Comparative Effectiveness Review
Number 248

Prehabilitation and Rehabilitation for Major Joint Replacement

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Number 248

Prehabilitation and Rehabilitation for Major Joint Replacement

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None of the investigators have any affiliations or financial involvement that conflicts with the material presented in this report.

The information in this report is intended to help healthcare decision makers—patients and clinicians, health system leaders, and policymakers, among others—make well-informed decisions and thereby improve the quality of healthcare services. This report is not intended to be a substitute for the application of clinical judgment. Anyone who makes decisions concerning the provision of clinical care should consider this report in the same way as any medical reference and in conjunction with all other pertinent information, i.e., in the context of available resources and circumstances presented by individual patients.

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Preface

The Agency for Healthcare Research and Quality (AHRQ), through its Evidence-based Practice Centers (EPCs), sponsors the development of systematic reviews to assist public- and private-sector organizations in their efforts to improve the quality of healthcare in the United States. These reviews provide comprehensive, science-based information on common, costly medical conditions, and new healthcare technologies and strategies.

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If you have comments on this systematic review, they may be sent by mail to the Task Order Officer named below at: Agency for Healthcare Research and Quality, 5600 Fishers Lane, Rockville, MD 20857, or by email to epc@ahrq.hhs.gov.

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Key Informants

In designing the study questions, the EPC consulted several Key Informants who represent the end-users of research. The EPC sought the Key Informant input on the priority areas for research and synthesis. Key Informants are not involved in the analysis of the evidence or the writing of the report. Therefore, in the end, study questions, design, methodological approaches, and/or conclusions do not necessarily represent the views of individual Key Informants.

Key Informants must disclose any financial conflicts of interest greater than $5,000 and any other relevant business or professional conflicts of interest. Because of their role as end-users, individuals with potential conflicts may be retained. The TOO and the EPC work to balance, manage, or mitigate any conflicts of interest.

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In designing the study questions and methodology at the outset of this report, the EPC consulted several technical and content experts. Broad expertise and perspectives were sought. Divergent and conflicted opinions are common and perceived as healthy scientific discourse that results in a thoughtful, relevant systematic review. Therefore, in the end, study questions, design, methodologic approaches, and/or conclusions do not necessarily represent the views of individual technical and content experts.

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Prior to publication of the final evidence report, EPCs sought input from independent Peer Reviewers without financial conflicts of interest. However, the conclusions and synthesis of the scientific literature presented in this report do not necessarily represent the views of individual reviewers.

Peer Reviewers must disclose any financial conflicts of interest greater than $5,000 and any other relevant business or professional conflicts of interest. Because of their unique clinical or content expertise, individuals with potential nonfinancial conflicts may be retained. The TOO and the EPC work to balance, manage, or mitigate any potential nonfinancial conflicts of interest identified.

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Prehabilitation and Rehabilitation for Major Joint Replacement

Structured Abstract

Objectives. This systematic review evaluates the rehabilitation interventions for patients who have undergone (or will undergo) total knee arthroplasty (TKA) or total hip arthroplasty (THA) for the treatment of osteoarthritis. We addressed four Key Questions (KQs): comparisons of (1) rehabilitation prior ("prehabilitation") to TKA versus no prehabilitation, (2) comparative effectiveness of different rehabilitation programs after TKA, (3) prehabilitation prior to THA versus no prehabilitation, (4) comparative effectiveness of different rehabilitation programs after THA.

Data sources and review methods. We searched Medline®, PsycINFO®, Embase®, the Cochrane Register of Clinical Trials, CINAHL®, Scopus®, and ClinicalTrials.gov from Jan 1, 2005, to May 3, 2021, to identify randomized controlled trials (RCTs) and adequately adjusted nonrandomized comparative studies (NRCSs). We evaluated clinical outcomes selected with input from a range of stakeholders. We assessed the risk of bias and evaluated the strength of evidence (SoE) using standard methods. Meta-analysis was not feasible, and evidence was synthesized and reported descriptively. The PROSPERO protocol registration number is CRD42020199102.

Results. We found 78 RCTs and 5 adjusted NRCSs. Risk of bias was moderate to high for most studies.

- KQ 1: Compared with no prehabilitation, prehabilitation prior to TKA may increase strength and reduce length of hospital stay (low SoE) but may lead to comparable results in pain, range of motion (ROM), and activities of daily living (ADL) (low SoE). There was no evidence of an increased risk of harms due to prehabilitation (low SoE).
- KQ 2: Various rehabilitation interventions after TKA may lead to comparable improvements in pain, ROM, and ADL (low SoE). Rehabilitation in the acute phase (initiated within 2 weeks of surgery) may lead to increased strength (low SoE) but result in similar strength when delivered in the post-acute phase (low SoE). No studies reported evidence of risk of harms due to rehabilitation delivered in the acute period following TKA. Compared with various controls, post-acute rehabilitation may not increase the risk of harms (low SoE).
- KQ 3: For all assessed outcomes, there is insufficient (or no) evidence addressing the comparison between prehabilitation and no prehabilitation prior to THA.
- KQ 4: Various rehabilitation interventions after THA may lead to comparable improvements in pain, strength, ADL, and quality of life. There is some evidence of no increased risk of harms due to the intervention (low SoE).
- There is insufficient evidence regarding which patients may benefit from (p)rehabilitation for all KQs and insufficient evidence regarding comparisons of different providers and different settings of (p)rehabilitation for all KQs. There is insufficient evidence on costs of (p)rehabilitation and no evidence on cost effectiveness for all KQs.

Conclusion. Despite the large number of studies found, the evidence regarding various prehabilitation programs and comparisons of rehabilitation programs for TKA and THA is ultimately sparse. This is a result of the diversity of interventions studied and outcomes reported across studies. As a result, the evidence is largely insufficient or of low SoE. New high-quality research is needed, using standardized intervention terminology and core outcome sets, especially to allow network meta-analyses to explore the impact of intervention attributes on patient-reported, performance-based, and healthcare-utilization outcomes.

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Appendixes

Appendix A. Methods
Appendix B. Excluded Studies
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Evidence Summary

Main Points

- **Prehabilitation for Total Knee Arthroplasty**
  - Compared with no prehabilitation, prehabilitation prior to total knee arthroplasty (TKA), may reduce length of hospital stays and increase in strength but may lead to comparable outcomes of pain, range of motion, and activities of daily living (ADL) after TKA (low strength of evidence [SoE] for all).
  - Prehabilitation prior to TKA may not increase the risk of harms (low SoE).
  - There is insufficient evidence regarding the impact of prehabilitation on quality of life (QoL) or need for postoperative procedures.
  - There is no evidence on patient's satisfaction with care after prehabilitation or the impact of prehabilitation on posthospital disposition.
- **Rehabilitation for Total Knee Arthroplasty**
  - Compared with various controls (usually less intensive active rehabilitation), rehabilitation in the acute phase after TKA (initiated within 2 weeks of surgery) may result in increased strength (low SoE) and similar satisfaction with care (low SoE), whereas rehabilitation delivered in the post-acute phase may result in comparable strength (low SoE). Rehabilitation in the acute and post-acute phase after TKA may result in comparable pain, range of motion (ROM), and ADL (low SoE). Additionally, rehabilitation in the post-acute phase after TKA may result in comparable QoL.
  - There is insufficient evidence on the impact on QoL (for acute rehabilitation), satisfaction with care (for post-acute rehabilitation), and the need for postoperative procedures (both acute and post-acute rehabilitation).
  - No studies addressed the risk of harms due to rehabilitation delivered in the acute phase after TKA. Compared with various controls, there was no evidence of an increased risk of harms due to more active rehabilitation delivered in the post-acute phase (low SoE).
- **Prehabilitation for Total Hip Arthroplasty**
  - There is insufficient evidence on the impact of prehabilitation prior to total hip arthroplasty (THA) on pain, strength, ADL, QoL, length of stay, or posthospital disposition.
  - No studies compared prehabilitation to no rehabilitation on satisfaction with care or risk of harms due to prehabilitation.
- **Rehabilitation for Total Hip Arthroplasty**
  - Compared with various controls, rehabilitation in the acute and post-acute phase after THA may result in comparable pain, strength, QoL, and ADL (low SoE).
  - There is insufficient evidence regarding the impact of rehabilitation on satisfaction with care or ROM.
  - Compared with various less active rehabilitation controls or no rehabilitation, rehabilitation following THA may not lead to increased risk of harms (low SoE).
- **All Evidence**
  - There is insufficient evidence regarding which patients may most benefit from (p)rehabilitation for TKA or THA.

- There is insufficient evidence on the effectiveness of specific (p)rehabilitation intervention components at the level of goals (e.g., strength, flexibility) or the presence of specific exercise components to address these goals for TKA or THA.
- There is insufficient evidence regarding comparisons of different providers of (p)rehabilitation for TKA or THA.
- There is insufficient evidence regarding comparisons of different settings of (p)rehabilitation for TKA THA.

Background and Purpose

Total joint replacement, which includes total knee arthroplasty and total hip arthroplasty, is one of the most successful therapies to manage pain and dysfunction of the hip and knee joints for end-stage osteoarthritis. As the prevalence of osteoarthritis has increased, the numbers of TKAs and THAs have increased and are now the most common inpatient surgical procedures covered by Medicare. Patients may be offered rehabilitation prior to surgery (i.e., "prehabilitation") or after surgery, with the goal of optimizing postoperative function, reducing pain, and returning to normal ADL. The topic of prehabilitation and rehabilitation (hereafter "(p)rehabilitation") is of interest to health systems to enable evidence-based decision making regarding which interventions should be offered to adults undergoing TKA or THA for osteoarthritis to achieve best clinical outcomes, reduce avoidable complications or joint failures, and be cost- and resource-effective for the health system, patients, and their caregivers.

This systematic review (SR) aims to inform healthcare systems, guideline developers, orthopedic surgeons, physical therapists and other rehabilitation professionals and providers of care for patients who have undergone (or will undergo) TKA or THA for osteoarthritis about (p)rehabilitation options. The SR addresses four Key Questions (KQs): (1) prehabilitation for TKA, (2) rehabilitation for TKA (3) prehabilitation for THA, (4) and rehabilitation for THA.

Methods

We used methods consistent with Agency for Healthcare Research and Quality Evidence-based Practice Center Program Methods Guidance (https://effectivehealthcare.ahrq.gov/topics/cer-methods-guide/overview). The protocol was developed with input from stakeholders on a Key Informants and a Technical Expert Panel, including Learning Health Systems sponsors. Our searches targeted randomized controlled trials (RCTs) and adequately adjusted nonrandomized comparative studies (NRCSs) from January 1, 2005, to May 3, 2021. We extracted intervention details into Excel and all other study data into the Systematic Review Data Repository (SRDR). The evidence base was too heterogenous to allow for meta-analysis. We assessed the risk of bias and evaluated the SoE using standard methods. The PROSPERO protocol registration number is CRD42020199102.

Results

We found 83 primary studies comprising 14,533 patients in total. These included 78 RCTs (n=8,397 patients) and 5 adjusted NRCSs (n= 6,156 patients). Studies were of mostly moderate risk of bias, primarily related to a lack of blinding. The studies were highly heterogeneous. With only two exceptions, studies reported a unique (p)rehabilitation intervention and a wide range of disparate outcomes. The majority of both prehabilitation and rehabilitation interventions included components to increase strength (86% of studies) and flexibility (75%) and, to a lesser

extent, components to increase task-specific training (67%) and balance (41%). Studies varied widely in terms of the timing and intensity of the evaluated (p)rehabilitation interventions.

- **Prehabilitation for TKA**: Thirteen RCTs evaluated prehabilitation for TKA. Compared with no prehabilitation, prehabilitation may lead to increased strength and reduced lengths of acute hospital stays following TKA surgery (low SoE). Prehabilitation may result in comparable pain, range of motion, and activities of daily living (low SoE). There is insufficient evidence regarding the impact of prehabilitation on QoL or need for postoperative procedures and no evidence addressing satisfaction with care or posthospital disposition outcomes associated with prehabilitation prior to TKA. Prehabilitation prior to TKA may not increase the risk of harms (low SoE).
- **Comparison of Rehabilitation Interventions for TKA**: Forty-nine RCTs and 4 NRCSs evaluated various rehabilitation interventions and comparators following TKA. Various rehabilitation programs in the acute and post-acute phase following TKA may result in comparable improvements in outcomes of pain, ROM, and ADL (low SoE). Acute-phase rehabilitation programs resulted in similar satisfaction with care (low SoE for all). More intensive rehabilitation (e.g., via virtual rehabilitation or with neuromuscular stimulation) may result in increased strength when delivered in the acute phase. More intensive rehabilitation led to similar outcomes of strength among rehabilitation programs delivered in the post-acute phase. There is insufficient evidence on the impact on QoL (for acute rehabilitation), satisfaction with care (for post-acute rehabilitation), and the need for postoperative procedures (both acute and post-acute rehabilitation). We found no evidence regarding harms from acute-phase rehabilitation. Post-acute rehabilitation may have comparable risks of harms among various rehabilitation interventions compared (low SoE).
- **Prehabilitation for THA**: Six RCTs evaluated prehabilitation for THA. There is insufficient evidence for various patient-reported, performance-based, and healthcare-utilization outcomes when comparing prehabilitation to no prehabilitation prior to THA.
- **Comparison of Rehabilitation Interventions for THA**: Fourteen RCTs and one NRCS evaluated rehabilitation for THA. Rehabilitation in the acute and post-acute phase following THA may result in comparable improvements in patients experience of pain and QoL and performance of strength and ADLs (low SoE). There is insufficient evidence for ROM and satisfaction with care. There is no evidence of increased risk of harm from rehabilitation interventions compared with less active rehabilitation or no rehabilitation controls (low SoE).

Limitations

Although we found a large body of mostly RCT evidence, the evidence was ultimately sparse since relatively few studies reported the same outcomes pertaining to similar comparisons. With the exception of two interventions evaluated in two studies each, all studies reported unique (p)rehabilitation interventions. Reporting of intervention content was also highly variable, ranging from a few words (e.g., “inpatient rehabilitation”) to comprehensive (p)rehabilitation protocols. This variability made coding of intervention content challenging. Thus, evidence regarding prehabilitation (compared with no prehabilitation) and rehabilitation interventions (compared with other rehabilitation interventions) is largely insufficient or of low SoE. Very limited subgroup data was reported, precluding most evaluation of heterogeneity of treatment effects (differences in effect across subgroups). The included studies were mostly at moderate to

high risk of bias. Several prioritized outcomes, including strength, ROM, satisfaction with care, and QoL, were infrequently reported.

Implications and Conclusions

Our analysis of all prehabilitation and rehabilitation interventions for TKA and THA found no clear evidence of the effectiveness of prehabilitation versus no prehabilitation, or the comparative effectiveness of diverse rehabilitation programs compared with each other. However, there was some evidence of improved outcomes in specific (p)rehabilitation programs, and a strength of this review is its thorough standardized extraction and synthesis of all (p)rehabilitation interventions. In the absence of definitive evidence on which programs to implement, stakeholders may need to rely on other decision-making factors to decide which (p)rehabilitation program to implement or evaluate. Our detailed categorization of the components of (p)rehabilitation interventions and how they were delivered could be used to guide the efforts to better standardize and improve the evidence base. A strategic and coordinated program of research is needed to address the questions related to (p)rehabilitation, specifically to identify which components of interventions work best and under what circumstances (e.g., setting, personnel, or modes of delivery). To improve interpretation and allow for future meta-analyses, researchers (and funders of research) should consider the use of standardized terminology of intervention content and core outcome sets to measure intervention effects, combined with a universal expectation of robust and transparent reporting of both. Future studies should also consider collecting data on the direct and indirect costs of (p)rehabilitation programs and conduct cost-effectiveness analyses alongside effectiveness analyses to contribute a more complete evidentiary picture to inform evidence-based decision-making regarding which interventions should be offered to adults undergoing TKA or THA for osteoarthritis.

Introduction

Background

Osteoarthritis is a leading cause of joint disability in the United States. Approximately 54 million people (23% of adults) have osteoarthritis, and, of these, 24 million are limited in their daily activities due to osteoarthritis.[1] Total joint replacement—total knee arthroplasty (TKA) and total hip arthroplasty (THA)—have been some of the most successful therapies in managing pain and dysfunction of hip and knee joints for end-stage arthritis.[2-5] Patients who have undergone a TKA or THA experience reduced pain and improved function and quality of life.[2, 6, 7] As the prevalence of osteoarthritis has increased, the numbers of TKAs and THAs have correspondingly increased,[8] and they are now the most common inpatient surgical procedures covered by Medicare.[9] In 2014, an estimated 680,150 patients in the United States underwent a TKA and 370,770 underwent a THA. It is expected that by 2030, 1.26 million patients will undergo a TKA annually (an 85% increase from 2014) and 635,000 will undergo a THA (71% increase).[10]

THA involves the removal of the femoral head and part of the femoral neck, the reshaping of the acetabulum and the replacement of the joint with prosthetics made of titanium or cobalt chrome alloy (femoral stem) and either cobalt chrome or ceramic (femoral head). To minimize wear, a variety of materials have been used for the acetabular component of the prosthesis, including metal, ceramic, and cross-linked high-density polyethylene.[11-16] Newer highly cross-linked polyethylenes have been most successful of these materials and are most commonly used.[13, 17-19] TKA, on the other hand, does not involve replacement of the entire joint but rather is a resurfacing of the diseased bone and cartilage to provide a new bearing surface for the joint. The muscles, ligaments, and capsule are left in place, although they may be adjusted. The arthritic cartilage and bone at the distal head of the femur are replaced by cobalt chrome and the bearing surfaces of the patella and tibia are covered in polyethylene. Due to the more delicate alignment of the knee joint and the greater soft tissue manipulation necessary in TKA compared with THA, there is greater potential for scarring after TKA and the rehabilitation burden is typically greater. Surgical approaches are fairly standardized for TKA. The joint is entered anteromedial to the extensor mechanism and patella. In contrast, for THA, there are three approaches: anterior, anterolateral, and posterior.[20-22] Although each has its unique peculiarities, advantages, and disadvantages, overall, the outcomes from all three are similar.

While most patients experience improvements in pain after TKA or THA, deficits in functional performance and strength commonly persist a year after surgery for many patients.[23-26] Full recovery of muscle strength and physical function to a normal level is rare.[27, 28] Approximately 20% of patients who undergo TKA report dissatisfaction a year after TKA.[29] Physical rehabilitation is commonly offered to patients undergoing either TKA or TKA with the goal of optimizing postoperative outcomes, including strength, physical function, pain reduction, and return to normal activities of daily living. Increasingly, "prehabilitation" (rehabilitation services provided prior to surgery) is also considered to maximize patients' functional status prior to surgery to improve postoperative outcomes.

The topic of prehabilitation and rehabilitation (hereafter "(p)rehabilitation") is of interest to health systems to enable evidence-based decision making regarding which interventions should be offered to adults undergoing TKA or THA for osteoarthritis to achieve best clinical outcomes, reduce avoidable complications or joint failures, and be cost- and resource-effective for the health system, patients, and their caregivers. The Agency for Healthcare Research and Quality's Learning Health System Panel nominated this topic as being of particular interest.

Rehabilitation programs are complex interventions that incorporate multiple specific interventions (components) and multiple actors, including various rehabilitation specialists and personnel, orthopedic surgeons and other clinicians, other caregivers, and the patient. The provided rehabilitation services can occur at different times (i.e., before or after surgery) and in different settings. Furthermore, rehabilitation is commonly personalized for individuals, depending on their specific circumstances and their response to surgery and the rehabilitation. These factors are likely to be important determinants of the effectiveness of the rehabilitation programs to improve strength and mobility, reduce pain, and return the patient to their best-possible overall function. Nevertheless, they all have cost and resource use implications related to the features of the rehabilitation program, the personnel involved, and the location of services. Thus, there are four interrelated considerations at play in deciding on a rehabilitation program:

1. **Timing**: Rehabilitation can occur prior to surgery ("prehabilitation") or after
2. **Type**: Rehabilitation may comprise various types or components (e.g., strength training, education, balance training) delivered alone or in combination
3. **Setting**: Rehabilitation may occur in various settings (e.g., acute inpatient, skilled nursing facility, outpatient rehabilitation facility, home-based)
4. **Cost and resource use**: Each aspect of a rehabilitation program has its associated costs (e.g., due to specialized personnel, equipment, facility overhead)

Regarding **timing**, rehabilitation after TKA or THA is the most common practice in the United States. Previous reviews have reported that successful rehabilitation improves pain control, walking and gait, balance, and strength, and reduces length of stay.[30, 31] Though less commonly used, prehabilitation has also been recommended.[32] Preoperative health status is a strong predictor of favorable postoperative outcomes[2, 33] including reduced pain and improved functioning.[34] Thus, prehabilitation is hypothesized to accelerate improvement of function and strength postoperatively.[35] However, the effectiveness of prehabilitation prior to TKA or THA is unclear. A 2017 systematic review on prehabilitation for TKA or THA found conflicting evidence, with some studies finding no added benefit and others finding improvements in postoperative function, quadriceps strength, and length of stay.[36] A subsequent review of prehabilitation for patients about to undergo TKA found prehabilitation was associated with decreased length of stay while limited data suggested prehabilitation made no difference on patient-reported outcomes of pain or function, stiffness, and physical role.[37]

Prehabilitation and rehabilitation are complex interventions, with many facets that are typically individualized for given patients' needs, goals, capabilities, and even personalities. The **type** of (p)rehabilitation includes various concepts, including *what* the intervention is, *how* it is implemented, and *who* delivers it. The overall intervention program may include various components (typically in combination) that are aimed at improving a range of body function and structure, as well as activity and participation domains, defined by the International Classification of Functioning, Disability and Health (ICF)[38] to improve the mobility and stability of joint function, movement control, power and tone of muscles, gait, endurance; along with the related goal of reducing pain. Examples of components may include stretching exercises to improve muscle movement and range of motion; use of weights to improve muscle tone, power and endurance; and stair-climbing to improve mobility, muscle power, and movement control. In addition to the components that directly impact the ICF domains, numerous adjunctive modalities are employed to facilitate the performance of components to help the patient better achieve their rehabilitation goals. Examples of these include cryotherapy to reduce swelling and

acute pain; mindfulness programs to reduce stress, anxiety, and pain; neuromuscular electrical stimulation to increase muscle control and coordination and biofeedback devices to provide positive feedback and incentives. Each component, adjunctive modality, and the intervention as a whole (i.e., comprised of components and adjunctive modalities) may vary in how it is delivered, for example, the duration of each session (and the use of each component within a session), the intensity of the intervention (e.g., minimal vs. maximal extension of range of motion, fewer vs. more repetitions), and the overall duration of the program (e.g., 1 week vs. 2 months). Further complicating the types of (p)rehabilitation, the overall intervention (or the various components) may be delivered by different professionals, ancillary trained personnel, or the patients (or their caregivers) themselves.

Given the wide range of potential activities that may fall within the concept of (p)rehabilitation, it is challenging to determine even what counts as a form of (p)rehabilitation. Based on the primary interests of the nominating health systems, we focus on structured interventions that involve health professionals or other trained individuals. Thus, for the purpose of this review, we defined (p)rehabilitation to be active, structured physical activities designed to attain measurable goals of improving impairments and movement-related function as defined by the ICF.[38] The intervention must be delivered, supervised, and/or monitored by a healthcare professional or other trained individual, and the patient must be actively involved (i.e., not simply a passive recipient). Pharmaceutical and over-the counter interventions were outside the scope of interest.

Another important aspect of (p)rehabilitation is the **setting** in which it may be delivered. These vary widely, and examples include the acute hospital setting (i.e., immediately postoperative), a skilled nursing facility, outpatient rehabilitation facility, the patient's home, or a local community center or gym. Interventions may also be delivered virtually, by Internet, teleconference, Web app, or mobile device app. Various factors contribute to the choice of the (p)rehabilitation setting, including patient needs, caregiver support, and the specific components employed. Cost of the (p)rehabilitation services, which is largely determined by setting, plays a major role in decisions about which services to provide. In the inpatient setting, "accelerated" rehabilitation after TKA has been associated with reduced length of stay in the acute-hospital setting.[39] The impact of setting of (p)rehabilitation programs on patient outcomes is unclear, with some research suggesting facility-based rehabilitation does not provide better recovery compared to home-based programs for uncomplicated TKA and THA patients,[40] and other evidence suggesting early outpatient rehabilitation may lead to more rapid gains in function, strength, and reduced pain in the short term.[23] Insurance status may influence patient preference for setting of care, such that patients under public insurance may be more likely to utilize home-based rehabilitation programs (supervised or unsupervised) over more resource-intensive facility-based rehabilitation programs (including inpatient rehabilitation and outpatient-based sessions).[40] Although facility-based programs are more likely to have skilled, supervised personnel deliver services, evidence on the added benefit of a supervised program remains unclear.[41, 42]

The total direct **costs of care** for TKA and THA episodes include the preoperative period (for assessment and, if used, prehabilitation), operative (acute) and postoperative (post-acute) periods, with as much as 40 percent of the cost occurring after discharge (70% of which are from post-acute care facilities).[43] Both operative and postoperative costs (for the health systems, payers, and patients) vary greatly throughout the United States without notable differences in outcomes. As much as a sixfold difference has been observed in cost of care (from the perspective of the health system) for patients discharged to various types of post-acute care,[44]

despite similarities in patient characteristics, readmission, and complication rates. Total joint replacement of the lower extremity (both THA and TKA) was the most prevalent clinical episode participating in the Centers for Medicare & Medicaid Services bundled payment model.[9] As major joint replacement surgeries and bundled payment models become more prevalent,[45] many health systems and payers are working to understand how best to implement the most effective and also most cost-effective care for patients receiving TKA or THA without compromising their outcomes.[46-48]

Purpose of the Review

This systematic review assesses prehabilitation and rehabilitation for patients who are undergoing (or have undergone) elective, unilateral, total knee or hip replacement surgery for osteoarthritis. Specifically, the review addresses:

- The benefits and harms of preoperative active structured physical activity programs (and specific components) for TKA (Key Question [KQ] 1) and THA (KQ 3)
- The comparative benefits and harms of postoperative active structured physical activity programs (and specific components) for TKA (KQ 2) and THA (KQ 4).

As the evidence base for rehabilitation is more established, the objective of KQs 2 and 4 are focused on the comparative effectiveness of different rehabilitation programs (i.e., which programs and/or components and methods by which they are delivered work best to improve outcomes). As the evidence base for prehabilitation is less established, the objective of KQs 1 and 3 is to determine the benefit of prehabilitation in general (prehabilitation vs. no prehabilitation) as well as the comparative effectiveness of different prehabilitation programs (i.e., which programs and/or components and method in which they are delivered work best to improve outcomes).

The intended audience for this systematic review includes healthcare systems, guideline developers, orthopedic surgeons, physical therapists and other rehabilitation professionals and providers of care for patients who have undergone (or will undergo) TKA or THA for osteoarthritis and are considering (p)rehabilitation, as well as patients and their caregivers. It is expected that the findings will inform individual professional practice and health system decision making for (p)rehabilitation care surrounding total knee or hip replacement surgery.

Methods

Review Approach

The Brown Evidence-based Practice Center conducted this systematic review (SR) based on the Agency for Healthcare Research and Quality (AHRQ) Methods Guide for Effectiveness and Comparative Effectiveness Reviews (available at https://effectivehealthcare.ahrq.gov/topics/cer-methods-guide/overview). This SR also reports in accordance with the Preferred Items for Reporting in Systematic Reviews and Meta-Analyses (PRISMA),[49] A Measurement Tool to Assess Systematic Reviews (AMSTAR 2),[50] and any relevant extension statements.

A more detailed version of the SR methodology used can be found in Appendix A.

The topic of this report and preliminary Key Questions (KQs) arose through a process involving the nominator (AHRQ's Learning Health System Panel), a panel of Key Informants (KI), a Technical Expert Panel (TEP), the public, and AHRQ. The TEP provided high-level content and methodological expertise throughout development of the review protocol. The final protocol was posted on the Effective Health Care website at https://effectivehealthcare.ahrq.gov/products/major-joint-replacement/protocol on July 14, 2020, and revised and reposted on October 6, 2020. We submitted the protocol for registration in PROSPERO in July 2019. On August 16, 2020, PROSPERO published the protocol with registration number CRD42020199102.

Key Questions

KQ 1: What are the effects, comparative effects, and harms of (preoperative) **prehabilitation** services (and specific components) for patients with osteoarthritis undergoing elective, unilateral **total knee replacement** surgery on patient-reported outcomes, performance-based outcomes, and healthcare utilization?

KQ 2: What are the effects, comparative effects, and harms of (postoperative) **rehabilitation** services (and specific components) for patients with osteoarthritis undergoing elective, unilateral **total knee replacement** surgery on patient-reported outcomes, performance-based outcomes, and healthcare utilization?

KQ 3: What are the effects, comparative effects, and harms of (preoperative) **prehabilitation** services (and specific components) for patients with osteoarthritis undergoing elective, unilateral **total hip replacement** surgery on patient-reported outcomes, performance-based outcomes, and healthcare utilization?

KQ 4: What are the effects, comparative effects, and harms of (postoperative) **rehabilitation** services (and specific components) for patients with osteoarthritis undergoing elective, unilateral **total hip replacement** surgery on patient-reported outcomes, performance-based outcomes, and healthcare utilization?

For all KQs:

> **Subquestion a**: Do the effects, comparative effects, and harms vary by patient factors, such as age, sex, race/ethnicity, socioeconomic status, body mass index, and comorbidities?
>
> **Subquestion b**: Do the effects, comparative effects, and harms vary by surgical factors, such as surgical procedure, type of implant, perioperative protocol, type of hospital, and length of hospital stay?
>
> **Subquestion c**: Do the effects, comparative effects, and harms vary by setting of active structured physical activity programs?

Contextual Question

Contextual Question: What are the major direct and indirect cost factors for the various aspects of rehabilitation and prehabilitation around major joint replacement surgery, including such factors as personnel, setting overhead, materials, and training?

Analytic Framework

Based on discussions with KIs and TEP, we developed an analytic framework (Appendix A Figure A-1) capturing the key elements of all KQs in one figure. It graphically lays out the populations, interventions, outcomes, and modifiers as they pertain to all KQs and, where applicable, specific KQs.

Study Selection

Literature searches were conducted in MEDLINE® (via PubMed), PsycINFO®, Embase®, The Cochrane Register of Clinical Trials, CINAHL®, and Scopus®, restricted to 2005 through May 3, 2021. The time restriction was included to account for temporal trends related to changes in surgical techniques, implants, anesthesia, and, in particular, postoperative protocols (e.g., enhanced recovery after surgery protocol and rapid hospital discharge) more commonly employed since about 2000.[51] While there is no clear cutoff date to mark a practice changing shift in care, 2005 was selected as a reasonable date before which the KIs agreed that studies would be less generalizable to contemporary practice.

Table 1 presents the major eligibility criteria for each KQ. More detailed criteria are presented in Appendix A. We included randomized controlled trials (RCT) and nonrandomized comparative studies (NRCS) with appropriate adjustment for confounding factors.

Table 1. Study eligibility criteria for Key Questions

Eligibility Categories	Criteria
Population	Adult patients undergoing (or planning to undergo) elective non-revision, unilateral total knee or hip replacement surgery for primary osteoarthritis KQs 1 & 3: Patients for whom the decision has been made to have TKA/THA surgery
Intervention/Comparator	(P)rehabilitation intervention: Active, structured physical activity or activities designed to attain measurable goals of reducing impairments and improving movement-related function as defined by the International Classification of Function, Disability, and Health May be combined with an adjunctive modality (e.g., neuromuscular electrical stimulation) KQs 1 & 3: Prehabilitation/rehabilitation ≤3 months prior to surgery KQs 2 & 4: Rehabilitation ≤ 6 months after surgery Comparison with no (p)rehabilitation, other (p)rehabilitation, (p)rehabilitation without adjunctive modality, (p)rehabilitation combined with other adjunctive modality or of different intensity, or delivered by different personnel, or in different setting To be included, the intervention had to have been delivered, supervised, and/or monitored by a healthcare professional or other trained individual (e.g., physical therapist, physical therapy assistant, nurse trained in rehabilitation, health educator with training in exercise delivery or rehabilitation, other healthcare professional trained in rehabilitation) ▪ Peer-led (or patient-led) interventions were eligible if monitored by a professional or other trained individual ▪ The physical therapist (or other trained individual) had to have be involved in patient engagement and assessment of progress, and provided ongoing feedback to the patient throughout the course of intervention • Interactions could be direct (e.g., in-person therapy) or remote (e.g., via app, Web, or telephone) • Remote therapy had to have included active monitoring by a physical therapist (or other trained individual), although the (p)rehabilitation therapy could have been guided completely by the app ○ The patient needs to be actively involved or engaged in at least part of the intervention (and not be only a passive recipient of the intervention) We categorized the content of the rehabilitation interventions according to a categorization scheme based on ongoing research by Oatis and Franklin to develop a taxonomy defining the components of physical therapy after TKA.[52, 53] The taxonomy comprehensively lists specific rehabilitation content that are hierarchically linked to larger rehabilitation goals. The larger component goals include: • Strengthening exercise • Aerobic exercise • Flexibility exercise • Balance-motor/learning-agility exercise • Task specific training • Patient education We used the taxonomy to code both the subcategory content and larger category goals (e.g., intervention content of squats would be coded for the subcategory of “squats” hierarchically linked to the goal of “strengthening”). We assessed whether progression was used, and if so, if it was appropriate (i.e., according to patient-specific parameters assessed by the therapist). We did not formally assess dose, intensity, and duration aside from minimal criteria needed to meet our rehabilitation definition. More details about how we defined and operationalized our definition of (p)rehabilitation can be found in Appendix A

Eligibility Categories	Criteria
Outcomes	• Performance-based measures o Mobility of joint function (e.g., knee range of motion)[A] o Power and tone of muscle (e.g., strength)[A] o Joint stability o Endurance o Gait o Balance • Patient-reported outcomes o Activities of daily living[A] o Patient satisfaction with care[A] o Health-related quality of life o Pain o Injury related to arthroplasty (e.g., fall) o Time lost from work • Healthcare utilization o Hospital- or surgical clinic-based procedures postoperatively (e.g., MUA)[a] o Hospital readmission Postoperative care (excluding physical therapy services) KQs 1 & 3 (Prehabilitation) o Length of stay (postoperative) (KQs 1&3) o Length of (postoperative) rehabilitation needed (KQs 1&3) o Posthospital disposition (KQs 1&3) KQs 2 & 4 (Rehabilitation)
Design	RCT: N≥20/arm[B] NRCS: Restrict to studies that use analytic methods to minimize selection bias N≥20[B,C] Cost-effectiveness analyses

Abbreviations: KQ = Key Question, MUA = manipulation under anesthesia, NRCS = nonrandomized comparative study, RCT = randomized controlled trial, THA = total hip arthroplasty, TKA = total knee arthroplasty

[A] Denotes important/priority outcomes that are included in strength of evidence tables.

[B] Minimum sample size cutoffs were employed to restrict the evidence base to studies that were more likely to be powered to detect differences in outcomes between arms while also being balanced for important baseline characteristics (in RCTs; otherwise, sufficient sample to allow for adjustment of baseline characteristics in NRCSs). The sample size of 20 or more per arm is not a concrete benchmark for achieving these aims, but rather, was chosen in consideration of the evidence base and with input from stakeholders.

[C] Restricted to studies that use modeling or other analytic methods to minimize selection bias (due to inherent differences between people who receive one or the other intervention) or that restrict study eligibility criteria such that comparisons being made are between patients with similar presentations.

Risk of Bias Assessment

We evaluated each study for risk of bias and methodological quality. Because we included different study designs, we incorporated items from three different commonly used tools and tailored the set of items for each study design.

For RCTs, we used all the items from the Cochrane Risk of Bias tool,[54] focusing on issues related to randomization and allocation concealment methodology; blinding of patients, study personnel/care providers, objective outcome assessors, and subjective outcome assessors; incomplete outcome data; selective outcome reporting; and other issues that could be related to bias. We supplemented the Cochrane Risk of Bias tool with items from the National Heart, Lung, and Blood Institute (NHLBI) tool that pertain to the adequacy of descriptions of study eligibility criteria, interventions, and outcomes.[55]

For NRCSs, we used the specific sections of Risk of Bias In Non-randomised Studies – of Interventions (ROBINS-I) tool[56] that pertain to confounding and selection bias. ROBINS-I requires the identification of specific confounders of interest for the systematic review. For the

purpose of assessing for the presence of potential confounding in studies, we considered demographics (such as age, sex, race/ethnicity), socioeconomic status, caregiver support, body mass index, comorbidities, prior arthroplasty of contralateral joint, narcotic use, preoperative symptoms/status (e.g., severity of symptoms including pain, impaired function, restricted movement, physical activity, frailty), surgical factors (e.g., surgical procedure or protocol, type of implant), and hospital type for all KQs. Additionally, for KQs 2 and 4 related to postoperative care, we considered length of hospital stay as an additional potential confounder.

Data Synthesis and Analysis

We had planned to summarize the evidence both qualitatively and, when feasible, quantitatively (via a network meta-analysis across the programs, focusing on comparisons of different components). However, due to the heterogeneity of interventions (i.e., almost completely unique content in (p)rehabilitation intervention and comparator arms, delivered at different times, in different settings, and by different personnel) and the lack of consistency of outcomes (e.g., different scales and metrics reported), meaningful statistical meta-analyses were not feasible, and we summarized the evidence only qualitatively.

Each study included in the systematic review is described in summary and evidence tables presenting study design features, study participant characteristics, descriptions of interventions, outcome results, and risk of bias/methodological quality. Summary tables briefly describe the studies and their findings.

For all KQs, we compared interventions with their comparators for their effects (grouping related interventions and comparisons as feasible), using post mean differences in continuous outcome data (i.e., difference in follow-up mean between groups) or net mean differences (i.e., difference-in-difference, or the between-intervention comparison of within-intervention changes). As there were not sufficient studies reporting sufficiently similar outcomes to explore the association of the specific intervention factors (components, personnel, setting), using statistical methods, we sought to explore associations narratively across studies by considering each of the factors as a 'lens' of potential impact when looking at the evidence.

Grading the Strength of the Body of Evidence

We summarized the strength of evidence (SoE), addressing each major comparison for each KQ. As the evidence base for KQs 1, 3, and 4 was relatively small, we summarized the evidence base for these questions as a whole. For KQ 2 we summarized the evidence base for acute-rehabilitation and post-acute rehabilitation for total knee arthroplasty (TKA). We graded the strength of the body of evidence as per the Agency for Healthcare Research and Quality (AHRQ) Methods Guide on assessing SoE.[57, 58] Further details are provided in the Methods Appendix A. We assessed SoE for each of the important patient and clinical outcome categories (starred outcomes in Eligibility Criteria outcome lists). We determined the relative importance of the outcomes with input from the TEP. The outcome categories for which SoE was assessed include activities of daily living; patient satisfaction with care; quality of life; mobility of joint function (e.g., knee range of motion); power of muscle (e.g., strength); hospital- or surgical clinic-based procedures postoperatively (e.g., need for manipulation under anesthesia); and injury related to therapy intervention. Additionally, for KQs 1 and 3 related to prehabilitation, we included: length of stay (postoperative) and posthospital disposition (e.g., to home, outpatient, skilled nursing facility, "subacute" rehabilitation, "acute" inpatient rehabilitation). The prioritized outcome domains are consistent with the "core outcome sets" recommended by Osteoarthritis

Research Society International (OARSI)[59] and the Total Joint Arthroplasty and Outcome Measures (TJAOM)[60] toolkits, published in 2013 and 2014, respectively. Core outcome sets are agreed minimum sets of outcomes that should be reported in research in a given topic area.[61]

For each SoE assessment, we considered the number of studies, their designs and limitations (i.e., risk of bias and overall methodological quality), the directness of the evidence to the KQs (direct/indirect), the consistency (consistent/inconsistent) of study results, the precision (precise/imprecise) of any estimates of effect, the likelihood of reporting bias, other limitations, and the overall findings across studies. We also assessed the extent to which different (p)rehabilitation interventions were replicated within each KQ (replicated/not replicated interventions). Based on these assessments, we assigned a SoE rating as being either high, moderate, low, or insufficient evidence to estimate an effect.

Outcomes with highly imprecise estimates, highly inconsistent findings across studies, or with data from only one study (or in some cases, where a small number of all unique interventions contributed evidence to the outcome) were deemed to have insufficient evidence to allow for a conclusion (with the exception that a particularly large and generalizable single study could provide at least low SoE). This approach is consistent with the concept that for imprecise evidence "any estimate of effect is very uncertain," the definition of Very Low quality evidence per the Grading of Recommendations, Assessment, Development, and Evaluations (GRADE) approach.[62] Outcomes for which we could make a conclusion but have limited confidence (i.e., it would not be unexpected for future studies to alter conclusions) due to limited number of studies, inconsistent findings, and/or poor replication of interventions were given low a SoE.

We summarized the data sources, basic study characteristics, and each SoE dimensional rating in an "Evidence Profile" table. This table details our reasoning for arriving at the overall SoE rating.

Assessing Applicability

For each KQ (or specific subquestion), we assessed the applicability of the included studies to adults having TKA or total hip arthroplasty (THA) in the United States. Applicability was primarily based on the studies' eligibility criteria and their included participants, specifically related to such factors as age, sex, and frailty, or comorbidities. We also considered operative procedures used and perioperative and postoperative care in relation to their applicability to contemporary practice, although these details were inconsistently reported.

Addressing the Contextual Question

Based on data and input garnered during our systematic review of the KQs, we answer the Contextual Question in a narrative format. In particular, we assessed the cost-effectiveness analyses regarding information about direct and indirect costs. We did not systematically extract or review eligible studies, create summary tables, or assess the strength of evidence for the Contextual Question.

Contextual Question

The evidence was insufficient to comment on the costs, both indirect and direct, associated with prehabilitation and rehabilitation programs. Of particular note, we found no cost-effectiveness analyses regarding prehabilitation or rehabilitation. Despite this, many studies noted cost as a justification for their study question — particularly studies of rehabilitation after total knee arthroplasty and total hip arthroplasty that evaluated the safety and effectiveness of rehabilitation delivered in lower resource settings or by lower resource personnel (as compared with interventions delivered in higher resource settings or by higher resource personnel.

Results

Literature Search Results

The electronic literature search yielded 22,361 unique citations. A total of 83 unique primary studies met criteria. Appendix B provides a list of excluded studies. Appendix Figure C-1 summarizes the results of the search and screening processes. The 83 included studies were reported in 98 articles that were published between 2005 (based on our eligibility criteria) and 2021. The 83 studies comprised 78 randomized controlled trials (RCTs) and 5 nonrandomized comparative studies (NRCSs). The 83 included studies enrolled a total of 14,533 patients: 78 RCTs with 8,397 patients (ranging from 20 to 212 patients each) and 5 NRCSs with 6,156 patients (ranging from 68 to 1,213 patients each).

Table 2 summarizes the number of studies that addressed each Key Question (KQ), by study design. In general, there was a larger evidence base for total knee arthroplasty (TKA) compared with total hip arthroplasty (THA) and for prehabilitation compared with rehabilitation. Seventeen percent of the studies (13/78) addressed KQ 1 (prehabilitation for TKA). All studies addressing KQ 1 were RCTs. Sixty-three percent of the studies (49/78) addressed KQ 2 (rehabilitation for TKA) which was further categorized into rehabilitation in the acute phase after TKA (initiated within 2 weeks of surgery) (n=18 studies; 15 RCTs, 3 NRCSs) and the post-acute phase (initiated 2 weeks or later following surgery) (n=31 studies; 30 RCTs, 1 NRCS). Eight percent of studies (6/78) addressed KQ3. All studies addressing KQ 3 were RCTs. Finally, 18 percent of the studies (14/78) addressed KQ 4 (prehabilitation for THA) (13 RCTS, 1 NRCS). These were further categorized into rehabilitation in the acute phase further THA (4 RCTs) and the post-acute phase (9 RCTs, 1 NRCS).

Table 2. Number of studies addressing each Key Question, by study design

Design	KQ 1	KQ 2	KQ 3	KQ 4	Total
Randomized controlled trials	13	49	6	14	78*
Nonrandomized comparative studies	0	4	0	1	5
Total	13	53	6	15	83*

* Some randomized controlled trials addressed multiple Key Questions (KQs): 1 study included for both KQs 1 and 2, 1 study included for both KQs 1 and 3, 2 studies included for both KQs 2 and 4)

For all 83 studies, Appendix Tables C-1 to C-4 summarize the design, arm, and patient characteristics, intervention details and risk of bias assessments (separate sub-tables by study design. as risk of bias assessments for RCTs and NRCSs are reported separately). Further details about the literature search, included studies, and excluded studies (with reasons for their exclusion) are in Appendixes A and B.

Description of Included Evidence

Detailed findings, including tables for study designs, arms, and sample characteristics; and risk of bias are in the Results Appendix C. For each KQ, we grouped and reported outcomes under four larger categories: Body structure and function outcomes; Activity and participation outcomes; Other patient-reported outcomes; and Healthcare-utilization outcomes. The first three of these categories (and the outcomes that comprised within them) were informed by the International Classification of Functioning, Disability, and Health framework as operationalized by a group of US- and Canadian-based TKA and THA experts (clinicians, researchers, and

patients). Where relevant, we call attention to specific appendix table numbers in the relevant subsections.

Key Question 1: Prehabilitation for Total Knee Arthroplasty

Key Points

- Compared with no prehabilitation, prehabilitation prior to TKA may reduce length of hospital stays and increase strength but may lead to comparable outcomes of pain, range of motion, and activities of daily living (ADL) after TKA (low strength of evidence [SoE] for all).
- Prehabilitation prior to TKA may not increase the risk of harms (low SoE).
- There is insufficient evidence regarding the impact of prehabilitation on quality of life (QoL) or need for postoperative procedures.
- There is no evidence on patient satisfaction with care after prehabilitation or the impact of prehabilitation on posthospital disposition.
- Given the heterogeneity of interventions and outcomes across studies, there is insufficient evidence on the effectiveness of specific prehabilitation intervention components at the level of goals (e.g., strength, flexibility) or presence of specific exercise components to address these goals.
- There is insufficient evidence on how the effect of prehabilitation programs may vary by patient, surgical, or setting factors.
- There is no evidence on the cost effectiveness of prehabilitation for TKA.

Findings Pertaining to Prehabilitation for Total Knee Arthroplasty

We found 13 eligible studies, all RCTs, that compared some version of a prehabilitation intervention to no prehabilitation (defined variably as “usual care”, "activities as usual”, or some form of minimal patient education). We rated seven of these 13 studies to be at overall high risk of bias, mostly related to lack of blinding of participants, study personnel, and/or outcome assessors and unclear methods of how random sequences were generated and/or concealed from patients. We rated the remaining six RCTs to be at overall moderate risk of bias mostly related to lack of blinding of participants, study personnel, and/or outcome assessors.

The 13 RCTs enrolled between 45 and 243 participants each. Most (n=9; 69%) were conducted in Europe. Two trials were conducted in the United States, one in Malaysia, and one in Taiwan. Two RCTs (Topp 2009 and Villadsen 2014)[63, 64] were funded in part by companies that produce rehabilitation and orthopedic equipment. The average ages of participants were similar across studies, ranging from 63 to 72 years. The percentage of women in the studies varied between 27 and 82 percent. Average body mass indices (BMIs) ranged from 27 to 33 kg/m^2. In a subset of three studies that reported data, prior contralateral TKA ranged from 10 to 30 percent. Appendix Tables C-1.1, C-1.2, and C-1.3 include the full data for all 13 RCTs.

Prehabilitation Versus No Prehabilitation

Thirteen RCTs, reported in 15 articles,[63-76] compared prehabilitation to no prehabilitation in a total of 1,328 patients who would undergo TKA (summarized in Figure 1). Only two specific prehabilitation interventions were evaluated by more than one study (two studies each)[64, 67, 68, 71]; the remaining nine studies evaluated unique prehabilitation interventions comprised of varying

goals and exercise components (as coded by our taxonomy) in different combinations, delivered in varying settings (by different modalities) by diverse personnel. Huber 2015 and Villadsen 2014 evaluated the neuromuscular training program (NEMEX-TJR) (targeting strength, aerobic endurance, flexibility, balance, task-specific training, and patient education) to patient education alone. [a] Huang 2012 and Matassi 2014 evaluated a prehabilitation program targeting strength, flexibility, and patient education goals with a no prehabilitation control.

Prehabilitation interventions were initiated between 2 and 12 weeks prior to the scheduled TKA. Most prehabilitation interventions in these 13 RCTs included components to target strength (n=11/13 prehabilitation arms) and flexibility (n=10/13), followed by components to address task-specific training (n=7/13), balance-motor-learning-agility (n=5/13), and patient education (n=5/13). Aerobic exercise was present in only two of prehabilitation programs. Specific exercise components within prehabilitation goal components varied across programs. Only one study included an adjunctive modality (acupuncture) in combination with the prehabilitation program as compared with no prehabilitation.[74] While one other study also assessed the effect of acupuncture, it was assessed alone as a single modality compared with standard rehabilitation or home exercise. Because the modality (acupuncture) did not meet our eligibility criteria of co-occurring with a prehabilitation program, the specific acupuncture arm is not discussed further.[76] Six studies reported some form of progression (i.e., any change in exercise type, repetition, or load consistent with an increase in exercise intensity or difficulty), of which three were assessed by clinical experts on our team as appropriate (i.e., the progression was based on patient-specific or individualized parameters as opposed to a universal, time-based progression).[64, 65, 68, 69] No study compared prehabilitation with versus without progression.

Interventions were delivered by physical therapists in nine of the 13 studies. In other studies, the intervention was delivered by research personnel (Topp 2009), no one (i.e., unsupervised self-guided home component) (Huang 2012, Matassi 2014, Topp 2009), or this information was not reported (Valtonen 2015). Except in Matassi 2014, the prehabilitation interventions had at least part of the program delivered to patients in-person: six in outpatient rehabilitation facilities, three in both outpatient and home environments (with either some remote support or a self-guided component), one exclusively at home, one at an aquatic center, and one in an unclear setting. Matassi 2014 was designed to be self-guided at home.

Specific codes for intervention (and control arm, where present) goals and exercises, use of progression (and assessment of appropriateness), and details on personnel, mode of delivery, and setting are detailed in Tables 3.1 and 3.2 and Appendix Table C-2.3.

The heterogeneity of the included prehabilitation interventions (varying content, use and appropriateness of progression, and personnel, setting, and timing of intervention delivery) made it challenging to identify meaningful groupings of similar studies to synthesize. In the absence of meaningful clusters of similar studies, we opted to summarize all prehabilitation studies together but contextualize interpretations of individual study results with details about the specific form of prehabilitation evaluated in those studies. We report outcomes under the four following outcome categories**:** body structure and function; activity and participation; other patient-reported; and healthcare utilization. Given intervention heterogeneity, we determined that meta-analysis was not warranted (i.e., average result would not have been interpretable/meaningful) and instead summarize results narratively.

[a] For the purpose of our coding, we determined that the intervention in Huber 2014 met coding criteria for patient education but Villadsen 2014 did not. For the purpose of this Key Question, however, the intervention and comparison of interest in the two studies seemed sufficiently similar to compare.

Figure 1. Overview of studies of prehabilitation and no prehabilitation interventions for total knee arthroplasty

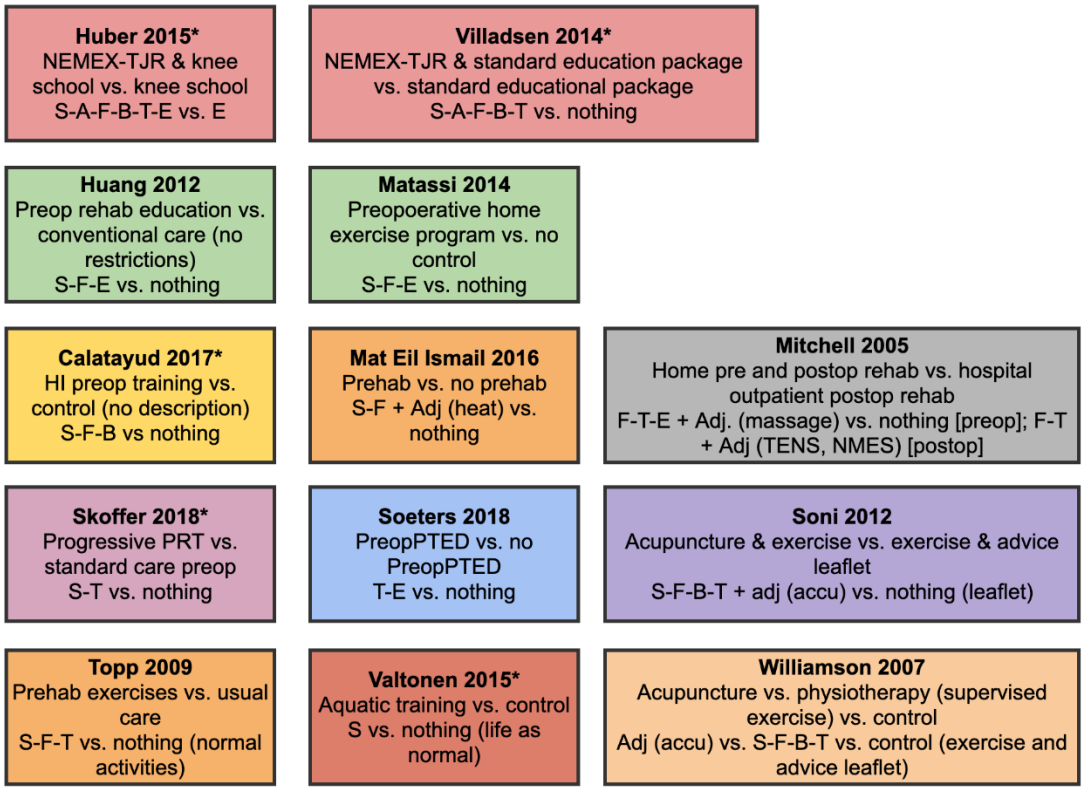

Figure presents studies (n=13) that evaluated prehabilitation programs for total knee arthroplasty versus various controls (predominately no active control with the exception of Mitchell 2005 which evaluated prehabilitation and postoperative rehabilitation combined vs. postoperative rehabilitation alone and did not include any active rehabilitation in the control arm during preoperative phase of the study). Study arms are described using study descriptors followed by goal components coded by the review team using the Oatis and Franklin taxonomy. The color is added for visual display and does not provide unique information.

Abbreviations: Adj = adjunctive, A = aerobic exercise, B= Balance-motor/learning-agility exercise, E = patient education, F = flexibility exercise, HI = high intensity, NEMEX = neuromuscular exercise, prehab = prehabilitation, preop = preoperative, postop = postoperative, RT = resistance training, S = strengthening exercise, T = task-specific training, TENS = transcutaneous electrical nerve stimulation, TJR = total joint replacement

* Intervention included progression which was deemed appropriate.

Table 3.1. Goal components strength, aerobic, and flexibility and their specific exercise components for prehabilitation interventions versus no prehabilitation for total knee arthroplasty

Study	Arm	Strength	Bridges	Core Strengthening	Heel Raises	Hip Abduction	Hip Adduction	Hip Extension	Hip Flexion	Knee Extension	Knee Flexion	Leg Press	Lunges	Open Chain Ankle	Quad Sets	Single Leg Stance	Sit-To-Stand	Squats	Step Down	Step Up	Straight Leg Raises	Aerobic	Bike (Endurance)	Flexibility	Ankle Pumps	Bike (ROM)	Calf Stretch	Hamstring Stretch	Heel Slides	Hip Extensor Stretch	Hip Flexor Stretch	Iliotibial Band Stretch	Knee Extension	Knee Flexion
Calatayud, 2017	HI preop training	1	0	0	1	1	0	0	0	1	1	1	0	0	0	1	0	0	0	1	0	0	0	1	0	1	1	1	0	0	0	1	0	1
	Control	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Huang, 2012	Preop rehab ed	1	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	1	1	0	0	0	0	0	0	0	0	0
	Conventional care	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Huber, 2015	NEMEX-TJR & knee school	1	0	1	0	1	1	0	0	1	1		1									1	1	1	0	0	0	0	0	0	0	0	0	0
	Knee school	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Matassi, 2014	Preoperative home exercise program	1	0	0	0	0	0	0	0	1	1	0	0	0	1	0	0	0	1	1	0	0	0	1	0	0	0	1	0	0	0	0	0	1
	Control	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mat Eil Ismail, 2016	Prehab	1	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	1	0	0	1	1	1		1	1					
	No prehab	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mitchell, 2005	Home preop & postop rehab	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	1
	Hospital outpatient postoperative rehab	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	1
Skoffer, 2016	Preop PRT	1	0	0	0	1	1	1	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	1	1
	Standard care preop	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Soeters, 2018	PreopPTEd	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0											
	NoPreopPTEd	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Soni, 2012	Acupuncture & exercise	1	0	0	0	0	0	0	0	1	1	0	0	0	1	0	1	0	0	0	1	0	0	1		1	1	1	0	0	0	0	0	0
	Exercise & advice leaflet	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Topp, 2009	Prehab exercises	1	0	0	0	1	1	1	1	1	1	0	0	1	0	0	0	1	1	1	0	0	0	1	0	0	1	1	0	1	1	0	0	0
	Usual care	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Valtonen, 2015	Aquatic training	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Control	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Villadsen, 2014	NEMEX-TJR & standard education package	1	1	1	0	1	1	0	0	1	1	0	1	0	0	0	0	0	1	1	0	1	1	1	0	1	0	0	0	0	0	0	0	0
	Standard education package	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Williamson, 2007	Acupuncture	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Physiotherapy (supervised exercise)	1	0	0	0	0	0	0	0	1	0	0	0	0	1	0	1	0	0	0	1	0	0	1	0	1	1	0	0	0	0	0	0	0
	Home exercise	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

See Table 3.2 for goal components balance-motor-learning-agility, task specific training, patient education, and adjunctive modalities. The color is added for visual display and does not provide unique information.

1 = presence of component, 0 = absence of component

Abbreviations: ed = education, HI = high intensity, NEMEX-TJR = neuromuscular training program, PRT = progressive resistive training; preop = preoperative; rehab = rehabilitation, ROM = range of motion

Table 3.2. Goal components balance-motor-learning-agility, task specific training, patient education, and adjunctive modalities and their specific exercise components for prehabilitation interventions versus no prehabilitation for total knee arthroplasty

Study	Arm	Balance-Motor Learning-Agility	Balance On Unstable Surface	Balance With perturbations	Step Down	Step up – Forward	Task specific training	Gait Backwards	Gait Training	Sit-To-Stand Training	Stair Training	Transfers	Patient Education	Activities Of Daily Living	Home Exercise Program	Pain Management	Adjunctive Modality	Heat	E-stim For Pain (TENS)	E-stim For Strength (NMES)	Massage	Dry Needling (Acupuncture)	Progression (Appropriate?)	Personnel	Mode of delivery	Setting
Calatayud, 2017	HI preop training	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Y (Y)	PT	I	O
	Control	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N	NA	NA	NA
Huang, 2012	Preop rehab ed	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	N	PT; None	I; R[A]; SG	O; H
	Conventional care	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N	NA	NA	NA
Huber, 2015	NEMEX-TJR & knee school	1	0	1	1	1	1	1	1	1	1		1	0	0	1	0	0	0	0	0	0	Y (Y)	PT	I	O
	Knee school	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	N	PT	I	O
Matassi, 2014	Preoperative home exercise program	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	N	None	SG	H
	Control	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N	NA	NA	NA
Mat Eil Ismail, 2016	Prehab	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	N	NR	NR	NR
	No prehab	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N	NA	NA	NA
Mitchell, 2005	Home preop & postop rehab	0	0	0	0	0	1	0	1	0	0	0	1	1		1	1	0	0	0	1	0	N	PT	I	H
	Hospital outpatient postoperative rehab	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	1	0	1	1	0	0	N	PT	I	O
Skoffer, 2016	Preop PRT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Y (N)	PT	I	O
	Standard care preop	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N	NA	NA	NA
Soeters, 2018	PreopPTEd	0	0	0	0	0	1			1	1	1	1	1	0	0	0	0	0	0	0	0	N	PT	I	NR
	NoPreopPTEd	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N	NA	NA	NA
Soni, 2012	Acupuncture & exercise	1	1	0	0	0	1	0	0	0	1	0	0	0	0	0	1	0	0	0	0	1	N	PT	I	O
	Exercise & advice leaflet	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N	NA	NA	NA
Topp, 2009	Prehab exercises	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N	Other[B]; None	I; SG	O; H
	Usual care	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N	NA	NA	NA
Valtonen, 2015	Aquatic training	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Y (N)	NR	I	Other[C]
	Control	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N	NA	NA	NA
Villadsen, 2014	NEMEX-TJR & standard education package	1	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	Y (Y)	PT	I	O
	Standard education package	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N	NA	NA	NA
Williamson, 2007	Acupuncture	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	N	PT	I	O
	Physiotherapy (supervised exercise)	1	1	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	N	PT	I	O
	Home exercise	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N	None	None	NA

See Table 3.1 for goal components strength, aerobic, and flexibility. The color is added for visual display and does not provide unique information.

1 = presence of component, 0 = absence of component

Abbreviations: ed = education, H = home, HI = high intensity, I = in-person; NA = not applicable, NEMEX-TJR = neuromuscular training program, O = outpatient physiotherapy center, PreopPTEd = Preoperative physical therapy education, PRT = progressive resistive training; preop = preoperative, prehab = prehabilitation, R = remote, rehab = rehabilitation, SG = self-guided.

[A] Remote via telephone
[B] Research personnel
[C] Aquatic center

Body Structure and Function Outcomes

Ten RCTs (Calatayud 2017, Huber 2015, Matassi 2014, Mitchell 2005, Skoffer 2016, Soni 2012, Topp 2009, Valtonen 2015, Villadsen 2014, Williamson 2007) reported on body structure and function outcomes comparing prehabilitation to no prehabilitation (Tables 4 to 9). The outcome domains included: Symptoms, Pain, Range of motion, Muscle strength, Energy and vigor, and Emotional functioning.

Symptoms

Five RCTs (Calatayud 2017, Huber 2015, Mitchell 2005, Skoffer 2016, Villadsen 2014) reported on physical well-being as continuous measures using the stiffness component of the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC; scores 0 to 8; lower score indicates reduced stiffness) and the symptoms component of the Knee Injury and Osteoarthritis Outcome Score (KOOS; scores 0-100; higher is better) score at 3 months after surgery (Table 4).

Four studies reported comparable scores between prehabilitation and control groups 3 months after TKA. One RCT (Calatayud 2017) reported statistically significant improvements in patients experience of stiffness among patients randomized to high intensity preoperative training at 3 month follow-up compared to control (mean difference [MD] –0.9, 95% confidence interval [CI] –1.3 to –0.6).

Pain

Nine RCTs reported pain data (Calatayud 2017, Huber 2015, Mitchell 2005, Skoffer 2016, Soni 2012, Topp 2009, Valtonen 2015, Villadsen 2014, Williamson 2007). Seven studies reported no significant differences between groups with respect to pain. Two studies (Calatayud 2017, Valtonen 2015) reported that prehabilitation was associated with significantly less pain than no prehabilitation (Table 5).

Huber 2015 and Villadsen 2014 evaluated a similar prehabilitation neuromuscular training program (NEMEX-TJR) combined with education, which was compared with an education control. Huber 2015 reported pain data using three different scores: the pain/discomfort component of EuroQol-5D (EQ-5D) (for each component 0 to 3, higher is worse), the pain component of KOOS (for each component: 0-100; higher is better), and the pain component of 36-Item Short Form Health Survey (SF-36) (for each component: 0-100; higher is better). Villadsen 2014 reported data using the pain component of the KOOS. Both studies of NEMEX-TJR found no difference in pain between prehabilitation and control groups at 3 or 12 months after surgery.

The remaining eight studies evaluated different prehabilitation training programs and reported pain data using the visual analog scale (VAS), pain components of the WOMAC, KOOS, and SF-36 at 3 months after surgery. Of these, only Calatayud 2017 and Valtonen 2015 reported reduced pain associated with their various prehabilitation programs. Calatayud 2017 (high intensity preoperative training) reported data using a VAS (0 to 10; higher is worse) and pain component of the KOOS (for each component: 0-100; higher is better). At 3 months after surgery, patients randomized to the high intensity preoperative training had lower pain scores on the VAS (MD –1.5, 95% CI –1.9 to –1.1) and the pain component of the WOMAC (MD –0.9, 95% CI –1.5 to –0.14) compared to patients who did not receive prehabilitation training. Valtonen 2015 (aquatic training) reported data using a VAS (1 to 10; higher is worse). At 3

months of followup, patients randomized to aquatic training reported a 58% decrease in pain (p=0.001; MD not reported) compared to patients who continued life as usual.

All other studies reported comparable pain scores between prehabilitation and control groups at 3 months after TKA.

Range of Motion

Four RCTs (Calatayud 2017, Huber 2015, Matassi 2014, Skoffer 2016) reported range of motion (ROM) data from various outcome measures, including active and passive knee ROM for extension and flexion of the knee joint. In several cases, whether ROM was active or passive was not specified. Studies measured ROM in degrees using goniometry. With the exception of one study (Matassi 2014), all ROM data was reported at 3 months after knee surgery (Table 6).

Two RCTs (Calatayud 2017 and Matassi 2014) reported that prehabilitation was associated with improvements in ROM of the knee joint compared to no prehabilitation. Calatayud 2017 reported significant improvements in active knee extension (MD –5.6, 95% CI –6.9 to –4.3) and active knee flexion (MD 4.8, 95% CI 0.2 to 9.5) in patients randomized to high intensity preoperative training compared to patients who did not receive prehabilitation training at 3 months follow-up. Matassi 2014 reported significant improvements in knee extension (MD and active/passive unspecified; p=0.032) in patients randomized to preoperative home exercise compared to control at 12 months after surgery but no significant between group difference in active or passive knee flexion.

The two other studies reported comparable range of motion between prehabilitation and control groups at 3 months after TKA.

Muscle Strength

Four RCTs (Calatayud 2017, Huber 2015, Skoffer 2016, Topp 2009) reported on muscle strength data from various outcome measures, including isometric and isokinetic knee extension and knee flexion strength. Studies measured strength in Newtons (N), kilograms (kg), or torque normalized to body weight (Nm/kg), using either a hand-held pull gauge or a dynamometer (for each, higher values indicate greater strength). All strength data was reported at 3 months following knee surgery (Table 7).

Two RCTs (Calatayud 2017 and Skoffer 2016) reported that prehabilitation was associated with greater improvements in muscle strength of the affected knee compared to no prehabilitation. Calatayud 2017 reported significant improvements in isometric knee extension (MD 8.5, 95% CI 4.8 to12.1) and knee flexion (MD 5.0, 95% CI 4.3 to 5.7) in patients randomized to high intensity preoperative training compared to patients who did not receive prehabilitation training at 3 months follow-up. Skoffer 2016 reported significant improvements in isometric (MD 0.2, 95% CI 0.1 to 0.3) and isokinetic knee extension (MD 0.2 95% CI 0.06 to 0.34), as well as isometric (MD 0.1, 95% CI 0.001 to 0.2) and isokinetic knee flexion (MD 0.1, 95% CI -0.01 to 0.21) in patients randomized to preoperative progressive resistance training compared to control at 3 months after surgery.

The two other studies reported comparable muscle strength between prehabilitation and control groups at 3 months after TKA.

Energy and Vigor

Two RCTs (Huber 2015 and Mitchell 2005) reported on vigor using the vitality component of the SF-36 (scores 0 to 100, higher is better) (Table 8) and found no significant differences between prehabilitation and control at 3 months after surgery.

Emotional Functioning

Two RCTs (Huber 2015 and Mitchell 2005) reported on emotional functioning data from mental health, emotional role functioning and social functioning component scales of the SF-36 (scores 0 to 100, higher is better) and found no significant differences between prehabilitation and control at 3 months after surgery (Table 9).

Table 4. Prehabilitation versus no prehabilitation for total knee arthroplasty – continuous outcomes, symptoms

Study, Year, PMID, Country	Outcome Measurement	Overall RoB	Time Point[A]	Prehab, N	Prehab, Mean (SD)	Control, N	Control Mean (SD)	Effect Size (95% CI)	Reported p-Value
Calatayud, 2017, 26768606, Spain	WOMAC: Stiffness (0-8)	Moderate	3 mo	22	2.2 (95% CI 2.0,2.5)	22	3.2 (95% CI 2.9,3.4)	**–0.9 (–1.3, –0.6)**	**<0.05**
Huber, 2015, 25925404, Switzerland	KOOS: Symptoms (0-100)	High	3 mo	21	NR	20	NR	4.6 (–5.0, 14.2)	NR
Mitchell, 2005, 15869558, UK	WOMAC: Stiffness (0-8)	High	3 mo	57	3.5 (1.4)	57	3.6 (2.1)	Adj MD –0.2 (–0.9, 0.4)	0.496
Skoffer, 2016, 26713665, Denmark	KOOS: Symptoms (0-100)	Moderate	3 mo	29	72.8 (16.4)	21	71.9 (11.4)	0.9 (–4.6, 6.4)[B]	NR
Villadsen, 2014, 23661494, Denmark	KOOS: Symptoms (0-100)	Moderate	3 mo	84	NR	81	NR	–6.0 (–13.4,1.5)	0.12

Statistically significant effect sizes are in bold text. In cases where calculated effect size confidence intervals were not-statistically significant but reported p-values were, we deferred to reported p-values and still bolded results.

Abbreviations: Adj MD = adjusted mean difference CI = confidence interval, KOOS = Knee injury and osteoarthritis outcome score, mo = month, NR = not reported, PMID = PubMed identifier, Prehab = prehabilitation, RoB = risk of bias, SD = standard deviation, SF-36 = 36-Item Short Form survey, WOMAC = Western Ontario and McMaster Universities Osteoarthritis Index

[A] Time from surgery
[B] Calculated

Table 5. Prehabilitation versus no prehabilitation for total knee arthroplasty – continuous outcomes, pain

Study, Year, PMID, Country	Outcome Measurement	Overall RoB	Time Point[A]	Prehab, N	Prehab, Mean (SD)	Control, N	Control Mean (SD)	Effect Size (95% CI)	Reported p-Value
Calatayud, 2017, 26768606, Spain	VAS (0-10)	Moderate	3 mo	22	1.4 (95% CI 1.1,1.7)	22	2.9 (95% CI 2.5,3.2)	**–1.5 (–1.9, –1.1)**	**<0.05**
	WOMAC: Pain (0-20)	Moderate	3 mo	22	2.9 (95% CI 2.5,3.3)	22	3.8 (95% CI 3.4,4.2)	**-0.9 (–1.5, –0.14)**	**<0.05**
Huber, 2015, 25925404, Switzerland	EQ-5D: Pain/discomfort (1-3)	High	3 mo	21	NR	20	NR	−0.0 (−0.5, 0.3)	NR
	EQ-5D: Pain/discomfort (1-3)	High	12 mo	21	NR	20	NR	−0.1 (−0.4, 0.3)	NR
	KOOS: Pain (0-100)	High	3 mo	21	NR	20	NR	–3.3 (–13.5, 6.8)	NR
	EQ-5D (VAS) (0-100)	High	3 mo	21	NR	20	NR	1.2 (–8.4, 10.8)	NR
	KOOS: Pain (0-100)	High	12 mo	21	NR	20	NR	2.3 (-8.5,13.0)	NR
	SF-36: Bodily pain (0-100)	High	3 mo	21	NR	20	NR	−3.4 (−15.5, 8.7)	NR
	SF-36: Bodily pain (0-100)	High	12 mo	21	NR	20	NR	4.9 (−7.8, 17.7)	NR
Mitchell, 2005, 15869558, UK	SF-36: Bodily pain (0-100)	High	3 mo	57	46.6 (20.6)	57	48.5 (26.8)	Adj MD –3.4 (–12.0, 5.2)	0.432
	WOMAC: Pain (0-20)	High	3 mo	57	6.8 (3.7)	57	6.9 (4.3)	Adj MD –0.5 (–2.0, 1.0)	0.530
Skoffer, 2016, 26713665, Denmark	VAS: Current pain (0-10)	High	3 mo	29	1.0 (1.7)	21	1.1 (1.3)	–0.1 (–0.7, 0.5)[B]	NR
	VAS: Average pain[C] (0-10)	High	3 mo	29	1.4 (1.6)	21	1.5 (1.1)	–0.1 (–0.6, 0.4)[B]	NR
	VAS: Worst pain[C] (0-10)	High	3 mo	29	2.6 (2.6)	21	2.4 (1.9)	0.2 (–0.7, 1.1)[B]	NR
	KOOS: Pain (0-100)	High	3 mo	29	78.1 (16.3)	21	79.9 (14.2)	–1.8 (–7.8, 4.2)[B]	NR
Soni, 2012, 22914302, UK	VAS (0-10)	Moderate	3 mo	28	3.9 (3)	28	4.7 (2.8)	–0.8 (–2.6, 1.1)	NR
Topp, 2009, 19695525, USA	VAS: Ascend stairs (0-10)	High	3 mo	26	1.33 (0.31)	28	1.26 (0.30)	0.07 (-0.09, 0.23)[B]	NR
	VAS: Descend stairs (0-10)	High	3 mo	26	1.42 (0.37)	28	1.45 (0.35)	-0.03 (-0.22, 0.16)[B]	NR
	VAS: Sit-to-stand (0-10)[D]	High	3 mo	26	1.62 (0.29)	28	1.06 (0.28)	0.56 (0.41, 0.71)[B]	NR
	VAS: 6-min walk (0-10)	High	3 mo	26	1.53 (0.34)	28	1.38 (0.33)	0.15 (-0.03, 0.33)[B]	NR
Valtonen, 2015, CN-01126383, Finland	VAS (0-10)	High	3 mo	31	NR	24	NR	**–58%**	**0.001**
Villadsen, 2014, 23661494, Denmark	KOOS: Pain (0-100)	Moderate	3 mo	84	NR	81	NR	–5.5 (–13.0, 2.9)	0.1556
	EQ-5D (VAS) (0-100)	Moderate	3 mo	84	NR	81	NR	2.8 (–4.8, 10.4)	0.4684
Williamson, 2007, 17604311, UK	VAS (0-10)	High	3 mo	23	3.86 (2.59)	19[E]	3.95 (2.59)	–0.09 (–1.71,1.53)	NR

Statistically significant effect sizes are in bold text. In cases where calculated effect size confidence intervals were not-statistically significant but reported p-values were, we deferred to reported p-values and still bolded results.

Abbreviations: Adj MD = adjusted mean difference, CI = confidence interval, EQ-5D = EuroQol-5 dimensions, KOOS = Knee injury and osteoarthritis outcome score, min = minute, mo = month, NR = not reported, PMID = PubMed identifier, RoB = risk of bias, SD = standard deviation, SF-36 = 36-item short form health survey, WOMAC = Western Ontario and McMaster Universities Osteoarthritis Index, VAS = visual analog scale.

