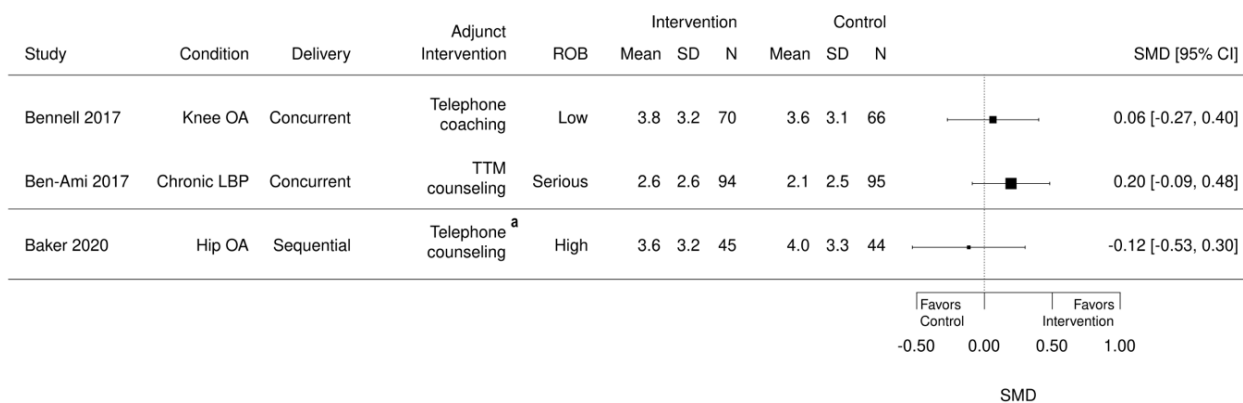
Abbreviations. NR=not reported; NRS=numeric rating scale; OR=odds ratio; ROB=risk of bias; SD=standard deviation.

Figure 6. Forest Plot of Adherence Outcomes at 3 to 6 Months



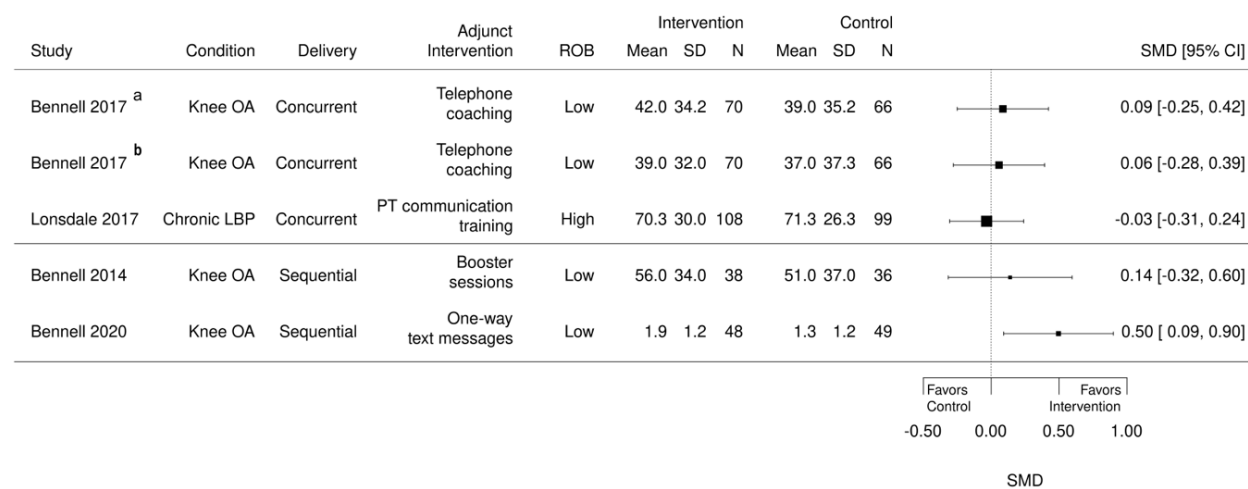
Notes. Bennell 2017 outcomes reported at 6 months after end of rehabilitation; Lonsdale 2017 outcomes reported at 3 months after end of rehabilitation; Bennell 2014 outcomes reported at 6 months after end of rehabilitation; Bennell 2020 outcomes reported at 6 months after end of rehabilitation.

Figure 7. Forest Plot of Adherence Outcomes at 9+ Months



Notes. Bennell 2017 outcomes reported at 12 months after end of rehabilitation; Ben-Ami 2017 outcomes reported at approximately 9 months after end of rehabilitation; Baker 2020 outcomes reported at 24 months after end of rehabilitation. ^a Computer-based telephone counseling.

Figure 8. Forest Plot of Adherence Outcomes as Percent of Prescribed Rehabilitation



Notes. Lonsdale 2017 outcomes reported at 3 months after end of rehabilitation; Bennell 2014 outcomes reported at 6 months after end of rehabilitation; Bennell 2020 outcomes reported at 6 months after end of rehabilitation. ^a Bennell 2017 outcomes reported at 6 months after end of rehabilitation. ^b Bennell 2017 outcomes reported at 12 months after end of rehabilitation.

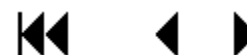
Physical Function

All but 1¹⁸ of the 10 included studies reported on function as an outcome to evaluate intervention impact. Across the studies, function was assessed by several established self-reported outcome measures including the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC)—a well-validated, self-report measure for individuals with OA with a functional status subscale,^{21-23,25} the Roland-Morris Disability Questionnaire for back pain,^{19,24} the Knee and Osteoarthritis Outcome Score (KOOS) functional subscale,²⁰ and the low back outcome score.²⁷ Two studies reported both self-reported function and objective measures of function including several indicators of strength and flexibility in key lower extremity muscle groups.^{21,27} As noted above for adherence outcomes, function was assessed at a range of time points spanning from 3 months to 5 years from the end of the index rehabilitation program. Functional status was considered the primary outcome or co-primary outcome in 4 studies.^{19,22,23,25}

For functional outcomes, we considered the difference in change from end of index to follow-up between study arms. For *concurrently* delivered adherence adjunct interventions, function was typically reported as baseline (pre-index rehabilitation) to follow-up; thus, we calculated the mean difference in change from end of rehabilitation to follow-up from reported data when possible.

Concurrently Delivered Adjunct Adherence Interventions (N = 5)

Among the 5 concurrently delivered adherence adjunct interventions^{19,24-27} that measured function as an outcome, 4 were rated to have high or serious ROB.^{19,24,25,27} Pisters et al²⁶ was rated to have some concerns for ROB and reported functional status via the indirect assessment of meeting physical activity recommendations among participants with hip or knee OA who received usual physiotherapy with or without an adjunct intervention informed by operant conditioning and self-regulation principles. They reported a higher proportion of individuals in



the intervention arm achieved rehabilitation goals versus the comparator arm at both end of index rehabilitation (OR = 5.3, 95% CI [1.9, 14.8]) and 12 months after end of index rehabilitation (OR = 2.9, 95% CI [1.2, 6.7]). Of the 4 high/serious ROB studies, only 1 reported a positive intervention effect. Ben-Ami et al found a significant intervention benefit for difference in change of functional status as measured by the Roland-Morris Disability Questionnaire from pre-index rehabilitation program to 9 months post-index rehabilitation (change in mean difference = 2.7, 95% CI [0.9, 4.5]).¹⁹ This falls below the estimated clinically meaningful difference of 3–5-point threshold.²⁹ Finally, 2 papers from Friedrich et al report on a single high ROB study that examined the addition of a motivational counseling intervention to a submaximal graded rehabilitation program and found better performance on the fingertip-to-floor distance test at 3 months after the end of intervention in the motivation adjunct group that was not sustained at 11 months.^{27,28} See Table 4 for additional details. However, when considering mean change from end of index rehabilitation to follow-up as measured by SMD, there was no evidence of benefit among concurrently delivered adjunct interventions at 3–6 months (SMD range = -0.12– -0.02). At 9 months or longer, SMDs were generally larger, but were more inconsistent than at earlier timepoints and were nonsignificant (SMD range = -0.23–0.20) (Figures 9 and 10).

Sequentially Delivered Adjunct Adherence Interventions (N = 4)

Four studies delivered adjunct adherence interventions after the end of the index rehabilitation program and also measured functional outcomes.²⁰⁻²³ By design, sequentially delivered trials evaluated effect as a mean difference from intervention baseline (*ie*, end of index rehabilitation) to follow-up time point. There was no evidence of significant treatment effect at 3 to 6 months (SMD range = -0.04–0.02) across 2 low ROB studies and one with some concerns (Figure 9). Similarly, there was no evidence of significant treatment effect at 9 months or longer (SMDs = -0.04 and 0.10) in 1 high ROB study and 1 study with some concerns for ROB (Figure 10). Of note, there was no evidence of intervention effect on function at 6 months for the 1 low ROB study by Bennell et al that demonstrated improved adherence among participants receiving 24 weeks of sequentially delivered behavior change text messages.²⁰

Table 4. Physical Function Results

Study Risk of Bias	Time After End of Rehabilitation Program	Outcome
<i>Concurrent</i>		
Bennell, 2017 ²⁵	6 months	<i>Western Ontario and McMaster Universities Osteoarthritis Index (function subscale)</i>
Low ROB		
		Intervention mean at end of rehabilitation = 52.6 (SD = 16.3) Comparator mean at the end of rehabilitation = 48.8 (SD = 16.4)
		Intervention mean = 13.3 (SD = 10.5) Comparator mean = 17.4 (SD = 11.9)
		Mean difference = 3.9 (95% CI [-0.3, 8.2]) ^a SMD (change from end of treatment) = -0.05 (95% CI [0.39, 0.28])

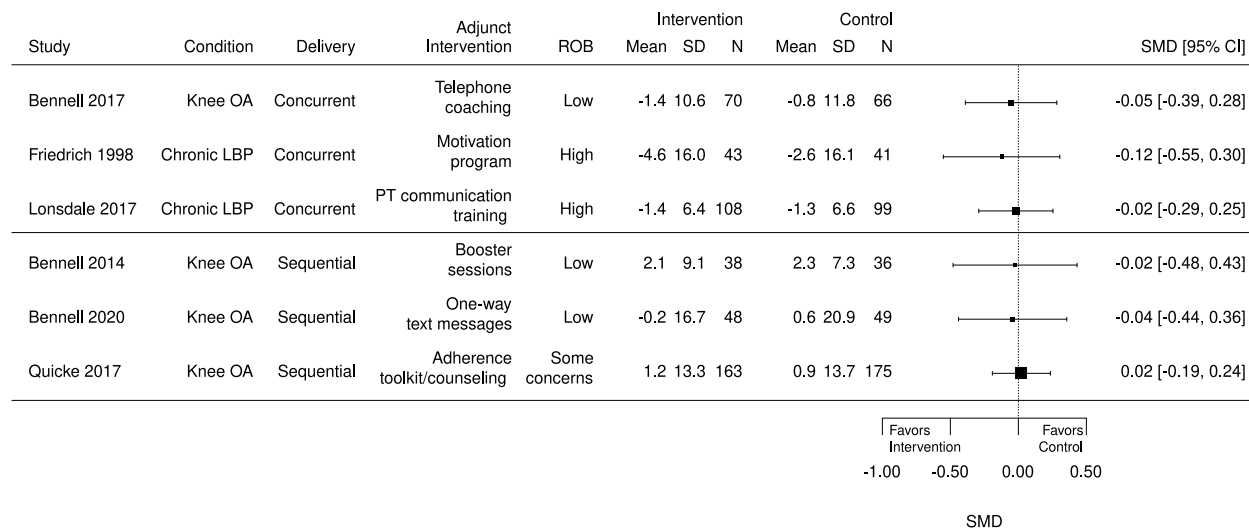
Study Risk of Bias	Time After End of Rehabilitation Program	Outcome
	12 months	<p><i>Western Ontario and McMaster Universities Osteoarthritis Index (function subscale)</i></p> <p>Intervention mean at end of rehabilitation = 52.6 (SD = 16.3) Comparator mean at the end of rehabilitation = 48.8 (SD = 16.4)</p> <p>Intervention mean = 12.2 (SD = 10.5) Comparator mean = 16.4 (SD = 11.7)</p> <p>Mean difference = 3.9 (95% CI [-1.0, 8.7])^a SMD (change from end of treatment) = -0.06 (95% CI [-0.41, 0.28])</p>
Pisters, 2010 ²⁶	13 months	<p><i>Meeting recommendations for physical activity</i></p> <p>Intervention = 76/87 Comparator = 67/92 OR = 2.9 (95% CI [1.2 to 6.7])</p>
Some concerns about ROB		
Ben-Ami, 2017 ¹⁹	Estimated at 9 months	<p><i>Roland-Morris Disability Questionnaire</i></p> <p>Intervention change in mean from baseline = 6.7 (95% CI [5.4, 8.0]) Comparator change in mean from baseline = 4.0 (95% CI [2.7 to 5.2])</p> <p>Change in mean difference = 2.7 (95% CI [0.9, 4.5]) SMD (change from end of treatment) = 0.20 (95% CI [-0.09, 0.49])</p>
Serious ROB		
Friedrich, 1998 ²⁷	3 months	<p><i>Low back outcome score</i></p> <p>Intervention mean = 57.2 (SD = 15.7) Comparator mean = 51.0 (SD = 15.7) Mean difference = NR</p>
Companion: Friedrich 2005 ²⁸		
High ROB		
	11 months	<p><i>Fingertip to floor distance</i></p> <p>Intervention mean = 8.6 (SD = 18.6) Comparator mean = 16.6 (SD = 18.4) Mean difference = NR, <i>p</i>-value = 0.01</p> <p>SMD (change from end of treatment) = -0.12 (95% CI [-0.55, 0.30])</p> <p><i>Fingertip to floor distance</i></p> <p>Intervention mean = 4.3 (SD = 6.1) Comparator mean = 10.1 (SD = 13.0) Mean difference = NR, <i>p</i>-value = 0.052</p> <p><i>Low back outcome score</i></p> <p>Intervention mean = 58.9 (SD = 12.6) Comparator mean = 50.9 (SD = 18.7)</p>

Study Risk of Bias	Time After End of Rehabilitation Program	Outcome
		Mean difference = NR
		SMD (change from end of treatment) = -0.23 (95% CI [-0.70, 0.24])
	5 years	<i>Disability</i> Intervention mean = NR Comparator mean = NR Mean difference = NR
		Intervention arm showed greater improvement in disability vs control between 12 months and 5 years (p -value = 0.003)
Lonsdale 2017 ²⁴ High ROB	3 months	<i>Roland-Morris Disability Questionnaire</i> Intervention mean = NR Comparator mean = NR
		Difference in change from baseline intervention vs Comparator = 0.09 (95% CI [-1.43, 1.6]) SMD (change from end of treatment) = -0.02 (95% CI [-0.29, 0.25])
<i>Sequential</i>		
Bennell, 2014 ²³ Sequential Low ROB	6 months	<i>Western Ontario McMaster Universities Osteoarthritis Index (function subscale)</i> Intervention mean = 20.2 (SD = 12.4) Comparator mean = 21 (SD = 12.3) Mean difference = -0.3 (95% CI [-0.4, 3.5]) ^b
		SMD (change from end of treatment) = -0.02 (95% CI [-0.48, 0.43])
Bennell, 2020 ²⁰ Sequential Low ROB	6 months	<i>Function Knee Injury and Osteoarthritis Outcome Score (KOOS) function subscale</i> Intervention mean = 72.4 (SD = 17.6) Comparator mean = 70 (SD = 21.1) Mean difference = -0.2 (95% CI [-6.7, 6.3]) ^b
		SMD (change from end of treatment) = -0.04 (95% CI [-0.44, 0.36])
Quicke, 2020 ²² Sequential Some concerns about ROB	3 months	<i>Western Ontario McMaster Universities Osteoarthritis Index (function subscale)</i> Intervention mean = 22.7 (SD = 13.3) Comparator mean = 22.3 (SD = 13.3) Mean difference = -0.7 (95% CI [-3.3, 1.9]) ^a
		SMD (change from end of treatment) = 0.02 (95% CI [-0.19, 0.24])
	12 months	<i>Western Ontario McMaster Universities Osteoarthritis Index (function subscale)</i>

Study Risk of Bias	Time After End of Rehabilitation Program	Outcome
		Intervention mean = 23 (SD = 14.4) Comparator mean = 21.5 (SD = 14.4) Mean difference = 0.4 (95% CI [-2.6, 3.3]) ^a SMD (change from end of treatment): 0.10 (95% CI [-0.11, 0.31])
Baker, 2020 ²¹ Sequential	24 months	<i>Western Ontario McMaster Universities Osteoarthritis Index function subscale</i> Intervention mean = 12.74 (95% CI [9.78, 15.69]) Comparator mean = 13.09 (95% CI [9.76, 16.43]) Mean difference = -0.46 (95% CI [-4.84, 3.93]) ^b SMD (change from end of treatment) = -0.04 (95% CI [-0.46, 0.37]) <i>Quad strength</i> Intervention mean = 0.30 (95% CI [0.27, 0.34]) Comparator mean = 0.32 (95% CI [0.28, 0.35]) Mean difference = 0.02 (95% CI [-0.01, 0.05]) <i>Hamstring strength</i> Intervention mean = 0.15 (95% CI [0.13, 0.17]) Comparator mean = 0.16 (95% CI [0.14, 0.18]) Mean difference = 0.00 (95% CI [-0.02, 0.02]) <i>Timed up and go test (seconds)</i> Intervention mean = 7.45 (95% CI [6.91, 8.00]) Comparator mean = 7.71 (95% CI [6.71, 8.71]) Mean difference = -0.19 (95% CI [-1.13, 0.75]) <i>Repeated chair stands (5 times, seconds)</i> Intervention mean = 13.43 (95% CI [12.40, 14.45]) Comparator mean = 13.40 (95% CI [12.50, 14.31]) Mean difference = -0.12 (95% CI [-1.55, 1.31]) <i>Stair climb (seconds)</i> Intervention mean = 13.72 (95% CI [12.14, 15.30]) Comparator mean = 13.53 (95% CI [11.11, 15.94]) Mean difference = 0.31 (95% CI [-1.81, 2.43])

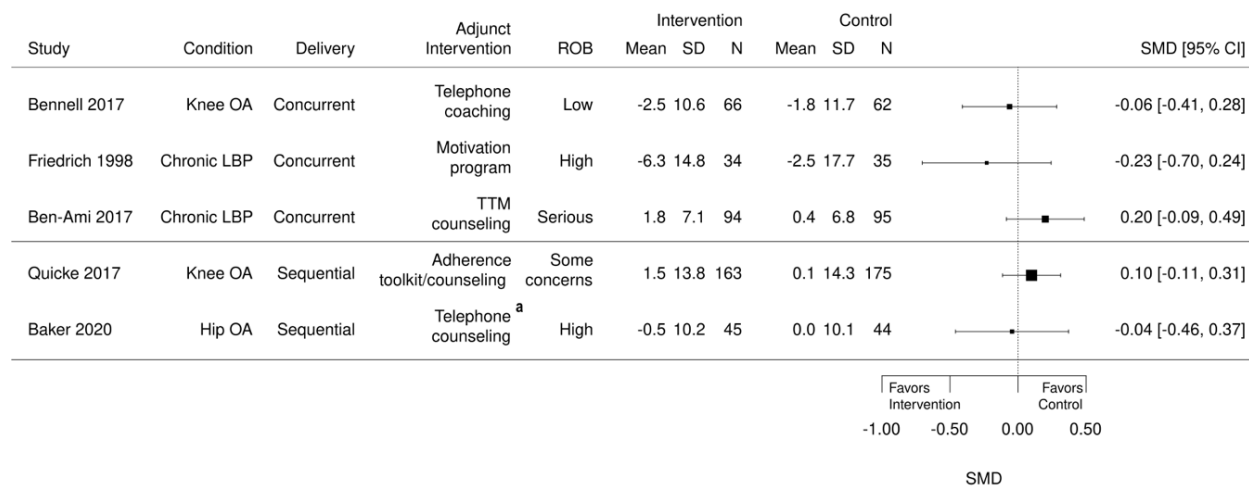
Notes. ^a Change from pre-rehabilitation baseline to follow-up. ^b Change from post-rehabilitation baseline to follow-up.
 Abbreviations. NR=not reported; NRS=numeric rating scale; OR=odds ratio; ROB=risk of bias; SD=standard deviation; SMD=standardized mean difference.

Figure 9. Forest Plot of Physical Function Outcomes at 3 to 6 Months



Notes. Bennell 2017 outcomes reported at 6 months after end of rehabilitation; Friedrich 1998 outcomes reported at 3 months after end of rehabilitation; Lonsdale 2017 outcomes reported at 3 months after end of rehabilitation; Bennell 2014 outcomes reported at 6 months after end of rehabilitation; Bennell 2020 outcomes reported at 6 months after end of rehabilitation; Quicke 2017 outcomes reported at 3 months after end of rehabilitation.

Figure 10. Forest Plot of Physical Function Outcomes at 9 Months



Notes. Bennell 2017 outcomes reported at 12 months after end of rehabilitation; Friedrich 1998 outcomes reported at 11 months after end of rehabilitation; Ben-Ami 2017 outcomes reported approximately 9 months after end of rehabilitation; Quicke 2017 outcomes reported at 12 months after end of rehabilitation; Baker 2020 outcomes reported at 24 months after end of rehabilitation. ^a Computer-based telephone counseling.

Self-Efficacy

Five studies reported on self-efficacy for exercise or related constructs as an intermediate outcome of interest due to its role as an important determinant of long-term adherence. Two of the 4 studies measuring self-efficacy were delivered concurrently^{18,24} and 2 were delivered sequentially.^{20,22} One additional study with a concurrent intervention²⁷ reported on motivation, a distinct but related construct that, for the purpose of this review, is reported here. In all 5 studies, self-efficacy was reported as a secondary outcome (Table 5).



Concurrently Delivered Adjunct Adherence Interventions (N = 3)

All 3 concurrent studies reporting self-efficacy-related constructs had high ROB. The Lonsdale²⁴ study examined 2 subdomains: “autonomous motivation to follow recommendations” (subdomain of the Treatment Self-Regulation Questionnaire) and “controlled motivation to follow recommendations” (subdomain of the Treatment Self-Regulation Questionnaire) among patients with chronic LBP and found no significant intervention effect. The Friedrich²⁷ study reported motivation towards exercise therapy via selected questions from a Psychotherapy Motivation Questionnaire and found no significant difference.

The third concurrent¹⁸ study examined the “confidence about doing things” and “coping with symptoms” subdomains of the Stanford Questionnaire on Chronic Disease among patients with knee OA and reported a significantly improved “confidence about doing things” at 6 months post-index rehabilitation in the intervention group (a behavioral adjunct intervention delivered concurrently to a supervised walking intervention) versus walking intervention alone ($p = 0.041$).

Sequentially Delivered Adjunct Adherence Interventions (N = 2)

Both sequential studies (1 with some concerns for ROB²² and 1 low ROB²⁰) utilized validated measures for self-efficacy: Self-Efficacy for Exercise Scale (SEE), which they used to measure a participant’s “confidence in ability to exercise,”²² and the Arthritis Self-Efficacy Scale (ASES), which breaks down self-efficacy as it relates to “pain,” “function,” and “other.”²⁰ Bennell et al (2020) found no evidence of treatment effect on any of the subdomains at 24 weeks after index rehab program. Quicke et al²² reported no statistically significant change within or between treatment arms.

Table 5. Self-efficacy Results

Study Risk of Bias	Time After End of Rehabilitation Program	Outcome
<i>Concurrent</i>		
Brosseau, 2012 ¹⁸	6 months	<i>Stanford questionnaire on chronic disease; coping with symptoms subdomain</i>
High ROB		Intervention mean = 1.388 (SD = 0.856) Comparator mean = 1.064 (SD = 0.952) p -value = 0.286
	6 months	<i>Stanford questionnaire on chronic disease; confidence about doing things subdomain</i>
		Intervention mean = 7.546 (SD = 1.848) Comparator mean = 7.690 (SD = 1.920) p -value = 0.041
Friedrich, 1998 ²⁷	Estimated at 9 months	<i>Attitude towards exercise therapy</i>
Companion: Friedrich 2005 ²⁸		Intervention mean = 6.3 (SD = 1.6) Comparator mean = 5.6 (SD = 2.1)
High ROB		

Study Risk of Bias	Time After End of Rehabilitation Program	Outcome
Lonsdale 2017 ²⁴	3 months	<i>Autonomous motivation to follow recommendations</i>
High ROB		Mean difference = -0.10 (95% CI [-0.35, 0.16]), <i>p</i> -value = 0.41
	3 months	<i>Controlled motivation to follow recommendations</i>
		Mean difference = -0.15 (95% CI [-0.69, 0.38]), <i>p</i> -value = 0.57
<i>Sequential</i>		
Bennell, 2020 ²⁰ Sequential	6 months	<i>Arthritis Self-Efficacy Scale (ASES)</i>
Low ROB		<i>Self-efficacy: pain</i> Intervention mean = 6.6 (SD = 2.2) Comparator mean = 6.4 (SD = 2.1) Difference in change from baseline between groups = -0.4 (95% [CI -1.2, 0.4])
		<i>Self-efficacy: function</i> Intervention mean = 8.3 (SD = 1.5) Comparator mean = 8.2 (SD = 1.7) Difference in change from baseline between groups = 0.1 (95% CI [-0.5, 0.7])
Quicke, 2020 ²² Sequential	3 months	<i>Self-Efficacy for Exercise (SEE)</i>
Some concerns about ROB		Intervention mean = 5.7 (SD = 2.2) Comparator mean = 5.4 (SD = 2.3) Mean difference = 0.4 (95% CI [0.8, -0.2])

Abbreviations. ROB=risk of bias; SD=standard deviation.

Adverse Events

Four studies reported adverse events associated with interventions to improve long-term adherence to rehabilitation programs^{20,22,23,25} Overall, there was no evidence of increased adverse events among patients receiving adjunct adherence interventions (Table 6).

Bennell et al (2014)²³ determined adverse events by questionnaire at the end of a 24-week adjunct intervention of 2 booster PT sessions after an index rehabilitation program. They reported few adverse events; specifically, 6 participants reported increased knee pain (4 intervention vs 2 control) and 1 participant from the control group reported increased hip pain.

A second study by Bennell et al (2017)²⁵ collected adverse event reports prospectively through log sheets collected every 3 months for an adjunct telephone coaching intervention delivered concurrently to an index rehabilitation program. They reported that adverse events occurred primarily during intervention delivery and were infrequent during the post-treatment follow-up period. During the treatment phase, 21 of 84 participants from the intervention arm reported 23 adverse events, compared with 21 of 84 participants in the comparator arm reporting 27 adverse events. The most common event was increased knee pain (17 or 26% intervention vs 16 or 23%

comparator). Other adverse events were reported less frequently, including pain in other regions, swelling/inflammation, and increased stiffness. Adverse events were less frequent during the follow-up period from the end of the index intervention to 12 months post-end of index, when 7 intervention participants reported 8 adverse events and 12 comparator participants reported 13 events. Similarly, increased knee pain was most frequent.

A third study by Bennell et al (2020)²⁰ considered adverse events to be “any problem participant believed was caused by advice received and required them to seek treatment or take medication and/or interfered with function for ≥ 2 days.” They found no difference in overall adverse events between arms (16% sequentially delivered behavioral change text message intervention vs 15% usual care, $p = 0.53$), for knee pain (9% vs 6%, $p = 0.38$), or pain in other areas (7% vs 9%, $p = 0.48$).

Quicke et al²² reported 2 adverse events in the arms of interest for this review; 1 participant in the comparator arm had a twisted ankle, and 1 in the sequential monitoring intervention arm had a fall while walking. Of note, the authors reported expected soreness and transient increases in pain among 12% of intervention participants and 19% of comparator participants.

Table 6. Adverse Events Results

Study Risk of Bias	Time After End of Rehabilitation Program	Outcome
<i>Concurrent</i>		
Bennell, 2017 ²⁵	12 months	<i>Number of adverse events during treatment phase</i>
Low ROB		Total number: Intervention = 7 (11%) Comparator = 2 (19%) Increased knee pain: Intervention = 5 (8%) Comparator = 9 (15%) Pain in other region: Intervention = 2 (3%) Comparator = 4 (6%) Swelling/Inflammation: Intervention = 1 (2%) Comparator = 0 (0%)
<i>Sequential</i>		
Bennell, 2014 ²³	6 months	<i>Adverse events</i>
Low ROB		Increased knee pain: Intervention = 4 Comparator = 2

Study Risk of Bias	Time After End of Rehabilitation Program	Outcome
		Increased hip pain: Intervention = 0 Comparator = 1
Bennell, 2020 ²⁰ Sequential	6 months	<i>Any adverse event</i>
Low ROB		Intervention = 9 (16%) Comparator = 8 (15%) <i>p</i> -value = 0.53
		Knee pain: Intervention = 5 (9%) Comparator = 3 (6%) <i>p</i> -value = 0.38
		Pain in other areas: Intervention = 4 (7%) Comparator = 5 (9%) <i>p</i> -value = 0.48
Quicke, 2020 ²² Sequential	12 months	<i>Adverse events</i>
Some concerns about ROB		Sprained ankle: Intervention = 0 Comparator = 1
		Fall while walking: Intervention = 1 Comparator = 0

Abbreviations. ROB=risk of bias.

Quality of Evidence

Risk of bias was assessed separately for each study design and outcome type (*ie*, patient reported and objectively measured) using the RoB 2 and the ROBINS-I tools. Overall, only 4 studies were judged to be low ROB. Key sources of bias across study designs and outcomes include deviations from intended intervention, bias in outcome assessment, and missing outcome data. Missing outcome data was a particular issue for studies reporting outcomes at later time points. Four studies were downgraded to high ROB on the missing outcome data domain.^{18,21,24,27}

For the 7 individually randomized controlled trials, the ROB (Figure 11) for patient-reported outcomes was judged to be low for 3 studies, some concerns for 1 study, and high for 3 studies.^{18,20-23,25,27} Patterns that led to judgments of high ROB and some concerns for ROB (Figure 12) included (1) some concerns about the randomization process; (2) deviations from intended interventions; (3) deviations from adherence to the intervention; (4) missing outcome data; (5) bias in measurements of the outcome; and (6) bias in selection of the reported result.

Of the 3 individually randomized controlled trials reporting objective outcomes, 1 was low risk and 2 were high risk.^{18,21,27} Patterns that led to judgments of high ROB (Figure 13 and 14) included: (1) some concerns about the randomization process; (2) deviations from intended interventions; (3) some concerns about deviations from adherence to the intervention; (4) missing outcome data; (5) bias in measurements of the outcome; and (6) bias in selection of the reported result.

Of the 2 cluster-randomized controlled trials, 1 was judged to have some concerns and 1 was judged as high ROB.^{24,26} Patterns that led to judgments of high ROB and some concerns for ROB (Figure 15 and 16) included: (1) missing outcome data; (2) bias in measurements of the outcome; and (3) some concerns for bias in selection of the reported result.

The 1 non-randomized study evaluated with the ROBINS-I tool was assessed to have serious risk of bias.¹⁹ Patterns that led to judgments of high ROB and some concerns for ROB included: (1) bias due to confounding; (2) bias due to deviations from intended interventions; (3) moderate risk of bias due to measurement of outcomes; and (4) bias in selection of reported results (Figure 17).

Figure 11. Risk of Bias Ratings Across Randomized Trials: Patient-reported Outcomes

	Bias arising from the randomization process	Bias due to deviations from the intended interventions	Missing outcome data	Bias in measurement of the outcome	Bias in selection of the reported result	Overall
Baker et al., 2020	+	+	-	-	+	-
Bennell et al., 2014	+	+	+	?	+	+
Bennell et al., 2017	+	+	+	?	+	+
Bennell et al., 2020	+	+	+	+	+	+
Brosseau et al., 2012	+	+	-	-	+	-
Friedrich et al., 1998	?	-	-	-	-	-
Quicke et al., 2017	+	+	+	+	+	?