[A] Time from surgery
[B] Calculated
[C] During the past 14 days
[D] Repetitions in 30 seconds
[E] Control arm sample size is uncertain from study report. Study was retained despite potential sample size of control being less than 20

Table 6. Prehabilitation versus no prehabilitation for total knee arthroplasty – continuous outcomes, range of motion

Study, Year, PMID, Country	Outcome Measurement	Overall RoB	Time Point[A]	Prehab, N	Prehab, Mean (SD)	Control, N	Control, Mean (SD)	Effect Size (95% CI)	Reported p-Value
Calatayud,2017, 26768606, Spain	Active Knee ROM: Extension (deg)[B]	Moderate	3 mo	22	8.2 (95% CI 7.2,9.3)	22	13.9 (95% CI 12.8,14.9)	**–5.6 (–6.9, -4.3)**	**<0.05**
	Active Knee ROM: Flexion (deg)	Moderate	3 mo	22	101.2 (95% CI 97.8,104.7)	22	96.4 (95% CI 92.9,99.9)	**4.8 (0.2, 9.5)**	**<0.05**
Huber, 2015, 25925404, Switzerland	Knee ROM (active/passive unspecified): Extension (deg)	High	3 mo	21	NR	20	NR	1.4 (–1.8. 4.5)	NR
	Knee ROM (active/passive unspecified): Flexion (deg)	High	3 mo	21	NR	20	NR	–3.9 (–10.2, 2.4)	NR
Matassi, 2014, 23271039, Belgium	Knee ROM (active/passive unspecified): Extension (deg)	Moderate	12 mo	61	1.00 (NR)	61	0.68 (NR)	**NR**	**0.032**
	Active Knee ROM: Flexion (deg)	Moderate	12 mo	61	118.3 (NR)	61	118.7 (NR)	NR	ns
	Passive Knee ROM: Flexion (deg)	Moderate	12 mo	61	120.5 (NR)	61	120.4 (NR)	NR	ns
Skoffer, 2016, 26713665, Denmark	Active Knee ROM: Extension (deg)	Moderate	3 mo	29	3.3 (2.8)	21	4.3 (2.4)	-1.00 (-2.45, 0.45)	0.089
	Passive Knee ROM: Extension (deg)	Moderate	3 mo	29	1.2 (2.3)	21	1.7 (2.4)	–0.5 (–1.4, 0.4)[C]	0.207
	Active Knee ROM: Flexion (deg)	Moderate	3 mo	29	113.0 (14.8)	21	112.5 (7.81)	0.5 (-5.84, 6.84)	0.995
	Passive Knee ROM: Flexion (deg)	Moderate	3 mo	29	118.7 (15.7)	21	118.3 (8.0)	0.4 (-4.6, 5.4)[C]	0.678

Statistically significant effect sizes are in bold text. In cases where calculated effect size confidence intervals were not-statistically significant but reported p-values were, we deferred to reported p-values and still bolded results.

Abbreviations: CI = confidence interval, deg = degree, mo = month, N= number, NR = not reported, PMID = PubMed identifier, RoB = risk of bias, ROM = range of motion, SD = standard deviation.

[A] Time from surgery
[B] Measured with goniometer
[C] Calculated

Table 7. Prehabilitation versus no prehabilitation for total knee arthroplasty – continuous outcomes, muscle strength

Study, Year, PMID, Country	Outcome Measurement	Overall RoB	Time Point[A]	Prehab, N	Prehab, Mean (SD)	Control, N	Control, Mean (SD)	Effect Size (95% CI)	Reported p-Value
Calatayud, 2017, 26768606, Spain	Strength: Isometric knee extension (kg)[B]	Moderate	3 mo	22	22.8 (95% CI 19.7,25.9)	22	14.3 (95% CI 11.1,17.5)	**8.5 (4.8,12.1)**	**<0.05**
	Strength: Isometric knee flexion (kg)	Moderate	3 mo	22	9.4 (95% CI 8.8,9.9)	22	4.4 (95% CI 3.8,5.0)	**5.0 (4.3, 5.7)**	**<0.05**
Huber, 2015, 25925404, Switzerland	Strength: Isometric knee extension (N)[C]	High	3 mo	21	NR	20	NR	–3.5 (–52.7, 45.6)	NR
	Strength: Isometric knee flexion (N)	High	3 mo	21	NR	20	NR	–12.7 (–36.2, 10.8)	NR
	Strength: Knee-bending/30s[D]	High	3 mo	21	NR	20	NR	–3.3 (–7.4, 0.8)	NR
Skoffer, 2016, 26713665, Denmark	Strength: Isometric peak knee extension (Nm/kg)[B]	Moderate	3 mo	29	1.0 (0.3)	21	0.8 (0.3)	**0.2 (0.1, 0.3)**[E]	**<0.001**
	Strength: Isokinetic peak knee extension (Nm/kg)	Moderate	3 mo	29	0.9 (0.3)	21	0.7 (0.2)	**0.2 (0.06, 0.34)**[E]	**0.002**
	Strength: Isometric peak knee flexion (Nm/kg)	Moderate	3 mo	29	0.7 (0.3)	21	0.6 (0.2)	**0.1 (0.001, 0.2)**[E]	**0.042**
	Strength: Isokinetic peak knee flexion (Nm/kg)	Moderate	3 mo	29	0.5 (0.2)	21	0.4 (0.2)	**0.1 (-0.01, 0.21)**[E]	**0.002**
Topp, 2009, 19695525, USA	Strength: Knee peak extension (Nm/kg)[B]	High	3 mo	26	62.27 (SE=4.81)	28	60.23 (SE=5.00)	2.04 (-11.56, 15.64)[E]	NR

Statistically significant effect sizes are in bold text. In cases where calculated effect size confidence intervals were not-statistically significant but reported p-values were, we deferred to reported p-values and still bolded results.

Abbreviations: CI = confidence interval, kg = kilogram, N = Newton, Nm/kg = torque normalized to body weight, NR = not reported, PMID = PubMed identifier, RoB = risk of bias, s = second, SD = standard deviation, SE = standard error.

[A] Time from surgery
[B] Measured with a dynamometer
[C] Measured with a hand-held pull gauge
[D] Measure rapid alternation between concentric and eccentric function, maximum number of knee-bending in 30 seconds (higher is better function)
[E] Calculated

Table 8. Prehabilitation versus no prehabilitation for total knee arthroplasty – continuous outcomes, energy and vigor

Study, Year, PMID, Country	Outcome Measurement	Overall RoB	Time Point[A]	Prehab, N	Prehab, Mean (SD)	Control, N	Control, Mean (SD)	Effect Size (95% CI)	Reported p-Value
Huber, 2015, 25925404, Switzerland	SF-36: Vitality (0-100)	High	3 mo	21	NR	20	NR	−8.3 (−20.0, 3.3)	NR
Mitchell, 2005, 15869558, UK	SF-36: Vitality (0-100)	High	3 mo	57	50.7 (19.5)	57	48.2 (23.7)	3.4 (–3.5, 10.3)	0.330

Statistically significant effect sizes are in bold text. In cases where calculated effect size confidence intervals were not-statistically significant but reported p-values were, we deferred to reported p-values and still bolded results.

Abbreviations: CI = confidence interval, NR = not reported, PMID = PubMed identifier, RoB = risk of bias, SF-36 = 36-Item short form survey, SD = standard deviation.

[A] Time from surgery

Table 9. Prehabilitation versus no prehabilitation for total knee arthroplasty – continuous outcomes, emotional functioning (stress/coping)

Study, Year, PMID, Country	Outcome Measurement	Overall RoB	Time Point[A]	Prehab, N	Prehab, Mean (SD)	Control, N	Control, Mean (SD)	Effect Size (95% CI)	Reported p-Value
Huber, 2015, 25925404, Switzerland	SF-36: Emotional role functioning (0-100)	High	3 mo	21	NR	20	NR	−10.2 (−34.0, 13.5)	NR
	SF-36: Social functioning (0-100)	High	3 mo	21	NR	20	NR	−1.6 (–13.7, 10.5)	NR
	SF-36: Mental health (0-100)	High	3 mo	21	NR	20	NR	−3.0 (−12.2, 6.1)	NR
Mitchell, 2005, 15869558, UK	SF-36: Emotional role functioning (0-100)	High	3 mo	57	48.0 (46.7)	57	45.6 (44.8)	Adj MD 4.1 (–10.9, 19.0)[B]	0.592
	SF-36: Social functioning (0-100)	High	3 mo	57	64.1 (26.6)	57	60.8 (33.1)	Adj MD 6.7 (–3.4, 16.7)	0.193
	SF-36: Mental health (0-100)	High	3 mo	57	68.0 (20.4)	57	71.2 (20.0)	Adj MD –2.9 (-9.3, 3.5)	0.368

Statistically significant effect sizes are in bold text. In cases where calculated effect size confidence intervals were not-statistically significant but reported p-values were, we deferred to reported p-values and still bolded results.

Abbreviations: Adj = adjusted, CI = confidence interval, MD = mean difference, mo = month, NR = not reported, PMID = PubMed identifier, RoB = risk of bias, SD = standard deviation, SF-36 = 36-Item short form survey.

[A] Time from surgery
[B] Regression coefficient represents the effect on post-operative quality of life due to the presence of intervention after adjusting for pre-operative quality of life and pre-operative waiting time

Activity and Participation Outcomes

Nine RCTs (Calatayud 2017, Huber 2015, Mitchell 2005, Skoffer 2016, Soni 2012, Topp 2009, Valtonen 2015, Villadsen 2014, Williamson 2007) reported on patient-reported outcomes comparing prehabilitation to no prehabilitation (Tables 10 to 16). The outcome domains included: Physical function and activities of daily living, repeat sit-to-stand test, balance, walking speed, walking distance, stair ascent and descent, and timed up and go.

Physical Function and Activities of Daily Living

Eight RCTs (Calatayud 2017, Huber 2015, Matassi 2014, Mitchell 2005, Skoffer 2016, Soni 2012, Villadsen 2014, Williamson 2007) reported on physical function and ADL using six different measurement instruments (Table 10). Seven studies found no significant differences between prehabilitation and control at 3 to 12 months after surgery.

Calatayud 2017 reported function using the physical component of the SF-36 (0-100, higher is better) and the physical function component of the WOMAC (0 to 68, lower is better) and found significant improvements in function on both measures (SF-36: MD 2.7, 95% CI 1.3 to 4.1; WOMAC: –3.9, 95% CI –5.2 to –2.7) among patients randomized to high intensity preoperative training compared to patients who did not receive prehabilitation training at 3 months follow-up.

Repeated Sit-To-Stand Test

Four RCTs (Huber 2015, Skoffer 2016, Topp 2009, Valtonen 2015) reported on three different outcomes measurements from repeated sit-to-stand tests (Table 11). Two studies reported the outcome measurement of the number of sit-to-stands completed in 30 seconds (higher is better), one study reported the amount of time to complete 5 sit-to-stands (in seconds; lower is better), and another study reported the number of times to complete an unspecified number of sit-to-stands (lower is better). Two studies reported improved performance in this test associated with prehabilitation compared to no prehabilitation, while the other two found no difference. Skoffer 2016 reported the number of sit-to stands performed in 30 seconds and found patients randomized to preoperative progressive resistance training performed significantly better than patients randomized to control (MD 3.3, 95% CI 0.76 to 5.84) at 3 months after surgery. Valtonen 2015 reported the time to complete an unspecified number of sit-to-stands and found a 15% decrease in the sit-to-stand time (MD=not reported; p=0.003) among patients randomized to aquatic training at 3 months after surgery.

The two other studies reported comparable sit-to-stand time (Huber 2015) and number of sit-to-stands (Topp 2009) for their prehabilitation compared to control at 3 months follow-up.

Balance

One RCT (Calatayud 2017) reported static balance data from three different outcomes measurements of the Romberg Test: the anteroposterior range of center of pressure (COP) (millimeters [mm], lower COP indicates better balance); COP area (millimeters [mm], lower COP area indicates better balance); and medial lateral range of COP (mm, lower COP indicates better balance) (Table 12). Tests were conducted with eyes open and closed using the NedSVE/IBV force platform. (Note that only results for eyes open were extracted.) Calatayud 2017 reported significant improvements in two of the three balance measures (anteroposterior range of COP; MD –3.2 (–4.0, -2.4) and COP area: –7.4 (–12.3, –2.4) among patients

randomized to the high intensity preoperative training compared to control at 3 months after surgery. The other balance measure (medial lateral range of COP) favored the prehabilitation group but was not significant (MD –0.5, 95% CI–1.1 to 0.2).

Walking Speed

Five RCTs (Huber 2015, Skoffer 2016, Soni 2012, Soni 2012, Valtonen 2015, Williamson 2007), reported on four different outcomes measurements of walking speed: the 50, 20, and 10 meter walk tests, and maximal walking speed (metric not specified) (Table 13).

Two studies reported prehabilitation was associated with improved performance of walking speed compared to control, while three studies reported no difference between groups. Skoffer 2016 reported findings from the 10-meter walk test and found patients randomized to preoperative progressive resistance training took significantly less time to complete 10-meter walk test compared to the control group at 3 months after surgery (MD –0.6 seconds, P = 0.216). Valtonen 2015 reported maximal walking speed and observed a 15 percent increase in walking speed among patients randomized to aquatic training compared to control at 3 months after surgery (P = 0.005).

The three other studies reported no significant difference between groups in terms of walking speed.

Walking Distance

Two RCTs (Skoffer 2016 and Topp 2009) reported data on walking distance using the 6-minute walk test (6MWT), which measures the maximal walking distance covered in 6 minutes. Neither study observed significant differences in walking distance between prehabilitation and control at 3 months after surgery (Table 14).

Stair Ascent and Descent

Two RCTs (Calatayud 2017 and Topp 2009) reported data on stair tests from three different stair climb tests outcome measurements: four flights of stair ascend/descend (seconds, smaller is better); stair climb test to ascent flight of 22 steps (seconds, smaller is better); stair climb test to descend a flight of 22 steps (seconds, smaller is better) (Table 15). Calatayud 2017 reported data on the time it took patients to ascend and descend four flights of stairs and found improved performance of the stair test among patients randomized to the high intensity preoperative training compared to control at 3 months after surgery. Topp 2009 observed no significant differences between prehabilitation and no prehabilitation groups.

Timed Up and Go

Three RCTs (Calatayud 2017, Huber 2015, and Skoffer 2016) reported data on the Timed Up and Go (TUG) test (Table 16). TUG is designed to assess lower extremity mobility and function. It requires patients to stand from a chair, walk to a line 3 meters away, turn and walk back, turn and sit down in the chair (measured in seconds [s], smaller is better). Two RCTs (Calatayud 2017 and Skoffer 2016) reported improved performance of the TUG associated with their prehabilitation programs (high intensity preoperative training and progressive resistance training, respectively) compared to control at 3 months after surgery. Topp 2015 found no significant differences in the performance of the TUG test between prehabilitation and no prehabilitation groups at 3 months after surgery.

Table 10. Prehabilitation versus no prehabilitation for total knee arthroplasty – continuous outcomes, physical function and activities of daily living

Study, Year, PMID, Country	Outcome Measurement	Overall RoB	Time Point[A]	Prehab, N	Prehab, Mean (SD)	Control, N	Control Mean (SD)	Effect Size (95% CI)	Reported p-Value
Calatayud, 2017, 26768606, Spain	SF-36: Physical component (0-100)	Moderate	3 mo	22	55.7 (95% CI 54.6,56.8)	22	53 (95% CI 51.9,54.1)	**2.7 (1.3, 4.1)**	**<0.001**
	WOMAC: Physical function (0-68)	Moderate	3 mo	22	18.8 (95% CI 17.8,19.7)	22	22.7 (95% CI 21.7,23.7)	**–3.9 (–5.2, –2.7)**	**<0.05**
Huber, 2015, 25925404, Switzerland	EQ-5D: Self-care (1-3)	High	3 mo	21	NR	20	NR	0.1 (−0.1, 0.3)	NR
	EQ-5D: Usual activities (1-3)	High	3 mo	21	NR	20	NR	0.0 (−0.4, 0.4)	NR
	EQ-5D: Mobility (1-3)	High	3 mo	21	NR	20	NR	−0.1 (−0.4, 0.2)	NR
	KOOS: ADL (0-100)	High	3 mo	21	NR	20	NR	–4.9 (–16.3, 6.5)	NR
	KOOS: Sport/rec (0-100)	High	3 mo	21	NR	20	NR	1.0 (–19.9, 21.8)	NR
	SF-36: Physical role functioning (0-100)	High	3 mo	21	NR	20	NR	−3.2 (−32.2, 25.9)	NR
	SF-36: Physical functioning (0-100)	High	3 mo	21	NR	20	NR	−6.6 (−8.5, 17.5)	NR
Matassi, 2014, 23271039, Belgium	Knee Society Score: Knee score	Moderate	12 mo	61	NR	61	NR	NR	ns
	Knee Society Score: Function score	Moderate	12 mo	61	NR	61	NR	NR	ns
Mitchell, 2005, 15869558, UK	SF-36: Physical role functioning (0-100)	High	3 mo	57	27.6 (37.1)	57	23.2 (36.2)	Adj MD 7.8 (–5.6, 21.2)	0.249
	SF-36: Physical function (0-100)	High	3 mo	57	41.6 (22.2)	57	43.3 (27.6)	Adj MD 2.5 (–6.3, 11.3)	0.579
	WOMAC: Physical function (0-68)	High	3 mo	57	24.9 (13.4)	57	26.4 (14.9)	Adj MD –1.0 (–5.9, 3.8)	0.677
Skoffer, 2016, 26713665, Denmark	KOOS: ADL (0-100)	Moderate	3 mo	29	82.9 (11.7)	21	78.2 (12.9)	4.7 (–0.3, 9.7)[B]	NR
	KOOS: Sport/rec (0-100)	Moderate	3 mo	29	50.2 (28.4)	21	40 (22.5)	10.2 (0.2, 20.2)[B]	NR
Soni, 2012, 22914302, UK	Oxford knee score (0-48)	Moderate	3 mo	20	27.4 (10)	21	25.1 (10.6)	–2.2 (–8.7, 4.3)	NR
Villadsen, 2014, 23661494, Denmark	KOOS: ADL (0-100)	Moderate	3 mo	84	NR	81	NR	-5.6 (–12.9, 1.8)	0.1371
	KOOS: Sport/rec (0-100)	Moderate	3 mo	84	NR	81	NR	–5.6 (–15.6, 4.5)	0.2779
Williamson, 2007, 17604311,UK	Oxford knee score (0-48)	High	3 mo	23	28.3 (9.78)	19[C]	26.7 (7.45)	1.61 (–3.91,7.13)	NR

Statistically significant effect sizes are in bold text. In cases where calculated effect size confidence intervals were not-statistically significant but reported p-values were, we deferred to reported p-values and still bolded results.

Abbreviations: Adj = adjusted, ADL = activities of daily living, CI = confidence interval, EQ-5D = EuroQual, KOOS = Knee injury and osteoarthritis outcome score, MD = mean difference, mo = month, NR = not reported, ns = not significant, PMID = PubMed identifier, rec = recreation, RoB = risk of bias, SD = standard deviation, SF-36 = 36-Item short form survey, WOMAC = Western Ontario and McMaster Universities Osteoarthritis Index.

[A] Time from surgery
[B] Calculated
[C] Control arm sample size is uncertain from study report. Study was retained despite potential sample size of control being less than 20.

Table 11. Prehabilitation versus no prehabilitation for total knee arthroplasty – continuous outcomes, repeated stand test (sit-to-stand)

Study, Year, PMID, Country	Outcome Measurement	Overall RoB	Time Point[A]	Prehab, N	Prehab, Mean (SD)	Control, N	Control Mean (SD)	Effect Size (95% CI)	Reported p-Value
Huber, 2015, 25925404, Switzerland	Chair stand test: Time to complete 5 sit-to-stands (s)	High	3 mo	21	NR	20	NR	2.0 (-1.8, 5.8)	NR
Skoffer, 2016, 26713665, Denmark	Chair stand test: Total sit-to-stands in 30s (n)	Moderate	3 mo	29	14.7 (4.7)	21	11.0 (4.4)	**3.3 (0.76, 5.84)**[B]	**0.001**
Topp, 2009, 19695525, USA	Chair stand test: Total sit-to-stands in 30s (n)	High	3 mo	26	12.87 (SE=0.82)	28	11.25 (SE=0.79)	1.62 (-0.73, 3.97)[B]	NR
Valtonen, 2015, CN-01126383, Finland	Chair stand test: Time to complete unspecified number of sit-to-stands (NR)	High	3 mo	31	NR	24	NR	**15% decrease in sit-to-stand time**	**0.003**

Statistically significant effect sizes are in bold text. In cases where calculated effect size confidence intervals were not-statistically significant but reported p-values were, we deferred to reported p-values and still bolded results.

Abbreviations: CI = confidence interval, mo = month, NR = not reported, PMID = PubMed identifier, RoB = risk of bias, SD = standard deviation, SE = standard error.

[A] Time from surgery
[B] Calculated

Table 12. Prehabilitation versus no prehabilitation for total knee arthroplasty – continuous outcomes, balance

Study, Year, PMID, Country	Outcome Measurement	Overall RoB	Time Point[A]	Prehab, N	Prehab, Mean (SD)	Control, N	Control Mean (SD)	Effect Size (95% CI)	Reported p-Value
Calatayud, 2017, 26768606, Spain	Romberg test (eyes open): Anteroposterior range of COP (mm)	Moderate	3 mo	22	17 (95% CI 16.4,17.6)	22	20.2 (95% CI 19.6,20.9)	**–3.2 (–4.0, –2.4)**	**NR**
	Romberg test (eyes open): COP area	Moderate	3 mo	22	42.1 (95% CI 38.4,45.7)	22	49.4 (95% CI 45.6,53.3)	**–7.4 (–12.3, –2.4)**	**NR**
	Romberg test (eyes open): Medial lateral range of COP (mm)	Moderate	3 mo	22	14.7 (95% CI 14.2,15.1)	22	15.1 (95% CI 14.7,15.6)	–0.5 (–1.1, 0.2)	NR

Statistically significant effect sizes are in bold text. In cases where calculated effect size confidence intervals were not-statistically significant but reported p-values were, we deferred to reported p-values and still bolded results.

Abbreviations: CI = confidence interval, COP = center of pressure , mm = milimeter, mo = month, NR = not reported, PMID = PubMed identifier, RoB = risk of bias, SD = standard deviation.

[A] Time from surgery

Table 13. Prehabilitation versus no prehabilitation for total knee arthroplasty – continuous outcomes, walking speed

Study, Year, PMID, Country	Outcome Measurement	Overall RoB	Time Point[A]	Prehab, N	Prehab, Mean (SD)	Control, N	Control Mean (SD)	Effect Size (95% CI)	Reported p-Value
Huber, 2015, 25925404, Switzerland	20-m walk test[B]	High	3 mo	21	NR	20	NR	-0.5 (-2.0, 1.0)	NR
Skoffer, 2016, 26713665, Denmark	10-m walk test (s)	Moderate	3 mo	29	7.1 (1.5)	21	7.7 (1.2)	**–0.6 (–1.1, –0.1)**[C]	**0.216**
Soni, 2012, 22914302, UK	50-m walk test (s)	Moderate	3 mo	20	64.1 (44.7)	21	55.0 (18.4)	9.1 (-12.7, 31.0)	NR
Valtonen, 2015, CN-01126383, Finland	Maximal walking speed (NR)	High	3 mo	31	NR	24	NR	**15% increase in walking speed**	**0.005**
Williamson, 2007, 17604311, UK	50-m walk test (s)	High	3 mo	23	46.6 (11.4)	19[D]	44.1 (6.91)	2.51 (-3.48,8.51)	NR

Statistically significant effect sizes are in bold text. In cases where calculated effect size confidence intervals were not-statistically significant but reported p-values were, we deferred to reported p-values and still bolded results.

Abbreviations: CI = confidence interval, mo = month, NR = not reported, PMID = PubMed identifier, RoB = risk of bias, s = second, SD = standard deviation.

[A] Time from surgery
[B] Study reported that the test measures the time it takes to walk 20 meters at the participant's usual walking pace, and the number of steps that they take to walk 20 meters. Study did not specify what scale was used for reported outcome (i.e., seconds vs. steps)
[C] Calculated
[D] Control arm sample size is uncertain from study report. Study was retained despite potential sample size of control being less than 20

Table 14. Prehabilitation versus no prehabilitation for total knee arthroplasty – continuous outcomes, walking distance

Study, Year, PMID, Country	Outcome Measurement	Overall RoB	Time Point[A]	Prehab, N	Prehab, Mean (SD)	Control, N	Control Mean (SD)	Effect Size (95% CI)	Reported p-Value
Skoffer, 2016, 26713665, Denmark	6MWT (m)	Moderate	3 mo	29	449 (94)	21	433 (74)	16 (-17, 49)[B]	0.208
Topp, 2009, 19695525, USA	6MWT (m)	High	3 mo	26	1337 (SE=58)	28	1365 (SE=56)	-28 (-194.28, 138.28)[B]	NR

Statistically significant effect sizes are in bold text. In cases where calculated effect size confidence intervals were not-statistically significant but reported p-values were, we deferred to reported p-values and still bolded results.

Abbreviations: 6MWT = six-minute walk test CI = confidence interval, mo = month, m = meter, NR = not reported, PMID = PubMed identifier, RoB = risk of bias, SD = standard deviation, SE = standard error.

[A] Time from surgery
[B] Calculated

Table 15. Prehabilitation versus no prehabilitation for total knee arthroplasty – continuous outcomes, stair ascent/descent

Study, Year, PMID, Country	Outcome Measurement	Overall RoB	Time Point[A]	Prehab, N	Prehab, Mean (SD)	Control, N	Control Mean (SD)	Effect Size (95% CI)	Reported p-Value
Calatayud, 2017, 26768606, Spain	Stair climb test: Ascend descend and descend flight of 4 stairs (s)	Moderate	3 mo	22	7.9 (95% CI 7.2,8.5)	22	12.1 (95% CI 11.5,12.8)	**–4.2 (–5.1, –3.4)**	**<0.05**
Topp, 2009, 19695525, USA	Stair climb test: Ascend flight of 22 stairs (s)	High	3 mo	26	8.44 (SE=0.77)	28	7.45 (SE=0.77)	0.99 (-1.26, 3.24)[B]	NR
	Stair climb test: Descend flight of 22 stairs (s)	High	3 mo	26	8.6 (SE=1.06)	28	8.06 (SE=1.06)	0.54 (-2.56, 3.64)[B]	NR

Statistically significant effect sizes are in bold text. In cases where calculated effect size confidence intervals were not-statistically significant but reported p-values were, we deferred to reported p-values and still bolded results.

Abbreviations: CI = confidence interval, mo = month, NR = not reported, PMID = PubMed identifier, RoB = risk of bias, s = second, SD = standard deviation, SE = standard error.

[A] Time from surgery
[B] Calculated

Table 16. Prehabilitation versus no prehabilitation for total knee arthroplasty – continuous outcomes, Timed Up and Go

Study, Year, PMID, Country	Overall RoB	Time Point[A]	Prehab, N	Prehab, Mean (SD)	Control, N	Control Mean (SD)	Effect Size (95% CI)	Reported p-Value
Calatayud, 2017, 26768606, Spain	Moderate	3 mo	22	7.0 (95% CI 6.7,7.3)	22	8.7 (95% CI 8.3,9.1)	**–1.7 (–2.1, –1.3)**	**<0.05**
Huber, 2015, 25925404, Switzerland	High	3 mo	21	NR	20	NR	1.6 (-0.1, 3.3)	NR
Skoffer,2016, 26713665, Denmark	Moderate	3 mo	29	7.9 (2.3)	21	8.9 (2.1)	**–1.0 (-1.9. –0.1)[B]**	**0.05**

Statistically significant effect sizes are in bold text. In cases where calculated effect size confidence intervals were not-statistically significant but reported p-values were, we deferred to reported p-values and still bolded results.

Abbreviations: CI = confidence interval, mo = month, NR = not reported, PMID = PubMed identifier, RoB = risk of bias, s = second, SD = standard deviation.

[A] Time from surgery
[B] Calculated

Other Patient-Reported Outcomes

Seven RCTs (Calatayud 2017, Huber 2015, Mitchell 2005, Skoffer 2016, Soni 2012, Villadsen 2014, Williamson 2007) reported data on other patient-reported outcomes not captured by body structure and function or activity and participation domains comparing prehabilitation to no prehabilitation (Tables 17 and 18). Outcome domains included: QoL, patient satisfaction with care, and patient global assessments.

Quality of Life

Three RCTs (Huber 2015, Skoffer 2016, Villadsen 2014) reported data on QoL, using two different measurement instruments. These studies reported data using the KOOS (for each component 0-100; higher is better). One study (Skoffer 2018) also reported a study-specific assessment of QoL, in which patients were asked to rate their QoL on a scale from 0 (worse QoL imaginable) to 100 (best QoL imaginable) (Table 17).

Two studies (Huber 2015 and Villadsen 20214) reported comparable QoL scores between prehabilitation and control groups at 3 months after TKA. Skoffer 2016 reported QoL using the QoL component of the KOOS (scores 0-100; higher is better), as well as a study-specific scale (scores 0-100; higher is better), and reported significant improvement in QoL among patients randomized to progressive resistance training compared to control using the study-specific outcome measure at 3 months after surgery (MD 10.3, 95% CI 2.8 to 17.8) but there was no significant difference observed between groups on the QoL component of the KOOS.

Patient Satisfaction With Care

No RCTs reported data on satisfaction with care.

Patient Global Assessments

Five RCTs (Calatayud 2017, Huber 2015, Mitchell 2005, Villadsen 2014, Williamson 2007) provided data on patients self-reported global assessment of their health using three different measurement instruments: the total score of the WOMAC (score 0-96; smaller is better); the general health component of the SF-36 (scores 0-100, higher is better), and the EQ-5D index (0-1) (Table 18).

Only one RCT (Calatayud 2017) reported that prehabilitation was associated with improvements in patients' global assessment of health. Calatayud 2017 reported data on patients' global health assessment using the total WOMAC score and found significant improvements among patients randomized to the high intensity preoperative training group compared to control (MD–5.8, 95% CI–7.6 to –3.9) at 3 months after surgery.

All other studies reported comparable findings in patients' global health assessment scores among prehabilitation and control groups at 3 months after surgery.

Table 17. Prehabilitation versus no prehabilitation for total knee arthroplasty – continuous outcomes, health-related quality of life

Study, Year, PMID, Country	Outcome Measurement	Overall RoB	Time Point[A]	Prehab, N	Prehab, Mean (SD)	Control, N	Control Mean (SD)	Effect Size (95% CI)	Reported p-Value
Huber, 2015, 25925404, Switzerland	KOOS: QoL (0-100)	High	3 mo	21	NR	20	NR	–5.9 (–18.5, 6.8)	NR
Skoffer, 2016, 26713665, Denmark	KOOS: QoL (0-100)	Moderate	3 mo	29	66.2 (18.9)	21	61.9 (16.6)	4.3 (–2.7, 11.3)[B]	NR
	Study-specific QoL scale[C] (0- 100)	Moderate	3 mo	29	86.7 (10.5)	21	76.4 (20.1)	**10.3 (2.8, 17.8)**[B]	**NR**
Villadsen, 2014, 23661494, Denmark	KOOS: QoL (0-100)	Moderate	3 mo	84	23	81	19	–4.6 (–12.9, 3.6)	0.2666

Statistically significant effect sizes are in bold text. In cases where calculated effect size confidence intervals were not-statistically significant but reported p-values were, we deferred to reported p-values and still bolded results.

Abbreviations: CI = confidence interval, KOOS = Knee injury and osteoarthritis outcome score, mo = month, NR = not reported, PMID = PubMed identifier, QoL = quality of life, RoB = risk of bias, SD = standard deviation.

[A] Time from surgery
[B] Calculated
[C] Health-related quality of life was recorded on a rating scale from 0 (worse health-related quality of life imaginable) to 100 (best health-related quality of life imaginable)

Table 18. Prehabilitation versus no prehabilitation for total knee arthroplasty – continuous outcomes, patient global assessment

Study, Year, PMID, Country	Outcome Measurement	Overall RoB	Time Point[A]	Prehab, N	Prehab, Mean (SD)	Control, N	Control Mean (SD)	Effect Size (95% CI)	Reported p-Value
Calatayud, 2017, 26768606, Spain	WOMAC: Total (0-96)	Moderate	3 mo	22	25 (95% CI 23.5,26.4)	22	30.7 (95% CI 29.2,32.2)	**–5.8 (–7.6, –3.9)**	**<0.05**
Huber, 2015, 25925404, Switzerland	SF-36: General health (0-100)	High	3 mo	21	NR	20	NR	−2.8 (−12.0, 6.3)	NR
Mitchell, 2005, 15869558, UK	SF-36: General health (0-100)	High	3 mo	57	61.0 (23.4)	57	61.0 (22.9)	Adj MD –0.2 (–7.0, 6.7)	0.964
Villadsen, 2014, 23661494, Denmark	EQ-5D index (0-1)	Moderate	3 mo	84	NR	81	NR	–0.06 (–0.13, 0.01)	0.0781
Williamson, 2007, 17604311,UK	WOMAC: Total (0-96)	High	3 mo	23	26 (17.7)	19	24.6 (16.8)	1.33 (–9.53,12.18)	NR

Statistically significant effect sizes are in bold text. In cases where calculated effect size confidence intervals were not-statistically significant but reported p-values were, we deferred to reported p-values and still bolded results.

Abbreviations: Adj MD = adjusted mean difference CI = confidence interval, EQ-5D = EuroQual, KOOS = Knee injury and osteoarthritis outcome score, mo = month, NR = not reported, PMID = PubMed identifier, RoB = risk of bias, SD = standard deviation, SF-36 = 36-Item short form survey, VAS = visual analogue scale, WOMAC = Western Ontario and McMaster Universities Osteoarthritis Index.

[A] Time from surgery

Healthcare Utilization Outcomes

Five RCTs (Calatayud 2017, Huang 2012, Matassi 2014, Soeters 2018, Williamson 2007) reported on healthcare utilization outcomes comparing prehabilitation to no prehabilitation (Tables 19 to 21). Outcome domains included: length of stay, need for postoperative procedures, and other healthcare utilization outcomes.

Length of Stay

Five RCTs (Calatayud 2017, Huang 2012, Matassi 2014, Soeters 2018, Williamson 2007) provided data on length of stay (LOS) (mean days; smaller is better). While all studies reported reduced LOS among patients who were randomized to prehabilitation compared to control, only three studies were significant (Calatayud 2017: MD –1.9, 95% CI –2.49 to –1.31; Huang 2012; MD –1 (95% CI –1.8 to 0.2 [based on calculated group data from report; study reported p-value=0.027]), Matassi 2014 MD –0.8 (95% CI –1.58 to –0.02) (Table 19).

Need for Postoperative Procedures

One RCT (Matassi 2014) reported data on need for postoperative procedures. Matassi 2014 reported on the number of patients reporting stiff knee who went on to receive manipulation under anesthesia and found no significant difference between prehabilitation and control groups (Table 20).

Other Healthcare Utilization Outcomes

One RCT (Soeters 2018) reported data on additional healthcare utilization outcome not captured above, including time to post-acute physical therapy discharge criteria (number of days, smaller is better) and the number of outpatients physical therapy sessions required (number of sessions, smaller is better). Readiness to discharge from physical therapy was defined as the ability to 1) independently transfer in and out of bed, a chair, and a toilet seat; 2) independently ambulate approximately 150 feet; 3) independently negotiate stairs; and 4) be independent with a home exercise program and activities of daily living. Soeters 2018 reported patients randomized to prehabilitation were more likely to meet physical therapists discharge criteria and require fewer outpatient therapy sessions, as compared to the control group (Table 21).

No RCT reported specific data on costs.

Cost-Effectiveness

We found no studies comparing the cost-effectiveness of prehabilitation with no prehabilitation.

Harms From Prehabilitation

Six RCTs (Huber 2015, Matassi 2014, Skoffer 2016, Soni 2012, Villadsen 2014, Williamson 2007) reported data on harms from participation in the prehabilitation intervention. All data was reported narratively and the severity of harms was low. Matassi 2014 reported exercise-related complaints in two patients: one patient developed knee pain and needed to stop the home exercise program and another patient develop ipsilateral adductor tendinitis (although there were no adductor-specific exercises in the program). Huber 2015, Skoffer 2016, Soni 2012, Villadsen 2014, Williamson 2007 reported no harms related to prehabilitation intervention.

Table 19. Prehabilitation versus no prehabilitation for total knee arthroplasty – continuous outcomes, length of stay

Study, Year, PMID, Country	Outcome	Overall RoB	Time Point[A]	Prehab, N	Prehab (SD)	Control, N	Control, Mean (SD)	Effect Size (95% CI)	Reported p-Value
Calatayud, 2017, 26768606, Spain	Length of stay (d)	Moderate	NA	22	4.5 (0.9)	22	6.4 (1.1)	**–1.9 (-2.49, –1.31)[B]**	**<0.001**
Huang, 2012, 22480863,Taiwan	Length of stay (d)	High	NA	126	7 (5) Range (5, 10)	117	8 (1) Range (5, 12)	**–1 (–1.8, 0.2)[B]**	**0.027**
Matassi, 2014, 23271039, Belgium	Length of stay (d)	Moderate	NA	61	9.1 (2.1)	61	9.9 (2.3)	**–0.8 (–1.58, –0.02)[B]**	**0.011**
Soeters, 2018, 29529614, USA	Length of stay (d)	Moderate	NA	32	2.7 (95% CI 2.4, 3.0)	31	3.0 (95% CI 2.7, 3.3)	NR	0.161
Williamson, 2007, 17604311, UK	Length of stay (d)	Moderate	NA	23	6.49 (1.99)	19[C]	6.6 (2.62)	–0.12 (–1.11,0.88)	0.0984

Statistically significant effect sizes are in bold text. In cases where calculated effect size confidence intervals were not-statistically significant but reported p-values were, we deferred to reported p-values and still bolded results.

Abbreviations: CI = confidence interval, d = day, LOS = length of stay, NR = not reported, PMID = PubMed identifier, RoB = risk of bias, SD = standard deviation.

[A] Time from surgery
[B] Calculated
[C] Control arm sample size is uncertain from study report. Study was retained despite potential sample size of control being less than 20

Table 20. Prehabilitation versus no prehabilitation for total knee arthroplasty – categorical outcomes, need for postoperative procedures

Study, Year, PMID, Country	Outcome Measurement	Overall RoB	Time Point[A]	Prehab, N	Prehab, Mean (SD)	Control, N	Control Mean (SD)	Effect Size (95% CI)	Reported p-Value
Matassi, 2014, 23271039, Belgium	Need for postoperative procedures: Stiff knee requiring MUA	Moderate	12 mo	61	5 (8.2%)	61	3 (4.9%)	1.73 (0.39, 7.57)	NR

Statistically significant effect sizes are in bold text. In cases where calculated effect size confidence intervals were not-statistically significant but reported p-values were, we deferred to reported p-values and still bolded results.

Abbreviations: CI = confidence interval, d = day, MUA = manipulation under anesthesia, NR = not reported, PMID = PubMed identifier, RoB = risk of bias, SD = standard deviation.

[A] Time from surgery

Table 21. Prehabilitation versus no prehabilitation for total knee arthroplasty – continuous outcomes, other healthcare utilization outcomes

Study, Year, PMID, Country	Outcome Measurement	Overall RoB	Time Point[A]	Prehab, N	Prehab, Mean (SD)	Control, N	Control Mean (SD)	Effect Size (95% CI)	Reported p-Value
Soeters, 2018, 29529614, USA	Met discharge criteria from physical therapy	Moderate	NA	32	1.8 (95% CI 1.4, 2.3)	31	2.9 (95% CI 2.5. 3.4)	NR	<0.001
	Outpatient physical therapy sessions (n)	Moderate	NA	32	3.4 (95% CI 3.0, 3.9)	31	4.6 (95% CI 4.2, 5.0)	NR	<0.001

Statistically significant effect sizes are in bold text. In cases where calculated effect size confidence intervals were not-statistically significant but reported p-values were, we deferred to reported p-values and still bolded results.

Abbreviations: CI = confidence interval, n = number, NR = not reported, PMID = PubMed identifier, RoB = risk of bias, SD = standard deviation

[A] Time from surgery

Heterogeneity of Treatment Effects (Subgroup Differences)

No studies reported subgroup analyses or more specifically, formally analyzed possible heterogeneity of treatment effects, such as statistical tests for whether the comparative effect of rehabilitation versus its various comparators differed in one subgroup of patients versus another (e.g., patients with higher vs. lower measures of strength, flexibility, function, etc. at baseline).

Applicability

Studies were conducted across the globe (two in the United States) using diverse interventions employed in diverse healthcare settings. While the relative effect of the interventions on clinical outcomes (and harms) from non-US-based studies are likely applicable to the U.S. context, findings pertaining to healthcare system or resources (such as costs or comparisons of inpatient vs. outpatient rehabilitation) are likely country- and healthcare system-specific. The sex of participants varied widely across studies ranging from 27 to 82 percent of participants being female. The average age of patients ages ranged from 63 to 72 years and the average BMIs ranged from 27 to 33 kg/m^2 (thus, in all studies, most patients were obese, but in several, many to most were morbidly obese). Most studies did not report whether patients had undergone previous contralateral replacement surgery; of those that did, proportions were low (less than 25%). As such, the conclusions in this KQ are likely most applicable to middle-to-older-aged adults in high-income countries who are receiving their first total TKA for osteoarthritis.

Summary of Comparison of Prehabilitation Versus No Prehabilitation for Patients Undergoing Total Knee Arthroplasty

Table 22 summarizes the evidence for the comparison of prehabilitation versus no prehabilitation for TKA. We focus on the outcomes we prioritized in discussion with stakeholders.

There is low to insufficient SoE for all conclusions. Prehabilitation may result in increased strength and reduced length of hospital stay following TKA and may not lead to increased harms. Based on the evidence available, there is no evidence of a difference between prehabilitation and no prehabilitation in terms of pain, range of motion, and ADL. Additionally, there is insufficient evidence of the impact of prehabilitation on QoL, posthospital disposition or need for postoperative procedures (such as manipulation under anesthesia). No studies reported evidence on patients' satisfaction with prehabilitation as compared with no prehabilitation and posthospital disposition.

Table 22. Evidence profile: Prehabilitation versus no prehabilitation for total knee arthroplasty

Outcome Category	Outcome	N Studies (Participants)	RoB	Consistency	Precision	Directness	Intervention Replication	SoE	Conclusions
Body structure and function	Pain	9 (725)	High	Consistent	Precise	Direct	2 studies evaluated a similar intervention; remainder unique	Low	Similar pain
	Range of motion	4 (448)	Moderate	Consistent	Precise	Direct	All unique	Low	Similar ROM
	Strength	4 (257)	Moderate	Consistent	Precise	Direct	All unique	Low	Increased strength
Activity and participation	ADLs	6 (636)	Moderate	Inconsistent	Precise	Direct	All unique	Low	Similar ADL
Other outcomes	Satisfaction with care	0	NA	NA	NA	NA	NA	Insufficient	No evidence
	QoL	3 (356)	Moderate	Inconsistent	Precise	Direct	All unique	Insufficient	No conclusion
Healthcare utilization	Length of stay	5 (485)	Moderate	Consistent	Precise	Direct	All unique	Low	Reduced LOS
	Posthospital disposition	0	NA	NA	NA	NA	NA	Insufficient	No evidence
	Need for postoperative procedures	1 (122)	Moderate	Consistency unknown (single study)	Precise	Direct	NA (single study)	Insufficient	No conclusion
Harms	Harms from prehabilitation	6 (474)	Moderate	Consistent	Precise	Direct	All unique	Low	No increased harm

Abbreviations: ADLs = activities of daily living, LOS = length of stay, NA = not applicable, QoL = quality of life, ROM = range of motion, RoB = risk of bias, SoE = strength of evidence

Key Question 2: Rehabilitation for Total Knee Arthroplasty

Key Points

- Rehabilitation delivered in the acute phase after TKA may result in increased strength (low SoE).
- There is low SoE of no difference between the various programs of rehabilitation initiated in the acute and post-acute period and their comparators in terms of in pain, ROM, or ADL (low SoE for all).
- There is low SoE of no difference in satisfaction with care among patients who received rehabilitation in the acute phase compared with various less intensive controls or in QoL among patients who received rehabilitation in the post-acute phase compared with comparators (low SoE for both).
- No studies reported evidence on the risk of harms due to acute rehabilitation (insufficient evidence); harms from post-acute rehabilitation were low and comparable among groups (low SoE).
- There is insufficient evidence on the impact of acute rehabilitation on QoL, post-acute rehabilitation on satisfaction with care, and both acute and post-acute rehabilitation on the need for postoperative procedures.
- Given the heterogeneity of interventions and outcomes across studies, there is insufficient evidence on the effectiveness of specific rehabilitation intervention components at the level of goals (e.g., strength, flexibility) or presence of specific exercise components to address these goals.
- There is insufficient evidence on how the effect of rehabilitation programs may vary by patient, surgical, or setting factors.
- There is no evidence on the cost effectiveness of rehabilitation for TKA.

Findings Pertaining to Rehabilitation for Total Knee Arthroplasty

We found 53 studies (49 RCTs and 4 NRCSs) reported in 61 articles that evaluated the effectiveness of rehabilitation among patients who had undergone TKA.[70, 77-136] All studies were unique in terms of rehabilitation component goals and specific exercise components employed to address these goals; no rehabilitation intervention was evaluated by more than one study. Across studies, rehabilitation interventions were delivered in varying settings (by different modalities), by diverse personnel, at varying intensity, and at various points during the rehabilitation period. The heterogeneity of the interventions (and their comparators) made it challenging to identify meaningful groupings of similar studies to synthesize. In the absence of meaningful clusters of similar intervention/comparator studies, we opted to summarize the rehabilitation studies within two main groups of when the intervention/comparator rehabilitation content was initiated: in the acute and post-acute phases after surgery. As expert consensus is unclear regarding the definition of the different phases of rehabilitation following surgery, we defined these time periods using our best judgement. Acute phase was defined as rehabilitation initiated within 2 weeks of surgery and post-acute rehabilitation was defined as rehabilitation initiated 2 weeks or more after surgery. We report outcomes under the four following outcome categories: body structure and function; activity and participation; other patient-reported; and healthcare utilization. Given intervention heterogeneity, we determined that meta-analysis was not warranted; a summarized,

average result would not have been interpretable or meaningful. Instead we summarize results narratively.

We coded 21 studies (18 RCTs and 3 NRCSs) as being delivered within an acute rehabilitation phase and 32 studies (31 RCTs and 1 NRCS) as being delivered within a post-acute rehabilitation phase. Of the acute rehabilitation studies, 4 RCTs evaluated novel (hypothesized better) rehabilitation programs vs. standard care (variously defined) or alternative rehabilitation programs, 4 RCTs evaluated comparatively similar rehabilitation programs delivered with varying intensity and/or timing, 6 studies (3 RCTs, 3 NRCSs) evaluated comparatively similar rehabilitation programs delivered in different settings or by different personnel, and 7 RCTs evaluated comparatively similar rehabilitation programs with or without an adjunctive modality (Figure 2).

Among the 32 post-acute rehabilitation studies, 17 RCTs evaluated novel (hypothesized better) rehabilitation programs vs. standard care (variously defined) or alternative rehabilitation program, 1 RCT evaluated two active programs hypothesized to be similar effects, 1 NRCS evaluated a comparatively similar rehabilitation program delivered with varying intensity/timing, 6 RCTs evaluated comparatively similar rehabilitation programs delivered in different settings or by different personnel, and 7 RCTs evaluated comparatively similar rehabilitation programs with or without an adjunctive modality (Figure 3).

We rated 19 of the 49 RCTs to be at overall high risk of bias, mostly related to lack of blinding of participants, study personnel, and/or outcome assessors and unclear methods of how random sequences were generated and/or concealed from patients. We rated the remaining 30 RCTs to be at overall moderate risk of bias, mostly related to lack of blinding of participants, study personnel, and/or outcome assessors. We rated all four NRCSs to be at moderate risk of bias based on their non-randomized design; all four NRCSs reported data that was adjusted for important confounders using appropriate methods as per our inclusion criteria.

The 53 studies enrolled between 41 and 2,426 participants each. Studies were conducted across the globe, mostly commonly in the Europe (n=25), followed by Asia (n=13), North America (n=9), and Australia (n=6). Of the studies that reported funding information, three RCTs (DeJong 2020, den Hertog 2012, Piqueras 2013, Rockstroh 2010) were funded in part by industry that produce medical equipment or telecommunication technology. The average ages of participants varied across studies, ranging from 54 and 79 years. The percentage of women in the studies varied across studies, from 27 to 100 percent. Average BMIs ranged from 27 to 35 kg/m^2. In a subset of six studies that reported data, prior contralateral TKA ranged from 13 to 43 percent. Appendix Tables C-2.1, C-2.2, C-2.3, and C-2.4 include the full data for all 53 studies.

Acute-Phase Rehabilitation

Twenty-one studies evaluated acute-phase rehabilitation in 6,049 patients (summarized in Figure 2). Acute-phase rehabilitation interventions were initiated in-hospital from immediately post-op to 2 weeks after surgery. Three acute-phase studies did not provide data to code the rehabilitation interventions (Chan 2018, Naylor 2017, Padgett 2018). The focus of these three studies was the setting to which patients were discharged. All remaining 18 acute-phase studies included some form of active rehabilitation in all 36 arms and included exercises to address the goal component of flexibility (n=36/36). Most studies also included exercises address the goal component of strength (n=32/36), task-specific training (n=32/36), patient education (n=15/30) and balance-motor-learning-agility (n=12/36). Aerobic exercise was not commonly targeted in

acute-phase rehabilitation interventions (n=6/36). Specific exercise components within rehabilitation goal components varied across programs. Nine studies included an adjunctive modality in combination with the rehabilitation program: two (Li 2014 and Li 2017) with the same adjunctive modalities delivered to both study arms and seven (Avramidis 2011, Eymir 2020, Stevens-Lapsley 2012, Tsukada 2018, Jin 2018, Rockstroh 2010, Zapparoli 2020) where the added benefit of adjunctive therapy was the question of interest and the adjuvant modality varied between arms. The adjunctive modalities evaluated in these seven studies included neuromuscular electrical stimulation (NMES; n=3 RCTs); transcutaneous electrical nerve stimulation (TENS; n=1 RCT), biofeedback (n=1 RCT), motor imagery (n=1 RCT), and continuous passive motion (vs. active-heel slides which was the comparison of interest for this review) (n=1 RCT). Eight studies reported some form of exercise progression, of which three were assessed by clinical experts on our team as appropriate (Buhagiar 2017, Eymir 2020, Stevens-Lapsley 2012). One study (Piquerras 2013) compared acute-phase virtual rehabilitation with progression to acute-phase conventional rehabilitation without progression.

Acute-phase rehabilitation interventions were delivered by physical therapists in 13 of the 18 studies. In other studies, the intervention was delivered by research personnel (Jin 2018) or was not reported (den Hertog 2012, Li 2017, Naylor 2017, Padgett 2018, Li 2014, Avramidis 2011, Rockstroh 2010). All acute-phase rehabilitation interventions were delivered to patients in-person (although, two studies that compared discharge destinations did not report the mode of delivery for each discharge destination). In addition to in-person delivery, three studies had a self-guided home-based component (Buhagiar 2017, Eymir 2020, Stevens-Lapsley 2012), and one study had a remote (via app or telephone) component (Piqueras 2013). Ten studies were delivered exclusively in an inpatient rehabilitation setting (den Hertog 2012, Sattler 2019, Iwakiri 2020, Lenssen 2006, Li 2017, Li 2014, Tsukada 2018, Jin 2018, Rockstroh 2010, Zapparoli 2020).

Three acute-phase rehabilitation interventions were compared in different settings. Harmer 2009 compared rehabilitation delivered in a swimming pool (combined with home-based therapy) to land-based rehabilitation delivered in the outpatient and home setting. Buhagiar 2017 compared an acute rehabilitation program delivered in the hospital to one delivered at home. Piqueras 2013 compared an identical program delivered in the acute and outpatient setting.

Three acute-phase rehabilitation studies (Chan 2018, Naylor 2017, and Padgett 2018) reported the destination to which patients were discharged (e.g., home, community hospital, long term care facility) and not the setting in which rehabilitation was provided, per se.

Specific codes for intervention (and control arm, where present) goals and exercises, use of progression (and assessment of appropriateness), and details on personnel, mode of delivery, and setting are detailed in Tables 23.1 and 23.2 and Appendix C-2.2.

Figure 2. Overview of studies of acute-phase rehabilitation interventions and various controls for total knee arthroplasty

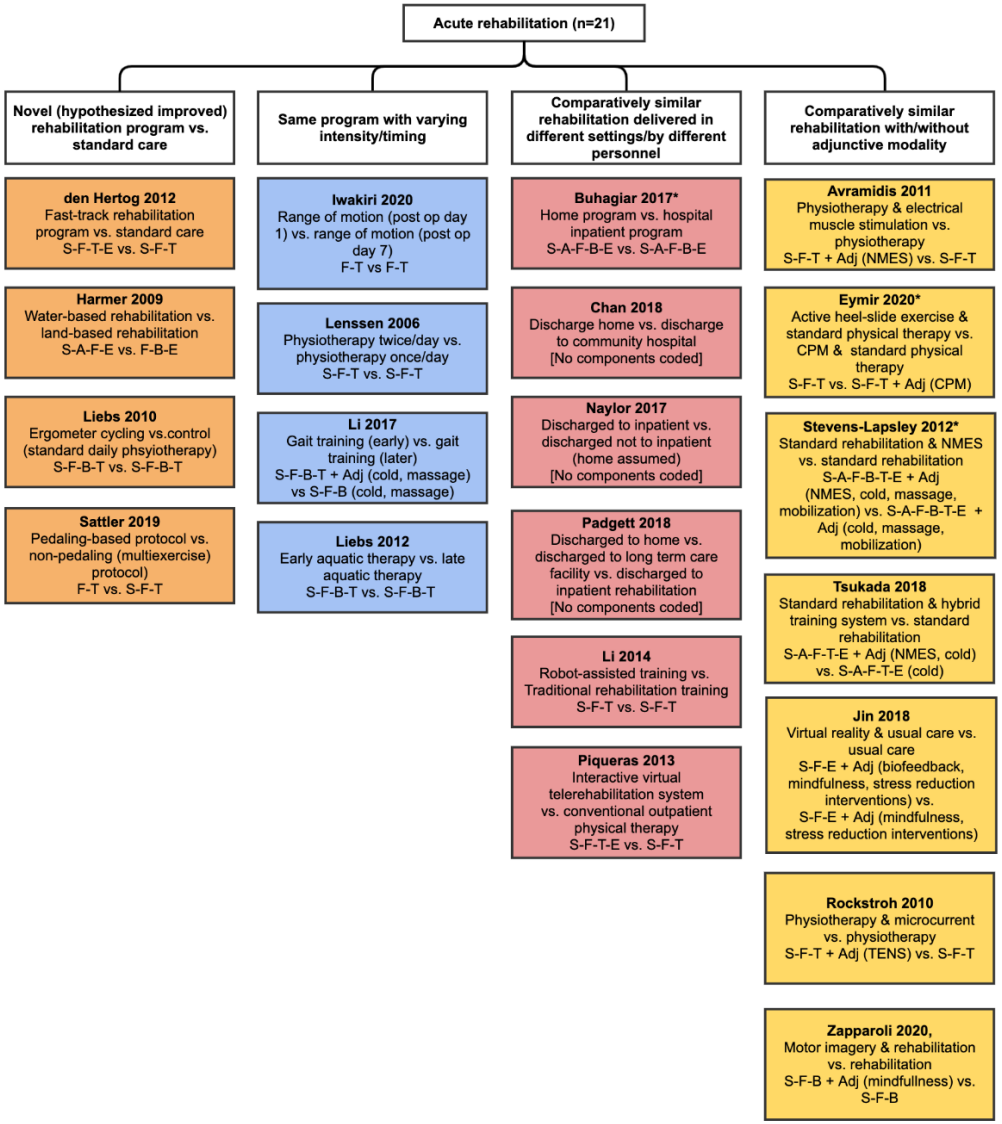

Figure presents categorization of studies (n=21) that evaluated acute rehabilitation programs for total knee arthroplasty. The first column lists novel (more intensive) programs compared with different programs (first group hypothesized to be better); the second column lists studies with comparatively similar rehabilitation programs in both arms that were delivered with different timing or intensity (first group hypothesized to be better); the third column lists studies with comparatively similar rehabilitation programs delivered in different settings or by different personnel (i.e., shift in resources providing care; groups hypothesized to be comparable); the fourth column lists studies with rehabilitation interventions comparing a rehabilitation program and an adjunctive modality vs. the same rehabilitation program alone (first group hypothesized to be better). Studies are defined using arm descriptors first and component coding second. The different colors are added to visually separate the columns and do not provide unique information.

Abbreviations: Adj = adjunctive, A = aerobic exercise, B= balance-motor/learning-agility exercise, E = patient education, F = flexibility exercise, NMES = neuromuscular electrical stimulation, S = strengthening exercise, T = task-specific training.

* Intervention included progression which was deemed appropriate.

Table 23.1. Goal components strength, aerobic, and flexibility and their specific exercise components for acute-rehabilitation intervention versus various controls for total knee arthroplasty

Study	Arm	Strength	Bridges	Calf Press	Clamshells	Core Strengthening	Gluteal Sets	Heel Raises	Hip Abduction	Hip Adduction	Hip Extension	Hip Flexion	Hip Hikes	Knee Extension	Knee Flexion	Leg Press	Lunges	OCA Strengthening	Quad sets	Single Leg stance	Sit-to-Stand	Squats	Standing TKE	Step Down	Step Lateral	Step Up	Stool Scoots	Straight Leg Raises	UE Strengthening	Wall Slides	Aerobic	Aquatics	Bike (Endurance)	Elliptical Machine	Stepper	Walking	Flexibility	Ankle Pumps	Bike (ROM)	Calf Stretch	Hamstring Stretch	Heel Slides	Hip Extensor Stretch	Hip Flexor Stretch	Knee Extension	Knee Flexion	Standing TKE
den Hertog, 2012[A]	Fast-track rehab	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	1	0
	Standard rehab	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	1	0
Harmer, 2009[A]	Water-based rehab	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	1	0	0	0	0	0	0	0	1	1	0
	Land-based rehab	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	1	1	0
Liebs, 2010[A]	Ergometer cycling	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0
	Control (standard daily physiotherapy)	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Sattler, 2019[A]	Pedaling-based protocol	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	1	0	0	0	0	0	0
	Non-pedaling (multi-exercise) protocol	1	0	0	0	0	0	1	0	0	0	0	0	1	1	0	0	0	1	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	1	1	0	1	0	1	0	0	1	1	0
Iwakiri, 2008	ROM (day 1)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	1	0
	ROM (day 7)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	1	0
Lenssen, 2006[B]	Exercise (twice/day)	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	1	0
	Exercise (once/day)	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	1	0
Li, 2017[B]	GT & usual care	1	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	1	1	0
	Usual care (GT later)	1	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	1	1	0
Liebs, 2012[B]	Early AT	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
	AT after wound healing	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Buhagiar, 2017[C]	Home	1	0	0	0	0	0	1	0	0	1	0	0	1	1	0	0	0	0	0	1	0	0	0	0	1	0	1	1	0	0	0	1	0	1	1	0	0	1	1	1	0	0	1	1	0
	Hospital inpatient	1	0	0	0	0	0	1	0	1	1	0	0	1	1	0	0	0	0	0	1	1	0	0	0	1	0	1	1	0	1	0	1	0	1	1	0	0	1	1	1	0	0	1	1	0
Chan, 2018[C]	Discharged to H	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Discharged to CH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Naylor-2017[C]	Discharged to H	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Discharged to IF	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Padgett, 2018[C]	Discharged to H	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Discharged to LTC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Discharged to IF	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Li, 2014[C]	Robot-assisted training	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0
	Traditional rehab training	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0
Piqueras, 2013[C]	Virtual telerehab	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
	Conventional rehab	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Avramimdis, 2014[D]	Physio & NMES	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0
	Standard physio	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	1	0	0
Eymir, 2020[D]	Active heel-slide exercise & standard PT	1	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	1	0	0	0	1	0	0	1	1	0
	CPM & standard PT	1	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	1	1	0
Stevens-Lapsley, 2012[D]	Standard rehab & NMES	1	0	0	0	0	1	0	1	0	0	0	0	1	1	0	0	0	1	0	0	1	1	1	0	1	0	1	0	1	1	0	1	0	0	1	1	1	0	0	1	0	0	1	1	1
	Standard rehab	1	0	0	0	0	1	0	1	0	0	0	0	1	1	0	0	0	1	0	0	1	1	1	0	1	0	1	0	1	1	0	1	0	0	1	1	1	0	0	1	0	0	1	1	1
Tsukada, 2018[D]	Standard rehab & HTS	1	0	0	0	0	1	0	1	0	0	0	0	1	1	0	0	1	1	0	0	0	0	0	0	0	0	1	0	0	1	0	1	0	0	1	1	1	0	0	1	0	0	1	1	1
	Standard rehab	1	0	0	0	0	1	0	1	0	0	0	0	1	1	0	0	1	1	0	0	0	0	0	0	0	0	1	0	0	1	0	1	0	0	1	1	1	0	0	1	0	0	1	1	1
Jin, 2018[D]	Virtual reality	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1	0
	Conventional rehab	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1	0
Rockstroh, 2010[D]	Physio & microcurrent	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
	Physio	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Zapparoli, 2020[D]	Motor imagery & rehab	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	1	0
	Rehab	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	1	0

See Table 23.2 for goal components balance-motor-learning-agility, task specific training, patient education, and adjunctive modalities. The color is added for visual display and does not provide unique information.

1 = presence of component, 0 = absence of component

Abbreviations: AT = aquatic therapy, CH = community hospital, ex = exercise, GT = gait training, H = home, HTS = hybrid training system, IF = inpatient facility, LTC = long term care facility, OCA = open chain ankle, UP = upper extremity, physio = physiotherapy, rehab = rehabilitation, ROM = range of motion, TKE = terminal knee extension

[A] Novel rehabilitation vs. standard care/other rehabilitation
[B] Similar rehabilitation with varying intensity/timing
[C] Similar rehabilitation delivered in different setting/by different personnel
[D] Similar rehabilitation with/without adjuvant modality

Table 23.2. Goal components balance-motor-learning-agility, task specific training, patient education, and adjunctive modalities and their specific exercise components for acute-rehabilitation intervention versus various controls for total knee arthroplasty

Study	Arm	Balance-Motor Learning-Agility	Balance On Unstable Surface	Balance With Perturbations	Marching	Single Leg Stance	Standing Weight Shifts	Stepping Multiple Directions	Step Down	Step Lateral (Side Step)	Step Up – Forward	Tandem Standing	Tandem Walking	Task Specific Training	Gait Backwards	Gait Downhill	Gait On Uneven Surfaces	Gait Sideways	Gait Training	Gait Uphill	Gait With Perturbations	Obstacle Training	Sit-to-stand Training	Stair Training	Transfers	Patient Education	Activities Of Daily Living	Home Exercise Program	Life-style Change	Pain Management	Self-Management	Wound Care Management	Adjunctive modality	Cold	Heat	E-stim For Pain (TENS)	E-stim for Strength (NMES)	Massage	Mobilizations	Biofeedback Devices	Dry Needling (Acupuncture)	MSAR	CAM	Progression (Appropriate?)	Personnel	Mode Of Delivery	Setting
den Hertog, 2012[A]	Fast-track rehab	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0		1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N	NR	I	AI
	Standard rehab	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N	NR	I	AI
Harmer, 2009[A]	Water-based rehab	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Y (N)	PT	I	Other[E]; H
	Land-based rehab	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	1	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Y (N)	PT	I	O; H
Liebs, 2010[A]	Ergometer cycling	1	1	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	1	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N	PT	I	O
	Control (standard daily physiotherapy)	1	1	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	1	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N	PT	I	O
Sattler, 2019[A]	Pedaling-based protocol	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N	PT	I	AI
	Non-pedaling (multi-exercise) protocol	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N	PT	I	AI
Iwakiri, 2020[B]	ROM (day 1)	0	0	0	0	0	0	0	0	0	0	0	0	1					1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N	PT	I	AI
	ROM (day 7)	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N	PT	I	AI
Lenssen, 2006[B]	Exercise (twice/day)	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N	PT	I	AI
	Exercise (once/day)	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N	PT	I	AI
Li, 2017[B]	GT & usual care	1	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	1	0	0	0	0	Y (N)	NR	I	AI
	Usual care (GT later)	1	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	1	0	0	0	0	Y (N)	NR	I	AI
Liebs, 2012[B]	Early AT	1	1	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	1	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N	PT	I	O
	AT after wound healing	1	1	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	1	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N	PT	I	O
Buhagiar, 2017[C]	Home		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Y (Y)	PT	I; SG	H
	Hospital inpt	1	0	0	1	1	0	0	0	0	1	0	0	1	0	0	0	0	1	0	0	0	1	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Y (Y)	PT	I	AI
Chan, 2018[C]	Discharged to H	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N	PT	I	H
	Discharged to CH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N	PT	I	OIF
Naylor-2017[C]	Discharged to H	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	NR	NR	NR	NR
	Discharged to IF	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	NR	NR	NR	NR
Padgett, 2018[C]	Discharged to H	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	NR	NR	NR	NR
	Discharged to LTC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	NR	NR	NR	NR
	Discharged to IF	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	NR	NR	NR	NR
Li, 2014[C]	Robot assisted training	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	N	NR	I	AI
	Traditional rehab training	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	N	NR	I	AI
Piqueras, 2013[C]	Virtual telerehab	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Y (N)	PT	I; R[F]	AI; H
	Conventional rehab	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N	PT	I	AI; O
Avramimdis, 2014[D]	Physio & NMES	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	Y (N)	NR	I	AI; O
	Standard physio	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Y (N)	NR	I	AI; O
Eymir, 2020 [D]	Active heel-slide exercise & standard PT	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	1	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Y (Y)	PT; None	I; SG	AI; H
	CPM & standard PT	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	1	1	1	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	Y (Y)	PT; None	I; SG	AI; H
Stevens-Lapsley, 2012[D]	Standard rehab & NMES	1	0	0	0	1	0	0	1	0	1	0	0	1	0	0	0	0	1	0	0	0	1	1	1	1	1	1	0	0	0	0	1	0	0	0	1	1	1	0	0	0	Y (Y)	PT	I; SG	AI; O; H
	Standard rehab	1	0	0	0	1	0	0	1	0	1	0	0	1	0	0	0	0	1	0	0	0	1	1	1	1	1	1	0	0	0	0	1	0	0	0	1	1	0	0	0	0	Y (Y)	PT	I; SG	AI; O; H
Tsukada, 2018[D]	Standard rehab & HTS	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	1	1	1	1	0	0	0	0	0	1	1	0	0	1	0	0	0	0	0	Y (N)	PT	I	AI
	Standard rehab	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	1	1	1	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	Y (N)	PT	I	AI
Jin, 2018[D]	Virtual reality	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	1	0	0	0	0	0	0	1	0	1	0	N	Other[G]	I	AI
	Conventional rehab	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	1	0	0	0	0	0	0	0	1	0	N	Other[G]	I	AI
Rockstroh, 2010[D]	Physio & microcurrent	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	N	NR	I	AI
	Physio	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	N	NR	I	AI
Zapparoli, 2020[D]	Motor imagery & rehab	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	N	PT	I	AI
	Rehab	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	N	PT	I	AI

See Table 23.1 for goal components strength, aerobic, and flexibility. The color is added for visual display and does not provide unique information.

1 = presence of component, 0 = absence of component

Abbreviations: AI = acute inpatient, AT = aquatic therapy, CAM = complementary and alternative therapies, GT = gait training, H = home, HTS = hybrid training system, I = in-person; inpt = inpatient, IF = inpatient facility, LTC = long term care facility, MSAR = mindfulness, stress/anxiety reduction, NA = not applicable, NMES = neuromuscular electrical stimulation, O = outpatient physiotherapy center, OIF = other inpatient facility, PRT = progressive resistive training; preop = preoperative; PT = physical therapist, R = remote, tele = telephone, TENS = transcutaneous electrical nerve stimulation, rehab = rehabilitation, SG = self-guided

[A] Novel rehabilitation vs. standard care/other rehabilitation
[B] Similar rehabilitation with varying intensity/timing
[C] Similar rehabilitation delivered in different setting/by different personnel
[D] Similar rehabilitation with/without adjuvant modality
[E] Pool
[F] Remote via app or telephone
[G] Research personnel

Body Structure and Function Outcomes Following Acute Rehabilitation

Fourteen studies reported on body structure and function outcomes following acute rehabilitation compared with various controls: three studies (Harmer 2009, Liebs 2010, Sattler 2019) comparing novel acute rehabilitation programs with various comparators (less intensive rehabilitation or no care); four studies (Iwakiri 2020, Lenssen 2006, Li 2017, Liebs 2012) comparing acute rehabilitation programs with different timing and/or intensity; two studies (Buhagiar 2017 and Piqueras 2013) comparing acute rehabilitation programs delivered in different settings or by different personnel; and five studies (Avramidis 2011, Eymir 2020 Rockstroh 2010, Stevens-Lapsley 2012, Tsukada 2020) comparing acute rehabilitation programs with or without an adjunctive modality (Tables 24 to 28). The outcome domains included: symptoms, pain, range of motion, muscle strength, and emotional functioning.

Symptoms

Four studies (Harmer 2009, Liebs 2010, Lenssen 2006, Liebs 2012) reported data on symptoms using the stiffness component of the WOMAC (scores 0 to 8; lower score indicates reduced stiffness; Liebs 2010 and 2012 used a 0 to 100 score) and observed no differences between groups at follow-up ranging from 3 to 12 months after TKA (Table 24).

Pain

Twelve studies reported pain data (Harmer 2009, Liebs 2010, Sattler 2019, Lenssen 2006, Liebs 2012, Buhagiar 2017, Li 2015, Piqueras 2013, Rockstroh 2010, Eymir 2020, Stevens-Lapsley 2012, Tsukada 2020) using three different measurement instruments (the pain component of the WOMAC, EQ-5D VAS, and VAS) (Table 25). Most studies (n=10) found no difference in pain data between comparison groups. Two studies (Li 2017 and Rockstroh 2010) reported reduced pain in their respective intervention groups. Li 2017 reported pain on a VAS (0-10, lower is better) and found that patients randomized to gait training and usual care reported significantly lower pain compared with patients randomized to usual care at 6 months after TKA (MD −2.4, 95% CI −2.7 to −2.2). Rockstroh 2010 found reduced pain on the VAS scale among patients randomized to physiotherapy with adjunctive microcurrent therapy versus physiotherapy alone (MD 2.0, 95% CI 1.4 to 2.6) at 3 months following TKA.

Range of Motion

Nine studies (Harmer 2009, Sattler 2019, Iwakiri 2020, Lenssen 2006, Li 2017, Piqueras 2013, Buhagiar 2017, Eymir 2020, Stevens Lapsley 2012) reported ROM data from various outcome measures, including active and passive knee ROM for extension and flexion of the knee joint (Table 26). In several cases, whether active or passive ROM was measured was not specified. Where reported, studies measured ROM in degrees using goniometry. Seven studies reported comparable ROM between arms at follow-up measured between 3 and 24 months after TKA. Sattler 2019 reported improved knee flexion ROM at 4 months among patients randomized to the pedaling-based protocol (i.e., ROM exercise was a core component of the intervention) compared with patients randomized to the non-pedaling multi-exercise protocol (MD 2.7, 95% CI 2.6 to 7.9) at 4 months after TKA. Li 2017 also reported improved knee extension and flexion among patients randomized to early gait training and usual care compared with usual care alone at 6 months after TKA.

Muscle Strength

Three studies (Piqueras 2013, Stevens Lapsley 2012, Tsukada 2020) reported data on muscle strength using various outcome measures, including isometric and isokinetic knee extension and knee flexion strength, quadricep and hamstring strength and torque, and percent quadriceps activation (Table 27). Studies measured strength in Newtons (N), kilograms (kg), or torque normalized to body weight (Nm/kg), usually with a dynamometer. All studies reported significant improvement for at least one measure of strength with the intervention rehabilitation arm. Piquera 2013 reported hamstring and quadricep strength data and found patients randomized to virtual rehabilitation achieved comparable functional improvements in strength as the conventional outpatient physical therapy group (as hypothesized by the non-inferiority design) and, in fact, the virtual rehabilitation demonstrated greater improvements in quadricep strength (MD not reported; $p=0.018$) at 3 months after TKA. Stevens Lapsley 2012 compared the added effect of adjunctive NMES combined with standard rehabilitation and found improved strength as measured by normalized quadricep torque and normalized hamstring torque at 1 year after TKA in the rehabilitation and adjunctive therapy group compared to rehabilitation alone. Tsukada 2020 compared the added effect of an NMES hybrid training system combined with standard rehabilitation and found improved strength in terms of isometric knee extension ($p<0.01$) but not isometric knee flexion compared to standard rehabilitation at 3 months after TKA.

Energy and Vigor

No acute rehabilitation studies reported data on energy or vigor.

Emotional Functioning

Two studies (Avramidis 2011 and Stevens Lapsley 2012) reported on emotional functioning data from the mental health component scale of the SF-36 (scores 0 to 100, higher is better). Although Avramidis 2011 reported significant improvements among patients randomized to adjunctive TENS in combination with physiotherapy compared to physiotherapy alone at 3 months, differences were no longer significant at 12 months after surgery. Stevens Lapsley found no significant differences between groups who received physiotherapy combined with adjunctive NMES versus physiotherapy alone at 12 months after surgery (Table 28).

Table 24. Acute rehabilitation versus various controls for total knee arthroplasty – continuous outcomes, symptoms

Study, Year, PMID, Country	Arm 1	Arm 2	Overall RoB	Outcome Measurement	Time Point[A]	N Arm 1	Arm 1, Mean (SD)	N Arm 2	Arm 2, Mean (SD)	Effect Size (95% CI)	Reported p-Value
Harmer, 2009, 19177536, Australia	Water-based rehabilitation	Land-based rehabilitation	Moderate	WOMAC: Stiffness (0-8)	6 mo	53	0.97 (NR)	49	0.86 (NR)	NR	NR
Lenssen, 2006, 16942627, Netherlands	Physiotherapy [twice daily (40 min/day)]	Physiotherapy [once daily (20 min/day)]	Moderate	WOMAC: Stiffness (0-8)	3 mo	21	6.1 (1.2)	22	6.5 (1.1)	-0.4 (-1.04, 0.32)	NR
Liebs, 2010, 20360503	Ergometer cycling	Control	Moderate	WOMAC: Stiffness (0-100)	24 mo	52	23 (22.8)	66	17.4 (17.3)	NR	0.235
Liebs, 2012, 22196125	Early Aquatic therapy	Late Aquatic therapy	Moderate	WOMAC: Stiffness (0-100)	24 mo	66	15.2 (14.1)	69	20.4 (21.7)	0.28 (NR)	0.347

Statistically significant effect sizes are in bold text. In cases where calculated effect size confidence intervals were not-statistically significant but reported p-values were, we deferred to reported p-values and still bolded results.

Abbreviations: Adj = adjusted, CI = confidence interval, MD = mean difference, mo = month, min = minutes, NR = not reported, PMID = PubMed identifier, RoB = risk of bias, SD = standard deviation, WOMAC = Western Ontario and McMaster Universities Osteoarthritis Index.

[A] Time from surgery

Table 25. Acute rehabilitation versus various controls for total knee arthroplasty – continuous outcomes, pain

Study, Year, PMID, Country	Arm 1	Arm 2	Overall RoB	Outcome Measurement	Time Point[A]	N Arm 1	Arm 1, Mean (SD)	N Arm 2	Arm 2, Mean (SD)	Effect Size (95% CI)	Reported p-Value
Buhagiar, 2017, 28291891, Australia	Hospital Inpatient Rehabilitation	Home Program	Moderate	EQ-5D (VAS) (0-100)	6.5 mo	79	78.8 (95 % CI 75.3 , 82.3)	80	80.2 (95 % CI 76.7 , 83.8)	−1.41 (−6.42, 3.60)	NR
	Hospital Inpatient Rehabilitation	Home Program	Moderate	EQ-5D (VAS) (0-100)	12 mo	79	76.9 (95 % CI 73.4 , 80.4)	77	77.4 (95 % CI 73.8 , 81)	−0.50 (−5.53, 4.52)	NR
Eymir, 2020, 32778907 Turkey	Standard Physiotherapy plus Active heel-slide exercise (AHSE)	Physiotherapy plus CPM	High	VAS (0-10): Activity	3 mo	55	1.5 (2.3)	58	1.0 (1.9)	0.6 (0.8, 3.0)	NS
	Standard Physiotherapy plus Active heel-slide exercise (AHSE)	Physiotherapy plus CPM	High	VAS (0-10): Rest	3 mo	55	0.8 (1.5)	58	1.0 (2.0)	1.9 (1.4, 2.4)	NS
Harmer, 2009, 19177536, Australia	Water-based rehabilitation	Land-based rehabilitation	Moderate	WOMAC: Pain (0-20)	6 mo	53	1.69 (NR)	49	1.89 (NR)	NR	NR
	Water-based rehabilitation	Land-based rehabilitation	Moderate	VAS (0-10)	6 mo	53	0.76 (NR)	49	0.67 (NR)	0.5 (0.2, 1.1)	NR

Study, Year, PMID, Country	Arm 1	Arm 2	Overall RoB	Outcome Measurement	Time Point[A]	N Arm 1	Arm 1, Mean (SD)	N Arm 2	Arm 2, Mean (SD)	Effect Size (95% CI)	Reported p-Value
Lenssen, 2006, 16942627, Netherlands	Physiotherapy [twice daily(40 mins/day)]	Physiotherapy [once daily(20 mins/day)]	Moderate	WOMAC: Pain (0-20)	3 mo	21	15.2 (3.0)	22	16.2 (2.4)	-1 (-2.7, 0.7)	NR
	Physiotherapy [twice daily(40 mins/day)]	Physiotherapy [once daily(20 mins/day)]	Moderate	VAS (0-10): Last 24hrs	3 mo	21	1.3 (1.9)	22	0.8 (1.5)	0.5 (-0.6, 1.6)	NR
Li, 2017, CN-01084888, China	Gait training & usual care	Usual care	Moderate	Pain-VAS	6 mo	43	0.51 (0.74)	43	2.93 (0.88)	**-2.4 (-2.7, -2.2)[B]**	NR
Liebs, 2010, 20360503, Germany	Ergometer cycling	Control	Moderate	WOMAC: Pain (0-20)	24 mo	66	14.3 (17.7)	52	11.1 (14.4)	NR	0.278
Liebs, 2012, 22196125	Early Aquatic therapy	Late Aquatic therapy	Moderate	WOMAC: Pain (0-20)	24 mo	66	9.6 (11.9)	69	15.2 (19.2)	0.35 (NR, NR)	0.097
Piqueras, 2013, 23474735, Spain	Interactive virtual telerehabilitation system	Conventional outpatient physical therapy	Moderate	VAS (NR)	3 mo	68	NR (NR)	65	NR (NR)	NR	0.284
Rockstroh, 2010, 20533147, Germany	Physiotherapy & microcurrent	Physiotherapy	High	VAS (NR)	3 mo	37	Median (IQR) 0 (0 ,1)	41	Median (IQR) 2 (0 ,3)	**2.0 (1.4, 2.6)[B]**	**<0.001**
Sattler, 2019, 30994586, Australia	Pedaling-based protocol	Non-pedaling (multi-exercise) protocol	Moderate	EQ-5D (VAS) (0-100)	4 mo	28	Median (90)	28	Median (8.8)	NR	NR
Stevens Lapsley, 2012, 22095207, USA	Standard rehabilitation & NMES	Standard rehabilitation	High	VAS (0-10): Pain while resting	12 mo	25	0.6 (1.4)	30	0.4 (1.5)	0.2 (-0.3, 0.7)[B]	NR
Tsukada, 2020, 31723080, Japan	Standard rehabilitation & hybrid training system	Standard rehabilitation	High	VAS (0-10)	3 mo	20	21 (NR)	20	18 (NR)	NR	ns

Statistically significant effect sizes are in bold text. In cases where calculated effect size confidence intervals were not-statistically significant but reported p-values were, we deferred to reported p-values and still bolded results.

Abbreviations: Adj = adjusted, CI = confidence interval, EQ-5D = EuroQol-5D, KOOS = Knee injury and osteoarthritis outcome score, MD = mean difference, mo = month, NR = not reported, PMID = PubMed identifier, RoB = risk of bias, SD = standard deviation, VAS = visual analog scale, WOMAC = Western Ontario and McMaster Universities Osteoarthritis Index.

[A] Time from surgery
[B] Calculated

Table 26. Acute rehabilitation versus various controls for total knee arthroplasty – continuous outcomes, range of motion

Study, Year, PMID, Country	Arm 1	Arm 2	Overall RoB	Outcome Measurement	Time Point[A]	N Arm 1	Arm 1, Mean (SD)	N Arm 2	Arm 2, Mean (SD)	Effect Size (95% CI)	Reported p-Value
Buhagiar, 2017, 28291891, Australia	Hospital Inpatient Rehabilitation	Home Program	Moderate	Knee ROM (active/passive unspecified): Flexion ≥100 degrees[B]	6.5 mo	80	66 events	80	62 events	1.29 (0.59, 2.84)[C]	NR
Eymir, 2020, 32778907 Turkey	Standard Physiotherapy plus Active heel-slide exercise	Physiotherapy plus CPM	High	Knee ROM (active/passive unspecified): Flexion (deg)	3 mo	55	110.0 (11.8)	58	109.1 (13.0)	-0.9 (-4.1, 2.3)	NS
Harmer, 2009, 19177536, Australia	Water-based rehabilitation	Land-based rehabilitation	Moderate	Passive Knee ROM: Extension (deg)	6 mo	53	0.86 (NR)	49	1.71 (NR)	NR	NR
	Water-based rehabilitation	Land-based rehabilitation	Moderate	Passive Knee ROM: Flexion (deg)	6 mo	53	104.04 (NR)	49	105.18 (NR)	NR	NR
Iwakiri, 2020, 32373475, Japan	ROM day 1	ROM day 7	High	Knee ROM (active/passive unspecified: Extension (deg)	3 mo	55	1.20 (NR)	54	2.45 (NR)	NR	NS
	ROM day 1	ROM day 7	High	Knee ROM (active/passive unspecified: Extension (deg)	12 mo	55	0 (NR)	54	0 (NR)	NR	NS
	ROM day 1	ROM day 7	High	Knee ROM (active/passive unspecified: Extension (deg)	24 mo	55	0 (NR)	54	0 (NR)	NR	NS
	ROM day 1	ROM day 7	High	Knee ROM (active/passive unspecified: Flexion (deg)	3 mo	55	125.82 (NR)	54	123.21 (NR)	NR	NS
	ROM day 1	ROM day 7	High	Knee ROM (active/passive unspecified: Flexion (deg)	12 mo	55	124.41 (NR)	54	119.84 (NR)	NR	NS
	ROM day 1	ROM day 7	High	Knee ROM (active/passive unspecified: Flexion (deg)	24 mo	55	124.74 (NR)	54	119.84 (NR)	NR	NS
Lenssen, 2006, 16942627, Netherlands	Physiotherapy [twice daily(40 mins/day)]	Physiotherapy [once daily(20 mins/day)]	Moderate	Passive knee ROM: Extension (deg)	3 mo	21	3.8 (4.3)	22	5.5 (4.6)	-1.7 (-4.5, 1.03)	NR
	Physiotherapy [twice daily(40 mins/day)]	Physiotherapy [once daily(20 mins/day)]	Moderate	Passive knee ROM: Flexion (deg)	3 mo	21	36.6 (17.9)	22	32.1 (18.4)	4.5 (-6.8, 15.6)	NR

Study, Year, PMID, Country	Arm 1	Arm 2	Overall RoB	Outcome Measurement	Time Point[A]	N Arm 1	Arm 1, Mean (SD)	N Arm 2	Arm 2, Mean (SD)	Effect Size (95% CI)	Reported p-Value
	Physiotherapy [twice daily(40 mins/day)]	Physiotherapy [once daily(20 mins/day)]	Moderate	Active knee ROM: Extension (deg)	3 mo	21	5.3 (5.1)	22	8.3 (5.5)	-3 (-6, 7.03)	NR
	Physiotherapy [twice daily(40 mins/day)]	Physiotherapy [once daily(20 mins/day)]	Moderate	Active knee ROM: Flexion (deg)	3 mo	21	103.7 (13)	22	105.1 (15)	-1.4 (-10.0, 7.3)	NR
Li, 2017, CN-01084888, China	Gait training &usual care	Usual care	Moderate	Knee ROM: Extension and flexion	6 mo	43	135.14 (7.19)	43	94.84 (2.77)	**40.3 (38.4, 42.2)[B]**	**NR**
Piqueras, 2013, 23474735, Spain	Interactive virtual telerehabilitation system	Conventional outpatient physical therapy	Moderate	Active knee ROM: Extension (deg)	3 mo	68	NR (NR)	65	NR (NR)	NR	0.478
	Interactive virtual telerehabilitation system	Conventional outpatient physical therapy	Moderate	Active knee ROM: Flexion (deg)	3 mo	68	NR (NR)	65	NR (NR)	NR	0.193
Sattler, 2019, 30994586, Australia	Pedaling-based protocol	Non-pedaling (multi-exercise) protocol	High	Knee ROM (active/passive unspecified): Flexion (deg)	4 mo	28	113.0 ± 10.4	28	110.4 (9.1)	**2.7 (2.6 to 7.9)**	**0.310**
Stevens Lapsley,2012, 22095207, USA	Standard rehabilitation & NMES	Standard rehabilitation	Moderate	Active Knee ROM: Extension	12 mo	25	-2 (3.5)	30	-1.4 (3.4)	-0.6 (-1.9, 0.7)[C]	NR
	Standard rehabilitation & NMES	Standard rehabilitation	Moderate	Active Knee ROM: Flexion	12 mo	25	119.4 (6.3)	30	117 (9.1)	2.4 (-0.5, 5.3)[C]	NR

Statistically significant effect sizes are in bold text. In cases where calculated effect size confidence intervals were not-statistically significant but reported p-values were, we deferred to reported p-values and still bolded results.

Abbreviations: Adj MD = adjusted mean difference, CI = confidence interval, CPM = continuous passive motion, deg = degree, mo = month, NMES = neuromuscular electric stimulation, NR = not reported, PMID = PubMed identifier, RoB = risk of bias, ROM = range of motion, SD = standard deviation.

[A] Time from surgery
[B] Categorical outcome
[C] Calculated

Table 27. Acute rehabilitation versus various controls for total knee arthroplasty – continuous outcomes, muscle strength

Study, Year, PMID, Country	Arm 1	Arm 2	Overall RoB	Outcome Measurement	Time Point[A]	N Arm 1	Arm 1, Mean (SD)	N Arm 2	Arm 2, Mean (SD)	Effect Size (95% CI)	Reported p-Value
Piqueras, 2013, 23474735, Spain	Interactive virtual telerehabilitation system	Conventional outpatient physical therapy	Moderate	Strength: Hamstring (kg)	3 mo	68	NR (NR)	65	NR	NR	0.349

Study, Year, PMID, Country	Arm 1	Arm 2	Overall RoB	Outcome Measurement	Time Point[A]	N Arm 1	Arm 1, Mean (SD)	N Arm 2	Arm 2, Mean (SD)	Effect Size (95% CI)	Reported p-Value
	Interactive virtual telerehabilitation system	Conventional outpatient physical therapy	Moderate	Strength: Quadriceps (kg)	3 mo	68	NR (NR)	65	NR	**NR**	**0.018**
Stevens Lapsley,2012, 22095207, USA	Standard rehabilitation & NMES	Standard rehabilitation	Moderate	Strength: Quadriceps femoris torque[B] (Nm/kg)	3 mo	30	1.42 (0.52)	29	1.20 (0.42)	**0.22 (-0.02, 0.46)**	**≤0.05**
	Standard rehabilitation & NMES	Standard rehabilitation	Moderate	Strength: Quadriceps femoris torque[B] (Nm/kg)	6 mo	31	1.51 (0.48)	27	1.39 (0.44)	0.12 (-0.12, 0.36)[C]	NR
	Standard rehabilitation & NMES	Standard rehabilitation	Moderate	Strength: Quadriceps femoris torque[B] (Nm/kg)	12 mo	30	1.66 (0.52)	25	1.50 (0.43)	**0.16 (-0.09, 0.41)[C]**	**≤0.05**
	Standard rehabilitation & NMES	Standard rehabilitation	Moderate	Strength: Hamstring torque (Nm/kg)	3 mo	29	0.73 (0.21)	30	0.65 (0.24)	0.08 (-0.03, 0.19)[C]	NR
	Standard rehabilitation & NMES	Standard rehabilitation	Moderate	Strength: Hamstring torque (Nm/kg)	6 mo	31	0.79 (0.25)	27	0.72 (0.25)	0.07 (-0.06, 0.2)[C]	NR
	Standard rehabilitation & NMES	Standard rehabilitation	Moderate	Strength: Hamstring torque (Nm/kg)	12 mo	30	0.83 (0.25)	24	0.72 (0.29)	**0.11 (-0.04, 0.26)[C]**	**≤0.05**
	Standard rehabilitation & NMES	Standard rehabilitation	Moderate	Quadriceps activation (%)	3 mo	30	86.5 (12.9)	29	85.4 (11.5)	1.1 (-5.13, 7.33)	NR
	Standard rehabilitation & NMES	Standard rehabilitation	Moderate	Quadriceps activation (%)	6 mo	31	88.4 (10.1)	26	84.2 (10.0)	4.2 (-1.04, 9.44)[C]	NR
	Standard rehabilitation & NMES	Standard rehabilitation	Moderate	Quadriceps activation (%)	12 mo	30	87.6 (9.2)	23	85.9 (11.9)	1.7 (-3.87, 7.27)[C]	NR
Tsukada, 2020, 31723080, Japan	Standard rehabilitation & hybrid training system	Standard rehabilitation	Moderate	Strength: Isometric knee extension (N)	3 mo	20	184 (NR)	20	155 (NR)	NR	ns
	Standard rehabilitation & hybrid training system	Standard rehabilitation	Moderate	Strength: Isometric knee flexion (N)	3 mo	20	102 (NR)	20	98 (NR)	**NR**	**<0.01**

Statistically significant effect sizes are in bold text. In cases where calculated effect size confidence intervals were not-statistically significant but reported p-values were, we deferred to reported p-values and still bolded results.

Abbreviations: CI = confidence interval, N = Newton, Nm = peak torque, NR = not reported, kg = kilogram, PMID = PubMed identifier, RoB = risk of bias, SD = standard deviation, SE = standard error.

[A] Time from surgery
[B] Normalized to body weight for all strength outcomes
[C] Calculated

Table 28. Acute rehabilitation versus various controls for total knee arthroplasty – continuous outcomes, emotional functioning (stress/coping)

Study, Year, PMID, Country	Arm 1	Arm 2	Overall RoB	Outcome Measurement	Time Point[A]	N Arm 1	Arm 1, Mean (SD)	N Arm 2	Arm 2, Mean (SD)	Effect Size (95% CI)	Reported p-Value
Avramidis, 2011, 21410130, Greece	TENS plus Physiotherapy	Physiotherapy	Moderate	SF-36: Mental health (0-100)	3 mo	12	53.51 (4.2)	19	49.2 (4.23)	**4.3 (2.1, 6.5)[B]**	**<0.001**
	TENS plus Physiotherapy	Physiotherapy	Moderate	SF-36: Mental health (0-100)	12 mo	15	50.49 (5.32)	21	50.1 (3.69)	0.4 (2.0, 2.7)[B]	0.694
Stevens Lapsley, 2012, 22095207,USA	Standard rehabilitation & NMES	Standard rehabilitation	Moderate	SF-36: Mental health (0-100)	12 mo	25	57.8 (4.4)	30	54.8 (6.9)	3 (0.8, 5.2)[B]	NR

Statistically significant effect sizes are in bold text. In cases where calculated effect size confidence intervals were not-statistically significant but reported p-values were, we deferred to reported p-values and still bolded results.

Abbreviations: CI = confidence interval, NR = not reported, PMID = PubMed identifier, RoB = risk of bias, SF-36 = 36-Item short form survey, SD = standard deviation, TENS = transcutaneous electrical nerve stimulation.

[A] Time from surgery
[B] Calculated

Activity and Participation Outcomes Following Acute-Rehabilitation

Fifteen studies in total reported on activity and participation outcomes following acute rehabilitation compared to various controls: three studies (Harmer 2009, Liebs 2010, Sattler 2019) compared novel acute rehabilitation programs with various comparators (less intensive rehabilitation or no care); two studies (Lenssen 2006, Liebs 2012) compared acute rehabilitation programs with different timing and/or intensity; five studies (Buhagiar 2017, Chan 2018, Naylor 2017, Li 2014, Piqueras 2013) compared acute rehabilitation programs delivered in different settings or by different personnel, and three studies (Avramidis 2011, Eymir 2020, Stevens-Lapsley 2012, Tsukada 2020, Zapparoli 2020) compared acute rehabilitation programs with or without an adjunctive modality (Tables 29 to 33). Outcome domains included: physical function and activities of daily living, transfers, balance, mobility, and timed up and go.

Physical Function and Activities of Daily Living

Eleven RCTs (Harmer 2009, Liebs 2010, Sattler 2019, Lenssen 2006, Liebs 2012, Buhagiar 2017, Chan 2018, Naylor 2017, Avramidis 2011, Eymir 2020, Stevens Lapsley 2012) reported data on patient-reported physical function and ADLs using various outcome measures (Table 29) at follow-ups between 3 months and 2 years after TKA surgery. Eight studies found no difference between groups in terms of patient-reported function and ADL; three studies (Harmer 2009, Chan 2018 and Avramidis 2011) reported significant differences between groups. Harmer 2009 reported physical function data using the function component of the WOMAC (0-68, lower is better) and found patients randomized to water-based rehabilitation reported significantly greater improvements in physical function compared to patients randomized to land-based rehabilitation ($p=0.04$). Chan 2018 reported physical function and ADL data using the ADL Oxford Knee score (scores 0 to 48, higher is better), the physical component of the SF-36 (0-100, higher is better), and the function component of the Knee Society Clinical Rating System (0-100, higher is better) and observed that while patients discharged home had lower ADL measured on the Oxford Knee Score, they had higher physical function as rated on the SF-36 and Knee Society Rating Scales. Avramidis 2011 also reported physical function and ADL using the physical component of the SF-36 and function component of the Knee Society Clinical Rating System and found that patients randomized to physiotherapy combined with adjunctive TENS reported better knee function on both scales at 3 and 12 months after TKA.

Transfers

Two studies reported data on transfers (Li 2014 and Tsukada 2020). Tsukada 2020 observed no differences between groups at follow-up 3 months; Li 2014 found patients randomized to rob-assisted training had improved performance of transfers (based on 10-minute sitting-standing times) at 6 and 12 months after TKA (Li 2014) (Table 30).

Balance

Two studies reported balance data. Li 2014 reported balance data from the Berg Balance Scale and found significant difference between compared groups at 6 or 12 months after TKA among patients randomized to robot-assisted training compared to those who received traditional rehabilitation training (Table 31). Zapparoli 2020 reported significantly fewer falls/near fall in the past year among patients randomized to specific motor imagery and rehabilitation compared to rehabilitation alone at 2 years following surgery.

Mobility

Seven studies (Harmer 2009, Sattler 2019, Buhagiar 2017, Li 2014, Eymir 2020, Stevens Lapsley 2012, and Tsukada 2020) reported on various outcome measures of mobility including the 6-minute walk test, 10- and 15-meter walk tests, stair climb tests, Functional Ambulation Category system, and Iowa Ambulation Velocity Scale. Five studies reported no difference in mobility among groups at follow-up ranging from 3 to 12 months after TKA (Table 32). Li 2014 reported improved performance of the six-minute walk test (6MWT) among patients randomized to robot-assisted training compared to control at both 6 months (MD 63.6, 95% CI 48.4 to 78.8) and 12 months (MD 73.4, 95% CI 60.4 to 86.4) after TKA, but no difference in Functional Ambulation Category. Stevens Lapsley reported improved performance of the 6MWT (meters, larger is better; MD 46.8, $p<0.05$) and stair climb test (seconds, smaller is better; MD −3.3, $p<0.05$) among patients randomized to standard rehabilitation with adjunctive NMES compared with standard rehabilitation alone.

Timed Up and Go

Five studies (Sattler 2019, Piqueras 2013, Eymir 2020, Stevens Lapsley 2012, Tsukada 2020) reported data on the TUG test. Sattler 2019, Eymir 2020, Tsukada 2020 reported no difference in in the performance of the TUG (Table 33). Piqueras 2013 and Stevens Lapsley reported significantly improved performance of the TUG among patients receiving interactive virtual rehabilitation (vs. conventional outpatient physical therapy) and standard rehabilitation plus adjunctive NMES (vs. standard rehabilitation alone), respectively.

Table 29. Acute rehabilitation versus various controls for total knee arthroplasty – continuous outcomes, physical function and activities of daily living

Study, Year, PMID, Country	Arm 1	Arm 2	Overall RoB	Outcome Measurement	Time Point[A]	N Arm 1	Arm 1, Mean (SD)	N Arm 2	Arm 2, Mean (SD)	Effect Size (95% CI)	Reported p-Value
Avramidis, 2011, 21410130, Greece	TENS plus Physiotherapy	Physiotherapy	Moderate	Knee Society Score: Function	3 mo	12	150.94 (14.26)	19	141.74 (12.38)	**9.2 (2.0, 16.4)**[B]	**0.003**
	TENS plus Physiotherapy	Physiotherapy	Moderate	Knee Society Score: Function	12 mo	15	159.63 (12.69)	21	156.40 (12.11)	3.2 (2.7, 9.1)[B]	0.349
	TENS plus Physiotherapy	Physiotherapy	Moderate	SF-36: Physical component (0-100)	3 mo	12	46.6 (5.13)	19	37.63 (6.43)	**9 (6.1, 11.9)**[B]	**<0.001**
	TENS plus Physiotherapy	Physiotherapy	Moderate	SF-36: Physical component (0-100)	12 mo	15	53.9 (4.26)	21	47.37 (3.84)	**6.5 (4.6, 8.5)**[B]	**<0.001**
Buhagiar, 2017, 28291891, Australia	Hospital Inpatient Rehabilitation	Home Program	Moderate	Oxford knee score (0-48)	6.5 mo	79	36.9 (95 % CI 35, 38.7)	80	34.8 (95 % CI 32.9, 36.7)	0.54 (-2.26,3.33)	NR
	Hospital Inpatient Rehabilitation	Home Program	Moderate	Oxford knee score (0-48)	12 mo	79	36.5 (95 % CI 34.6, 38.4)	77	37 (95 % CI 35.2, 38.9)	2.06 (-0.59, 4.71)	NR
Chan, 2018, 29372260, Singapore	Discharge to home	Discharge to community hospitals	Moderate	Oxford knee score (0-48)	6 mo	967	19.6 (95 % CI 19.3, 20.0)	98	21.5 (95 % CI 20.3, 22.6)	**1.8 (0.6,3.0)**	**0.003**
	Discharge to home	Discharge to community hospitals	Moderate	Oxford knee score (0-48)	24 mo	801	18.5 (95 % CI 18.1, 18.9)	78	22.0 (95 % CI 20.9, 23.2)	**-3.5 (-4.8, -2.3)**	**<0.0001**
	Discharge to home	Discharge to community hospitals	Moderate	SF-36: Physical functioning (0-100)	6 mo	967	66.9 (95 % CI 65.6, 68.2)	98	59.1 (95 % CI 55.0, 63.1)	**7.8 (3.5, 12.0)**	**0.0004**
	Discharge to home	Discharge to community hospitals	Moderate	SF-36: Physical functioning (0-100)	24 mo	801	69.5 (95 % CI 67.9, 71.0)	78	57.2 (95 % CI 52.2, 62.1)	**12.3 (7.1, 17.5)**	**<0.0001**
	Discharge to home	Discharge to community hospitals	Moderate	Knee Society Clinical Rating System: Function domain	6 mo	967	71.0 (95 % CI 69.9, 72.1)	98	62.3 (95 % CI 58.8, 65.9)	**8.7(4.9, 12.4)**	**<0.0001**
	Discharge to home	Discharge to community hospitals	Moderate	Knee Society Clinical Rating System: Function domain	24 mo	801	73.9 (95 % CI 72.6 , 75.2)	78	60.9 (95 % CI 56.7, 65.1)	**-13.0(-17.4,08.6)**	**<0.0001**
Eymir, 2020, 32778907 Turkey	Standard physiotherapy & AHS	Physiotherapy & CPM	High	Iowa Level of Assistant Scale: Total[C]	3 mo	55	20.7 (2.1)	58	20.3 (2.0)	-0.4 (-0.9, 0.1)	ns
	Standard physiotherapy & AHS	Physiotherapy & CPM	High	Iowa Level of Assistant Scale: Supine to sit	3 mo	55	5.7 (0.6)	58	5.7 (0.6)	0 (-0.2, 0.2)	ns
	Standard physiotherapy & AHS	Physiotherapy & CPM	High	Iowa Level of Assistant Scale: Sit to stand	3 mo	55	5.3 (0.6)	58	5.2 (0.7)	0.4 (0.2, 0.6)	ns

Study, Year, PMID, Country	Arm 1	Arm 2	Overall RoB	Outcome Measurement	Time Point[A]	N Arm 1	Arm 1, Mean (SD)	N Arm 2	Arm 2, Mean (SD)	Effect Size (95% CI)	Reported p-Value
	Standard physiotherapy & AHS	Physiotherapy & CPM	High	Iowa Level of Assistant Scale: Ambulation	3 mo	55	5.5 (0.6)	58	5.4 (0.7)	-0.1 (-0.3, 0.07)	ns
	Standard physiotherapy & AHS	Physiotherapy & CPM	High	Iowa Level of Assistant Scale: Stair climbing	3 mo	55	4.1 (1.0)	58	3.8 (0.9)	-0.3 (-0.5, -0.05)	ns
	Standard physiotherapy & AHS	Physiotherapy & CPM	High	Hospital for Special Surgery: Total (0-80)[D]	3 mo	55	77.8 (11.4)	58	75.3 (12.4)	-2.5 (-5.6, 0.6)	ns
	Standard physiotherapy & AHS	Physiotherapy & CPM	High	Hospital for Special Surgery: Pain (0-30)	3 mo	55	22.9 (5.4)	58	23.8 (5.3)	0.9 (-0.5, 2.3)	ns
	Standard physiotherapy & AHS	Physiotherapy & CPM	High	Hospital for Special Surgery: Function (0-22)	3 mo	55	14.3 (3.7)	58	14.0 (3.8)	-0.3 (-1.3, 0.7)	ns
	Standard physiotherapy & AHS	Physiotherapy & CPM	High	Hospital for Special Surgery: ROM (0-18)	3 mo	55	13.0 (1.1)	58	13.0 (1.2)	0 (-0.3, 0.3)	ns
	Standard physiotherapy & AHS	Physiotherapy & CPM	High	Hospital for Special Surgery: Muscle strength (0-10)	3 mo	55	9.0 (1.0)	58	9.0 (1.0)	0.1 (-0.3, 0.3)	ns
	Standard physiotherapy & AHS	Physiotherapy & CPM	High	Hospital for Special Surgery: Deformation (unclear)	3 mo	55	0.7 (1.8)	58	1.0 (2.0)	0.3 (-0.2, 0.8)	ns
	Standard physiotherapy & AHS	Physiotherapy & CPM	High	Hospital for Special Surgery: Instability	3 mo	55	8.7 (0.9)	58	8.9 (1.0)	0.2 (-0.05, 0.5)	ns
Harmer, 2009, 19177536, Australia	Water-based rehabilitation	Land-based rehabilitation	Moderate	WOMAC: Physical function (0-68)	6 mo	53	4.36(NR)	49	5.75 (NR)	NR	0.04
Lenssen, 2006, 16942627, Netherlands	Physiotherapy [twice daily(40 mins/day)]	Physiotherapy [once daily(20 mins/day)]	Moderate	WOMAC: Physical function (0-68)	3 mo	21	51.9 (10.6)	22	55.3 (8.3)	-3.4 (-9.2, 2.5)	NR
	Physiotherapy [twice daily(40 mins/day)]	Physiotherapy [once daily(20 mins/day)]	Moderate	Knee Society Score: Function	3 mo	21	69 (15)	22	69 (20)	0 (-11, 11)	NR
Liebs, 2010, 20360503, Germany	Ergometer cycling	Control	Moderate	SF-36: Physical component (0-100)	24 mo	66	42.3 (9.4)	52	40.4 (9.7)	NR	0.275
	Ergometer cycling	Control	Moderate	WOMAC: Physical function (0-68)	24 mo	66	20.4 (21.2)	52	16.4 (18.2)	NR	0.328
	Ergometer cycling	Control	Moderate	Lequesne hip and knee score (0-24)	24 mo	66	7.6 93.8)	52	7.5 (4.4)	NR	0.807
Liebs, 2012, 22196125,	Early Aquatic therapy	Late Aquatic therapy	Moderate	SF-36: Physical component (0-100)	24 mo	66	43.9 (9.4)	69	41 (9.7)	0.31 (NR, NR)	0.131

Study, Year, PMID, Country	Arm 1	Arm 2	Overall RoB	Outcome Measurement	Time Point[A]	N Arm 1	Arm 1, Mean (SD)	N Arm 2	Arm 2, Mean (SD)	Effect Size (95% CI)	Reported p-Value
Germany	Early Aquatic therapy	Late Aquatic therapy	Moderate	WOMAC: Physical function (0-68)	24 mo	66	13.8 (13.6)	69	20.7 (21.3)	0.39 (NR, NR)	0.117
	Early Aquatic therapy	Late Aquatic therapy	Moderate	Lequesne hip and knee score (0-24)	24 mo	66	6.8 (3.8)	69	7.4 (3.8)	0.15 (NR, NR)	0.361
Naylor, 2017, 28899328, Australia	Inpatient rehabilitation	No inpatient rehabilitation	High	Oxford knee score (0-48)	3 mo	129	Median (IQR) 40 (34,43)	129	Median (IQR) 40 (34, 43)	0 (-1.2, 1.2)[B]	NR
	Inpatient rehabilitation	No inpatient rehabilitation	High	Oxford knee score (0-48)	12 mo	129	Median (IQR) 44 (42, 45)	129	Median (IQR) 44 (42, 46)	0 (-0.4, 0.4)[B]	NR
Sattler, 2019, 30994586, Australia	Pedaling-based protocol	Non-pedaling (multi-exercise) protocol	Moderate	Oxford knee score (0-48)	4 mo	28	39.3 (6.1)	28	37.6 (4.8)	1.7 (-0.4, 3.8)[B]	NR
Stevens Lapsley, 2012, 22095207, USA	Standard rehabilitation & NMES	Standard rehabilitation	Moderate	SF-36: Physical component (0-100)	12 mo	25	52.6 (2.9)	30	50.7 (7.4)	1.9 (-0.4, 4.2)[B]	NR

Statistically significant effect sizes are in bold text. In cases where calculated effect size confidence intervals were not-statistically significant but reported p-values were, we deferred to reported p-values and still bolded results.

Abbreviations: ACSE = active heal slide exercise, CI = confidence interval, CPM = continuous passive motion, IQR = interquartile range, mo = month, NMES = neuromuscular electrical stimulation, NR = not reported, PMID = PubMed identifier, RoB = risk of bias, SD = standard deviation, SF-36 = 36-Item short form survey, WOMAC = Western Ontario and McMaster Universities Osteoarthritis Index.

[A] Time from surgery
[B] Calculated
[C] The Iowa Level of Assistance Scale was used to assess four functional activities (moving from the supine position to the sitting position, rising from the sitting position, walking 4.57 m, and ascending and descending stairs for three steps). Activities are scored between 0–6 (6=independence). The total score is the sum of the four activity scores.
[D] Total Hospital for Special Surgery score is obtained by summing all the item scores and subtracting scores related to walking aids, loss of knee extension and varus/valgus deformity.

Table 30. Acute rehabilitation versus various controls for total knee arthroplasty – continuous outcomes, transfers

Study, Year, PMID, Country	Arm 1	Arm 2	Overall RoB	Outcome Measurement	Time Point[A]	N Arm 1	Arm 1, Mean (SD)	N Arm 2	Arm 2, Mean (SD)	Effect Size (95% CI)	Reported p-Value
Li, 2014, 23412304, China	Robot-assisted training	Control (CPM)	High	10m sitting standing time(s)	6 mo	30	8.7 (1.7)	30	11.1 (1.9)	**-2.4 (-3.0, -1.8)[B]**	**<0.05**
	Robot-assisted training	Control (CPM)	High	10m sitting standing time(s)	12 mo	30	8.7 (1.4)	30	11.5 (2.1)	**-2.8 (-3.5, -2.1)[B]**	**<0.05**
Tsukada, 2020, 31723080, Japan	Standard rehabilitation & hybrid training system	Standard rehabilitation	Moderate	10m sitting standing time (s)	3 mo	20	9 (NR)	20	11 (NR)	NR	ns

Statistically significant effect sizes are in bold text. In cases where calculated effect size confidence intervals were not-statistically significant but reported p-values were, we deferred to reported p-values and still bolded results.

Abbreviations: CI = confidence interval, CPM = continuous passive motion, mo = month, NR = not reported, ns = not significant, PMID = PubMed identifier, RoB = risk of bias, s = second, SD = standard deviation, SE = standard error.

[A] Time from surgery
[B] Calculated

Table 31. Acute rehabilitation versus various controls for total knee arthroplasty – continuous outcomes, balance

Study, Year, PMID, Country	Arm 1	Arm 2	Overall RoB	Outcome Measurement	Time Point[A]	N Arm 1	Arm 1, Mean (SD)	N Arm 2	Arm 2, Mean (SD)	Effect Size (95% CI)	Reported p-Value
Li, 2014, 23412304, China	Robot-assisted training	Traditional rehabilitation training	High	Berg Balance Scale	6 mo	30	53.9 (1.9)	30	50.2 (2.2)	**3.7 (3, 4.4)[B]**	**<0.05**
	Robot-assisted training	Traditional rehabilitation training	High	Berg Balance Scale	12 mo	30	54.5 (1.7)	30	49.9 (2.4)	**4.6 (3.8, 5.4)[B]**	**<0.05**
Zapparoli, 2020, 32488010 Italy	Motor imagery & rehabilitation	Rehabilitation	High	Falls/near falls in the past 12 mo	24 mo	24	NR	24	NR	Exponential effect size (95% CI): 1.75 (1.31, 2.29) Standardized mean difference effect size (95%CI): 0.96 (0.39, 1.72)	**<0.001**

Statistically significant effect sizes are in bold text. In cases where calculated effect size confidence intervals were not-statistically significant but reported p-values were, we deferred to reported p-values and still bolded results.

Abbreviations: CI = confidence interval, mo = month, NR = not reported, ns = not significant, PMID = PubMed identifier, RoB = risk of bias, SD = standard deviation.

[A] Time from surgery
[B] Calculated

Table 32. Acute rehabilitation versus various controls for total knee arthroplasty – continuous outcomes, mobility

Study, Year, PMID, Country	Arm 1	Arm 2	Overall RoB	Outcome Measurement	Time Point[A]	N Arm 1	Arm 1, Mean (SD)	N Arm 2	Arm 2, Mean (SD)	Effect Size (95% CI)	Reported p-Value
Buhagiar, 2017, 28291891, Australia	Home program	Hospital inpatient rehabilitation	Moderate	6MWT (m)	12 mo	80	408.8 (95 % CI 371.6 , 438)	79	391.2 (95 % CI 358.1 , 424.4)	13.54 (-13.61, 40.69,)	NR
	Home program	Hospital inpatient rehabilitation	Moderate	15m walk test (s)	6.5 mo	80	12.0 (95% CI 10.9,13.1)	79	12.5 (95 % CI 11.4 , 13.6)	0.50 (-2.01, 1.01)	NR
	Home program	Hospital inpatient rehabilitation	Moderate	15m walk test (s)	12 mo	77	12.7 (95% CI 11.6 to 13.8)	79	12.3 (95 % CI 11.2 , 13.4)	-0.42 (-1.10, 1.94)	NR
Eymir, 2020, 32778907 Turkey	Standard physiotherapy & AHS	Physiotherapy & CPM	High	Iowa Ambulation Velocity Scale (s)D[B]	3 mo	55	17.2 (14.1)	58	23.3 (15.6)	6.1 (2.2, 9.9)	ns
	Standard physiotherapy & AHS	Physiotherapy & CPM	High	10MWT (m)	3 mo	55	12.9 (9.9)	58	17.6 (11.6)	4.7 (1.8, 7.5)	ns
Harmer, 2009, 19177536, Australia	Water-based rehabilitation	Land-based rehabilitation	Moderate	6MWT (m)	6mo	53	407.24 (NR)	49	407.24 (NR)	NR	ns
	Water-based rehabilitation	Land-based rehabilitation	Moderate	Stair climb power (W)[C]	6 mo	53	164.35 (NR)	49	146.76 (NR)	NR	NR
Li, 2014, 23412304, China	Robot-assisted training	Control	High	6MWT (m)	6 mo	30	668 (46.3)	30	604.4 (36.9)	**63.6 (48.4, 78.8)[D]**	**<0.05**
	Robot-assisted training	Control	High	6MWT (m)	12 mo	30	681.9 (37.7)	30	608.5 (34.8)	**73.4 (60.4, 86.4)[D]**	**<0.05**
	Robot-assisted training	Control	High	FunctioNRI ambulation category (0-5)	6 mo	30	5 (NR)	30	5 (NR)	NR	NR
	Robot-assisted training	Control	High	FunctioNRI ambulation category (0-5)	12 mo	30	5 (NR)	30	5 (NR)	NR	NR
Sattler, 2019, 30994586, Australia	Pedaling-based protocol	Non-pedaling (multi-exercise] protocol	Moderate	6MWT (m)	4 mo	28	514.0 (78.5)	28	488.3 (89.7)	25.7 (19.5, 70.8	0.259
	Pedaling-based protocol	Non-pedaling (multi-exercise] protocol	Moderate	10m walk test (m/s)	4 mo	28	1.54 (0.24)	28	1.50 (0.25)	0.04 (-0.01, 0.12)	0.592
Stevens Lapsley,2012, 22095207, USA	Standard rehabilitation & NMES	Standard rehabilitation	Moderate	6MWT (m)	12 mo	25	524.6 (81.6)	30	477.8 (94)	**46.8 (0.4, 93.2)[D]**	**<0.05**
	Standard rehabilitation & NMES	Standard rehabilitation	Moderate	Stair climb test (s)[E]	12 mo	25	11.5 (4.3)	30	14.8 (9.3)	**-3.3 (-7, 0.4)[D]**	**<0.05**
Tsukada, 2020, 31723080, Japan	Standard rehabilitation & hybrid training system	Standard rehabilitation	Moderate	Stair climb test (s)[F]	3 mo	20	13 (NR)	20	16 (NR)	NR	ns

Statistically significant effect sizes are in bold text.

Abbreviations: AHS = active heel slides, CI = confidence interval, mo = month, m = meter, NR = not reported, PMID = PubMed identifier, RoB = risk of bias, s= second, SD = standard deviation, SE = standard error, W = watt.

[A] Time from surgery
[B] Speed at a distance of 13.4m
[C] The time required to ascend 18 stairs (flights of 8 to 10 stairs, separated by a small landing) as fast as possible using handrails and walking aids as required. Stair climb power was calculated using this time, combined with patient's body mass index, total stair height, and ascent time.
[D] Calculated
[D] Speed at a distance of 13.4m
[E] Defined as the total time to ascend a flight of stairs, turn around and descend
[F] Defined as the total time to ascend 18 stairs as quickly as possible

Table 33. Acute rehabilitation versus various controls for total knee arthroplasty – continuous outcomes, Timed Up and Go

Study, Year, PMID, Country	Arm 1	Arm 2	Overall RoB	Outcome Measurement	Time Point[A]	N Arm 1	Arm 1, Mean (SD)	N Arm 2	Arm 2, Mean (SD)	Effect Size (95% CI)	Reported p-Value
Eymir, 2020, 32778907 Turkey	Standard physiotherapy & AHS	Physiotherapy & CPM	High	TUG (s)	3 mo	55	15.2 (13.1)	58	22.8 (18.4)	7.6 (3.3, 11.8)	ns
Piqueras, 2013, 23474735, Spain	Interactive virtual telerehabilitation system	Conventional outpatient physical therapy	Moderate	TUG (s)	3 mo	68	NR (NR)	65	NR (NR)	**NR**	**0.020**
Sattler, 2019, 30994586, Australia	Pedaling-based protocol	Non-pedaling (multi-exercise) protocol	Moderate	TUG (s)	4 mo	28	6.9 (1.3)	28	7.1 (1.3)	-0.2 (-0.7, 0.3)[B]	NR
Stevens Lapsley,2012, 22095207,USA	Standard rehabilitation & NMES	Standard rehabilitation	Moderate	TUG (s)	12 mo	25	6.7 (1.7)	30	8.3 (2.8)	**-1.6 (-2.5, -0.7)**[B]	**NR**
Tsukada, 2020, 31723080, Japan	Standard rehabilitation & hybrid training system	Standard rehabilitation	Moderate	TUG (s)	3 mo	20	9 (NR)	20	11 (NR)	NR	ns

Statistically significant effect sizes are in bold text.

Abbreviations: CI = confidence interval, CPM = continuous passive motion, mo = month, NR = not reported, PMID = PubMed identifier, RoB = risk of bias, s = second, SD = standard deviation, TUG = timed up and go test.

[A] Time from surgery
[B] Calculated

Other Patient-Reported Outcomes Following Acute Rehabilitation

Ten studies in total reported other patient-reported outcomes following acute rehabilitation compared to various control: two studies (den Hertog 2012, Sattler 2019) compared novel acute rehabilitation programs to various comparators (less intensive rehabilitation or no care); two studies (Lenssen 2006, Liebs 2012) compared acute rehabilitation programs with different timing and/or intensity; three studies (Buhagiar 2017, Chan 2018, Padgett 2018) compared acute rehabilitation programs delivered in different settings or by different personnel, and three studies (Stevens-Lapsley 2012, Jin 2018, Rockstroh 2010) compared acute rehabilitation programs with or without an adjunctive modality (Tables 34 to 37). Outcome domains included: QoL, patient satisfaction with care, and patient global assessments.

Health-Related Quality of Life

Rockstroh 2010 reported QoL using the Oswestry Disability Index (0-100, lower is better) and found patients randomized to physiotherapy combined with adjunctive microcurrent (TENS) reported clinically significant improvements compared with patients randomized to physiotherapy alone at 3 months after TKA (Table 34).

Patient Satisfaction With Care

Three studies (Liebs 2010, Buhagiar 2017, Lenssen, 2006) reported data on satisfaction with care. While Liebs 2010 and Lenssen 2006 found no differences between rehabilitation arms (Table 35), Buhagiar 2017 found patients randomized to hospital inpatient rehabilitation reported significantly higher satisfaction with care compared with patients randomized to the home program (MD 8.9%, 95% CI 3.0 to 13.9).

Patient Global Assessments

Ten studies (den Hertog 2012, Sattler 2019, Iwakiri 2020, Lenssen 2006, Liebs 2012, Chan 2018, Padgett 2018, Buhagiar 2017, Stevens Lapsley 2012, Jin 2018) provided data on patients' self-reported global health assessment using nine different measurement instruments assessed between 3 and 24 months after TKA surgery (Table 36). Studies reported mixed findings: five studies reported comparable results among groups (Sattler 2019, Iwakiri 2020, Liebs 2012, Padgett 2018, Buhagiar, 2017) and five studies reported significant differences among groups (den Hertog, 2012, Lenssen, 2006, Chan, 2018, Stevens Lapsley, 2012, Jin, 2018). den Hertog reported global patient assessment data using the WOMAC index (0-10, lower is better) and the Knee Society Score (KSS; 0-100, higher is better) and found significant improvements for both measures among patients randomized to the fast-track rehabilitation in the acute period compared with standard care (p=0.002 for WOMAC index, p=0.003 for KSS).

Lenssen 2006 reported global patient assessment data using the KSS and total WOCAC score (0-96, lower is better) and found no difference on the KSS but improvements on the WOMAC associated with twice daily physiotherapy in the acute period (compared with once daily) (MD −4.6, 95% CI −13 8 to −3.9).

Chan 2018 reported global patient assessment data using the KSS among patients discharged to home compared with community hospitals using an NRCS design observed patients discharged home had significantly improved compared with patients discharged to community hospitals at 2 years after TKA (MD 4.4, 95% CI 1.4 to 7.3).

Stevens Lapsley 2012 reported patient global assessment data using the global rating scale of perceived knee function (0-100, higher is better) and found greater improvements among patients

randomized to adjunctive NMES and standard rehabilitation compared with patients randomized to standard rehabilitation alone (MD 8.3, 95% CI 2.5 to 14.1) at 12 months after TKA.

Jin 2018 reported patient global assessment using the total WOMAC score and found significant improvements among patients randomized to virtual reality and usual care compared with usual care alone at both 3 months (MD −3.9, 95% CI −5.6 to −2.2) and 6 months (MD −4.8, 95% CI −6.1 to −3.4) after TKA.

Table 34. Acute rehabilitation versus various controls for total knee arthroplasty – continuous outcomes, quality of life

Study, Year, PMID, Country	Arm 1	Arm 2	Overall RoB	Outcome Measurement	Time Point[A]	N Arm 1	Arm 1, Mean (SD)	N Arm 2	Arm 2, Mean (SD)	Effect Size (95% CI)	Reported p-Value
Rockstroh, 2010, 20533147, Germany	Physiotherapy & microcurrent	Physiotherapy	High	QoL (Oswestry score)	3 mo	37	Median (IQR) 91 (81 ,91)	41	Median (IQR) 78 (57 ,87)	**-13 (-19.0, -7.02)[B]**	**<0.001**

Statistically significant effect sizes are in bold text. In cases where calculated effect size confidence intervals were not-statistically significant but reported p-values were, we deferred to reported p-values and still bolded results.

Abbreviations: CI = confidence interval, IQR = interquartile range, mo = month, NR = not reported, PMID = PubMed identifier, QoL = quality of life, RoB = risk of bias, SD = standard deviation.

[A] Time from surgery
[B] Calculated

Table 35. Acute rehabilitation versus various controls for total knee arthroplasty – continuous outcomes, patient satisfaction with care

Study, Year, PMID, Country	Arm 1	Arm 2	Overall RoB	Outcome Measurement	Time Point[A]	N Arm 1	Arm 1, Mean (SD)	N Arm 2	Arm 2, Mean (SD)	Effect Size (95% CI)	Reported p-Value
Buhagiar, 2017, 28291891, Australia	Hospital Inpatient Rehabilitation	Home Program	Moderate	Patient satisfaction with care	NR	81	91.9 (95 % CI 87.6, 96.1)	84	82.9 (95 % CI 78.7, 87.2)	**8.9 (3.0,14.9)**	**NR**
Lenssen, 2006, 16942627, Netherlands	Physiotherapy [twice daily(40 mins/day)]	Physiotherapy [once daily(20 mins/day)]	Moderate	Patient satisfaction with care	3 mo	21	8.7 (1.6)	22	9.4 (0.9)	-0.7 (-1.5, 0.15)	NR
Liebs, 2010, 20360503, Germany	Ergometer cycling	Control	Moderate	Patient satisfaction with care	24 mo	66	53 (80%)[B]	52	39 (75%)	RR: 1.359 (0.57-3.26)	0.490

Statistically significant effect sizes are in bold text. In cases where calculated effect size confidence intervals were not-statistically significant but reported p-values were, we deferred to reported p-values and still bolded results.

Abbreviations: CI = confidence interval, KOOS = Knee injury and osteoarthritis outcome score, mo = month, NR = not reported, PMID = PubMed identifier, RoB = risk of bias, RR = relative risk SD = standard deviation.

[A] Time from surgery
[B] Reported as number of patients responding (%) 'very satisfied' with results of TKA

Table 36. Acute rehabilitation versus various controls for total knee arthroplasty – continuous outcomes, patient global assessment

Study, Year, PMID, Country	Arm 1	Arm 2	Overall RoB	Outcome Measurement	Time Point[A]	N Arm 1	Arm 1, Mean (SD)	N Arm 2	Arm 2, Mean (SD)	Effect Size (95% CI)	Reported p-Value
Buhagiar, 2017, 28291891, Australia	Hospital Inpatient Rehabilitation	Home Program	Moderate	KOOS (0-100)	6.5 mo	79	75.7 (95 % CI 71.7, 79.9)	80	73.7 (95 % CI 69.7, 77.7)	1.99 (-3.68,7.67)	NR
	Hospital Inpatient Rehabilitation	Home Program	Moderate	KOOS (0-100)	12 mo	79	76.4 (95 % CI 72.4, 80.4)	77	77 (95 % CI 73, 81)	-2.95 (-8.74, 2.84)	NR
	Hospital Inpatient Rehabilitation	Home Program	Moderate	EQ-5D index: 0-1	6.5 mo	79	0.74 (95 % CI 0.70, 0.78)	80	0.72 (95 % CI 0.68, 0.77)	-0.01 (-0.07, 0.05)	NR
	Hospital Inpatient Rehabilitation	Home Program	Moderate	EQ-5D index: 0-1	12 mo	79	0.70 (95 % CI 0.66, 0.75)	77	0.73 (95 % CI 0.69, 0.78)	0.02 (-0.04, 0.08)	NR
Chan, 2018, 29372260, Singapore	Discharge to home	Discharge to community hospitals	Moderate	Knee Society Clinical Rating System: Knee domain (0-100)	6 mo	967	84.6 (95 % CI 83.8 , 85.4)	98	82.2 (95 % CI 79.7, 84.7)	-2.4 (-5.1, 0.2)	0.0712
	Discharge to home	Discharge to community hospitals	Moderate	Knee Society Clinical Rating System: Knee domain (0-100)	24 mo	801	85.1 (95 % CI 84.2 , 86.0)	78	80.7 (95 % CI 77.9, 83.5)	**4.4 (1.4, 7.3)**	**0.0035**
den Hertog, 2012, 22643801, Germany	Fast-track rehabilitation	Standard care	Moderate	WOMAC index (0-10)	3 mo	74	NR	73	NR	**NR**	**0.002**
	Fast-track rehabilitation	Standard care	Moderate	Knee society score (0-100)[B]	3 mo	74	NR	73	NR	**NR**	**0.0003**
Iwakiri, 2020, 32373475, Japan	ROM day 1	ROM day 7	High	WOMAC: Total (0-96)[C]	3 mo	55	19.1 (16.8)	54	15.0 (10.3)	**-4.1 (-8.0, -0.2)**	0.35
	ROM day 1	ROM day 7	High	WOMAC: Total (0-96)[C]	1 y	55	15.6 (16.3)	54	13.4 (8.6)	**-2.2 (-5.9, 1.5)**	0.56
	ROM day 1	ROM day 7	High	WOMAC: Total (0-96)[C]	2 yrs	55	13.3 (13.1)	54	12.5 (12.7)	**-0.8 (-4.2, 2.6)**	0.76
Jin, 2018, CN-01617489, China	Virtual reality & usual care	Usual care	High	WOMAC: Total (0-96)	3 mo	33	25.79 (4.20)	33	29.67 (5.55)	**-3.9 (-5.6, -2.2)[D]**	**0.002**
	Virtual reality & usual care	Usual care	High	WOMAC: Total (0-96)	6 mo	33	21.58 (4.19)	33	26.33 (3.85)	**-4.8 (-6.1, -3.4)[D]**	**0**
Lenssen, 2006, 16942627, Netherlands	Physiotherapy [twice daily(40 mins/day)]	Physiotherapy [once daily(20 mins/day)]	Moderate	WOMAC: Total (0-96)	3 mo	21	73.4 (14.9)	22	78.0 (11.3)	**-4.6 (-13 8, -3.9)**	**NR**
	Physiotherapy [twice daily(40 mins/day)]	Physiotherapy [once daily(20 mins/day)]	Moderate	Knee society score (knee)	3 mo	21	80 (17)	22	80 (18)	0 (-11.3, 11.3)	NR
Liebs, 2012, 22196125, Germany	Early Aquatic therapy	Late Aquatic therapy	Moderate	SF-6D	24 mo	66	0.721 (0.119)	69	0.703 (0.135)	0.14 (NR, NR)	0.298
Padgett, 2018, 29352683, USA	Inpatient rehabilitation	Discharge Home	Moderate	SF-12 (0-100)	24 mo	1213	NR (NR)	1213	NR (NR)	NR	ns

Study, Year, PMID, Country	Arm 1	Arm 2	Overall RoB	Outcome Measurement	Time Point[A]	N Arm 1	Arm 1, Mean (SD)	N Arm 2	Arm 2, Mean (SD)	Effect Size (95% CI)	Reported p-Value
	Inpatient rehabilitation	Skilled nursing facility	Moderate	SF-12 (0-100)	24 mo	1213	NR (NR)	492	NR (NR)	NR	ns
Sattler, 2019, 30994586, Australia	Pedaling-based protocol	Non-pedaling (multi-exercise) protocol	Moderate	EQ-5D (5-15)	4 mo	28	Median (6.0)	28	Median (7.0)	NR	NR
Stevens Lapsley, 2012, 22095207, USA	Standard rehabilitation & NMES	Standard rehabilitation	Moderate	Global rating scale of perceived knee function (0-100)	12 mo	25	95.6 (5.7)	30	87.3 (15)	**8.3 (2.5, 14.1)[D]**	**NR**

Statistically significant effect sizes are in bold text. In cases where calculated effect size confidence intervals were not-statistically significant but reported p-values were, we deferred to reported p-values and still bolded results.

Abbreviations: CI = confidence interval, EQ-5D = EuroQual, KOOS = Knee injury and osteoarthritis outcome score, mo = month, NMES = neuromuscular electrical stimulation, NR = not reported, ns = not significant, PMID = PubMed identifier, RoB = risk of bias, ROM = range of motion, SD = standard deviation, ROM = range of motion, SF-12 = 12-item short form survey, SF-36 = 36-item short form survey, SF-6D = short-form six-dimension, WOMAC = Western Ontario and McMaster Universities Osteoarthritis Index.

[A] Time from surgery
[B] Scale combines assessment of function with pain, stability, range of motion, and muscle power and thus combines patient-reported with clinic-assessed outcomes
[C] Study did not report scale or interpretation for WOMAC total score. Low values are not consistent with the WOMAC score (0-96) where higher is better and may reflect the within-group change from baseline (which was also lower than expected: 38.3 [SD 20.9] for ROM Day 1 group vs. 43.7 [SD 16.1] for ROM Day 7 group).
[D] Calculated

Healthcare Utilization Outcomes Following Acute Rehabilitation

Two studies (Harmer 2009 and Buhagiar, 2017) reported on healthcare-utilization outcomes following acute rehabilitation compared with various controls (Tables 37 and 38). Outcome domains included: need for postoperative procedures and other healthcare-utilization outcomes.

Need for Postoperative Procedures

Two studies (Harmer 2009 and Buhagiar 2017) reported data on the need for postoperative procedures after acute rehabilitation following TKA surgery and observed few events in which patient needed manipulation under anesthesia (MUA) to address stiff knee, with the proportions of patients requiring MUA comparable among groups (Table 37).

Other Healthcare Utilization Outcomes

Three studies reported other healthcare utilization data (Liebs 2010, Liebs 2012, and Buhagiar 2017), including the number of patients readmitted for limited ROM, time lost from work, and the number of outpatient physical therapy sessions required. Studies reported no significant differences between groups in these measures (Table 38).

Costs (indirect or direct) associated with rehabilitation programs were rarely reported. Sattler 2019 evaluated a pedaling-based protocol and reported purchasing pedals (total not reported) at a fixed cost (in the United States) of $35 each. The pedals were loaned to trial participants who were asked to return them for future use. Buhagiar 2017 collected direct and indirect costs associated with the hospital inpatient and home-based rehabilitation programs but did not report them.

Cost-Effectiveness

We found no studies that compared the cost-effectiveness of acute rehabilitation with various comparators. Buhagiar 2017 had planned a cost-effectiveness analysis to complement their RCT of inpatient versus home rehabilitation if inpatient therapy was shown to be superior but did not conduct the analysis after findings were found to be comparable between groups with respect to patient-reported (quality of life, pain, function) and performance-based (6MWT) outcome measures.

Harms From Rehabilitation

No study reported adverse events from participating in the acute rehabilitation programs.

Summary of Comparison of Acute Rehabilitation Versus Various Controls for Total Knee Arthroplasty

Tables 39 summarize the evidence for the comparison of acute rehabilitation versus various comparators. We focus on the outcomes we prioritized in discussion with stakeholders.

There is low to insufficient SoE for all conclusions. Compared with various controls (usually less intensive active rehabilitation controls), rehabilitation in the acute phase after TKA may result in increased strength (low SoE) and comparable outcomes of pain, ROM, ADL and satisfaction with care (low SoE). There is insufficient evidence on the impact of acute rehabilitation on QoL and the need for postoperative procedures (such as manipulation under anesthesia). No studies reported evidence on harms associated with acute rehabilitation.

Table 37. Acute rehabilitation versus various controls for total knee arthroplasty – categorical outcomes, need for postoperative procedures

Study, Year, PMID, Country	Arm 1	Arm 2	Overall RoB	Outcome Measurement	Time Point[A]	N Arm 1	N Events Arm 2 (%)	N Arm 2	N Events Arm 2 (%)	Effect Size (95% CI)	Reported p-Value
Buhagiar, 2017, 28291891, Australia	Hospital Inpatient Rehabilitation	Home Program	Moderate	MUA	12 mo	79	4 (5%)	77	3 (4%)	1.30 (0.30, 5.62)[B]	NR
Harmer, 2009, 19177536, Australia	Water-based rehabilitation	Land-based rehabilitation	Moderate	MUA	6 mo	53	2 (4%)	49	2 (4%)	0.92 (0.14, 6.31)[B]	NR

Statistically significant effect sizes are in bold text. In cases where calculated effect size confidence intervals were not-statistically significant but reported p-values were, we deferred to reported p-values and still bolded results.

Abbreviations: CI = confidence interval, mo = month, MUA = manipulation under anesthesia, NR = not reported, PMID = PubMed identifier, RoB = risk of bias, ROM = range of motion.

[A] Time from surgery
[B] Calculated

Table 38. Acute rehabilitation versus various controls for total knee arthroplasty – continuous outcomes, other healthcare utilization outcomes

Study, Year, PMID, Country	Arm 1	Arm 2	Overall RoB	Outcome Measurement	Time Point[A]	N Arm 1	Arm 1, Mean (SD)	N Arm 2	Arm 2, Mean (SD)	Effect Size (95% CI)	Reported p-Value
Buhagiar, 2017, 28291891, Australia	Hospital Inpatient Rehabilitation	Home Program	Moderate	Time lost from work (time to return to work) (week)	NA	81	7.57 (95 % CI 4.86, 10.25)	84	7.80 (95 % CI 5.54, 10.06)	-0.23(-3.76, 3.30)	NR
	Hospital Inpatient Rehabilitation	Home Program	Moderate	Outpatient physical therapy sessions	NA	81	3.02 (95 % CI 2.75, 3.3)	84	3.07 (95 % CI 2.81, 3.34)	-0.05(-0.43, 0.33)	NR
Liebs, 2010, 20360503, Germany	Ergometer cycling	Control	Moderate	Admitted to hospital for limited range of motion	24 mo	66	1 (2%)	52	0 (0)	1.88 (0.06, 55.02)[B]	NR
Liebs, 2012, 22196125, Germany	Early Aquatic therapy	Late Aquatic therapy	Moderate	Readmitted to hospital for limited range of motion	3 mo	21	2 (10%)	22	1 (5%)	2.10 (0.20, 21.42)[B]	NR

Statistically significant effect sizes are in bold text. In cases where calculated effect size confidence intervals were not-statistically significant but reported p-values were, we deferred to reported p-values and still bolded results.

Abbreviations: CI = confidence interval, mo = month, NA = not applicable, NR = not reported, PMID = PubMed identifier, RoB = risk of bias, ROM = range of motion.

[A] Time from surgery
[B] Calculated

Table 39. Evidence profile: Acute rehabilitation versus various controls for total knee arthroplasty

Outcome Category	Outcome	N Studies (Participants)	RoB	Consistency	Precision	Directness	Intervention Replication	SoE	Conclusions
Body structure and function	Pain	12 (1115)	Moderate	Consistent	Precise	Direct	All unique	Low	Similar pain
	ROM	9 (857)	Moderate	Consistent	Precise	Direct	All unique	Low	Similar ROM
	Strength	3 (232)	Moderate	Consistent	Precise	Direct	All unique	Low	Increased strength
Activity and participation	ADLs	11 (2055)	Moderate	Inconsistent	Precise	Direct	All unique	Low	Similar ADL
Other patient-reported outcomes	Satisfaction with care	3 (326)	Moderate	Inconsistent	Precise	Direct	All unique	Low	Similar satisfaction with care
	QoL	1 (78)	High	Consistency unknown (single study)	Precise	Direct	NA (single study)	Insufficient	No conclusion
Healthcare utilization	Need for postoperative procedures	2 (258)	Moderate	Consistent	Precise	Direct	Both unique	Insufficient	No conclusion
Harms	Harms from rehabilitation	0	NA	NA	NA	NA	NA	Insufficient	No evidence

Abbreviations: ADLs = activities of daily living, QoL = quality of life, NA = not applicable, QoL = quality of life, RoB = risk of bias, ROM = range of motion, SoE = strength of evidence.

Post-Acute Phase Rehabilitation

There were 32 studies that evaluated post-acute phase rehabilitation in 5,484 patients (summarized in Figure 3). Post-acute phase rehabilitation interventions were typically initiated post-discharge between 2 and 8 weeks following TKA surgery. The interventions subsequently continued up to 6 months. One study defined itself as both acute and post-acute as it initiated rehabilitation 4 days after surgery but continued for 11 weeks (Bade 2017); we categorized this study as post-acute.

One study (Andersen 2018), which focused on the comparison of the setting of rehabilitation and personnel delivering it, did not provide data to code the rehabilitation interventions. We coded rehabilitation content in the remaining 30 studies. Most studies had some form of active comparison, even when described as "usual" or "standard care". Studies varied in their definitions of standard practice and in some cases usual care was no further rehabilitation (or was not reported). We were able to code rehabilitation content in 57 of the 66 arms of the 31 studies. Most rehabilitation interventions included exercises to address the goal components of strength (27/31 studies; 49/66 arms) and flexibility (25/31 studies; 44/66 arms), followed by task-specific training (21/31 studies; 34/66 arms), patient education (20/31 studies; 29/66 arms), and balance-motor-learning-agility (17/31 studies; 25/66 arms). Only half the studies included exercises targeted at aerobic endurance (15/31 studies; 24/66 arms).

We found 14 studies that included an adjunctive modality in combination with the rehabilitation program (i.e., heat, cold, NMES, TENS, biofeedback devices, dry needling, massage, mobilization, mindfulness/stress reducing activities, and complementary and alternative therapies). Of these, six RCTs were designed to evaluate the added benefit of an adjunctive therapy (NMES: 2 RCTs; biofeedback: 1 RCT; dry needling: 1 RCT; and Tai chi: 1 RCT). We found 24 studies that reported some form of progression, of which 16 were assessed by clinical experts on our team as appropriate in at least one arm of the study. One study compared a high-intensity progressive rehabilitation versus low-intensity rehabilitation without progression (Bade 2017). Eight other studies had appropriate progression coded in one arm and no progression in the comparison arm (Brun-Olsen 2013, Fransen 2017, Lenguerrand 2020, Liao 2020, Madsen 2013, Bily 2016, Hamilton 2020, Piva 2019).

Post-acute rehabilitation interventions were delivered by physical therapists in 28 of the 32 studies. Four remaining studies did not report who delivered the rehabilitation intervention (Li 2015, Demircioglu 2015, Shanb 2014, Li 2019). Three studies had either additional personnel deliver one arm of the intervention (an athletic trainer for one arm in Piva 2019, a Tai Chi instructor for one arm in Li 2019) or a component of the intervention in combination with the physical therapist (a psychologist delivered the cognitive-behavioral component in Cai 2018).

Most of the post-acute rehabilitation interventions were delivered to patients in-person (n=30). Li 2015 had no in-person component and compared remote Patient Education (by telephone, once a month for 6 months) to promote physical activity to no Patient Education. Moutzouri 2018 compared two patient self-guided interventions intended to be performed by patients independently at home (focal sensorimotor exercise training vs. functional exercise training). Several studies had self-guided components in addition to in-person supervised rehabilitation in either or both arms or compared some form of supervised rehabilitation to self-guided rehabilitation in the comparison arm. Four studies included some form of remote rehabilitation, delivered either by telephone (n=2 studies), video (n=1 study), or Web (1 study).

Interventions were delivered in various settings (and often, in combinations of settings). Ten studies evaluated one or both rehabilitation arms in outpatient settings exclusively (Artz 2017, Bruun-Olsen 2013, DeJong 2020, Lenguerrand 2020, Liao 2015, Bily 2016, Pua 2017, Petterson 2009, Shanb 2014, Petersen 2018). Four studies evaluated one or both rehabilitation arms at home exclusively (Li 2015, Minns Lowe, 2012, Moutzouri, 2018, Moffet, 2015). Six studies evaluated rehabilitation programs delivered both in both outpatient and home settings in one or both arms (Bade 2017, Fransen 2017, Heikkila 2017, Liao 2020 Madsen 2013, Piva 2017) and six studies evaluated rehabilitation programs that were delivered in the outpatient setting in one arm and to patients in their home in the other arm (Vuorenmaa 2014, Andersen 2018, Hamilton 2020, Mitchell 2005, Tousignant 2011, Demircioglu 2015). In one study the intervention was delivered in the acute and outpatient setting in both study arms (Schache, 2019) and one study was delivered in the acute, outpatient, and home setting in both study arms (Kauppila 2009). In one study the intervention was delivered in a non-acute inpatient facility in both study arms (Monticone 2013). In one study the intervention was delivered in a gym setting (for group-classes) in one arm, compared with an outpatient setting in the other arm (Piva 2019). Two studies did not report the setting in which the rehabilitation was delivered (Cai 2018 and Li 2019).

Specific codes for intervention (and control arm, where present) goals and exercises, use of progression (and assessment of appropriateness), and details on personnel, mode of delivery, and setting are detailed in Tables 40 and 41 and Appendix C-2.2.

Figure 3. Overview of studies of post-acute phase rehabilitation interventions for total knee arthroplasty

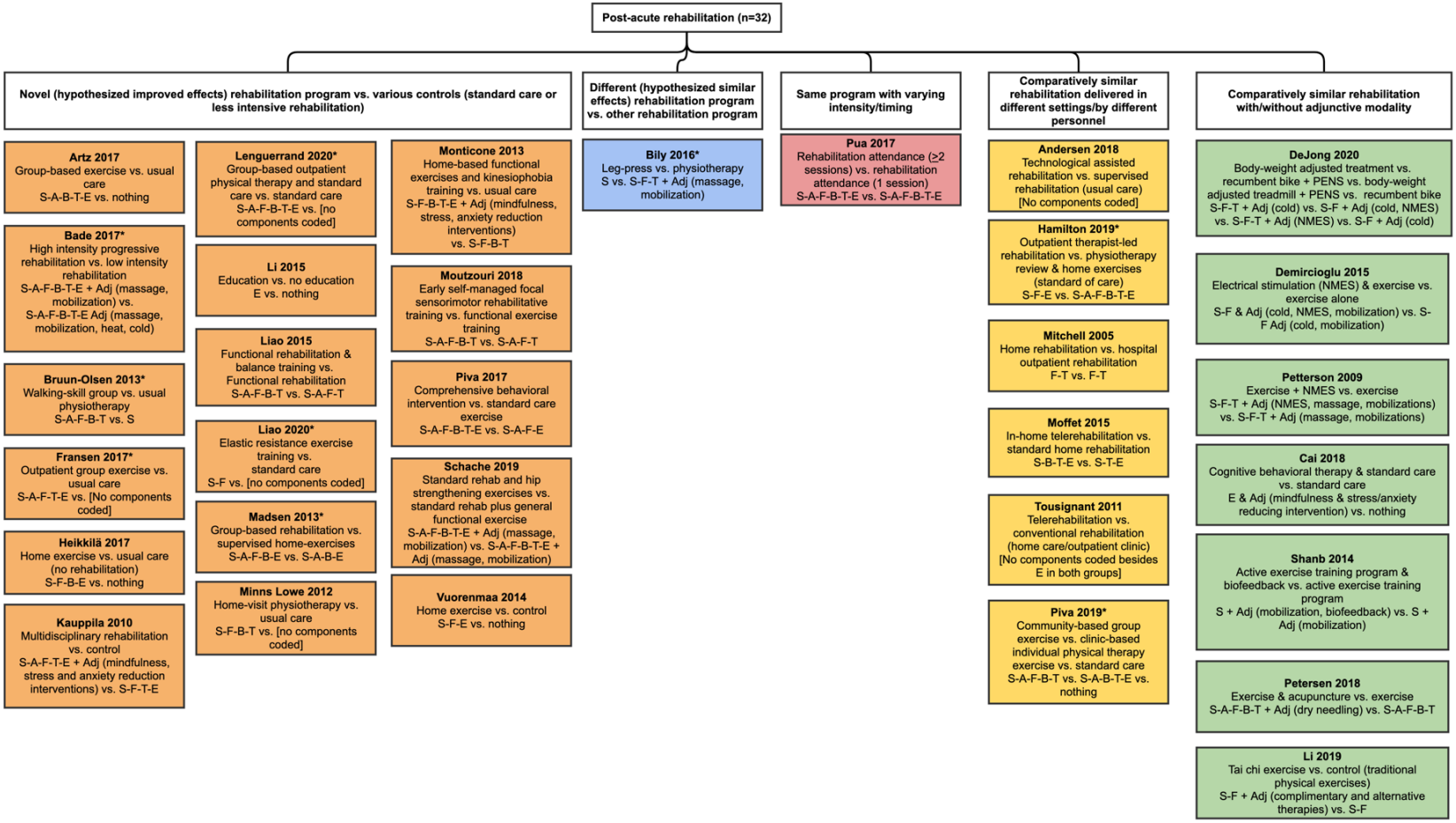

Figure presents categorization of studies (n=32) that evaluated post rehabilitation programs for TKA. The first column lists a novel (more intensive) program compared to a different program (first group hypothesized to be better); the second column lists a single study comparing two different rehabilitation programs hypothesized to be equivalent; the third column lists a single study with comparatively similar rehabilitation programs in both arms that were delivered with different timing or intensity (first group hypothesized to be better); the fourth column lists studies with comparatively similar rehabilitation programs delivered in different settings or by different personnel (i.e., shift in resources providing care; groups hypothesized to be comparable); the fifth column lists studies with rehabilitation interventions comparing a rehabilitation program and an adjunctive modality vs. the same rehabilitation program alone (first group hypothesized to be better). Studies are defined using arm descriptors first and component coding second. The different colors are added to visually separate the columns and do not provide unique information.

Abbreviations: Adj = adjunctive, A = aerobic exercise, B= balance-motor/learning-agility exercise, E = patient education, F = flexibility exercise, S = strengthening exercise, T = task-specific training.

* Intervention included progression which was deemed appropriate

Table 40.1. Goal components strength, aerobic, and flexibility and their specific exercise components for post-acute-rehabilitation interventions (part 1) versus various controls for total knee arthroplasty

Study	Arm	Strength	Bridges	Calf Press	Clamshells	Core Strengthening	Gluteal Sets	Heel Raises	Hip Abduction	Hip Adduction	Hip Extension	Hip Flexion	Hip Hikes	Knee Extension	Knee Flexion	Leg Press	Lunges	OCA Strengthening	Quad Sets	Single Leg Stance	Sit-To-Stand	Squats	Standing TKE	Step Down	Step Lateral	Step Up	Stool Scoots	Straight Leg Raises	UE Strengthening	Wall Slides	Aerobic	Aquatics	Bike (Endurance)	Elliptical Machine	Stepper	Walking	Flexibility	Ankle Pumps	Bike (ROM)	Calf Stretch	Hamstring Stretch	Heel Slides	Hip Extensor Stretch	Hip Flexor Stretch	Knee Extension	Knee Flexion	Standing TKE
Artz, 2017	Group-based ex	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Usual care	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bade, 2017	HI prog rehab	1	0	1	1	0	1	1	1	1	1	1	0	1	1	1	1	0	1	0	1	1	0	1	1	1	0	1	0	1	1	0	1	0	0	1	1	1	1	1	1	0	0	1	1	0
	LI rehab	1	0	0	1	0	1	1	0	0	0	0	0	0	1	0	0	0	1	1	1	1	1	0	0	0	1	1	0	0	1	0	1	0	0	1	1	1	1	1	1	0	0	1	1	0
Bruun-Olsen, 2013	Walking skill program	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1	1	0	1		1	0	0	0	0	0	1	1	0	0	0	1	1	0	0	1	1	0	0	0	0	1	0
	Usual physio	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cai, 2018	CBT for kinesiophobia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Standard care	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fransen, 2017	O-grp ex	1	1	0	0	0	1	1	0	1	0	0	1	0	0	1	0	0	0	1	1	0	1	1	1	0	0	0	1	1	1	0	1	0	0	1	1	0	0	1	1	0	0	1	1	0
	Usual care	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Heikkila, 2017	Exercise	1	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	1	0	1	1	0	0	1	0	0	0	0	1	0	0	0	0	0	0	1	0	1	1	1	0	0	1	0	0
	Control	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Kauppila, 2009	Multidisciplinary rehab	1	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	1	1	0	0	0	0	0	0	0	0	0
	Control	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Lenguerrand, 2020	Grp-based O-PT	1	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0	0	0	0	1	0	1	0	1	0	0	0	0	1	0	1	0	0	1	1	0	1	0	0	0	0	1	1	0
	Usual care	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Li, 2015	Ed for daily PA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Non-ed for daily PA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Liao, 2015	Fxtl rehab & BT	1	0	0	0	0	0	0	1	0	0	0	0	1	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	1	1	1	0	0	1	0	0	1	1	0
	Fxtl rehab	1	0	0	0	0	0	0	1	0	0	0	0	1	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	1	1	1	0	0	1	0	0	1	1	0
Liao, 2020	Elastic resistance ex	1	0	0	0	0	0	0	1	1	1	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
	Standard care	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Madsen, 2013	Group-based rehab	1	0	0	0	1	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	1	0	0	0	0	0	0	1	0	1	0	1	0	0	1	1	0	1	0	0	0	0	0	0	0
	Individual-based rehabilitation	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0
Minns Lowe, 2012	Home-visit physio	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	1	0	0	0	1	0	0	0	0	0	0	1	1	0	0	0	0	1	0		
	Usual physio	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
Monticone, 2013	Experimental	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0
	Control	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0
Moutzouri, 2018	FSET	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	1	0	1	0	0	1	0	0	0	0	1	0	0	1	1	0
	Fxtl ex training	1	0	0	0	0	0	1	1	0	0	0	0	1	1	0	0	0	0	0	1	0	0	0	0	0	0	1	0	1	1	0	1	0	0	1	1	0	0	0	1	0	0	1	1	0
Piva, 2017	CBI	1	0	0	0	0	0	1	0	1	0	0	1	1	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1	1	0	0	0	0	1	0	1	1	1	0	0	0	1	1	0
	Standard care	1	0	0	0	0	0	0	1	0	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	1	0	1	1	1	0	0	0	1	1	0
Schache, 2019	Standard rehab & HAS	1	0	0	0	0	0	1	1	0	1	0	1	0	1	1	0	0	1	0	0	1	0	1	1	1	0	0	0	0	1	0	1	0	0	0	1	0	0	1	0	0	1	1	1	0
	Standard rehab & general fxn ex	1	0	0	0	0	0	1	0	0	0	0	0	0	1	1	0	0	1	0	0	1	0	1	0	1	0	0	0	0	1	0	1	0	0	0	1	0	0	1	0	0	1	1	1	0
Vuorenmaa, 2014	Intervention	1	0	0	0	0	0	1	0	0	0	0	0	1	1	0	0	0	0	0	1	1	0	0	0	1	0	0	0	1		0	0	0	0	0	1	0	1	1	1	0	0	1	0	1	0
	Control	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0

This table represents the first half of the studies assessing post-acute rehabilitation interventions (part 1). All studies in this table assessed novel interventions hypothesized to improve effects compared with controls. See Tables 41.1 and 41.2 for remainder of the studies assessing post-acute rehabilitation interventions (part 2). See Table 40.2 for goal components balance-motor-learning-agility, task specific training, patient education, and adjunctive modalities for part 1 studies. The color is added for visual display and does not provide unique information.