+ Low risk of bias
 ? Some concerns
 - High risk of bias

Figure 12. Risk of Bias Ratings by Bias Domain: Patient-reported Outcomes

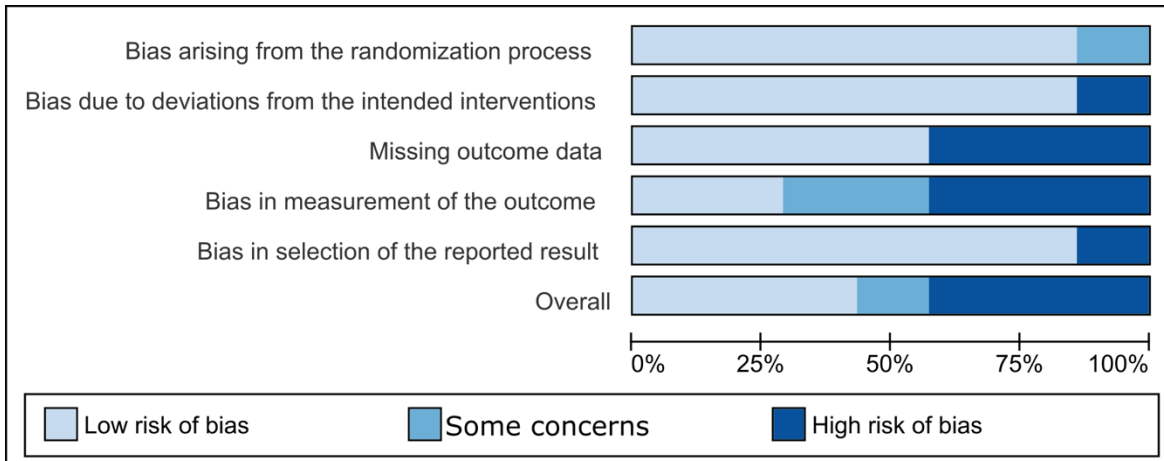


Figure 13. Risk of Bias Ratings Across Randomized Trials: Objective Outcomes

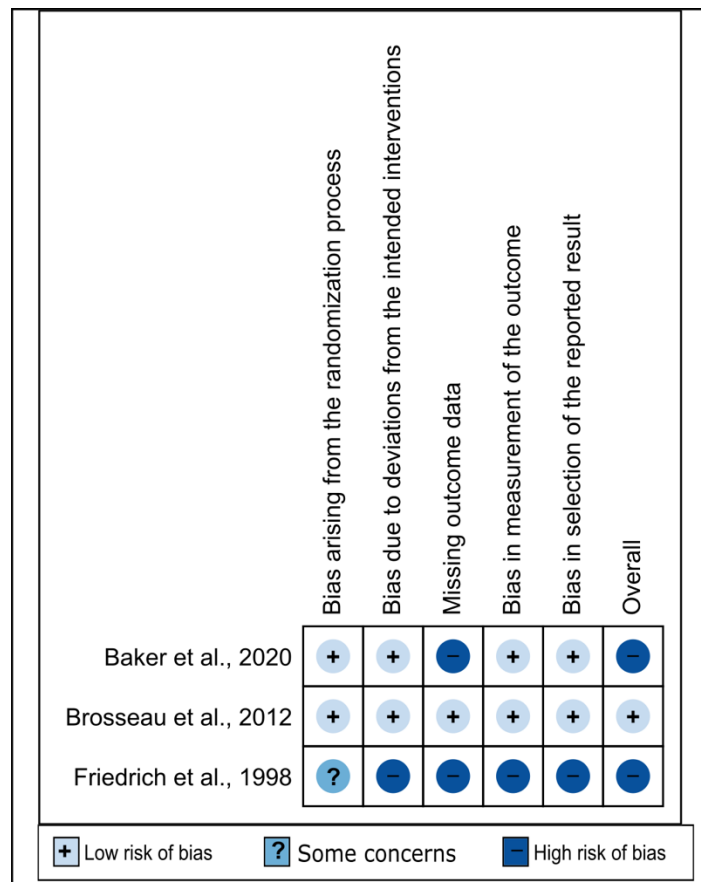


Figure 14. Risk of Bias Ratings by Bias Domain: Objective Outcomes

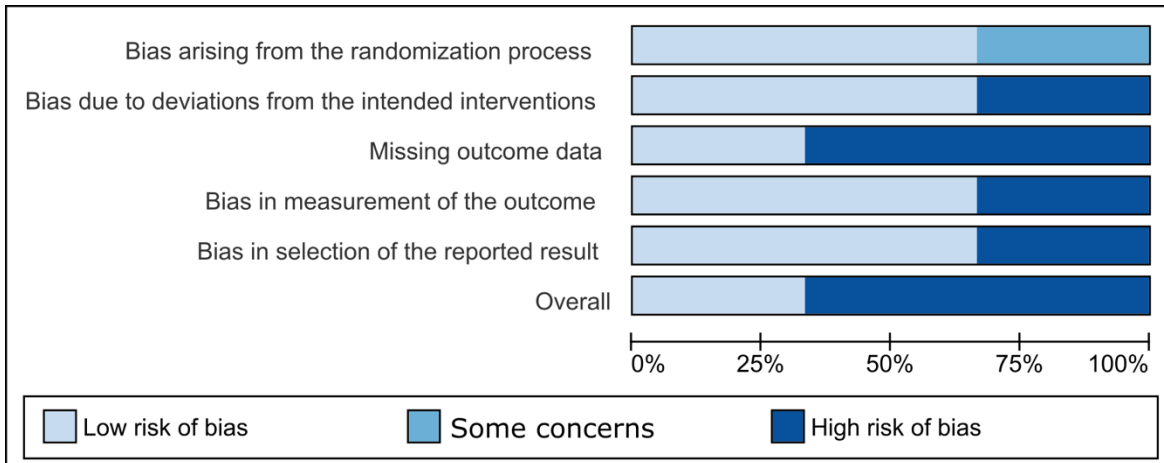


Figure 15. Risk of Bias Ratings for Cluster-randomized Trials

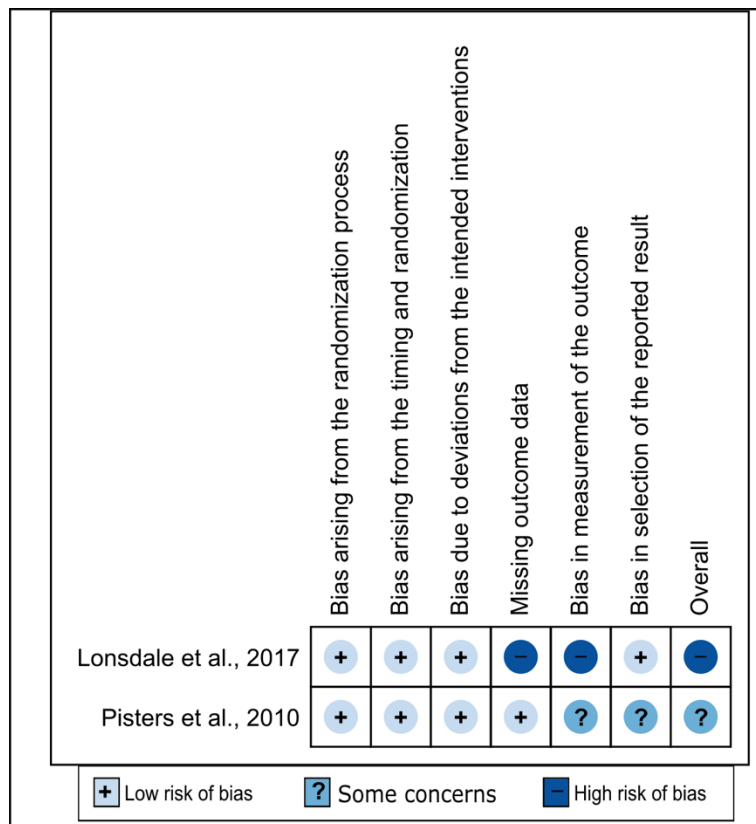


Figure 16. Risk of Bias Ratings by Bias Domain: Objective Outcomes (Cluster-randomized Trials)

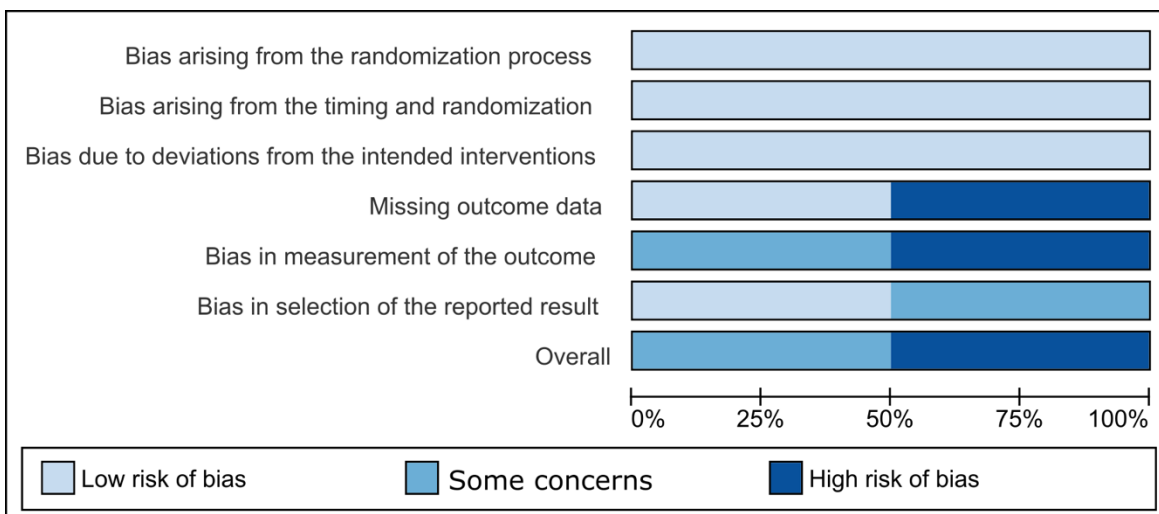
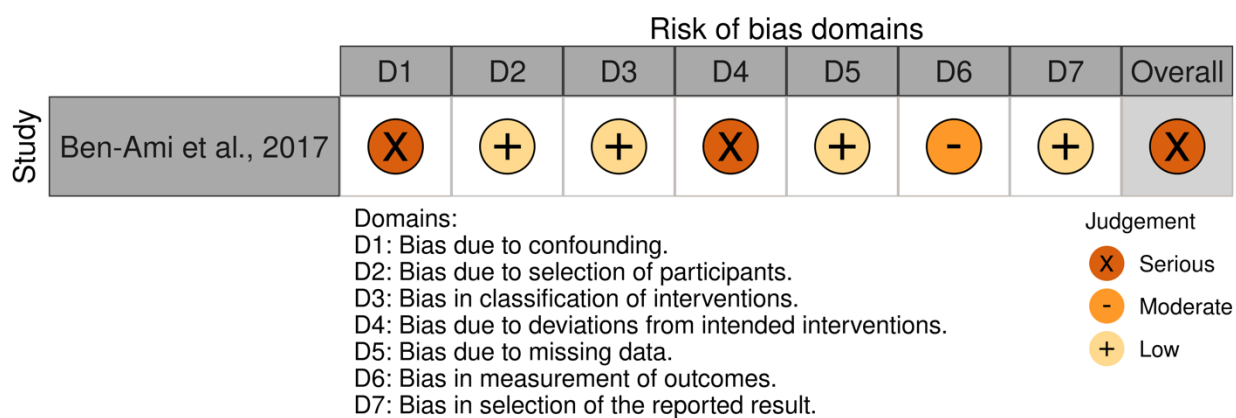


Figure 17. Risk of Bias Ratings for Non-randomized Trials



DISCUSSION

We evaluated the impact of physical rehabilitation programs supplemented with 1 or more adjunct components designed to promote long-term adherence to recommended rehabilitation programs. Specifically, we evaluated the effect of these interventions on self-efficacy for exercise, adherence to recommended home rehabilitation program, and function at ≥ 3 months after completing the index rehabilitation program among adults with hip/knee OA or LBP. Our review is novel; we focus on sustained adherence to physical rehabilitation programs supplemented with adherence-enhancing adjunct components, and we conducted a rigorous analysis of the adjunct components using an established tool, the Behavior Change Technique Taxonomy (v1).¹⁰

SUMMARY OF FINDINGS

We identified 10 studies that included physical rehabilitation programs supplemented by adherence-enhancing adjunct interventions. Six studies were theory informed and included elements of the Transtheoretical Model,³⁰ Self-Determination Theory,³¹ COM-B (capability, opportunity, and motivation),³² Social Cognitive Theory,³³ and/or Health Change methodology.³⁴ None explicitly included Veterans or focused on a predominantly Veteran population. We identified behavior change techniques present in adherence-enhancing adjunct interventions and in control interventions. We found limited evidence of benefit across the included interventions on long-term adherence and no evidence for benefit to functional outcomes, though few of the evaluated adherence interventions were theory based or addressed long-term home rehabilitation program adherence as distinct from initiation. Self-efficacy and adverse events were sparsely reported.

The majority of included studies (60%) delivered the adjunct adherence-enhancing intervention concurrently with the index rehabilitation program. Yet, delivering these approaches at the same time may not be an optimal strategy to foster sustained adherence to PT over time. Moreover, some health behavior models suggest that initiation of PT and long-term adherence to PT are conceptually different behaviors that require different skills and psychological processes for support.^{35,36} If long-term behavioral maintenance of a home rehabilitation program is the appropriate clinical goal for patients with chronic musculoskeletal conditions, then the conceptual difference between starting and sustaining physical rehabilitation is critical. Designing interventions that disentangle behavioral initiation and maintenance (*ie*, sequential interventions) and target distinct content to support these behaviors may lead to improved results.^{7,37-41}

We coded BCTs in adjunct adherence-enhancing interventions and comparator interventions. Comparator interventions generally used BCTs in similar amounts and clusters across studies, which is reflective of typical practice in rehabilitation settings during the initiation of a new home rehabilitation program. Most adjunct adherence-enhancing interventions included few individual BCTs (mean = 5.5), while only 3 included more than 8 BCTs, which prior literature has suggested can enhance behavioral maintenance.⁵ Further, many BCT clusters remain largely unexplored. Because behavior change is a complex phenomenon, the lack of complexity in the adjunct interventions as seen by the few BCT clusters explored remains a missed opportunity. Moreover, the majority of interventions from studies in our review included BCTs from clusters already represented in the comparator arm (such as goal setting, feedback and monitoring, and

repetition and substitution). While none addressed a rationale for this overlap, only 1 study specifically refers to the BCTs as a part of intervention development. Because initiating a behavior and behavioral maintenance are distinct psychological processes requiring different skills, goals, and processes of change, designing interventions that focus on “just more of the same” BCTs may be insufficient to promote behavioral maintenance. Studies that were theory informed and embraced the distinction between initiation of behaviors and behavioral maintenance (such as Bennell et al²⁰ and Ben-Ami et al¹⁹) tended to include more BCTs in the adjunct adherence-enhancing interventions and demonstrated BCTs across a broader range of clusters compared to studies that did not address this distinction.

Adherence was generally reported using non-validated self-report measures. Three studies had evidence of a positive effect on our primary outcome of long-term adherence to recommended home rehabilitation programs across end points within included studies. Of these 3 positive studies, 1 was a low-ROB study by Bennell et al²⁰. The second study with serious ROB reported a mean difference of 0.7 (95% CI [0.07, 1.3]) on the validated Baecke Physical Activity Questionnaire at 9 months from the end of an enhanced intervention informed by the Transtheoretical Model for patients with LBP. When considering the difference at follow-up between intervention and comparator arms, only the study by Bennell et al²⁰ had a beneficial effect for both measures of long-term adherence, specifically general self-reported adherence and adherence as a proportion of the prescribed home rehabilitation program completed, with an SMD of 0.42 (95% CI [0.02, 0.82]) and an SMD of 0.50 (95% CI [0.09, 0.90]), respectively.

All but 1 included study¹⁸ measured functional outcomes and all used at least 1 established self-report measure of function. Two studies also included objective measures of function including several indicators of strength and flexibility in key lower extremity muscle groups.^{21,27} Three studies with concurrently delivered adherence adjunct interventions reported a positive effect of the intervention on functional status from pre-index rehabilitation to follow-up, but all had some concerns for ROB or were high ROB. To evaluate sustained functional improvement, we considered the difference in change of function from the end of rehabilitation to follow-up. There was no evidence of intervention effect at any time point, including across both concurrently and sequentially delivered interventions and across the 3 low-ROB studies.

We attempted to identify measures of self-efficacy to carry out home practice of prescribed rehabilitation exercise, but given the limited assessments of this construct, we included related constructs (eg, self-efficacy for managing arthritis, motivation to follow [rehabilitation] recommendations, and confidence in doing things [in the context of knee OA]). Of the 5 studies reporting these constructs, only 2 used validated measures specifically related to self-efficacy of any type. One low-ROB study by Bennell et al²⁰ used the Arthritis Self-Efficacy Scale and found no difference between the sequentially delivered semi-interactive SMS message adjunct intervention and comparator at 24 weeks across any of the 3 subscales (ie, pain, function, controlling other symptoms). Of the other 4 studies, only 1 high-ROB study¹⁸ found a significant difference using a non-validated measure assessing confidence-like attitudes. However, we note that self-efficacy is most accurately measured when related to a specific behavior, so these related findings are tangentially relevant. In addition, it is unclear if any of the studies measuring self-efficacy included intervention strategies to specifically target this construct. While we assessed the BCTs of the included interventions, it is unknown which BCTs are most effective at promoting self-efficacy.^{42,43} Four studies reported adverse events, though none found any

difference in events by receipt of adjunct adherence interventions and most of those reported were minor musculoskeletal discomforts.

Certainty of Evidence for Key Outcomes

To contextualize the overall base of the evidence on key outcomes, we conducted Certainty of Evidence (COE) ratings for adherence and function outcomes. These assessments reflect the degree of confidence we have in our summary findings. For each outcome of interest, we present the COE by outcome (*ie*, adherence, function) and time point (*ie*, 3 to 6 months, \geq 9 months). The non-randomized study and studies reporting categorical outcomes are evaluated separately (Table 7).