1 = presence of component, 0 = absence of component

Abbreviations. BT = balance training, CBI = comprehensive behavioral intervention, ed = education, ex = exercise, fxn = function, fxtl = functional, FSET = focal sensorimotor exercise training, grp = group, HAT = hip abduction training, HI = high intensity, LI = low intensity, O = outpatient, PA = physical activity, physio = physiotherapy, rehab = rehabilitation, ROM = range of motion, TKE = terminal knee extension

Table 40.2. Goal components balance-motor-learning-agility, task specific training, patient education, and adjunctive modalities and their specific exercise components for post-acute-rehabilitation interventions (part 1) versus various controls for total knee arthroplasty

Study	Arm	Balance-Motor Learning-Agility	Balance On Unstable Surface	Balance With Perturbations	Marching	Single Leg Stance	Standing Weight Shifts	Stepping Multiple Directions	Step Down	Step Lateral (Side Step)	Step Up – Forward	Tandem Standing	Tandem Walking	Task Specific Training	Gait Backwards	Gait Downhill	Gait On Uneven Surfaces	Gait Sideways	Gait Training	Gait Uphill	Gait With Perturbations	Obstacle Training	Sit-To-Stand Training	Stair Training	Transfers	Patient Education	Activities Of Daily Living	Home Exercise Program	Lifestyle Change	Pain Management	Self-Management	Wound Care Management	Adjunctive modality	Cold	Heat	E-stim For Pain (TENS)	E-stim For Strength (NMES)	Massage	Mobilizations	Biofeedback Devices	Dry Needling (Acupuncture)	Mindfulness, Stress/Anxiety-Reduction	CAM	Progression (appropriate?)	Personnel	Mode of delivery	Setting
Artz, 2017	Group-based ex	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N	PT	I	O
	Usual care	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N	NA	NA	NA
Bade, 2017	HI prog rehab	1	1	0	1	1	1	1	0	1	0	0	0	1	0	0	0	0	1	0	0	0	0	1	1	1	0	1	0	1	0	1	1	0	0	0	0	1	1	0	0	0	0	Y (Y)	PT	I; SG	O; H
	LI rehab	1	1	0	1	1	1	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	1	1	1	1	0	1	0	1	0	1	1	1	0	0	1	1	0	0	0	0	Y (N)	PT	I; SG	O; H
Bruun-Olsen, 2013	Walking skill	1	1	1	0	1	1	0	1	1	1	0	0	1	0	0	1	1	1	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Y (Y)	PT	I	O
	Usual physio	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N	PT	I	O
Cai, 2018	CBT for kinesiophobia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	N	PT; Other[A]	I	NR
	Standard care	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N	NA	NA	NA
Fransen, 2017	O-grp ex	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	1	0	0	0	0	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Y (Y)	PT	I	O; H
	Usual care	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N	PT	I	O; H
Heikkila, 2017	Exercise	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Y (N)	PT	I; SG	O; H
	Control	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N	NA	NA	NA
Kauppila, 2009	Multidisciplinary rehab	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	1	1	1	0	1	1	0	0	0	1	0	0	0	0	0	0	0	0	1	0	Y (N)	PT	I; SG	AI; O; H
	Control	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	1	1	1	0	1	0	0	0	0		0	0	0	0	0	0	0	0	0	0	Y (N)	PT	I; SG	AI; O; H
Lenguerrand, 2020	Grp-based O-PT	1	1	0	0	1	0	0	1	0	1	0	0	1	0	0	1	1	1	0	0	1	1	1	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Y (Y)	PT	I	O
	Usual care	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N	NA	NA	NA
Li, 2015	Ed for daily PA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N	NR	R[B]	H
	Non-ed for daily PA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N	NR	NR	NR
Liao, 2015	Fxtl rehab & BT	1	1	0	0	0	0	1	0	1	0	0	1	1	1	1	0	1	1	1	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Y (N)	PT	I	O
	Fxtl rehab	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	1	1	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Y (N)	PT	I	O
Liao, 2020	Elastic resistance ex	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Y (Y)	PT	I; SG	O; H
	Standard care	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N	NR	I	NR
Madsen, 2013	Grp-based	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Y (Y)	PT	I; None	O; H
	Individual-based	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N	PT	I; None	O; H
Minns Lowe, 2012	Home-visit physio	1	0	0	1	1	1	0	0	0	0	0	0	1	0	0	1	0	1	0	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Y (N)	PT	I	H
	Usual physio	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N	NA	NA	NA
Monticone, 2013	Experimental	1	1	0	1	0	0	1	0	0	0	0	0	1	0	0	0	0	1	0	0	1	1	1	0	1	1	1	0	1	1	0	1	0	0	0	0	0	0	0	0	1	0	N	PT	I; R†	OIF; H
	Control	1	1	0	1	0	0	1	0	0	0	0	0	1	0	0	0	0	1	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N	PT	I	OIF
Moutzouri, 2018	FSET	1	1	0	1	0	0	1	0	1	0	0	1	1	0	0	0	0	0	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Y (Y)	PT	SG	H
	Fxtl ex training	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Y (Y)	PT	SG	H
Piva, 2017	CBI	1	1	0	1	0	0	1		1			1	1	1	0	0	0	0	0	0	0	0	1	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Y (Y)	PT	I	O; H
	Standard care	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Y (Y)	PT	I	O; H
Schache, 2019	Standard rehab & HAT	1	0	0	1	0	0	0	1	0	1	0	0	1	0	0	0	1	1	0	0	0	1	0	0	1	0	1	0	0	0	0	1	0	0	0	0	1	1	0	0	0	0	Y (Y)	PT	I	AI; O
	Standard rehab & general fxn ex	1	0	0	1	0	0	0	1	0	1	0	0	1	0	0	0	0	1	0	0	0	1	0	0	1	0	1	0	0	0	0	1	0	0	0	0	1	1	0	0	0	0	Y (Y)	PT	I	AI; O
Vuorenmaa, 2014	Intervention	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Y (N)	PT	I; H	O; H
	Control	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N	None	NA	H

This table represents the first half of the studies assessing post-acute rehabilitation interventions (part 1). All studies in this table assessed novel interventions hypothesized to improve effects compared with controls. See Tables 41.1 and 41.2 for remainder of the studies assessing post-acute rehabilitation interventions (part 2). See Table 40.1 for goal components strength, aerobic, and flexibility for part 1 studies. The color is added for visual display and does not provide unique information. The color is added for visual display and does not provide unique information. 1 = presence of component, 0 = absence of component

Abbreviations: AI = acute in-patient; BT = balance training, CBI = comprehensive behavioral intervention, ex = exercise, fxn = function, fxtl = functional, , FSET = focal sensorimotor exercise training, grp = group, HAT = hip abduction training, HI = high intensity, H = home, I = in-person, G = gym/other community center, NA = not applicable, NMES = neuromuscular electrical stimulation, NR = not reported, O = outpatient physiotherapy center; OIF = other inpatient facility, PENS = patterned electrical neuromuscular stimulation, PT = physical therapist R = remote; rehab = rehabilitation; SG = self-guided; tele = telephone; TENS = transcutaneous electrical nerve stimulation, video = videoconference

[A] Psychologist
[B] Remote via telephone

Table 41.1. Goal components strength, aerobic, and flexibility and their specific exercise components for post-acute-rehabilitation interventions (part 2) versus various controls for total knee arthroplasty

Study	Arm	Strength	Bridges	Calf Press	Clamshells	Core Strengthening	Gluteal Sets	Heel Raises	Hip Abduction	Hip Adduction	Hip Extension	Hip Flexion	Hip Hikes	Knee Extension	Knee Flexion	Leg Press	Lunges	OCA Strengthening	Quad Sets	Single Leg Stance	Sit-To-Stand	Squats	Standing TKE	Step Down	Step Lateral	Step Up	Stool Scoots	Straight Leg Raises	UE Strengthening	Wall Slides	Aerobic	Aquatics	Bike (Endurance)	Elliptical Machine	Stepper	Walking	Flexibility	Ankle Pumps	Bike (ROM)	Calf Stretch	Hamstring Stretch	Heel Slides	Hip Extensor Stretch	Hip Flexor Stretch	Knee Extension	Knee Flexion	Standing TKE
Bily, 2016[A]	Leg press group	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Physiotherapy group	1	0	0	0	0	0	0	1	0	0	0	0	1	1	0	0	0	1	0	0	1	0	0	0	1	0	1	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0
Pua, 2017[B]	≥2 rehab session	1	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	1	0	1	0	0	1	0	1	0	1	0	1	1	0	0	0	1	0	1	0	1	0	0	0	1	1	0
	1 rehab session	1	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	1	0	1	0	0	1	0	1	0	1	0	1	1	0	0	0	1	0	1	0	1	0	0	0	1	1	0
	No rehabilitation attendance	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Andersen, 2018[C]	Technology-assisted rehab	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Supervised rehab	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hamilton, 2020[C]	Outpatient therapist-led rehab	1	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	1	0	0	1	0	0	0	1	0	1	0	0	1	0	0	0	0	1	1	0	1	1	1	0	0	0	1	1	0
	Physio review and home exercises	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Mitchell, 2005[C]	Home	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	1	0
	Outpatient	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	1	0
Moffet, 2015[C]	Telerehabilitation	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Home standard program	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tousignant, 2011[C]	Telerehabilitation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Home care/outpatient clinic group	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Piva, 2019[C]	Clinic-based PT	1	0	0	0	0	0	0	0	0	1	1	0	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0
	Community-based grp exercise	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
	Usual care	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DeJong, 2020[D]	Body-weight adjusted treatment	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
	Recumbent bike & PENS	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0
	Body-weight adjusted Treadmill & PENS	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
	Recumbent bike	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0
Demircioglu, 2015[D]	Home exercise & NMES	1	0	0	0	0	0	0	1	1	0	0	0	1	0	0	0	0	1	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	1	1	0
	Home exercise	1	0	0	0	0	0	0	1	1	0	0	0	1	0	0	0	0	1	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	1	1	0
Petterson, 2009[D]	Exercise & NMES	1	0	0	0	0	0	0	1	0	0	0	0	1	1	0	1	0	1	0	0	0	1	1	0	1	0	1	0	1	0	0	0	0	0	0	1	0	1	0	0	0	0	0	1	1	0
	Exercise	1	0	0	0	0	0	0	1	0	0	0	0	1	1	0	1	0	1	0	0	0	1	1	0	1	0	1	0	1	0	0	0	0	0	0	1	0	1	0	0	0	0	0	1	1	0
Shanb, 2014[D]	Active exercise training & biofeedback	1	0	0	0	0	0	0	1	0	0	0	0	1	1	0	0	1	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Active exercise training	1	0	0	0	0	0	0	1	0	0	0	0	1	1	0	0	1	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Petersen, 2018[D]	Exercise & acupuncture	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
	Exercise	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Li, 2019[D]	Standard care	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0
	Tai chi	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0

This table represents the second half of the studies assessing post-acute rehabilitation interventions (part 2). See Tables 40.1 and 40.2 for first half of the studies assessing post-acute rehabilitation interventions (part 1). See Table 41.2 for goal components balance-motor-learning-agility, task specific training, patient education, and adjunctive modalities for part 2 studies. The color is added for visual display and does not provide unique information.

1 = presence of component, 0 = absence of component

Abbreviations: NMES = neuromuscular electrical stimulation, rehab = rehabilitation, ROM = range of motion, PT = physiotherapy, TKE = terminal knee extension.

[A] Different rehabilitation program (hypothesized similar)
[B] Similar rehabilitation with varying intensity/timing
[C] Similar rehabilitation delivered in different setting/by different personnel
[D] Similar rehabilitation with/without adjuvant modality

Table 41.2. Goal components balance-motor-learning-agility, task specific training, patient education, and adjunctive modalities and their specific exercise components for post-acute-rehabilitation interventions (part 2) versus various controls for total knee arthroplasty

Study	Arm	Balance-Motor Learning-Agility	Balance On Unstable Surface	Balance With Perturbations	Marching	Single Leg Stance	Standing Weight Shifts	Stepping Multiple Directions	Step Down	Step Lateral (Side Step)	Step Up – Forward	Tandem Standing	Tandem Walking	Task Specific Training	Gait Backwards	Gait Downhill	Gait On Uneven Surfaces	Gait Sideways	Gait Training	Gait Uphill	Gait With Perturbations	Obstacle Training	Sit-To-Stand Training	Stair Training	Treadmill Gait	Patient Education	Activities of Daily Living	Home Exercise Program	Lifestyle Change	Pain Management	Self-Management	Wound Care Management	Adjunctive modality	Cold	Heat	E-stim For Pain (TENS)	E-stim For Strength (NMES)	Massage	Mobilizations	Biofeedback Devices	Dry Needling (Acupuncture)	Mindfulness, Stress/Anxiety-Reduction	CAM	Progression (appropriate?)	Personnel	Mode of delivery	Setting
Bily, 2016[A]	Leg press group	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Y (N)	NR	I	O
	Physiotherapy group	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1	0	0	0	Y (Y)	PT	I	O
Pua, 2017[B]	>2 rehab session	1	0	0	1	1	0	0	0	1	0	1	0	1	0	0	0	0	1	0	0	0	0	1	0	1	0	1	0	1	0	0	1	1	0	0	1	0	0	0	0	0	Y (N)	PT	I	O
	1 rehab session	1	0	0	1	1	0	0	0	1	0	1	0	1	0	0	0	0	1	0	0	0	0	1	0	1	0	1	0	1	0	0	1	1	0	0	1	0	0	0	0	0	Y (N)	PT	I	O
	No attendance	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N	NA	NA	NA
Andersen, 2018[C]	Technology-assisted rehab	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N	NR	NR	H
	Supervised rehab	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N	PT	I	O
Hamilton, 2020[C]	Outpatient therapist-led rehab	1	1	0	0	1	0	1	0	0	0	0	1	1	0	0	0	0	1	0	1	0	1	0	0	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	Y (Y)	PT; None	I; SG	O; H
	Physio review & home exercises	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	N	None	SG	H
Mitchell, 2005[C]	Home	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	1	1	0	0	1	0	0	1	0	0	0	0	0	1	0	0	0	N	PT	I	H
	Outpatient	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1	0	0	0	0	0	N	PT	I	O
Moffet, 2015[C]	Telerehabilitation	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	Y (Y)	PT	R[E]	H
	Home standard program	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	Y (Y)	PT	I	H
Tousignant, 2011[C]	Telerehabilitation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Y (N)	PT	R[F]	H
	Home care/outpatient clinic group	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Y (N)	PT	I	O
Piva, 2019[C]	Clinic-based PT	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	1	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Y (Y)	PT	I	O
	Community-based grp exercise	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N	Other[G]	I	G
	Usual care		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N	NA	NA	NA
DeJong, 2020[D]	Body-weight adjusted treatment	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	1	0	0	0	0	1	0	0	0	Y (N)	PT	I	O
	Recumbent bike & PENS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	0	1	0	0	0	N	PT	I	O
	Body-weight adjusted Treadmill & PENS	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	1	0	0	1	0	1	0	0	0	Y (N)	PT	I	O
	Recumbent bike	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	1	0	0	0	N	PT	I	O
Demircioglu, 2015[D]	Home exercise & NMES	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	0	1	0	0	0	N	NR	I	O
	Home exercise	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	1	1	0	0	0	0	1	0	0	0	N	None	SG	H
Petterson, 2009[D]	Exercise & NMES	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	1	1	1	0	0	0	Y (Y)	PT	I	O
	Exercise	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1	0	0	0	Y (Y)	PT	I	O
Shanb, 2014[D]	Active exercise training & biofeedback	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1	0	0	0	Y (Y)	NR	I	O
	Active exercise training		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	Y (Y)	NR	I	O
Petersen, 2018[D]	Exercise & acupuncture	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	Y (Y)	PT	I	O
	Exercise	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	Y (Y)	PT	I	O
Li, 2019[D]	Standard care		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	N	NR	NR	NR
	Tai chi		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	N	Other[H]	I	NR

This table represents the second half of the studies assessing post-acute rehabilitation interventions (part 2). See Tables 40.1 and 40.2 for first half of the studies assessing post-acute rehabilitation interventions (part 1). See Table 41.2 for goal components balance-motor-learning-agility, task specific training, patient education, and adjunctive modalities for part 2 studies. The color is added for visual display and does not provide unique information. The color is added for visual display and does not provide unique information.

1 = presence of component, 2 = absence of component

Abbreviations: AI = acute in-patient; CAM = complementary and alternative therapies, I = in-person; G = gym/other community center; H = home; NA = not applicable, NR = not reported, NMES = neuromuscular electrical stimulation, O = outpatient physiotherapy center, OIF = other inpatient facility, PT = physical therapist, R = remote; rehab = rehabilitation, SG = self-guided; tele = telephone; TENS = transcutaneous electrical nerve stimulation.

[A] Different rehabilitation program (hypothesized similar)
[B] Similar rehabilitation with varying intensity/timing
[C] Similar rehabilitation delivered in different setting/by different personnel
[D] Similar rehabilitation with/without adjuvant modality
[E] Remote via video
[F] Remote via video
[G] Athletic trainer
[H] Tai Chi instructors

Body Structure and Function Outcomes Following Post-Acute Rehabilitation

We found 26 studies that reported on body structure and function outcomes following post-acute rehabilitation, with various comparators: 17 studies (Artz 2017, Bade 2017, Bruun-Olsen 2013, Cai 2018, Fransen 2017, Heikkilä 2017, Kauppila 2010, Lenguerrand 2020, Li 2015, Liao 2015, Liao 220, Madsen 2013, Minns Lowe 2012, Monticone 2013, Moutzouri 2018, Schache 2019, Vuorenmaa 2014) compared novel rehabilitation programs with various comparators (less intensive rehabilitation or no care); one study (Bily 2016) compared different (hypothesized equivalent) rehabilitation programs, no studies compared rehabilitation programs with different timing and/or intensity; four studies (Andersen 2018, Mitchell 2005, Moffet 2015, Tousignant 2011) compared rehabilitation programs delivered in different settings or by different personnel, and five studies (Demircioglu 2015, Li 2019, Petterson 2009, Peterson 2018, Shanb 2014) compared rehabilitation programs with or without an adjunctive modality (Tables 42 to 47). The outcome domains included: symptoms, pain, range of motion, muscle strength, energy and vigor, and emotional functioning.

Symptoms

Eleven studies (Artz 2017, Bruun-Olsen 2013, Lenguerrand 2020, Minns Lowe 2012, Monticone 2013, Schache 2019, Mitchell 2005, Moffet 2015, DeJong 2020, Demircioglu 2015, Petersen 2018) reported data on symptoms using the stiffness component of the WOMAC and the symptoms component of the KOOS (Table 42). Most (n=9) studies observed no differences between groups at follow-up ranging from 3 to 12 months after TKA. Monticone 2013 reported symptoms using the symptoms component of the KOOS (0-100, larger is better) and found that patients randomized to home-based functional exercises and kinesiophobia training reported experiencing fewer symptoms than patients randomized to usual care (a less intensive rehabilitation exercise program without kinesiophobia training) at 6 and 12 months after TKA. Demircioglu 2015 reported symptoms using the stiffness component of the WOMAC (0-100, larger is worse) and found that patients randomized to exercise and adjunctive NMES reported experiencing fewer symptoms than patients randomized to exercise alone at 3 months after TKA (MD −5.0, 95% CI −9.5 to −0.5).

Pain

We found pain data reported in 22 studies (Artz 2017, Cai 2018, Bruun-Olsen 2013, Fransen 2017, Heikkilä 2017, Lenguerrand 2020, Li 2015, Liao 2015, Liao 2020, Minns Lowe 2012, Monticone 2013, Moutzouri 2018, Schache 2019, Vuorenmaa 2014, Bily 2016, Mitchell 2005, Moffet 2015, DeJong 2020, Demircioglu 2015, Li 2019, Petersen 2018, Petterson 2009) (Table 43), using six different outcome measures assessed between 3 and 12 months after surgery. Ten of the 13 studies that compared a novel (hypothesized better) rehabilitation program with various comparators found no difference in pain measures between groups. In three studies (Liao 2020, Monticone 2013, Moutzouri 2018) the novel rehabilitation program was associated with significant reductions in pain. Liao 2020 reported pain data using the pain component of the WOMAC (0-20; lower is better) and found that patients randomized to elastic resistance exercise training reported significantly reduced pain compared with patients randomized to standard care (conservative physical therapy without any resistance training) (p=0.001) at 4 months after TKA. Monticone 2013 reported pain data using the pain component of the KOOS (0-100; higher is

better) and a VAS (0-10; lower is better) and found that patients randomized to home-based functional exercises and kinesiophobia training reported significantly reduced pain at 6 and 12 months after TKA on both KOOS (12 months MD: 9.6, 95% CI 4.6 to 14.5) and VAS (12 months MD: −1.0, 95% CI −1.6 to −0.5) measures. Moutzouri 2018 reported pain data using a VAS (0-10, lower is better) and found that patients randomized to early self-managed focal sensorimotor exercise training reported significantly reduced pain compared with those randomized to function exercise training at 3.5 months after TKA (MD −1.7, 95% CI −2 to −1.4).

Bily 2016 (evaluating two rehabilitation programs hypothesized to be equivalent) found no difference between patients randomized to the leg press group compared with patients randomized to the physiotherapy group at 3 months follow-up.

Two studies assessed the impact of the setting of rehabilitation on measures of pain (Mitchell 2005: hospital vs. home; Moffet 2015: in-home telerehabilitation versus standard rehabilitation) and found no differences between groups at 3 and 4 months after TKA, respectively.

Finally, three of the four studies that assessed the impact of different rehabilitation programs with and without adjunctive therapy found no difference between compared groups. Two studies (Cai 2018 and Demircioglu 2015) reported reduced pain in the adjunctive therapy groups. Cai 2018 reported pain data using two measures: the VAS (0-10, lower is better) and the Pain Catastrophizing Scale (0-52, lower is better) and found that patients randomized to the cognitive behavior therapy and standard care arm reported reduced pain (net mean difference [NMD] −0.57, 95% CI −0.9 to −0.2) and pain catastrophizing (NMD −7.7, 95% CI −9.3 to −6.1) at 6 months after TKA. Demircioglu 2015 reported pain data using the pain component of the WOMAC (0-20 but appeared to convert to 0-100, smaller is better) compared exercise with NMES to exercise alone found reduced pain among patients who received the adjunctive NMES (MD −5.7, 95% CI −11.3 to −0.1).

Range of Motion

We found 15 studies (Bade 2017, Bruun-Olsen 2013, Fransen 2017, Kauppila 2010, Madsen 2013, Moutzouri 2018, Schache 2019, Vuorenmaa 2014, Bily 2016, Demircioglu 2015, Li 2019, Petterson 2009, Andersen 2018, Moffet 2015, Tousignant 2011) that reported range of motion (ROM) data from various outcome measures, including active and passive knee ROM for extension and flexion of the knee joint (Table 44). In several cases, whether the measure was active or passive ROM was not specified. Where reported, studies measured ROM in degrees using goniometry. Most studies (n=13) reported comparable ROM between arms at follow-up measured between 3 and 12 months after TKA across the various interventions and comparisons. Moutzouri 2018 showed significant improvements in active knee ROM flexion among patients randomized to early self-managed focal sensorimotor exercise training compared with patients randomized to functional exercise training. Li 2019 found significant differences between groups: extension ROM, but not flexion ROM, (whether active or passive not specified) was significantly increased among patients randomized to Tai Chi compared with patients randomized to rehabilitation at 3 months after TKA.

Muscle Strength

We found 14 studies (Bade, 2017, Bruun-Olsen, 2013, Fransen, 2017, Heikkilä, 2017, Kauppila, 2010, Madsen, 2013, Minns Lowe, 2012, Moutzouri, 2018, Schache, 2019, Vuorenmaa, 2014, Bily, 2016, Moffet, 2015, Petterson, 2009, Shanb, 2014) reported strength

data from various outcome measures including isometric and isokinetic knee extension and knee flexion strength, and quadricep and hamstring strength and torque, among others (Table 45). Studies typically used a dynamometer to measure strength and presented strength data variably (Newtons [N], kilograms [kg], torque normalized to body weight [Nm/kg] and others; for each, higher values indicate greater strength). One study reported strength using a composite scale, the Index of Muscle Function designed to assess strength and function.

Seven of the 10 studies that compared patients randomized to a novel (hypothesized better) rehabilitation program with various comparators found no difference in strength measures between groups. In three studies (Heikkilä, 2017, Moutzouri 2018, and Vuorenmaa 2014) the novel rehabilitation program was associated with significant increases in strength (in at least one measure reported). Heikkilä 2017 reported patients randomized to home-based rehabilitation showed increased knee extension (MD 70, 95% CI 33 to 108) and knee flexion strength (MD 30, 95% CI 17 to 43) compared with patients randomized to usual care (no additional rehabilitation after discharge) at 14 months after TKA. Moutzouri 2018 reported that patients randomized to early self-managed focal sensorimotor exercise training had improved peak force (N) compared with patients randomized to functional exercise training (MD 12.1, 95% CI 3.9 to 20.2). Vuorenmaa 2014 reported patients randomized to home exercise had significantly improved isometric knee flexion (but not extension) (MD NR; P=0.009) compared with patients randomized to control (no additional guidance after baseline measurements). Of the remaining four studies (that compared rehabilitation in different settings or with or without an adjunctive modality) only one study (Shanb 2014) reported improved strength. Shanb 2014 reported patients randomized to active exercise training and biofeedback had significantly improved performance of quadricep isometric peak torque at 4 months following surgery (P=0.01)

Energy and Vigor

One study (Mitchell 2005) reported on vigor using the vitality component of the SF-36 (scores 0 to 100, higher is better) (Table 46) and found no significant differences between groups at 3 months after surgery.

Emotional Functioning

Eight studies (Bade 2017, Fransen 2017, Schache 2019, Vuorenmaa 2014, Mitchell 2005, Demircioglu 2015, Li 2019, Petterson 2009) reported on emotional functioning data from the mental health, emotional role functioning and social functioning component scales of the SF-36 (scores 0 to 100, higher is better) (Table 47). Most studies (n=7) reported comparable results among groups on measures of emotional functioning between 3 and 12 months after TKA. One study (Li 2009) reported significant improvements in mental health among patients randomized to adjunctive Tai Chi compared with rehabilitation alone at 3 months after TKA (p=0.03).

Table 42. Post-acute rehabilitation versus various controls for total knee arthroplasty – continuous outcomes, symptoms

Study, Year, PMID, Country	Arm 1	Arm 2	Overall RoB	Outcome Measurement	Time Point[A]	N Arm 1	Arm 1, Mean (SD)	N Arm 2	Arm 2, Mean (SD)	Effect Size (95% CI)	Reported p-Value
Artz, 2017, 27068368,UK	Group-based exercise	Usual care	High	KOOS: Symptoms (0-100)	3 mo	19	59.6 (16.4)	12	54.8 (16.9)	4.8 (-3.9, 13.5)[B]	NR
	Group-based exercise	Usual care	High	KOOS: Symptoms (0-100)	6 mo	21	58.4 (18.9)	15	56.7 (14.3)	1.7 (-6, 9.4)[B]	NR
Bruun-Olsen, 2013, 23614370, Norway	Walking-skill group	21 individual physiotherapy sessions	Moderate	KOOS: Symptoms (0-100)	9 mo	29	52 (18)	28	73 (21)	adj 2 (-9, 13)	NR
DeJong, 2020, 32360105 USA	Body Weight-Adjustable Treadmill & PENS	Recumbent Bike & PENS	High	KOOS: Symptoms (0-100)	6 mo	70	84.3 (18.7)	78	81.1 (16.2)	-3.2 (-7.2, 0.8)	NR
	Body Weight-Adjustable Treadmill & PENS	Body Weight-Adjustable Treadmill	High	KOOS: Symptoms (0-100)	6 mo	70	84.3 (18.7)	76	83.3 (19.8)	-1.0 (-5.5, 3.4)	NR
	Body Weight-Adjustable Treadmill & PENS	Recumbent Bike/Usual Care	High	KOOS: Symptoms (0-100)	6 mo	70	84.3 (18.7)	74	87.0 (12.2)	2.7 (-1.1, 6.5)	NR
Demircioglu, 2015, 26355656, Turkey	NMES & exercise	Exercise	High	WOMAC: Stiffness (0-100)	3 mo	30	42.9 (12.6)	30	47.9 (12.3)	**-5 (-9.5, -0.5)[B]**	**NR**
Lenguerrand, 2020, 31033232, UK	Physical therapy and standard care	Standard care	Moderate	KOOS: Symptoms (0-100)	12 mo	74	77 (17)	64	77 (20)	0 (-4.5, 45)[B]	0.377
Minns Lowe, 2012, 22180446, UK	Home-visit physiotherapy	Usual care	High	KOOS: Symptoms (0-100)	3 mo	46	Media (IQR) 67.9 (29)	47	Media (IQR) 71.4 (29)	NR	NR
	Home-visit physiotherapy	Usual care	High	KOOS: Symptoms (0-100)	6 mo	42	Media (IQR) 76.8 (21)	44	Media (IQR) 71.4 (29)	NR	NR
	Home-visit physiotherapy	Usual care	High	KOOS: Symptoms (0-100)	12 mo	44	Media (IQR) 82.1 (18)	48	Media (IQR) 78.8 (31)	NR	NR
Mitchell, 2005, 15869558, UK	Hospital	Home	High	WOMAC: Stiffness (0-100)	4 mo	57	3.6 (2.1)	57	3.5 (1.4)	Adj MD -0.2 (-0.9, 0.4)	0.496
Moffet, 2015, 26178888, Canada	In-home Telerehabilitation	Standard home rehabilitation	Moderate	KOOS: Symptoms (0-100)	4 mo	100	71.9 (NR)	98	74.8 (NR)	-2.6 (-7, 1.8)	NR
	In-home Telerehabilitation	Standard home rehabilitation	Moderate	WOMAC: Stiffness (0-100)	4 mo	100	72.1 (NR)	98	71 (NR)	-0.7 (-5.2, 6.5)	NR

Study, Year, PMID, Country	Arm 1	Arm 2	Overall RoB	Outcome Measurement	Time Point[A]	N Arm 1	Arm 1, Mean (SD)	N Arm 2	Arm 2, Mean (SD)	Effect Size (95% CI)	Reported p-Value
Monticone, 2013, 23063624, Italy	Home-based functional exercises and kinesiophobia training	Usual care	Moderate	KOOS: Symptoms (0-100)	6 mo	55	NR (NR)	55	NR (NR)	**13.1 (8.44, 17.76)**	**NR**
	Home-based functional exercises and kinesiophobia training	Usual care	Moderate	KOOS: Symptoms (0-100)	12 mo	55	NR (NR)	55	NR (NR)	**10.59 (6.0, 15.18)**	**NR**
Petersen, 2018, 29294078, Netherlands	Exercise & acupuncture	Exercise	Moderate	KOOS: Symptoms (0-100)	3 mo	82	N with success (%) 46 (55)	83	N with success (%) 50 (60)	RR 0.92 (0.71, 1.19)	0.53
Schache, 2019, 31208916, Australia	Standard rehabilitation and hip strengthening exercises	Standard rehabilitation plus general functional exercise	Moderate	KOOS: Symptoms (0-100)	6.5 mo	48	82 (13)	48	79 (14)	2 (-4, 9)	NR

Statistically significant effect sizes are in bold text. In cases where calculated effect size confidence intervals were not-statistically significant but reported p-values were, we deferred to reported p-values and still bolded results.

Abbreviations: Adj MD = adjusted mean difference CI = confidence interval, KOOS = Knee injury and osteoarthritis outcome score, mo = month, NR = not reported, PENS = patterned electrical neuromuscular stimulation, PMID = PubMed identifier, RR = relative risk; RoB = risk of bias, SD = standard deviation, WOMAC = Western Ontario and McMaster Universities Osteoarthritis Index.

[A] Time from surgery
[B] Calculated

Table 43. Post-acute rehabilitation versus various controls for total knee arthroplasty – continuous outcomes, pain

Study, Year, PMID, Country	Arm 1	Arm 2	Overall RoB	Outcome Measurement	Time Point[A]	N Arm 1	Arm 1, Mean (SD)	N Arm 2	Arm 2, Mean (SD)	Effect Size (95% CI)	Reported p-Value
Artz, 2017, 27068368, UK	Group-based exercise	Usual care	High	KOOS: Pain (0-100)	3 mo	19	74.1 (19.9)	12	19 (74.1)	55.1 (16.9, 93.3)[B]	NR
	Group-based exercise	Usual care	High	KOOS: Pain (0-100)	6 mo	21	78.6 (25.9)	15	70.9 (27.1)	7.7 (-4.9, 20.3)[B]	NR
	Group-based exercise	Usual care	High	VAS (NR)	3 mo	19	3.5 (3.1)	12	3.6 (2.2)	-0.1 (-1.4, 1.2)[B]	NR
	Group-based exercise	Usual care	High	VAS (NR)	6 mo	21	2.9 (3.4)	15	3.9 (3.6)	-1 (-2.7, 0.7)[B]	NR
Bruun-Olsen, 2013, 23614370, Norway	Walking-skill group	15 individual physiotherapy sessions	Moderate	KOOS: Pain (0-100)	9 mo	29	82 (21)	28	74 (23)	Adj 0 (-9, 10)	NR
	Leg-press group	Physiotherapy group	High	VAS (0-100): During activity[C]	3 mo	26	2.7 (0.45)	29	2.3 (0.41)	0.4 (0.2, 0.6)[B]	0.17

Study, Year, PMID, Country	Arm 1	Arm 2	Overall RoB	Outcome Measurement	Time Point[A]	N Arm 1	Arm 1, Mean (SD)	N Arm 2	Arm 2, Mean (SD)	Effect Size (95% CI)	Reported p-Value
Bily, 2016, 26763947, Austria	Leg-press group	Physiotherapy group	High	VAS (0-100): At rest[D]	3 mo	26	1.3 (0.36)	29	1.1 (0.31)	0.2 (0.1, 0.3)[B]	0.51
Cai, 2018, 29239772, China	Cognitive behavioral therapy & standard care	Standard care	Moderate	VAS (0-10)	6 mo	50	5.63 (0.73)	50	6.27 (0.86)	NMD -0.57 (-0.9, -0.2)[B]	0.080
	Cognitive behavioral therapy & standard care	Standard care	Moderate	Pain catastrophizing scale (0-52)	6 mo	50	23.34 (3.82)	50	30.40 (4.34)	**NMD -7.7 (-9.3, -6.1)[B]**	**<.001**
DeJong, 2020, 32360105 USA	Body Weight-Adjustable Treadmill & PENS	Recumbent Bike & PENS	High	KOOS: Pain (0-100)	6 mo	70	86.7 (18.4)	78	83.8 (18.5)	-2.9 (-7.1, 1.3)	NR
	Body Weight-Adjustable Treadmill & PENS	Body Weight-Adjustable Treadmill	High	KOOS: Pain (0-100)	6 mo	70	86.7 (18.4)	76	87.6 (18.6)	0.9 (-3.3, 5.1)	NR
	Body Weight-Adjustable Treadmill & PENS	Recumbent Bike/Usual Care	High	KOOS: Pain (0-100)	6 mo	70	86.7 (18.4)	74	89.9 (18.6)	3.2 (-1.0, 7.4)	NR
Demircioglu, 2015, 26355656, Turkey	NMES & exercise	Exercise	High	WOMAC: Pain (0-20)	3 mo	30	42.8 (16.8)	30	48.5 (14.2)	**-5.7 (-11.3, -0.1)[B]**	NR
	NMES & exercise	Exercise	High	VAS (0-10)	3 mo	30	8.4 (0.6)	30	3.5 (0.6)	**4.9 (4.7, 5.1)[B]**	**NR**
Fransen, 2017, 27868384, Australia	Outpatient exercise group	Usual care	Moderate	WOMAC: Pain (0-20)	12 mo	179	2.6 (0.2)	169	2.5 (0.2)	-0.1 (-0.7, 0.5)	0.71
Heikkilä, 2017, 28119232, Finland	Home exercise	Control	High	VAS (0-100)[E]	2 mo	53	22 (20)	55	27 (22)	-5 (-10.6, 0.6)[B]	NR
	Home exercise	Control	High	VAS (0-100)[E]	14 mo	50	12 (21)	52	15 (20)	-3 (-8.6, 2.6)[B]	NR
Lenguerrand, 2020, 31033232, UK	Physical therapy and standard care	Standard care	Moderate	KOOS: Pain (0-100)	12 mo	66	83 (20)	57	81 (21)	2 (-3.2, 7.2)[B]	0.111
Li, 2015, CN-01084888, China	Education	No education	High	VAS (NR)	3 mo	25	NR	25	NR	No difference	NR
	Education	No education	High	VAS (NR)	6 mo	25	NR	25	NR	No difference	NR
Li, 2019, 31003647, China	Tai chi exercise	Control	Moderate	WOMAC: Pain (0-20)	3 mo	54	9.1 (2)	53	9.3 (1.9)	-0.2 (-0.7, 0.3)[B]	0.07
Liao, 2015, 25552523, Taiwan	Functional plus balance rehabilitation	Functional rehabilitation	High	WOMAC: Pain (0-20)	32 w	65	1.9 (1.2)	65	1.6 (1.0)	0.3 (0.03, 0.6)[B]	NR

Study, Year, PMID, Country	Arm 1	Arm 2	Overall RoB	Outcome Measurement	Time Point[A]	N Arm 1	Arm 1, Mean (SD)	N Arm 2	Arm 2, Mean (SD)	Effect Size (95% CI)	Reported p-Value
Liao, 2020, 31687984, Taiwan	Elastic resistance exercise training	Standard care	Moderate	WOMAC: Pain (0-20)	4 mo	30	2.97 (1.59)	30	4.48 (1.39)	**-1.5 (-2, -1)[B]**	**0.001**
Minns Lowe, 2012, 22180446, UK	Home-visit physiotherapy	Usual care	High	KOOS: Pain (0-100)	3 mo	46	Median (IQR) 69.1 (28)	47	Median (IQR) 72.2 (29)	NR	NR
	Home-visit physiotherapy	Usual care	High	KOOS: Pain (0-100)	6 mo	42	Median (IQR) 75 (25)	43	Median (IQR) 75 (31)	NR	NR
	Home-visit physiotherapy	Usual care	High	KOOS: Pain (0-100)	12 mo	44	Median (IQR) 80.6 (36)	48	Median (IQR) 90.3 (33)	NR	NR
Mitchell, 2005, 15869558, UK	Hospital	Home	High	SF-36: Bodily pain (0-100)	4 mo	57	48.5 (26.8)	57	46.6 (20.6)	Adj MD -3.4 (-12.0, 5.2)	0.432
	Hospital	Home	High	WOMAC: Pain (0-20)	4 mo	57	6.9 (4.3)	57	6.8 (3.7)	Adj MD -0.5 (-2.0, 1.0)	0.53
Moffet, 2015, 26178888, Canada	In-home Telerehabilitation	Standard home rehabilitation	Moderate	KOOS: Pain (0-100)	4 mo	100	78.1 (NR)	98	80.1 (NR)	-1.8 (-6.2, 2.5)	NR
	In-home Telerehabilitation	Standard home rehabilitation	Moderate	WOMAC: Pain (0-20)	4 mo	100	82.8 (NR)	98	84 (NR)	-0.7 (-4.8, 3.4)	NR
Monticone, 2013, 23063624, Italy	Home-based functional exercises and kinesiophobia training	Usual care	Moderate	KOOS: Pain (0-100)	6 mo	55	NR	55	NR	**10.34 (4.34, 16.35)**	**NR**
	Home-based functional exercises and kinesiophobia training	Usual care	Moderate	KOOS: Pain (0-100)	12 mo	55	NR	55	NR	**9.56 (4.58, 14.54)**	**NR**
	Home-based functional exercises and kinesiophobia training	Usual care	Moderate	VAS (0-10)	6 mo	55	NR	55	NR	**-1.5 (-2, -1)**	**NR**
	Home-based functional exercises and kinesiophobia training	Usual care	Moderate	VAS (0-10)	12 mo	55	NR	55	NR	**-1.0 (-1.6, -0.5)**	**NR**
Moutzouri, 2018, 29473481, Greece	Early self-managed focal sensorimotor exercise training	Functional exercise training	Moderate	VAS (0-10)	3.5 mo	25	0.7 (0.7)	26	2.4 (0.8)	**-1.7 (-2, -1.4)[B]**	**NR**
Petersen, 2018, 29294078, Netherlands	Exercise & acupuncture	Exercise	High	KOOS: Pain (0-100)	3 mo	82	N with success (%) 56 (67)	83	N with success (%) 60 (73)	RR 0.73 (1.09, 0.89)	0.259

Study, Year, PMID, Country	Arm 1	Arm 2	Overall RoB	Outcome Measurement	Time Point[A]	N Arm 1	Arm 1, Mean (SD)	N Arm 2	Arm 2, Mean (SD)	Effect Size (95% CI)	Reported p-Value
Petterson, 2009, 19177542, USA	Exercise & NMES group	Exercise	High	KOS: Pain (0-5)[F]	3 mo	92	1.08 (NR)	78	1.11 (NR)	NR	NR
	Exercise & NMES group	Exercise	High	KOS: Pain (0-5)	12 mo	61	0.89 (NR)	68	0.82 (NR)	NR	NR
Schache, 2019, 31208916, Australia	Standard rehabilitation and hip strengthening exercises	Standard rehabilitation plus general functional exercise	Moderate	KOOS: Pain (0-100)	6.5 mo	48	87 (11)	48	71 (15)	1 (-5, 8)	NR
	Standard rehabilitation and hip strengthening exercises	Standard rehabilitation plus general functional exercise	Moderate	KOOS: Pain (0-100)	6.5 mo	48	73 (19)	48	70 (21)	3 (-6, 13)	NR
	Standard rehabilitation and hip strengthening exercises	Standard rehabilitation plus general functional exercise	Moderate	VAS (0-10)	6.5 mo	48	0 (1)	48	1 (0)	0 (-1, 1)	NR
Vuorenmaa, 2014, 24241606, Finland	Home exercise	Control	Moderate	WOMAC: Pain (0-20)	12 mo	53	38 (NR)	55	37 (NR)	NR	NR

Statistically significant effect sizes are in bold text. In cases where calculated effect size confidence intervals were not-statistically significant but reported p-values were, we deferred to reported p-values and still bolded results.

Abbreviations: Adj MD = adjusted mean difference, CI = confidence interval, EQ-5D = EuroQuol, KOS = Knee Outcome Survey, KOOS = Knee injury and osteoarthritis outcome score, min = minute, mo = month, NMES = neuromuscular electrical stimulation, NR = not reported, PENS = patterned electrical neuromuscular stimulation, PMID = PubMed identifier, RR = relative risk, RoB = risk of bias, SD = standard deviation, SF-36 = 36-item short form survey, WOMAC = Western Ontario and McMaster Universities Osteoarthritis Index, VAS = visual analogue scale, w = weeks.

[A] Time from surgery
[B] Calculated
[C] During last 48 hours
[D] Before the functional activity
[E] Knee pain during loading
[F] Measured with question from the Knee Outcome Survey (designed for Activities of Daily Living) on pain "How does pain affect the function of your knee during daily activities?" Scores ranged from 0 (pain prevents me from all activities) to 5 (pain has no effect on daily activities).

Table 44. Post-acute rehabilitation versus various controls for total knee arthroplasty – continuous outcomes, range of motion

Study, Year, PMID, Country	Arm 1	Arm 2	Overall RoB	Outcome Measurement	Time Point[A]	N Arm 1	Arm 1, Mean (SD)	N Arm 2	Arm 2, Mean (SD)	Effect Size (95% CI)	Reported p-Value
Andersen, 2018, CN-01647420, Denmark	Technological assisted rehabilitation	Supervised rehabilitation	High	Active knee ROM: Extension and flexion (deg)	6 mo	NR	NR (NR)	NR	NR (NR)	<10% MD	NR
	Technological assisted rehabilitation	Supervised rehabilitation	High	Active knee ROM: Extension and flexion(deg)	12 mo	NR	NR (NR)	NR	NR (NR)	<10% MD	NR
Bade, 2017, 27813347, USA	High-intensity progressive rehabilitation	Low-intensity rehabilitation	Moderate	Active knee ROM: Extension (deg)	3 mo	77	-0.09 (2.97)	76	0.06 (2.37)	-0.2 (-0.8, 0.5)[B]	NR
	High-intensity progressive rehabilitation	Low-intensity rehabilitation	Moderate	Active knee ROM: Extension (deg)	6 mo	71	-1.38 (1.66)	71	-0.90 (2.62)	-0.5 (-1.0, 0.1)[B]	NR
	High-intensity progressive rehabilitation	Low-intensity rehabilitation	Moderate	Active knee ROM: Extension (deg)	12 mo	71	-2.18 (2.43)	67	-1.76 (2.28)	-0.4 (-1, 0.1)[B]	NR
	High-intensity progressive rehabilitation	Low-intensity rehabilitation	Moderate	Active knee ROM: Flexion (deg)	3 mo	77	123.79 (9.1)	76	123.71 (8.97)	0.1 (-1.9, 2.1)[B]	NR
	High-intensity progressive rehabilitation	Low-intensity rehabilitation	Moderate	Active knee ROM: Flexion (deg)	6 mo	71	127.10 (6.57)	71	127.45 (7.88)	-0.4 (-2.1, 1.4)[B]	NR
	High-intensity progressive rehabilitation	Low-intensity rehabilitation	Moderate	Active knee ROM: Flexion (deg)	12 mo	71	129.28 (8.89)	67	128.27 (8.61)	1 (-1.1, 3.1)[B]	NR
Bily, 2016, 26763947, Austria	Leg-press group	Physiotherapy group	High	Active knee ROM: Extension and flexion (deg)	3 mo	26	114.1 (2.36)	29	111.2 (1.58)	NR	0.09
	Leg-press group	Physiotherapy group	High	Passive knee ROM: Extension and flexion(deg)	3 mo	26	116.2 (2.46)	29	112.8 (1.51)	3.4 (2.6, 4.2)[B]	0.30
Bruun-Olsen, 2013, 23614370, Norway	Walking-skill group	Usual physiotherapy	Moderate	Active knee ROM: Extension and flexion: (deg)	9 mo	29	118 (7)	28	114 (17)	adj 1(-4, 7)	NR
Demircioglu, 2015, 26355656, Turkey	NMES & exercise	Exercise	High	Passive knee ROM: Extension (deg)	3 mo	30	-0.3 (1.3)	30	-0.5 (1.5)	0.2 (-0.3, 0.7)[B]	NR
	NMES & exercise	Exercise	High	Passive knee ROM: Flexion (deg)	3 mo	30	113.2 (7.7)	30	110.5 (7.9)	2.7 (-0.1, 5.5)[B]	NR
Fransen, 2017, 27868384, Australia	Outpatient exercise group	Usual care	Moderate	Active knee ROM: Extension (deg)	12 mo	112	-1.6 (0.4)	98	Mean (SE) -2.7 (0.4)	NR	NR
	Outpatient exercise group	Usual care	Moderate	Active knee ROM: Flexion (deg)	12 mo	112	109.2 (0.9)	98	Mean (SE) 109.6 (1)	NR	NR

Study, Year, PMID, Country	Arm 1	Arm 2	Overall RoB	Outcome Measurement	Time Point[A]	N Arm 1	Arm 1, Mean (SD)	N Arm 2	Arm 2, Mean (SD)	Effect Size (95% CI)	Reported p-Value
Kauppila, 2010, 20354057, Finland	Multidisciplinary rehabilitation group	Control	Moderate	Active knee ROM: Flexion (deg)	6 mo	36	Lower limit mean (SD); upper limit mean(SD) (6 , 36 , 3)	38	Lower limit mean(SD); upper limit mean(SD) (6 , 36 , 3)	NR	NR
	Multidisciplinary rehabilitation group	Control	Moderate	Active knee ROM: Flexion (deg)	12 mo	36	Lower limit mean(SD); upper limit mean(SD) (5, 45, 4)	38	Lower limit mean (SD); upper limit mean (SD) (4, 44, 4)	NR	NR
Li, 2019, 31003647, China	Tai chi	Control	Moderate	Knee ROM (active/passive unspecified): Extension (deg)	3 mo	54	1.5 (0.3)	53	1.9 (0.2)	**-0.4 (-0.5, -0.3)[B]**	**0.59**
	Tai chi	Control	Moderate	Knee ROM (active/passive unspecified): Flexion (deg)	3 mo	54	112.1 (14.8)	53	110 (12.9)	2.1 (-1.6, 5.8)[B]	0.62
Madsen, 2013, 23651717, Denmark	Group-based rehabilitation	Supervised home-exercises	High	Active Knee ROM: Flexion and extension (deg)	3 mo	36	NR (NR)	34	NR (NR)	NR	0.9
	Group-based rehabilitation	Supervised home-exercises	High	Knee ROM flexion and extension (deg)	6 mo	36	NR (NR)	32	NR (NR)	NR	0.5
Moffet, 2015, 26178888, Canada	In-home Telerehabilitation	Standard home rehabilitation	Moderate	Knee ROM (active/passive unspecified): Extension (deg)	4 mo	100	-3.4 (NR)	98	-3.6 (NR)	0.01 (-1, 1)	NR
	In-home Telerehabilitation	Standard home rehabilitation	Moderate	Knee ROM (active/passive unspecified): Flexion (deg)	4 mo	100	112.4 (NR)	98	111.5 (NR)	1.1 (-2.1, 4.3)	NR
Moutzouri, 2018, 29473481, Greece	Early self-managed focal sensorimotor exercise training	Functional exercise training	Moderate	Active knee ROM extension: (deg)	3.5 mo	25	0.2 (1.1)	26	-1.6 (0.9)	1.8 (1.4, 2.2)[B]	ns
	Early self-managed focal sensorimotor exercise training	Functional exercise training	Moderate	Active knee ROM flexion: (deg)	3.5 mo	25	107.3 (6.9)	26	103.7 (6.9)	**3.6 (0.9, 6.3)[B]**	< 0.005
Petterson, 2009, 19177542, USA	Exercise & NMES group	Exercise	High	Active knee ROM: Extension (deg)	3 mo	92	1.8 (NR)	78	2.0 (NR)	NR	NR
	Exercise & NMES group	Exercise	High	Active knee ROM: Extension (deg)	12 mo	61	0.4 (NR)	68	0.3 (NR)	NR	NR
	Exercise & NMES group	Exercise	High	Active knee ROM: Flexion (deg)	3 mo	92	114.7 (NR)	78	115.2 (NR)	NR	NR
	Exercise & NMES group	Exercise	High	Active knee ROM: Flexion (deg)	12 mo	61	119 (NR)	68	120.9 (NR)	NR	NR

Study, Year, PMID, Country	Arm 1	Arm 2	Overall RoB	Outcome Measurement	Time Point[A]	N Arm 1	Arm 1, Mean (SD)	N Arm 2	Arm 2, Mean (SD)	Effect Size (95% CI)	Reported p-Value
Schache, 2019, 31208916, Australia	Standard rehabilitation and hip strengthening exercises	Standard rehabilitation plus general functional exercise	Moderate	Knee ROM extension (deg)	6.5 mo	48	0 (1)	48	0 (2)	-1 (-3, 2)	NR
	Standard rehabilitation and hip strengthening exercises	Standard rehabilitation plus general functional exercise	Moderate	Knee ROM flexion (deg)	6.5 mo	48	121 (6)	48	118 (9)	1 (-4, 6)	NR
Tousignant, 2011, 21398389, Canada	Telerehabilitation	Home care/outpatient clinic	Moderate	Knee ROM (active/passive unspecified): Extension (deg)	4 mo	21	-2.1 (NR)	20	-1.8 (NR)	NR	NR
	Telerehabilitation	Home care/outpatient clinic	Moderate	Knee ROM (active/passive unspecified): Flexion (deg)	4 mo	21	115.2 (NR)	20	109.7 (NR)	NR	NR
Vuorenmaa, 2014, 24241606, Finland	Home exercise	Control	Moderate	Active knee ROM: Extension deficit (deg)	12 mo	53	14.9 (NR)	55	14.3 (NR)	NR	NR
	Home exercise	Control	Moderate	Passive knee ROM Extension deficit (deg)	12 mo	53	8.7 (NR)	55	7.8 (NR)	NR	NR
	Home exercise	Control	Moderate	Active knee ROM: Flexion (deg)	12 mo	53	113.4 (NR)	55	114.8 (NR)	NR	0.98
	Home exercise	Control	Moderate	Passive knee ROM: Flexion (deg)	12 mo	53	117.2 (NR)	55	116.9 (NR)	NR	0.86

Statistically significant effect sizes are in bold text. In cases where calculated effect size confidence intervals were not-statistically significant but reported p-values were, we deferred to reported p-values and still bolded results.

Abbreviations: Adj MD = adjusted mean difference, CI = confidence interval, deg = deg, mo = month, ns = not significant, NR = not reported, PMID = PubMed identifier, RoB = risk of bias, ROM = range of motion, SD = standard deviation.

[A] Time from surgery
[B] Calculated

Table 45. Post-acute rehabilitation versus various controls for total knee arthroplasty – continuous outcomes, muscle strength and function

Study, Year, PMID, Country	Arm 1	Arm 2	Overall RoB	Outcome Measurement	Time Point[A]	N Arm 1	Arm 1, Mean (SD)	N Arm 2	Arm 2, Mean (SD)	Effect Size (95% CI)	Reported p-Value
Bade, 2017, 27813347, USA	High-intensity progressive rehabilitation	Low-intensity rehabilitation	Moderate	Strength: Isometric peak contraction of the hamstring (Nm/kg)	3 mo	77	0.76 (0.28)	76	0.74 (0.26)	0.02 (-0.04, 0.1)[B]	NR
	High-intensity progressive rehabilitation	Low-intensity rehabilitation	Moderate	Strength: Isometric peak contraction of the hamstring (Nm/kg)	6 mo	71	0.8 (0.29)	71	0.8 (0.27)	0 (-0.1, 0.1)[B]	NR
	High-intensity progressive rehabilitation	Low-intensity rehabilitation	Moderate	Strength: Isometric peak contraction of the hamstring (Nm/kg)	12 mo	70	0.84 (0.31)	67	0.85 (0.29)	-0.01 (-0.1, 0.1)[B]	NR
	High-intensity progressive rehabilitation	Low-intensity rehabilitation	Moderate	Strength: Isometric peak contraction of the quadricep (Nm/kg)	3 mo	77	1.21 (0.42)	76	1.15 (0.4)	0.03 (-0.1, 0.2)[B]	NR
	High-intensity progressive rehabilitation	Low-intensity rehabilitation	Moderate	Strength: Isometric peak contraction of the quadricep (Nm/kg)	6 mo	71	1.35 (0.46)	71	1.35 (0.4)	0 (-0.1, 0.1)[B]	NR
	High-intensity progressive rehabilitation	Low-intensity rehabilitation	Moderate	Strength: Isometric peak contraction of the quadricep (Nm/kg)	12 mo	70	1.42 (0.47)	67	1.43 (0.44)	-0.01 (-0.1, 0.1)[B]	NR
	High-intensity progressive rehabilitation	Low-intensity rehabilitation	Moderate	Quadriceps activation (%)	3 mo	67	82.77 (10.78)	63	79.94 (13.78)	2.8 (-0.2, 5.9)[B]	NR
	High-intensity progressive rehabilitation	Low-intensity rehabilitation	Moderate	Quadriceps activation (%)	6 mo	61	80.87 (12.01)	62	82.92 (9.55)	-2.1 (-4.8, 0.7)[B]	NR
	High-intensity progressive rehabilitation	Low-intensity rehabilitation	Moderate	Quadriceps activation (%)	12 mo	62	83.39 (11.73)	59	83.73 (10.12)	-0.3 (-3.1, 2.4)[B]	NR
Bily, 2016, 26763947, Austria	Leg-press group	Physiotherapy group	High	Strength: Isometric peak knee extension (Nm/kg)	3 mo	26	1.0 (0.09)	29	0.9 (0.06)	NR	0.16
	Leg-press group	Physiotherapy group	High	Strength: Leg press (N/kg)	3 mo	26	10.3 (1.06)	29	9.1 (0.7)	NR	0.19
Bruun-Olsen, 2013, 23614370, Norway	Walking-skill group	27 individual physiotherapy sessions	Moderate	Strength/function: Index of muscle function[C]	9 mo	29	11 (7)	28	12 (7)	Adj MD -1 (-3, 2)	NR
Fransen, 2017, 27868384, Australia	Outpatient exercise group	Usual care	Moderate	Strength: Isometric knee extension (Nm)	12 mo	112	77.2 (3.3)	98	Mean (SE) 74.6 (3.4)	NR	NR
	Outpatient exercise group	Usual care	Moderate	Strength: Isometric knee flexion (Nm)	12 mo	112	42.8 (2.3)	98	Mean (SE) 44.3 (2.5)	NR	NR
Heikkilä, 2017, 28119232, Finland	Home exercise	Control	High	Strength: Isometric knee extension (N)	14 mo	53	350 (130)	55	280 (150)	**70 (32.5, 107.5)[B]**	**NR**
	Home exercise	Control	High	Strength: Isometric knee flexion (N)	14 mo	53	150 (50)	55	120 (50)	**30 (16.7, 43.3)[B]**	**NR**

Study, Year, PMID, Country	Arm 1	Arm 2	Overall RoB	Outcome Measurement	Time Point[A]	N Arm 1	Arm 1, Mean (SD)	N Arm 2	Arm 2, Mean (SD)	Effect Size (95% CI)	Reported p-Value
Kauppila, 2010, 20354057, Finland	Multidisciplinary rehabilitation group	Control	Moderate	Strength: Peak torque extension (Nm)[D]	6 mo	29	88.8 (25)	33	93.8 (30.4)	-5 (-14.8, 4.8)[B]	NR
	Multidisciplinary rehabilitation group	Control	Moderate	Strength: Peak torque extension (Nm)[D]	12 mo	29	98 (28.1)	32	99.2 (39.1)	-1.2 (-13.4, 11)[B]	NR
	Multidisciplinary rehabilitation group	Control	Moderate	Strength: Relative peak torque extension (Nm/kg)	6 mo	28	1.15 (0.44)	29	1.14 (0.39)	0.01 (-0.1, 0.2)[B]	NR
	Multidisciplinary rehabilitation group	Control	Moderate	Strength: Relative peak torque extension (Nm/kg)	12 mo	29	1.23 (0.43)	32	1.21 (0.49)	0.02 (-0.1, 0.2)[B]	NR
	Multidisciplinary rehabilitation group	Control	Moderate	Strength: Relative peak torque flexion (Nm/kg)	6 mo	28	0.80 (0.27)	29	0.83 (0.24)	-0.03 (-0.1, 0.1)[B]	NR
	Multidisciplinary rehabilitation group	Control	Moderate	Strength: Relative peak torque flexion (Nm/kg)	12 mo	29	0.85 (0.3)	32	0.78 (0.21)	0.1 (-0.03, 0.2)[B]	NR
	Multidisciplinary rehabilitation group	Control	Moderate	Strength: Hamstring/ quadricep ratio (proportion)	6 mo	29	0.74 (0.24)	33	0.77 (0.22)	-0.03 (-0.1, 0.1)[B]	NR
	Multidisciplinary rehabilitation group	Control	Moderate	Strength: Hamstring/ quadricep ratio (proportion)	12 mo	29	0.70 (0.18)	31	0.79 (0.71)	-0.1 (-0.3, 0.1)[B]	NR
Madsen, 2013, 23651717, Denmark	Group-based rehabilitation	Supervised home-exercises	High	Strength: Asymmetry leg extensor power (W/kg)[E]	3 mo	36	NR (NR)	34	NR (NR)	NR	0.1
	Group-based rehabilitation	Supervised home-exercises	High	Strength: Asymmetry leg extensor power (W/kg)[E]	6 mo	36	NR (NR)	32	NR (NR)	NR	0.5
	Group-based rehabilitation	Supervised home-exercises	High	Strength: Peak force (W/kg)	3 mo	36	NR (NR)	34	NR (NR)	NR	0.2
	Group-based rehabilitation	Supervised home-exercises	High	Strength: Peak force (W/kg)	6 mo	36	NR (NR)	32	NR (NR)	NR	0.1
Minns Lowe, 2012, 22180446, UK	Home-visit physiotherapy	Usual care	High	Strength: Leg extension power (W/kg)	3 mo	42	Median 0.7 (NR)	39	Median 0.72 (NR)	NR	NR
	Home-visit physiotherapy	Usual care	High	Strength: Leg extension power (W/kg)	12 mo	38	Median 0.87 (NR)	42	Median 0.87 (NR)	NR	NR
Moffet, 2015, 26178888, Canada	In-home Telerehabilitation	Standard home rehabilitation	Moderate	Strength: Isokinetic knee extension at 30 deg flexion (Nm)	4 mo	100	74.6 (NR)	98	76.4 (NR)	0.4 (-9.7, 10.4)	NR
	In-home Telerehabilitation	Standard home rehabilitation	Moderate	Strength: Isokinetic knee extension at 60 deg flexion (Nm)	4 mo	100	105.4 (NR)	98	105.7 (NR)	-1.1 (-7.9, 5.7)	NR

Study, Year, PMID, Country	Arm 1	Arm 2	Overall RoB	Outcome Measurement	Time Point[A]	N Arm 1	Arm 1, Mean (SD)	N Arm 2	Arm 2, Mean (SD)	Effect Size (95% CI)	Reported p-Value
	In-home Telerehabilitation	Standard home rehabilitation	Moderate	Strength: Isokinetic knee flexion at 30 deg flexion (Nm)	4 mo	100	74.6 (NR)	98	76.4 (NR)	-1.1 (-7.9, 5.7)	NR
	In-home Telerehabilitation	Standard home rehabilitation	Moderate	Strength: Isokinetic knee flexion at 60 deg flexion (Nm)	4 mo	100	105.4 (NR)	98	105.7 (NR)	0.4 (-9.7, 10.4)	NR
Moutzouri, 2018, 29473481, Greece	Early self-managed focal sensorimotor exercise training	Functional exercise training	Moderate	Strength: Peak force (N)	3.5 mo[F]	25	67.5 (17.4)	26	55.4 (23.5)	**12.1 (3.9, 20.2)[B]**	**NR**
Petterson, 2009, 19177542, USA	Exercise & NMES group	Exercise	High	Normalized maximum voluntary isometric contraction (N/kg/m^2)	3 mo	92	17.35 (NR)	78	19.05 (NR)	NR	NR
	Exercise & NMES group	Exercise	High	Normalized maximum voluntary isometric contraction (N/kg/m^2)	12 mo	61	20.60 (NR)	68	22.64 (NR)	NR	NR
Schache, 2019, 31208916, Australia	Standard rehabilitation and hip strengthening exercises	Standard rehabilitation plus general functional exercise	Moderate	Strength: Quadricep (N/kg/m^2)[G]	6 mo	48	4.0 (1.6)	48	4.1 (1.7)	0.0 (-0.5, 0.5)	NR
	Standard rehabilitation and hip strengthening exercises	Standard rehabilitation plus general functional exercise	Moderate	Strength: Quadricep (N/kg/m^2)	6 mo	48	6.6 (3.0)	48	6.9 (3.4)	-0.4 (-1.6, 0.8)	NR
Shanb, 2014, CN-01041112, Saudi Arabia	Active exercise training program & biofeedback	Active exercise training program	High	Central activation ratio[H] (0-1)	4 mo	21	0.89 (0.04)	24	0.93 (0.03)	-0.04 (-0.1, -0.03)[B]	0.97
	Active exercise training program & biofeedback	Active exercise training program	High	Strength: Quadriceps isometric peak torque	4 mo	21	2.31 (0.66)	24	2.3 (0.32)	**0.01 (-0.2, 0.3)[B]**	**0.01**
Vuorenmaa, 2014, 24241606, Finland	Home exercise	Control	Moderate	Strength: Isometric knee extension (Kg)	12 mo	53	33.3 (NR)	55	27.9 (NR)	NR	0.50
	Home exercise	Control	Moderate	Strength: Isometric knee flexion (Kg)	12 mo	53	14.7 (NR)	55	12.5 (NR)	**NR**	**0.009**

Statistically significant effect sizes are in bold text. In cases where calculated effect size confidence intervals were not-statistically significant but reported p-values were, we deferred to reported p-values and still bolded results.

Abbreviations: Adj MD = adjusted mean difference, CI = confidence interval, N = Newton, Nm = Newton meters, NR = not reported, PMID = PubMed identifier, RoB = risk of bias, SD = standard deviation, SE = standard error.

[A] Time from surgery
[B] Calculated
[C] Functional test comprising of 13 items evaluating muscle strength, balance and endurance in lying, sitting and standing positions, sum score is 40, best is 0

[D] Measured with the Lido Active Multijoint Rehabilitation System
[E] Measured using the Nottingham Leg Extensor Power Rig
[F] Defined as 14 weeks
[G] Normalized to body mass index
[H] Larger is better; central activation ratio of 1.0 indicates complete activation of the muscle with no increase of the maximal voluntary force being detected during the electrical stimulation

Table 46. Post-acute rehabilitation versus various controls for total knee arthroplasty – continuous outcomes, energy and vigor

Study, Year, PMID, Country	Arm 1	Arm 2	Overall RoB	Outcome Measurement	Time Point[A]	N Arm 1	Arm 1, Mean (SD)	N Arm 2	Arm 2, Mean (SD)	Effect Size (95% CI)	Reported p-Value
Mitchell, 2005, 15869558, UK	Home	Hospital	High	SF-36: Vitality (0-100)	3 mo	57	50.7 (19.5)	57	48.2 (23.7)	3.4 (-3.5, 10.3)	0.33

Statistically significant effect sizes are in bold text. In cases where calculated effect size confidence intervals were not-statistically significant but reported p-values were, we deferred to reported p-values and still bolded results.

Abbreviations: CI = confidence interval, mo = month, NR = not reported, PMID = PubMed identifier, RoB = risk of bias, SF-36 = 36-Item short form survey, SD = standard deviation.

[A] Time from surgery

Table 47. Post-acute rehabilitation versus various controls for total knee arthroplasty – continuous outcomes, emotional functioning

Study, Year, PMID, Country	Arm 1	Arm 2	Overall RoB	Outcome Measurement	Time Point[A]	N Arm 1	Arm 1, Mean (SD)	N Arm 2	Arm 2, Mean (SD)	Effect Size (95% CI)	Reported p-Value
Bade, 2017, 27813347, USA	High-intensity progressive rehabilitation	Low-intensity rehabilitation	Moderate	SF 12: Mental health (0-100)	3 mo	75	56.73 (7.29)	75	57.05 (6.86)	-0.3 (-1.9, 1.3)[B]	>0.05
	High-intensity progressive rehabilitation	Low-intensity rehabilitation	Moderate	SF 12: Mental health (0-100)	6 mo	71	55.76 (7.26)	68	56.64 (6.20)	-0.9 (-2.5, 0.7)[B]	>0.05
	High-intensity progressive rehabilitation	Low-intensity rehabilitation	Moderate	SF 12: Mental health (0-100)	12 mo	67	55.76 (6.48)	61	57.83 (3.58)	-2.1 (-3.4, -0.7)[B]	>0.05
Demircioglu, 2015, 26355656, Turkey	NMES & exercise	Exercise	High	SF-36: Mental health (0-100)	3 mo	30	65.1 (12.1)	30	60.9 (15.8)	4.2 (-0.9, 9.3)[B]	NR
Fransen, 2017, 27868384, Australia	Outpatient exercise group	Usual care	Moderate	SF-36: Mental health (0-100)	12 mo	179	54.3 (0.7)	169	Mean 53.1	NR	NR
Li, 2019, 31003647, China	Tai chi chuan exercise	Control	Moderate	SF-36: Mental health (0-100)	3 mo[C]	54	58.5 (1.5)	53	54.1 (1.7)	**4.4 (4.0, 4.8)[B]**	**0.03**
Mitchell, 2005, 15869558, UK	Hospital	Home	High	SF-36: Emotional role functioning (0-100)	3 mo	57	45.6 (44.8)	57	48.0 (46.7)	Adj MD 4.1 (-10.9, 19.0)	0.592

Study, Year, PMID, Country	Arm 1	Arm 2	Overall RoB	Outcome Measurement	Time Point[A]	N Arm 1	Arm 1, Mean (SD)	N Arm 2	Arm 2, Mean (SD)	Effect Size (95% CI)	Reported p-Value
	Hospital	Home	High	SF-36: Social functioning (0-100)	3 mo	57	60.8 (33.1)	57	64.1 (26.6)	Adj MD 6.7 (-3.4, 16.7)	0.193
	Hospital	Home	High	SF-36: Mental health (0-100)	3 mo	57	71.2 (20.0)	57	68.0 (20.4)	Adj MD -2.9 (-9.3, 3.5)	0.368
Petterson, 2009, 19177542, USA	Exercise & NMES group	Exercise	High	SF-36: Mental health (0-100)	3 mo	92	56.77 (NR)	78	57.17 (NR)	NR	NR
	Exercise & NMES group	Exercise	High	SF-36: Mental health (0-100)	12 mo	61	57.16 (NR)	68	56.63 (NR)	NR	NR
Schache, 2019, 31208916, Australia	Standard rehabilitation & hip strengthening exercises	Standard rehabilitation & general functional exercise	Moderate	SF-36: Mental health (0-100)	6.5 mo	48	57 (6)	48	55 (8)	1 (-4, 5)	NR
Vuorenmaa, 2014, 24241606, Finland	Home exercise	Control	Moderate	SF-36: Mental health (0-100)	12 mo	53	47 (NR)	55	48 (NR)	NR	NR

Statistically significant effect sizes are in bold text. In cases where calculated effect size confidence intervals were not-statistically significant but reported p-values were, we deferred to reported p-values and still bolded results.

Abbreviations: CI = confidence interval, NR = not reported, PMID = PubMed identifier, RoB = risk of bias, SF-12 = 12-item short form survey, SF-36 = 36-item short form survey, SD = standard deviation.

[A] Time from surgery
[B] Calculated
[C] Defined as 14 weeks

Activity and Participation Outcomes Following Post-Acute Rehabilitation

We found 27 studies in total reported on activity and participation outcomes following post-acute rehabilitation compared with various comparators: 17 studies (Artz 2017, Bade 2017, Bruun-Olsen 2013, Cai 2018, Fransen 2017, Heikkilä 2017, Kauppila 2010, Lenguerrand 2020, Li 2015, Liao 2015, Liao 220, Madsen 2013, Minns Lowe 2012, Monticone 2013, Moutzouri 2018, Schache 2019, Vuorenmaa 2014) compared novel rehabilitation programs to various comparators (less intensive rehabilitation or no care); one study (Bily 2016) compared different (hypothesized equivalent) rehabilitation programs, no studies compared rehabilitation programs with different timing/intensities; four studies (Andersen 2018, Mitchell 2005, Moffet 2015, Tousignant 2011) compared rehabilitation programs delivered in different settings or by different personnel, and four studies (DeJong 2020, Demircioglu 2015, Petterson 2009, Peterson 2018, Li 2019) compared rehabilitation programs with or without an adjunctive modality (Tables 48 to 52). Outcomes included: physical function and activities of daily living, transfers, balance, mobility, and timed up and go.

Physical Function and Activities of Daily Living

We found 22 studies (Artz 2017, Fransen 2017, Lenguerrand 2020, Liao 2015, Liao 2020, Madsen 2013, Minns Lowe 2012, Monticone 2013, Moutzouri 2018, Piva 2017, Schache 2019, Vuorenmaa 2014, Pua 2017, Hamilton 2020, Mitchell 2005, Moffet 2015, Piva 2019, DeJong 2020, Demircioglu 2015, Li 2019, Petersen 2018, Petterson 2009) that reported data on patient-reported physical function and ADLs using various outcome measures (Table 48) at follow-up times between 3 and 12 months after TKA surgery.

Fifteen studies reported no difference in patient-reported function and ADL measures between groups. Seven studies (Artz 2017, Liao 2015, Liao 2020, Minns Lowe 2012, Moutzouri 2018, Hamilton 2020, Li 2019) found significant differences between groups, though the direction of effect was not consistent whether the intervention favored more or less intensive forms of rehabilitation.

Artz 2018 reported function and ADL data using five scales (UCLA Activity Scale, ADL component of the KOOS, Sports and recreation component of the KOOS, the Lower Extremity Functional Scale [LEFS], and the Activities-specific balance confidence scale) and observed no differences between groups on all scales at 3 and 6 months after TKA with the exception of the LEFS (0-80, higher is better, minimal clinically important difference [MCID] 9). Based on the LEFS scale, the Artz 2017 feasibility study reported patients randomized to group-exercise had clinically and statistically significant improvement in function compared with patients randomized to usual care (referral to physiotherapy as needed) (MD 12.8, 95% CI 3.6 to 22.0).

Liao 2015 reported function using the functional component of the WOMAC (0-48, higher is worse) and found patients randomized to functional and balance rehabilitation reported worse function compared with patients randomized to functional rehabilitation alone (MD 6.2, 95% CI 4.3 to 8.1) at 32 weeks follow-up.

Liao 2020 reported function data using the function component of the WOMAC (0-68, higher is worse) and found patients randomized to elastic resistance exercise training reported better function than those randomized to standard care (consisting of conservative rehabilitation without any resistance exercise training) (MD −8.6, 95% CI −10.4 to −6.7).

Minns Lowe 2012 reported ADL using the Oxford Knee Score (0-48, higher is better) and ADL component of the KOOS (0-100, higher is better) and found patients randomized to home care reported comparable ADL with patients randomized to usual care (dissemination of exercise booklet and referral to outpatient physiotherapy as needed) based on the Oxford Knee Score at 3, 6, and 12 months following surgery and the ADL component of the KOOS as 12 months following surgery, but exhibited greater improvement in the ADL component of the KOOS early at 3 months after TKA (MD −7.1, 95% CI −12.1 to −2.1), and 6 months (MD −6.0, 95% CI −11.8 to −0.2).

Moutzouri 2018 reported the ADL component of the Knee Outcome Survey (distinct from the KOOS; 0-48, higher is better) and found that patients randomized to early self-managed focal sensorimotor exercise training reported better ADL performance than those randomized to functional exercise training (MD 19.0, 95% CI 15.4 to 22.6).

Li 2019 reported function using the physical component of the SF-36 (0-100, higher is better) and the function component of the WOMAC (0-68, higher is worse) and found patients randomized to Tai Chi and rehabilitation reported more improved function compared to patients randomized to traditional rehabilitation exercises alone (physical component of the SF-36: MD 9.0, 95% CI 8.5 to 9.5; function component of WOMAC: MD −6.1 , 95% CI −7.1 to −5.1).

Hamilton 2020 reported ADL using the Oxford Knee Score and found patients randomized to therapist-led rehabilitation reported comparable ADL to patients randomized to home-based rehabilitation at 6 and12 months following surgery despite early benefits in favor of home-based rehabilitation observed at 3 months.

Transfers

Seven studies (Liao 2015, Liao 2020, Madsen 2013, Minns Lowe 2012, Piva 2017, Schache 2019, Andersen 2018) reported transfer data using either the 30-second Timed Chair Stand Test (number of repetitions, larger is better) or time to complete five sit-to-stands on the Chair Stand Test (seconds, smaller is better) (Table 49). Most studies (n=5) reported comparable sit-to-stand performance among groups with the exception of Liao 2015 and Liao 2020. Liao 2015 reported that patients randomized to functional plus balance rehabilitation completed significantly more sit-to-stands compared with those randomized to functional rehabilitation alone (MD -1, 95% CI −1.4 to −0.6). Liao 2020 reported that patients randomized to elastic resistance exercise training completed significantly more sit-to-stands compared with those randomized to standard care (MD 3.1, 95% CI 2.0 to 4.1).

Balance

Five studies (Bruun-Olsen 2013, Liao 2020, Madsen 2013, Piva 2017, Schache 2019) reported on five difference outcome measurements of static and dynamic balance (Table 50). Most studies reported comparable balance between groups 3 to 9 months after TKA. Liao 2020 reported balance using the Forward Reach Test (measured in centimeters, larger is better) and Single-Leg Stance (measured in seconds, larger is better) and found significantly improved balance on both measures among patients randomized to the elastic resistance training exercise group compared with patients randomized to standard care.

Mobility

Sixteen studies (Bade 2017, Bruun-Olsen 2013, Fransen 2017, Heikkilä 2017, Kauppila 2010, Liao 2015, Madsen 2013, Minns Lowe 2012, Piva 2017, Schache 2019, Vuorenmaa 2014,

Bily 2016, Andersen 2018, Moffet 2015, Petterson 2009, Li 2019) reported on various outcome measures of mobility including the 6MWT, 10-, 15- and 40-meter walk tests, stair climb tests among others (Table 51). Most studies (n=11) reported no difference in mobility among groups at follow-up times ranging from 3 to 12 months after TKA.

Five studies reported significant differences between groups for at least one mobility outcome (Bruun-Olsen 2013, Heikkilä 2017, Liao 2015, Piva 2017, Li 2019). Bruun-Olsen 2013 reported three measures of mobility (Figure eight test, 6MWT, and Stair climb test) and found groups were comparable in their performance of the measures with the exception of the 6MWT (meters, larger is better) where patients randomized to the walking-skill group were able to walk further than patients randomized to the usual physiotherapy group at 9 months after TKA (adjusted MD 44, 95% CI 8 to 80).

Heikkilä 2017 reported four measures of mobility (cadence at maximal and normal walking speed; velocity at maximal and normal walking speed) and found patients randomized to home exercise had improved cadence at maximal walking speed (steps/minute, larger is better, MD 7.7 95% CI 3.5 to 11.9) and velocity at normal walking speed (meters/seconds, larger is better, MD 0.2, 95% CI 0.04 to 0.3) compared to control (no intervention after discharge) at 14 months; other measures were comparable between groups.

Liao 2015 reported mobility data using the stair climb test (seconds, shorter is better) and gait speed (meters/second, larger is better) and found patients randomized to functional and balance rehabilitation had improved mobility as assessed on both measures (stair climb test: MD −2.5, 95% CI −3.2 to −1.7; gait speed: MD 0.16, 95% CI 0.07 to 0.26) compared with patients randomized to functional rehabilitation alone at 32 weeks after TKA surgery.

Piva 2017 reported mobility data using three measures and found comparable performance between groups based on self-selected gait speed and stair climb test but observed less improvement on the 6MWT among patients randomized to the comprehensive behavioral intervention (including rehabilitation) compared with the standard of care exercise program (MD −45.4, 95% CI −87.2 to −3.6) at 6 months after TKA.

Li 2019 reported mobility using the 6MWT and found improved mobility among patients randomized to adjunctive Tai Chi compared with patients who received standard rehabilitation alone (MD 37.9, 95% CI 24.6 to 51.2) at 3 months after TKA.

Timed Up and Go

Ten studies (Bade 2017, Liao 2020, Moutzouri 2018, Schache 2019, Vuorenmaa 2014, Bily 2016, Andersen 2018, Hamilton 2020, Demircioglu 2015, Petterson 2009) reported data on the TUG (Table 52). Most studies (n=9) reported comparable performance of the TUG test between groups. One study (Liao 2020) reported significant improvement in the performance of the TUG test (seconds, smaller is better) among patients randomizing to elastic resistance training compared with those randomized to standard care (MD −3.2, 95% CI − 4.0 to −2.3) at 4 months after surgery.

Table 48. Post-acute rehabilitation versus various controls for total knee arthroplasty – continuous outcomes, physical function and activities of daily living

Study, Year, PMID, Country	Arm 1	Arm 2	Overall RoB	Outcome Measurement	Time Point[A]	N Arm 1	Arm 1, Mean (SD)	N Arm 2	Arm 2, Mean (SD)	Effect Size (95% CI)	Reported p-Value
Artz, 2017, 27068368,UK	Group-based exercise	Usual care	High	UCLA activity scale	3 mo	19	4.9 (1.7)	12	4.3 (1.1)	0.6 (-0.1, 1.3)[B]	NR
	Group-based exercise	Usual care	High	UCLA activity scale	6 mo	21	5.2 (1.5)	15	4.5 (1.9)	0.7 (-0.1, 1.5)[B]	NR
	Group-based exercise	Usual care	High	KOOS: ADL (0-100)	3 mo	19	81.2 (15.9)	12	76.1 (18.5)	5.1 (-4.2, 14.4)[B]	NR
	Group-based exercise	Usual care	High	KOOS: ADL (0-100)	6 mo	21	79.6 (23.4)	15	73.5 (26.4)	6.1 (-5.9, 18.1)[B]	NR
	Group-based exercise	Usual care	High	KOOS: Sport/rec (0-100)[C]	3 mo	19	39.2 (29.4)	12	27.9 (20.2)	11.3 (-1.1, 23.7)[B]	NR
	Group-based exercise	Usual care	High	KOOS: Sport/rec (0-100)[C]	6 mo	21	46.3 (35.4)	15	37.1 (25.7)	9.2 (-5, 23.4)[B]	NR
	Group-based exercise	Usual care	High	LEFS	3 mo	19	55.8 (15.6)	12	48.8 (17.4)	7 (-1.8, 15.8)[B]	NR
	Group-based exercise	Usual care	High	LEFS	6 mo	21	57.8 (15.2)	15	45.0 (20.8)	**12.8 (3.6, 22.0)[B]**	**NR**
	Group-based exercise	Usual care	High	Activities-specific balance confidence scale[D]	3 mo	19	84.3 (15.2)	12	79.0 (19.4)	5.3 (-4.3, 14.9)[B]	NR
	Group-based exercise	Usual care	High	Activities-specific balance confidence scale[D]	6 mo	21	84.1 (17.3)	15	80.7 (19.8)	3.4(-5.6, 12.4)[B]	NR
DeJong, 2020, 32360105 USA	Body Weight-Adjustable Treadmill & PENS	Recumbent Bike & PENS	High	KOOS: ADL (0-100)	6 mo	70	90.7 (17.2)	78	88.9 (15.2)	-1.8 (-5.5, 1.9)	NR
	Body Weight-Adjustable Treadmill & PENS	Body Weight-Adjustable Treadmill	High	KOOS: ADL (0-100)	6 mo	70	90.7 (17.2)	76	90.5 (17.2)	-0.2 (-4.1, 3.7)	NR
	Body Weight-Adjustable Treadmill & PENS	Recumbent Bike/Usual Care	High	KOOS: ADL (0-100)	6 mo	70	90.7 (17.2)	74	92.8 (8.1)	2.1 (-1.8, 6.0)	NR
	Body Weight-Adjustable Treadmill & PENS	Recumbent Bike & PENS	High	KOOS: Sport/rec (0-100)	6 mo	70	53.3 (26.4)	78	49.9 (29.6)	-3.4 (-9.8, 3.0)	NR
	Body Weight-Adjustable Treadmill & PENS	Body Weight-Adjustable Treadmill	High	KOOS: Sport/rec (0-100)	6 mo	70	53.3 (26.4)	76	50.0 (28.2)	-3.3 (-9.5, 2.9)	NR

Study, Year, PMID, Country	Arm 1	Arm 2	Overall RoB	Outcome Measurement	Time Point[A]	N Arm 1	Arm 1, Mean (SD)	N Arm 2	Arm 2, Mean (SD)	Effect Size (95% CI)	Reported p-Value
	Body Weight-Adjustable Treadmill & PENS	Recumbent Bike/Usual Care	High	KOOS: Sport/rec (0-100)	6 mo	70	53.3 (26.4)	74	55.9 (25.5)	2.6 (-3.4, 8.6)	NR
Demircioglu, 2015, 26355656, Turkey	NMES & exercise	Exercise	High	SF-12: Physical component	3 mo	30	68.5 (14.8)	30	67.8 (14.5)	0.7 (-4.5, 5.9)[B]	NR
	NMES & exercise	Exercise	High	WOMAC: Physical function (0-68)	3 mo	30	44.5 (12.5)	30	48.8 (16.5)	-4.3 (-9.6, 1.0)[B]	NR
Fransen, 2017, 27868384, Australia	Outpatient exercise group	Usual care	Moderate	QoL: SF-12 (physical component)	12 mo	179	42.7 (0.6)	169	Mean (SE) 43.2 (0.6)	NR	NR
	Outpatient exercise group	Usual care	Moderate	WOMAC: Physical function (0-68)	12 mo	179	11.3 (0.7)	169	Mean (SE) 10.4 (0.7)	NR	0.71
Hamilton, 2020, 33051212,UK	Therapist led	Home-based exercises	Moderate	Oxford knee score (0-48)	3 mo[E]	154	3.97 (2.46)	150	4.44 (2.41)	**1.60 (0.05,3.16)**	**0.04**
	Therapist led	Home-based exercises	Moderate	Oxford knee score (0-48)	6 mo	150	32.12 (8.81)	151	30.34 (8.75)	1.70 (-0.11,3.51)	0.07
	Therapist led	Home-based exercises	Moderate	Oxford knee score (0-48)	12 mo	148	33.55 (10.06)	156	31.57 (9.68)	1.91 (-0.18,3.99)	0.07
Lenguerrand, 2020, 31033232, UK	Physical therapy and standard care	Standard care	Moderate	KOOS: ADL (0-100)	12 mo	66	82 (17)	57	81 (20)	1 (-3.7, 5.7)[B]	0.291
	Physical therapy and standard care	Standard care	Moderate	KOOS: Sport/rec (0-100)	12 mo	61	Median (IQR) 45 (25 , 75)	55	Median (IQR) 45 (25 , 65)	NR	0.199
	Physical therapy and standard care	Standard care	Moderate	LEFS	12 mo	81	56 (19)	83	53 (18)	3 (-1.0, 7.0)[B]	NR
Li, 2019, 31003647, China	Tai chi exercise	Control	Moderate	SF-36: Physical component (0-100)	3 mo[E]	54	54.2 (1.5)	53	45.2 (1.9)	**9.0 (8.5, 9.5)[B]**	**0.01**
	Tai chi exercise	Control	Moderate	WOMAC: Physical function (0-68)	3 mo	54	35.5 (3.2)	53	41.6 (4.1)	**-6.1 (-7.1, -5.1)[B]**	**0.03**
Liao, 2015, 25552523, Taiwan	Functional plus balance rehabilitation	Functional rehabilitation	High	WOMAC: Physical function (0-68)	32 w	65	28.6 (8.1)	65	22.4 (7.9)	**6.2 (4.3, 8.1)[B]**	**NR**
Liao, 2020, 31687984, Taiwan	Elastic resistance exercise training	Standard care	Moderate	WOMAC: Physical function (0-68)	4 mo	30	13.17 (3.78)	30	21.72 (6.06)	**-8.6 (-10.4, -6.7)[B]**	**<0.001**
Madsen, 2013, 23651717, Denmark	Group-based rehabilitation	Supervised home-exercises	High	Oxford knee score (0-48)	3 mo	36	NR (NR)	34	NR (NR)	NR	0.7
	Group-based rehabilitation	Supervised home-exercises	High	Oxford knee score (0-48)	6 mo	36	NR (NR)	32	NR (NR)	NR	0.7
	Group-based rehabilitation	Supervised home-exercises	High	SF-36: Physical function (0-100)	3 mo	36	NR (NR)	34	NR (NR)	NR	0.7
	Group-based rehabilitation	Supervised home-exercises	High	SF-36: Physical function (0-100)	6 mo	36	NR (NR)	32	NR (NR)	NR	0.5

Study, Year, PMID, Country	Arm 1	Arm 2	Overall RoB	Outcome Measurement	Time Point[A]	N Arm 1	Arm 1, Mean (SD)	N Arm 2	Arm 2, Mean (SD)	Effect Size (95% CI)	Reported p-Value
Minns Lowe, 2012, 22180446, U	Home-visit physiotherapy	Usual care	High	Oxford knee score (0-48)	3 mo	46	Media (IQR) 33.5 (13)	47	Median (IQR) 34 (12)	Median diff -2.2 (-6.4, 2)	0.3
	Home-visit physiotherapy	Usual care	High	Oxford knee score (0-48)	6 mo	42	Median (IQR) 36 (12)	44	Median (IQR) 36 (13)	Median diff -0.05 (-4.6, 4.5)	0.98
	Home-visit physiotherapy	Usual care	High	Oxford knee score (0-48)	12 mo	46	Median (IQR) 40 (10)	48	Median (IQR) 38.5 (12)	Median diff 0.2 (-3.8, 4.2)	0.94
	Home-visit physiotherapy	Usual care	High	KOOS: ADL (0-100)	3 mo	42	Median (IQR) 69.9 (21)	44	Median (IQR) 75 (31)	**-7.1 (-12.1, -2.1)[B]**	**NR**
	Home-visit physiotherapy	Usual care	High	KOOS: ADL (0-100)	6 mo	41	Median (IQR) 78.1 (26)	41	Median (IQR)72.1 (34)	**-6.0 (-11.8, -0.2)[B]**	**NR**
	Home-visit physiotherapy	Usual care	High	KOOS: ADL (0-100)	12 mo	41	Median (IQR) 85.3 (21)	46	Median (IQR) 89.4 (23)	4.1 (-0.3, 8.4)[B]	NR
	Home-visit physiotherapy	Usual care	High	KOOS: Sport/rec (0-100)	3 mo	18	Median (IQR) 41.7 (25)	22	Median (IQR) 31.7 (57)	NR	NR
	Home-visit physiotherapy	Usual care	High	KOOS: Sport/rec (0-100)	6 mo	28	Median (IQR) 50 (44)	30	Media (IQR) 35 (35)	NR	NR
	Home-visit physiotherapy	Usual care	High	KOOS: Sport/rec (0-100)	12 mo	33	Median (IQR) 60 (41)	35	Media (IQR) 50 (55)	NR	NR
Mitchell, 2005, 15869558, UK	Hospital	Home	High	QoL: SF-36 (physical component)	3 mo	57	43.3 (27.6)	57	41.6 (22.2)	Adj MD 2.5 (-6.3, 11.3)	0.579
	Hospital	Home	High	SF-36: Physical function (0-100)	3 mo	57	23.2 (36.2)	57	27.6 (37.1)	Adj MD 7.8 (-5.6, 21.2)	0.249
	Hospital	Home	High	WOMAC: Physical function (0-68)	3 mo	57	24.4 (14.9)	57	24.9 (13.4)	Adj Md -1.0 (-5.9, 3.8)	0.677
Moffet, 2015, 26178888, Canada	In-home Telerehabilitation	Standard home rehabilitation	Moderate	KOOS: ADL (0-100)	4 mo	100	84.2 (NR)	98	85.7 (NR)	-0.8 (-4.7, 3)	NR
	In-home Telerehabilitation	Standard home rehabilitation	Moderate	KOOS: Sport/rec (0-100)	4 mo	100	29.8 (NR)	98	30.9 (NR)	-1.9 (-8.8, 5)	NR
	In-home Telerehabilitation	Standard home rehabilitation	Moderate	WOMAC: Physical function (0-68)	4 mo	100	83.9 (NR)	98	84.9 (NR)	-0.1 (-3.9, 3.7)	NR
Monticone, 2013, 23063624, Italy	Home-based functional exercises and kinesiophobia training	Usual care	Moderate	KOOS: ADL (0-100)	6 mo	55	NR	55	NR	14.22 (8.35, 20.08)	NR
	Home-based functional	Usual care	Moderate	KOOS: ADL (0-100)	12 mo	55	NR	55	NR	11.84 (6.79, 16.89)	NR

Study, Year, PMID, Country	Arm 1	Arm 2	Overall RoB	Outcome Measurement	Time Point[A]	N Arm 1	Arm 1, Mean (SD)	N Arm 2	Arm 2, Mean (SD)	Effect Size (95% CI)	Reported p-Value
	exercises and kinesiophobia training										
	Home-based functional exercises and kinesiophobia training	Usual care	Moderate	KOOS: Sport/rec (0-100)	6 mo	55	NR	55	NR	13.31 (5.81, 20.79)	NR
	Home-based functional exercises and kinesiophobia training	Usual care	Moderate	KOOS: Sport/rec (0-100)	12 mo	55	NR	55	NR	10.69 (2.79, 18.62)	NR
Moutzouri, 2018, 29473481, Greece	Early self-managed focal sensorimotor exercise training	Functional exercise training	Moderate	KOS: ADL (0-100)	3.5 mo	25	79.6 (9)	26	60.6 (9.3)	**19.0 (15.4, 22.6)**[B]	**NR**
Piva, 2017, 28217891, USA	Comprehensive behavioral intervention	Standard of care exercise	Moderate	SF-36: Physical function (0-100)	6 mo	21	76.7 (16.1)	20	70.3 (24.2)	6.4 (-2.9, 15.7)[B]	NR
	Comprehensive behavioral intervention	Standard of care exercise	Moderate	WOMAC: Physical function (0-68)	6 mo	21	11.8 (6.7)	20	12.8 (10.8)	-1 (-5.1, 3.1)[B]	
Piva, 2019, 30794296, USA	Clinic-based group exercise	Standard care	Moderate	Canadian occupational performance measure: Performance (0-10)	3 mo	90	6.5 (1.7)	44	5.4 (1.7)	1.3 (0.7, 0.6	NR
	Clinic-based group exercise	Standard care	Moderate	Canadian occupational performance measure: Performance (0-10)	6 mo	88	6.8 (1.9)	45	6.0 (1.6)	0.7 (0.1, 1.2)	NR
	Clinic-based group exercise	Standard care	Moderate	Canadian occupational performance measure: Satisfaction (0-10)	3 mo	90	6.6 (1.8)	44	5.0 (2.0)	0.7 (0.1, 1.4)	NR
	Clinic-based group exercise	Standard care	Moderate	Canadian occupational performance measure: Satisfaction (0-10)	6 mo	89	6.8 (2.1)	45	5.7 (1.9)	0.8 (0.1, 1.5)	NR
	Community-based group exercise	Standard care	Moderate	Canadian occupational performance	3 mo	87	6.0 (1.8)	44	5.4 (1.7)	1.3 (0.7, 0.6	NR

Study, Year, PMID, Country	Arm 1	Arm 2	Overall RoB	Outcome Measurement	Time Point[A]	N Arm 1	Arm 1, Mean (SD)	N Arm 2	Arm 2, Mean (SD)	Effect Size (95% CI)	Reported p-Value
				measure: Performance (0-10)							
	Community-based group exercise	Standard care	Moderate	Canadian occupational performance measure: Performance (0-10)	6 mo	88	6.6 (1.9)	45	6.0 (1.6)	0.7 (0.1, 1.2)	NR
	Community-based group exercise	Standard care	Moderate	Canadian occupational performance measure: Satisfaction (0-10)	3 mo	87	57 (2.1)	44	5.0 (2.0)	0.7 (0.1, 1.4)	NR
	Community-based group exercise	Standard care	Moderate	Canadian occupational performance measure: Satisfaction (0-10)	6 mo	88	6.5 (2.1)	45	5.7 (1.9)	0.8 (0.1, 1.5)	NR
	Clinic-based group exercise	Standard care	Moderate	WOMAC: Physical function (0-68)	3 mo	90	10.1 (6.6)	44	11.9 (7.6)	0.1 (-2.7, 2.9)	NR
	Clinic-based group exercise	Standard care	Moderate	WOMAC: Physical function (0-68)	6 mo	89	9.8 (7.2)	45	11.8 (7.5)	-0.8 (-3.7, 2.0)	NR
	Community-based group exercise	Standard care	Moderate	WOMAC: Physical function (0-68)	3 mo	87	12.2 (7.9)	44	11.9 (7.6)	-2.1 (-4.9, 0.7)	NR
	Community-based group exercise	Standard care	Moderate	WOMAC: Physical function (0-68)	6 mo	88	10.8 (7.9)	45	11.8 (7.5)	-2.1 (-5.0, 0.7)	NR
Petersen, 2018, 29294078, Netherlands	Exercise & acupuncture	Exercise	High	KOOS: ADL (0-100)	3 mo	86	N with success (%) 54 (63%)	82	N with success (%) 54 (63%)	**RR 0.95 (0.76 to 1.19)**	**0.679**
Petterson, 2009, 19177542, USA	Exercise & NMES group	Exercise	High	KOS: ADL	3 mo	92	0.81 (NR)	78	0.80 (NR)	NR	NR
	Exercise & NMES group	Exercise	High	KOS: ADL	12 mo	61	0.86 (NR)	68	0.85 (NR)	NR	NR
	Exercise & NMES group	Exercise	High	WOMAC: Physical function (0-68)	3 mo	92	44.64 (NR)	78	44.45 (NR)	NR	NR
	Exercise & NMES group	Exercise	High	WOMAC: Physical function (0-68)	12 mo	61	46.74 (NR)	68	46.05 (NR)	NR	NR
Pua, 2017, 27810379, Singapore	Rehabilitation attendance (2 or more sessions)	Rehabilitation attendance: none	Moderate	SF-36: Physical function (0-100)	6 mo	NR	68 (20)	NR	58 (28)	**5.1 (0.6, 9.6)**	**0.025**
	Rehabilitation attendance (2 or more sessions)	Rehabilitation attendance: none	Moderate	SF-36: Physical function (0-100)	6 mo	NR	63 (22)	NR	58 (28)	3.5 (-2.4, 9.3)	0.24

Study, Year, PMID, Country	Arm 1	Arm 2	Overall RoB	Outcome Measurement	Time Point[A]	N Arm 1	Arm 1, Mean (SD)	N Arm 2	Arm 2, Mean (SD)	Effect Size (95% CI)	Reported p-Value
Schache, 2019, 31208916, Australia	Standard rehabilitation and hip strengthening exercises	Standard rehabilitation plus general functional exercise	Moderate	KOOS: ADL (0-100)	6.5 mo	48	90 (11)	48	88 (13)	3 (-5, 11)	NR
	Standard rehabilitation and hip strengthening exercises	Standard rehabilitation plus general functional exercise	Moderate	LEFS	6.5 mo	48	53 (12)	48	54 (12)	-2 (-7.0, 3.0)	NR
	Standard rehabilitation and hip strengthening exercises	Standard rehabilitation plus general functional exercise	Moderate	SF-12: Physical component	6.5 mo	48	47 (8)	48	46 (9)	1 (-3, 5)	NR
Vuorenmaa, 2014, 24241606, Finland	Home exercise	Control	Moderate	SF-36: Physical function (0-100)	12 mo	53	23 (NR)	55	27 (NR)	NR	NR
	Home exercise	Control	Moderate	WOMAC: Physical function (0-68)	12 mo	53	44 (NR)	55	40 (NR)	NR	NR

Statistically significant effect sizes are in bold text. In cases where calculated effect size confidence intervals were not-statistically significant but reported p-values were, we deferred to reported p-values and still bolded results.

Abbreviations: Adj MD = adjusted mean difference, ADL = activities of daily living, CI = confidence interval, EQ-5D = EuroQual, KOS = Knee outcome survey, KOOS = Knee injury and osteoarthritis outcome score, LEFS = Lower Extremity Functional Scale, mo = month, NR = not reported, PMID = PubMed identifier, rec = recreation, RR = relative risk, RoB = risk of bias, SD = standard deviation, SF-36 = 36-Item short form survey, WOMAC = Western Ontario and McMaster Universities Osteoarthritis Index.

[A] Time from surgery
[B] Calculated
[C] We included the sports and recreation component of the KOOS in the table of physical function as it was most related to other domains. Given it assesses function beyond activities of daily living though, it was not included in our assessment of the evidence of ADLs for the evidence profile
[D] This scale is patient-reported and distinct from the other performance-based measures, but relates to patient's confidence about balance specifically and was therefore included here
[E] Defined as 14 weeks

Table 49. Post-acute rehabilitation versus various controls for total knee arthroplasty – continuous outcomes, transfers

Study, Year, PMID, Country	Arm 1	Arm 2	Overall RoB	Outcome Measurement	Time Point[A]	N Arm 1	Arm 1, Mean (SD)	N Arm 2	Arm 2, Mean (SD)	Effect Size (95% CI)	Reported p-Value
Andersen, 2018, CN-01647420, Denmark	Technological assisted rehabilitation	Supervised rehabilitation	High	Chair stand test (timed or number of repetitions unspecified)	6 mo	NR	NR (NR)	NR	NR	<10%(MD)	ns
	Technological assisted rehabilitation	Supervised rehabilitation	High	Chair stand test (timed or number of repetitions unspecified)	12 mo	NR	NR (NR)	NR	NR	<10%(MD)	ns
Liao, 2015, 25552523, Taiwan	Functional plus balance rehabilitation	Functional rehabilitation	High	Chair stand test: Total sit-to-stands in 30s (n)	32 w	65	8.7 (1.7)	65	7.7 (1.7)	**1 (0.6, 1.4)[B]**	**<0.001**
Liao, 2020, 31687984, Taiwan	Elastic resistance exercise training	Standard care	Moderate	Chair stand test: Total sit-to-stands in 30s (n)	4 mo	30	17.67 (2.92)	30	14.60 (2.86)	**3.1 (2.0, 4.1)[B]**	**0.001**
Madsen, 2013, 23651717, Denmark	Group-based rehabilitation	Supervised home-exercises	High	Chair stand test: Time to complete 5 sit-to-stands (s)	3 mo	36	NR (NR)	34	NR (NR)	NR	0.2
	Group-based rehabilitation	Supervised home-exercises	High	Chair stand test: Time to complete 5 sit-to-stands (s)	6 mo	36	NR (NR)	32	NR (NR)	NR	0.1
	Group-based rehabilitation	Supervised home-exercises	High	Chair stand test: Total sit-to-stands in 30s (n)	3 mo	36	NR (NR)	34	NR (NR)	NR	0.8
	Group-based rehabilitation	Supervised home-exercises	High	Chair stand test: Total sit-to-stands in 30s (n)	6 mo	36	NR (NR)	32	NR (NR)	NR	0.2
Minns Lowe, 2012, 22180446, UK	Home-visit physiotherapy	Usual care	High	Chair stand test: Total sit-to-stands in 30s (n)	3 mo	43	Median (IQR) 7 (4)	43	Median (IQR) 7 (6)	Median difference 0.56 (0.44, -0.9)	0.2
	Home-visit physiotherapy	Usual care	High	Chair stand test: Total sit-to-stands in 30s (n)	6 mo	NR	NR	NR	NR	NR	NR
	Home-visit physiotherapy	Usual care	High	Chair stand test: Total sit-to-stands in 30s (n)	12 mo	40	Media (IQR) 7 (8)	43	Media (IQR) 8 (6)	Median difference -0.2 (-1.8, 1.5)	0.85
Piva, 2017, 28217891, USA	Comprehensive behavioral intervention	Standard of care exercise	Moderate	Chair stand test: Time to complete 5 sit-to-stands (s)	6 mo	21	12.2 (2.8)	20	13.7 (7.5)	-1.5 (-4.4, 1.4)[†]	NR
Schache, 2019, 31208916, Australia	Standard rehabilitation & hip strengthening exercises	Standard rehabilitation & general functional exercise	Moderate	Chair stand test: Total sit-to-stands in 30s (n)	6.5 mo	48	15 (4)	48	15 (5)	0 (-2, 1)	NR

Statistically significant effect sizes are in bold text. In cases where calculated effect size confidence intervals were not-statistically significant but reported p-values were, we deferred to reported p-values and still bolded results.

Abbreviations: CI = confidence interval, CST = chair stand test, IQR = interquartile range, MD = mean difference, mo = month, n = number, NR = not reported, PMID = PubMed identifier, RoB = risk of bias, SD = standard deviation, SE = standard error.

[A] Time from surgery
[B] Calculated

Table 50. Post-acute rehabilitation versus various controls for total knee arthroplasty – continuous outcomes, balance

Study, Year, PMID, Country	Arm 1	Arm 2	Overall RoB	Outcome Measurement	Time Point[A]	N Arm 1	Arm 1, Mean (SD)	N Arm 2	Arm 2, Mean (SD)	Effect Size (95% CI)	Reported p-Value
Bruun-Olsen, 2013, 23614370, Norway	Walking-skill group	Usual physiotherapy care	Moderate	Balance: Time stands (s)	9 mo	29	29 (7)	28	32 (13)	Adj MD -2(-7, 3)	NR
Liao, 2020, 31687984, Taiwan	Elastic resistance exercise training	Standard care	Moderate	Balance: Forward reach test (cm)	4 mo	30	24.23 (6.99)	30	18.34 (5.69)	**5.9 (3.6, 8.2)[B]**	**0.004**
	Elastic resistance exercise training	Standard care	Moderate	Balance: Single-leg stance (s)	4 mo	30	18.84 (5.73)	30	13.87 (7.58)	**5 (2.5, 7.4)[B]**	**0.004**
Madsen, 2013, 23651717, Denmark	Group-based rehabilitation	Supervised home-exercises	High	Balance: Tandem test[C]	3 mo	36	NR (NR)	34	NR (NR)	NR	0.2
	Group-based rehabilitation	Supervised home-exercises	High	Balance: Tandem test[C]	6 mo	36	NR (NR)	32	NR (NR)	NR	0.5
Piva, 2017, 28217891, USA	Comprehensive behavioral intervention	Standard of care exercise	Moderate	Balance: Single-leg stance[D]	6 mo	21	16.1 (9.6)	20	17.4 (9.8)	-1.3 (-5.5, 2.9)[B]	NR
Schache, 2019, 31208916, Australia	Standard rehabilitation and hip strengthening exercises	Standard rehabilitation plus general functional exercise	Moderate	Balance: Step test	6.5 mo	48	17 (4)	48	18 (5)	-1 (-3, 1)	NR

Statistically significant effect sizes are in bold text. In cases where calculated effect size confidence intervals were not-statistically significant but reported p-values were, we deferred to reported p-values and still bolded results.

Abbreviations: Adj MD = adjusted mean difference, CI = confidence interval, cm = centimeter, mo = month, NR = not reported, PMID = PubMed identifier, RoB = risk of bias, s = seconds, SD = standard deviation.

[A] Time from surgery
[B] Calculated
[C] 10 seconds each in side-by-side, semi-tandem and tandem stand
[D] Measures the time that participants balanced on 1 leg while keeping their hands on the waist

Table 51. Post-acute rehabilitation versus various controls for total knee arthroplasty – continuous outcomes, mobility

Study, Year, PMID, Country	Arm 1	Arm 2	Overall RoB	Outcome Measurement	Time Point[A]	N Arm 1	Arm 1, Mean (SD)	N Arm 2	Arm 2, Mean (SD)	Effect Size (95% CI)	Reported p-Value
Andersen, 2018, CN-01647420, Denmark	Technological assisted rehabilitation	Supervised rehabilitation	High	10-m walk test (s)	6 mo	NR	NR (NR)	NR	NR (NR)	<10%(MD)	ns
	Technological assisted rehabilitation	Supervised rehabilitation	High	10-m walk test (s)	12 mo	NR	NR (NR)	NR	NR (NR)	<10%(MD)	ns
Bade, 2017, 27813347, USA	High-intensity progressive rehabilitation	Low-intensity rehabilitation	Moderate	6MWT (m)	3 mo	77	493.7 (92.4)	76	478.7 (82.7)	15 (-4.7, 34.7)[B]	NR
	High-intensity progressive rehabilitation	Low-intensity rehabilitation	Moderate	6MWT (m)	6 mo	71	520.3 (91.1)	71	511.7 (77.7)	8.6 (-11.2, 28.4)[B]	NR
	High-intensity progressive rehabilitation	Low-intensity rehabilitation	Moderate	6MWT (m)	12 mo	69	531.7 (98.9)	67	513.6 (78.4)	18.1 (-3.3, 39.5)[B]	NR
	High-intensity progressive rehabilitation	Low-intensity rehabilitation	Moderate	Stair climb test[C]	3 mo	77	13.02 (4.62)	76	13.60 (3.58)	-0.6 (-1.5, 0.4)[B]	NR
	High-intensity progressive rehabilitation	Low-intensity rehabilitation	Moderate	Stair climb test[C]	6 mo	71	11.78 (4.29)	71	12.15 (3.3)	-0.4 (-1.3, 0.5)[B]	NR
	High-intensity progressive rehabilitation	Low-intensity rehabilitation	Moderate	Stair climb test[C]	12 mo	70	11.40 (3.62)	67	11.77 (3.15)	-0.4 (-1.2, 0.4)[B]	NR
Bily, 2016, 26763947, Austria	Leg-press group	Physiotherapy group	High	Stair climb test (s)[C]	3 mo	26	12.8 (0.74)	29	14.8 (1.03)	-2 (-2.3, -1.7)[B]	0.29
Bruun-Olsen, 2013, 23614370, Norway	Walking-skill group	Usual physiotherapy group	Moderate	Figure eight test (steps)	9 mo	29	9 (11)	28	12 (12)	Adj -4(-8, 1)	NR
	Walking-skill group	Usual physiotherapy group	Moderate	6MWT (m)	9 mo	29	492 (90)	28	425 (93)	**Adj 44 (8, 80)**	**0.02**
	Walking-skill group	Usual physiotherapy group	Moderate	Stair climb test (s)[D]	9 mo	29	14 (8)	28	15 (7)	Adj 0(-4, 4)	NR
Fransen, 2017, 27868384, Australia	Outpatient exercise group	Usual care	Moderate	50-foot walk speed (s)	12 mo	179	1.6 (0)	169	1.6; SE (0)	NR	NR
	Outpatient exercise group	Usual care	Moderate	Stair climb power (W)[E]	12 mo	179	278 (9)	169	279; SE (9)	NR	NR
Heikkilä, 2017, 28119232, Finland	Home exercise	Control	High	Cadence: Maximal (Steps/min)	14 mo	53	141.4 (16.5)	55	133.7 (14.9)	**7.7 (3.5, 11.9)[B]**	**NR**
	Home exercise	Control	High	Cadence: Normal (Steps/min)	14 mo	53	120.9 (21.4)	55	116.8 (11.2)	4.1 (-0.9, 9.1)[B]	NR
	Home exercise	Control	High	Walking velocity: Maximal (m/s)	14 mo	53	1.24 (0.37)	55	1.18 (0.28)	0.1 (-0.03, 0.2)[B]	NR

Study, Year, PMID, Country	Arm 1	Arm 2	Overall RoB	Outcome Measurement	Time Point[A]	N Arm 1	Arm 1, Mean (SD)	N Arm 2	Arm 2, Mean (SD)	Effect Size (95% CI)	Reported p-Value
	Home exercise	Control	High	Walking velocity: Normal (m/s)	14 mo	53	1.67 (0.40)	55	1.52 (0.41)	**0.2 (0.04, 0.3)[B]**	**NR**
Kauppila, 2010, 20354057, Finland	Multidisciplinary rehabilitation group	Control	Moderate	15-m walk test (s)	6 mo	36	13.4 (2.4)	39	13.3 (2.5)	0.1 (-0.7, 0.9)[B]	NR
	Multidisciplinary rehabilitation group	Control	Moderate	15-m walk test (s)	12 mo	36	13.8 (3.6)	37	13.7 (2.9)	0.1 (-1, 1.2)[B]	0.3
	Multidisciplinary rehabilitation group	Control	Moderate	Stair climb test: Ascend (s)	6 mo	36	11 (5.6)	36	9.6 (3.4)	1.4 (-0.2, 3)[B]	NR
	Multidisciplinary rehabilitation group	Control	Moderate	Stair climb test: Ascend (s)	12 mo	36	10.3 (3.7)	34	10 (4.1)	0.3 (-1, 1.6)[B]	0.5
	Multidisciplinary rehabilitation group	Control	Moderate	Stair climb test: Descend (s)	6 mo	36	10.7 (5)	36	10.5 (4.1)	0.2 (-1.3, 1.7)[B]	NR
	Multidisciplinary rehabilitation group	Control	Moderate	Stair climb test: Descend (s)	12 mo	36	10.7 (5.3)	33	10.7 (5)	0 (-1.7, 1.7)[B]	0.2
Li, 2019, 31003647, China	Tai chi exercise	Control	Moderate	6MWT (m)	3 mo[K]	54	467.1 (51.4)	53	429.2 (47.5)	**37.9 (24.6, 51.2)[B]**	**0.01**
Liao, 2015, 25552523, Taiwan	Functional plus balance rehabilitation	Functional rehabilitation	High	Stair climb test (s)[F]	32 w	65	12.2 (1.8)	65	14.5 (2.5)	**−2.5 (−3.2, −1.7)**	**<0.001**
	Functional plus balance rehabilitation	Functional rehabilitation	High	Gait speed (m/sec)	4 mo	30	1.42 (0.28)	30	1.25 (0.30)	**0.16 (0.07, 0.26)**	**<0.01**
Madsen, 2013, 23651717, Denmark	Group-based rehabilitation	Supervised home-exercises	High	Walking velocity (NR)[G]	3 mo	36	0.32 (0.21)	34	0.3 (0.2)	NR	0.7
	Group-based rehabilitation	Supervised home-exercises	High	Walking velocity (NR)[G]	6 mo	36	0.40 (0.22)	32	0.36 (0.22)	NR	0.5
Minns Lowe, 2012, 22180446, UK	Home-visit physiotherapy	Usual care	High	10-m walk test (s)	3 mo	42	Median 9.9	43	Median 10.3	Median difference -0.4 (-1.6, 1.3)	0.55
	Home-visit physiotherapy	Usual care	High	10-m walk test (s)	12 mo	40	Median 9.2	43	Median 9.1	Median difference -0.2 (-1.5, 1.2)	0.8
Moffet, 2015, 26178888, Canada	In-home Telerehabilitation	Standard home rehabilitation	Moderate	6MWT (m)	4 mo	100	396.3 (NR)	98	407.5 (NR)	-7.4 (-27.8, 13.1)	NR
	In-home Telerehabilitation	Standard home rehabilitation	Moderate	Stair climb test (s)[F]	4 mo	100	29.9 (NR)	98	26.6 (NR)	-1.2 (-4.8, 2.4)	NR
Petterson, 2009, 19177542, USA	Exercise & NMES group	Exercise	High	6MWT (m)	3 mo	76	530 (NR)	92	535 (NR)	NR	NR
	Exercise & NMES group	Exercise	High	6MWT (m)	12 mo	68	545 (NR)	81	554 (NR)	NR	NR
	Exercise & NMES group	Exercise	High	Stair climb test (s)[F]	3 mo	76	14.28 (NR)	92	12.78 (NR)	NR	NR
	Exercise & NMES group	Exercise	High	Stair climb test (s)[F]	12 mo	68	13.62 (NR)	81	11.75 (NR)	NR	NR
Piva, 2017, 28217891, USA	Comprehensive behavioral intervention	Standard of care exercise	Moderate	6MWT (m)	6 mo	21	472.6 (86.5)	20	518 (103.3)	**-45.4 (-87.2, -3.6)[B]**	**NR**

Study, Year, PMID, Country	Arm 1	Arm 2	Overall RoB	Outcome Measurement	Time Point[A]	N Arm 1	Arm 1, Mean (SD)	N Arm 2	Arm 2, Mean (SD)	Effect Size (95% CI)	Reported p-Value
	Comprehensive behavioral intervention	Standard of care exercise	Moderate	Self-selected gait speed (m/s)	6 mo	21	1.14 (0.16)	20	1.18 (0.24)	-0.04 (-0.1, 0.1)[B]	NR
	Comprehensive behavioral intervention	Standard of care exercise	Moderate	Stair climb test (s)[H]	6 mo	21	14.3 (4.1)	20	15.6 (7.4)	-1.3 (-4.1, 1.5)[B]	NR
Schache, 2019, 31208916, Australia	Standard rehabilitation & hip strengthening exercises	Standard rehabilitation & general functional exercise	Moderate	40m-fast-paced walk test (s)	6.5 mo	48	29 (9)	48	29 (10)	0 (-15, 16)	NR
	Standard rehabilitation & hip strengthening exercises	Standard rehabilitation & general functional exercise	Moderate	6MWT (m)	6.5 mo	48	474 (106)	48	477 (128)	-3 (-36.5, 30.5)[B]	NR
	Standard rehabilitation & hip strengthening exercises	Standard rehabilitation & general functional exercise	Moderate	Stair climb test (s)[I]	6.5 mo	48	7 (2)	48	7 (2)	-2 (-5, 1)	NR
Vuorenmaa, 2014, 24241606, Finland	Home exercise	Control	Moderate	Maximal walking speed (m/s)[J]	12 mo	53	1.04 (NR)	55	1.18 (NR)	NR	NR

Statistically significant effect sizes are in bold text. In cases where calculated effect size confidence intervals were not-statistically significant but reported p-values were, we deferred to reported p-values and still bolded results. If p-values were not significant, we did not bold our calculated confidence intervals, even if significant.

Abbreviations: 6MWT = six-minute walk test CI = confidence interval, MD = mean difference, mo = month, m = meter, NR = not reported, ns = not significant, PMID = PubMed identifier, RoB = risk of bias, SD = standard deviation, SE = standard error, W = watt.

[A] Time from surgery
[B] Calculated
[C] Defined as the total time to ascend and descend flight of 12 stairs
[D] Defined as the total time to ascend and descend a flight of 16 stairs
[E] Calculated from time to perform stair climb test, number of stairs, stair height, and body weight.
[F] Specifics of the stair climb test not defined
[G] Measured during a 10-m walk test. Unit not reported, likely m/s
[H] Defined as the total time to ascend and descend a flight of 11 stairs
[I] Defined as the time taken to ascend four steps in seconds
[J] Measured using GAITRite Walkway System (CIR Systems Inc., Sparta, USA). Participants were instructed to walk barefoot as rapidly as possible. The participants started walking from a point 2 meters in front of the mat and stopped at a point 2 meters beyond the mat
[K] Defined as 14 weeks

Table 52. Post-acute rehabilitation versus various controls for total knee arthroplasty – continuous outcomes, Timed Up and Go

Study, Year, PMID, Country	Arm 1	Arm 2	Overall RoB	Time Point[A]	N Arm 1	Arm 1, Mean (SD)	N Arm 2	Arm 2, Mean (SD)	Effect Size (95% CI)	Reported p-Value
Andersen, 2018, CN-01647420, Denmark	Technological assisted rehabilitation	Supervised rehabilitation	High	6 mo	NR	NR	NR	NR	<10%(MD)	ns
	Technological assisted rehabilitation	Supervised rehabilitation	High	12 mo	NR	NR	NR	NR	<10%(MD)	ns
Bade, 2017, 27813347, USA	High-intensity progressive rehabilitation	Low-intensity rehabilitation	Moderate	3 mo	77	7.58 (1.82)	76	7.98 (1.58)	-0.4 (-0.8, -0.01)[B]	NR
	High-intensity progressive rehabilitation	Low-intensity rehabilitation	Moderate	6 mo	71	7.33 (1.6)	71	7.48 (1.45)	-0.2 (-0.5, 0.2)[B]	NR
	High-intensity progressive rehabilitation	Low-intensity rehabilitation	Moderate	12 mo	71	7.36 (1.77)	67	7.44 (1.50)	-0.1 (-0.5, 0.3)[B]	NR
Bily, 2016, 26763947, Austria	Leg-press group	Physiotherapy group	High	3 mo	26	7.3 (0.32)	29	8.1 (0.41)	-0.8 (-0.9, -0.7)[B]	0.29[C]
Demircioglu, 2015, 26355656, Turkey	NMES & exercise	Exercise	High	3 mo	30	12.3 (2.1)	30	12.9 (1.9)	-0.6 (-1.3, 0.1)[B]	NR
Hamilton, 2020, 33051212,UK	Therapist led	Home-based exercises	Moderate	3 mo[D]	143	14.65 (38.0)	143	22.5 (77.2)	4.64(-14.25,4.96)	0.34
Liao, 2020, 31687984, Taiwan	Elastic resistance exercise training	Standard care	Moderate	4 mo	30	9.13 (1.13)	30	12.32 (2.71)	**-3.2 (-4.0, -2.3)**[B]	**0.002**
Moutzouri, 2018, 29473481, Greece	Early self-managed focal sensorimotor exercise training	Functional exercise training	Moderate	3.5 mo	25	8.1 (1.7)	26	12.4 (2.5)	-4.3 (-5.2, -3.4)[B]	NR
Petterson, 2009, 19177542, USA	Exercise & NMES group	Exercise	High	3 mo	92	8.02 (NR)	78	8.29 (NR)	NR	NR
	Exercise & NMES group	Exercise	High	12 mo	61	7.68 (NR)	68	8.07 (NR)	NR	NR
Schache, 2019, 31208916, Australia	Standard rehabilitation and hip strengthening exercises	Standard rehabilitation plus general functional exercise	Moderate	6.5 mo	48	8 (2)	48	8 (3)	-2 (-6, 2)	NR
Vuorenmaa, 2014, 24241606, Finland	Home exercise	Control	Moderate	12 mo	53	9.18 (NR)	55	10.33 (NR)	NR	NR

Statistically significant effect sizes are in bold text. In cases where calculated effect size confidence intervals were not-statistically significant but reported p-values were, we deferred to reported p-values and still bolded results.

Abbreviations: CI = confidence interval, MD = mean difference, mo = month, NMES = neuromuscular electrical stimulation, NR = not reported, ns = not significant, PMID = PubMed identifier, RoB = risk of bias, s = second, SD = standard deviation.

[A] Time from surgery
[B] Calculated
[C] Two-way repeated-measure analysis of variance adjusted for time and group was not significant
[D] Defined as 14 weeks

Other Patient-Reported Outcomes Following Post-Acute Rehabilitation

We found 14 studies in total that reported other patient-reported outcomes following post-acute rehabilitation compared with various comparators: seven studies (Artz 2017, Bade 2017, Bruun-Olsen 2013, Kauppila 2010, Lenguerrand 2020, Minns Lowe 2012, Monticone 2013) compared novel rehabilitation programs to various comparators (less intensive rehabilitation or no care); one study (Bily 2016) compared different (hypothesized equivalent) rehabilitation programs, no studies compared rehabilitation programs with different timing and/or intensities; four studies (Andersen 2018, Mitchell 2005, Moffet 2015, Piva 2019) compared rehabilitation programs delivered in different settings or by different personnel, and two studies (Demircioglu 2015, Peterson 2018) compared rehabilitation programs with or without an adjunctive modality (Tables 53 to 55). Outcomes included: quality of life, patient satisfaction with care, and patient global assessments.

Quality of Life

Twelve studies (Artz, 2017, Bruun-Olsen, 2013, Kauppila, 2010, Lenguerrand, 2020, Minns Lowe, 2012, Monticone, 2013, Andersen, 2018, Moffet, 2015, Piva, 2019, DeJong 2020, Demircioglu, 2015, Petersen, 2018) QoL using the QoL component of the KOOS and the total SF-36 (Table 53). Most studies (n=10) reported comparable QoL among rehabilitation arms at follow-up, ranging between 3 and 12 months following TKA surgery. Two studies (Monticone 2013 and Andersen 2018) reported improved QoL in one group. Monticone 2013 reported the QoL component of the KOOS (scores 0-100; higher is better) and found that patients randomized to the home-based functional exercises and kinesiophobia training reported improved QoL than those randomized to usual care at 6 and 12 months after TKA. Andersen 2018 also reported data on the QoL component of the KOOS and found that patients randomized to technological assisted rehabilitation had improved QoL compared to patients randomized to usual care at 6 months (difference of 12.2%; P NR) after TKA but not at 12 months.

Patient Satisfaction With Care

One study (Moffet 2015) reported data on satisfaction with care and found no differences between patients randomized to in-home telerehabilitation compared with standard home rehabilitation (Table 54).

Patient Global Assessments

Ten studies (Artz 2017, Bade 2017, Kauppila 2010, Bily 2016, DeJong 2020, Demircioglu 2015, Mitchell 2005, Piva 2019) provided data on patients' self-reported global assessment of their health using five different measurement instruments assessed between 3 and 12 months after TKA surgery (Table 55). Most studies (n=9) reported comparable results between groups with the exception of Artz 2017 and Demircioglu 2015. Artz 2017 reported significant improvements in the Measure yourself medical outcome profile (scores 0-6; lower is better, MCID 0.5-1.0) among patients randomized to group-based exercise compared to usual care at 3 months following surgery (MD -0.9, 95% CI −1.5 to −0.3) but not at 6 months. Demircioglu 2015 reported improved overall WOMAC outcomes (0-96, lower is better) among patients randomized to rehabilitation with adjunctive NMES compared with rehabilitation alone at 3 months after TKA (MD −4.9, 95% CI −9.5 to −0.3).

Table 53. Post-acute rehabilitation versus various controls for total knee arthroplasty – continuous outcomes, quality of life

Study, Year, PMID, Country	Arm 1	Arm 2	Overall RoB	Outcome Measurement	Time Point[A]	N Arm 1	Arm 1, Mean (SD)	N Arm 2	Arm 2, Mean (SD)	Effect Size (95% CI)	Reported p-Value
Andersen, 2018, CN-01647420, Denmark	Technological assisted rehabilitation	Supervised rehabilitation	High	KOOS: QoL (0-100)	6 mo	NR	NR (NR)	NR	NR (NR)	**12.2% (in favor of technological assisted rehabilitation)**	**NR**
	Technological assisted rehabilitation	Supervised rehabilitation	High	KOOS: QoL (0-100)	12 mo	NR	NR (NR)	NR	NR (NR)	**<10% difference between groups**	**NR**
Artz, 2017, 27068368,UK	Group-based exercise	Usual care	High	KOOS: QoL (0-100)	3 mo	19	52.4 (27.1)	12	36.1 (17.3)	16.3 (5.1, 27.5)[B]	NR
	Group-based exercise	Usual care	High	KOOS: QoL (0-100)	6 mo	21	61.5 (32.3)	15	45.1 (29.2)	16.4 (2.1, 30.7)[B]	NR
Bruun-Olsen, 2013, 23614370, Norway	Walking-skill group	17 individual physiotherapy sessions	Moderate	KOOS: QoL (0-100)	9 mo	29	72 (24)	28	62 (26)	adj 5 (-7, 17)	NR
DeJong, 2020, 32360105 USA	Body Weight-Adjustable Treadmill & PENS	Recumbent Bike & PENS	High	KOOS: QoL (0-100)	6 mo	70	77.1 (22.0)	78	73.2 (22.9)	-3.9 (-9.0, 1.2)	NR
	Body Weight-Adjustable Treadmill & PENS	Body Weight-Adjustable Treadmill	High	KOOS: QoL (0-100)	6 mo	70	77.1 (22.0)	76	76.1 (24.3)	1.0 (-6.3, 4.3)	NR
	Body Weight-Adjustable Treadmill & PENS	Recumbent Bike/Usual Care	High	KOOS: QoL (0-100)	6 mo	70	77.1 (22.0)	74	77.9 (21.6)	0.8 (-4.2, 5.8)	NR
Demircioglu, 2015, 26355656, Turkey	NMES & exercise	Exercise	High	SF-36 (0-100)	3 mo	30	68 (11.6)	30	67.8 (15.6)	0.2 (-4.8, 5.2)[B]	NR
Kauppila, 2010, 20354057, Finland	Multidisciplinary rehabilitation group	Control	Moderate	HRQoL-15D score	1y	36	NR (NR)	39	NR (NR)	NR	>0.05
Lenguerrand, 2020, 31033232, UK	Physical therapy and standard care	Standard care	Moderate	KOOS: QoL (0-100)	12 mo	72	Median (IQR) 75 (50 , 94)	69	Median (IQR) 63 (56 , 88)	NR	0.264
Minns Lowe, 2012, 22180446, UK	Home-visit physiotherapy	Usual care	High	KOOS: QoL (0-100)	3 mo	46	Median (IQR) 53.1 (25)	47	Media (IQR) 56.3 (31)	3.2 (-2.8, 9.2)[B]	NR
	Home-visit physiotherapy	Usual care	High	KOOS: QoL (0-100)	6 mo	42	Median (IQR) 59.4 (31)	43	Media (IQR) 59.4 (41)	0 (-8.1, 8.1)[B]	NR

Study, Year, PMID, Country	Arm 1	Arm 2	Overall RoB	Outcome Measurement	Time Point[A]	N Arm 1	Arm 1, Mean (SD)	N Arm 2	Arm 2, Mean (SD)	Effect Size (95% CI)	Reported p-Value
	Home-visit physiotherapy	Usual care	High	KOOS: QoL (0-100)	12 mo	44	Median (IQR) 63 (43)	48	Media (IQR) 62.5 (42)	-0.5 (-9.6, 8.6)	NR
Moffet, 2015, 26178888, Canada	In-home Telerehabilitation	Standard home rehabilitation	Moderate	KOOS: QoL (0-100)	4 mo	100	69 (NR)	98	69.5 (NR)	-0.4 (-6.8, 6.1)	NR
Monticone, 2013, 23063624, Italy	Home-based functional exercises and kinesiophobia training	Usual care	Moderate	KOOS: QoL (0-100)	6 mo	55	NR	55	NR	**10.81 (3.01, 18.61)**	**NR**
	Home-based functional exercises and kinesiophobia training	Usual care	Moderate	KOOS: QoL (0-100)	12 mo	55	NR	55	NR	**12.27 (4.80, 19.74)**	**NR**
Petersen, 2018, 29294078, Netherlands	Exercise & acupuncture	Exercise	Moderate	KOOS: QoL (0-100)	3 mo	82	N with success (%) 33 (39)	83	N with success (%) 31 (37)	RR 1.05 (0.72, 1.55)	0.797
Piva, 2019, 30794296, USA	Community-based group exercise	Standard care	Moderate	SF-36 (0-100)	3 mo	90	45 (9)	44	44 (8)	0.7 (-1.8, 3.2)	NR
	Clinic-based group exercise	Standard care	Moderate	SF-36 (0-100)	3 mo	87	45 (8)	44	44 (8)	2.3 (-0.2, 4.7)	NR
	Community-based group exercise	Standard care	Moderate	SF-36 (0-100)	6 mo	89	46 (9)	45	44 (10)	0.9 (-2.0, 3.7)	NR
	Clinic-based group exercise	Standard care	Moderate	SF-36 (0-100)	6 mo	88	45 (9)	45	44 (10)	3.4 (0.5, 6.2)	NR

Statistically significant effect sizes are in bold text. In cases where calculated effect size confidence intervals were not-statistically significant but reported p-values were, we deferred to reported p-values and still bolded results.

Abbreviations: CI = confidence interval, HRQoL-15D = 15-dimensional instrument of health-related quality of life, IQR = interquartile range, KOOS = Knee injury and osteoarthritis outcome score, mo = month, NR = not reported, PMID = PubMed identifier, QoL = quality of life, RoB = risk of bias, SF-36 = 36-item short form survey, SD = standard deviation.

[A] Time from surgery
[B] Calculated

Table 54. Post-acute rehabilitation versus various controls for total knee arthroplasty – continuous outcomes, satisfaction with care

Study, Year, PMID, Country	Arm 1	Arm 2	Overall RoB	Outcome Measurement	Time Point[A]	N Arm 1	Arm 1, Mean (SD)	N Arm 2	Arm 2, Mean (SD)	Effect Size (95% CI)	Reported p-Value
Moffet, 2015, 26178888, Canada	In-home Telerehabilitation	Standard home rehabilitation	Moderate	Health care satisfaction questionnaire	4 mo	98	90.3 (9.9)	82	89.3 (9.6)	-1.0 (-3.02, 1.02)[B]	0.34

Abbreviations: CI = confidence interval, mo = month, PMID = PubMed identifier, RoB = risk of bias, SD = standard deviation.

[A] Time from surgery
[B] Calculated

Table 55. Post-acute rehabilitation versus various controls for total knee arthroplasty – continuous outcomes, patient global assessment

Study, Year, PMID, Country	Arm 1	Arm 2	Overall RoB	Outcome Measurement	Time Point[A]	N Arm 1	Arm 1, Mean (SD)	N Arm 2	Arm 2, Mean (SD)	Effect Size (95% CI)	Reported p-Value
Artz, 2017, 27068368,UK	Group-based exercise	Usual care	High	Measure yourself medical outcome profile	3 mo	19	1.9 (1.3)	12	2.8 (0.9)	**-0.9 (-1.5, -0.3)**[B]	**NR**
	Group-based exercise	Usual care	High	Measure yourself medical outcome profile	6 mo	21	1.9 (1.4)	15	2.4 (1.3)	-0.5 (-1.1, 0.1)[B]	NR
Bade, 2017, 27813347, USA	High-intensity progressive rehabilitation	Low-intensity rehabilitation	Moderate	WOMAC: Total (0-96)	3 mo	72	14.49 (8.98)	75	14.55 (8.38)	-0.1 (-2.1, 1.9)[B]	NR
	High-intensity progressive rehabilitation	Low-intensity rehabilitation	Moderate	WOMAC: Total (0-96)	6 mo	66	8.97 (7.27)	67	10.60 (9.45)	-1.6 (-3.7, 0.4)[B]	NR
	High-intensity progressive rehabilitation	Low-intensity rehabilitation	Moderate	WOMAC: Total (0-96)	12 mo	62	6.69 (7.75)	62	7.16 (6.28)	-0.5 (-2.2, 1.3)[B]	NR
Bily, 2016, 26763947, Austria	Leg-press group	Physiotherapy group	High	WOMAC: Total (0-96)	3 mo	26	2.3 (0.28)	29	2.0 (0.18)	0.3 (0.2, 0.4)[B]	0.26
DeJong, 2020, 32360105 USA	Body Weight-Adjustable Treadmill & PENS	Recumbent Bike & PENS	High	KOOS: Total (0-100)	6 mo	70	78.4 (17.8)	78	75.4 (17.7)	-3.0 (-7.1, 1.1)	NR
	Body Weight-Adjustable Treadmill & PENS	Body Weight-Adjustable Treadmill	High	KOOS: Total (0-100)	6 mo	70	78.4 (17.8)	76	77.5 (18.3)	-0.9 (-5.0, 3.2)	NR
	Body Weight-Adjustable Treadmill & PENS	Recumbent Bike/Usual Care	High	KOOS: Total (0-100)	6 mo	70	78.4 (17.8)	74	80.7 (13.2)	2.3 (-1.4, 6.0)	NR
Demircioglu, 2015, 26355656, Turkey	NMES & exercise	Exercise	High	WOMAC: Total (0-96)	3 mo	30	42.3 (11.3)	30	47.2 (13.8)	**-4.9 (-9.5, -0.3)**[B]	**NR**

Study, Year, PMID, Country	Arm 1	Arm 2	Overall RoB	Outcome Measurement	Time Point[A]	N Arm 1	Arm 1, Mean (SD)	N Arm 2	Arm 2, Mean (SD)	Effect Size (95% CI)	Reported p-Value
Kauppila, 2010, 20354057, Finland	Multidisciplinary rehabilitation group	Control	Moderate	WOMAC: Total (0-96)	12 mo	36	NR (NR)	39	NR (NR)	NR	NR
Mitchell, 2005, 15869558, UK	Hospital	Home	High	SF-6D (0.3-1.0)	3 mo	57	0.56 (0.12)	57	0.57 (0.09)	Adj MD 0.002 (-0.034, 0.039)	0.894
	Hospital	Home	High	SF-36 (0-100)	3 mo	57	61.0 (22.9)	57	61.0 (23.4)	Adj MD -0.2 (-7.0, 6.7)	0.964
Piva, 2019, 30794296, USA	Community-based group exercise	Standard care	Moderate	PROMIS	3 mo	90	45 (5)	44	45 (5)	0.5 (-1.0, 1.9)	NR
	Community-based group exercise	Standard care	Moderate	PROMIS	6 mo	89	45 (5)	45	44 (5)	1.4 (-0.1, 2.9)	NR
	Clinic-based group exercise	Standard care	Moderate	PROMIS	3 mo	87	45 (5)	44	45 (5)	1.0 (-0.4, 2.5)	NR
	Clinic-based group exercise	Standard care	Moderate	PROMIS	6 mo	88	45 (5)	45	44 (5)	2.1 (0.7, 3.6)	NR

Statistically significant effect sizes are in bold text. In cases where calculated effect size confidence intervals were not-statistically significant but reported p-values were, we deferred to reported p-values and still bolded results.

Abbreviations: Adj MD = adjusted mean difference CI = confidence interval, KOOS = Knee injury and osteoarthritis outcome score, mo = month, NMES = neuromuscular electrical stimulation, NR = not reported, PENS = patterned electrical neuromuscular stimulation, PMID = PubMed identifier, PROMIS = patient-reported outcomes measurement information system, RoB = risk of bias, SD = standard deviation, SF-36 = 36-Item short form survey, SF-6D = short-form six-dimension, WOMAC = Western Ontario and McMaster Universities Osteoarthritis Index.

[A] Time from surgery
[B] Calculated

Healthcare Utilization Outcomes Following Post-Acute Rehabilitation

Three studies (Bade 2017, Hamilton 2020, Mitchel 2005)) reported on healthcare-utilization outcomes following acute rehabilitation compared to various control. Outcomes included: need for postoperative procedures and other healthcare-utilization outcomes.

Need for Postoperative Procedures

One study (Bade 2017) reported data on the need for postoperative procedures after rehabilitation following TKA surgery and observed few events in which patient needed MUA to address stiff knee, with comparable proportions of patients requiring MUA between groups (Table 56).

Other Healthcare Utilization Outcomes

Cost data (indirect or direct) associated with rehabilitation programs were rarely reported. Hamilton 2020 (UK-based) compared outpatient therapist-led rehabilitation with physiotherapy review and home exercises. Both programs operated within the constraints of standard UK National Health Service (NHS) resources allotted for TKA rehabilitation (equivalent to about six sessions). Mitchell 2005, also UK-based, reported no significant difference in the total NHS costs per patient between groups, but the costs associated with the home physiotherapy program were significantly more expensive compared with hospital outpatient (MD £137, 95% CI £113 to £160; approximately $217, 95% CI $179 to $253 US dollars during study time period).

Cost-Effectiveness

We found no studies comparing the cost-effectiveness of rehabilitation with various comparators. Lenguerrand 2020 (comparing group-based outpatient physical therapy and standard care vs. standard care alone) has planned to publish a cost-effectiveness analysis separately which was not identified by our searches.

Harms From Rehabilitation

Among studies that reported on harms, most (n=10/17) reported no adverse events associated with the diverse rehabilitation programs (Bily 2016, Heikkila 2017, Kauppila 2010, Lenguerrand 2020, Li 2015, Liao 2020, Minns Lowe 2012, Moutzouri 2018, Petterson 2009, Petersen 2018) (Table 57). Of the seven studies (Bade 2017, Fransen 2017, Piva 2017, Vuorenmaa 2014, Moffet 2015, Piva 2019, Li 2019) reported data on harms, harms were of low severity (e.g., falls, musculoskeletal injuries, stiffness), uncommon (0 to 6% for all outcomes with the exception of Piva which reported 13% for arthralgia/joint pain for patients receiving clinic-based care), and comparable between groups.

Table 56. Post-acute rehabilitation versus various controls for total knee arthroplasty – need for postoperative procedures

Study, Year, PMID, Country	Arm 1	Arm 2	Overall RoB	Outcome Measurement	Time Point[A]	Arm 1 n/N (%)	Arm 2 n/N (%)	OR (95% CI)	Reported p-Value
Bade, 2017, 27813347, USA	High-intensity progressive rehabilitation	Low-intensity rehabilitation	Moderate	Knee manipulation	12 mo	3/84	1/78	2.85 (0.29, 28.01)[A]	NR

Statistically significant effect sizes are in bold text. In cases where calculated effect size confidence intervals were not-statistically significant but reported p-values were, we deferred to reported p-values and still bolded results.

Abbreviations: CI = confidence interval, mo = month, NR = not reported, OR = odds ratio, PMID = PubMed identifier, RoB = risk of bias.

[A] Calculated

Table 57. Post-acute rehabilitation versus various controls for total knee arthroplasty – harms

Study, Year, PMID, Country	Arm 1	Arm 2	Overall RoB	Outcome Measurement	Time Point[A]	Arm 1 n/N (%)	Arm 2 n/N (%)	OR (95% CI)	Reported p-Value
Bade, 2017, 27813347, USA	High-intensity progressive rehabilitation	Low-intensity rehabilitation	Moderate	Musculoskeletal injuries	12 mo	0/84 (0%)	1/78 (1%)	0.46 (0.02, 13.94)[B]	NR
	High-intensity progressive rehabilitation	Low-intensity rehabilitation	Moderate	Restricted knee ROM	12 mo	3/84 (4%)	3/78 (4%)	0.93 (0.18, 4.73)[B]	NR
	High-intensity progressive rehabilitation	Low-intensity rehabilitation	Moderate	Fall	12 mo	1/84 (1%)	3/78 (4%)	0.30 (0.03, 2.96)[B]	NR
Li, 2019, 31003647, China	Tai Chi	Control	Moderate	Fall	3 mo	0/54 (0%)	3/53 (6%)	0.16 (0.01, 3.19)[B]	NR
Moffet, 2015, 26178888, Canada	In-home Telerehabilitation	Standard home rehabilitation	Moderate	Fall	4 mo	1/101 (1%)	0/104 (0%)	2.06 (0.07, 60.71)[B]	NR
	In-home Telerehabilitation	Standard home rehabilitation	Moderate	Wound bleeding (during flexion exercises)	4 mo	1/101 (1%)	0/104 (0%)	2.06 (0.07, 60.71)[B]	NR
Piva, 2019, 30794296, USA	Community-based group exercise	Standard care	Moderate	Arthralgia	4 mo	7/96 (1%)	1/48 (1%)	3.70 (0.44, 30.95)[B]	NR
	Community-based group exercise	Standard care	Moderate	Back Pain	4 mo	2/96 (2%)	0/48 (0%)	2.02 (0.09, 45.71)[B]	NR
	Community-based group exercise	Standard care	Moderate	Fall	4 mo	1/96 (1%)	1/48 (2%)	0.49 (0.03, 8.09)[B]	NR
	Community-based group exercise	Standard care	Moderate	Myalgia	4 mo	1/96 (1%)	0/48 (0%)	1.00 (0.03, 30.35)[B]	NR
	Community-based group exercise	Standard care	Moderate	Other musculoskeletal and connective tissue	4 mo	0/96 (0%)	0/48 (0%)	0.50 (0.01, 25.46)[B]	NR
	Clinic based	Standard care	Moderate	Arthralgia/joint pain	4 mo	12/96 (13%)	1/48 (2%)	6.71 (0.85, 53.26)[B]	NR

Study, Year, PMID, Country	Arm 1	Arm 2	Overall RoB	Outcome Measurement	Time Point[A]	Arm 1 n/N (%)	Arm 2 n/N (%)	OR (95% CI)	Reported p-Value
	Clinic based	Standard care	Moderate	Back Pain	4 mo	1/96 (1%)	0/48 (0%)	1.00 (0.03, 30.35)[B]	NR
	Clinic based	Standard care	Moderate	Injury related to arthroplasty-Fall	4 mo	0/96 (0%)	1/48 (2%)	0.25 (0.01, 7.47)[B]	NR
	Clinic based	Standard care	Moderate	Myalgia	4 mo	0/96 (0%)	0/48 (0%)	0.50 (0.01, 25.46)[B]	NR
	Clinic based	Standard care	Moderate	Other musculoskeletal and connective tissue	4 mo	5/96 (5%)	0/48 (0%)	5.22 (0.28, 97.58)[B]	NR

Statistically significant effect sizes are in bold text. In cases where calculated effect size confidence intervals were not-statistically significant but reported p-values were, we deferred to reported p-values and still bolded results.

Abbreviations: CI = confidence interval, mo = month, NR = not reported, OR = odds ratio, PMID = PubMed identifier, RoB = risk of bias, ROM = range of motion.

[A] Time from surgery
[B] Calculated

Heterogeneity of Treatment Effects (Subgroup Differences)

No studies reported subgroup analyses or more specifically, formally analyzed possible heterogeneity of treatment effects, i.e., statistical tests for whether the comparative effect of rehabilitation versus its various comparators differed in one subgroup of patients versus another (e.g., patients with higher vs. lower measures of strength, flexibility, function, etc. at baseline).

Applicability

Studies were conducted across the globe (seven in the United States) using diverse interventions employed in diverse healthcare settings. While the relative effect of the interventions on clinical outcomes (and harms) from non-U.S.-based studies are likely applicable to the U.S. context, findings pertaining to healthcare system or resources (such as costs or comparisons of inpatient vs. outpatient rehabilitation) are likely country and healthcare system specific. The sex of participants varied widely across studies, ranging from 27 to 100 percent of participants being female. The average age of patients ages ranged from 56 to 79 years and the average BMIs ranged from 27 to 35 kg/m^2 (thus, in all studies, most patients were obese, but in several, many to most were morbidly obese). Most studies did not report whether patients had undergone previous contralateral replacement surgery; of those that did, proportions were low (less than 30%). As such, the conclusions in this KQ are likely most applicable to middle-to-older-aged adults in high-income countries who are receiving their first total TKA for osteoarthritis.

Summary of Comparison of Rehabilitation Versus Various Controls for Total Knee Arthroplasty

Table 58 summarizes the evidence for the comparison of post-acute rehabilitation versus various comparators. We focus on the outcomes we prioritized in discussion with stakeholders.

There is low to insufficient SoE for all conclusions. Compared with various controls (usually less intensive active rehabilitation controls), rehabilitation in the post-acute phase may result in comparable outcomes of pain, ROM, strength, ADL, and QoL (low SoE). There is insufficient evidence on the impact of post-acute rehabilitation on satisfaction with care and need for postoperative procedures. There is low SoE that there is no difference between post-acute rehabilitation and various comparators in harms related to the intervention.

Table 58. Evidence profile: Post-acute rehabilitation versus various controls for total knee arthroplasty

Outcome Category	Outcome	N Studies (Participants)	RoB	Consistency	Precision	Directness	Intervention Replication	SoE	Conclusions
Body structure and function	Pain	22 (2478)	Moderate	Consistent	Precise	Direct	All unique	Low	Similar pain
	ROM	15 (1487)	Moderate	Consistent	Precise	Direct	All unique	Low	Similar ROM
	Strength	14 (1464)	Moderate	Consistent	Precise	Direct	All unique	Low	Similar strength
Activity and participation	ADLs	22 (2657)	Moderate	Inconsistent	Precise	Direct	All unique	Low	Similar ADL
Other patient-reported outcomes	Satisfaction with care	1 (180)	Moderate	Consistency unknown (single study)	Precise	Direct	NA (single study)	Insufficient	No conclusion
	QoL	12 (1208)	Moderate	Consistent	Precise	Direct	All unique	Low	Similar QoL
Healthcare utilization	Need for postoperative procedures	1 (162)	Moderate	Consistency unknown (single study)	Precise	Direct	NA (single study)	Insufficient	No conclusion
Harms	Harms from rehabilitation	17 (2333)	Moderate	NA	Precise	Direct	All unique	Low	Similar harms

Abbreviations: ADLs = activities of daily living, QoL = quality of life, NA = not applicable, QoL = quality of life, RoB = risk of bias, ROM = range of motion, SoE = strength of evidence.

Key Question 3: Prehabilitation for Total Hip Arthroplasty

Key Points

- For patients undergoing THA, there is insufficient evidence of a difference between prehabilitation and no prehabilitation for outcomes of pain, strength, ADLs, QoL, length of stay, or posthospital disposition.
- There was no evidence on satisfaction with care or risk of harms due to prehabilitation.
- There is insufficient evidence on the effectiveness of specific prehabilitation intervention components at the level of goals (e.g., strength, flexibility, etc.) or presence of specific exercise components to address these goals.
- There is insufficient evidence on modification of prehabilitation effects by patient, surgical, or setting factors.
- There is no evidence on the cost effectiveness of prehabilitation compared with no prehabilitation.

Findings Pertaining to Prehabilitation for Total Hip Arthroplasty

We found six eligible studies, all RCTs, that compared some version of a prehabilitation intervention to no prehabilitation (summarized in Figure 4). No prehabilitation was defined variably and generally included either specification of no additional care (e.g., "no therapy" [Bitterli 2011],[137] "no additional care" (Vukomanović 2008),[138] "care as usual" (Holsgaard-Larsen 2020, Pour 2007),[139, 140] or dissemination of information on surgical and postoperative expectations (Pour 2007, Rooks 2006, Soeters 2018).[73, 140, 141] Of note, Pour 2007 and Holsgaard-Larsen 2020 noted their dissemination of information as usual care, although this was not defined as usual care in other studies. We rated two of the RCTs to be at overall high risk of bias, mostly related to lack of blinding of participants, study personnel, and/or outcome assessors and unclear methods of how random sequences were generated and/or concealed from patients. We rated the remaining four trials to be at overall moderate risk of bias mostly related to lack of blinding of participants, study personnel, and/or outcome assessors.

The six RCTs enrolled between 45 and 94 participants each. Three were conducted in the United States and three in Europe. One study reported information on funding and was supported by industry (a medical technology company).[140] The average ages of participants were similar across studies, ranging from 56 to 74 years. The percentage of women in the studies varied from 25 to 80 percent. Average BMI ranged from 26 to 30 kg/m^2. No trials reported information on the proportion of patients who had undergone prior contralateral THA. Appendix Tables C-3.1, C-3.2, and C-3.3 include the full data for all six RCTs.