We identified low COE that adjunct adherence interventions have no effect on adherence to rehabilitation at 3 to 6 months and 9 months after the end of the rehabilitation period. Adjunct components had no significant effect when studies reported adherence as percent adherent to the prescribed dose of rehabilitation. These were also determined to be very low certainty. We found low certainty and very low certainty that adherence interventions have no effect on physical function at 3 to 9 months and very low certainty at 9 months. Ratings of low and very low COE indicate that the true effect of adjunct interventions on long-term adherence to recommended rehabilitation programs and physical function might be considerably different from the estimated effect we found in the included studies. Future studies may shift these COE ratings.

Table 7. Certainty of Evidence for Rehabilitation Adherence by Intervention and Outcome Timing

Intervention	Number of Studies (N)	Findings	Certainty of Evidence (Rationale)
Adherence 3 to 6 months	4 randomized (514 participants)	SMD range = 0.05–0.42 (95% CI range = -0.23–0.82)	Very low certainty of no effect (rated down for serious risk of bias, serious inconsistency, and serious imprecision)
	1 randomized (200 participants)	OR = 2.9 (95% CI [1.2, 6.7])	Very low certainty of increased adherence (rated down for serious risk of bias, serious indirectness, and serious imprecision)
Adherence 9+ months	2 randomized (225 participants)	SMD range = -0.12–0.06 (95% CI range = -0.53–0.40)	Very low certainty of no effect (rated down for serious risk of bias, serious inconsistency, and serious imprecision)
	1 non-randomized (189 participants)	SMD = 0.20 (95% CI [-0.09, 0.48])	Very low certainty of no effect (rated down for serious risk of bias and serious imprecision)
	1 randomized (200 participants)	Adherence to rehabilitation: OR = 3.0 (95% CI [1.5, 6.0]) Adherence to activities: OR = 1.8 (95% CI [0.8, 3.8])	Very low certainty of increased adherence (rated down for serious risk of bias, serious indirectness, and serious imprecision)

Intervention	Number of Studies (N)	Findings	Certainty of Evidence (Rationale)
Adherence % of Dose Prescribed	4 randomized (514 participants)	SMD range = -0.03–0.50 (95% CI range = -0.31–0.90)	Very low certainty of no effect (rated down for serious risk of bias, serious inconsistency, serious imprecision)
Physical Function 3 to 6 months	6 randomized (936 participants)	SMD range = -0.12–0.02 (95% CI range = -0.55–0.24)	Low certainty of no effect (rated down for serious risk of bias and serious imprecision)
	1 randomized (200 participants)	OR = 5.3 (95% CI [1.9, 14.8])	Very low certainty of increased function (rated down for serious risk of bias, serious indirectness, and serious imprecision)
Physical Function 9+ months	4 randomized (624 participants)	SMD range = -0.23–0.10 (95% CI range = -0.70–0.31)	Low certainty of no effect (rated down for serious risk of bias and serious imprecision)
	1 non-randomized (189 participants)	Mean = 0.20 (95% CI [-0.09, 0.49])	Very low certainty of no effect (rated down for serious risk of bias, and serious imprecision)
	1 randomized (200 participants)	OR = 2.9 (95% CI [1.2, 6.7])	Very low certainty of increased function (rated down for serious risk of bias, serious indirectness, and serious imprecision)

Notes. Randomized and non-randomized designs were not combined as per GRADE guidance.¹⁷ Studies reporting dichotomous outcomes were not be combined with studies reporting continuous outcomes.

Abbreviations. OR=odds ratio; SMD=standardized mean difference.

PRIOR SYSTEMATIC REVIEWS

Several prior systematic reviews provide additional context for our findings. Nicolson et al⁴⁴ aimed to determine the effectiveness of interventions to increase adherence to therapeutic exercise among older adults with LBP and/or hip/knee OA. Four studies in this review reported improved adherence from 4 weeks to 12 months (SMD= 0.26–1.23) and standardized mean differences with low to very low COE indicated a small effect in favor of adjunct sessions. Yet, the authors of this review defined adherence in a way that included short-term (< 3 months) adherence or adherence during delivery of a rehabilitation intervention. In contrast, our review focused on adherence following an index rehabilitation intervention and was interested in long-term adherence (≥ 3 months) after completing the index rehabilitation intervention, and few interventions demonstrated improvements in this outcome. Moreover, we allowed the inclusion of high-quality non-randomized trials in our review that were excluded by Nicolson et al. Four^{18,23,26,27} of our included studies overlapped with Nicolson et al, likely due to similar populations, outcomes, and inclusion criteria.^{18,23,26,27} However, our results extend the work of Nicolson et al in providing data on long-term adherence to home rehabilitation programs.

Two prior reviews examined the use of BCTs to improve adherence to exercise or physical activity. Eisele et al⁴⁵ examined the effectiveness of BCTs to enhance physical activity among patients with chronic musculoskeletal conditions across 22 studies (3 included in our review^{18,19,25}). A subgroup analysis examining the difference between high BCT (defined as an

adherence-enhancing intervention containing ≥ 8 BCTs) and low BCT (defined as an adherence-enhancing intervention containing < 8 BCTs) interventions found a higher effect (SMD = 0.29, 95% CI [0.19, 0.40]) for interventions using a greater number of BCTs. Our results largely follow this trend with the exception of Pisters et al²⁶ (adherence-enhancing intervention containing 2 BCTs and a positive effect) and Friedrich et al²⁷ (adherence-enhancing intervention containing 10 BCTs and a null result). Comparing our review to Eisele et al reveals that while researchers and clinicians often focus primarily on intervention content, our results point to the importance of considering the comparator arm content in comparison to the intervention. Specifically, we found that adjunct adherence interventions largely employed similar BCTs to those used in comparator arms. To move the field forward, interventions designed to improve long-term adherence to home rehabilitation programs should make sure that intervention BCTs build on and complement those BCTs used in the routine rehabilitation programs that focus on initiating a home rehabilitation program; in particular, interventions should employ BCTs with the theoretical grounding and an evidence base that supports the maintenance of behavior change.

Including 24 studies (2 included in our review),^{23,25} a systematic review by Willett et al⁴⁶ identified 5 BCTs that had high effectiveness ratios ($\geq 50\%$) in promoting adherence to exercise among those with hip/knee OA (behavioral contract, nonspecific reward, goal setting [behavior], self-monitoring of behavior, and social support [unspecified]). Two of the 5 effective BCTs identified by Willett et al were present in nearly all (80%, self-monitoring of behavior) or all (goal setting [behavior]) interventions included in our review. In contrast, 3 of the 5 effective BCTs were rarely seen (behavioral contract, 20%; nonspecific reward, 30%; social support [unspecified], 30%) in our review. Including these BCTs known to be effective at promoting exercise adherence may enhance the effectiveness of future interventions designed to enhance adherence, especially as the intention to perform exercises and social support are previously identified predictors of long-term adherence to exercise.⁵

Jordan et al¹¹ completed a Cochrane review of 42 RCTs (1 included in our review²⁷) examining interventions including self-management interventions, psychological interventions, and rehabilitation interventions to improve exercise adherence for individuals with chronic musculoskeletal pain. The authors' conclusions were limited by a lack of high-quality RCTs with long-term follow-up that explicitly address adherence to exercises and the lack of standard validated measures of exercise adherence. Though these recommendations are now 12 years old, based on our review findings we believe that these conclusions remain valid.

CLINICAL AND POLICY IMPLICATIONS

As noted, we found little evidence for the benefit of existing adjunct adherence interventions on long-term adherence or functional outcomes. Included studies differed in many core features, including patient population, follow-up length, and study quality, as well as in how they approached the goal of engaging patients with chronic musculoskeletal conditions in the long-term practice of prescribed home rehabilitation programs. The adjunct adherence interventions we identified included a limited number of established strategies (*ie*, BCTs) known to promote sustained behavior change, used the same strategies as are used for initial rehabilitation treatment, and generally did not draw a distinction between initiation and maintenance of home rehabilitation programs.

These findings and methodological limitations make specific clinical recommendations challenging. Nonetheless, we believe a few key concepts may inform current clinical practice. First, rehabilitation clinicians and primary care providers should consider disentangling support for starting a rehabilitation program and coaching to commit to long-term rehabilitation recommendations. In doing so, rehabilitation clinicians should approach the prescription of home rehabilitation as a behavior change initiation conversation and employ appropriate approaches for initiating a new behavior.

Second, typical rehabilitation practice utilizes a number of strategies (*ie*, BCTs) as part of the standard of care for LBP and lower limb arthritis⁴⁷ (*eg*, goal setting, behavioral practice, and information about health consequences). When shifting aims to the promotion and encouragement of long-term sustainment of a home rehabilitation practice after successful initiation, clinicians need to employ a targeted and distinct set of strategies for maintenance.^{5,7} Unfortunately, the field lacks evidence-based or clinical guidelines to draw from to inform which strategies, or BCTs, are most appropriate for the promotion of the sustained practice of prescribed home rehabilitation programs in the context of LBP or hip/knee OA. We can draw from other fields of behavioral maintenance that suggest approaches such as a shift in self-regulatory focus^{48,49} (*ie*, focus on approaching a favorable endpoint vs avoiding a less favorable alternative state), relapse prevention planning, fostering effective self-monitoring, and shifting social support from the physical therapist to the patient's social network.⁵⁰ We can also look to existing successful VHA programs that seek to promote long-term behavior change. While not rehabilitation specific, the VA has already invested in some programs to promote the long-term physical function of Veterans, using social support. Two such examples include the nationally disseminated VHA Gerofit program, with demonstrated evidence of improvement in morbidity and mortality⁵¹ (now being disseminated nationwide), and the Peer-To-Peer Whole Health program.⁵²

LIMITATIONS

It is important to consider our findings within the context of both the limitations of our methodological approach to this systematic review and those of the identified literature meeting our inclusion criteria.

Our methodological approach includes multiple strengths, including following an *a priori* developed protocol, obtaining guidance for approach and eligibility criteria from an expert panel, using a conceptual model to frame our review, and rigorous categorization of behavioral change techniques reported in the included interventions using an established method. It should be noted that we focused this review on common chronic musculoskeletal conditions that require long-term maintenance for improvement of function; findings may not be relevant to other clinical conditions requiring physical therapy for rehabilitation (*eg*, post joint replacement, after an acute injury). In addition, there may be other studies that did not explicitly intend to promote long-term adherence or measure adherence at time points 3 months and greater but that could provide useful insight into this topic. Further, half of the included studies did not have an *a priori* focus on long-term adherence and, as such, were not directly designed to address the key question proposed here about maintenance of physical rehabilitation programs. Our use of the BCT taxonomy also has limitations. Although 2 authors independently coded and reviewed the BCTs present in each study, reporting of control arm and intervention arm components was often insufficient. Thus, we cannot guarantee the completeness and comparability of the coded BCTs.

Finally, we did not attempt to combine studies reporting continuous and dichotomous outcomes; a future synthesis employing methods to do so may arrive at different conclusions.”

Publication Bias

In the context of this review, which found a small number of included studies, existing statistical methods are not useful to detect publication bias. It is possible that there are existing studies or projects evaluating interventions to promote long-term adherence to physical therapy that were not published in the indexed literature. For example, it is possible that individual clinics or health care systems have developed internal programs to promote long-term rehabilitation adherence that have been evaluated as quality improvement projects but not published in the peer-reviewed literature.

Study Quality

We were also limited by the quality of identified studies. Common potential sources of bias across the included studies included an inadequate description of intervention delivery, deviations from intended intervention delivery, missing outcome data (especially for longer-term outcome assessment time points), and reliance on self-reported outcomes with the potential for bias.

Heterogeneity

Potential sources of heterogeneity in effects include the participating patient population, the length of follow-up assessments (which ranged from 3 months to 60 months), measurement of key outcomes (*eg*, type of instrument used), and the type of interventions themselves. Specifically, 6 of the included studies^{18,19,24,25,27,28,53} reported on adjunct adherence interventions delivered concurrently to the index rehabilitation intervention and 2 focused on training the PT providers in advance of providing direct patient care. On the other hand, 4 studies evaluated the effect of interventions delivered after the completion of index rehabilitation care, effectively extending the contact and support provided to participants. While we categorized studies as delivering the adjunct intervention either concurrently to the index rehab program or sequentially, the identified studies were not always easy to classify. In some cases, this was due to overlap of the adherence adjunct intervention both during the index rehab program and subsequently (*eg*, Pisters et al²⁶ and Quicke et al²²). In addition, we sought to include studies whose sole comparison was the addition of an adjunct adherence intervention to a standard rehabilitation program (*ie*, A vs A + B study design). However, in an effort to identify potentially relevant literature, some of the included studies did not feature an index rehabilitation intervention identical to that of the comparator (*eg*, Quicke et al²²). This was particularly challenging to clarify in studies that administered the adjunct adherence intervention concurrently with the index rehabilitation program.

Applicability of Findings to the VA Population

While none of the included studies were conducted in the VA or specifically sought to include Veterans, the identified studies were conducted in settings *similar* to the VA Health Care System, and it is reasonable to expect they would function similarly. In addition, the participants in the included studies are similar in age and comorbidities to Veterans cared for in the VA.

FUTURE RESEARCH

To guide our assessment of important gaps in the existing literature, we consider each category in the PICOTS (population, intervention, comparator, outcomes, timing, setting) framework (Table 8). We identify those study design characteristics that we feel would provide the greatest contribution to this body of literature given the current state of the evidence. For each of the gaps described in Table 8, we identified that there is currently insufficient information.

Table 8. Highest Priority Evidence Gaps for Long-term PT Adherence

PICOTS Domain	Evidence Gap/Area for Future Exploration
Population	<ul style="list-style-type: none"> • Populations including underrepresented racial and ethnic groups • Younger patients with knee and hip osteoarthritis and lower back pain, as their challenges and needs for incorporating long-term strategies into working-age lifestyles may be different from other age groups
Intervention	<ul style="list-style-type: none"> • Distinction between interventions promoting the initiation of behavior change versus behavioral maintenance grounded in best theoretical/conceptual approaches • Adherence-enhancing adjunct interventions that use different BCTs than are typically seen in usual rehabilitation care • Interventions aimed at both the rehabilitation provider and patient simultaneously • Virtual and/or asynchronous interventions for flexibility and convenience of long-term patient engagement • Titrating adherence interventions to individual's needed level of support • Use of BCTs known to be effective from related literature for long-term home adherence • Clearly described and varied dose of the intervention delivered to patients
Comparator	<ul style="list-style-type: none"> • Well-described usual care/standard rehabilitation programs that clearly demonstrate provision of standards of care and identified behavior change techniques • Various delivery modalities in order to compare in-person to virtually delivered
Outcomes	<ul style="list-style-type: none"> • Objective functional outcomes (eg, 6-minute walk test, 30-second sit to stand test) • Validated measures specific to self-efficacy for exercise/physical activity • Standardized and validated measures of adherence (objective when possible, such as accelerometer data)
Timing	<ul style="list-style-type: none"> • Longer-term outcomes at least 6 months after completion of index rehabilitation program to facilitate comparison across studies
Setting	<ul style="list-style-type: none"> • Community-based rehabilitation

Future Intervention Design Considerations

Initiation of behavior change requires a skill set fundamentally different from that needed to maintain behavior change.⁷ Long-term adherence to home rehabilitation programs prescribed by rehabilitation clinicians should be considered behavioral maintenance and thus requires different BCTs, goals, and skills compared to behavioral initiation. Moreover, the potential for the type,

sequence, and number of BCTs to interact dynamically to optimally promote behavioral initiation and maintenance offers new avenues for intervention development.

While we are unable to draw definitive conclusions about the type of interventions most likely to lead to long-term adherence and functional improvement, we can suggest the types of strategies that could be explored in the future, including social support, behavioral contracts, and the use of rewards. Social support is particularly intriguing for VA-based rehabilitation adherence efforts, as social support delivered through peer support has been shown to be broadly accepted and effective within the Veteran population,⁵⁴⁻⁵⁶ and peer support specialists are already incorporated into multiple kinds of VA care provision.^{57,58} Further, theoretical and empirical evidence suggests the critical role of positive, structural social support from within the patient's own social network as a key factor in behavioral maintenance.^{7,59,60}

The collected literature shows that the field of behavioral maintenance of home rehabilitation programs is nascent. In addition to methodologically rigorous randomized trials testing adjunct interventions designed to promote behavioral maintenance of prescribed home rehabilitation, more recent innovations in clinical trials design such as SMART or MOST designs could be helpful to move this body of literature forward.⁶¹ Programs should ensure that the adherence adjunct intervention arm is delivered in addition to an index rehabilitation program identical to that administered to the comparator arm (*ie*, a true A vs A + B comparison). This is particularly important for concurrently delivered adjunct interventions, from which adjunct components are inherently more difficult to disentangle compared to sequentially delivered adjunct intervention studies. Further, studies should consider a purposefully sequenced combination of intervention approaches (*ie*, behavior initiation followed by behavioral maintenance).

CONCLUSIONS

Long-term sustainment of functional improvements gained by short-term rehabilitation programs requires ongoing adherence to recommended home rehabilitation programs well past the end of direct clinical treatment. We found that there is inadequate evidence evaluating rigorously designed adherence-enhancing interventions for the specific promotion of long-term adherence to home rehabilitation programs. As long-term adherence represents a distinct behavioral target (*ie*, behavioral maintenance), future studies may want to consider testing interventions specifically built to target behavioral maintenance of home rehabilitation programs. Future development of interventions to promote long-term or sustained adherence to prescribed home rehabilitation programs could benefit from use of theoretically informed approaches and successful behavioral maintenance interventions validated in similar conditions. In the meantime, rehabilitation clinicians and referring providers should be aware that long-term commitment to prescribed home rehabilitation programs is necessary to realize ongoing health benefits.

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APPENDIX A. SEARCH STRATEGIES

Database: MEDLINE (via Ovid MEDLINE ALL 1946 to July 26, 2021)

Search date: 7/27/2021

Search Set	Search Strategy	Results
#1	(osteoarthritis/ AND (knee* OR hip* OR patella*).ti,ab.) OR exp Osteoarthritis, Hip/ or exp Osteoarthritis, Knee/ OR ((knee OR knees OR patella* OR hip OR hips) AND (osteoarthritis OR osteoarthritic OR arthrosis OR arthroses OR OA OR coxarthrosis OR coxarthroses)).ti,ab. OR ((knee* OR patella* OR hip OR hips) AND degenerative AND (arthritis OR arthritic OR joint OR joints)).ti,ab.	55,259
#2	exp low back pain/ OR exp sciatica/ OR (lumbago OR sciatica).ti,ab.	30,239
#3	((back or low?back or spine or spinal or thoracic or vertebr* or intervertebr* or sciatic* or lumbar or lumbr* or lumbo*) adj3 (pain* or ache* or radiculopath* or polyradiculopath* or compress*)).ti,ab.	80,218
#4	(low or lower or lowback or sciatic* or ischia* or lumbo* or lumba* or sacroili* OR sacral).ti,ab.	4,298,601
#5	3 AND 4	52,655
#6	1 OR 2 OR 5	117,475
#7	(exp Rehabilitation/ AND physical.ti,ab.) OR exp Exercise/ OR exp Exercise Therapy/ OR exp Physical Fitness/ OR exp Physical Conditioning, Human/ OR exp Circuit-Based Exercise/ OR exp Endurance Training/ OR exp High-Intensity Interval Training/ OR exp Plyometric Exercise/ OR exp Resistance Training/ OR exp Physical Therapy Modalities/ OR exp Exercise Movement Techniques/ OR exp Tai Ji/ OR exp Yoga/ OR exp Hydrotherapy/ OR exp Musculoskeletal Manipulations/ OR exp Cognitive Behavioral Therapy/ OR exp "Acceptance and Commitment Therapy"/ OR exp Mindfulness/ OR exp Meditation/ OR exp Motivational Interviewing/ OR exp Wearable Electronic Devices/ OR exp Fitness Trackers/ OR exp Reminder Systems/ OR exp Peer Group/ OR exp Peer Influence/ OR exp Social Support/ OR exp Mentoring/ OR exp Text Messaging/ OR exp Mobile Applications/ OR (Physical ADJ rehab*).ti,ab. OR (Physical ADJ telerehab*).ti,ab. OR (Physical ADJ activit*).ti,ab. OR (Movement OR exercis* OR sport OR sports OR athletics OR athletic OR yoga OR pilates OR "Tai chi" OR "Tai ji" OR fitness OR plyometrics OR hydrotherapy OR "interval training" OR HIIT OR physiotherap* OR kinesiol* OR cycling OR spinning).ti,ab. OR ((circuit* OR strength* OR resistance* OR weight* OR aerobic* OR endurance) ADJ train*).ti,ab. OR (Physical ADJ therap*).ti,ab. OR ((musculoskeletal OR MSK) ADJ2 (therap* OR treat* OR therapeutic OR intervention* OR mobilization OR mobilisation)).ti,ab. OR ((behavior* OR behaviour* OR psychological OR mental) ADJ2 (therap* OR treat* OR therapeutic OR intervention* OR adaptation*)).ti,ab. OR CBT.ti,ab. OR ((acceptance OR commitment) ADJ2 (therap* OR treat* OR therapeutic OR intervention*)).ti,ab. OR (Motivation* ADJ2 interview*).ti,ab. OR (biopsychosocial OR bio?psycho?social OR counselling OR mindfulness OR meditation OR "Peer-to-peer").ti,ab. OR ((peer OR peers OR social OR caregiver*) ADJ support*).ti,ab. OR (coach* OR mentor* OR counsel* OR boost* OR wearable* OR "fitness tracker" OR "fitness tracker" OR "activity tracker" OR "activity trackers" OR fitbit OR "apple watch").ti,ab. OR (reminder* ADJ2 (system* OR messag* OR text* OR mail OR telephone OR phone)).ti,ab. OR (automated ADJ (messag* OR text* OR mail OR	1,498,833

Search Set	Search Strategy	Results
	telephone OR phone)).ti,ab. OR (text?messag* OR email OR e?mail OR "electronic mail" OR "electronic message" OR "electronic messages").ti,ab. OR (performance ADJ feedback).ti,ab. OR (Remote ADJ monitor*).ti,ab. OR ("mobile application" OR "mobile applications" OR "mobile apps").ti,ab.	
#8	6 AND 7	24,101
#9	exp Patient Compliance/ OR exp Medication Adherence/ OR exp Patient Participation/ OR "Patient Acceptance of Health Care"/ OR Treatment Refusal/ OR exp Motivation/ OR exp Self Efficacy/ OR exp Problem Solving/ OR exp Decision Making/ OR exp Choice Behavior/ OR (Adhere* OR adhering OR Complian* OR complying OR Cooperat*).ti,ab. OR ((change OR changes OR changing OR modify OR modifies OR modifying OR modification) ADJ (behavior* OR behaviour*).ti,ab. OR (Motivat* OR incentiv* OR disincentiv* OR perceiv* OR perception* OR belief*).ti,ab. OR (Self ADJ efficacy).ti,ab. OR Self-efficacy.ti,ab. OR (Self ADJ monitoring).ti,ab. OR Self-monitoring.ti,ab. OR (Self ADJ talk).ti,ab. OR (Self-talk OR Attitude* OR Empower*).ti,ab. OR ((treat* OR therapy OR therapeutic) ADJ refus*).ti,ab. OR ((goal OR goals) ADJ setting).ti,ab. OR Goal-setting.ti,ab. OR (Action ADJ plan*).ti,ab. OR (Non?compliant* OR Non?adheren* OR Attendance OR Non?attend* OR Encourag*).ti,ab. OR (patient ADJ3 participation).ti,ab.	1,818,940
#10	8 AND 9	4,193
#11	randomized controlled trial.pt. OR controlled clinical trial.pt. OR clinical trial.pt. OR randomized.ti,ab. OR randomised.ti,ab. OR randomization.ti,ab. OR randomisation.ti,ab. OR placebo.ti,ab. OR randomly.ti,ab. OR trial.ti,ab. OR groups.ti,ab. OR nonrandom.ti,ab. OR "non-random".ti,ab. OR nonrandomized.ti,ab. OR "nonrandomized".ti,ab. OR nonrandomised.ti,ab. OR "non-randomised".ti,ab. OR quasi-experiment*.ti,ab. OR quazi-experiment*.ti,ab. OR quasixperiment*.ti,ab. OR quaziexperiment*.ti,ab. OR quasirandom*.ti,ab. OR quazirandom*.ti,ab. OR quasi-random*.ti,ab. OR quazi-random*.ti,ab. OR quasi-control*.ti,ab. OR quazi-control*.ti,ab. OR quasicontrol*.ti,ab. OR quazicontrol*.ti,ab. OR ((controlled.ti,ab.) AND (trial.ti,ab. OR study.ti,ab.))	3,640,469
#12	10 AND 11	2,145
#13	12 NOT (exp animals/ not exp humans/)	2,140
#14	13 NOT (case reports.pt OR editorial.pt OR letter.pt OR comment.pt)	2,119

Database: Embase (via Elsevier)

Search date: 7/27/2021

Search Set	Search Strategy	Results
#1	'knee osteoarthritis'/exp OR 'hip osteoarthritis'/exp OR ((knee OR knees OR patella* OR hip OR hips) AND (osteoarthritis OR osteoarthritic OR arthrosis OR arthroses OR OA OR coxarthrosis OR coxarthroses)).ti,ab OR ((knee* OR patella* OR hip OR hips) AND degenerative AND (arthritis OR arthritic OR joint OR joints)).ti,ab	79,989
#2	'low back pain'/exp OR 'sciatica'/exp OR (lumbago OR sciatica):ti,ab	70,044

Search Set	Search Strategy	Results
#3	((back or low?back or spine or spinal or thoracic or vertebr* or intervertebr* or sciatic* or lumbar or lumbr* or lumbo*) NEAR/3 (pain* or ache* or radiculopath* or polyradiculopath* or compress*)):ti,ab	117,457
#4	(low or lower or lowback or sciatic* or ischia* or lumbo* or lumba* or sacroili* OR sacral):ti,ab	5,793,899
#5	#3 AND #4	77,207
#6	#1 OR# 2 OR #5	183,162
#7	('rehabilitation'/exp AND physical:ti,ab) OR 'exercise'/exp OR 'kinesiotherapy'/exp OR 'fitness'/exp OR 'physiotherapy'/exp OR 'Tai Chi'/exp OR 'yoga'/exp OR 'hydrotherapy'/exp OR 'musculoskeletal manipulation'/exp OR 'cognitive behavioral therapy'/exp OR 'acceptance and commitment therapy'/exp OR 'mindfulness'/exp OR 'meditation'/exp OR 'motivational interviewing'/exp OR 'wearable computer'/exp OR 'activity tracker'/exp OR 'reminder system'/exp OR 'peer group'/exp OR 'peer pressure'/exp OR 'social support'/exp OR 'mentoring'/exp OR 'text messaging'/exp OR 'mobile application'/exp OR (Physical NEAR/1 rehab*):ti,ab OR (Physical NEAR/1 telerehab*):ti,ab OR (Physical NEAR/1 activit*):ti,ab OR (Movement OR exercis* OR sport OR sports OR athletics OR athletic OR yoga OR pilates OR 'Tai chi' OR 'Tai ji' OR fitness OR plyometrics OR hydrotherapy OR 'interval training' OR HIIT OR physiotherap* OR kinesiol* OR cycling OR spinning):ti,ab OR ((circuit* OR strength* OR resistance* OR weight* OR aerobic* OR endurance) NEAR/1 train*):ti,ab OR (Physical NEAR/1 therap*):ti,ab OR ((musculoskeletal OR MSK) NEAR/2 (therap* OR treat* OR therapeutic OR intervention* OR mobilization OR mobilisation)):ti,ab OR ((behavior* OR behaviour* OR psychological OR mental) NEAR/2 (therap* OR treat* OR therapeutic OR intervention* OR adaptation*)):ti,ab OR CBT:ti,ab OR ((acceptance OR commitment) NEAR/2 (therap* OR treat* OR therapeutic OR intervention*)):ti,ab OR (Motivation* NEAR/2 interview*):ti,ab OR (biopsychosocial OR bio?psycho?social OR counselling OR mindfulness OR meditation OR 'Peer-to-peer'):ti,ab OR ((peer OR peers OR social OR caregiver*) NEAR/1 support*):ti,ab OR (coach* OR mentor* OR counsel* OR boost* OR wearable* OR 'fitness tracker' OR 'fitness tracker' OR 'activity tracker' OR 'activity trackers' OR fitbit OR 'apple watch'):ti,ab OR (reminder* NEAR/2 (system* OR messag* OR text* OR mail OR telephone OR phone)):ti,ab OR (automated NEAR/1 (messag* OR text* OR mail OR telephone OR phone)):ti,ab OR (text?messag* OR email OR e?mail OR 'electronic mail' OR 'electronic message' OR 'electronic messages'):ti,ab OR (performance NEAR/1 feedback):ti,ab OR (Remote NEAR/1 monitor*):ti,ab OR ('mobile application' OR 'mobile applications' OR 'mobile apps'):ti,ab	1,937,779
#8	#6 AND #7	37,245
#9	'patient compliance'/exp OR 'medication compliance'/exp OR 'patient participation'/exp OR 'patient attitude'/exp OR 'treatment refusal'/exp OR 'motivation'/exp OR 'self concept'/exp OR 'problem solving'/exp OR 'decision making'/exp OR (Adhere* OR adhering OR Complian* OR complying OR Cooperat*):ti,ab OR ((change OR changes OR changing OR modify OR modifies OR modifying OR modification) NEAR/1 (behavior* OR behaviour*)):ti,ab OR (Motivat* OR incentiv* OR disincentiv* OR perceiv* OR perception* OR belief*):ti,ab OR (Self NEAR/1 efficacy):ti,ab OR Self-	2,749,149

Search Set	Search Strategy	Results
	efficacy:ti,ab OR (Self NEAR/1 monitoring):ti,ab OR Self-monitoring:ti,ab OR (Self NEAR/1 talk):ti,ab OR (Self-talk OR Attitude* OR Empower*):ti,ab OR ((treat* OR therapy OR therapeutic) NEAR/1 refus*):ti,ab OR ((goal OR goals) NEAR/1 setting):ti,ab OR Goal-setting:ti,ab OR (Action NEAR/1 plan*):ti,ab OR (Non?complan* OR Non?adheren* OR Attendance OR Non?attend* OR Encourag*):ti,ab OR (patient NEAR/3 participation):ti,ab	
#10	#8 AND #9	8,078
#11	'crossover procedure'/exp OR 'randomized controlled trial'/exp OR 'controlled clinical trial'/exp OR 'single blind procedure'/exp OR 'double blind procedure'/exp OR 'crossover procedure':de OR 'double-blind procedure':de OR 'randomized controlled trial':de OR 'single-blind procedure':de OR (random* OR factorial* OR crossover* OR cross NEXT/1 over* OR placebo* OR doubl* NEAR/1 blind* OR singl* NEAR/1 blind* OR assign* OR allocat* OR volunteer*):ti,ab OR placebo:ti,ab OR groups:ti,ab OR nonrandom:ti,ab OR non?random:ti,ab OR nonrandomized:ti,ab OR non?randomized:ti,ab OR nonrandomised:ti,ab OR non?randomised:ti,ab OR quasi?experiment*:ti,ab OR quazi?experiment*:ti,ab OR quasirandom*:ti,ab OR quazirandom*:ti,ab OR quasi?random*:ti,ab OR quazi?random*:ti,ab OR quasi?control*:ti,ab OR quazi?control*:ti,ab OR quasicontrol*:ti,ab OR quazicontrol*:ti,ab OR ((controlled:ti,ab) AND (trial:ti,ab OR study:ti,ab))	5,425,748
#12	#10 AND #11	3,771
#13	#12 AND [humans]/lim	3,676
#14	#13 NOT ('case report'/exp OR 'case study'/exp OR 'editorial'/exp OR [editorial]/lim OR 'letter'/exp OR [letter]/lim OR 'note'/exp OR [note]/lim OR [conference abstract]/lim OR 'conference abstract'/exp OR 'conference abstract'/it)	2,655

Database: CINAHL Complete (via EBSCO)

Search date: 7/27/2021

Search Set	Search Strategy	Results
#1	((MH osteoarthritis) AND ((TI knee* OR AB knee*) OR (TI hip* OR AB hip*) OR (TI patella* OR AB patella*))) OR (MH "Osteoarthritis, Hip") OR (MH "Osteoarthritis, Knee") OR (((TI knee OR AB knee) OR (TI knees OR AB knees) OR (TI patella* OR AB patella*) OR (TI hip OR AB hip) OR (TI hips OR AB hips)) AND ((TI osteoarthritis OR AB osteoarthritis) OR (TI osteoarthritic OR AB osteoarthritic) OR (TI arthrosis OR AB arthrosis) OR (TI arthroses OR AB arthroses) OR (TI OA OR AB OA) OR (TI coxarthrosis OR AB coxarthrosis) OR (TI coxarthroses OR AB coxarthroses))) OR (((TI knee* OR AB knee*) OR (TI patella* OR AB patella*) OR (TI hip OR AB hip) OR (TI hips OR AB hips)) AND (TI degenerative OR AB degenerative) AND ((TI arthritis OR AB arthritis) OR (TI arthritic OR AB arthritic) OR (TI joint OR AB joint) OR (TI joints OR AB joints)))	26,315
#2	(MH "Low Back Pain") OR (MH "sciatica") OR ((TI lumbago OR AB lumbago) OR (TI sciatica OR AB sciatica))	22,894