Prehabilitation Versus No Prehabilitation

Six RCTs, reported in six articles (Bitterli 2011, Holsgaard-Larsen 2020, Pour 2007, Rooks 2006, Soeters 2018, Vukomanović 2008) compared prehabilitation to no prehabilitation in a total of 425 patients who subsequently underwent THA. Only two studies had somewhat similar interventions (Soeters 2018, Vukomanović 2008); the remaining four studies evaluated unique prehabilitation interventions comprised of varying goals and exercise components (as coded by our taxonomy), delivered in a variety of settings (by different modalities) by diverse (or no) personnel. Soeters 2018 and Vukomanović 2008 evaluated a preoperative physical therapy

program (targeting task-specific training, and patient education goals) with a no prehabilitation control.

Prehabilitation interventions were initiated between 2 and 10 weeks prior to the scheduled THA (in four trials). Pour 2007 and Vukomanović 2008 did not report when participants began their prehabilitation programs.

The six trials did not have consistent component goals for the evaluated prehabilitation interventions. Exercises to target strength and task specific training were included in three trials. Components to target patient education were also included in three trials. Exercises to target aerobic endurance and flexibility were only included in one trial. No prehabilitation interventions included components of balance-motor-learning-agility. Specific exercise components within prehabilitation goal components varied across programs. No study included adjunctive modalities in combination with the prehabilitation programs.

Two studies reported some form of progression, of which one (Holsgaard-Larsen 2020) was assessed by clinical experts on our team as appropriate. No study compared prehabilitation with versus without progression.

Interventions were delivered by physical therapists in five of the six studies. Bitterli 2011 included one group where prehabilitation comprised an unsupervised self-guided home component (i.e., no one supervised) and a second group who received an in-person training component without a report of who delivered the intervention. Reported settings included home (Bitterli 2011), an outpatient rehabilitation facility (Pour 2007; Holsgaard-Larsen 2020), and a community fitness center (Rooks 2006). Two studies did not report where prehabilitation was delivered.

Specific codes for intervention (and control arm, where present) goals and exercises, use of progression (and assessment of appropriateness), and details on personnel, mode of delivery, and setting are detailed in Table 59 and Appendix Table C-3.2.

Figure 4. Overview of studies of prehabilitation interventions for total hip arthroplasty

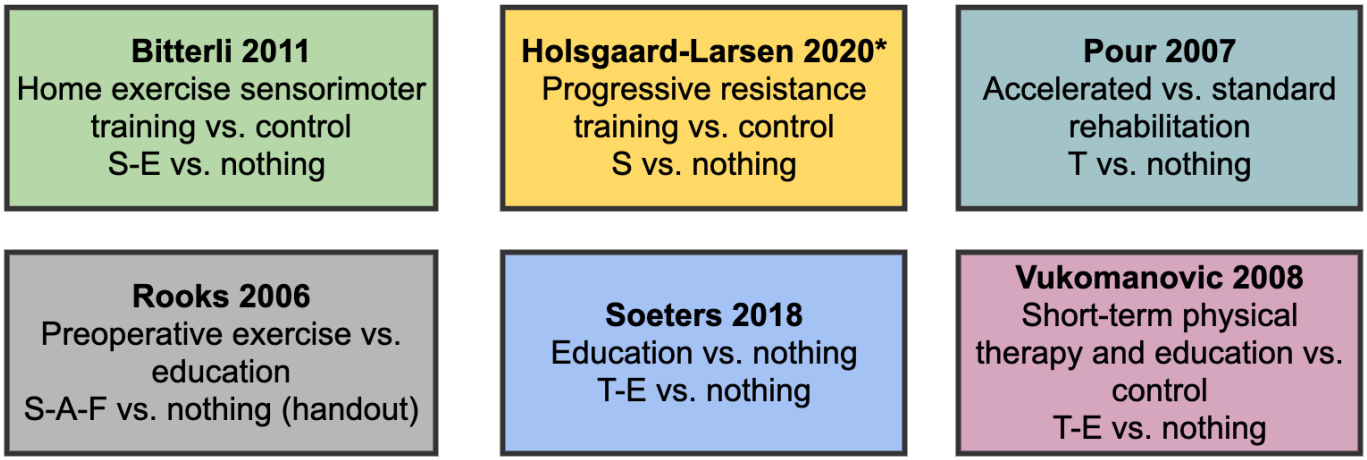

Figure presents studies (n=6) that evaluated prehabilitation programs for total hip arthroplasty versus nothing (defined by the study and the goal components coded by the Oatis and Franklin taxonomy). The color is added for visual display and does not provide unique information.

Abbreviations: Adj = adjunctive, A = aerobic exercise, B= Balance-motor/Learning-agility exercise, E = patient education, F = flexibility exercise, S = strengthening exercise, T = task-specific training.

* Intervention included progression which was deemed appropriate.

Table 59. Goal components and their specific exercise components for prehabilitation interventions versus no prehabilitation for total hip arthroplasty

Study	Arm	Strength	Bridges	Core Strengthening	Gluteal Sets	Hip Abduction	Knee Flexion	Leg Press	Quad Sets	Squats	Upper Extremity Strengthening	Aerobic	Bike (Endurance)	Elliptical Machine	Flexibility	Ankle Pumps	Calf Stretch	Hip Extensor Stretch	Hip Flexor Stretch	Knee Extension	Knee Flexion	Task Specific Training	Gait Training	Sit-To-Stand Training	Stair Training	Transfers	Patient Education	Activities Of Daily Living	Home Exercise Program	Adjunctive Modality	Progression (Appropriate?)	Personnel	Mode of delivery	Setting
Bitterli, 2011	Preop exercise	1	1	0	1	1	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	N	NR; None	I; SG	H
	No therapy	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N	NA	NA	NA
Holsgaard-Larsen	Preop PRT	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Y (Y)	PT	I	O
2020	Control	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N	NA	NA	NA
Pour, 2007	Accelerated reh	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	N	PT	I	O
	Standard rehab	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N	NA	NA	NA
Rooks, 2006	Preop exercise	1	0	1	0	0	0	1	0	0	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	Y (N)	PT	I	G
	Preop ed	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N	NA	NA	NA
Soeters, 2018	PreopPTEd	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	1	1	1	0	0	N	PT	I	NR
	NoPreopPTEd	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N	NA	NA	NA
Vukomanović, 2008	Preop PT & ed	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	N	PT	I	NR
	Control	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N	NA	NA	NA

The color is added for visual display and does not provide unique information.

1 = presence of component, 0 = absence of component

Abbreviations: AI = acute in-patient; ed = education, I = in-person, G = gym/other community center, H = home, NA = not applicable, NR = not reported, O = outpatient physiotherapy center, PT = physical therapy, preop = preoperative; PRT = progression resistance training, rehab = rehabilitation

The heterogeneity of the included prehabilitation interventions (varying content, use and appropriateness of progression, and personnel, setting, and timing of intervention delivery) made it challenging to identify meaningful groupings of similar studies to synthesize. In the absence of meaningful clusters of similar studies, we opted to summarize all prehabilitation studies together but contextualize interpretations of individual study results with details about the specific form of prehabilitation evaluated in those studies. We report outcomes under the four following outcome categories: body structure and function; activity and participation; other patient-reported; and healthcare-utilization. Given intervention heterogeneity, we determined that meta-analysis was not warranted (i.e., average result would not have been interpretable/meaningful) and instead summarize results narratively.

Body Structure and Function Outcomes

Three RCTs (Bitterli 2011, Holsgaard-Larsen, 2020, Rooks 2006) reported on body structure and function outcomes comparing prehabilitation with no prehabilitation (Tables 60 to 65). The outcomes included: symptoms, pain, range of motion, muscle strength, energy and vigor, and emotional functioning.

Symptoms

One study (Holsgaard-Larsen 2020) reported data on symptoms using the symptoms component of the Hip Disability Osteoarthritis Outcome Score (HOOS; 0 to 100; higher is better) (Table 60) and observed no difference between groups 12 months after THA.

Pain

Two studies (Holsgaard-Larsen 2020 and Rooks 2006) reported data on symptoms using the pain components of the HOOS (0 to 100; higher is better), SF-36 (for each component: 0-100; higher is better) and the WOMAC (0 to 20, smaller is better) and observed no differences between groups at 6 and 12 months after THA (Table 61).

Range of Motion

One study (Holsgaard-Larsen 2020) reported data on knee extension and hip extension and observed no differences as 12-month follow-up (Table 62).

Muscle Strength

Rooks 2006 reported on muscle strength data using the one-repetition maximum leg press test, which is designed to assess lower-extremity strength (Table 63). During the test, resistance is systematically increased until patients maximum voluntary muscle force is achieved. Higher values indicate greater strength. Rooks 2006 reported no statistically (or clinically) significant difference between prehabilitation and control groups 6 months after THA (Rooks 2006).

Energy and Vigor

Bitterli 2011 reported on vigor using the vitality component of the SF-36 (scores 0 to 100, higher is better) (Table 64). The trial found a statistically significant improvement in vitality among patients randomized to the preoperative home exercise sensorimotor training program compared with those who received no preoperative therapy ($P<0.05$) at 12 months after surgery. The authors reported that Cohen's $d = 0.65$, but did not provide data to allow estimation of the MD.

Emotional Functioning

Bitterli 2011 reported on emotional functioning data from mental health scale of the SF-36 (scores 0 to 100, higher is better) and found a statistically significant improvement in mental health among patients randomized to the pre-operative home exercise sensorimotor training program compared with those who received no preoperative therapy (Cohen's d=0.75; P<0.05) at 12 months after surgery (Table 65). No further data were reported.

Table 60. Prehabilitation versus no prehabilitation for total hip arthroplasty – continuous outcomes, symptoms

Study, Year, PMID, Country	Outcome Measurement	Overall RoB	Time Point[A]	Prehab, N	Prehab, Mean (SD)	Control, N	Control, Mean (SD)	Effect Size (95% CI)	Reported p-Value
Holsgaard-Larsen, 2020, 32376477, Denmark	HOOS: Symptoms (0-100)	Moderate	12 mos	40	NR	40	NR	NMD 4.9 (-12.7,2.8)	0.21

Statistically significant effect sizes are in bold text. In cases where calculated effect size confidence intervals were not-statistically significant but reported p-values were, we deferred to reported p-values and still bolded results.

Abbreviations: CI = confidence interval, mo = month, NMD = net mean difference, NR = not reported, PMID = PubMed identifier, RoB = risk of bias, SD = standard deviation, HOOS = Hip disability and osteoarthritis outcome

[A] Time from surgery

Table 61. Prehabilitation versus no prehabilitation for total hip arthroplasty – continuous outcomes, pain

Study, Year, PMID, Country	Outcome Measurement	Overall RoB	Time Point[A]	Prehab, N	Prehab, Mean (SD)	Control, N	Control, Mean (SD)	Effect Size (95% CI)	Reported p-Value
Holsgaard-Larsen, 2020, 32376477, Denmark	HOOS: Pain (0-100)	Moderate	12 mos	40	NR	40	NR	NMD 0.5 (-6.7,7.7)	0.89
Rooks, 2006, 17013852, USA	SF-36: bodily pain (0, 100)	Moderate	6 mo	25	79.6 (21.2)	24	77.4 (16.3)	MD 2.2 (-8.36, 12.76)[B]	NR
	WOMAC: pain (0, 20)	Moderate	6 mo	25	1.1 (1.7)	24	1.0 (1.2)	NMD 0.9 (-0.59, 2.39)[B]	NR

Statistically significant effect sizes are in bold text. In cases where calculated effect size confidence intervals were not-statistically significant but reported p-values were, we deferred to reported p-values and still bolded results.

Abbreviations: CI = confidence interval, mo = month, HOOS = Hip disability and osteoarthritis outcome, NMD = net mean difference, NR = not reported, PMID = PubMed identifier, RoB = risk of bias, SD = standard deviation, SF-36 = 36-Item short form survey, WOMAC = Western Ontario and McMaster Universities Osteoarthritis Index

[A] Time from surgery
[B] Calculated

Table 62. Prehabilitation versus various controls for total hip arthroplasty – continuous outcomes, range of motion

Study, Year, PMID, Country	Outcome Measurement	Overall RoB	Time Point[A]	Prehab, N	Prehab, Mean (SD)	Control, N	Control, Mean (SD)	Effect Size (95% CI)	Reported p-Value
Holsgaard-Larsen, 2020, 32376477, Denmark	Knee extension	Moderate	12 mo	40	NR	40	NR	NMD 0.10 (0.02,0.22)	0.088
	Hip extension	Moderate	12 mo	40	NR	40	NR	NMD 0.09 (-0.05,0.22)	0.23

Statistically significant effect sizes are in bold text. In cases where calculated effect size confidence intervals were not-statistically significant but reported p-values were, we deferred to reported p-values and still bolded results.

Abbreviations: CI = confidence interval, kg = kilogram, mo = month, NMD = net mean difference, NR = not reported, PMID = PubMed identifier, RoB = risk of bias, SD = standard deviation

[A] Time from surgery

Table 63. Prehabilitation versus various controls for total hip arthroplasty – continuous outcomes, muscle strength

Study, Year, PMID, Country	Outcome Measurement	Overall RoB	Time Point[A]	Prehab, N	Prehab, Mean (SD)	Control, N	Control, Mean (SD)	Effect Size (95% CI)	Reported p-Value
Rooks, 2006, 17013852, USA	1-repetition maximum (kg)	Moderate	6 mo	25	99 (37)	24	117 (51)	NMD -1 (-27.29, 25.29)[B]	NR

Statistically significant effect sizes are in bold text. In cases where calculated effect size confidence intervals were not-statistically significant but reported p-values were, we deferred to reported p-values and still bolded results.

Abbreviations: CI = confidence interval, kg = kilogram, mo = month, NMD = net mean difference, NR = not reported, PMID = PubMed identifier, RoB = risk of bias, SD = standard deviation

[A] Time from surgery
[B] Calculated

Table 64. Prehabilitation versus no prehabilitation for total hip arthroplasty – continuous outcomes, energy and vigor

Study, Year, PMID, Country	Outcome Measurement	Overall RoB	Time Point[A]	Prehab, N	Prehab, Mean (SD)	Control, N	Control, Mean (SD)	Effect Size (95% CI)	Reported p-Value
Bitterli, 2011, 21630176, Switzerland	SF-36: vitality (NR, NR)	Moderate	12 mo	41	NR	39	NR	**Cohen's d 0.65**	**<0.05**

Statistically significant effect sizes are in bold text. In cases where calculated effect size confidence intervals were not-statistically significant but reported p-values were, we deferred to reported p-values and still bolded results.

Abbreviations: CI = confidence interval, NR = not reported, PMID = PubMed identifier, RoB = risk of bias, SF-36 = 36-Item short form survey, SD = standard deviation

[A] Time from surgery

Table 65. Prehabilitation versus no prehabilitation for total hip arthroplasty – continuous outcomes, emotional functioning (stress/coping)

Study, Year, PMID, Country	Outcome Measurement	Overall RoB	Time Point[A]	Prehab, N	Prehab, Mean (SD)	Control, N	Control, Mean (SD)	Effect Size (95% CI)	Reported p-Value
Bitterli, 2011, 21630176, Switzerland	SF-36: mental health (0-100)	Moderate	12 mo	41	NR	39	NR	**Cohen's d 0.75**	**<0.05**

Statistically significant effect sizes are in bold text. In cases where calculated effect size confidence intervals were not-statistically significant but reported p-values were, we deferred to reported p-values and still bolded results.

Abbreviations: CI = confidence interval, NR = not reported, PMID = PubMed identifier, RoB = risk of bias, SF-36 = 36-Item short form survey, SD = standard deviation.

[A] Time from surgery

Activity and Participation Outcomes

Three RCTs (Bitterli 2006, Holsgaard-Larsen 2020, Rooks 2006) reported on activity and participation outcomes, comparing prehabilitation to no prehabilitation (Tables 66 to 70). The outcomes included: patient-reported physical function, transfers, balance, mobility, and timed up and go.

Patient-Reported Physical Function and Activities of Daily Living

Rooks 2006, Bitterli 2006, and Holsgaard-Larsen 2020 reported on patient-reported physical function on ADL using three different measurement instruments and found no differences between groups between 6 and 12 months after THA (Table 66).

Transfers

One study (Holsgaard-Larsen 2020) reported data on transfers using the 5-time sit-to-stand test and observed no differences between groups at 12 months (Table 67).

Balance

Two studies (Bitterli 2006, Rooks 2006) reported data on balance. Bitterli 2006 recorded data on balance (dynamic or static not specified) from the Biodex Balance System but reported only that there were no statistically significant differences at 12 month follow-up. Rooks 2006 reported data on dynamic balance using the functional reach test (distance in centimeters [cm], higher is better) (Table 68) and found that patients randomized to preoperative exercise demonstrated significantly further capacity to reach compared with control groups at 6 months after THA (NMD 5.9, 95% CI 1.8 to 10.0).

Mobility

Holsgaard-Larsen 2020 reported data on mobility from two stair test measures and two walk test measures. The stair climb tests assessed the steps/second to ascend or descend a flight of stairs (more is better) and found significant differences in the performance of the stair tests in favor of the prehabilitation group compared with no prehabilitation (Table 69). The 25-meter walk tests assessed the speed (meters/second) to walk 25 meters at normal speed and maximum speed and found no difference between groups.

Timed Up and Go

Rooks 2006 reported data on the TUG test and found no statistically significant differences between groups at 6 months after THA (Table 70).

Table 66. Prehabilitation versus no prehabilitation for total hip arthroplasty – continuous outcomes, patient-reported physical function and activities of daily living

Study, Year, PMID, Country	Outcome Measurement	Overall RoB	Time Point[A]	Prehab, N	Prehab, Mean (SD)	Control, N	Control, Mean (SD)	Effect Size (95% CI)	Reported p-Value
Bitterli, 2011, 21630176, Switzerland	SF-36: physical functioning (0-100)	Moderate	12 mo	41	80.0 (SE 93.1[B])	39	85.0 (SE 98.9[B])	Cohen's d 0.39 MD -5 (-163.93, 153.93)[B]	0.39
	WOMAC (0, 68)	Moderate	12 mo	41	NR	39	NR	Cohen's d 0.08	0.47
Holsgaard-Larsen, 2020, 32376477, Denmark	HOOS: Sport/rec (0-100)	Moderate	12 mo	40	NR	40	NR	NMD 6.2 (-3.2,15.6)	0.20
	HOOS: ADL (0-100)	Moderate	12 mo	40	NR	40	NR	NMD 2.6 (-4.2,9.8)	0.44
Rooks, 2006, 17013852, USA	SF-36: role limitation physical (0, 100)	Moderate	6 mo	25	83.0 (35.2)	24	86.5 (24.4)	NMD -2.4 (-23.02, 18.22)[B]	NR
Rooks, 2006, 17013852, USA	SF-36: physical functioning (0-100)	Moderate	6 mo	25	81.7 (18.1)	24	76.6 (18.6)	NMD 8.9 (-1.31, 19.11)[B]	NR
Rooks, 2006, 17013852, USA	WOMAC: function (0-68)	Moderate	6 mo	25	5.4 (5.8)	24	5.3 (5.4)	NMD 0.8 (-5.06, 6.66)[B]	NR

Statistically significant effect sizes are in bold text. In cases where calculated effect size confidence intervals were not-statistically significant but reported p-values were, we deferred to reported p-values and still bolded results.

Abbreviations: ADL = activities of daily living, CI = confidence interval, HOOS = Hip Disability Osteoarthritis Outcome Score, mo = month, NMD = net mean difference, NR = not reported, PMID = PubMed identifier, rec = recreation, RoB = risk of bias, SD = standard deviation, SF-36 = 36-Item short form survey, WOMAC = Western Ontario and McMaster Universities Osteoarthritis Index.

[A] Time from surgery
[B] Calculated

Table 67. Prehabilitation versus no prehabilitation for total hip arthroplasty – continuous outcomes, transfers

Study, Year, PMID, Country	Outcome Measurement	Overall RoB	Time Point[A]	Prehab, N	Prehab, Mean (SD)	Control, N	Control, Mean (SD)	Effect Size (95% CI)	Reported p-Value
Holsgaard-Larsen, 2020, 32376477, Denmark	Sit-to-stand (5 times) (s)	Moderate	12 mo	40	NR	40	NR	0.7 (-1.0,4.3)	0.41

Statistically significant effect sizes are in bold text. In cases where calculated effect size confidence intervals were not-statistically significant but reported p-values were, we deferred to reported p-values and still bolded results.

Abbreviations: CI = confidence interval, mo = month, NR = not reported, PMID = PubMed identifier, RoB = risk of bias, s = second, SD = standard deviation, SE = standard error.

[A] Time from surgery

Table 68. Prehabilitation versus no prehabilitation for total hip arthroplasty – continuous outcomes, balance

Study, Year, PMID, Country	Outcome	Overall RoB	Outcome Measurement	Time point[A]	Prehab, N	Prehab, Mean (SD)	Control, N	Control, Mean (SD)	Effect Size (95% CI)	Reported p-Value
Rooks, 2006, 17013852, USA	Balance	Moderate	Functional reach (cm)	6 mo	25	33.5 (5.2)	24	31.4 (7.1)	**NMD 5.9 (1.83, 9.97)[B]**	**<0.05**

Statistically significant effect sizes are in bold text. In cases where calculated effect size confidence intervals were not-statistically significant but reported p-values were, we deferred to reported p-values and still bolded results.

Abbreviations: CI = confidence interval, cm = centimeter, mo = month, NMD = net mean difference, PMID = PubMed identifier, RoB = risk of bias, SD = standard deviation.

[A] Time from surgery
[B] Calculated

Table 69. Prehabilitation versus no prehabilitation for total hip arthroplasty – continuous outcomes, mobility

Study, Year, PMID, Country	Outcome Measurement	Overall RoB	Time Point[A]	Prehab, N	Prehab, Mean (SD)	Control, N	Control, Mean (SD)	Effect Size (95% CI)	Reported p-Value
Holsgaard-Larsen, 2020, 32376477, Denmark	Stair climb test: ascending stairs (steps/s)	Moderate	12 mo	40	NR	40	NR	**1.3 (0.3, 2.3)**	**0.0011**
	Stair climb test: descending stairs (steps/s)	Moderate	12 mo	40	NR	40	NR	**1.6 (0.3, 2.9)**	**0.017**
	25-m walk test (normal speed) (m/s)	Moderate	12 mo	40	NR	40	NR	1.4 (-0.07,2.8)	0.062
	25-m walk test (max speed) (m/s)	Moderate	12 mo	40	NR	40	NR	0.9 (-0.4,2.2)	0.17

Statistically significant effect sizes are in bold text. In cases where calculated effect size confidence intervals were not-statistically significant but reported p-values were, we deferred to reported p-values and still bolded results.

Abbreviations: CI = confidence interval, m = meter, mo = month, NR = not reported, PMID = PubMed identifier, RoB = risk of bias, SD = standard deviation, s = seconds.

[A] Time from surgery

Table 70. Prehabilitation versus no prehabilitation for total hip arthroplasty – continuous outcomes, Timed Up and Go

Study, Year, PMID, Country	Outcome Measurement	Overall RoB	Time point[A]	Prehab, N	Prehab, Mean (SD)	Control, N	Control, Mean (SD)	Effect Size (95% CI)	Reported p-Value
Rooks, 2006, 17013852, USA	TUG (s)	Moderate	6 mo	25	9.76 (1.29)	24	9.41 (1.46)	NMD -1.04 (-2.4, 0.32)[B]	NR

Statistically significant effect sizes are in bold text. In cases where calculated effect size confidence intervals were not-statistically significant but reported p-values were, we deferred to reported p-values and still bolded results.

Abbreviations: CI = confidence interval, NMD = net mean difference, NR = not reported, PMID = PubMed identifier, RoB = risk of bias, mo = month, s = second, SD = standard deviation, TUG = timed up and go.

[A] Time from surgery
[B] Calculated

Other Patient-Reported Outcomes

One study reported on other patient-reported outcomes, comparing prehabilitation with no prehabilitation (Holsgaard-Larsen 2020) (Table 71). The outcome domain included: quality of life.

Health-Related Quality of Life

One study (Holsgaard-Larsen 2020) reported the QoL component of HOOS and observed no differences between groups at 12 months follow-up after THA (Table 71).

Table 71. Prehabilitation versus no prehabilitation for total hip arthroplasty – continuous outcomes, quality of life

Study, Year, PMID, Country	Outcome Measurement	Overall RoB	Time Point[A]	Prehab, N	Prehab, Mean (SD)	Control, N	Control, Mean (SD)	Effect Size (95% CI)	Reported p-Value
Holsgaard-Larsen, 2020, 32376477, Denmark	HOOS: QoL (0-100)	Moderate	12 mo	40	NR	40	NR	0.2 (-8.9,9.3)	0.97

Statistically significant effect sizes are in bold text. In cases where calculated effect size confidence intervals were not-statistically significant but reported p-values were, we deferred to reported p-values and still bolded results.

Abbreviations: CI = confidence interval, HOOS = Hip disability and osteoarthritis outcome score, mo = month, NR = not reported, PMID = PubMed identifier, QoL = quality of life, RoB = risk of bias, SD = standard deviation.

[A] Time from surgery

Healthcare Utilization Outcomes

Four RCTs (Bitterli 2011, Pour 2007, Soeters 2018, Vukomanović) reported on healthcare-utilization outcomes comparing prehabilitation to no prehabilitation (Tables 72 and 73). The outcomes included: length of stay and other healthcare utilization outcomes.

Length of Stay

Four RCTs (Bitterli 2011, Pour 2007, Soeters 2018, Vukomanović 2008) provided data on LOS (mean days; smaller is better) (Table 72). Three studies reported no significant differences in LOS between prehabilitation and control groups (Bitterli 2011, Soeters 2018 [the calculated effect size confidence interval was significant, but the reported p-value was not], Vukomanović 2008), but the fourth trial (Pour 2007) reported only that LOS was significantly reduced among patients who were randomized to prehabilitation compared with control (MD not reported; P=0.001).

Other Healthcare Utilization Outcomes

Three RCTs (Pour 2007, Soeters 2018, and Vukomanović 2008) reported data on discharge disposition, time to post-acute physical therapy discharge criteria (number of days, smaller is better) and the number of outpatient physical therapy sessions required (number of sessions, smaller is better) (Table 73). Pour 2007 reported patients randomized to the accelerated rehabilitation group (which comprised prehabilitation) were more likely to be discharged home (odds ratio [OR] 3.73, 95% CI 1.23, 11.32), and less likely to be discharged to a skilled rehabilitation facility (OR 0.26, 95% CI 0.08 to 0.78), as compared with patients who received standard rehabilitation (i.e., no prehabilitation).

Soeters 2018 defined readiness to discharge from physical therapy as the ability to 1) independently transfer in and out of bed, a chair, and a toilet seat; 2) independently ambulate approximately 150 feet; 3) independently negotiate stairs; and 4) be independent with a home exercise program and activities of daily living. They reported patients randomized to prehabilitation were more likely to meet physical therapists discharge criteria and require fewer outpatient therapy sessions, as compared with the control group.

Vukomanović 2008 also reported that patients randomized to prehabilitation had fewer outpatient physical therapy sessions compared with those who received no prehabilitation.

No RCT reported specific data on costs. Soeters 2018 noted that local resources may limited the uptake of their program despite “the negligible associated costs” they observed.

Cost-Effectiveness

We found no studies comparing the cost-effectiveness of prehabilitation with no prehabilitation.

Harms From Prehabilitation

No RCT reported data on harms from prehabilitation.

Table 72. Prehabilitation versus no prehabilitation for total hip arthroplasty – continuous outcomes, length of stay

Study, Year, PMID, Country	Outcome Measurement	Overall RoB	Prehab, N	Prehab, Mean (SD)	Control, N	Control, Mean (SD)	Effect Size (95% CI)	Reported p-Value
Bitterli, 2011, 21630176, Switzerland	Length of stay (d)	Moderate	41	14.6 (2.5), Range (11-23)	39	14.6 (2.6), Range (8-22)	0 (-1.12, 1.12)[A]	NR
Pour, 2007, 17768187, USA	Length of stay (d)	High	46	4.2, Range (3-8)	48	3.5, Range (2-5)	NR	**0.001**
Soeters, 2018, 29529614, USA	Length of stay (d)	Moderate	31	3.1 (SE: 0.26†) 95% CI 2.6, 3.6	32	4.1 (SE: 0.26[A]) 95% CI 3.6, 4.6	**MD -1 (-1.72, -0.28)[A]**	0.15
Vukomanović, 2008, 18499950, Serbia	Length of stay (d)	High	20	9.8 (2.4)	20	10.2 (1.7)	MD -0.4 (-1.56, 0.76)[A]	0.67

Statistically significant effect sizes are in bold text. In cases where calculated effect size confidence intervals were not-statistically significant but reported p-values were, we deferred to reported p-values and still bolded results.

Abbreviations: CI = confidence interval, d= day, MD = mean difference, mo = months, NR = not reported, PMID = PubMed identifier, RoB = risk of bias, SD = standard deviation, SE = standard error

[A] Calculated

Table 73. Prehabilitation versus no prehabilitation for total hip arthroplasty – continuous outcomes, other healthcare utilization outcomes

Study, Year, PMID, Country	Outcome Measurement	Overall RoB	Time Point[A]	Prehab, N	Prehab, Mean (SD)	Control, N	Control, Mean (SD)	Effect Size (95% CI)	Reported p-Value
Pour, 2007, 17768187, USA	Discharge disposition – home (n)	High	NA	46	41[B]	48	33[B]	**OR 3.73 (1.23, 11.32)[C]**	**NR**
	Discharge disposition – skilled rehabilitation facility (n)	High	NA	46	5[B]	48	15[B]	**OR 0.26 (0.08, 0.78)[C]**	**NR**
Soeters, 2018, 29529614, USA	Met PT discharge criteria (d)	Moderate	NA	31	1.3, 95% CI 0.8, 1.8	32	2.3, 95% CI 2.0. 2.9	**-1 (-1.68, -0.32)[C]**	**<0.001**
	Outpatient physical therapy sessions (PT visits)	Moderate	NA	31	3.1, 95% CI 2.6, 3.6	32	4.1, 95% CI 3.6, 4.6	**-1 (-1.72, -0.28)[C]**	**0.001**
Vukomanović, 2008, 18499950, Serbia	Outpatient physical therapy sessions (service utilization - classes needed with the therapist)	High	NA	20	5.2 (2.35)	20	6.85 (1.14)	**-1.65 (-2.68, -0.62)[C]**	**0.02**

Statistically significant effect sizes are in bold text. In cases where calculated effect size confidence intervals were not-statistically significant but reported p-values were, we deferred to reported p-values and still bolded results.

Abbreviations: CI = confidence interval, d = day, MD = mean difference, NR = not reported, n = number, PMID = PubMed identifier, PT = physical therapy, RoB = risk of bias, SD = standard deviation.

[A] Time from surgery
[B] Categorical outcome; number of patients
[C] Calculated

Heterogeneity of Treatment Effects (Subgroup Differences)

No studies reported subgroup analyses or more specifically, formally analyzed possible heterogeneity of treatment effects, such as statistical tests for whether the comparative effect of rehabilitation versus its various comparators differed in one subgroup of patients versus another (e.g., patients with higher vs. lower measures of strength, flexibility, function, etc. at baseline).

Applicability

Studies were conducted across the globe (three in the United States) using diverse interventions employed in diverse healthcare settings. While the relative effect of the interventions on clinical outcomes (and harms) from non-U.S.-based studies are likely applicable to the U.S. context, findings pertaining to healthcare system or resources are likely country and healthcare system specific. The sex of participants varied widely across studies ranging from 29 to 80 percent of participants being female. The average age of patients ages ranged from 56 to 74 years, and the average BMIs ranged from 26 to 30 kg/m^2 (thus, in all studies, most patients were obese, but in several, many to most were morbidly obese). No study reported whether patients had undergone previous contralateral replacement surgery. As such, the conclusions in this KQ are likely most applicable to middle-to-older-aged adults in high-income countries who are receiving their first total THA for osteoarthritis.

Summary of Comparison of Prehabilitation Versus No Prehabilitation for Patients Undergoing Total Hip Arthroplasty

Table 74 summarizes the evidence for the comparison of prehabilitation versus no prehabilitation for THA. We focus on the outcomes we prioritized in discussion with stakeholders.

There is insufficient evidence whether there is a difference between prehabilitation and no prehabilitation for pain, strength, ADLs, QoL, LOS, or posthospital disposition. No studies reported evidence on satisfaction with care, or risk of harms due to prehabilitation.

Table 74. Evidence profile: Prehabilitation versus no prehabilitation for total hip arthroplasty

Outcome Category	Outcome	N Studies (Participants)	RoB	Consistency	Precision	Directness	Intervention Replication	SoE	Conclusions
Body structure and function	Pain	2 (129)	Moderate	Consistent	Precise	Direct	Both unique	Insufficient	No conclusion
	Strength	1 (49)	Moderate	Consistency unknown (single study)	Precise	Direct	NA (single study)	Insufficient	No conclusion
Activity and participation	ADLs	3 (209)	Moderate	Consistent	Precise	Direct	All unique	Insufficient	No conclusion
Other outcomes	Satisfaction with care	0	NA	NA	NA	NA	NA	Insufficient	No evidence
	QoL	1 (80)	Moderate	Consistency unknown (single study)	Precise	Direct	NA (single study)	Insufficient	No conclusion
Healthcare utilization	Length of stay	4 (277)	High	Inconsistent	Precise	Direct	All unique	Insufficient	No conclusion
	Posthospital disposition	1 (94)	High	Consistency unknown (single study)	NA	Direct	NA (single study)	Insufficient	No conclusion
Harms	Harms from prehabilitation	0	NA	NA	NA	NA	NA	Insufficient	No evidence

Abbreviations: ADLs = activities of daily living, QoL = health-related quality of life, NA = not applicable, QoL = quality of life, RoB = risk of bias, SoE = strength of evidence.

Key Question 4: Rehabilitation for Total Hip Arthroplasty

Key Points

- There is low SoE of no difference between the various programs of rehabilitation and their comparators in terms of pain, strength, ADL, or QoL (low SoE for all), and insufficient evidence on the impact of rehabilitation on hip range of motion.
- There is low SoE that there is no difference among rehabilitation programs with respect to harms from the rehabilitation interventions (low SoE).
- There is insufficient evidence for whether there is a difference between rehabilitation and various comparators on hip range of motion and satisfaction with care
- Given the heterogeneity of interventions and outcomes across studies, there is insufficient evidence on the effectiveness of specific rehabilitation intervention components at the level of goals (e.g., strength, flexibility, etc.) or presence of specific exercise components to address these goals.
- There is insufficient evidence on heterogeneity of treatment effect of rehabilitation programs by patient, surgical, or setting factors.
- There is no evidence on the cost effectiveness of rehabilitation for THA.

Findings Pertaining to Rehabilitation for Total Hip Arthroplasty

We found 15 studies (14 RCTs and one NRCS) reported in 20 articles that evaluated the effectiveness of rehabilitation among patients who had undergone THA (summarized in Figure 5).[104, 105, 142-159] No rehabilitation intervention was evaluated by more than one study. Across studies, rehabilitation interventions were delivered in varying settings (by different modalities), by diverse personnel, at varying intensity, and at various points during the rehabilitation period.

The heterogeneity of the interventions (and their comparators, as almost all comparison groups had active rehabilitation content) made it challenging to identify meaningful groupings of similar studies to synthesize. In the absence of meaningful clusters of similar intervention/comparator studies, we opted to summarize the rehabilitation studies within two main groups of when the intervention/comparator rehabilitation content was initiated: in the acute and post-acute phases after surgery. As expert consensus is unclear in its definition of the different phases of rehabilitation following surgery (despite its perceived importance), we defined these time periods using our best judgement. Acute phase was defined as rehabilitation initiated immediately post-op to within the two weeks following surgery and post-acute rehabilitation was defined as rehabilitation initiated two to eight weeks following surgery. Within these two groups, we summarize the diverse rehabilitation studies together but contextualize interpretations of individual study results with details about the specific form of rehabilitation evaluated (in the intervention and comparator groups) in those studies. We report outcomes under the four following outcome categories: body structure and function; activity and participation; other patient-reported; and healthcare utilization. Given intervention heterogeneity, we determined that meta-analysis was not warranted (i.e., average result would not have been interpretable/meaningful) and instead summarize results narratively.

We coded four studies (4 RCTs) as being delivered within an acute rehabilitation phase and 11 studies (10 RCTs and 1 NRCS) as being delivered within a post-acute rehabilitation phase. Of the acute rehabilitation studies, two RCTs evaluated novel (hypothesized better) rehabilitation

programs versus less intensive rehabilitation programs and two RCTs evaluated similar programs with varying timing of delivery. Of the post-acute rehabilitation studies, six RCTs evaluated novel (hypothesized better) rehabilitation programs versus standard care (variously defined) or alternative rehabilitation programs, and five studies (4 RCTs and 1 NRCS) evaluated comparatively similar rehabilitation programs delivered in different settings or by different personnel.

We rated four of the 14 RCTs to at overall high risk of bias, mostly related to lack of blinding of participants, study personnel, and/or outcome assessors and unclear methods of how random sequences were generated and/or concealed from patients. We rated nine of the remaining RCTs to be at overall moderate risk of bias, mostly related to lack of blinding of participants, study personnel, and/or outcome assessors. One RCT was rated to be at overall low risk of bias. We rated the one NRCS to be at moderate risk of bias on the basis of their non-randomized design, although, all extracted data from this study were adjusted for important confounders using appropriate methods, as per our eligibility criteria.

The 15 studies enrolled between 54 and 280 participants each. Studies were conducted across the globe, mostly commonly in Europe (n=10), followed by Australia (n=3), with two studies from the United States. Of the studies that reported funding information, only one study was funded by industry (Medacta USA, Inc., which specializes in orthopedic products). The average ages of participants were similar across studies, ranging from 50 to 60 years. The percentage of women in the studies varied across studies, from 21 to 70 percent. Average BMIs ranged from 25 to 30 kg/m^2. Only one study (Mikkelsen 2014) reported the proportion of patients who had undergone prior contralateral THA (25%). Appendix Tables C-4.1, C-4.2, C-4.3, and C-4.4 include the full data for all 14 studies.

Most rehabilitation interventions included exercises to address the goal components of strength (14/15 studies; 21/29 arms) and flexibility (11/15 studies; 15/29 arms), followed by task-specific training (8/15 studies; 13/29 arms), patient education (7/15 studies; 11/29 arms), and balance-motor-learning-agility (5/15 studies; 7/29 arms). Few studies included exercises targeted at aerobic endurance (3/15 studies; 3/29 arms).

Three of the studies included an adjunctive modality in combination with the rehabilitation program, including modalities of massage and mindfulness/stress reducing activities. In all cases, the adjunctive modalities were not the intervention component of interest in the study. We found seven studies that reported some form of progression, of which five were assessed by clinical experts on our team as appropriate in at least one arm of the study. One acute-phase rehabilitation study (Mikkelsen 2014) compared an early supervised rehabilitation program with appropriate progression to unsupervised home-based exercise without appropriate progression and one post-acute rehabilitation study (Coulter 2017) compared an unsupervised home-based physiotherapy program without appropriate progression to a supervised physiotherapy intervention with appropriate progression.

Rehabilitation interventions were delivered by physical therapists in 11 of the 15 studies. The remaining four studies did not report who delivered the rehabilitation intervention (Beck 2019, Giaquinto 2010, Lyp 2016, Naylor 2018). Three of these latter studies also had a self-guided component of the intervention where no personnel were with the patients while they performed their rehabilitation at home. No studies reported the use of additional or non-physical therapist personnel to deliver any interventions.

Fourteen of the 15 studies delivered the rehabilitation interventions to patients in-person for at least one of the study arms. Five studies had self-guided components in which patients

performed self-directed exercise and one study evaluated rehabilitation delivered remotely via telephone. Interventions were delivered in varying settings (and often, combinations of settings). Six studies evaluated one or both rehabilitation arms in acute inpatient (Smith, 2009) or outpatient settings, exclusively (Beck, 2019, Giaquinto 2010, Heiberg 2012, Liebs 2010, Liebs 2012, Lyp 2016, Monticone 2014, Winther 2018). Three studies compared rehabilitation programs delivered in outpatient and home settings versus home alone (Austin 2017, Coulter 2017, Nelson 2020, Rao 2021). One study evaluated a rehabilitation program initiated in a fitness center followed by home exercise compared to home exercises alone (Mikkelsen 2014). Naylor 2018 compared discharge to inpatient versus no inpatient care but did not report the specifics of the type of setting for each arm.

Specific codes for intervention (and control arm, where present) goals and exercises, use of progression (and assessment of appropriateness), and details on personnel, mode of delivery, and setting are detailed in Table 75.1 and 75.2 and Appendix C-4.2.

Figure 5. Overview of studies of acute and post-acute rehabilitation interventions versus various controls for total hip arthroplasty

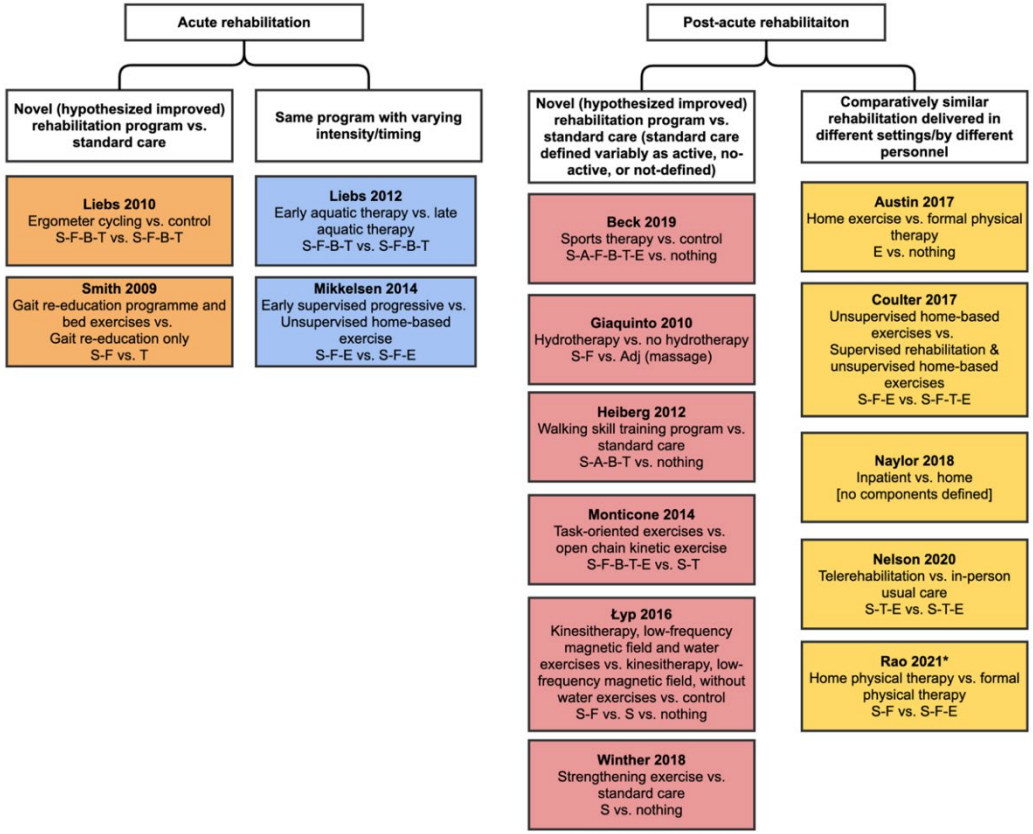

Figure presents categorization of KQ 4 studies that evaluated acute and post-acute rehabilitation programs for THA. The first column lists a novel (more intensive) acute rehabilitation program compared to a different program (first group hypothesized to be better); the second column lists studies with comparatively similar acute rehabilitation programs in both arms that were delivered with different timing or intensity (first group hypothesized to be better); the third column lists a novel (more intensive) post-acute rehabilitation program compared to a different program (first group hypothesized to be better); the fourth column lists studies with comparatively similar rehabilitation programs delivered in different settings or by different personnel

Abbreviations: Adj = adjunctive, A = aerobic exercise, B= balance-motor-learning-agility exercise, E = patient education, F = flexibility exercise, S = strengthening exercise, T = task-specific training, THA = total hip arthroplasty.

* Intervention included progression which was deemed appropriate

Table 75.1. Goal components strength, aerobic, and flexibility and their specific exercise components for rehabilitation interventions versus various controls for total hip arthroplasty

Study	Arm	Strength	Bridges	Gluteal Sets	Hip Abduction	Hip Extension	Hip Flexion	Hip Rotation	Knee Extension	Knee Flexion	Leg Press	Lunges	Quad Sets	Single Leg Stance	Sit-To-Stand	Squats	Step Down	Step Up	Aerobic	Bike (Endurance)	Walking	Flexibility	Ankle Pumps	Bike (ROM)	Calf Stretch	Heel Slides	Hip Flexor Stretch	Knee Extension
Austin, 2017	Home exercise	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Formal PT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Beck, 2019	Sport rehab	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1	1	1	0	0	0	0	1	0
	Control	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Coulter, 2017	Home PT	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
	Supervised PT	1	1	0	1	1	0	0	1	0	0	0	0	0	1	0	0	1	1	0	0	1	0	1	0	0	0	0
Giaquinto, 2010	Hydrotherapy	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
	Land-based rehab	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Heiberg, 2012	Walking skill training	1	0	0	0	0	0	0	0	0	0	1		1	1	1	1	1	1	0	1	1	0	0	1	0	0	0
	Control (no PT)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Liebs, 2010	Cycling	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0
	No cycling	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Liebs, 2012	Early AT	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
	AT after wound healing	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Lyp, 2016	Group I	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
	Group II	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Group V		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mikkelsen, 2014	Early supervised PRT	1	0	0	1	1	1	0	1	1	1	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0
	Control	1	0	0	1	1	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Monticone, 2014	Intervention[A]	1	0	0	0	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0
	Control[B]	1	0	0	1	1	1	1	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Naylor, 2018	Inpatient rehab	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	No inpatient rehab	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nelson, 2020	Telerehabilitation	1	0	0	1	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Control	1	0	0	1	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rao, 2021	Home PT	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1
	Formal PT	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Smith, 2009	Gait re-ed & bed ex	1	0	1	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	1	0	0	1	0	0
	Gait re-ed	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Winther, 2018	Maximal ST	1	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Conventional PT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

See Table 75.2 for goal components Balance-motor-learning-agility, task specific training, patient education, and adjunctive modalities. The color is added for visual display and does not provide unique information.

1 = presence of component, 0 = absence of component
Group I: kinesiotherapy, low-frequency magnetic field and water exercises; Group II: undergoing kinesiotherapy and low-frequency magnetic field, without water exercises; Group V: awaiting rehabilitation

Abbreviations: PRT = progressive resistance training, PT = physical therapy, rehab = rehabilitation; ROM = range of motion, ST = strength training

[A] Task-oriented exercises; encouragement to abandon walking aids.
[B] Open kinetic chain exercises

Table 75.2. Goal components balance-motor-learning-agility, task specific training, patient education, and adjunctive modalities and their specific exercise components for rehabilitation interventions versus various controls for total hip arthroplasty

Study	Arm	Balance-Motor Learning-Agility	Balance On Unstable Surface	Balance With Perturbations	Single Leg Stance	Stepping Multiple Directions	Step Down	Step Lateral (Side Step)	Step Up – Forward	Task Specific Training	Gait On Uneven Surfaces	Gait Training	Gait With Perturbations	Obstacle Training	Sit-To-Stand Training	Stair Training	Transfers	Patient Education	Activities Of Daily Living	Home Exercise Program	Adjunctive Modality	Massage	CAM	Progression (Appropriate?)	Personnel	Mode of delivery	Setting
Austin, 2017	Home exercise	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	N	None	SG	H
	Formal PT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N	PT	I	O; H
Beck, 2019	Sport rehab	1	1	0	0	0	0	0	0	1	0	1	0	0	0	0	0	1	0	0	1	1	0	N	NR	I	O
	Control	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N	NA	NA	NA
Coulter, 2017	Home PT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	Y (N)	None	SG	H
	Supervised PT	0	0	0	0	0	0	0	0	1	0	1	0	0	1	1	0	1	0	1	0	0	0	Y (Y)	PT; None	I; SG	O; H
Giaquinto, 2010	Hydrotherapy	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N	NR	I	OIF
	Land-based rehab	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	N	NR	I	OIF
Heiberg, 2012	Walking skill training	1	1	1	1	0	1	1	1	1	1	0	1	1	0	1	0	0	0	0	0	0	0	Y (Y)	PT	I	O
	Control (no PT)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N	NA	NA	NA
Liebs, 2010	Cycling	1	1	0	0	0	0	0	0	1	1	1	0	0	0	1	1	0	0	0	0	0	0	N	PT	I	O
	No cycling	1	1	0	0	0	0	0	0	1	1	1	0	0	0	1	1	0	0	0	0	0	0	N	PT	I	O
Liebs, 2012	Early AT	1	1	0	0	0	0	0	0	1	1	1	0	0	0	1	1	0	0	0	0	0	0	N	PT	I	O
	AT after wound healing	1	1	0	0	0	0	0	0	1	1	1	0	0	0	1	1	0	0	0	0	0	0	N	PT	I	O
Lyp, 2016	Group I	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	N	NR	I	O
	Group II	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	N	NR	I	O
	Group V	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N	NA	NA	NA
Mikkelsen, 2014	Early supervised PRT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	Y (Y)	PT; None	I; SG	G; H
	Control	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	Y (N)	None	SG	H
Monticone, 2014	Intervention[A]	1	1	0	0	1	0	0	0	1	0	1	1	1	1	1		1	1	0	0	0	0	Y (N)	PT	I	OIF
	Control[B]	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	N	PT	I	OIF
Naylor, 2018	Inpatient rehab	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	NR	NR	NR	NR
	No inpatient rehab	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	NR	NR	NR	NR
Nelson, 2020	Telerehabilitation	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	1	0	1	0	0	0	Y (N)	PT	R[C]	H
	Control	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	1	0	1	0	0	0	Y (N)	PT	SG; I	O; H
Rao, 2021	Home PT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	Y (N)	None	SG	H
	Formal PT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	Y (Y)	PT; None	I; SG	O; H
Smith, 2009	Gait re-ed & bed ex	0	0	0	0	0	0	0	0	1	0	1	0	0	0	1	0	0	0	0	0	0	0	Y (Y)	PT	I	AI
	Gait re-ed	0	0	0	0	0	0	0	0	1	0	1	0	0	0	1	0	0	0	0	0	0	0	Y (Y)	PT	I	AI
Winther, 2018	Maximal ST	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Y (Y)	PT	I	O
	Conventional PT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N	PT	I	O

See Table 75.1 for goal components strength, aerobic, and flexibility. The color is added for visual display and does not provide unique information.The color is added for visual display and does not provide unique information.

1 = presence of component, 0 = presence of component

Group I: kinesiotherapy, low-frequency magnetic field and water exercises; Group II: undergoing kinesiotherapy and low-frequency magnetic field, without water exercises; Group V: awaiting rehabilitation

Abbreviations: CAM = complementary and alternative therapies, ed = education, exercises, I = in-person; G = gym/other community center; H = home; O = outpatient physiotherapy center; OIF = other inpatient facility; PRT PT = physical therapy, rehab = rehabilitation; SG = self-guided; ST = strength training.

[A] Task-oriented exercises; encouragement to abandon walking aids
[B] Open kinetic chain exercises
[C] Remote via telephone

Body Structure and Function Outcomes

Twelve studies in total reported on body structure and function outcomes following rehabilitation compared to various controls: one study (Liebs 2010) compared novel acute rehabilitation programs to control; two studies (Liebs 2012, Mikkelsen 2014) compared acute rehabilitation programs with different timing and/or intensity; four studies (Beck 2019, Giaquinto 2010, Heiberg 2012, Monticone 2014) compared novel post-acute rehabilitation programs to various comparators (less intensive rehabilitation or no care); and four studies (Austin 2017, Coulter 2017, Naylor 2018, Nelson 2020, Rao 2021) compared rehabilitation programs delivered in different settings or by different personnel (Tables 76 to 81). The outcomes included: symptoms, pain, range of motion, muscle strength, energy and vigor, and emotional functioning.

Symptoms

Nine studies (Beck 2019, Giaquinto 2010, Heiberg 2012, Liebs 2010, Liebs 2012, Mikkelsen 2014, Monticone 2014, Nelson 2020, Rao 2021) reported data on symptoms using the stiffness component of the WOMAC (0 to 8; lower score indicates reduced stiffness; Beck 2019, Liebs 2012, and Monticone 2014 converted to a 0 to 100 score) and the symptoms component of the HOOS (0 to 100; higher is better) (Table 76). Seven studies observed no differences between groups at follow-up ranging from 6 months to 5 years post-THA. Liebs 2010 reported reduced stiffness among patients randomized to ergometer cycling compared with control (calculated MD −5.2 95% CI −11.08 to 0.068; P=0.047) and Monticone 2014 reported reduced stiffness among patients randomized to task-oriented exercises compared with open chain kinetic exercises (calculated MD -9.0, 95% CI −13.6, −4.4; P=0.037).

Pain

Eleven studies reported pain data (Beck 2019, Giaquinto 2010, Heiberg 2012, Liebs 2010, Liebs 2012, Łyp, 2016, Mikkelsen 2014, Monticone 2014, Naylor 2018, Nelson 2020, Rao 2021) using six different measurement instruments (the pain component of the HOOS, the pain component of the WOMAC, the bodily pain component of the SF-36, the EQ-5D VAS, the VAS, and the Latinen scale measuring pain intensity) (Table 77). Most studies (n=8) found no difference in pain data between comparison groups. Three studies (Beck 2019, Giaquinto 2010, Monticone 2014) reported reduced pain in their respective intervention groups. Beck 2019 reported pain data using the VAS, the pain component of WOMAC, and EQ-5D VAS. They found no difference between groups on two scales at 6 and 12 months after THA, but pain on the WOMAC scale was significantly better in the sport therapy group compared with the control group at 12 months follow-up (p=0.023). Giaquinto 2010 reported pain data using the pain component of the WOMAC only and found patients randomized to hydrotherapy had significantly reduced pain compared with patients randomized to no hydrotherapy ("land therapy" followed by scar mobility massage) at 6 months after THA (p<0.01). Monticone 2014 reported pain data using the pain component of the WOMAC (0 to 100, lower is better), the bodily pain component of the SF-36 (0 to 100, higher is better), and the VAS and found patients randomized to task-oriented exercises reported significantly less pain compared to patients randomized to open-chain kinetic exercises at 12 months after THA on the WOMAC and SF-36 scales but not VAS.

Range of Motion

Three studies (Heiberg 2012, Łyp, 2016, Winther 2020) reported ROM data from various outcome measures to assess ROM of the hip extensors, flexors, abductors and adductors. Two studies found no significant differences between arms; Lyp 2016 found significant improvements in active ROM of the hip in both groups that received kinesiotherapy (the therapeutic and corrective application of passive and active movements, such as massage, and of exercise) with or without water exercises (Table 78).

Muscle Strength

Five studies (Beck 2019, Heiberg 2012, Łyp, 2016, Mikkelsen 2014, Nelson 2020) reported strength data from various outcome measures to assess strength of the hip extensors, flexors, abductors and adductors (Table 79). Studies used a dynamometer to measure strength and presented strength data variably (Newton-meters [Nm], kilograms [kg], Watts [W]; for each, higher values indicate greater strength). One study reported strength using a composite scale, the Index of muscle function, which was designed to assess strength and function. Studies reported no significant differences between groups at follow-up ranging from 6 to 15 months after THA.

Energy and Vigor

Monticone 2014 reported on vigor using the vitality component of the SF-36 (scores 0 to 100, higher is better) (Table 80). The study found a statistically significant improvement in vitality among patients randomized to task-oriented exercises compared to patients randomized to open-chain kinetic exercises (MD 8.5, 95% CI 3.9 to 13.1).

Emotional and Social Functioning

Four studies (Austin 2017, Coulter 2017, Monticone 2014, Nelson 2020) reported on emotional and social functioning data from the mental health, social function, and emotional role scales of the SF-36. Studies reported comparable findings among groups on all scales at 6 to 12 months after THA (Table 81).

Table 76. Rehabilitation versus various controls for total hip arthroplasty – continuous outcomes, symptoms

Study, Year, PMID, Country	Arm 1	Arm 2	Overall RoB	Outcome Measurement	Time Point[A]	Arm 1, N	Arm 1, Mean (SD)	Arm 2, N	Arm 2, Mean (SD)	Effect Size (95% CI)	Reported p-Value
Beck, 2019, 30782304	Sports therapy	Control	High	WOMAC: Stiffness (0-100)	6 mo	63	Median (Q1, Q3) 87.5 (70, 100)	51	Median (Q1, Q3) 87.5 (70, 100)	NR	NR
	Sports therapy	Control	High	WOMAC: Stiffness (0-100)	12 mo	57	Median (Q1, Q3) 87.5 (75, 100)	41	Median (Q1, Q3) 100 (75, 100)	NR	NR
Giaquinto, 2010, 19282040	Hydrotherapy	No hydrotherapy	Low	WOMAC: Stiffness (0-8)	6 mo	31	Median 0	33	Median 1	NR	NR
Heiberg, 2012, 22170790	Walking skill training program	Standard care	Moderate	HOOS: Symptoms (0-100)	12 mo	35	86 (95% CI: 82, 89)	33	87 (95% CI: 84, 91)	-2 (-6, 3)	NR
	Walking skill training program	Standard care	Moderate	HOOS: Symptoms (0-100)	5 y	30	Mean (95% CI) 84 (79, 89)	30	Mean (95% CI) 88 (83, 92)	-4 (-10.73, 2.73)[B]	NR
Liebs, 2010, 20360503	Ergometer cycling	Control	Moderate	WOMAC: Stiffness (0-100)	24 mo	74	13.4 (17.9)	88	18.6 (20.3)	**-5.2 (-11.08, 0.68)[B]**	**0.047**
Liebs, 2012, 22196125	Early aquatic therapy	Late aquatic therapy	Moderate	WOMAC: Stiffness (0-100)	24 mo	100	20.8 (23.4)	110	16.9 (18.2)	3.9 (-1.81, 9.61)[B]	0.552
Mikkelsen, 2014, 25305374	Early supervised progressive resistance training	Unsupervised home-based exercise	Moderate	HOOS: Symptoms (0-100)	6 mo	32	85 (15)	30	86.2 (13)	-1.2 (-6.1, 3.7)[B]	NR
	Early supervised progressive resistance training	Unsupervised home-based exercise	Moderate	HOOS: Symptoms (0-100)	12 mo	32	90.7 (11)	30	90 (14)	0.7 (-3.8, 5.2)[B]	NR
Monticone, 2014, 24459172	Task-oriented exercises	Open chain kinetic exercises	Moderate	WOMAC: Stiffness (0-100)	12 mo	50	19.8 (12.4)	50	28.8 (18.8)	**-9.0 (-13.6, -4.4)[B]**	**0.037**
Nelson, 2020, 32026820	Telerehabilitation	In-person usual care	Moderate	HOOS: Symptoms (0-100)	6 mo	34	88 (13)	35	88 (12)	0 (-4.2, 4.2)[B]	NR
Rao, 2021, 33863614 USA	Home physical therapy	Formal physical therapy	High	HOOS: Symptoms (0-100)	6 mo	70	86.8 (14.1)	66	85.0 (16.2)	-1.8 (-5.4, 1.8)	0.506

Statistically significant effect sizes are in bold text. In cases where calculated effect size confidence intervals were not-statistically significant but reported p-values were, we deferred to reported p-values and still bolded results.

Abbreviations: CI = confidence interval, HOOS = Hip disability and osteoarthritis outcome score, mo = month, NR = not reported, PMID = PubMed identifier, RoB = risk of bias, SD = standard deviation, WOMAC = Western Ontario and McMaster Universities Osteoarthritis Index.

[A] Time from surgery
[B] Calculated

Table 77. Rehabilitation versus various controls for total hip arthroplasty – continuous outcomes, pain

Study, Year, PMID, Country	Arm 1	Arm 2	Overall RoB	Outcome Measurement	Time Point[A]	Arm 1, N	Arm 1, Mean (SD)	Arm 2, N	Control, Mean (SD)	Effect Size (95% CI)	Reported p-Value
Beck, 2019, 30782304	Sports therapy	Control	High	VAS (0-10)	6 mo	63	Median (Q1, Q3) 1 (0, 2)	51	Median (Q1, Q3) 1 (0, 2)	NR	1.00
	Sports therapy	Control	High	VAS (0-10)	12 mo	57	Median (Q1, Q3) 0 (0, 1)	41	Median (Q1, Q3) 0 (0, 2)	NR	0.882
	Sports therapy	Control	High	WOMAC: Pain (0-100)	6 mo	63	Median (Q1, Q3) 95 (90, 100)	51	Median (Q1, Q3) 92.5 (90, 100)	NR	1.00
	Sports therapy	Control	High	WOMAC: Pain (0-100)	12 mo	57	Median (Q1, Q3) MD 100 (95, 100)	41	Median (Q1, Q3) MD 95 (90, 100)	**NR**	**0.023**
	Sports therapy	Control	High	EQ-5D (VAS) (0-100)	6 mo	63	Median (Q1, Q3) 85 (80, 90)	51	Median (Q1, Q3) 85 (75, 90)	NR	1.00
	Sports therapy	Control	High	EQ-5D (VAS) (0-100)	12 mo	57	Median (Q1, Q3) 90 (80, 90)	41	Median (Q1, Q3) 85 (70, 90)	NR	1.00
Giaquinto, 2010, 19282040	Hydrotherapy	No hydrotherapy	Low	WOMAC: Pain (0-20)	6 mo	31	Median 0	33	Median 3	**NR**	**<0.01**
Heiberg, 2012, 22170790	Walking skill training program	Standard care	Moderate	HOOS: Pain (0-100)	12 mo	35	Mean (95% CI) 94 (91, 96)	33	Mean (95% CI) 94 (92, 97)	-1 (-4, 3)	ns
	Walking skill training program	Standard care	Moderate	HOOS: Pain (0-100)	5 y	30	Mean (95% CI) 92 (87, 96) SE 2.30*	30	Mean (95% CI) 95 (91, 98) SE 1.79*	-3 (-8.71, 2.71)[B]	NR
Liebs, 2010, 20360503	Ergometer cycling	Control	Moderate	WOMAC: Pain (0-100)	24 mo	74	54.3 (25.7)	88	6.2 (11.3)	48.1 (41.8, 54.41)[B]	0.076
Liebs, 2012, 22196125	Early aquatic therapy	Late aquatic therapy	Moderate	WOMAC: Pain (0-100)	24 mo	100	12.2 (17.2)	110	9.9 (14.4)	2.3 (-2.01, 6.61)[B]	0.839
Łyp, 2016, 27455419	Kinesiotherapy, low-frequency magnetic field and water exercises	Control	High	VAS (0-10)	14.8 mo	NR	1.9 (NR)	NR	3.9 (NR)	NR	NR
	Kinesiotherapy, low-frequency magnetic field, without water exercises	Control	High	VAS (0-10)	14.8 mo	NR	3.3 (NR)	NR	3.9 (NR)	NR	NR
	Kinesiotherapy, low-frequency magnetic field and water exercises	Control	High	Pain intensity: Laitinen scale	14.8 mo	NR	0.2 (NR)	NR	1.1 (NR)	NR	NR

Study, Year, PMID, Country	Arm 1	Arm 2	Overall RoB	Outcome Measurement	Time Point[A]	Arm 1, N	Arm 1, Mean (SD)	Arm 2, N	Control, Mean (SD)	Effect Size (95% CI)	Reported p-Value
	Kinesiotherapy, low-frequency magnetic field, without water exercises	Control	High	Pain intensity: Laitinen scale	14.8 mo	NR	0.7 (NR)	NR	1.1 (NR)	NR	NR
Mikkelsen, 2014, 25305374	Early supervised progressive resistance training	Unsupervised home-based exercise	Moderate	HOOS: Pain (0-100)	6 mo	32	91.7 (10)	30	91.4 (13)	0.3 (-3.9, 4.5)[B]	NR
	Early supervised progressive resistance training	Unsupervised home-based exercise	Moderate	HOOS: Pain (0-100)	12 mo	32	94 (8)	30	92.2 (14)	1.8 (-2.5, 6.1)[B]	NR
Monticone, 2014, 24459172	Task-oriented exercises	Open chain kinetic exercises	Moderate	WOMAC: Pain (0-100)	12 mo	50	25.2 (16.1)	50	34.9 (18.7)	**-9.7 (-14.6, -4.8)[B]**	NR
	Task-oriented exercises	Open chain kinetic exercises	Moderate	SF-36: Bodily pain (0-100)	12 mo	50	79.8 (26.1)	50	63.9 (25.2)	**15.9 (8.8, 23.0)[B]**	NR
	Task-oriented exercises	Open chain kinetic exercises	Moderate	VAS (0-10)	12 mo	50	0.8 (1.3)	50	1.4 (2.6)	-0.6 (-1.2, 0.02)[B]	NR
Naylor, 2018, 30021552	In-patient rehabilitation	No in-patient rehabilitation	Moderate	EuroQol VAS (0-100)	12 mo	123	Median (Q1, Q3) 85 (75, 95)	123	Median (Q1, Q3) 90 (80, 95)	Median difference (Q1, Q3) 5 (-10, 15)	0.09
Nelson, 2020, 32026820	Telerehabilitation	In-person usual care	Moderate	HOOS: Pain (0-100)	6 mo	34	92 (12)	35	89 (13)	3 (-1.2, 7.2)[B]	NR
	Telerehabilitation	In-person usual care	Moderate	EQ-5D: VAS (0-100)	6 mo	34	82 (14)	35	81 (18)	1 (-4.4, 6.4)[B]	NR
Rao, 2021, 33863614 USA	Home physical therapy	Formal physical therapy	High	HOOS pain	6 mo	70	87.6 (15.4)	66	85.2 (18.6)	-2.4 (-6.5, 1.7)	0.427

Statistically significant effect sizes are in bold text. In cases where calculated effect size confidence intervals were not-statistically significant but reported p-values were, we deferred to reported p-values and still bolded results.

Abbreviations: CI = confidence interval, EQ-5D = EuroQuol, HOOS = Hip disability and osteoarthritis outcome score , mo = month, NR = not reported, PMID = PubMed identifier, Q = quartile, RoB = risk of bias, SD = standard deviation, WOMAC = Western Ontario and McMaster Universities Osteoarthritis Index, VAS = visual analogue scale,.

[A] Time from surgery
[B] Calculated

Table 78. Rehabilitation versus various controls for total hip arthroplasty – continuous outcomes, range of motion

Study, Year, PMID, Country	Arm 1	Arm 2	Overall RoB	Outcome Measurement	Time Point*	Arm 1, N	Arm 1, Mean (SD)	Arm 2, N	Control, Mean (SD)	Effect Size (95% CI)	Reported p-Value
Heiberg, 2012, 22170790	Walking skill training program	Standard care	Moderate	Active ROM in hip: Flexion (deg)	12 mo	35	Mean (95% CI) 95 (91, 98)	33	Mean (95% CI) 94 (90, 98)	1 (-5, 6)	ns
	Walking skill training program	Standard care	Moderate	Active ROM in hip: Flexion (deg)	5 y	30	Mean (95% CI) 104 (99, 109) SE 2.55[B]	30	Mean (95% CI) 100 (94, 106) SE 3.06[B]	4 (-3.81, 11.81)[B]	NR
	Walking skill training program	Standard care	Moderate	Active ROM in hip: Extension (deg)	12 mo	35	Mean (95% CI) 0 (-2, 1)	33	Mean (95% CI) -1 (-3, 0)	1 (-1, 3)	ns
	Walking skill training program	Standard care	Moderate	Active ROM in hip: Abduction (deg)	12 mo	35	Mean (95% CI) 25 (23, 27)	33	Mean (95% CI) 25 (23, 27)	0 (-3, 3)	ns
Łyp, 2016, 27455419	Kinesiotherapy, low-frequency magnetic field and water exercises	Control	High	Active ROM in hip: Unspecified (deg)	14.8 mo	NR	205.6 (NR)	NR	127.0 (NR)	**NR**	**0.001[C]**
	Kinesiotherapy, low-frequency magnetic field, without water exercises	Control	High	Active ROM in hip: Unspecified (deg)	14.8 mo	NR	197.6 (NR)	NRN	161.0 (NR)	**NR**	**0.001**
	Kinesiotherapy, low-frequency magnetic field and water exercises	Control	High	Active ROM in hip: Unspecified (deg)	14.8 mo	NR	149.9 (NR)	NR	127.0 (NR)	**NR**	**0.001**
	Kinesiotherapy, low-frequency magnetic field, without water exercises	Control	High	Active ROM in hip: Unspecified (deg)	14.8 mo	NR	187.5 (NR)	NR	161.0 (NR)	**NR**	**0.001**
Winther, 2020, 31977324	Strengthening exercise	Standard care	Moderate	Hip abduction (deg)	12 mo	22	12 (4)	22	12 (4)	0 (-1.7, 1.7)[B]	NR

Statistically significant effect sizes are in bold text. In cases where calculated effect size confidence intervals were not-statistically significant but reported p-values were, we deferred to reported p-values and still bolded results.

Abbreviations: CI = confidence interval, deg = deg, mo = month, NR = not reported, ns = not significant, PMID = PubMed identifier, RoB = risk of bias, ROM = range of motion, SD = standard deviation.

[A] Time from surgery
[B] Calculated
[C] Noted as p<0.001 for hip range of motion in general

Table 79. Rehabilitation versus various controls for total hip arthroplasty – continuous outcomes, muscle strength

Study, Year, PMID, Country	Arm 1	Arm 2	Overall RoB	Outcome Measurement	Time Point[A]	Arm 1, N	Arm 1, Mean (SD)	Arm 2, N	Arm 2, Mean (SD)	Effect Size (95% CI)	Reported p-Value
Beck, 2019, 30782304	Sports therapy	Control	High	Strength capacity: Isokinetic extension (J/kg)	6 mo	63	Median (Q1, Q3) 0.69 (0.44, 0.96)	51	Median (Q1, Q3) 0.55 (0.06, 0.79)	NR	1.00
	Sports therapy	Control	High	Strength capacity: Isokinetic extension (J/kg)	12 mo	57	Median (Q1, Q3) 0.86 (0.46, 1.11)	41	Median (Q1, Q3) 0.93 (0.42, 1.07)	NR	1.00
	Sports therapy	Control	High	Strength capacity: Isokinetic flexion (J/kg)	6 mo	63	Median (Q1, Q3) 0.31 (0.19, 0.43)	51	Median (Q1, Q3) 0.26 (0.09, 0.35)	NR	1.00
	Sports therapy	Control	High	Strength capacity: Isokinetic flexion (J/kg)	12 mo	57	Median (Q1, Q3) 0.55 (0.31, 0.69)	41	Median (Q1, Q3) 0.42 (0.31, 0.58)	NR	0.616
	Sports therapy	Control	High	Strength capacity: Isokinetic abduction (J/kg)	6 mo	63	Median (Q1, Q3) 0.18 (0.09, 0.26)	51	Median (Q1, Q3) 0.13 (0.04, 0.17)	NR	0.112
	Sports therapy	Control	High	Strength capacity: Isokinetic abduction (J/kg)	12 mo	57	Median (Q1, Q3) 0.23 (0.14, 0.35)	41	Median (Q1, Q3) 0.19 (0.15, 0.28)	NR	1.00
	Sports therapy	Control	High	Strength capacity: Isokinetic adduction (J/kg)	6 mo	63	Median (Q1, Q3) 0.17 (0.09, 0.29)	51	Median (Q1, Q3) 0.14 (0.03, 0.24)	NR	1.00
	Sports therapy	Control	High	Strength capacity: Isokinetic adduction (J/kg)	12 mo	57	Median (Q1, Q3) 0.23 (0.14, 0.35)	41	Median (Q1, Q3) 0.19 (0.15, 0.28)	NR	1.00
Heiberg, 2012, 22170790	Walking skill training program	Standard care	Moderate	Index of muscle function[B]	12 mo	35	Mean (95% CI) 7 (6, 9)	33	Mean (95% CI) 10 (8, 11)	-2 (-5, 0)	ns
Łyp, 2016, 2745541	Kinesiotherapy, low-frequency magnetic field and water exercises	Control	High	Strength: Extensors and abductors (Nm)[C]	14.8 mo[D]	NR	81.8 (NR)	NR	48.8 (NR)	NR	NR
	Kinesiotherapy, low-frequency magnetic field and water exercises	Kinesiotherapy, low-frequency magnetic field, without water exercises	High	Strength: Extensors and abductors (Nm)[E]	14.8 mo	NR	83.6 (NR)	NR	67.5 (NR)	NR	NR
	Kinesiotherapy, low-frequency magnetic field, without water exercises	Control	High	Strength: Extensors and abductors (Nm)	14.8 mo	NR	67.3 (NR)	NR	48.8 (NR)	NR	NR

Study, Year, PMID, Country	Arm 1	Arm 2	Overall RoB	Outcome Measurement	Time Point[A]	Arm 1, N	Arm 1, Mean (SD)	Arm 2, N	Arm 2, Mean (SD)	Effect Size (95% CI)	Reported p-Value
	Kinesiotherapy, low-frequency magnetic field and water exercises	Kinesiotherapy, low-frequency magnetic field, without water exercises		Strength: Extensors and abductors (Nm)	14.8 mo	NR	68.7 (NR)	NR	67.5 (NR)	NR	NR
Mikkelsen, 2014, 25305374	Early supervised progressive resistance training	Unsupervised home-based exercise	Moderate	Strength: Peak abduction strength (Nm/kg)	6 mo	32	1.08 (0.3)	30	1.15 (0.3)	-0.1 (-0.2, 0.03)[F]	NR
	Early supervised progressive resistance training	Unsupervised home-based exercise	Moderate	Strength: Hip flexion	6 mo	32	1.33 (0.3)	30	1.41 (0.4)	-0.1 (-0.2, 0.05)[F]	NR
	Early supervised progressive resistance training	Unsupervised home-based exercise	Moderate	Leg extension power (W/kg))	6 mo	32	2.04 (0.7)	30	1.97 (0.6)	0.1 (-0.2, 0.3)[F]	NR
Nelson, 2020, 32026820	Telerehabilitation	In-person usual care	Moderate	Strength: Hip extension (kg)	6 mo	34	8.6 (2.9)	35	8.1 (2.7)	0.5 (-0.4, 1.4)	NR
	Telerehabilitation	In-person usual care	Moderate	Strength: Hip adduction (kg)	6 mo	34	4.5 (1.4)	35	4.1 (1.4)	0.4 (-0.1, 0.9)[F]	NR
	Telerehabilitation	In-person usual care	Moderate	Strength: Hip abduction (kg)	6 mo	34	4.9 (2.0)	35	4.5 (1.8)	0.4 (-0.2, 1.0)[F]	NR
	Telerehabilitation	In-person usual care	Moderate	Strength: Hip internal rotator (kg)	6 mo	34	4 (1.5)	35	3.9 (1.3)	0.1 (-0.4, 0.6)[F]	NR
	Telerehabilitation	In-person usual care	Moderate	Strength: Hip external rotator (kg)	6 mo	34	2.3 (1)	35	2 (0.8)	0.3 (-0.01, 0.6)[F]	NR
	Telerehabilitation	In-person usual care	Moderate	Strength: Hip flexion (kg)	6 mo	34	7.2 (2.5)	35	7 (1.9)	0.2 (-0.6, 1)[F]	NR

Statistically significant effect sizes are in bold text. In cases where calculated effect size confidence intervals were not-statistically significant but reported p-values were, we deferred to reported p-values and still bolded results.