Search Set	Search Strategy	Results
#3	((TI back OR AB back) OR (TI low#back OR AB low#back) OR (TI spine OR AB spine) OR (TI spinal OR AB spinal) OR (TI thoracic OR AB thoracic) OR (TI vertebr* OR AB vertebr*) OR (TI intervertebr* OR AB intervertebr*) OR (TI sciatic* OR AB sciatic*) OR (TI lumbar OR AB lumbar) OR (TI lumbr* OR AB lumbr*) OR (TI lumbo* OR AB lumbo*)) N3 ((TI pain* OR AB pain*) OR (TI ache* OR AB ache*) OR (TI radiculopath* OR AB radiculopath*) OR (TI polyradiculopath* OR AB polyradiculopath*) OR (TI compress* OR AB compress*))	39,563
#4	((TI low OR AB low) OR (TI lower OR AB lower) OR (TI lowback OR AB lowback) OR (TI sciatic* OR AB sciatic*) OR (TI ischia* OR AB ischia*) OR (TI lumbo* OR AB lumbo*) OR (TI lumba* OR AB lumba*) OR (TI sacroili* OR AB sacroili*) OR (TI sacral OR AB sacral))	760,111
#5	S3 AND S4	27,382
#6	S1 OR S2 OR S5	60,510
#7	((MH "Rehabilitation+") AND (TI physical OR AB physical)) OR (MH "Exercise+") OR (MH "Therapeutic Exercise+" OR (MH "Physical Fitness+") OR (MH "Physical Therapy+") OR (MH "Resistance Training") OR (MH "Yoga+") OR (MH "Tai Chi") OR (MH "Meditation") OR (MH "Mental Healing") OR (MH "Hydrotherapy") OR (MH "Applied Kinesiology") OR (MH "Manual Therapy") OR (MH "Cognitive Therapy+") OR (MH "Acceptance and Commitment Therapy") OR (MH "Mindfulness") OR (MH "Motivational Interviewing") OR (MH "Wearable Sensors+") OR (MH "Fitness Trackers") OR (MH "Reminder Systems") OR (MH "Peer Group") OR (MH "Peer Pressure") OR (MH "Support, Psychosocial") OR (MH "Mentorship") OR (MH "Text Messaging+") OR (MH "Mobile Applications") OR ((TI Physical OR AB Physical) W1 (TI rehab* OR AB rehab*)) OR ((TI Physical OR AB Physical) W1 (TI telerehab* OR AB telerehab*)) OR ((TI Physical OR AB Physical) W1 (TI activit* OR AB activit*)) OR ((TI Movement OR AB Movement) OR (TI exercis* OR AB exercis*) OR (TI sport OR AB sport) OR (TI sports OR AB sports) OR (TI athletics OR AB athletics) OR (TI athletic OR AB athletic) OR (TI yoga OR AB yoga) OR (TI pilates OR AB pilates) OR (TI "Tai chi" OR AB "Tai chi") OR (TI "Tai ji" OR AB "Tai ji") OR (TI fitness OR AB fitness) OR (TI plyometrics OR AB plyometrics) OR (TI hydrotherapy OR AB hydrotherapy) OR (TI "interval training" OR AB "interval training") OR (TI HIIT OR AB HIIT) OR (TI physiotherap* OR AB physiotherap*) OR (TI kinesiol* OR AB kinesiol*) OR (TI cycling OR AB cycling) OR (TI spinning OR AB spinning)) OR (((TI circuit* OR AB circuit*) OR (TI strength* OR AB strength*) OR (TI resistance* OR AB resistance*) OR (TI weight* OR AB weight*) OR (TI aerobic* OR AB aerobic*) OR (TI endurance OR AB endurance)) W1 (TI train* OR AB train*)) OR ((TI Physical OR AB Physical) W1 (TI therap* OR AB therap*)) OR (((TI musculoskeletal OR AB musculoskeletal) OR (TI MSK OR AB MSK)) N2 ((TI therap* OR AB therap*) OR (TI treat* OR AB treat*) OR (TI therapeutic OR AB therapeutic) OR (TI intervention* OR AB intervention*) OR (TI mobilization OR AB mobilization) OR (TI mobilisation OR AB mobilisation))) OR (((TI behavior* OR AB behavior*) OR (TI behaviour* OR AB behaviour*) OR (TI psychological OR AB psychological) OR (TI mental OR AB mental)) N2 ((TI therap* OR AB therap*) OR (TI treat* OR AB treat*) OR (TI therapeutic OR AB therapeutic) OR (TI intervention* OR AB intervention*) OR (TI adaptation* OR AB adaptation*)) OR (TI CBT OR AB CBT) OR (((TI acceptance OR AB acceptance) OR (TI commitment OR AB commitment)) N2 ((TI therap* OR AB therap*) OR (TI treat* OR AB treat*) OR (TI therapeutic OR AB therapeutic) OR (TI intervention* OR AB intervention*)))	773,686

Search Set	Search Strategy	Results
	<p>OR ((TI Motivation* OR AB Motivation*) N2 (TI interview* OR AB interview*)) OR ((TI biopsychosocial OR AB biopsychosocial) OR (TI bio#psycho#social OR AB bio#psycho#social) OR (TI counselling OR AB counselling) OR (TI mindfulness OR AB mindfulness) OR (TI meditation OR AB meditation) OR (TI Peer-to-peer OR AB Peer-to-peer)) OR (((TI peer OR AB peer) OR (TI peers OR AB peers) OR (TI social OR AB social) OR (TI caregiver* OR AB caregiver*)) W1 (TI support* OR AB support*)) OR ((TI coach* OR AB coach*) OR (TI mentor* OR AB mentor*) OR (TI counsel* OR AB counsel*) OR (TI boost* OR AB boost*) OR (TI wearable* OR AB wearable*) OR (TI "fitness tracker" OR AB "fitness tracker") OR (TI "fitness tracker" OR AB "fitness tracker") OR (TI "activity tracker" OR AB "activity tracker") OR (TI "activity trackers" OR AB "activity trackers") OR (TI fitbit OR AB fitbit) OR (TI "apple watch" OR AB "apple watch")) OR ((TI reminder* OR AB reminder*) N2 ((TI system* OR AB system*) OR (TI messag* OR AB messag*) OR (TI text* OR AB text*) OR (TI mail OR AB mail) OR (TI telephone OR AB telephone) OR (TI phone OR AB phone))) OR ((TI automated OR AB automated) W1 ((TI messag* OR AB messag*) OR (TI text* OR AB text*) OR (TI mail OR AB mail) OR (TI telephone OR AB telephone) OR (TI phone OR AB phone))) OR ((TI text#messag* OR AB text#messag*) OR (TI email OR AB email) OR (TI e#mail OR AB e#mail) OR (TI "electronic mail" OR AB "electronic mail") OR (TI "electronic message" OR AB "electronic message") OR (TI "electronic messages" OR AB "electronic messages")) OR ((TI performance OR AB performance) W1 (TI feedback OR AB feedback)) OR ((TI Remote OR AB Remote) W1 (TI monitor* OR AB monitor*)) OR ((TI "mobile application" OR AB "mobile application") OR (TI "mobile applications" OR AB "mobile applications") OR (TI "mobile apps" OR AB "mobile apps"))</p>	
#8	S6 AND S7	17,992
#9	<p>(MH "Patient Compliance+") OR (MH "Medication Compliance") OR (MH "Consumer Participation") OR (MH "Treatment Refusal") OR (MH "Motivation+") OR (MH "Self Efficacy") OR (MH "Problem Solving+") OR (MH "Decision Making+") OR ((TI Adhere* OR AB Adhere*) OR (TI adhering OR AB adhering) OR (TI Complian* OR AB Complian*) OR (TI complying OR AB complying) OR (TI Cooperat* OR AB Cooperat*)) OR (((TI change OR AB change) OR (TI changes OR AB changes) OR (TI changing OR AB changing) OR (TI modify OR AB modify) OR (TI modifies OR AB modifies) OR (TI modifying OR AB modifying) OR (TI modification OR AB modification)) W1 ((TI behavior* OR AB behavior*) OR (TI behaviour* OR AB behaviour*)) OR ((TI Motivat* OR AB Motivat*) OR (TI incentiv* OR AB incentiv*) OR (TI disincentiv* OR AB disincentiv*) OR (TI perceiv* OR AB perceiv*) OR (TI perception* OR AB perception*) OR (TI belief* OR AB belief*)) OR ((TI Self OR AB Self) W1 (TI efficacy OR AB efficacy)) OR (TI Self-efficacy OR AB Self-efficacy) OR ((TI Self OR AB Self) W1 (TI monitoring OR AB monitoring)) OR (TI Self-monitoring OR AB Self-monitoring) OR ((TI Self OR AB Self) W1 (TI talk OR AB talk)) OR ((TI Self-talk OR AB Self-talk) OR (TI Attitude* OR AB Attitude*) OR (TI Empower* OR AB Empower*)) OR (((TI treat* OR AB treat*) OR (TI therapy OR AB therapy) OR (TI therapeutic OR AB therapeutic)) W1 (TI refus* OR AB refus*)) OR (((TI goal OR AB goal) OR (TI goals OR AB goals)) W1 (TI setting OR AB setting)) OR (TI Goal-setting OR AB Goal-setting) OR ((TI Action OR AB Action) W1 (TI plan* OR AB plan*)) OR ((TI Non#complan* OR AB Non#complan*) OR (TI Non#adheren* OR AB Non#adheren*) OR (TI Attendance OR AB Attendance) OR (TI Non#attend* OR AB</p>	792,963

Search Set	Search Strategy	Results
	Non#attend*) OR (TI Encourag* OR AB Encourag*) OR ((TI patient OR AB patient) N3 (TI participation OR AB participation))	
#10	S8 AND S9	3,188
#11	(ZT "randomized controlled trial") OR (MH "Randomized Controlled Trials") OR TI ("randomized controlled trial" OR "controlled clinical trial" OR randomized OR randomised OR randomization OR randomisation OR placebo OR randomly OR trial OR trials OR groups OR "single blind" OR "single blinded" OR "double blind" OR "double-blinded OR nonrandom* OR non-random* OR quasiexperiment* OR quasi-experiment* OR quaziexperiment* OR quazi-experiment* OR quasirandom* OR quasi-random* OR quazirandom* OR quazi-random* OR quasicontrol* OR quasi-control* OR quazicontrol* OR quazi-control*) OR AB ("randomized controlled trial" OR "controlled clinical trial" OR randomized OR randomised OR randomization OR randomisation OR placebo OR randomly OR trial OR trials OR groups OR "single blind" OR "single blinded" OR "double blind" OR "double-blinded OR nonrandom* OR non-random* OR quasiexperiment* OR quasi-experiment* OR quaziexperiment* OR quazi-experiment* OR quasirandom* OR quasi-random* OR quazirandom* OR quazi-random* OR quasicontrol* OR quasi-control* OR quazicontrol* OR quazi-control*)	300,658
#12	S10 AND S11	758
#13	S12 NOT PT (Abstract OR Book OR Book Chapter OR Book Review OR Case Study OR Commentary OR Editorial OR Letter OR Masters Thesis OR Pamphlet OR Pamphlet Chapter OR Poetry)	738

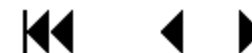
APPENDIX B. STUDY CHARACTERISTICS

Study	Sample Size Condition Targeted	Population Mean Age Female % Race %	Index Rehabilitation Program Characteristics (Duration)	Adherence Adjunct Characteristics (Frequency, Duration)	Outcomes Assessed	Risk of Bias Funding Source Conflict Declared
<i>Concurrently Delivered Adjunct Adherence Interventions</i>						
Bennell, 2017 ²⁵	N=168 Knee OA	Median age: 62.3 Women: 63% Race: NR	5 sessions focused on quad and hip strengthening (6 months)	Coaching, motivation, self-efficacy, and therapeutic alliance (6 telephone coaching sessions over 6 months with the option for 6 more for total of 12)	Adherence, Physical function, Adverse events	Low risk Supported by the National Health and Medical Research Council Primary author declared conflict
Pisters, 2010 ²⁶	N=200 Hip OA, Knee OA	Median age: 65.0 Women: 77% Race: NR	Maximum of 18 individual usual care physical therapy sessions (3 months)	Eighteen sessions behavioral graded activity over 12 weeks + up to 7 booster sessions over the next year focused on patient functioning, addressing barriers, support, and integrating change into daily living	Adherence, Physical function	Some concerns None listed No conflicts declared

Study	Sample Size Condition Targeted	Population Mean Age Female % Race %	Index Rehabilitation Program Characteristics (Duration)	Adherence Adjunct Characteristics (Frequency, Duration)	Outcomes Assessed	Risk of Bias Funding Source Conflict Declared
Brosseau, 2012 ¹⁸	N=222 Knee OA	Median age: 63.4 Women: 68.9% Race: 89% White, 2.3% Black, 3.6% Hispanic, 4.5% Asian or Pacific Islander	Community-based supervised aerobic walking program. All provided with pedometers and log books to track physical activity. Three weekly sessions (12 months)	Twenty group sessions: short/long-term goal setting and instructional sessions about benefits of physical activity and in-person monthly sessions with moral support. Goal setting and telephone counselling were also provided. (32 sessions possible over 12 months)	Adherence, Self-efficacy	Patient reported: High Objective: Low Canadian Institute of Health Research (CIHR) No conflicts declared
Ben-Ami, 2017 ¹⁹	N=220 Low back pain	Median age: 42.0 Women: 54% Race: NR	Usual care physical therapy (3 months)	Enhanced transtheoretical model intervention: focused on motivation/self-efficacy, mutual decision-making about recreational aerobic activity; could offer up to 4 specific back exercises (1 initial evaluation, at least 2 follow-ups over an estimated 3 months)	Adherence, Physical function	Serious risk Maccabi Healthcare Services in Israel No conflicts declared
Lonsdale, 2017 ²⁴	N= 255 Low back pain	Median age: 45.4 Women: 54% Race: NR	Usual care physical therapy (3 months)	Communication training for providers included self-determination theory, implementing communication strategies, simulated treatment sessions, role play, goal setting, group sessions and email follow-up (8 hours of training)	Adherence	High risk Health registration board of Ireland Author declared conflicts



Study	Sample Size Condition Targeted	Population Mean Age Female % Race %	Index Rehabilitation Program Characteristics (Duration)	Adherence Adjunct Characteristics (Frequency, Duration)	Outcomes Assessed	Risk of Bias Funding Source Conflict Declared
Friedrich, 1998 ²⁷ Companion: Friedrich 2005 ²⁸	N=93 Low back pain	Median age: 44.1 Women: 50% Race: NR	Rehabilitation consisted of a submaximal graded exercise program for 10 sessions (approximately 1 month)	Same exercise program as comparator + counseling covering: 1) information strategies including adherence, 2) reinforcement, 3) treatment contract, 4) placing treatment contract in prominent place, 5) exercise diary	Adherence, Physical function, Self-efficacy	High risk None listed No conflicts declared
<i>Sequentially Delivered Adjunct Adherence Interventions</i>						
Bennell, 2020 ²⁰	N=110 Knee OA	Median age: 62.3 Women: 67% Race: NR	5 physical therapy sessions (3 months)	One-way text messages (5 messages weekly for 24 weeks)	Adherence, Physical function, Adverse events	Low risk National Health and Medical Research Council Program Grant First author declared conflicts
Quicke, 2017 ²²	N=514 Knee OP	Median age: 62.8 Women: 51% Race: NR	Up to 4 one-on-one sessions with physical therapist (3 months)	Adherence toolkit: self-monitoring, diaries, and follow-up adherence sessions (8-10 contacts over 6 months)	Adherence, Physical function, Adverse events, Self-efficacy	Some concerns National Institute for Health Research No conflicts declared



Study	Sample Size Condition Targeted	Population Mean Age Female % Race %	Index Rehabilitation Program Characteristics (Duration)	Adherence Adjunct Characteristics (Frequency, Duration)	Outcomes Assessed	Risk of Bias Funding Source Conflict Declared
Baker, 2020 ²¹	N=104 Hip OA	Median age: 65.2 Women: 82% Race: 60% White	Tailored supervised strength training exercise program (1.5 months)	Computer-based telephone counseling with assessment of behavior, goal setting, lapsing information. Alerts to the study team when the participants experienced bad pain or an extended lapse in exercise. (Weekly call for first 6 months, then monthly for next 18 months)	Adherence, Physical function	High risk National Institute of Disability, Independent Living, and Rehabilitation No conflicts declared
Bennell, 2014 ²³	N=78 Knee OA	Median age: 62.1 Women: 54% Race: NR	14 physical therapy visits over 12 weeks. 2 sessions in first week and then 1 session per week after. Patients completed a quad strengthening program or a neuromuscular exercise program (3 months)	Booster sessions (2 additional sessions over 24 weeks)	Adherence, Physical function, Adverse events	High risk Supported by the National Health and Medical Research Council No conflicts declared

Notes. Two studies reported adjunct components that both overlapped the rehabilitation intervention and continued sequentially after the rehabilitation ended.^{22,26}
Abbreviations. OA=Osteoarthritis.



APPENDIX C. INTERVENTION CHARACTERISTICS

Study	Index Rehabilitation Program	Adjunct Intervention Components	Intervention Timing	Type of Provider	# BCTs Described
Condition	Duration	Duration Fidelity	Theory or Conceptual Approach	Mode	
<i>Concurrently Delivered Adjunct Adherence Interventions</i>					
Bennell, 2017 ²⁵	5 (30 minute) sessions over 6 months focused on quad and hip strengthening and prescription for evidence-based progressive individualized home exercise program	Coaching, motivation, self-efficacy, and therapeutic alliance	Concurrent	Physical therapist, Nurse, Psychologist, Occupational therapist	Adjunct intervention group: 13
Knee OA	: 6 months	6 months with the option for 6 more (for a total of 12) Most attended all 5 therapy sessions; 4.4 (SD 1.2) intervention vs 4.3 (SD 1.4) control; overall mean fidelity of coaches on calls 7.1 (SD 0.6) out of 10	HealthChange (ie, motivational interviewing, cognitive behavioral therapy, and solution focused coaching)	Telephone	Control group: 11
Pisters, 2010 ²⁶	Maximum of 18 sessions (30 minute) individual sessions with physical therapist (intervention arm received behavioral exercise program vs usual PT care in comparator arm)	Behavioral exercise program with additional booster sessions focused on patient functioning, addressing barriers, support, and integrating change into daily living	Concurrent	Physiotherapists	Adjunct intervention group: 12
Knee/Hip OA	3 months	Additional 7 booster sessions over 5 weeks 17% deviated from trial protocol; intervention average 9.8 of 18 sessions (SD 3.5) vs 11.7 (SD 4.3) over 12 weeks	Operant conditioning	In-person	Control group: 10

Study	Index Rehabilitation Program	Adjunct Intervention Components	Intervention Timing	Type of Provider	# BCTs Described
Condition	Duration	Duration Fidelity	Theory or Conceptual Approach	Mode	
Brosseau, 2012 ¹⁸	Community-based supervised aerobic walking program. All provided with pedometers and log books to track physical activity. Three (65 minute) weekly sessions. 12 months	20 (2 hour) group sessions: short/long-term goal setting and instructional sessions about benefits of physical activity and in-person monthly sessions with moral support. Goal setting and telephone counselling were also provided. 32 sessions possible over 12 months NR	Concurrent Not reported	Not reported In-person and telephone	Adjunct intervention group: 9 Walking control group: 5
Knee OA					
Ben-Ami, 2017 ¹⁹	Usual care physical therapy 3 months	Counseling included minimum of 2 (20-30 minute) one-on-one sessions with no upper limit. Sessions focused on motivation/self-efficacy, mutual decision-making about recreational aerobic activity; could offer up to 4 specific back exercises One 40 min initial evaluation, at least two 1:1 20-30 min follow-ups 65% intervention group completed treatment vs 45% control group	Concurrent Transtheoretical model	Physical therapist In-person	Adjunct intervention group: 17 Control group: 9
Chronic Low Back Pain					

Study	Index Rehabilitation Program	Adjunct Intervention Components	Intervention Timing	Type of Provider	# BCTs Described
Condition	Duration	Duration Fidelity	Theory or Conceptual Approach	Mode	
Lonsdale, 2017 ²⁴	Usual care physical therapy	Communication training for providers included self-determination theory, implementing communication strategies, simulated treatment sessions, role play, goal setting, group sessions and email follow-up	Concurrent	Physical therapist	Adjunct intervention group: 12
Chronic Low Back Pain	3 months	Physical therapists received 8 hours of training Planned for use of blinded accelerometers but didn't use 2/2 participant burden; convenience sample of 24 patients to evaluate support provision – found large positive effect of training $d = 2.27$	Self-determination theory	In-person	Control group: 9
Friedrich, 1998 ²⁷	Rehabilitation consisted of a submaximal graded exercise program for 10 (25 minute) sessions.	Counseling elements included 1) information, 2) reinforcement, 3) treatment contract, 4) placing treatment contract in prominent place, 5) exercise diary.	Concurrent	Physical therapist	Adjunct intervention group: 18
Companion: Friedrich 2005 ²⁸	1 month	10 (25-minute) sessions over approximately 5 weeks	Not reported	In-person	Control group: 8
Chronic Low Back Pain		Intervention arm: 81.8% treatment sessions vs 51% control			

Study	Index Rehabilitation Program	Adjunct Intervention Components	Intervention Timing	Type of Provider	# BCTs Described
Condition	Duration	Duration	Theory or Conceptual Approach	Mode	
<i>Sequentially Delivered Adjunct Adherence Interventions</i>					
Bennell, 2020 ²⁰	Five (30-40 minute) physical therapy sessions included non-weight-bearing exercise aimed at the quads and functional weight-bearing exercises aimed at hips and quads/hamstrings.	24 weeks of automated, semi-interactive text messages	Sequential	Physical therapist	Adjunct intervention group: 26 BCTs
Knee OA	3 months	Up to 5 text messages weekly for 24 weeks 2 in intervention arm stopped SMS messages; mean messages 57.9 (9.1) total (total range 46-58); reply rate to self-reporting home sessions 66% (SD 34%)	COM-B (capability, opportunity, and motivation)	Test messages	Control group: 11 BCTs
Quicke, 2017 ²²	Up to 4 one-on-one sessions with physical therapist	Adherence toolkit: self-monitoring, diaries, and follow-up adherence sessions	Sequential	Physical therapist	Adjunct intervention group: 11
Companion: Hay 2018 ⁶²	3 months	8-10 contacts over 6 months	Self-efficacy and self-regulation theory	In-person and telephone	Control group: 7
Knee OA		7.6% received no PT (6.9% control, 7.4% intervention group); control group had fewer sessions than intervention: median 3 (IQR 2-4) vs 7 (4-8); control received 89% in line with protocol vs 48% in intervention group			

Study	Index Rehabilitation Program	Adjunct Intervention Components	Intervention Timing	Type of Provider	# BCTs Described
Condition	Duration	Duration	Theory or Conceptual Approach	Mode	
		Fidelity			
Baker, 2020 ²¹	Tailored supervised strength training exercise program. Participants were asked to continue the program for 2 years following the run-in period.	Monthly motivational adherence counseling telephone calls: Assessment of behavior, goal setting, overcoming barriers to exercise, lapsing information, alerts to the study team when the participants experienced bad pain or an extended lapse in exercise; optional booster session	Sequential	Exercise physiologists, physical therapists, interventionists	Adjunct intervention group: 14 BCTs
Knee OA	1.5 months	Weekly call for first 6 months, then monthly for next 18 months	Transtheoretical module, social cognitive theory, self-efficacy	Telephone	Control group: 9 BCTs
		Specifics of compliance not given; only a few used booster sessions from each arm			
Bennell, 2014 ²³	Fourteen (30-40 minute) physical therapy visits over 12 weeks. 2 sessions in first week and then 1 session per week after. Patients completed a quad strengthening program or a neuromuscular exercise program.	Booster sessions	Sequential	Physical therapist	Adjunct intervention group: 11
Knee OA	3 months	2 additional 30-minute sessions over 24 weeks	Not reported	In person	Control group: 9
		In intervention group: 63% attended both, 25% only 1, 12% neither			

Notes. Two studies reported adjunct components that both overlapped the rehabilitation intervention and continued sequentially after the rehabilitation ended.^{22,26}
 Abbreviations. OA=Osteoarthritis.



APPENDIX D. EXCLUDED STUDIES

Exclude reasons: 1=Non-OECD, 2=Ineligible population, 3=Ineligible comparator, 4=Ineligible outcome, 5=Ineligible intervention, 5=Ineligible timing, 6=Ineligible study design.

Citation	Exclude Reason
Aliyu, 2018 ¹	1
Bagheri, 2020 ²	1
Buchner, 2006 ³	2
Canaway, 2018 ⁴	4
Chen, 2020 ⁵	1
Chen, 2016 ⁶	2
Cheung, 2016 ⁷	3
Christiansen, 2020 ⁸	2
Christiansen, 2010 ⁹	4
Coppack, 2012 ¹⁰	6
Davergne, 2019 ¹¹	2
De Oliveira Silva, 2020 ¹²	2
Elbadawy, 2017 ¹³	1
Focht, 2014 ¹⁴	3
Garver, 2011 ¹⁵	3
Gay, 2020 ¹⁶	3
George, 2010 ¹⁷	3
Geraghty, 2018 ¹⁸	5
Godges, 2008 ¹⁹	2
Gohner, 2006 ²⁰	2
Hay, 2018 ²¹	7
Hugli, 2015 ²²	5
Hunt, 2013 ²³	4
Iles, 2011 ²⁴	2
Jacobson, 2015 ²⁵	5
Jensen, 2001 ²⁶	2
Jensen, 2012 ²⁷	3
Jessep, 2009 ²⁸	3
Johansson, 2009 ²⁹	2
Kaapa, 2006 ³⁰	5
Karvannan, 2012 ³¹	1
Keefe, 2004 ³²	4
Keefe, 1999 ³³	5
Kerns, 2014 ³⁴	3
King, 2008 ³⁵	3

Citation	Exclude Reason
Krein, 2013 ³⁶	3
Ledingham, 2020 ³⁷	3
Li, 2020 ³⁸	3
Lonsdale, 2012 ³⁹	3
Marconcin, 2021 ⁴⁰	5
Meng, 2017 ⁴¹	3
Monticone, 2021 ⁴²	2
Nelligan, 2019 ⁴³	7
Nelson, 2020 ⁴⁴	2
Nicolson, 2018 ⁴⁵	3
O'Brien, 2013 ⁴⁶	4
O'Neill, 2020 ⁴⁷	5
Palmer, 2014 ⁴⁸	5
Patel, 2014 ⁴⁹	4
Pelle, 2021 ⁵⁰	3
Penttinen, 2002 ⁵¹	4
Pires, 2020 ⁵²	3
Reilly, 1989 ⁵³	5
Rejeski, 1997 ⁵⁴	3
Rini, 2015 ⁵⁵	3
Ronzi, 2017 ⁵⁶	4
Şahin Onat, 2013 ⁵⁷	4
Schiltenswolf, 2006 ⁵⁸	5
Shimo, 2021 ⁵⁹	4
Smeets, 2006 ⁶⁰	5
Smeets, 2008 ⁶¹	3
Steinhilber, 2012 ⁶²	2
Storro, 2004 ⁶³	3
Suzuki, 2019 ⁶⁴	2
Thomas, 2002 ⁶⁵	5
Van Dillen, 2016 ⁶⁶	2
van Dulmen, 2014 ⁶⁷	1
Vong, 2011 ⁶⁸	3
Walsh, 2013 ⁶⁹	2
Willett, 2017 ⁷⁰	3

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APPENDIX E. PEER REVIEW DISPOSITION

Question Text	Reviewer Number	Comment	Response
Are the objectives, scope, and methods for this review clearly described?	1	Yes	
	2	Yes	
	3	Yes	
	4	Yes	
	5	Yes	
	6	Yes	
Is there any indication of bias in our synthesis of the evidence?	1	No	
	2	No	
	3	No	
	4	No	
	5	No	
	6	No	
Are you aware of any <u>published</u> or <u>unpublished</u> studies that we may have overlooked?	1	No	
	2	No	
	3	No	
	4	No	
	5	No	
	6	No	
Additional suggestions or comments can be provided below. If applicable, please indicate the page and line numbers from the draft report.	1		
	2	Executive Summary, Key Findings Page 11, 3rd bullet from top, and on page 14 key findings and strength of evidence - report states "...overlap in behavior change techniques with comparator arms" - Were rationales provided in the study publications on why the BCT overlap between arms? Or adherence/maintenance was not the	We appreciate this important question. Five of the 10 unique included studies had adherence as a primary outcome or aim of the study. Of these, only one study (Bennell et al) ²⁰ mentions that the intervention development was informed by the BCTs and related theory. No studies provide a rationale for the overlap. We have added this to the executive summary and the main body of the report (Key Findings and Discussion sections).

Question Text	Reviewer Number	Comment	Response
		primary aim of the trial?	
	2	Executive summary Page 11 - 7th bullet - appears to be a typo - says "imitation" Should it be "initiation?"	Thank you, this typo has been corrected.
	2	Page 12: intervention characteristics - all were PTs who delivered intervention - did the research report training/knowledge/experience of PT in behavior change techniques? Did any of the final studies report fidelity or quality of delivery?	<p>We agree that these are key details about the included studies that warrant reporting.</p> <p>Little information was provided about the training of the physical therapy interventionists. Only three studies mentioned PT training and they reported on the standard of care training.^{19,24,27} None reported training specifically about PT knowledge or familiarity with BCTs. A comment was added about this lack of available detail (see Executive Summary and main report in Intervention Characteristics sections).</p> <p>All but one study¹⁸ provided some information about fidelity to intervention protocol, though the method of reporting fidelity was variable. There was no clear pattern between higher reported fidelity and intervention effect. We have added this information to Appendix C.</p>
	2	Page 15 - Lines 20-23 "Overall we determined there was low certainty that adjunctive intervention components have no effect on the adherence....." THIS IS A CONFUSING STATEMENT -do you mean your team could not conclude that actually no effect exists on adherence or low certainty of any effect existing on adherence??	<p>We have clarified the wording of the certainty of evidence statement in the key findings and strength of evidence section of the executive summary to read:</p> <p>"Overall, based on GRADE criteria, we found low certainty of evidence that there is no effect of adjunctive interventions on adherence..."</p>
	2	Page 25 lines 12 - we analyzed data narratively?? What does that mean?	<p>We have reworded this section of the data synthesis methods in the executive summary for clarity and the passage now reads as follows:</p> <p>"Because quantitative synthesis was not feasible, we analyzed data narratively through descriptive approaches which identify patterns in</p>



Question Text	Reviewer Number	Comment	Response
			key outcomes, comparators, intervention approaches, and other study characteristics.”
	2	Page 29 Behavior Change Techniques How was goal setting utilized? Were these clinical goals or patient self management goals? Support? The report includes very little details on the operationalization of BCTs. The authors do state often BCTs were insufficiently described in papers. (page 57)	The Behavior Change Technique Taxonomy provides extensive definitions of each of the 93 individual BCTs. There are multiple specific techniques for goal setting. For example, BCT 1.1 is related to behavioral goal setting while BCT 1.3 described a goal focused on a specific outcome. While it is beyond the scope of this report to provide granular detail about each technique, we would refer readers to the reference by Mitchie et al ¹⁰ for more extensive definitions. We have also added text noting that there was little detail about how individual BCTs were operationalized across the included studies (see BCT section in main report results).
	2	Page 30 - line #16 - What is covert learning? Is this vicarious learning?	The BCT cluster “covert learning” includes BCTs for imaginary punishment, imaginary reward, and vicarious consequences. Further detail can be found in Michie et al ¹⁰
	2	Overall, the authors performed rigorous methods with a limited set of eligible trials.	Thank you
	5	This manuscript focused on synthesizing the evidence regarding interventions to improve long-term adherence to physical rehabilitation among adults with hip or knee osteoarthritis or chronic low back pain. Overall, this was a well-written review and the authors used rigorous study selection and review methods. Most of my comments (outlined below) focus on additional contextualization of the literature or revisions for clarity/readability.	Thank you
	5	1. What was the length of intervention provided (not just time to the follow-up assessment) for each sequentially delivered adjunct adherence intervention (some of this info is in the appendix, but it would be helpful to have it in the main	We agree fully that intervention dose plays an important role in behavior maintenance. The duration of contact across the sequentially delivered interventions was 6 months for 3 of the 4 sequential studies and 2 years for the 4 th . The frequency of contact during the intervention period ranged from 2 contacts over 6 months to 42 contacts over 2 years. As noted by the reviewer, the one

Question Text	Reviewer Number	Comment	Response
		<p>paper)? For example, it is described that the Bennell et al study (which showed an effect) was delivered weekly for 24 weeks, which represents weekly contact throughout the 6-month follow-up period. Another intervention is described as including two booster sessions; however, the frequency/duration of contact in the other studies is not described. This might be important as, in other health behavior change areas, the amount and continued nature of contact appears to be critical for promoting maintenance (e.g., in research on obesity treatment programs, provision of continued follow-up by an interventionist has been shown to promote long-term weight loss maintenance; however this effect disappears when extended-care interventions end, suggesting that a chronic disease/continuous care model may be more appropriate for continued promotion of weight loss maintenance). It would be helpful to investigate whether the frequency/duration of contact was associated with stated outcomes, and highlight this as an area of future research if a gap is identified.</p>	<p>sequentially delivered intervention that showed an effect was Bennell et al.²⁰ We have moved this information from the appendix into the Intervention Characteristics section of the Executive Summary and main report.</p> <p>Regarding the importance of the association between intervention dose and outcomes, we are unable to consider any subgroup analysis by this design feature given the small number of identified studies relevant to this question. We agree that it should be noted as a gap for future research. We have added this to the future research sections (see Table 8).</p>
	5	<p>2. The authors cite the Voils paper (citation 7) in several places to back up the argument that maintenance of behavior change requires fundamentally different skills than those used for initiation of behavior change. Although this has been argued in relation to several health behaviors, there still exists limited / preliminary data to back up this model. The Voils paper cited is</p>	<p>We appreciate the reviewer’s comment and agree we did not provide full support for our argument. While the study of Voils et al that we cited is a pilot study, it is one that incorporated over a decade of research and foundational thought into the development of a new framework. Examples of prior work contributing to this concept including work by Kwasnicka et al, Greaves et al, and Howlett et al.^{13,39-41} In addition, the framework from Voils’ paper has been subsequently used in well-powered trials which have gone on to demonstrate positive effect (Voils et al, 2017).^{37,38} We have added these citations to the discussion section of the main report as well.</p>