Abbreviations: CI = confidence interval, J = joule, kg = kilogram, N = Newton, Nm = peak torque, NR = not reported, PMID = PubMed identifier, RoB = risk of bias, SD = standard deviation, SE = standard error, W = watt.

[A] Time from surgery
[B] Functional test comprising of 13 items evaluating general functioning, muscle strength, muscle endurance, balance and coordination. Scores 0-40, lower is better.
[C] Subgroup of cemented participants
[D] Study reported the average time between surgery and follow-up was 14.8 months (range 14.2 to 14.8)
[E] Subgroup of uncemented participants
[F] Calculated

Table 80. Rehabilitation versus various controls for total hip arthroplasty – continuous outcomes, energy and vigor

Study, Year, PMID, Country	Arm 1	Arm 2	Overall RoB	Outcome Measurement	Time Point[A]	Arm 1, N	Arm 1, Mean (SD)	Arm 2, N	Arm 2, Mean (SD)	Effect Size (95% CI)	Reported p-Value
Monticone, 2014, 24459172	Task-oriented exercises	Open chain kinetic exercises	Moderate	SF-36: Vitality (0-100)	12 mo	50	66.9 (17)	50	58.4 (15.9)	8.5 (3.9, 13.1)[B]	NR

Abbreviations: CI = confidence interval, NR = not reported, PMID = PubMed identifier, RoB = risk of bias, SF-36 = 36-Item short form survey, SD = standard deviation.

[A] Time from surgery
[B] Calculated

Table 81. Rehabilitation versus various controls for total hip arthroplasty – continuous outcomes, emotional functioning (stress/coping)

Study, Year, PMID, Country	Arm 1	Arm 2	Overall RoB	Outcome Measurement	Time Point[A]	Arm 1 N	Arm 1, Mean (SD)	Arm 2, N	Arm 2, Mean (SD)	Effect Size (95% CI)	Reported p-Value
Austin, 2017, 28419032	Home exercise	Formal Physical Therapy	Moderate	SF-36: mental health (0-100)	6-12 mo	52	NR	52	NR	NR	0.70
Coulter, 2017, 28506775	Unsupervised home-based exercises	Supervised rehabilitation & unsupervised home-based exercises	High	SF-36: mental health (0-100)	6 mo	56	Mean (95% CI) 81.10 (74.94, 87.25)	42	Mean (95% CI) 78.60 (71.75, 85.47)	2.5 (-6.72, 11.72)[B]	NR
Monticone, 2014, 24459172	Task-oriented exercises	Open chain kinetic exercises	Moderate	SF-36: social function (0-100)	12 mo	50	84.4 (20.5)	50	76.7 (27)	7.7 (0.9, 14.5)[B]	NR
	Task-oriented exercises	Open chain kinetic exercises	Moderate	SF-36: emotional role (0-100)	12 mo	50	83 (31.5)	50	73.5 (31)	9.5 (0.8, 18.2)[B]	NR
	Task-oriented exercises	Open chain kinetic exercises	Moderate	SF-36: mental health (0-100)	12 mo	50	74 (16.6)	50	66.2 (19.3)	7.8 (2.8, 12.8)[B]	NR
Nelson, 2020, 32026820	Telerehabilitation	In-person usual care	Moderate	SF-12: mental health (0-100)	6 mo	34	53 (10)	35	55 (10)	-2 (-5.3, 1.3)[B]	NR

Statistically significant effect sizes are in bold text. In cases where calculated effect size confidence intervals were not-statistically significant but reported p-values were, we deferred to reported p-values and still bolded results.

Abbreviations: CI = confidence interval, NR = not reported, PMID = PubMed identifier, RoB = risk of bias, SF-12 = 12-item short form survey, SF-36 = 36-item short form survey, SD = standard deviation.

[A] Time from surgery
[B] Calculated

Activity and Participation Outcomes

Thirteen studies reported on activity and participation outcomes following rehabilitation compared to various control: two studies (Liebs 2010, Smith 2009) compared novel acute rehabilitation programs with control; two studies (Liebs 2012, Mikkelsen 2014) compared acute rehabilitation programs with different timing and/or intensity; five studies (Beck 2019, Giaquinto 2010, Heiberg 2012, Monticone 2014, Winther 2018) compared novel post-acute rehabilitation programs with various comparators (less intensive rehabilitation or no care); and four studies (Austin 2017, Coulter 2017, Nelson 2020, Rao 2021) compared rehabilitation programs delivered in different settings or by different personnel (Tables 82 to 85). Outcomes included: physical function and activities of daily living, transfers, mobility, and timed up and go.

Physical Function and Activities of Daily Living

Twelve studies (Austin 2017, Beck 2019, Coulter 2017, Giaquinto 2010, Heiberg 2012, Liebs 2010, Liebs 2012, Mikkelsen 2014, Monticone 2014, Nelson 2020, Rao 2021, Smith 2009) reported data on patient-reported physical function and ADLs, using various outcome measures (Table 82) at follow-ups between 6 months and 5 years after THA surgery. Eight studies found no difference between groups in terms of patient-reported function and ADL; four studies (Giaquinto 2010, Heiberg 2012, Liebs 2010, Monticone 2014) reported significant differences between groups. Giaquinto 2010 evaluated physical function data using the function component of the WOMAC (0-68, lower is better) and found that patients randomized to hydrotherapy-based rehabilitation reported significantly greater improvements compared with patients randomized to no hydrotherapy (median difference −14; P<0.01). Heiberg 2012 reported activity using the ADL and sports and recreation scales of the HOOS and the UCLA activity scale and found significant improvements on the UCLA activity score (1-10, higher is better) among patients randomized to walking skill program compared with patients randomized to standard care at 5 years after THA, but no differences between groups on the other scales. (Note that the study reported no between group differences; however, our calculated effect size suggested results were significant: MD 1, 95% CI 0.18 to 1.82.) Liebs 2010 reported physical function using the physical component scales of the SF-36 (0 to 100, higher is better) and WOMAC (0 to 100, lower is better) and found significant improvements on both scales among patients randomized to ergometer cycling compared with control (SF-36: MD 4.5, 95% CI 1.56 to 7.44; WOMAC: MD −5.7, 95% CI −10.4 to −1.0). Monticone 2014 reported function data using the Functional Independence Measure, the physical role and physical functioning components of the SF-36, and the function component of the WOMAC and found significant improvements among patients randomized to task-oriented exercises on all measures at 12 months after THA compared with patients randomized to open chain kinetic exercises.

Transfers

Two studies (Heiberg 2012 and Mikkelsen 2014) reported data on transfers using the 30-second timed Chair stand test and observed no differences between groups at 6 months (Mikkelsen 2014) and 5-year (Heiberg 2012) follow-up after THA (Table 83)

Mobility

Four studies (Heiberg 2012, Mikkelsen 2014, Nelson 2020, Winther 2020) reported various outcome measures of mobility including the 6MWT, 40-meter fast paced walk test, stair climb

tests, step test, figure eight test, speed in a 5-meter walkway, and step length. Studies reported no differences between groups at follow-up times ranging from 6 months to 5 years after THA (Table 84).

Timed Up and Go

Two studies (Coulter 2017 and Nelson 2020) reported data on the TUG test. Coulter 2017 reported no significant differences between groups. Nelson 2020 reported patients randomized to telerehabilitation performed the TUG test significantly quicker than patients randomized to in-person usual care (MD −1.5, 95% CI −2.4 to −0.6) (Table 85)

Table 82. Rehabilitation versus various controls for total hip arthroplasty – continuous outcomes, physical function and activities of daily living

Study, Year, PMID, Country	Arm 1	Arm 2	Overall RoB	Outcome Measurement	Time Point[A]	Arm 1, N	Arm 1, Mean (SD)	Arm 2, N	Arm 2, Mean (SD)	Effect Size (95% CI)	Reported p-Value
Austin, 2017, 28419032	Home exercise	Formal physical therapy	Moderate	SF-36: PCS (0-100)	6-12 mo	52	NR	52	NR	NR	0.90
Beck, 2019, 30782304	Sports therapy	Control	High	WOMAC: ADL (0-100)	6 mo	63	Median (Q1, Q3) 92.7 (85.2, 95.6)	51	Median (Q1, Q3) 92.6 (89.7, 95.6)	Median difference 0.03	1.00
	Sports therapy	Control	High	WOMAC: ADL (0-100)	12 mo	57	Median (Q1, Q3) 95.6 (89.7, 100)	41	Median (Q1, Q3) 95.6 (92.7, 97.1)	Median difference 0.11	1.00
	Sports therapy	Control	High	UCLA activity scale (1-10)	6 mo	63	Median (Q1, Q3) 7 (6, 7)	51	Median (Q1, Q3) 7 (6, 7)	Median difference 0.14	1.00
	Sports therapy	Control	High	UCLA activity scale (1-10)	12 mo	57	Median (Q1, Q3) 7 (7, 7)	41	Median (Q1, Q3) 7 (6, 7)	Median difference 0.18	0.378
Coulter, 2017, 28506775	Unsupervised home-based exercises	Supervised rehabilitation & unsupervised home-based exercises	High	SF-36: PCS (0-100)	26 w	56	Mean (95% CI) 71.40 (63.76, 79.03) SE 3.90*	42	Mean (95% CI) 68.50 (60.05, 77.02) SE 4.33*	MD 2.9 (-8.52, 14.32)[B]	ns
Giaquinto, 2010, 19282040	Hydrotherapy	No hydrotherapy	Low	WOMAC: function (0-68)	6 mo	31	Median 4	33	Median 18	**NR**	**<0.01**
Heiberg, 2012, 22170790	Walking skill training program	Standard care	Moderate	HOOS: ADL (0-100)	12 mo	35	Mean (95% CI) 92 (90, 95)	33	Mean (95% CI) 91 (88, 94)	1 (-3, 5)	ns
	Walking skill training program	Standard care	Moderate	HOOS: ADL (0-100)	5 y	30	Mean (95% CI) 90 (87, 94) SE 1.79*	30	Mean (95% CI) 93 (89, 97) SE 2.04*	MD -3 (-8.32, 2.32)[B]	NR
	Walking skill training program	Standard care	Moderate	HOOS: sport/rec (0-100)	12 mo	35	Mean (95% CI) 79 (73, 86)	33	Mean (95% CI) 78 (72, 84)	1 (-8, 10)	ns
	Walking skill training program	Standard care	Moderate	HOOS: sport/rec (0-100)	5 y	30	Mean (95% CI) 75 (69, 82) SE 3.32	30	Mean (95% CI) 82 (75, 90) SE 3.83	MD -7 (-16.94, 2.94)[B]	NR
	Walking skill training program	Standard care	Moderate	UCLA activity scale (1-10)	5 y	30	8 (1.3)	30	7 (1.9)	MD 1 (0.18, 1.82)[B]	**ns**
Liebs, 2010, 20360503	Ergometer cycling	Control	Moderate	SF-36: PCS (0-100)	24 mo	74	48.9 (9)	88	44.4 (10.1)	**4.5 (1.56, 7.44)[B]**	**0.004**
	Ergometer cycling	Control	Moderate	WOMAC: function (0-100)	24 mo	74	9.0 (13.9)	88	14.7 (16.7)	**-5.7 (-10.41, -0.99)[B]**	**0.019**
Liebs, 2012, 22196125	Early aquatic therapy	Late Aquatic therapy (after wound healing	Moderate	SF-36: PCS (0-100)	24 mo	100	45.1 (11.1)	110	45.2 (9.7)	-0.1 (-2.93, 2.73)[B]	0.808

Study, Year, PMID, Country	Arm 1	Arm 2	Overall RoB	Outcome Measurement	Time Point[A]	Arm 1, N	Arm 1, Mean (SD)	Arm 2, N	Arm 2, Mean (SD)	Effect Size (95% CI)	Reported p-Value
	Early aquatic therapy	Late Aquatic therapy (after wound healing	Moderate	WOMAC: function (0-100)	24 mo	100	15.6 (18.1)	110	14.1 (14.5)	MD 1.5 (-2.96, 5.96)[B]	0.825
Mikkelsen, 2014, 25305374	Early supervised progressive resistance training	Unsupervised home-based exercise	Moderate	HOOS: ADL (0-100)	6 mo	32	90.4 (11)	30	91.7 (10)	-1.3 (-5, 2.4)[B]	NR
	Early supervised progressive resistance training	Unsupervised home-based exercise	Moderate	HOOS: ADL (0-100)	12 mo	32	93.4 (8)	30	92.1 (12)	1.3 (-2.5, 5.1)[B]	NR
	Early supervised progressive resistance training	Unsupervised home-based exercise	Moderate	HOOS: sport/rec (0-100)	6 mo	32	80.1 (17)	30	83.7 (17)	-3.6 (-9.6, 2.4)[B]	NR
	Early supervised progressive resistance training	Unsupervised home-based exercise	Moderate	HOOS: sport/rec (0-100)	12 mo	32	81.9 (20)	30	92.8 (19)	-10.9 (-17.8, -4.0)[B]	NR
Monticone, 2014, 24459172	Task-oriented exercises	Open chain kinetic exercise	Moderate	Functional independence measure (18-126)	12 mo	50	117.9 (10.3)	50	104.7 (14)	**13.2 (9.7, 16.7)[B]**	**NR**
	Task-oriented exercises	Open chain kinetic exercise	Moderate	SF-36: physical functioning (0-100)	12 mo	50	73.1 (20.8)	50	60.9 (18.3)	**12.2 (6.7, 17.7)[B]**	**NR**
	Task-oriented exercises	Open chain kinetic exercise	Moderate	SF-36: physical role (0-100)	12 mo	50	76.1 (33.3)	50	51.1 (45.1)	**25 (13.8, 36.2)[B]**	**NR**
	Task-oriented exercises	Open chain kinetic exercise	Moderate	WOMAC: function (0-100)	12 mo	50	20.0 (11.1)	50	30.6 (14.9)	**-10.6 (-14.3, -6.9)[B]**	**NR**
Nelson, 2020, 32026820	Telerehabilitation	In-person usual care	Moderate	HOOS: ADL (0-100)	6 mo	34	91 (10)	35	88 (11)	3 (-0.5, 6.5)[B]	NR
	Telerehabilitation	In-person usual care	Moderate	HOOS: sport/rec (0-100)	6 mo	34	85 (18)	35	80 (19)	5 (-1.2, 11.2)[B]	NR
	Telerehabilitation	In-person usual care	Moderate	SF-12: PCS (0-100)	6 mo	34	47 (10)	35	43 (10)	4 (0.7, 7.3)[B]	NR
Rao, 2021, 33863614 USA	Home physical therapy	Formal physical therapy	High	HOOS: ADL (0-100)	6 mo	70	89.0 (14.5)	66	87.3 (15.6)	-4.0 (-7.7, -0.3)	0.517
	Home physical therapy	Formal physical therapy	High	HOOS: sport/rec (0-100)	6 mo	70	80.3 (20.6)	66	74.8 (24.3)	-5.5 (-10.9, -0.1)	0.167

Study, Year, PMID, Country	Arm 1	Arm 2	Overall RoB	Outcome Measurement	Time Point[A]	Arm 1, N	Arm 1, Mean (SD)	Arm 2, N	Arm 2, Mean (SD)	Effect Size (95% CI)	Reported p-Value
Smith, 2009, 19876883	Gait re-education program & bed exercises	Gait re-education program only	Moderate	Iowa level of assistance scale	12 mo	30	Median (Q1, Q3) 0 (0, 0)	30	Median (Q1, Q3) 0 (0, 3)	NR	0.2093
	Gait re-education program & bed exercises	Gait re-education program only	Moderate	Iowa level of assistance scale	12 mo[C]	23	Median (Q1, Q3) 0 (0, 2)	28	Median (Q1, Q3) 0 (0, 3.5)	NR	0.4296
	Gait re-education program & bed exercises	Gait re-education program only	Moderate	Iowa level of assistance scale	12 mo[D]	7	Median (Q1, Q3) 0 (0, 0)	2	Median (Q1, Q3) 0 (0, 0)	NR	1.000
	Gait re-education program & bed exercises	Gait re-education program only	Moderate	Iowa level of assistance scale	12 mo[E]	22	Median (Q1, Q3) 0 (0, 0)	24	Median (Q1, Q3) 0 (0, 3.5)	NR	0.3170
	Gait re-education program & bed exercises	Gait re-education program only	Moderate	Iowa level of assistance scale	12 mo [F]	8	Median (Q1, Q3) 0 (0, 0)	6	Median (Q1, Q3) 0 (0, 0)	NR	0.9156

Statistically significant effect sizes are in bold text. In cases where calculated effect size confidence intervals were not-statistically significant but reported p-values were, we deferred to reported p-values and still bolded results.

Abbreviations: CI = confidence interval, HOOS = Hip disability and osteoarthritis outcome score, mo = month, NR = not reported, PCS = physical component scale, PMID = PubMed identifier, rec = recreation, RoB = risk of bias, SD = standard deviation, SF-36 = 36-Item short form survey, WOMAC = Western Ontario and McMaster Universities Osteoarthritis Index.

[A] Time from surgery
[B] Calculated
[C] Subgroup: Cemented
[D] Subgroup: Uncemented
[E] Subgroup: Posterior
[F] Subgroup: Anterolateral

Table 83. Rehabilitation versus various controls for total hip arthroplasty – continuous outcomes, transfers

Study, Year, PMID, Country	Arm 1	Arm 2	Overall RoB	Outcome Measurement	Time Point[A]	Arm 1, N	Arm 1, Mean (SD)	Arm 2, N	Arm 2, Mean (SD)	Effect Size (95% CI)	Reported p-Value
Heiberg, 2012, 22170790	Walking skill training program	Standard care	Moderate	30s Chair stand test	5 y	30	12 (3.7)	30	12 (4.6)	0 (-2.11, 2.11)[B]	ns
Mikkelsen, 2014, 25305374	Early supervised progressive resistance training	Unsupervised home-based exercise	Moderate	30s Chair stand test	6 mo	32	15.47 (4.5)	30	15.07 (5.1)	0.4 (-1.3, 2.1)[B]	NR

Statistically significant effect sizes are in bold text. In cases where calculated effect size confidence intervals were not-statistically significant but reported p-values were, we deferred to reported p-values and still bolded results.

Abbreviations: CI = confidence interval, mo = month, NR = not reported, ns = not significant, PMID = PubMed identifier, RoB = risk of bias, s = second, SD = standard deviation.

[A] Time from surgery
[B] Calculated

Table 84. Rehabilitation versus various controls for total hip arthroplasty – continuous outcomes, mobility

Study, Year, PMID, Country	Arm 1	Arm 2	Overall RoB	Outcome Measurement	Time Point[A]	Arm 1, N	Arm 1, Mean (SD)	Arm 2, N	Arm 2, Mean (SD)	Effect Size (95% CI)	Reported p-Value
Heiberg, 2012, 22170790	Walking skill training program	Standard care	Moderate	6MWT	12 mo	35	535; 95% CI (516, 555)	33	483; 95% CI (463, 503)	**52 (24, 80)**	**<0.001**
	Walking skill training program	Standard care	Moderate	6MWT	5 y	30	524; 95% CI (483, 564)	30	530 95% CI (487, 573)	-6.33 (-186.67, 174.00)[B]	NR
	Walking skill training program	Standard care	Moderate	Stair climb test	12 mo	35	10; 95% CI (9, 11)	33	12; 95% CI (11, 13)	-1 (-3, 0)	ns
	Walking skill training program	Standard care	Moderate	Stair climb test	5 y	30	13; 95% CI (11, 15)	30	13; 95% CI (11,15)	0 (-2.83, 2.83)[B]	NR
	Walking skill training program	Standard care	Moderate	Figure eight test	12 mo	35	7; 95% CI (5, 8)	33	8 95% CI (7, 10)	-1 (-3, 1)	ns
Mikkelsen, 2014, 25305374	Early supervised progressive resistance training	Unsupervised home-based exercise	Moderate	40-m-fast-paced walk test	6 mo	32	10.81 (2.8)	30	11.02 (2.6)	-0.2 (-1.2, 0.7)[B]	NR
Nelson, 2020, 32026820	Telerehabilitation	In-person usual care	Moderate	Step test	6 mo	34	15.2 (4)	35	13.6 (4.6)	1.6 (0.2, 3.0)[B]	NR
	Telerehabilitation	In-person usual care	Moderate	Stair climb test	6 mo	32	9.07 (3.0)	30	9.03 (2.8)	0.04 (-1, 1.1)[B]	NR
Winther, 2020, 31977324	Strengthening exercise	Standard care	Moderate	6MWT	12 mo	22	627 (96)	22	628 (110)	-1 (-44.3, 42.3)[B]	NR
	Strengthening exercise	Standard care	Moderate	Speed in the 5-m walkway	6 mo	26	1.33 (NR)	21	1.38 (NR)	NR	NR
	Strengthening exercise	Standard care	Moderate	Speed in the 5-m walkway	12 mo	22	1.38 (NR)	22	1.42 (NR)	NR	NR

Study, Year, PMID, Country	Arm 1	Arm 2	Overall RoB	Outcome Measurement	Time Point[A]	Arm 1, N	Arm 1, Mean (SD)	Arm 2, N	Arm 2, Mean (SD)	Effect Size (95% CI)	Reported p-Value
	Strengthening exercise	Standard care	Moderate	Step length	6 mo	21	69.7 (NR)	21	71.4 (NR)	NR	NR
	Strengthening exercise	Standard care	Moderate	Step length	12 mo	22	71.6 (NR)	22	72.5 (NR)	NR	NR

Statistically significant effect sizes are in bold text. In cases where calculated effect size confidence intervals were not-statistically significant but reported p-values were, we deferred to reported p-values and still bolded results.

Abbreviations: 6MWT = six-minute walk test, CI = confidence interval, m= meter, mo = month, m = meter, NR = not reported, ns = not significant, PMID = PubMed identifier, RoB = risk of bias, SD = standard deviation, y = year.

[A] Time from surgery
[B] Calculated

Table 85. Rehabilitation versus various controls for total hip arthroplasty – continuous outcomes, Timed Up and Go

Study, Year, PMID, Country	Arm 1	Arm 2	Outcome Measurement	Overall RoB	Time Point[A]	Arm 1, N	Arm 1, Mean (SD)	Arm 2, N	Arm 2, Mean (SD)	Effect Size (95% CI)	Reported p-Value
Coulter, 2017, 28506775	Unsupervised home-based exercises	Supervised rehabilitation & unsupervised home-based exercises	TUG (s)	High	6 mo	56	8.2; 95% CI (6.9, 9.4)	42	8.9; 95% CI (7.38, 10.43)	-0.74 (-6.65, 5.17)[B]	NR
Nelson, 2020, 32026820	Telerehabilitation	In-person usual care	TUG (s)	Moderate	6 mo	34	7.9 (2.3)	35	9.4 (3)	**-1.5 (-2.4, -0.6)[B]**	**NR**

Statistically significant effect sizes are in bold text. In cases where calculated effect size confidence intervals were not-statistically significant but reported p-values were, we deferred to reported p-values and still bolded results.

Abbreviations: CI = confidence interval, mo = month, NR = not reported, PMID = PubMed identifier, RoB = risk of bias, s = second, SD = standard deviation, TUG = timed up and go.

[A] Time from surgery
[B] Calculated

Other Patient-Reported Outcomes

Thirteen studies in total reported on other patient-reported outcomes following rehabilitation compared with various controls: one study (Liebs 2010) compared novel acute rehabilitation programs with control; two studies (Liebs 2012, Mikkelsen 2014) compared acute rehabilitation programs with different timing and/or intensity; four studies (Beck 2019, Heiberg 2012, Monticone 2014, Winther 2018) compared novel post-acute rehabilitation programs with various comparators (less intensive rehabilitation or no care); and four studies (Austin 2017, Coulter 2017, Naylor 2018, Nelson 2020, Rao 2021) compared rehabilitation programs delivered in different settings or by different personnel (Tables 86-88). Outcomes include: quality of life, satisfaction with care, and patient global assessments.

Health-Related Quality of Life

Four studies (Heiber 2012, Mikkelsen 2014, Nelson 2020, Rao 2021) reported the QoL component of HOOS and observed no differences between groups at follow-up times between 6 months and 5 years after THA (Table 86)

Patient Satisfaction With Care

Two studies (Liebs 2010 and Liebs 2012) reported data on satisfaction with care and found no differences between rehabilitation arms (Table 87).

Patient Global Assessments

Ten studies (Austin 2017, Beck 2019, Coulter 2017, Heiberg 2012, Liebs 2010, Liebs 2012, Monticone 2014, Naylor 2018, Smith 2009, Winther 2020) provided data on patients' self-reported global assessment of their health using nine different measurement instruments (Table 88). The studies mostly observed no differences between groups at follow-up times between 6 months and 5 years after THA. Beck 2019 found a significant difference in favor of sports therapy compared with control on the EQ-5D scale at 6-month follow-up, but this difference was not sustained at the 12-month follow-up.

Table 86. Rehabilitation versus various controls for total hip arthroplasty – continuous outcomes, quality of life

Study, Year, PMID, Country	Arm 1	Arm 2	Overall RoB	Outcome Measurement	Time Point[A]	Arm 1, N	Arm 1, Mean (SD)	Arm 2, N	Arm 2, Mean (SD)	Effect Size (95% CI)	Reported p-Value
Heiberg, 2012, 22170790	Walking skill training program	Standard care	Moderate	HOOS: QoL (0-100)	12 mo	35	81; 95% CI (76, 86)	33	83; 95% CI (78, 88)	-2 (-9, 5)	ns
	Walking skill training program	Standard care	Moderate	HOOS: QoL (0-100)	5 y	30	85; 95% CI (80, 90)	30	84; 95% CI (78, 90)	1 (-6.81, 8.81)[B]	NR
Mikkelsen, 2014, 25305374	Early supervised progressive resistance training	Unsupervised home-based exercise	Moderate	HOOS: QoL (0-100)	6 mo	32	83.8 (18)	30	86.7 (17)	-2.9 (-9.1, 3.3)[B]	NR
	Early supervised progressive resistance training	Unsupervised home-based exercise	Moderate	HOOS: QoL (0-100)	12 mo	32	86.7 (16)	30	86 (20)	0.7 (-5.8, 7.2)[B]	NR
Nelson, 2020, 32026820	Telerehabilitation	In-person usual care	Moderate	HOOS: QoL (0-100)	6 mo	34	79 (22)	35	77 (21)	2 (-5.2, 9.2)[B]	NR
Rao, 2021, 33863614 USA	Home physical therapy	Formal physical therapy	High	HOOS: QoL (0-100)	6 mo	70	74.3 (21.9)	66	69.6 (27.9)	-4.7 (-10.8, 1.4)	0.294

Statistically significant effect sizes are in bold text. In cases where calculated effect size confidence intervals were not-statistically significant but reported p-values were, we deferred to reported p-values and still bolded results.

Abbreviations: CI = confidence interval, HOOS = Hip disability and osteoarthritis outcome score, mo = month, NR = not reported, ns = not significant, PMID = PubMed identifier, QoL = quality of life, RoB = risk of bias, SD = standard deviation, y = year.

[A] Time from surgery
[B] Calculated

Table 87. Rehabilitation versus various controls for total hip arthroplasty – categorical outcomes, satisfaction with care

Study, Year, PMID, Country	Arm 1	Arm 2	Overall RoB	Outcome Measurement	Time Point[A]	Arm 1 n/N (%)	Arm 2 n/N (%)	Effect Size (95% CI)	Reported p-Value
Liebs, 2010, 20360503	Ergometer cycling	Control	Moderate	Patient satisfaction with care	24 mo	69/74 (93%)	76/88 (86%)	RR 2.18 (0.73, 6.49)	0.155
Liebs, 2012, 22196125	Early aquatic therapy	Late aquatic therapy	Moderate	Patient satisfaction with care	24 mo	88/100 (88%)	97/110 (88%)	RR 1.02 (0.44, 2.35)	0.968

Abbreviations: CI = confidence interval, MD = mean difference, NMD = net mean difference, NR = not reported, NA = not applicable, NS = not significant, PMID = PubMed identifier, RR = relative risk, QOL = quality of life, d= days, mo = months, SD = standard deviation.

[A] Time from surgery

Table 88. Rehabilitation versus various controls for total hip arthroplasty – continuous outcomes, patient global assessment

Study, Year, PMID, Country	Arm 1	Arm 2	Overall RoB	Outcome Measurement	Time Point[A]	Arm 1, N	Arm 1, Mean (SD)	Arm 2, N	Arm 2, Mean (SD)	Effect Size (95% CI)	Reported p-Value
Austin, 2017, 28419032	Home exercise	Formal Physical Therapy	Moderate	WOMAC: total (0-100)	6-12 mo	52	NR	52	NR	NR	0.80
	Home exercise	Formal Physical Therapy	Moderate	Harris hip score (0-100)[B]	6-12 mo	52	NR	52	NR	NR	0.82
Beck, 2019, 30782304	Sport therapy	Control	High	EQ-5D (NR)	6 mo	63	Median (Q1, Q3) 1 (0.89, 1)	51	Median (Q1, Q3) 0.89 (0.89, 1)	NR	**0.036**
	Sport therapy	Control	High	EQ-5D (NR)	12 mo	57	Median (Q1, Q3) 1 (0.89, 1)	41	Median (Q1, Q3) 1 (0.89, 1)	NR	0.891
	Sport therapy	Control	High	WOMAC: total (0-100)	6 mo	63	Median (Q1, Q3) 92.7 (86.5, 95.8)	51	Median (Q1, Q3) 92.7 (85.4, 96.9)	NR	1.00
	Sport therapy	Control	High	WOMAC: total (0-100)	12 mo	57	Median (Q1, Q3) 95.8 (91.7, 100)	41	Median (Q1, Q3) 95.8 (88.5, 96.9)	NR	1.00
	Sport therapy	Control	High	Harris hip score (0-100)	6 mo	63	Median (Q1, Q3) 93 (86, 96)	51	Median (Q1, Q3) 95 (88, 96)	NR	1.00
	Sport therapy	Control	High	Harris hip score (0-100)	12 mo	57	Median (Q1, Q3) 96 (93, 98)	41	Median (Q1, Q3) 96 (90, 97)	NR	1.00
Coulter, 2017, 28506775	Unsupervised home-based exercises	Supervised rehabilitation & unsupervised home-based exercises	High	WOMAC: total (0-100)	6 mo	56	Mean (95% CI) 18.4 (11.88, 24.88) SE 3.32*	42	Mean (95% CI) 19.70 (12.46, 26.98) SE 3.70*	-1.3 (-11.04, 8.44)[C]	ns
Heiberg, 2012, 22170790	Walking skill training program	Standard care	Moderate	Harris hip score (0-100)	12 mo	35	Mean (95% CI) 96 (93, 98)	33	Mean (95% CI) 92 (90, 95)	3 (-1,7)	ns
Liebs, 2010, 20360503	Ergometer cycling	Control	Moderate	SF-6D	24 mo	74	0.746 (0.128)	88	0.729 (0.135)	0.02 (-0.02, 0.06)[C]	0.13
Liebs, 2012, 22196125	Early aquatic therapy	Late aquatic therapy	Moderate	SF-6D	24 mo	100	0.730 (0.146)	110	0.744 (0.122)	MD -0.01 (-0.05, 0.02)[C]	0.213
Monticone, 2014, 24459172	Task-oriented exercises	Open chain kinetic exercises	Moderate	SF-36: General health (0-100)	12 mo	50	72.1 (18.9)	50	57.7 (16.8)	14.4 (9.4, 19.4)[C]	NR
Naylor, 2018, 30021552	In-patient rehabilitation	No in-patient rehabilitation	Moderate	Oxford hip score (12-60)[D]	12 mo	123	Median (Q1, Q3) 48 (46, 48)	123	Median (Q1, Q3) 48 (46, 48)	Median difference (Q1, Q3) 0 (-1, 1)	0.91
Rao, 2021, 33863614 USA	Home physical therapy	Formal physical therapy	High	SF-12: PCS	6 mo	70	47.2 (10.7)	66	46.6 (12.2)	-0.6 (-3.4, 2.2)	0.644
	Home physical therapy	Formal physical therapy	High	SF-12: MCS	6 mo	70	54.9 (8.0)	66	52.3 (8.9)	-2.6 (-4.6, -0.6)	0.087

Study, Year, PMID, Country	Arm 1	Arm 2	Overall RoB	Outcome Measurement	Time Point[A]	Arm 1, N	Arm 1, Mean (SD)	Arm 2, N	Arm 2, Mean (SD)	Effect Size (95% CI)	Reported p-Value
Smith, 2009, 19876883	Gait re-education program & bed exercises	Gait re-education program only	Moderate	SF-12 (0-100)	12 mo	30	Median (Q1, Q3) 32 (30, 34)	30	Median (Q1, Q3) 33 (31, 34)	Median difference (95% CI) 0 (-1, 2)	0.4282
	Gait re-education program & bed exercises	Gait re-education program only	Moderate	SF-12 (0-100)	12 mo[E]	30	Median (Q1, Q3) 32 (31, 33)	30	Median (Q1, Q3) 33 (31, 34)	Median difference (95% CI) 0 (-1, 2)	0.288
	Gait re-education program & bed exercises	Gait re-education program only	Moderate	SF-12 (0-100)	12 mo[F]	30	Median (Q1, Q3) 30 (29, 34)	30	Median (Q1, Q3) 32.5 (32, 33)	Median difference (95% CI) 2 (NR, NR)	0.7649
	Gait re-education program & bed exercises	Gait re-education program only	Moderate	SF-12 (0-100)	12 mo[G]	30	Median (Q1, Q3) 32.5 (31, 34)	30	Median (Q1, Q3) 32 (32, 33)	Median difference (95% CI) 1 (-1, 3)	0.3193
	Gait re-education program & bed exercises	Gait re-education program only	Moderate	SF-12 (0-100)	12 mo[H]	30	Median (Q1, Q3) 31.5 (29.5, 33)	30	Median (Q1, Q3) 32 (32, 33)	Median difference (95% CI) 1 (-1, 3)	0.3193
Winther, 2020, 31977324	Strengthening exercise	Standard care	Moderate	Harris hip score (0-100)	12 mo	22	95 (7)	22	93 (9)	2 (-1.4, 5.4)[C]	NR
	Strengthening exercise	Standard care	Moderate	HOOS: Short form (0-100)	12 mo	22	8 (10)	22	8 (10)	0 (-4.2, 4.2)[C]	NR

Statistically significant effect sizes are in bold text. In cases where calculated effect size confidence intervals were not-statistically significant but reported p-values were, we deferred to reported p-values and still bolded results.

Abbreviations: CI = confidence interval, EQ-5D = EuroQual, mo = month, MCS = mental component scale, NR = not reported, PCS = physical component scale, PMID = PubMed identifier, RoB = risk of bias, SD = standard deviation, SF-6D = short-form six-dimension, SF-12 = 12-item short form survey, SF-36 = 36-item short form survey, WOMAC = Western Ontario and McMaster Universities Osteoarthritis Index.

[A] Time from surgery
[B] Measure combines domains of pain, function, absence of deformity, and range of motion
[C] Calculated
[D] Measure combines pain and function
[E] Subgroup of cemented participants
[F] Subgroup of uncemented participants
[G] Subgroup of posterior participants
[H] Subgroup of anterolateral participants

Healthcare Utilization Outcomes

Few studies reported on healthcare-utilization outcomes following rehabilitation compared to various control. Liebs 2010 and Liebs 2012 reported on the number of participants who needed to be readmitted to hospital due to various adverse events within three months of THA and found rates low (4 to 10%, including post-surgical adverse events) and comparable between groups.

Costs

Naylor 2018 compared the costs of an Australian-based inpatient versus no inpatient care and reported that median rehabilitation provider charges were 10 times higher for individuals who received inpatient rehabilitation compared with those who did not (median difference $7582 (95% CI $5649 to $10,249, $p < 0.001$).

Cost-Effectiveness

We found no studies that compared the cost-effectiveness of rehabilitation with various comparators for THA.

Harms From Rehabilitation

Four studies (reported the occurrence of adverse events associated with the rehabilitation programs (e.g., pain, falls). Of the studies that reported data on adverse events (Liebs 2010, Liebs 2012, Mikkelsen 2014, Monticone 2014), the proportion of patients experiencing harms due to participation in the rehabilitation interventions were low (0 to 18%; highest for “transitory pain worsening”), of low severity, and comparable between groups (Table 89).

Table 89. Rehabilitation versus various controls for total hip arthroplasty – categorical outcomes, harms from rehabilitation

Study, Year, PMID, Country	Arm 1	Arm 2	Overall RoB	Outcome Measurement	Time Point[A]	Arm 1, n/N	Arm 2, n/N	Effect Size (95% CI)	Reported p-Value
Liebs, 2010, 20360503	Ergometer cycling	Control	Moderate	Readmitted to hospital	Within 3 mo	5/74 (7%)[B]	5/88 (6%)[C]	RR 1.19 (0.36, 3.95)[D]	NR
Liebs, 2012, 22196125	Early aquatic group	Late aquatic group	Moderate	Readmitted to hospital	Within 3 mo	10/100 (10%)[E]	4/110 (4%)[F]	RR 2.75 (0.89, 8.49)[D]	NR
Mikkelsen, 2014, 25305374	Early supervised progressive resistance training	Unsupervised home-based training	Moderate	Knee pain in contralateral leg	12 mo	1/32 (3%)	0/30 (0%)	1.88 (0.07, 53.88)[D]	NR
Monticone, 2014, 24459172	Task-oriented exercises	Open chain kinetic exercises	Moderate	Transitory pain worsening	12 mo	8/50 (16%)	9/50 (18%)	0.89 (0.37, 2.12)[D]	NR
	Task-oriented exercises	Open chain kinetic exercises	Moderate	Falls	12 mo	2/50 (4%)	3/50 (6%)	0.67 (0.12, 3.82)[D]	NR

Statistically significant effect sizes are in bold text. In cases where calculated effect size confidence intervals were not-statistically significant but reported p-values were, we deferred to reported p-values and still bolded results.

Abbreviations: CI = confidence interval, NR = not reported, PMID = PubMed identifier, RR = relative risk, mo = month, SD = standard deviation.

[A] Time from surgery
[B] Due to dislocation of the hip, other hip problems, fracture of lumbar vertebrae, cardiovascular problems, and overall pain in one patient each
[C] Due to dislocation of the hip, acute coronary syndrome, hematoma revision, appendicitis, and an unknown reason in one each
[D] Calculated
[E] Due to dislocation of hip, wound dehiscence, thrombosis n=2, intestinal perforation, shunt revision, supervision after fall, abscess, appendicitis, pneumonia
[F] Due to dislocation of hip, wound dehiscence, pulmonary embolism, pulmonary edema

Heterogeneity of Treatment Effects (Subgroup Differences)

Two studies (Lyp 2016 and Smith 2009) formally analyzed possible heterogeneity of treatment effects, reporting statistical tests for whether the comparative effect of rehabilitation versus its various comparators differed in among subgroups. Lyp 2016 found that the type of prosthesis used (cemented or uncemented) did not impact the relative effects of rehabilitation on ROM or strength. Smith 2009 reported results by subgroups who received cemented or uncemented prosthesis and who had posterior or anterolateral surgical approaches. The study found no significant difference in outcomes across these subgroups, although sample sizes were small and likely lacked sufficient power for subgroup analyses. No study formally analyzed possible heterogeneity of treatment effects due to patients' baseline risk (e.g., patients with higher vs. lower measures of strength, flexibility, function, at baseline).

Applicability

Studies were conducted across the globe (two in the United States) using diverse interventions employed in diverse healthcare settings. While the relative effect of the interventions on clinical outcomes (and harms) from non-U.S.-based studies are likely applicable to the U.S. context, findings pertaining to healthcare system or resources (such as costs or comparisons of inpatient vs. outpatient rehabilitation) are likely country and healthcare system specific. The sex of participants varied widely across studies, ranging from 21 to 70 percent of participants being female. The average age of patients ages ranged from 54 to 71 years and the average BMIs ranged from 25 to 30 kg/m^2 (thus, in all studies, most patients were obese). Most studies did not report whether patients had undergone previous contralateral replacement surgery; of one study that did, the proportion was low (less than 25%). As such, the conclusions in this KQ are likely most applicable to middle-to-older-aged adults in high-income countries who are receiving their first total TKA for osteoarthritis.

Summary of Comparison of Rehabilitation Versus Various Controls for Total Hip Arthroplasty

Table 90 summarizes the evidence for the comparison of rehabilitation versus various comparators and rehabilitation. We focus on the outcomes we prioritized in discussion with stakeholders.

While some studies found significant effects for outcomes, most studies did not and given the heterogeneity of interventions and lack of replication of unique rehabilitation programs, we determined that there is low to insufficient SoE for all conclusions. Specifically, there is low SoE of no difference between the various programs of rehabilitation (compared with no rehabilitation, lesser intensive rehabilitation, rehabilitation at different timing, and rehabilitation provided in different settings) following THA in terms of pain, strength, ADL, and QoL. There is insufficient evidence on the impact of rehabilitation on ROM and satisfaction with care. There is low SoE that there is no difference among rehabilitation programs with respect to harms related to rehabilitation.

Table 90. Evidence profile: Rehabilitation versus various controls for total hip arthroplasty

Outcome Category	Outcome	N Studies (Participants)	RoB	Consistency	Precision	Directness	Intervention Replication	SoE	Conclusions
Body structure and function	Pain	11 (1297)	Moderate	Consistent	Precise	Direct	All unique	Low	Similar pain
	ROM	3 (178)	Moderate	Inconsistent	Precise	Direct	All unique	Insufficient	No conclusion
	Strength	5 (370)	Moderate	Consistent	Precise	Direct	All unique	Low	Similar strength
Activity and participation	ADLs	12 (1247)	Moderate	Consistent	Precise	Direct	All unique	Low	Similar ADL
Other outcomes	Satisfaction with care	2 (372)	Moderate	Consistent	Precise	Direct	All unique	Insufficient	No conclusion
	QoL	4 (335)	Moderate	Consistent	Precise	Direct	All unique	Low	Similar QoL
Healthcare utilization	Need for postoperative procedures	0	NA	NA	NA	NA	NA	Insufficient	No evidence
Harms	Harms from prehabilitation	4 (534)	Moderate	Consistent	Precise	Direct	All unique	Low	Similar harms

Abbreviations: ADLs = activities of daily living, QoL = health-related quality of life, NA = not applicable, QoL = quality of life, RoB = risk of bias, ROM = range of motion, SoE = strength of evidence.

Discussion

Findings in Relation to the Decisional Dilemmas

Despite a large overall body of evidence (83 studies), mostly from randomized controlled trials (RCTs), for the four Key Questions (KQs), the evidence was sparse due to the extensive heterogeneity of interventions and outcomes.

For healthcare services deciding whether to offer **prehabilitation** (rehabilitation provided prior to surgery) to patients about to undergo **total knee arthroplasty** (TKA) for osteoarthritis, the evidence suggests that prehabilitation is comparable to no prehabilitation in terms of pain, range of motion (ROM), and activities of daily living (ADL). Prehabilitation may lead to increased strength and reduced length of hospital stay following TKA although there is no or insufficient evidence on patient satisfaction with care, posthospital disposition, and need for postoperative procedures, precluding conclusions on these outcomes. Of the studies that reported data on harms, there was no evidence increased harms among patients who participated in prehabilitation interventions compared to those who did not.

Although the largest number of studies addressed the comparative effectiveness of postoperative **rehabilitation** interventions versus a variety of comparators for patients who have undergone **TKA** for osteoarthritis, the evidence does not clearly establish whether any of the TKA rehabilitation programs (or attributes of programs, including exercise components, personnel, or setting) are more or less effective relative to each other. The pervasive diversity of rehabilitation programs that have been studied has resulted in an actual sparsity of evidence for any particular program or program attribute. In addition, the high degree of inconsistency in which outcomes have been evaluated and reported further precludes definitive conclusions. Nevertheless, there is some evidence to suggest that the diverse rehabilitation interventions were associated with comparable improvements in pain, ROM, strength (although some improvements in strength were observed following acute rehabilitation), and ADL. Compared with a variety of (usually less intensive) comparators, there is also some evidence to suggest that rehabilitation programs offered in the acute phase (initiated within 2 weeks of surgery) lead to similar satisfaction with care and rehabilitation programs delivered in the post-acute phase leads to similar quality of life (QoL). In contrast, the evidence is insufficient to establish the impact of rehabilitation on QoL (for acute rehabilitation), satisfaction with care (for post-acute rehabilitation), and the need for postoperative procedures (for both acute and post-acute rehabilitation). The evidence suggests that the risks of harms from post-acute rehabilitation interventions are low and comparable across groups; no studies reported evidence on harms from acute rehabilitation interventions.

The evidence informing the question of whether to offer **prehabilitation** to patients about to undergo **total hip arthroplasty** (THA) for osteoarthritis was the most limited across the four KQs. There was no or insufficient evidence for all patient-reported, performance-based, healthcare-utilization outcomes, and harms, precluding conclusions for the outcomes.

For patients undergoing **rehabilitation** following **THA** for osteoarthritis, there is some evidence to suggest that there is no difference between various rehabilitation interventions and less active (or no) rehabilitation interventions following THA in terms of pain, strength, ADLs or QoL. There was no or insufficient evidence for whether there is a difference between rehabilitation and various comparators in terms of hip range of motion or satisfaction with care, precluding conclusions for these outcomes. In terms of adverse events, the evidence suggests that

the risks of harms from rehabilitation interventions are low (and of low severity) and are comparable across groups.

The most reassuring finding pertained to the safety of the prehabilitation and rehabilitation interventions. While the relative effectiveness of diverse programs for diverse outcomes remains uncertain, we found no evidence of increased harm from patients' participation in prehabilitation or rehabilitation programs prior to or after their TKA or THA, respectively.

Evidence was insufficient to comment on the costs, both indirect and direct, associated with prehabilitation and rehabilitation programs. Of particular note, we found no cost-effectiveness analyses regarding prehabilitation or rehabilitation. Despite this, many studies noted cost as a justification for their study question — particularly studies of rehabilitation after TKA and THA that evaluated the safety and effectiveness of rehabilitation delivered in lower-resource settings or by lower-resource personnel compared with higher-resource settings or personnel.

There was insufficient evidence of specific outcomes to explore heterogeneity of treatment effect of rehabilitation programs by patient, surgical, or setting factors. Thus, there is no evidence to help determine which patients, which specific surgeries, or which types of facilities would most benefit from rehabilitation programs (or any specific components of rehabilitation).

Strengths and Limitations

Strengths and Limitations of the Evidence Base

Although there have been numerous RCTs published on the topic of rehabilitation after TKA and THA (and to a lesser extent prehabilitation prior to TKA or THA), the evidence specific to almost all questions of interest is remarkably sparse. With the exception of three rehabilitation interventions evaluated in two pairs of studies each, every study evaluated a different (p)rehabilitation intervention comprised of different exercise goals and specific exercise components, delivered with varying timing and/or intensity, by different personnel, in different settings.

Adding to the complexity of diverse interventions, studies reported highly diverse outcomes — including not only different outcome domains, but also different scales and metrics within shared outcome domains (for example, different scores or tools or adapted versions of existing tools) – making it difficult to learn across studies. Studies were typically small to medium (with only 20 to 60 patients). The small sample sizes might have resulted in underpowered studies and, thus, misleadingly statistically nonsignificant findings. This is especially important for KQs 2 and 4 which compared various forms of active interventions (and thus would require a much larger sample to demonstrate an advantage of a likely smaller relative effect size). Relatively few studies directly assessed the setting of the intervention (i.e., evaluating the empirical effect of similar programs delivered in different settings). Among the 11 RCTs and 5 appropriately adjusted nonrandomized comparative studies (NRCSs) that did evaluate setting, all addressed postoperative rehabilitation. Most of these studies poorly reported the details of the rehabilitation programs (or did not report intervention content at all) making it difficult to compare with other studies. Many studies compared different intensity interventions conducted in different settings, making it difficult to disentangle the unique impact of setting from the intervention content (among other factors).

Progression is considered to be an important feature of well-designed (p)rehabilitation interventions to ensure programs of exercise are continuously adapted to specific patient-performance and do not become static. Yet, progression was rarely reported in our sample of

studies, and where it was, was often deemed inappropriate by our clinician experts (i.e., patients were not progressed based on patient-specific parameters).

Across study designs, data were rarely reported for subgroups based on factors, such as surgical approach (posterior vs. anterior) or prosthesis affixing method (cement vs. no cement) and never reported within patient subgroups or setting subgroups. We were therefore unable to conclude whether there was (or was not) heterogeneity of treatment effects based on patient, surgical setting, or other characteristics.

We assessed most of the comparative studies (RCTs and NRCSs) to be at overall moderate or high risk of bias, primarily because participants, care providers, and/or outcome assessors were not blinded and because of uncertain or high-risk methods of randomization. While blinding of participants (i.e., patients) and care providers (i.e., physical therapist) will almost always be impossible in studies addressing the (p)rehabilitation KQs in this systematic review (SR), lack of blinding can still lead to bias and should therefore still be considered in interpreting results. Moreover, although for subjective patient-reported outcomes, such as pain and activities of daily living, it may be impossible to blind the outcome assessors (i.e., patients), it is possible to blind the outcome assessors (e.g., rehabilitation assistants) for objective outcomes of physical performance. The NRCSs were usually considered to be at moderate risk of confounding. In general, reporting of interventions and outcomes varied widely, ranging from thoroughly to poorly described.

Strengths and Limitations of the Systematic Review Process

We followed contemporary standards for conducting SRs, including multiple stakeholder engagement in KQ development and refinement and careful adherence to recommended methods for literature searching, screening, data extraction, risk of bias assessment, qualitative synthesis, quantitative synthesis (deemed inappropriate in this case), and strength of evidence (SoE) assessment. The SR was narrowly focused on the population of patients who have undergone (or are planning to undergo) total, unilateral TKA or THA due to osteoarthritis but broad inclusive to the range of (p)rehabilitation interventions evaluated (and diversity of their reporting) in this population.

During protocol development, we prioritized outcomes (and timing of outcomes) in consultation with panels of Key Informants and Technical Experts and in keeping with published core outcome sets for performance-based outcomes and patient- and performance-based outcomes pertinent to patients undergoing TKA or THA.[59, 60] However, many of the prioritized outcomes were either not reported in included studies or were reported in an insufficient number of studies to allow conclusions from our narrative synthesis (or to support meta-analysis or meta-regression). Unreported or rarely reported patient-reported outcomes included QoL and satisfaction with care. Unreported or rarely reported performance-based outcomes (especially in studies of THA) included range of motion and strength. Healthcare-utilization outcomes were rarely reported across all studies. Eighty-one studies were excluded for reporting only short-term patient-reported and performance-based outcomes (i.e., <3 months for TKA and <6 months for THA). While these cutoffs were informed by stakeholder input, it may be considered a limitation for considering the evidence of early post-operative improvements in patient-reported and performance-based outcomes following TKA and THA.

One of the largest challenges we faced in this SR was that many factors were of interest that may affect outcomes and were combined in such diverse ways that it was difficult to disentangle their relative contribution and identify trends. We attempted to apply a systematic organization to

both the heterogeneity of the interventions and the outcomes using the most contemporary approaches and evidence in the field, as informed by our technical and clinical experts. We hoped to conduct a network meta-analysis across the programs, focusing on comparisons of different intervention components. However, the described heterogeneity of interventions and the lack of consistency of reported outcome precluded meaningful quantitative syntheses.

We believe a strength and novel feature of this SR was our detailed coding of the "active ingredients" of the (p)rehabilitation interventions using a comprehensive taxonomy developed by Oatis and Franklin.[52] For each intervention and comparator evaluated, we coded the specific exercises included in the program and goals these exercises sought to address (e.g., strength, flexibility). Systematic and standardized coding of the content of (p)rehabilitation interventions offers an important step forward in synthesizing (p)rehabilitation evidence by establishing a common language of the active ingredients contained within interventions to compare across studies. Such codes can be used decision makers to guide the replication of successful individual studies of interest and design future promising studies. While we were unable to link these codes to intervention outcomes (due to the large number of intervention components combined with the sparse reporting of specific outcomes across studies), the thorough process of coding each program provided insights into the general composition of (p)rehabilitation programs studied and what components were more or less commonly employed across studies. It also revealed the vast creativity and heterogeneity of the (p)rehabilitation interventions and the lack of reporting or standardization of "standard care" comparators. Prior to synthesizing results, we used these codes, combined with expert input to make sensible groupings of studies within KQs.

Despite the value of using this taxonomy, it was not without its limitations. The Oatis and Franklin taxonomy was designed to code interventions delivered to patients after TKA by physical therapists or physical therapy assistants in the outpatient or home health settings. As such, the taxonomy was excellent in capturing the interventions delivered in these settings and by these providers but faced certain challenges when applied to both TKA and THA, in a variety of settings, with a variety of providers (including patient-led). For example, some of the exercises used for the hip were not, or only crudely, reflected in the TKA-based taxonomy. As another example, some of the studies of interest included acute and/or inpatient rehabilitation. Thus, exercises that are only appropriate to these acute and/or inpatient rehabilitation settings were not always reflected in the taxonomy (e.g., open chain ankle strengthening exercises).

There were two aspects of the (p)rehabilitation programs, timing and intensity/dosage, that were not well-captured in this review. Regarding timing, the KQs separate prehabilitation from rehabilitation, which captures one aspect of timing. However, the extraction plan in capturing other aspects of timing within each KQ was limited, particularly for rehabilitation. For example, some studies investigated rehabilitation programs of equal length and in the same setting (e.g., 8-week outpatient program), yet started at different time points post-rehabilitation (e.g., at 1 week vs. 12 weeks). Rehabilitation at these stages target different goals and are not likely meaningful in comparison, yet this difference in the programs is masked in the current analysis. Future reviews should extract timing information in case it is meaningful for interpretation. Intensity and dosage, in any form (e.g., challenge of the exercise, duration of the session in minutes, duration of the program in days/weeks, number of sessions), were not captured in this review. Codes represented the presence or absence of the active ingredients and did not represent their dosage (i.e., an exercise only needed to be performed once in the program to be coded as present). This presents a major limitation in synthesizing the results to answer the KQs. In extracting and coding data according to the protocol, the investigators observed high variation

with respect to intensity among the included studies which may have led to the observed variation in results. For example, some studies used limited or no resistance with strengthening exercises (with and without progressions), while other studies were specifically prescribed resistance and progression consistent with recommendations for increasing muscle strength. Some studies included two supervised sessions with rehabilitation personnel, while others included over 30 supervised sessions with rehabilitation personnel. Some studies reported 10-minute intervention sessions while others reported 90-minute intervention sessions. Some studies investigated 2-week programs, while others investigated 16-week programs. This variation in intensity and dosage is not evident in this evidence synthesis yet may be an important factor driving outcomes. Given the high amount of variation in the other aspects of the extracted information, these details would only contribute to increased heterogeneity in addition to the heterogeneity already noted.

Finally, use pharmacological agents (particularly as adjunctive to (p)rehabilitation) may represent an important confounding variable but were considered beyond the scope of this review.

Applicability

Most studies in this SR were conducted outside the United States, particularly in Europe and high-or middle-income East Asian countries; a smaller portion of studies were conducted in Australia and North America, with only 14 studies conducted in the United States, While the relative effect of the interventions on clinical outcomes (and harms) from non-U.S.-based studies are likely applicable to the U.S. context, findings pertaining to healthcare system or resources (such as costs or comparisons of inpatient vs. outpatient rehabilitation) are likely country and healthcare system specific. For example, the relatively short inpatient stays in the United States (compared with other countries) may reduce the generalizability to the United States of comparisons of different settings conducted in other countries.

The sex ratios varied widely across studies, ranging from 27 to 100 percent of participants being female. The average age of patients ages ranged from 50 to 79 years and the average body mass indexes ranged from 25 to 35 kg/m^2 (thus, in all studies, most patients were obese, but in several, many to most were morbidly obese). Most studies did not report whether patients had undergone previous contralateral replacement surgery; of those that did, proportions were low (less than 25%). As such, the conclusions in this SR are likely most applicable to middle-to-older-aged adults in high-income countries who are receiving their first total TKA or THA for osteoarthritis.

The applicability of the findings may also be limited to the specific interventions that have been studied and the particular healthcare settings in which they are intended to (or could feasibly) be delivered. Several interventions were resource intensive in terms of technology, personnel, or setting whereas others were designed to be less intensive in materials or human resources. Beyond resources, variation of rehabilitation practice — including terminology and outcomes of measurement — is well established, and thus application of novel interventions to novel settings may be challenging, especially if the details of interventions and how they are operationalized are poorly described.

Implications for Clinical Practice

The evidence base for the KQ addressing prehabilitation for TKA is limited. While there is some evidence that prehabilitation may lead to reduced lengths of stay in the acute post-operative

period as compared to no prehabilitation, there is no clear indication that it leads to improvements in patient-reported, performance-based, or other healthcare-utilization outcomes. Follow-up for outcomes ranged from 3 to 12 months. Thus, the decision of whether or not to provide prehabilitation (or for patients, to participate in prehabilitation) appears to still largely be based on its hypothesized ability to increase patient function and capacity prior to surgery with the aim of quicker recovery afterwards. More evidence is needed to discern the relative effect of diverse prehabilitation programs to each other or specific components or methods of delivery of prehabilitation programs. As no studies provided evidence on patient satisfaction with receiving prehabilitation, it is difficult to determine the degree to which patients value receiving prehabilitation care to support their TKA recovery.

The evidence base for rehabilitation following TKA was largest, based on the number of studies included. Despite this, the evidence for the comparative value of specific rehabilitation interventions with their specific methods of delivery (timing, setting, personnel, progression) over comparator rehabilitation interventions was weak, due to sparsity of similar intervention/comparison/outcome combinations within group of studies. Follow-up for outcomes ranged from 3 to 24 months. There is some evidence to suggest that strength-based programs delivered in the acute phase after surgery, combined with adjunctive neuromuscular electrical stimulation may lead to reduced pain and increased strength. [64, 68, 69] The evidence supporting other rehabilitation programs (or specific components and how they are delivered) is inconclusive.

The evidence base for prehabilitation prior to THA was smallest, and like prehabilitation prior to TKA, showed no clear evidence to inform decisions on whether or not to offer (or participate in) prehabilitation programs, or what components of prehabilitation following THA may be more or less effective. Follow-up ranged from 6 to 12 months. No study reported patient satisfaction with prehabilitation for THA.

Similar to rehabilitation following THA, there is limited evidence of the comparative effectiveness of diverse rehabilitation programs following THA with respect to patient-reported, performance-based or healthcare-utilization outcomes and no evidence of what specific attributes of interventions (e.g., component goals or specific exercises, personnel, setting) are associated with better or worse outcomes. Follow-up ranged from 6 to 60 months.

In the absence of definitive evidence, stakeholders may want to use other decision-making factors to decide whether or not to implement prehabilitation or what specific rehabilitation program to implement. We have provided detailed extraction of content of these programs (overlaid with a standardized taxonomy) which decision makers may consider in conjunction with our extraction of outcomes. For example, decision makers considering (p)rehabilitation programs can identify studies in our review that are similar to programs that are being offered in their context and explore how these studies have performed on their prioritized outcomes or consider components of similar interventions that could be added to their own. Additionally, health systems could look at programs that are feasible to consider for implementation based on their available resources.

Implications for Research

Further research is needed to address various questions set out by this SR to determine the comparative effectiveness of diverse prehabilitation and rehabilitation interventions delivered in various settings by various personnel. More than just the conduct of large, well-executed RCTs, further work is needed by funders, researchers, and clinicians to **orchestrate an overall**

program of rehabilitation research that supports more efficient and synergistic learning across studies: namely through standardized labeling, defining, and reporting of the various (p)rehabilitation interventions and consistent use of a core set of patient-reported, performance-based, and healthcare-utilization outcomes. Such work is crucial if we are to efficiently build a body of rehabilitation evidence that truly seeks to enable evidence-based decision making about which interventions should be offered to adults undergoing TKA or THA for osteoarthritis to achieve the best clinical outcomes, reduce avoidable complications or joint failures, and be cost- and resource-effective for the health system, patients, and their caregivers.

For **interventions**, we found that the taxonomy of exercises created by Oatis and Franklin, which grouped interventions within goal components, offers a feasible foundation for a categorization scheme to design, implement, and report (p)rehabilitation interventions.[52] Consistent use of an agreed-upon taxonomy, adopted by the field, would greatly enhance the validity and efficiency of subsequent evidence syntheses of these studies, and ideally lend itself to more robust quantitative syntheses, such as multivariable meta-regression to estimate the independent effects of specific components.[160]

Regarding **outcomes**, we are aware of core performance-based outcome sets for many outcomes[59] but not for patient-reported or healthcare-utilization outcomes. Despite restricting our evidence to contemporary studies (since 2005), we found that reported outcomes were highly heterogenous and often did not include core outcomes. Further work is needed to define what core outcomes are essential to evaluation of (p)rehabilitation after TKA and THA and ideally that such outcomes become expected standards for funding of studies and publishing of their results. Many of the studies included in this review had moderate to high risk of bias, in part due to lack of blinding of clinicians, patients, and outcome assessors. While it is difficult to blind clinicians and patients in (p)rehabilitation studies, threats to bias may be minimized by improved blinding of outcomes. Specifically, studies may blind outcome assessors (for performance-based outcomes) and analysts (for all outcome). Thus, in addition to considering what core outcomes should be included in studies, stakeholders (including funders) should consider standards for how such core outcomes should be collected and analyzed to minimize threats to bias.

Finally, for **reporting**, future studies may consider using the Template for Intervention Description and Replication (TIDieR) checklist to ensure comprehensive reporting of all intervention elements (who, what, where, how, etc.).[161] Lenguerrand 2020 used the TIDIER checklist, which greatly enhanced our ability to code the intervention content for this study. Transparent and comprehensive reporting of rehabilitation interventions, including any active (p)rehabilitation components delivered to comparator arms, will greatly improve both the capacity of practitioners to apply (effective) interventions in practice and support more robust and informative evidence synthesis. Related to interventions, outcomes, and reporting, future studies (and reviews) should consider being more explicit in considering the therapeutic validity of interventions and matching outcomes to theoretically linked intervention content.[162]

Given the absence of evidence on costs across all KQs (despite many studies noting cost as a justification for their study question), future studies should consider collecting information on the direct and indirect costs of (p)rehabilitation for TKA and THA and consider conducting a CEA analysis alongside effectiveness analyses. Jette et al. make similar calls for action in rehabilitation research for TKA and note additional implications such as need for coordinated multisite programs of research to facilitate larger sample sizes, replication studies to enhance investigation of promising studies, and interventions grounded in theory, among others.[163]

Despite being an important feature of well-designed (p)rehabilitation interventions, progression was often not reported in our sample of studies, and where it was, was often deemed inappropriate by our clinician experts. Future studies should report whether progression was performed or not and if performed, on what patient parameters progression was based.

An important question remains regarding which patients might most benefit from (p)rehabilitation or from any specific component of therapy. However, there is sparse evidence to address this question. Future studies should be large enough, and thus sufficiently powered, to adequately address *a priori* aspects of heterogeneity of treatment effect.

Conclusions

Although we found a large body of evidence, we were able to make only a few specific conclusions in this SR, all of which were based on insufficient or low SoE. Generally speaking, there is low SoE that various forms of prehabilitation and rehabilitation may result in comparable pain, ROM, and strength; and insufficient SoE for ADLs, patient satisfaction, and need for postoperative procedures. There is low SoE that prehabilitation may lead to reduced length of stay for following TKA and low SoE that adverse events (where reported) due to (p)rehabilitation are low and comparable among groups. Future research, ideally large RCTs, is needed to compare the relative effectiveness of well specified (p)rehabilitation interventions, delivered by varying personnel, in different settings, on a core set of patient-reported, performance-based, and healthcare-utilization outcomes.

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Abbreviations and Acronyms

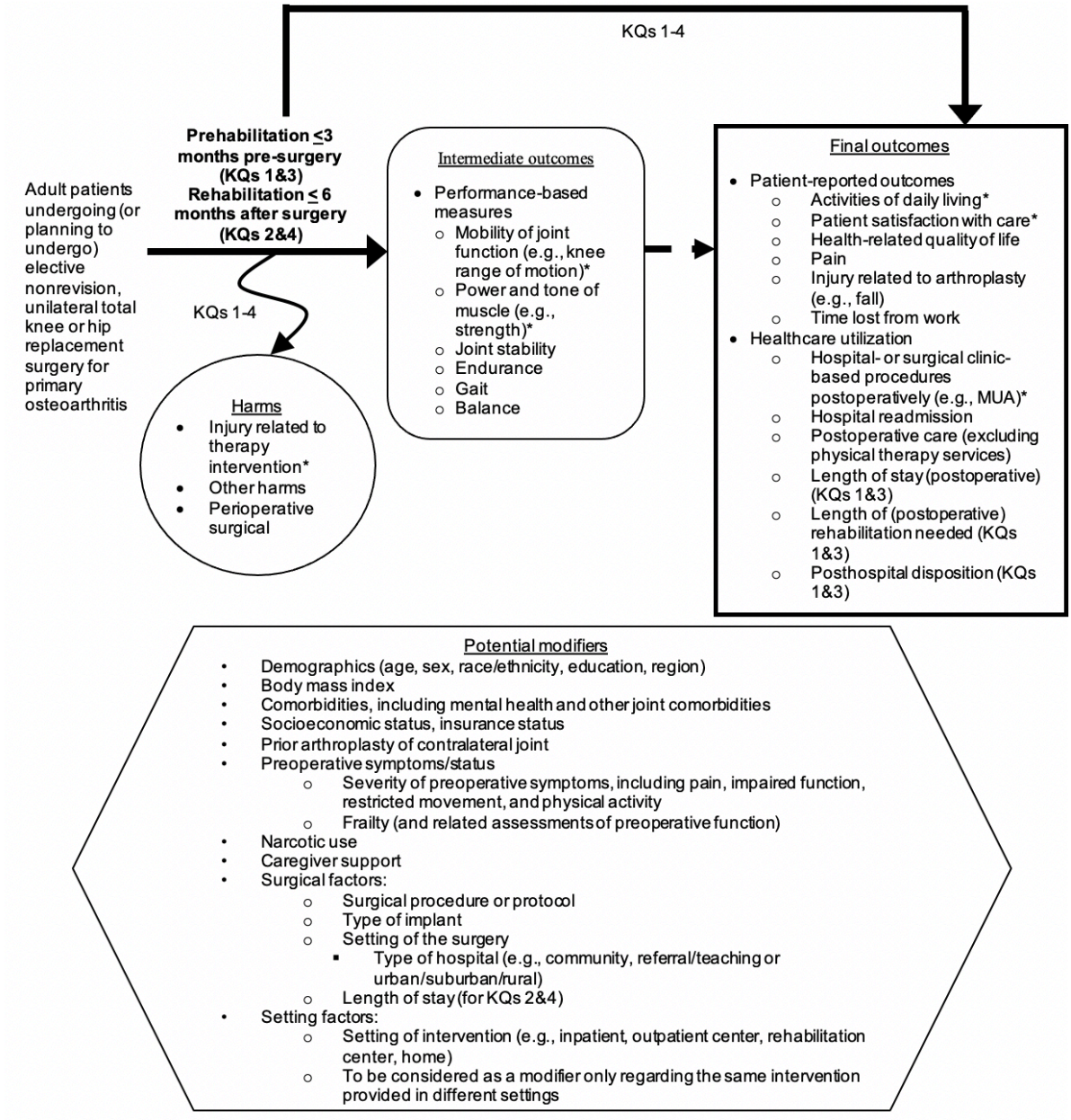
6MWT	Six-minute walk test
ADL	activities of daily living
AHRQ	Agency for Healthcare Research and Quality
AMSTAR-2	A Measurement Tool to Assess Systematic Reviews
BMI	body mass index
CI	confidence interval
CINAHL	Cumulative Index to Nursing and Allied Health Literature
COI	conflicts of interest
COP	center of pressure
CPG	clinical practice guideline
CPM	continuous passive motion
EPC	Evidence-based Practice Center
EQ-5D	EuroQol-5 dimensions
GRADE	Grading of Recommendations, Assessment, Development, and Evaluations
HOOS	Hip Disability Osteoarthritis Outcome Score
ICF	International Classification of Functioning, Disability and Health
IQR	interquartile range
KI	Key Informant
KOS	Knee Outcome Survey
KOOS	Knee injury and Osteoarthritis Outcome Score
KQ	Key Question
LEFS	Lower Extremity Functional Scale
MCID	minimal clinically important difference
MD	mean difference
MUA	manipulation under anesthesia
NHLBI	National Heart, Lung, and Blood Institute
NMD	net mean difference
NMES	neuromuscular electrical stimulation
NRCS	nonrandomized comparative study
OARSI	Osteoarthritis Research Society International
OR	odds ratio
PENS	patterned electrical neuromuscular stimulation
PMID	PubMed identifier
PROMIS	Patient-Reported Outcomes Measurement Information System
PRT	progressive resistive training
QoL	quality of life
RCT	randomized controlled trial
RoB	risk of bias
ROM	range of motion
ROBINS-I	Risk of Bias in Nonrandomized Studies of Interventions
RR	relative risk
SD	standard deviation
SE	standard error
SF-6D	Short-form six-dimension

SF-12	12-Item Short Form Health Survey
SF-36	36-Item Short Form Health Survey
SoE	strength of evidence
SR	systematic review
SRDR	Systematic Review Data Repository
TEP	Technical expert panel
TENS	transcutaneous electrical nerve stimulation
TJAOM	Total Joint Arthroplasty and Outcome Measures
TIDieR	Template for Intervention Description and Replications
TKA	total knee arthroplasty
THA	total hip arthroplasty
TUG	Timed Up and Go test
TOO	Task order officer
U.K.	United Kingdom
U.S.	United States
VAS	Visual Analog Scale
WOMAC	Western Ontario and McMaster Universities Osteoarthritis Index

Appendix A. Methods

Analytic Framework

Figure A-1. Analytic framework for KQs 1-4: Different types of prehabilitation or rehabilitation for knee or hip replacement surgery



Abbreviations: KQ = Key Question, MUA = manipulation under anesthesia.

* Denotes important/priority outcomes that are included in Strength of Evidence tables (Tables 22, 39, 58, 74, and 90 in the Main Report).

Literature Search

We searched for primary studies in MEDLINE (via PubMed), PsycINFO, Embase, the Cochrane Register of Clinical Trials, CINAHL, and Scopus. Duplicate citations were removed prior to screening. We did not employ any language restrictions to the search but included filters to remove nonhuman studies and articles that are not primary studies. Upon discussion with Key Informants and a Technical Expert Panel (TEP), we restricted studies to those published during or after 2005 to ensure the body of evidence is consistent with contemporary surgical and rehabilitation practices. We included MeSH or Emtree terms, along with free-text words, related to arthroplasty, knee replacement, hip replacement, total knee, total hip, rehabilitation, prehabilitation, physical therapy, physiotherapy, postoperative care. The searches were independently peer reviewed.

We also ran a search of the ClinicalTrials.gov registry for ongoing studies, unpublished study protocols, and unpublished study results. The reference lists of relevant existing systematic reviews were screened for additional eligible studies. Additional articles suggested to us from any source, including peer and public review, were screened applying identical eligibility criteria. Non-English language articles were screened and data extracted by readers of the relevant languages. All eligible studies were in languages extractable by the research team.