Question Text	Reviewer Number	Comment	Response
		only a pilot trial and by itself does not provide the level of evidence necessary to support this argument as it is written in the paper. Consider presenting more nuance within this argument, highlighting gaps in this area as another potential area for future research.	
	5	<p>Other comments by section:</p> <p>3. Data synthesis, page 14: the authors note “standardized mean differences...were calculated as the difference in change from the end of rehabilitation program between arms.” Please clarify how these were calculated (e.g., typically this means dividing means by SDs, was this done? Were SDs available in all articles?). For which studies were all data available and for which did you have to make assumptions based on baseline data?</p>	<p>We have added further details to the methods section describing how standardized mean differences were calculated for all studies in forest plots using the pooled standard deviation.</p> <p>One study²³, provided SD as a function of change directly. For all other studies, we computed SD of change from after-treatment to follow-up assuming correlation of 0.5 between after-treatment SD and follow-up SD.</p> <p>For two studies^{19,24}, we used mean change from baseline to after-treatment and the baseline mean (and corresponding SDs) to compute after-treatment mean change and SD (assuming 0.5 correlation between baseline and after-treatment measurements). We computed follow-up mean and SD the same way. Details have been added to the Key Outcomes of Interest results section of the main report.</p>
	5	4. The discussion describes issues with missing outcome data; however, it is unclear from the results how much data were missing and whether missing data procedures were used (this could also represent another important future direction for research).	Thank you, we have highlighted missing data as a key contributor to study ratings of high risk of bias in the quality of the evidence section of the results.
	5	5. Also in the discussion, it would be helpful to provide more information on the categories of BCTs/individual BCTs that were not included in reviewed	We discuss categories of BCTs that may be useful for future research that were not well represented in our included studies in the “Future Intervention Design Considerations” on page 65. Some

Question Text	Reviewer Number	Comment	Response
		interventions as potential areas for future research.	examples include social support, behavioral contracts, intention to perform exercises, and the use of rewards.
	5	6. In Appendix E, it would be helpful to provide more detail on what each BCT is (vs. just giving the #) so that readers do not have to reference another paper to understand which BCTs were included/which were excluded.	Thank you, the BCT domains have been added to this appendix (Appendix F in the final report).
	5	7. Figure 1: I find this figure confusing / hard to follow – I’m not sure what it adds beyond the text, and the use of boxes and arrows could potentially mislead readers to assume that moderation and mediation pathways are being described (these may be appropriate, but should be discussed in the text as well).	For our reports, we include a visual representation of an analytic framework, as opposed to a conceptual model, using standardized nomenclature for systematic reviews. We agree that the previous version was somewhat confusing and could be interpreted to imply that the listed intermediate outcomes were mediators of the distal health outcomes. We have reworked this figure and clarified the associated text.
	5	8. Table 7: I do not understand why there are studies separated out within rows (e.g., under adherence 3 to 6 months, 4 RCTs are in one row while another RCT is in another); shouldn’t certainty of evidence summarize certainty across ALL of these studies, combined?	Thank you. Randomized and nonrandomized designs are not combined as per GRADE guidance. ¹⁷ Studies reporting dichotomous outcomes could not be combined with studies reporting continuous outcomes. This clarification has been added to the report (rating the body of evidence methods section and table 7 notes).
	5	9. Table 8: The first bullet point is a full sentence but the remaining bullet points are not; it would be helpful for readability to pick one format and stick with it. Similarly, some of the bullet points identify gaps (missing research in the field) while others seem more like they are suggesting solutions (e.g., suggesting specific new areas). Consider clarifying how gaps are described (for further clarification between the two, could a column of	Thank you, we have standardized the bullet point formatting and clarified the language.

Question Text	Reviewer Number	Comment	Response
		"future directions" be added to the table?).	
	5	Other minor comments: 10. Acronyms are used before they are defined (e.g., use of OA, ROB, BCTs, SMD in the executive summary). PICOTS is undefined.	Thank you. We have added expansions for the acronyms.
	5	11. There are some typos/grammatical mistakes (I've identified some below); the manuscript would benefit from close proofing. For example: <ul style="list-style-type: none"> • The final bullet point in the executive summary: did the authors mean to write that "focus of differences in initiation" vs "imitation"? In this same bullet point, modifying "tailoring" to "tailor" would promote readability via parallel format across each recommendation. • Readability would be improved by consistently writing out or using numerals consistently (e.g., "two investigators" vs "2 investigators" in Data Abstraction section on page 2). • Readability would also be improved by consistent use of either active or passive voice. • Page 47, line 21: there is an extra word ("studies did not have an a prior focus") 	Thank you. These typos have been addressed where necessary. The ESP style guide stipulates that numbers are written as numerals unless they appear at the start of a sentence.
	6	•Page 3, line 52: adjective should be adjunctive	Thank you, we corrected this typo.
	6	• Page 4, lines 51-54 requires further explanation – too vague	We have added further clarification by adding the specific models that specify conceptually distinct stages for initiation and long-term adherence.
	6	• Page 47, line 21 "a prior" should be "a priori"	Thank you, we corrected this typo.

Question Text	Reviewer Number	Comment	Response
	6	<p>• I think the conclusions and findings are logical based on the review. I have input about self-efficacy. There are many different self-efficacy scales and self-efficacy is behavior specific. For example, the Arthritis Self-Efficacy Scale assesses a person’s confidence in managing their condition (arthritis). It is a poor reflection of a person’s confidence to complete their exercise home program, yet I’m guessing it was used in some of the studies for this purpose. I also wonder if in the studies that measured self-efficacy, they included specific interventions to improve self-efficacy. I looked at one of the articles cited (Bennell et al, 2020) and it doesn’t appear to me that they included interventions to improve exercise self-efficacy, but it’s difficult to tell. The types of interventions that should be used to improve self-efficacy for exercise include mastery experiences, vicarious experiences, verbal persuasion, and affective states. While I’m not sure this information changes your results/conclusions, it is an observation you could include that has implications for future research. You did mention that several of the self-efficacy scales were not valid and reliable; I think you could also indicate that they may not have been well-matched for the intervention, and, the interventions did not employ specific approaches to enhance self-efficacy. The fact that numerous articles found no difference between self-efficacy scores in the control and experimental groups illustrates my point.</p>	<p>We agree that measures of self-efficacy should be specific to the behavior in question and those used by the included studies did not all align with adherence to a home exercise program. We included all related outcomes though acknowledge this is not ideal and have clarified this in the report under key points in the discussion section of the main report.</p> <p>The reviewer raises an important point about the need for the inclusion of intervention components to promote self-efficacy related to completing recommended exercise regimens. At this point, there are no clear BCTs that have been identified which are clearly associated with improved self-efficacy though in the context of physical activities more BCTs seem to be associated with improved self-efficacy (Tang et al).⁴² We have added clarity around this limitation in the report and as an area for future research.</p>

Question Text	Reviewer Number	Comment	Response
	6	I wonder about the compounding factor of face-to-face interventions vs. telephonic or text message interventions. It seems that you lumped all approaches together. If the literature indicates that there is no difference in outcomes comparing face-to-face interventions and telephonic/SMS/computer, then I think this is a sound approach. If the literature does not support no difference, then the difference needs to be teased out.	Because the literature in the field is nascent and the volume of studies is small, it is challenging to draw comparisons for outcomes related to the face-to-face vs telephonic/text message interventions. No studies made this direct comparison. We highlight this as an evidence gap to be further explored in Table 8.

APPENDIX F. BEHAVIOR CHANGE TECHNIQUES USED IN INCLUDED STUDIES BY INTERVENTION AND COMPARATOR GROUPS

Please refer to the main report's reference list for full citations.

Study	Index Rehabilitation Program		Adjunct Adherence-Enhancing Intervention	
<i>Concurrently Delivered Adjunct Adherence</i>				
Bennell 2020 ²⁰	Goals and planning (1.1,1.4) Feedback and monitoring (2.1,2.2,2.3) Shaping knowledge (4.1)	Comparison of behavior (6.1) Repetition and substitution (8.1,8.6,8.7) Comparison of outcomes (9.1)	Goals and planning (1.2,1.3) Feedback and monitoring (2.4) Social support (3.1) Shaping knowledge (4.4) Natural consequences (5.1) Comparison of behavior (6.2) Associations (7.1)	Repetition and substitution (8.3) Reward and threat (10.9) Antecedents (12.1,12.4) Self-belief (15.1,15.3,15.4)
Baker 2020 ²¹	Goals and planning (1.1,1.4) Feedback and monitoring (2.3) Shaping knowledge (4.1) Comparison of behavior (6.1)	Repetition and substitution (8.1,8.6,8.7) Comparison of outcomes (9.1)	Goals and planning (1.2,1.5) Social support (3.1) Natural consequences (5.1) Regulation (11.2)	
Quicke 2017 ²²	Goals and planning (1.1,1.4) Feedback and monitoring (2.2) Shaping knowledge (4.1)	Comparison of behavior (6.1) Repetition and substitution (8.1) Generalization of a target behavior (8.6)	Goals and planning (1.2,1.8) Feedback and monitoring (2.3) Generalization of a target behavior (8.7)	
Bennell 2014 ²³	Goals and planning (1.1,1.4) Feedback and monitoring (2.2) Shaping knowledge (4.1) Comparison of behavior (6.1)	Repetition and substitution (8.1,8.6,8.7) Comparison of outcomes (9.1)	Goals and planning (1.2,1.5)	

Study	Index Rehabilitation Program		Adjunct Adherence-Enhancing Intervention	
<i>Sequentially Delivered Adjunct Adherence</i>				
Lonsdale 2017 ²⁴	Goals and planning (1.1,1.4) Feedback and monitoring (2.2) Shaping knowledge (4.1) Comparison of behavior (6.1)	Repetition and substitution (8.1,8.6,8.7) Comparison of outcomes (9.1)	Goals and planning (1.2) Feedback and monitoring (2.3) Natural consequences (5.1)	
Ben-Ami 2017 ¹⁹	Goals and planning (1.1,1.4) Feedback and monitoring (2.2) Feedback and monitoring (4.1) Comparison of behavior (6.1)	Repetition and substitution (8.1,8.6,8.7) Comparison of outcomes (9.1)	Goals and planning (1.2) Social support (3.1) Natural consequences (5.1) Associations (7.7)	Repetition and substitution (8.2) Comparison of outcomes (9.2,9.3) Identify (13.5)
Bennell 2017 ²⁵	Goals and planning (1.1,1.4) Feedback and monitoring (2.2,2.3) Shaping knowledge (4.1) Natural consequences (5.1)	Comparison of behavior (6.1) Repetition and substitution (8.1,8.6,8.7) Comparison of outcomes (9.1)	Goals and planning (1.2,1.5) Feedback and monitoring (2.3)	
Brosseau 2012 ¹⁸	Feedback and monitoring (2.3) Shaping knowledge (4.1) Comparison of behavior (6.1) Repetition and substitution (8.1) Reward and threat (10.1)		Goals and planning (1.1,1.2) Natural consequences (5.1) Comparison of outcomes (9.1)	
Pisters 2010 ²⁶	Goals and planning (1.1,1.4,1.5) Feedback and monitoring (2.2) Shaping knowledge (4.1)	Comparison of behavior (6.1) Repetition and substitution (8.1,8.6,8.7) Comparison of outcomes (9.1)	Goals and planning (1.2) Feedback and monitoring (2.3)	
Friedrich 1998 ²⁷	Feedback and monitoring (2.2) Shaping knowledge (4.1) Natural consequences (5.1) Comparison of behavior (6.1)	Repetition and substitution (8.1,8.6,8.7) Comparison of outcomes (9.1)	Goals and planning (1.1,1.2,1.4,1.8) Feedback and monitoring (2.3)	Natural consequences (5.2) Associations (7.1) Reward and threat (10.3,10.11) Self-belief (15.1)

Notes. Behavior change technique domains: 1.1 Goal setting (behavior); 1.2 Problem solving; 1.3 Goal setting (outcome); 1.4 Action planning; 1.5 Review behavior (goals); 1.8 Behavioral contract; 2.1 Monitoring of behavior by others without feedback; 2.2 Feedback on behavior; 2.3 Self-monitoring of behavior; 2.4 Self-monitoring of outcome of behavior; 3.1 Social support (unspecified); 4.1 Instruction on how to perform a behavior; 4.4 Behavioral experiments; 5.1 Information about health consequences; 5.2 Salience of consequences; 6.1 Demonstration of the behavior; 6.2 Social comparison; 7.1 Prompts/cues; 7.7 Exposure; 8.1 Behavioral practice/rehearsal; 8.2 Behavior Substitution; 8.3 Habit formation; 8.6 Generalization of a target behavior; 8.7 Graded tasks; 9.1 Credible source; 9.2 Pros and cons; 9.3 Comparative imagining of future outcomes; 10.1 Material incentive (behavior); 10.3 Non-specific reward; 10.9 Self-reward; 10.11 Future punishment; 11.2 Reduce negative emotions; 12.1 Restructuring the physical environment; 12.4 Distraction; 13.5 Identity associated with changed behaviors; 15.1 Verbal persuasion about capability; 15.3 Focus on past success; 15.4 Self-talk.

Abbreviations. BCT=Behavior Change Techniques.

APPENDIX G. BEHAVIOR CHANGE TECHNIQUES USED IN INCLUDED STUDIES

Please refer to the main report's reference list for full citations.

Cluster	BCT	Number of Interventions BCT Is Present In	Studies
Goals and planning	1.1 Goal setting (behavior)	10 (100%)	18-27
	1.2 Problem solving	10 (100%)	18-27
	1.3 Goal setting (outcome)	1 (10%)	20
	1.4 Action planning	9 (90%)	19-27
	1.5 Review behavior (goals)	4 (40%)	21,23,25,26
	1.8 Behavioral contract	2 (20%)	22,27
Feedback and monitoring	2.1 Monitoring of behavior by others without feedback	1 (10%)	20
	2.2 Feedback on behavior	8 (80%)	19,20,22-27
	2.3 Self-monitoring of behavior	8 (80%)	18,20-22,24-27
	2.4 Self-monitoring of outcome of behavior	1 (10%)	20
Social support	3.1 Social support (unspecified)	3 (30%)	19-21
Shaping knowledge	4.1 Instruction on how to perform a behavior	10 (100%)	18-27
	4.4 Behavioral experiments	1 (10%)	20
Natural consequences	5.1 Information about health consequences	7 (70%)	18-27
	5.2 Salience of consequences	1 (10%)	27
Comparison of behavior	6.1 Demonstration of the behavior	10 (100%)	18-27
	6.2 Social comparison	1 (10%)	20
Associations	7.1 Prompts/cues	2 (20%)	20,27
	7.7 Exposure	1 (10%)	19
Repetition and substitution	8.1 Behavioral practice/rehearsal	10 (100%)	18-27
	8.2 Behavior Substitution	1 (10%)	19
	8.3 Habit formation	1 (10%)	20

Cluster	BCT	Number of Interventions BCT Is Present In	Studies
	8.6 Generalization of a target behavior	9 (90%)	19-27
	8.7 Graded tasks	9 (90%)	19-27
Comparison of outcomes	9.1 Credible source	9 (90%)	18-21,23-27
	9.2 Pros and cons	1 (10%)	19
	9.3 Comparative imagining of future outcomes	1 (10%)	19
Reward and threat	10.1 Material incentive (behavior)	1 (10%)	18
	10.3 Non-specific reward	1 (10%)	27
	10.9 Self-reward	1 (10%)	20
	10.11 Future punishment	1 (10%)	27
Regulation	11.2 Reduce negative emotions	1 (10%)	21
Antecedents	12.1 Restructuring the physical environment	1 (10%)	20
	12.4 Distraction	1 (10%)	20
Identify	13.5 Identity associated with changed behaviors	1 (10%)	19
Self-belief	15.1 Verbal persuasion about capability	2 (20%)	27
	15.3 Focus on past success	1 (10%)	20
	15.4 Self-talk	1 (10%)	20