Database Search Strategies

PubMed 1/1/2005 to 5/3/2021

((arthroplast* or hip replacement* or knee replacement* or joint replacement* or total hip or total knee or total joint*) OR "Arthroplasty, Replacement, Hip"[Mesh] OR "Arthroplasty, Replacement, Knee"[Mesh] OR (("Arthroplasty"[Mesh] or arthroplasty or replacement) and (knee or hip)))
AND
((pre-hab* or prehab*) OR "Arthroplasty, Replacement, Knee/rehabilitation"[Mesh] OR "Arthroplasty, Replacement, Hip/rehabilitation"[Mesh] OR ((presurg* or preoperativ* or pre-surg* or pre-operativ* or early or home) and (rehab or rehabilitate or rehabilitation or re-hab* or "Rehabilitation"[Mesh] or "Physical Therapy Modalities"[Mesh] or “physical therapy” or physiotherapy*)) OR ("Preoperative Care/methods"[Mesh] OR "Preoperative Care/rehabilitation"[Mesh]) OR ((before or prior to) and (arthroplast* or hip replacement* or knee replacement* or joint replacement* or total hip or total knee or total joint*) and (rehab or rehabilitate or rehabilitation or re-hab* or intervention* or recovery)) OR ((“Preoperative Care”[MESH] OR “Preoperative Period”[MESH]) and (rehab or rehabilitate or rehabilitation or re-hab* or "Rehabilitation"[Mesh] or "Physical Therapy Modalities"[Mesh] or “physical therapy” or physiotherapy*)) OR (“Postoperative Period”[Mesh] and (rehab or rehabilitate or rehabilitation or re-hab*)) OR ((postsurg* or post-surg* or postoperativ* or post-operativ*) AND (rehab or rehabilitate or rehabilitation or re-hab* or "Rehabilitation"[Mesh] or "Physical Therapy Modalities"[Mesh] or “physical therapy” or physiotherapy*)) OR ((after or post) AND (arthroplast* or hip replacement* or knee replacement* or joint replacement* or total hip or total knee or total joint*) AND (rehab or rehabilitate or rehabilitation or re-hab* or "Rehabilitation"[Mesh] or "Physical Therapy Modalities"[Mesh] or “physical therapy” or physiotherapy*)))
AND

("Cohort Studies"[Mesh] OR cohort OR "Clinical Trial" [Publication Type] OR (follow-up or followup) OR longitudinal OR "Placebos"[Mesh] OR placebo* OR "Research Design"[Mesh] OR "Evaluation Study" [Publication Type] OR "Comparative Study" [Publication Type] OR ((comparative or Intervention) AND study) OR pretest* OR posttest* OR prepost* OR "before and after" OR interrupted time* OR time serie* OR intervention* OR ((quasi-experiment* OR quasiexperiment* OR quasi or experimental) and (method or study or trial or design*)) OR "real world" OR "real-world" OR "Case-Control Studies"[Mesh] OR (case and control) OR "Random Allocation"[Mesh] OR "Clinical Trial" [Publication Type] OR "Double-Blind Method"[Mesh] OR "Single-Blind Method"[Mesh] OR random* OR "Placebos"[Mesh] OR placebo OR ((clinical OR controlled) and trial*) OR ((singl* or doubl* or trebl* or tripl*) and (blind* or mask*)) OR rct OR crossover OR cross-over OR cross-over OR RCT OR "Randomized Controlled Trial" [Publication Type] OR systematic[sb] OR meta-analysis[pt] OR meta-analysis as topic[mh] OR meta-analysis[mh] OR meta analy* OR metanaly* OR metaanaly* OR met analy* OR (systematic AND (review* OR overview*)) OR "Review Literature as Topic"[Mesh] OR cochrane[tiab] OR embase[tiab] OR (psychlit[tiab] or psyclit[tiab]) OR (psychinfo[tiab] or psycinfo[tiab]) OR (cinahl[tiab] OR cinhal[tiab] OR "cumulative index to nursing and allied health") OR science citation index[tiab] OR ibids[tiab] OR "international bibliographic information on dietary supplements" OR cancerlit[tiab] OR reference list*[tiab] OR bibliograph*[tiab] OR hand-search*[tiab] OR relevant journals[tiab] OR manual search*[tiab] OR ((selection OR inclusion OR exclusion) AND criteria[tiab]) OR data extraction[tiab] OR relevant journals OR "Systematic Review" [Publication Type])
NOT
("address"[pt] or "autobiography"[pt] or "bibliography"[pt] or "biography"[pt] or "case reports"[pt] or "comment"[pt] or "congress"[pt] or "dictionary"[pt] or "directory"[pt] or "festschrift"[pt] or "historical article"[pt] or "interview"[pt] or "lecture"[pt] or "legal case"[pt] or "legislation"[pt] or "news"[pt] or "newspaper article"[pt] or "patient education handout"[pt] or "periodical index"[pt] or "comment on" or ("Animals"[Mesh] NOT "Humans"[Mesh]) OR rats[tw] or rat[tw] or cow[tw] or cows[tw] or chicken*[tw] or horse[tw] or horses[tw] or mice[tw] or mouse[tw] or bovine[tw] or sheep[tw] or ovine[tw] or murinae[tw] or cats[tw] or cat[tw] or dog[tw] or dogs[tw] or rodent[tw])

CINAHL/PsycINFO 1/1/2005 to 5/3/2021

(arthroplast* or hip replacement* or knee replacement* or joint replacement* or total hip or total knee or total joint* or ((arthroplasty or replacement) and (knee or hip)))
AND
(pre-hab* or prehab* or ((presurg* or preoperativ* or pre-surg* or pre-operativ* or early or home) and (rehab or rehabilitate or rehabilitation or re-hab* or "physical therapy" or physiotherapy*)) or ((before or prior to) and (arthroplast* or hip replacement* or knee replacement* or joint replacement* or total hip or total knee or total joint*) and (rehab or rehabilitate or rehabilitation or re-hab* or intervention* or recovery)) or ((postsurg* or post-surg* or postoperativ* or post-operativ*) and (rehab or rehabilitate or rehabilitation or re-hab* or "physical therapy" or physiotherapy*)) OR ((after or post) AND (arthroplast* or hip replacement* or knee replacement* or joint replacement* or total hip or total knee or total joint*) AND (rehab or rehabilitate or rehabilitation or re-hab* or "physical therapy" or physiotherapy*)))

Cochrane Databases 1/1/2005 to 5/3/2021

#1 MeSH descriptor: [Arthroplasty, Replacement, Hip] explode all trees
#2 MeSH descriptor: [Arthroplasty, Replacement, Knee] explode all trees
#3 (arthroplast* or hip replacement* or knee replacement* or joint replacement* or total hip or total knee or total joint*)
#4 ((arthroplasty or replacement) and (knee or hip))
#5 #1 OR #2 OR #3 OR #4
#6 (pre-hab* or prehab* OR ((presurg* or preoperativ* or pre-surg* or pre-operativ* or early or home) and (rehab or rehabilitate or rehabilitation or re-hab* or “physical therapy” or physiotherapy*)) OR ((before or prior to) and (arthroplast* or hip replacement* or knee replacement* or joint replacement* or total hip or total knee or total joint*) and (rehab or rehabilitate or rehabilitation or re-hab* or intervention* or recovery)) OR ((postsurg* or post-surg* or postoperativ* or post-operativ*) AND (rehab or rehabilitate or rehabilitation or re-hab* or “physical therapy” or physiotherapy*)) OR ((after or post) AND (arthroplast* or hip replacement* or knee replacement* or joint replacement* or total hip or total knee or total joint*) AND (rehab or rehabilitate or rehabilitation or re-hab* or “physical therapy” or physiotherapy*)))
#7 #5 AND #6

Embase 1/1/2005 to 5/3/2021

#5 #3 AND #4 AND ([article]/lim OR [article in press]/lim) AND [2005-2020]/py
#4 'pre hab*' OR prehab* OR ((presurg* OR preoperativ* OR 'pre surg*' OR 'pre operativ*' OR early OR home) AND (rehab OR rehabilitate OR rehabilitation OR 're hab*' OR 'physical therapy' OR physiotherapy*)) OR ((before OR prior) AND to AND ((((((arthroplast* OR hip) AND replacement* OR knee) AND replacement* OR joint) AND replacement* OR total) AND hip OR total) AND knee OR total) AND joint* AND (rehab OR rehabilitate OR rehabilitation OR 're hab*' OR intervention* OR recovery)) OR ((postsurg* OR 'post surg*' OR postoperativ* OR 'post operativ*') AND (rehab OR rehabilitate OR rehabilitation OR 're hab*' OR 'physical therapy' OR physiotherapy*)) OR ((after OR post) AND ((((((arthroplast* OR hip) AND replacement* OR knee) AND replacement* OR joint) AND replacement* OR total) AND hip OR total) AND knee OR total) AND joint* AND (rehab OR rehabilitate OR rehabilitation OR 're hab*' OR 'physical therapy' OR physiotherapy*))
#3 #1 OR #2
#2 (hip OR knee) AND replacement
#1 'arthropathy'/exp OR 'arthropathy' AND (knee OR hip)

Inclusion/Exclusion Criteria Details

Study Eligibility Criteria for All Key Questions

Population(s)

- Adults (≥18 years old) undergoing (or planning to undergo) total hip or knee replacement surgery
  - for primary osteoarthritis
  - elective (nonemergent) surgery
  - primary surgery (not revision)
  - unilateral TJR
- Exclude: Studies where ≥10% of patients underwent total knee or hip replacement surgery:
  - for partial joint replacement
  - for causes other than primary osteoarthritis (e.g., cancer, trauma, rheumatoid arthritis)
  - for emergency surgery
  - for revision joint replacement
  - bilateral TJR (simultaneous in both joints)
- N.B. Studies that reported stratified or subgroup analyses of the population of interest were included if they meet the other eligibility criteria (e.g., if they included unilateral and bilateral surgeries but reported data specific to unilateral)
- Did not exclude based on prior surgeries to other joints (including contralateral hip or knee)

Intervention(s):

- Active, structured physical activity or activities designed to attain measurable goals of reducing impairments and improving movement-related function as defined by the International Classification of Functioning, Disability and Health (ICF)
  - Any movement-related physical goal including improvements beyond the basal (or baseline) state in: mobility and stability of joint function (including flexibility and range of motion), movement control, power and tone of muscles (including strength), gait, endurance; along with the related goal of reducing pain.
  - Interventions need to be sufficiently described to be replicable by a therapist or other professional. The exception to this was rehabilitation interventions delivered in different settings (inpatient vs. outpatient), which we included even if there was not sufficient detail about their (p)rehabilitation interventions (and noted such in our coding).
  - Single or multiple components. For multicomponent interventions, the goals of the intervention criteria refer to the overall intervention, not necessarily to each individual component. We categorized the content of the rehabilitation interventions according to a categorization scheme based on ongoing research by Oatis and Franklin to develop a taxonomy defining the components of physical therapy after TKR.[1, 2] The taxonomy comprehensively lists specific rehabilitation content that are hierarchically linked to larger rehabilitation goals. The larger component goals include:
    - Strengthening exercise

        - Aerobic exercise
        - Flexibility exercise
        - Balance-motor/learning-agility exercise
        - Task specific training
        - Patient education
    - We used the taxonomy to code both the subcategory content and larger category goals (e.g., intervention content of squats would be coded for the subcategory of "squats" hierarchically linked to the goal of "strengthening").
    - *Exclude:* Continuous passive motion (CPM) was not included as there is strong evidence, summarized in an existing systematic review,[3] that that component is ineffective.
    - The intervention had to have been delivered, supervised, and/or monitored by a healthcare professional or other trained individual (e.g., physical therapist, physical therapy assistant, nurse trained in rehabilitation, health educator with training in exercise delivery or rehabilitation, other healthcare professional trained in rehabilitation)
        - Peer-led (or patient-led) interventions were eligible if monitored by a professional or other trained individual
        - The physical therapist (or other trained individual) had to have been involved in patient engagement and assessment of progress, and provided ongoing feedback to the patient throughout the course of intervention
            - This interaction could have been direct (e.g., in-person therapy) or remote (e.g., via app, Web, or telephone)
            - Remote therapy had to have included active monitoring by a physical therapist (or other trained individual), although the (p)rehabilitation therapy could have been guided completely by the app
    - The patient needed to be actively involved or engaged in at least part of the intervention (and not be only a passive recipient of the intervention)
- Interventions evaluating the combined benefit an intervention defined above with an adjunctive modality were also included.
  Adjunctive modalities are either passively applied to patients and/or do not (on their own) have the direct goals of reducing impairments or improving movement-related function but are used to help other components achieve these goals. Examples of therapies that were considered adjunctive modalities if combined with an intervention meeting criterion above included:
    - Neuromuscular electrical stimulation (NMES)
    - Transcutaneous electrical nerve stimulation (TENS)
    - Manual therapy (e.g., therapeutic massage, passive range of motion)
    - Biofeedback devices
    - Cryotherapy (or other thermal therapies)
    - Dry needling
    - Mindfulness, stress/anxiety-reduction interventions
    - Complementary and alternative therapies (*excluding* ingested, inhaled, or transcutaneous treatments)

    - Modalities had to have been sufficiently described to be replicable by a therapist or other professional
- *Exclude*: Interventions that were not active, structured physical activities delivered by a healthcare professional or other trained individual, including devices not designed to be used primarily during active therapy; for example:
    - Splinting, bracing, taping
    - One-time distribution of information
    - Assistive devices (e.g., crutches vs. canes or walkers)
- *Exclude*: Interventions (as a whole) without specific goals (e.g., unsupervised swimming, walking, cycling, hiking).
- *Exclude*: Interventions (as a whole) without active engagement of the healthcare professional (e.g., only set-up and removal of intervention without monitoring, or healthcare professional engagement only to measure pre- and post-intervention outcome measures).
- *Exclude*: Surgical or hospital process-improvement interventions (e.g., early mobilizations, enhanced recovery after surgery [ERAS], care managers, pre-anesthesia protocols)
- Exclude: Pharmaceutical (or over-the-counter) treatments (although, allowed as part of an overall intervention)

Comparator(s):

- No active, structured physical activity, as defined above
    - Allow "usual care" only if the intervention arm includes well-defined components or adjunctive modalities plus the same "usual care"
- Other active structured physical activity (or set of activities)
- Other adjunctive modality
- Different duration (or intensity) of intervention
- Different providers
- Different setting
- *Exclude*: no comparison (or comparison with only pre-intervention state)

Outcomes: (* denotes important/priority outcomes that were included in Strength of Evidence tables)

- Patient-reported outcomes
    - Activities of daily living*
    - Patient satisfaction with care*
    - Quality of life (QoL)*
    - Pain
    - Injury related to arthroplasty (e.g., fall)
    - Time lost from work
    - Measures that combined these outcome domains (e.g., Hip disability/Knee injury and osteoarthritis outcome score [HOOS/KOOS])
- Performance-based outcomes
    - Mobility of joint function (e.g., knee range of motion)*
    - Power and tone of muscle (e.g., strength)*
    - Joint stability

    - Endurance
    - Gait
    - Balance
    - Measures that combined these domains (e.g., timed-up-and-go [TUG], stair climb test)
- Healthcare utilization
    - Hospital- or surgical clinic-based procedures postoperatively (e.g., need for manipulation under anesthesia)*
    - Hospital readmission
    - Postoperative care (excluding physical therapy services)
- Harms
    - Injury related to therapy intervention*
    - Other harms related to therapy intervention

Modifiers/Subgroups of interest:

- Patient factors:
    - Demographics (age, sex, race/ethnicity, education, region)
    - Body mass index
    - Comorbidities, including mental health and other joint comorbidities
    - Socioeconomic status, insurance status
    - Prior arthroplasty of contralateral joint
    - Preoperative symptoms/status
        - Severity of preoperative symptoms, including pain, impaired function, restricted movement, and physical activity
        - Frailty (and related assessments of preoperative function)
    - Narcotic use
    - Caregiver support (outside of (p)rehabilitation)
- Surgical factors:
    - Surgical procedure
    - Perioperative protocols (e.g., enhanced recovery after surgery)
    - Type of implant
    - Setting of surgery
        - Type of hospital (e.g., community, referral/teaching, or urban/suburban/rural)
- Setting factors:
    - Setting of intervention (e.g., inpatient, outpatient center, rehabilitation center, home)
    - Was considered as a modifier only regarding the same intervention provided in different settings

Timing:

- Study publication date $\geq$2005
- $\geq$50% of surgeries occurred after 2005
- Outcomes

- Patient-reported and performance-based outcomes[a]
    - ≥3 months postoperative for KQ 1 and 2 (TKA)
    - ≥6 months postoperative for KQ 3 and 4 (THA)
- Healthcare utilization outcomes
    - Perioperative for KQ 1 and 3 (prehabilitation)
    - ≤3 months
    - For prehabilitation, starting at the initiation of intervention
- Harms: duration of (p)rehabilitation intervention

Setting:

- Any setting, including:
    - Acute inpatient (postoperative)
    - Other inpatient facility (e.g., skilled nursing facility)
    - Physical therapy/rehabilitation facility (outpatient)
    - Home
    - Gym or other community center
    - Other

Design:

- RCTs, N≥20 per group
- NRCS, N≥20 per group, with or without adjustment for confounders
    - Prospective or retrospective (as long as there was a clear, specific intervention)
    - Parallel or series comparisons (i.e., "pre-post" studies that evaluate different cohorts of patients receiving vs. not receiving an intervention before and after a change in available (p)rehabilitation services)
- Cost-effectiveness (and related) analyses (for relevant QoL data, as available)
- *Exclude*: noncomparative (single group) studies (i.e., where all received the same intervention and there is no comparison intervention)
- *Exclude*: crossover studies (where the same individual receives more than one intervention in series)
- *Exclude*: case reports or series; case-control studies {Davis, 2011 #523}

Additional Criteria for KQs 1 and 3 (Prehabilitation)

Population:

- Patients in whom the decision has been made to have a joint replacement surgery
- *Exclude*: Patients who are trying to avoid or delay surgery

[a] Time point cutoffs for outcomes were informed through stakeholder feedback which resonated with literature noting a lag in recovery immediately after TKA/THA. Specifically, for postoperative outcomes (for both prehabilitation and rehabilitation), stakeholders agreed that short-term outcomes (less than 3 months for TKA and 6 months for THA) were too early to see functional- and patient-reported improvements and suggested that these outcomes are likely to be influenced by other patient and surgical factors, in additional to any (p)rehabilitation received. The exception was short term post-operative healthcare utilization outcomes following prehabilitation (e.g., length of stay, discharge disposition).

Interventions:

- Delivered within 3 months prior to surgery
- *Exclude*: Preoperative interventions designed to reduce symptoms or prevent or delay surgery; i.e., interventions not designed to be prehabilitation for planned surgery

Outcomes (in addition to those listed above for all KQs):

- Healthcare utilization
  - Length of stay (postoperative)*
  - Posthospital disposition (e.g., to home, outpatient, skilled nursing facility, "subacute" rehabilitation, "acute" inpatient rehabilitation)*
  - Length of (postoperative) rehabilitation needed
- Harms
  - Perioperative surgical complications

Additional Criteria for KQs 2 and 4 (Postoperative Rehabilitation)

Interventions:

- Delivered within 6 months following surgery

Potential Modifiers:

- Length of hospital stay

Screening Process

Citations from all searches were de-duplicated and then entered into Abstrackr software (http://abstrackr.cebm.brown.edu/) to enable title and abstract screening. The team conducted multiple rounds of pilot screening. During each pilot round, all researchers screened the same 100 abstracts and discussed conflicts, with the goal of training the team in the nuances of the eligibility criteria and refining them as needed. After the pilot rounds, we screened abstracts in duplicate. Conflicts were discussed by the team (during the initial period of abstract screening) and then resolved by the Project Lead. The Abstrackr software has machine learning capabilities to predict the likelihood of relevance of each citation. Daily, the list of unscreened abstracts was sorted so that most potentially relevant articles are presented first. After the software suggested that no remaining unscreened abstracts were likely to be relevant (when the predictor value was <0.40 for all unscreened abstract), we single screened all remaining abstracts.

Potentially relevant citations were retrieved in full text and entered into an evidence map in Google Sheets for rescreening and data collection. We collected basic study information regarding Key Question (KQ) addressed, study design, sample size, timing of outcome reporting, and rejection reasons. Rejection reasons were confirmed by a senior researcher.

Data Extraction and Data Management

For all KQs, data for study elements other than intervention details, were extracted directly into the Systematic Review Data Repository (SRDR) at https://srdrplus.ahrq.gov/public_data?id=2965&type=project. We created a combined data extraction form for all KQs. We extracted information on study characteristics, eligibility criteria, participant characteristics, intervention and comparator details, outcome definitions, and results (including mean scale score for each arm, effect sizes, and P values). Study- and outcome-level risk of bias assessment was conducted during data extraction within SRDR.

We extracted intervention details for all KQs using an extraction form in Excel. We extracted information on the goals of the exercise(s) and where reported and specific exercises used to address these goals. We also extracted information on whether the (p)rehabilitation was progressed (i.e., changed over time) and if so, whether it was appropriate (i.e., according to patient-specific parameters assessed by the therapist) that was assessed by a clinical expert on our team. Finally, we extracted information about who delivered the intervention, (personnel), how (mode of delivery), and where (setting). Details follow.

Coding Interventions

Guiding Principles and Assumptions

- We assumed that some studies may describe interventions vaguely, that is, by the **goal** of the intervention (e.g., strengthening exercises) rather than the **specific content** components being delivered to achieve that goal (e.g., squats to promote muscle strength).
- We understood that some specific components of (p)rehabilitation interventions may target multiple (p)rehabilitation goals (e.g., step downs may have the goal of improving strength and balance).
- We assumed that the effects of interventions as defined by their i) goals and ii) specific content components are of interest to decision-makers to understand impact of (p)rehabilitation interventions from different categorization perspectives and given the limitations of varying reporting detail.
- We assumed that identifying the gaps in describing (p)rehabilitation interventions according to both their i) goals and ii) specific content components is of interest to decision-makers to identify areas for improving the design and reporting of primary studies
- We assumed that refining linkage of i) goals and ii) specific content components is of interest to decision-makers to improve intervention design and professional practice (e.g., understand what specific components are most/least frequently used to achieve certain goals and lead to most/least change in outcomes).

Coding Process and Taxonomy

We used Oatis/Franklin's hierarchical taxonomy[1] to code both the intervention **goal** and **specific content** components, as feasible.

We coded interventions:

- Per large categories largely defined by the goal/aim of the intervention (n=6 components)
    - Strengthening
    - Aerobic
    - Flexibility
    - Balance-motor/Learning-agility
    - Task specific training
    - Patient education (see note below)
        - Note that while we coded patient education, the intervention (as a whole) had to meet the criteria of an active, structured rehabilitation program. Thus, patient education alone would not be eligible.

- Per smaller subcategories nested within the large categories (that are not all distinct and may target multiple goals/aims) (n=91 specific content components)
    - Strengthening (n=62 components)
    - Aerobic (n=9 components)
    - Flexibility (n=17 components)
    - Balance-motor/Learning-agility (n=17 components)
    - Task specific training (n=17 components)
    - Patient education (n=6 components)
- Each study was independently coded by two investigators, one with expertise in rehabilitation interventions (LT) and the other with expertise in multicomponent interventions (KJK)
- Each investigator reviewed the content of the intervention and:
    - Sought to match the content to a **specific content** component *(i.e., subcategories)*. Where a match could be made, the investigator inserted a code '1' to indicate its presence in cell (otherwise '0' to indicate absence).
    - Subsequently sought to match the **specific content** component to the higher category intervention **goal**. Determination of the goal of the **specific content** component was based on the hierarchical taxonomy and interpretation of how the component was used (e.g., description of the parameters used to implement it) and other contextualizing details of the text.
        - The latter was especially important for specific content components capable of addressing multiple goals (e.g., 'step down' can address "strengthening" and "balance-motor learning-agility").
    - Inserted article text used to justify any specific content component or goal codes in the cell for the larger goal category and indicated what specific content component the text was meant to justify.
        - Descriptive content was used to justify coding where discrepancies arose and provided qualitative text for further consideration of the taxonomy.
- Both investigators met virtually to compare codes, identify disagreements, discuss and come to consensus, revising coding rules as necessary.
- Where conflicts remained, a third reviewer (DP) was engaged in group discussion until consensus was achieved.

Additional General Principles

The following principles were used to guide intervention coding:

a. The intervention of at least one arm of each included study needed to be sufficiently described to be replicable by a therapist or other professional.
    a. Studies defining interventions as "rehabilitation" without further detail were excluded.
    b. Studies defining interventions based on rehabilitation goals only (e.g., "strengthening exercises") were included and coded according to the goal, but not regarding the specific content component for which there was no information
b. We coded the rehabilitation i) goals and ii) specific content components of all study arms, regardless of arm label (e.g., control, "treatment as usual") if rehabilitation content and goals met the descriptions above.

Adjunctive Modalities and Intervention Modifiers

In addition to coding primary intervention components (by goals and specific content components, above), we coded the presence of the following **adjunctive modalities**:

- Modalities
    - Cold
    - Heat
    - Compression for edema
    - E-stim for pain (TENS)
    - E-stim for strength (NMES)
    - Other modalities for pain
    - Ultrasound
- Manual therapy (e.g., therapeutic massage, passive range of motion)
    - Contract-relax for knee flexion/extension ROM
    - Hold-relax for knee flexion/extension ROM
    - Massage for edema control
    - Massage for scar mobility
    - Massage/myofascial techniques for soft tissue
    - Mobilizations – Tibiofemoral
    - Mobilizations - Patellar
- Biofeedback devices
- Dry needling
- Mindfulness, stress/anxiety-reduction interventions
- Complementary and alternative therapies (*excluding* ingested or inhaled treatments)

Intervention modifiers:

- *Progression.* Study stated that progression was a part of the intervention (Code 1=yes; 0=no).
- *Appropriate progression*. Progression deemed appropriate based on parameters defined (Code 1=present; 0=absent).
- *Personnel.* The intervention had to have been delivered, supervised, and/or monitored by a healthcare professional or other trained individual. Peer-led (or patient-led) interventions are eligible if monitored by a professional or other trained individual. The physical/healthcare professional (or other trained individual) must be involved in patient engagement and assessment of progress, and must provide ongoing feedback to the patient throughout the course of intervention
- *Mode of delivery.* The interaction with the healthcare professional or other trained individual had to have been direct (e.g., in-person therapy) or remote (e.g., via app, Web, or telephone). Remote therapy must include active monitoring by a physical therapist (or other trained individual), although the (p)rehabilitation therapy may be guided completely by the app.
- *Setting of intervention.* Physical location in which the intervention was delivered (may overlap slightly with mode of delivery). We extracted all that applied
    - Acute inpatient (postoperative)
    - Other inpatient facility (e.g., skilled nursing facility)
    - Physical therapy/rehabilitation facility (outpatient)
    - Home

- Gym or other community center
- Other (specify)
- Not reported

Specific Coding Elements

- MJR_id (number=unique ID for study as created by MJR review)
- source (text= file pdf name used and additional sources other than primary paper).
- Exclude (category=yes/no/maybe). If no or maybe, give reason in note
- Exclude_note (text =specific text describing why intervention is/is not well specified)

Labels:

- arm_name (text=specific label for arm as written in article; each study arm extracted into a unique row)
- Ix_well_specified (binary 0=no; 1=yes; is the intervention as a whole well specified?)
  - Code YES if: Intervention is sufficiently described to be replicable by a therapist or other professional in practice
  - Code NO if: Intervention is generally not well specified
- Ix_well_specified_note (text =specific text describing why intervention is/is not well specified)

Intervention i) Goal and ii) Specific Content

For each arm evaluated in the study, determine:

1. **Strengthening** (binary 0=no; 1=yes)
   Code YES (to strengthening goal) if intervention describes
   - Strengthening exercise generally
   - One or more of the specific content components below and coder interprets that component supports the strengthening goal (also code YES to the specific content binary 0=no; 1=yes)
   - If position unclear code 1 (position unclear) for all relevant codes

1.1 Bridges One-legged (supine hip extension)
1.2 BridgesTwo-legged (supine hip extension)
1.3 Calf press (one-leg)
1.4 Calf press (two-legs)
1.5 Clamshells
1.6 Core strengthening
1.7 Deadlifts
1.8 Gluteal Sets
1.9 Heel raises – bilateral
1.10 Heel raises – unilateral
1.11 Hip abduction in sidelying
1.12 Hip abduction in standing
1.13 Hip abduction in supine
1.14 Hip adduction in sidelying

1.15 Hip adduction in standing
1.16 Hip adduction in supine
1.17 Hip extension in sidelying
1.18 Hip extension in prone
1.19 Hip extension in standing
1.20 Hip flexion in sidelying
1.21 Hip flexion in sitting
1.22 Hip flexion in standing
1.23 Hip flexion in supine
1.24 Hip hikes in standing
1.25 Hip hikes in supine
1.26 Hip rotation external (lateral)
1.27 Hip rotation internal (medial)
1.28 Knee extension machine (one-leg)
1.29 Knee extension machine (two-legs)
1.30 Knee extension AAROM in sitting or supine (short- or long arc quad)
1.31 Knee extension in sitting or supine (long arc quad)
1.32 Knee extension in sitting or supine (short arc quad)
1.33 Knee flexion machine (Hamstring curl) one knee
1.34 Knee flexion machine (Hamstring curl) two knees
1.35 Knee flexion in prone
1.36 Knee flexion in sitting or supine
1.37 Knee flexion in standing
1.38 Leg Press (one leg)
1.39 Leg Press (two legs)
1.40 Leg Press (side lying)
1.41 Lunges
1.42 Lunges to side (lateral lunge)
1.43 Quad sets
1.44 Quadruped arm lift
1.45 Quadruped leg lift
1.46 Quadruped arm and leg lift
1.47 Single Leg Stance (SLS)
1.48 Sit-to-stand
1.49 Squats
1.50 Squats (one leg)
1.51 Standing TKE (terminal knee extension)
1.52 Step down
1.53 Step down laterally
1.54 Step lateral
1.55 Step up – forward
1.56 Step up – lateral
1.57 Stool scoots
1.58 Straight leg raise (SLR)
1.59 Toe raises
1.60 Upper extremity strengthening

1.61 Wall slides
1.62 Wall slides - Lateral (hip AB and ADductors)

Code NO if:
- No mention of strengthening exercise goal generally
- No mention of specific content components interpreted as seeking to improve the strengthening goal

Strengthening note (text=text to support goal and specific content codes)

2. Aerobic (binary 0=no; 1=yes)

Code YES (to aerobic endurance goal) if intervention describes
- Aerobic exercise generally
- One or more of the specific content components below and coder interprets that component supports the aerobic endurance goal (also code YES to the specific content binary 0=no; 1=yes

2.1 Aquatics (water aerobics, water walking)
2.2 Bike (Endurance)
2.3 Elliptical machine
2.4 Jogging in place or overland
2.5 Rowing machine
2.6 Step-ups
2.7 Stepper (upright or sitting)
2.8 Treadmill walking
2.9 Walking

Code NO if:
- No mention of aerobic exercise goal generally
- No mention of specific content components interpreted as seeking to improve the aerobic endurance goal

Aerobic note (text =text to support goal and specific content codes)

3. Flexibility (binary 0=no; 1=yes)

Code YES (to flexibility goal) if intervention describes
- Flexibility exercise generally
- One or more of the specific content components below and coder interprets that component supports the flexibility goal (also code YES to the specific content binary 0=no; 1=yes)

- If position unclear code 1 (position unclear) for all relevant codes

3.1 Ankle pumps
3.2 Bike (ROM)
3.3 Calf stretch with knee bent
3.4 Calf stretch with knee straight

3.5 Hamstring stretch in any position
3.6 Heel slides
3.7 Hip extensor stretch (knee to chest)
3.8 Hip flexor stretch
3.9 Iliotibial band (ITB) stretch in any position
3.10 Knee extension AROM
3.11 Knee extension PROM in supine
3.12 Knee extension PROM in prone
3.13 Knee flexion AROM
3.14 Knee flexion PROM in sitting or supine
3.15 Knee flexion AROM in any position (rectus femoris stretch)
3.16 Knee flexion PROM in prone (rectus femoris stretch)
3.17 Standing terminal knee extension

Code NO if:
- No mention of flexibility exercise goal generally
- No mention of specific content components interpreted as seeking to improve the flexibility goal

Flexibility note (text =text to support goal and specific content codes)

4. Balance-Motor Learning-Agility (BMLA) (binary 0=no; 1=yes)

Code YES (to a BMLA goal) if intervention describes
- BMLA exercise generally
- One or more of the specific content components below and coder interprets that component supports the BMLA goal (also code YES to the specific content binary 0=no; 1=yes)

4.1 Balance in kneeling
4.2 Balance in quadruped
4.3 Balance on unstable surface
4.4 Balance with perturbations
4.5 Ladder drills
4.6 Marching
4.7 Quadruped
4.8 Single leg stance
4.9 Standing weight shifts
4.10 Stepping multiple directions (grapevine)
4.11 Step down
4.12 Step down laterally
4.13 Step lateral (side step)
4.14 Step up – forward
4.15 Step up – lateral
4.16 Tandem standing
4.17 Tandem walking

Code NO if:

- No mention of BMLA goal generally
- No mention of specific content components interpreted as seeking to improve the a BMLA goal

Balance-Motor Learning-Agility note (text =text to support goal and specific content codes)

5. Task specific training (binary 0=no; 1=yes)

Code YES (to task specific training goal) if intervention describes

- Task specific training generally
- One or more of the specific content components below and coder interprets that component supports the task specific training goal (also code YES to the specific content binary 0=no; 1=yes)

5.1 Car transfers
5.2 Deadlifts
5.3 Floor-to-sit or Floor-to-stand
5.4 Gait backwards
5.5 Gait downhill
5.6 Gait on uneven surfaces
5.7 Gait sideways
5.8 Gait training
5.9 Gait uphill
5.10 Gait with perturbations
5.11 Gait with resistance
5.12 Obstacle training
5.13 Sit-to-stand training
5.14 Sports specific training
5.15 Stair training
5.16 Treadmill gait
5.17 Treadmill gait (retro)

Code NO if:

- No mention of task specific training goal generally
- No mention of specific content components interpreted as seeking to improve the task specific training goal

Task specific training note (text =text to support goal and specific content codes)

6. Patient education (binary 0=no; 1=yes)

Code YES (to patient education goal) if intervention describes

- Patient education generally

- One or more of the specific content components below and coder interprets that component supports the patient education goal (also code YES to the specific content binary 0=no; 1=yes)

6.1 ADLs
6.2 Home exercise program (HEP)
6.3 Life-style change
6.4 Pain management
6.5 Self-management
6.6 Wound care management

Code NO if:
- No mention of patient education goal generally
- No mention of specific content components interpreted as seeking to improve the flexibility goal

Patient education note (text=text to support goal and specific content codes)

7. Adjunctive modalities (Binary 0=no; 1=yes)

Code YES (to each adjunctive modality as relevant) if intervention describes the presence of any of the following adjunctive modalities
- Modalities

7.1 Cold
7.2 Heat
7.3 Compression for edema
7.4 E-stim for pain (TENS)
7.5 E-stim for strength (NMES)
7.6 Other modalities for pain
7.7 Ultrasound
7.8 Manual therapy (e.g., therapeutic massage, passive range of motion)
7.9 Contract-relax for knee flexion/extension ROM
7.10 Hold-relax for knee flexion/extension ROM
7.11 Massage for edema control
7.12 Massage for scar mobility
7.13 Massage/myofascial techniques for soft tissue
7.14 Mobilizations – Tibiofemoral
7.15 Mobilizations – Patellar
7.16 Biofeedback devices
7.17 Dry needling
7.18 Mindfulness, stress/anxiety-reduction interventions
7.10 Complementary and alternative therapies (excluding ingested or inhaled treatments)

Code NO if:

- No mention of using adjunctive modality(ies)

For each arm evaluated in the study, determine:

Effect modifiers

Progression (binary 0=no; 1=yes)

Code YES if:
- Study states that progression was a part of the intervention (Code 1=yes; 0=no). May be progression by time and/or patient response.

Code NO if:
- The intervention does not mentioned progression of the intervention.

Progression_appropriate (binary 0=no; 1=yes)

Code YES if:
- The progression program is deemed appropriate based on parameters defined.

Code NO if:
- The progression program is not deemed appropriate based on parameters defined.

Code Unclear if:
- Not enough information to determine Yes or No.

Progression_ note (text=specific description of the details of progression)

Personnel (categories)

Indicate personnel who delivered the intervention from the following.
Select all that apply.

- Physical therapist
- Nurse
- Educator
- Peer
- Athletic trainer
- Exercise physiologist
- None (unsupervised)
- Other

Personnel_note (text=specific description of the details of the personnel delivering the intervention)

Mode_of_delivery (categories)

Indicate mode of how the intervention was delivered.
Select all that apply.

- In-person therapy
- Remote via app
- Remote via web
- Remote via telephone
- Self-guided (unsupervised)

Mode_of_delivery_note (text=specific description of the details of how the intervention was delivered)

Setting (categories)

Select a prespecified category of where the intervention was delivered.
Select all that apply.

- Acute inpatient (postoperative)
- Other inpatient facility (e.g., skilled nursing facility)
- Physical therapy/rehabilitation facility (outpatient)
- Home
- Gym or other community center
- Other (specify)
- Not reported

Setting_note (text=specific description of where the intervention was delivered)

Additional intervention comments

Use to note content of interventions that you think may be relevant/we may want to be aware of but are not of sufficient information, or cross the threshold to warrant coding (e.g., provided supplemental information, esp. in control group, but not really sufficient to count as patient education)

Concerns/queries

Use to note other potential methodological concerns separate from the intervention

Risk of Bias Assessment (Details)

We evaluated each study for risk of bias and methodological quality. Because we included a variety of study designs, we incorporated items from three different existing commonly-used tools and tailored the set of items for each study design. The three tools were the Cochrane Risk of Bias Tool,[4] the Risk of Bias in Nonrandomized Studies (ROBINS-I) Tool,[5] and the National Heart, Lung, and Blood Institute (NHLBI) Quality Assessment Tool.[6]

For RCTs, we used all the items from the Cochrane Risk of Bias tool,[4] focusing on issues related to randomization and allocation concealment methodology; blinding of patients, study personnel/care providers, objective outcome assessors, and subjective outcome assessors; incomplete outcome data; selective outcome reporting; and other issues that could be related to bias.

For NRCSs, we used the specific sections of ROBINS-I[5] that pertain to confounding and selection bias. ROBINS-I requires the identification of specific confounders of interest for the systematic review. For the purpose of assessing for the presence of potential confounding in studies, we considered demographics (such as age, sex, race/ethnicity), socioeconomic status, caregiver support, body mass index (BMI), comorbidities, prior arthroplasty of contralateral joint, narcotic use, preoperative symptoms/status (e.g., severity of symptoms including pain, impaired function, restricted movement, physical activity, frailty), surgical factors (e.g., surgical procedure or protocol, type of implant), and hospital type for all KQs. Additionally, for KQs 2 and 4 related to postoperative care, we considered length of hospital stay as an additional potential confounder. For RCTs, we also supplemented the Cochrane Risk of Bias tool with items from the NHLBI tool that pertain to the adequacy of descriptions of study eligibility criteria, interventions, and outcomes.[6]

Data Synthesis and Analysis (Details)

We had planned to summarize the evidence both qualitatively and, when feasible, quantitatively (via a network meta-analysis across the programs, focusing on comparisons of different components). However, due to the heterogeneity of interventions (i.e., almost completely unique content in (p)rehabilitation intervention and comparator arms, delivered at different times, in different settings and by different personnel) and lack of consistency of outcome reported, meaningful statistical meta-analyses were not feasible, and we summarized the evidence only qualitatively.

Each study included in the systematic review is described in summary and evidence tables presenting study design features, study participant characteristics, descriptions of interventions, outcome results, and risk of bias/methodological quality. Summary tables briefly describe the studies and their findings.

For KQs 1-4, we compared interventions with their comparators for their effects (grouping related interventions and comparisons as feasible), using post mean differences in continuous outcome data (i.e., difference in follow-up mean between groups) or net mean differences (i.e., difference-in-difference, or the between-intervention comparison of within-intervention changes). As there was not sufficient studies reporting sufficiently similar outcomes to explore the association of the specific intervention factors (components, personnel, setting), using statistical methods, we sought to explore associations narratively across studies by considering each of the factors as a ‘lens’ of potential impact when looking at the evidence.

Grading the Strength of the Body of Evidence (Details)

We evaluated the strength of evidence (SoE) addressing each major conclusion for each KQ (and subquestion). We graded the SoE as per the Agency for Healthcare Research and Quality (AHRQ) Methods Guide.[7, 8]

We assessed the SoE for key outcomes For each SoE assessment, we considered the number of studies, the study limitations (i.e., risk of bias and overall methodological quality), the directness of the evidence to the KQs, the consistency of study results, the precision of any

estimates of effect, the likelihood of reporting bias, other limitations, and the overall findings across studies. We interpreted directness based on the proximity of the outcome to the clinical outcome of interest (i.e., intermediate) and whether the outcome was assessed among the individuals of interest vs. proxy. For example, a patient-reported outcome of function or a performance-based outcome of strength would both be considered direct. We interpreted precision based on the confidence intervals of the individual studies. This is considered appropriate in the GRADE methods "if a meta-analysis is infeasible or inappropriate", reviewers may consider the narrowness of the range of CIs or the significant level of p-values in the individual studies in the evidence base".[8]

Based on these assessments, we assigned a SoE rating as being either high, moderate, low, or insufficient to estimate an effect.

Outcomes with highly imprecise estimates, highly inconsistent findings across studies, or with data from only one study, were deemed to have insufficient evidence to allow a conclusion. This overall approach is consistent with the definition of Very Low quality evidence per GRADE defined as "any estimate of effect is very uncertain".[9]

Peer Review and Public Commentary

Experts in fields of physiotherapy orthopaedic surgery, and individuals representing stakeholder and user communities (e.g., health systems, and guideline and policy development) were invited to provide external peer review of this systematic review; AHRQ and an associate editor also provided comments. Subsequent to peer review, the draft report was posted on the AHRQ website for 4 weeks to elicit public comment (May 10, 2021 to June 7, 2021). A disposition of comments table of public comments will be posted on the EHC website 3 months after the Agency posts the final systematic review.

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Appendix B. Excluded Studies

Abbas C; Daher J. Pilot study: Post-operative rehabilitation pathway changes and implementation of functional closed kinetic chain exercise in total hip and total knee replacement patient.. Journal of bodywork and movement therapies. 29037634.
D: NRCS not adjusted

Abbass Reslan H; Moustafa SM; Saghieh S; Sharara ES; Badr LK. Does intervention improve the outcomes of patients after total knee replacement surgery?. International journal of orthopaedic and trauma nursing. 30393030.
D: NRCS not adjusted

Actrn. Telerehabilitation for patients with total knee replacement.
http://www.who.int/trialsearch/Trial2.aspx?TrialID=ACTRN12606000346572. CN-01807385.
Protocol/study registration

Actrn. Early aquatic physiotherapy after total hip and total knee replacement surgery.
http://www.who.int/trialsearch/Trial2.aspx?TrialID=ACTRN12616000494437. CN-01860201.
Protocol/study registration

Actrn. The STEP study: a Pragmatic, randomized, controlled trial comparing two post operative management pathways in knee or hip replacement surgery.
http://www.who.int/trialsearch/Trial2.aspx?TrialID=ACTRN12616000696493. CN-01882269.
Protocol/study registration

Actrn. Face-to-face physiotherapy compared to a supported home exercise program for the management of musculoskeletal conditions: the REFORM trial.
http://www.who.int/trialsearch/Trial2.aspx?TrialID=ACTRN12619000065190. CN-01946979.
Protocol/study registration

Actrn. Biofeedback-assisted exercise in the rehabilitation of patients after total knee arthroplasty √¢‚Ç¬Äú effects on functional outcomes and quality of life.
http://www.who.int/trialsearch/Trial2.aspx?TrialID=ACTRN12618001782224. CN-01947485.
Protocol/study registration

Actrn. A pilot study of a psychologically informed physiotherapy for people awaiting knee replacement surgery.
http://www.who.int/trialsearch/Trial2.aspx?TrialID=ACTRN12618001867280. CN-01948991.
Protocol/study registration

Actrn. The effects of adding neuromuscular electrical stimulation to standard inpatient rehabilitation on quadriceps strength and physical function in individuals with total knee replacement.
http://www.who.int/trialsearch/Trial2.aspx?TrialID=ACTRN12610000601033. CN-01840019.
Protocol/study registration

Actrn. A Randomised Controlled Study on the Maxm Skate: a Lower Limb Rehabilitation Device for use following Total Knee Arthroplasty.
http://www.who.int/trialsearch/Trial2.aspx?TrialID=ACTRN12616001081404. CN-01877939.
Protocol/study registration

Actrn. The HIHO 2 Study: hospital Inpatient versus Home-based Rehabilitation after Total Hip Replacement.
http://www.who.int/trialsearch/Trial2.aspx?TrialID=ACTRN12617000848303. CN-01885965.
Protocol/study registration

Actrn. A pedaling-based three exercise protocol compared to a non-pedaling ten exercise protocol for immediate post-operative rehabilitation after total knee replacement in a randomized controlled trial.
http://www.who.int/trialsearch/Trial2.aspx?TrialID=ACTRN12617000647336. CN-01895094.
Protocol/study registration

Adie, S.; Kwan, A.; Naylor, J. M.; Harris, I. A.; Mittal, R.. Cryotherapy following total knee replacement. Cochrane Database of Systematic Reviews. 22972114.
SR or guideline

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SR or guideline

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P: Not unilateral replacement (exclude bilateral replacement surgeries)

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D: N<20 per group

Alghadir A; Iqbal ZA; Anwer S. Comparison of the effect of pre- and post-operative physical therapy versus post-operative physical therapy alone on pain and recovery of function after total knee arthroplasty.. Journal of physical therapy science. 27821929.
T: Timing outcome too early

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SR or guideline

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D: N<20 per group

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D: Single group/no comparison

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SR or guideline

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Protocol/study registration

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Duplicate/No additional data

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D: Single group/no comparison

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Full text unavailable

Anonymous. The effect of early application of electromyographic biofeedback to quadriceps femoris muscle on rehabilitation outcomes in patients with total knee arthroplasty. Turkish Journal of Physiotherapy Rehabilitation. 107984321. Language:.
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Aprile I; Iacovelli C; Cruciani A; Simbolotti C; Loreti S; Galli G; Vulpiani MC; Padua L. Technological rehabilitation versus conventional rehabilitation following hip replacement: A prospective controlled study.. Journal of back and musculoskeletal rehabilitation. 31743982.
P: Not osteoarthritis (exclude cancer, trauma, rheumatoid arthritis)

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I: Not (p)rehabilitation

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SR or guideline

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T: Timing outcome too early

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D: NRCS not adjusted

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I: Not (p)rehabilitation

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SR or guideline

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SR or guideline

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P: Not total relacement (exclude partial)

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SR or guideline

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T: Timing outcome too early

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D: N<20 per group

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Duplicate/No additional data

Bedekar N; Prabhu A; Shyam A; Sancheti K; Sancheti P. Comparative study of conventional therapy and additional yogasanas for knee rehabilitation after total knee arthroplasty.. International journal of yoga. 22869995.
D: NRCS not adjusted

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D: N<20 per group

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SR or guideline

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SR or guideline

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SR or guideline

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T: Timing outcome too early

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T: Timing outcome too early

Blasco, J. M.; Acosta-Ballester, Y.; Martinez-Garrido, I.; Garcia-Molina, P.; Igual-Camacho, C.; Roig-Casasus, S.. The effects of preoperative balance training on balance and functional outcome after total knee replacement: a randomized controlled trial. Clin Rehabil. 31608677.
T: Timing outcome too early

Blasco, J. M.; Hern√°ndez-Guillen, D.; Dom√≠nguez-Navarro, F.; Acosta-Ballester, Y.; Alakhdar-Mohmara, Y.; Roig-Casas√∫s, S.. Sensorimotor training prior total knee arthroplasty and effects on functional outcome: A systematic review and meta-analysis. Gait Posture. 33711615.
SR or guideline

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P: Not total relacement (exclude partial)

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SR or guideline

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D: Not primary study (or SR or GL)

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P: Mixed TKA/THA with no clean subgroup analyses

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D: Single group/no comparison

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O: No outcomes of interest

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I: Not (p)rehabilitation

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T: Timing outcome too early

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Protocol/study registration

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P: Not MJR (hip/knee)

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P: Not unilateral replacement (exclude bilateral replacement surgeries)

Westby, M. D.; Kennedy, D.; Jones, D. L.; Jones, A.; Doyle-Waters, M. M.; Backman, C. L.. Post-acute physiotherapy for primary total knee arthroplasty: a cochrane systematic review. Arthritis and rheumatism. CN-01781602.
SR or guideline

White PB; Carli AV; Meftah M; Ghazi N; Alexiades MM; Windsor RE; Ranawat AS. Patients Discharged to Inpatient Rehabilitation Facilities Undergo More Diagnostic Interventions With No Improvement in Outcomes.. Orthopedics. 30321438.
T: Timing outcome too early

White, S. C.; Lifeso, R. M.. Altering asymmetric limb loading after hip arthroplasty using real-time dynamic feedback when walking. Arch Phys Med Rehabil. 16213238.
D: N<20 per group

Wijnen A; Bouma SE; Seeber GH; van der Woude LHV; Bulstra SK; Lazovic D; Stevens M; van den Akker-Scheek I. The therapeutic validity and effectiveness of physiotherapeutic exercise following total hip arthroplasty for osteoarthritis: A systematic review.. PloS one. 29547670.
SR or guideline

Wijnen, A.; Hoogland, J.; Munsterman, T.; Gerritsma, C. L.; Dijkstra, B.; Zijlstra, W. P.; Dekker, J. S.; Annegarn, J.; Ibarra, F.; Slager, G. E.; Zijlstra, W.; Stevens, M.. Effectiveness of a Home-Based Rehabilitation Program After Total Hip Arthroplasty Driven by a Tablet App and Remote Coaching: Nonrandomized Controlled Trial Combining a Single-Arm Intervention Cohort With Historical Controls. JMIR Rehabil Assist Technol. 32338621.
D: N<20 per group

Winther, S. B.; Foss, O. A.; Husby, O. S.; Wik, T. S.; Klaksvik, J.; Husby, V. S.. A randomized controlled trial on maximal strength training in 60 patients undergoing total hip arthroplasty: implementing maximal strength training into clinical practice. Acta orthopaedica. CN-01465748.
Duplicate/No additional data

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Protocol/study registration

Wojcik, B.; Jablonski, M.; Gebala, E.; Drelich, M.. A comparison of effectiveness of fascial relaxation and classic model of patients rehabilitation after hip joint endoprosthetics. Ortop Traumatol Rehabil. 22619101.
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Wong J; Wong S; Nolde T; Yabsley RH. Effects of an experimental program on post-hospital adjustment of early discharged patients.. International journal of nursing studies. 2155881.
published before 2005

Worland RL; Arredondo J; Angles F; Lopez-Jimenez F; Jessup DE. Home continuous passive motion machine versus professional physical therapy following total knee replacement.. The Journal of arthroplasty. 9802665.
published before 2005

Wozniak-Czekierda W; Wozniak K; Hadamus A; Bialoszewski D. Use of Kinesiology Taping in Rehabilitation after Knee Arthroplasty: a Randomised Clinical Study.. Ortopedia, traumatologia, rehabilitacja. 29154230.
T: Timing outcome too early

Wu JQ; Mao LB; Wu J. Efficacy of exercise for improving functional outcomes for patients undergoing total hip arthroplasty: A meta-analysis.. Medicine. 30855443.
SR or guideline

Wu, J. Q.; Bao, H. W.; Mao, L. B.; Liu, L. F.; Li, Y. M.; Hou, J. Z.; Wu, C. H.; Zhou, Y. J.; Wang, Z.; Cheng, Y. X.; Wu, J.. Proprioceptive training on the recovery of total knee arthroplasty patients: A meta-analysis protocol of randomized controlled trial. Medicine (Baltimore). 33371137.
Protocol/study registration

Wylde V; Dennis J; Gooberman-Hill R; Beswick AD. Effectiveness of postdischarge interventions for reducing the severity of chronic pain after total knee replacement: systematic review of randomised controlled trials.. BMJ open. 29490967.
SR or guideline

Wylde V; Marques E; Artz N; Blom A; Gooberman-Hill R. Effectiveness and cost-effectiveness of a group-based pain self-management intervention for patients undergoing total hip replacement: feasibility study for a randomized controlled trial.. Trials. 24885915.
I: Not well defined/no (p)rehabilitation content to define

Wylde, V.; Artz, N.; Dixon, S.; Marques, E.; Lenguerrand, E.; Blom, A.; Gooberman-Hill, R.. Effectiveness and cost-effectiveness of a group-based outpatient physiotherapy intervention following knee replacement for osteoarthritis: feasibility study for a randomised controlled trial. Osteoarthritis and cartilage. CN-01727063.
O: No outcomes of interest

Xiaolong, Y.; Jianzhong, W.. The effect of acupuncture during post-acute phase of rehabilitation after total knee arthroplasty. Annals of physical and rehabilitation medicine.. CN-01065983.
P: Not total relacement (exclude partial)

Xiong J; Li H; Li X; Wang L; Zhao P; Meng D; Wei ZX; Tian T. Electroacupuncture for postoperative pain management after total knee arthroplasty: Protocol for a systematic review and meta-analysis.. Medicine. 29489645.
SR or guideline

Yan, B. P.. Effects of early rehabilitation training and psychological intervention on physical and mental health of patients undergoing replacement of total hip. Chinese Journal of Clinical Rehabilitation. .
P: Not osteoarthritis (exclude cancer, trauma, rheumatoid arthritis)

Yang TH; Yeh WL; Chen HY; Chen YF; Ni KC; Lee KH. Compare the Traditional Chinese Medicine manipulation with rehabilitation on inpatients after total knee arthroplasty.. The Journal of arthroplasty. 23602417.
D: N<20 per group

Yang X; Li GH; Wang HJ; Wang CY. Continuous Passive Motion After Total Knee Arthroplasty: A Systematic Review and Meta-analysis of Associated Effects on Clinical Outcomes.. Archives of physical medicine and rehabilitation. 30831093.
I: Not (p)rehabilitation

Yang, M.; Wang, H. L.; Qin, D. W.; Guo, X. F.. Gluteus maximus and gluteus medius exercise following elder total hip arthroplasty. Journal of clinical rehabilitative tissue engineering research. CN-01016098.
Full text unavailable

Yayac, M.; Moltz, R.; Pivec, R.; Lonner, J. H.; Courtney, P. M.; Austin, M. S.. Formal Physical Therapy Following Total Hip and Knee Arthroplasty Incurs Additional Cost Without Improving Outcomes. J Arthroplasty. 32674941.
P: Mixed TKA/THA with no clean subgroup analyses

Ye, X. p. Functional rehabilitation training following hip replacement. Journal of Clinical Rehabilitative Tissue Engineering Research. .
Full text unavailable

Yeh ML; Chen HH; Liu PH. Effects of multimedia with printed nursing guide in education on self-efficacy and functional activity and hospitalization in patients with hip replacement.. Patient education and counseling. 15911196.
P: Not osteoarthritis (exclude cancer, trauma, rheumatoid arthritis)

Yildirim, Ahmet √ñzg√ºr; √ñKen, √ñznur; √ñKen, √ñzdamar Fuad; K√ñSeo*f*ûLu, Belma F√ºsun; Sezer, Nebahat; U√áAner, Ahmet. Impact of Hospital Rehabilitation on Functional Outcomes and Quality of Life after Total Knee Arthroplasty. Turkish Journal of Physical Medicine & Rehabilitation / Turkiye Fiziksel Tip ve Rehabilitasyon Dergisi. 110383805. Language:.
T: Timing outcome too early

Yim, S. J.; Min, K. D.; Lee, Y. K.; Kim, H. T.; Kang, H. K.. Efficacy of Physiotherapist after Total Knee Arthroplasty. The journal of korean knee society. CN-01046648.
P: Not unilateral replacement (exclude bilateral replacement surgeries)

Yousefian Molla, R.; Sadeghi, H.; Kahlaee, A. H.. The Effect of Early Progressive Resistive Exercise Therapy on Balance Control of Patients with Total Knee Arthroplasty. Topics in geriatric rehabilitation. CN-01428208.
T: Timing outcome too early

Yue C; Zhang X; Zhu Y; Jia Y; Wang H; Liu Y. Systematic Review of Three Electrical Stimulation Techniques for Rehabilitation After Total Knee Arthroplasty.. The Journal of arthroplasty. 29530519.
SR or guideline

Zachwieja, E.; Theosmy, E. G.; Yacovelli, S. J.; Beatty, E. W.; McGrath, M. E.; Lonner, J. H.. Web-Based Self-Directed Exercise Program Is Cost-Effective Compared to Formal Physical Therapy After Primary Total Knee Arthroplasty. J Arthroplasty. 32423757.
D: NRCS not adjusted

Zech A; Hendrich S; Pfeifer K. Association Between Exercise Therapy Dose and Functional Improvements in the Early Postoperative Phase After Hip and Knee Arthroplasty: An Observational Study.. PM & R : the journal of injury, function, and rehabilitation. 25892356.
D: Single group/no comparison

Zeni J Jr; Abujaber S; Flowers P; Pozzi F; Snyder-Mackler L. Biofeedback to promote movement

symmetry after total knee arthroplasty: a feasibility study.. The Journal of orthopaedic and sports physical therapy. 23892267.
D: N<20 per group

Zeni Jr, Joseph; Zeni, Joseph, Jr.. Evidence supports supervised physical therapy programs after TKA. Orthopedics. .
D: Not primary study (or SR or GL)

Zhang, W. C.; Xiao, D.. Efficacy of proprioceptive training on the recovery of total joint arthroplasty patients: a meta-analysis. J Orthop Surg Res. 33143719.
SR or guideline

Zhao, X. Y.; Li, W. L.; Fang, W.. Clinical studies on postoperative rehabilitation for total hip replacement. Zhongguo gu shang = China journal of orthopaedics and traumatology. .
D: Not primary study (or SR or GL)

Zhu, Y.; Feng, Y.; Peng, L.. Effect of transcutaneous electrical nerve stimulation for pain control after total knee arthroplasty: A systematic review and meta-analysis. J Rehabil Med. 28933513.
SR or guideline

Zietek P; Zietek J; Szczypior K; Safranow K. Effect of adding one 15-minute-walk on the day of surgery to fast-track rehabilitation after total knee arthroplasty: a randomized, single-blind study.. European journal of physical and rehabilitation medicine. 25230888.
I: Not (p)rehabilitation

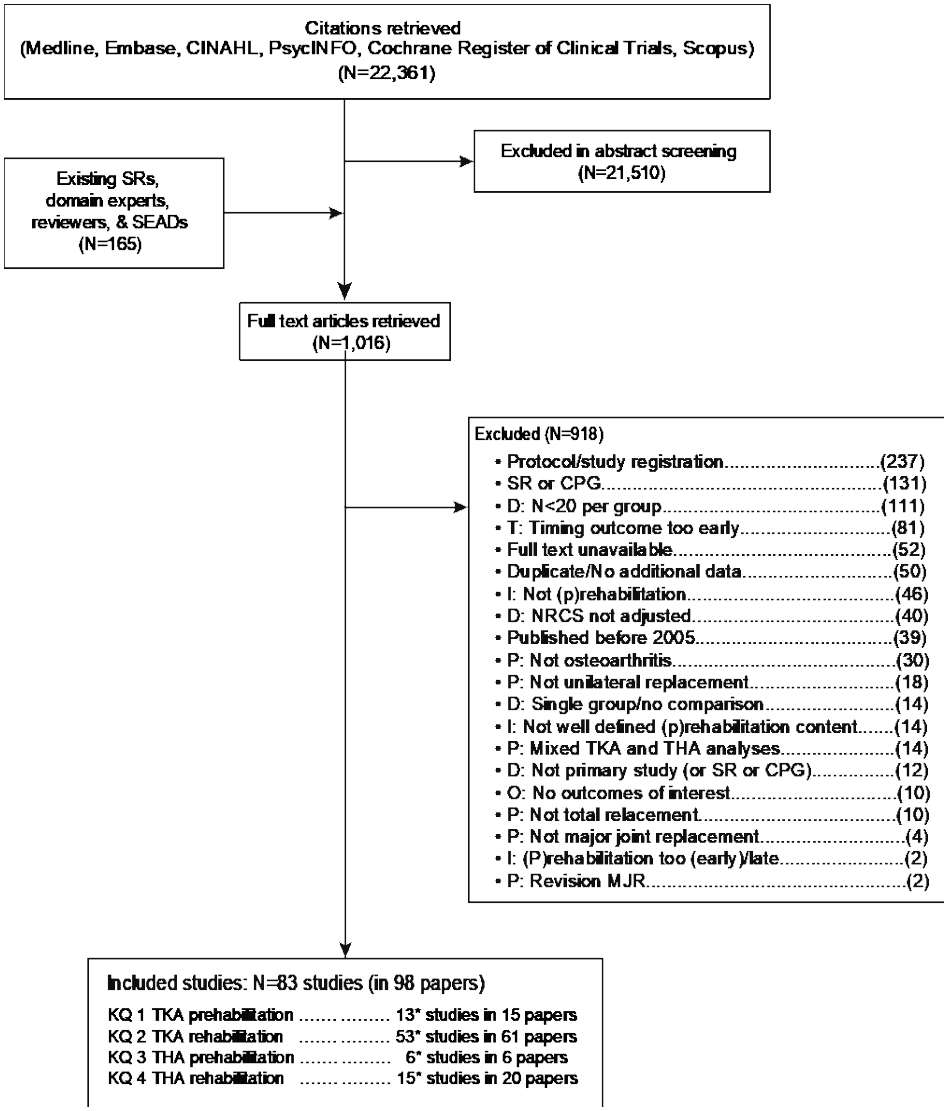
[Unreadable]. [Unreadable]. Arak Medical University Journal. 148323156. Language:.
D: N<20 per group

[Unreadable]. [Unreadable]. Nursing of Integrated Traditional Chinese & Western Medicine. .
Full text unavailable

Appendix C. Search Results, Study Design, Arm Details, Baseline Characteristics, and Risk of Bias Assessments

Search Results

Figure C-1. Literature flow diagram



Abbreviations: CPG = clinical practice guideline, D = (study) design, I = (study) intervention, KQ = Key Question, MJR = major joint replacement, NRCS = nonrandomized comparative study, O = (study) outcomes, P = (study) population, SEAD = supplemental evidence and data (request), SR = systematic review, T = (outcome) timing, THA = total hip arthroplasty, TKA = total knee arthroplasty.

* 1 study included for both KQs 1 and 2, 1 study included for both KQs 1 and 3, 2 studies included for both KQs 2 and 4.

Included Studies

Key Question 1 (Prehabilitation for Total Knee Arthroplasty)

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2. Casaña J, Calatayud J, Ezzatvar Y, et al. Preoperative high-intensity strength training improves postural control after TKA: randomized-controlled trial. Knee Surg Sports Traumatol Arthrosc. 2019 Apr;27(4):1057-66. doi: 10.1007/s00167-018-5246-2. PMID: 30361758.
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Key Question 2 (Rehabilitation for Total Knee Arthroplasty)

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Study Design Details and Arms, Risk of Bias

Key Question 1: Prehabilitation for Total Knee Arthroplasty

Table C-1.1. KQ 1. Design details and arms

Study[A], Year, PMID, Country	Funding Source	Risk of Bias	Eligibility Criteria	Intervention[B]	N, Enrolled	Mean Age, Years (SD)	Female, %	Mean BMI[C] (SD)	Prior Contralateral Arthroplasty
Calatayud, 2017, 26768606, Spain	Non-industry	Moderate	INCLUSION: ≥60 yo, diagnosed with advanced idiopathic knee OA and scheduled for unilateral TKA. EXCLUSION: Pain in the contralateral limb (defined as maximum pain of 4 of 10 during daily activities), hip or knee joint replacement in the previous year, any medical condition in which exercise was contraindicated, presence of any disease that affected functional performance.	High intensity preoperative training Comp: S-F-B AdjMod: - Set: O	25	66.8 (4.8)	72%	32.3 (4.2)	NR
	No data	No data	No data	Control Comp: NR AdjMod: NR Set: NR	25	66.7 (3.1)	76%	31.2 (3.8)	NR
Huang, 2012, 22480863, Taiwan	NR	High	INCLUSION: Scheduled to undergo unilateral, primary TKA for advanced OA, the ability to follow rehabilitation program and an interval of 4 weeks between enrolment and surgery. EXCLUSION: Inflammatory arthritis (e.g., RA or psoriatic arthritis), any medical condition in which a moderate level of exercise was contraindicated (e.g., heart failure or hypertension).	Preoperative rehabilitation education program Comp: S-F-E AdjMod: - Set: O, H	126	69.8 (7.2)	70%	27.1 (4.0)	NR
	No data	No data	No data	Conventional care Comp: - AdjMod: - Set: -	117	70.5 (7.4)	74%	27.2 (4.5)	NR
Huber, 2015, 25925404, Switzerland	Non-industry	High	INCLUSION: 55-90 yo, living at home, on waitlist for primary TKR, sufficient time prior to surgery to take (minimum 8 sessions of the training program. EXCLUSION: Revision surgery, history of inflammatory arthritis, cognitive impairments, absence before or after surgery, inability to walk at least 3 meters with or without a walking aid.	Neuromuscular training program (NEMEX-TJR) & knee school Comp: S-A-F-B-T-E AdjMod: - Set: O	22	68.8 (8.0)	50%	30.8 (4.9)	NR
	No data	No data	No data	Knee school Comp: E AdjMod: - Set: O	23	71.9 (8.1)	44%	29.9 (5.5)	NR

Study[A], Year, PMID, Country	Funding Source	Risk of Bias	Eligibility Criteria	Intervention[B]	N, Enrolled	Mean Age, Years (SD)	Female, %	Mean BMI[C] (SD)	Prior Contralateral Arthroplasty
Matassi, 2014, 23271039, Belgium	NR	Moderate	INCLUSION: 18-90 yo, non-inflammatory OA, scheduled primary unilateral TKA, moderate to severe pain in the affected knee. EXCLUSION: BMI > 35, physical activity needs less than moderate, previous hip or knee replacement surgery in the last 6 months, failed total or unicondylar knee replacement of the affected knee or high tibial osteotomy of the affected knee, active local infection or systemic infection, physical, emotional or neurological conditions that would compromise the patients compliance with the preoperative home exercise regime, postoperative rehabilitation and follow-up, grade three collateral ligament insufficiency, knee flexion less than 80, fixed flexion deformity greater then 20, varus or valgus align- ment greater than 10 unless correctable to under 10, immunosuppressive disorder, immunosuppressive therapy or auto-immune diseases including inflammatory arthritis, intra-articular steroid infiltration in the affected knee within 6 weeks of the baseline assessment, recent fracture (3 months) of upper or lower extremity, inability to understand the study (dementia, language problem), physiotherapy for the affected knee during the preceding 6 months.	Preoperative home exercise program Comp: S-F-E AdjMod: - Set: H	61	66 (7.2)	54%	29 (4.3)	NR
	No data	No data	No data	Control Comp: - AdjMod: - Set: -	61	67 (7.7)	43%	28 (3.7)	NR
Mat Eil Ismail, 2016, 26996450, Malaysia	NR	High	INCLUSION: > 45 yr, lived within a convenient distance of the physiotherapy facility, had been diagnosed with unilateral or bilateral primary knee OA; and underwent unilateral TKA at HUSM. EXCLUSION: Systemic inflammatory arthritis; degenerative joint diseases involving the hip or ankle joint or spine; medical comorbidities with an inability to tolerate a moderate level of physical exertion; premorbid knee joint stiffness; history of cardiovascular accident; and cognitive, psychological or language impairment.	Prehabilitation Comp: S-F AdjMod: Heat Set: NR	24	62.4 (NR)	92%	NR	NR
	No data	No data	No data	No prehabilitation Comp: - AdjMod: - Set: -	26	64.3 (NR)	81%	NR	NR

Study[A], Year, PMID, Country	Funding Source	Risk of Bias	Eligibility Criteria	Intervention[B]	N, Enrolled	Mean Age, Years (SD)	Female, %	Mean BMI[C] (SD)	Prior Contralateral Arthroplasty
Mitchell, 2005, 15869558, UK	Non-industry	High	INCLUSION: primary unilateral TKA for OA. EXCLUSION: revision TKA, bilateral and unicondylar knee replacements, TKA for trauma, onset of serious comorbidity or terminal illness since patient placed on the waiting list, contralateral knee replacement within the preceding 12 months.	Home pre-operative and post-operative rehabilitation Comp: F-T-E AdjMod: Massage Set: H	57	70.0 (7.2)	63%	NR	16%
	No data	No data	No data	Hospital outpatient post-operative rehabilitation Comp: F-T AdjMod: TENS, NMES Set: O	58	70.6 (8.2)	53%	NR	26%
Skoffer, 2016, 26713665, Denmark	Non-industry	Moderate	INCLUSION: >18 yo, scheduled for primary unilateral TKA, were radiographically and clinically diagnosed with OA, residents in the Aarhus municipality, able to transport themselves to training. EXCLUSION: Heart disease or uncontrolled hypertension, neuromuscular or neurodegenerative conditions, unable to comprehend the protocol instructions	Preoperative progressive resistance training Comp: S-F AdjMod: - Set: O	30	70.7 (7.3)	63%	30.0; Range (22.6, 42.5)	10%
	No data	No data	No data	Standard care preoperatively Comp: - AdjMod: - Set: -	29	70.1 (6.4)	59%	31.8; Range (24.3, 42.2)	14%
Soeters, 2018, 29529614, USA	NR	Moderate	INCLUSION: 18-85 yo, scheduled for unilateral THA or TKA, able to independently ambulate a half a block or more with or without an assistive device, able to independently perform nonreciprocal stairs with or without assistive devices, and planned to be discharged home after surgery. EXCLUSION: Patients who did not undergo scheduled surgery, underwent a procedure other than primary TJA, or were discharged to inpatient rehabilitation centers	Preoperative physical therapy education (PreopPTEd) Comp: T-E AdjMod: - Set: NR	32	61 (9); Range (37-98)[D]	44%	29 (6); Range (19-46)	NR
	No data	No data	No data	No preoperative physical therapy education Comp: - AdjMod: - Set: -	31	62 (8); Range (45-85)	29%	29 (6); Range (17-48)	NR

Study[A], Year, PMID, Country	Funding Source	Risk of Bias	Eligibility Criteria	Intervention[B]	N, Enrolled	Mean Age, Years (SD)	Female, %	Mean BMI[C] (SD)	Prior Contralateral Arthroplasty
Soni, 2012, 22914302, UK	Non-industry	Moderate	INCLUSION: Listed for knee arthroplasty due to OA who had unilateral or bilateral knee pain lasting more than 3 months. EXCLUSION: Anticoagulants or diagnosed as having a bleeding diathesis, needle-phobic, allergic to metal, experiencing any skin disease around the knee, within 3 months of receiving an intra-articular steroid injection, experiencing back or hip pain, diagnosed as having RA, within 12 months of receiving acupuncture or physiotherapy	Acupuncture & exercise Comp: S-F-B-T AdjMod: Acupuncture Set: O	28	66.9 (9.8)	54%	31.4 (4.2)	NR
	No data	No data	No data	Exercise & advice leaflet Comp: - AdjMod: - Set: -	28	70.0 (7.9)	46%	31.1 (4.9)	NR
Topp, 2009, 19695525, USA	Non-industry & Industry	High	INCLUSION: ≥ 50 yo, scheduled for a unilateral TKA, and did not meet standard exclusion criteria for engaging in moderate intensity exercise. EXCLUSION: NR	Prehabilitation exercises Comp: S-F-T AdjMod: - Set: O, H	26	64.1 (7.1)	27%	32.2 (5.9)	NR
	No data	No data	No data	Usual care Comp: - AdjMod: - Set: -	28	63.5 (6.7)	36%	32.0 (6.1)	NR
Valtonen, 2015, CN-01126383, Finland	NR	High	INCLUSION: Scheduled for unilateral TKA EXCLUSION: NR	Aquatic training Comp: S AdjMod: - Set: Aquatic center	31	NR	NR	NR	NR
	No data	No data	No data	Control Comp: - AdjMod:- Set: -	24	NR	NR	NR	NR
Villadsen, 2014, 23661494, Denmark	Non-industry and Industry	Moderate	INCLUSION: ≥18 years, scheduled for primary unilateral THA or TKA due to severe symptomatic OA. EXCLUSION: current or previous fractures in or adjacent to the joint, inflammatory arthritis and comorbidity (e.g., severe heart disease and neurological deficits) contraindicating exercise and testing, scheduled for bilateral TJA	Neuromuscular exercise (NEMEX-TJR) & standard education package Comp: S-A-F-B-T AdjMod: - Set: O	41	67.1 (8.8)	61%	30.8 (4.9)	NR
	No data	No data	No data	Standard education package Comp: - AdjMod: - Set: -	40	65.1 (9.0)	60%	33.4 (5.8)	NR

Study[A], Year, PMID, Country	Funding Source	Risk of Bias	Eligibility Criteria	Intervention[B]	N, Enrolled	Mean Age, Years (SD)	Female, %	Mean BMI[C] (SD)	Prior Contralateral Arthroplasty
Williamson, 2007, 17604311, UK	Non-industry	Moderate	INCLUSION: knee arthroplasty due to OA; with unilateral or bilateral knee pain lasting > 3 months. EXCLUSION: taking anticoagulants; within 2 months after receiving an intra-articular steroid injection; experiencing back pain associated with referred leg pain; suffering from ipsilateral OA of the hip; suffering psoriasis or other skin disease in the region of the knee; suffering from RA; received acupuncture or physiotherapy treatment in the previous year.	Acupuncture Comp: - AdjMod: Acupuncture Set: O	60	72.4 (7.7)	55%	30.9 (6.0)	NR
	No data	No data	No data	Physiotherapy (supervised exercise) Comp: S-F-B-T AdjMod:- Set: O	60	70.0 (8.8)	52%	32.8 (5.7)	NR
	No data	No data	No data	Control Comp: - AdjMod: - Set: -	61	69.6 (10)	54%	32.7 (6.4)	NR

Abbreviations: BMI = H = home, NA = not applicable, NMES = neuromuscular electrical stimulation, NR=not reported, O = outpatient physiotherapy center, OA = osteoarthritis, PMID = PubMed identifier, RA = rheumatoid arthritis, SD = standard deviation, SD = standard deviation, TENS = transcutaneous electrical nerve stimulation, THA = total hip arthroplasty, TJA = total joint arthroplasty, TKA = total knee arthroplasty, yo = years old

A All randomized controlled trials, except as footnoted. There were no non-randomized comparative studies in Key Question 1.
B Including Components (Comp); Adjunctive modalities (AdjMod); and Setting (Set).
Components: A = aerobic exercise, B= Balance-motor/Learning-agility exercise, E = patient education, F = flexibility exercise, S = strengthening exercise, T = task-specific training.
C kg/m^2
D Reported age, gender, BMI data for total joint replacement population (TKA and THA) combined

Table C-1.2. KQ 1. Prehabilitation component details

Study, Year, PMID, Country	Intended Comparison	Arm	Components (Specific Exercises/Strategies)	Progression (Appropriate?)	Personnel	Mode of Delivery	Setting
Calatayud, 2017, 26768606, Spain	High intensity preoperative training vs control group [undescribed]	High intensity preoperative training	**1. Strength** 1.9 Heel raises – bilateral (calf raises) 1.11 Hip abduction in sidelying (position unclear)[A] 1.12 Hip abduction in standing (position unclear) 1.13 Hip abduction in supine (position unclear) 1.31 Knee extension in sitting or supine (long arc quad) (position unclear) 1.32 Knee extension in sitting or supine (short arc quad) (position unclear) 1.35 Knee flexion in prone (position unclear) 1.36 Knee flexion in sitting or supine (position unclear) 1.37 Knee flexion in standing(position unclear) 1.38 Leg press (one leg) (one or two legs unclear) 1.39 Leg press (two legs) (one or two legs unclear) 1.47 Single leg stance 1.55 Step up – forward **3. Flexibility** 3.2 Bike (ROM) 3.3 Calf stretch with knee bent (soleus) (unclear bent or straight) 3.4 Calf stretch with knee straight (gastric) (unclear bent or straight) 3.9 Iliotibial band stretch in any position 3.15 Knee flexion AROM in any position (rectus femoris stretch) 3.16 Knee flexion PROM in prone (rectus femoris stretch) **4. Balance-Motor Learning-Agility** 4.3 Balance on unstable surface	Y (Y)	Physical therapist	In-person	Physical therapy/rehabilitation facility (outpatient)
	No data	Control	NR [No description provided]	NR	NR	NR	NR
Huang, 2012, 22480863, Taiwan	Preoperative rehabilitation education program vs. No preoperative rehabilitation education program (conventional care)	Preoperative rehabilitation education program	**1. Strength (goal)** 1.11 Hip abduction in sidelying (position unclear) 1.12 Hip abduction in standing (position unclear) 1.13 Hip abduction in supine (position unclear) 1.43 Quad sets 1.58 Straight leg raise **3. Flexibility** 3.1 Ankle pumps **6. Patient education** 6.1 ADLs 6.2 Home exercise program	N (NA)	Physical therapist; None (unsupervised)	In-person; Self-guided (unsupervised); Remote via telephone	Physical therapy/rehabilitation facility (outpatient); Home
	No data	Conventional pre-TKA care	NA [No prehab or education; usual activities and exercise not prohibited]	NA	NA	NA	NA

Study, Year, PMID, Country	Intended Comparison	Arm	Components (Specific Exercises/Strategies)	Progression (Appropriate?)	Personnel	Mode of Delivery	Setting
Huber, 2015, 25925404, Switzerland	Neuromuscular training program (NEMEX-TJR) & knee school (education) vs. Knee school (education)	Neuromuscular training program (NEMEX-TJR) & knee school (education)	**1. Strength** 1.6 Core strengthening 1.12 Hip abduction in standing 1.15 Hip adduction in standing 1.31 Knee extension in sitting or supine (long arc quad) 1.36 Knee flexion in sitting or supine 1.41 Lunges 1.42 Lunges to side (lateral lunge) **2. Aerobic** 2.2 Bike (endurance) **3. Flexibility** [specific exercises not defined] **4. Balance-Motor Learning-Agility** 4.4 Balance with perturbations 4.11 Step down 4.14 Step up – forward **5. Task specific training** 5.4 Gait backwards 5.8 Gait training 5.13 Sit-to-stand training 5.15 Stair training **6. Patient education** 6.4 Pain management	Y (Y)	Physical therapist	In-person	Physical therapy/rehabilitation facility (outpatient)
	No data	Knee school (education)	**6. Patient education** 6.4 Pain management	N (NA)	Physical therapist	In-person	Physical therapy/rehabilitation facility (outpatient)
Matassi, 2014, 23271039, Belgium	Preoperative home exercise program vs. usual activity	Preoperative home exercise program	**1. Strength** 1.31 Knee extension in sitting or supine (long arc quad) 1.35 Knee flexion in prone 1.43 Quad sets 1.52 Step down 1.55 Step up – forward **3. Flexibility** 3.5 Hamstring stretch in any position 3.15 Knee flexion AROM in any position (rectus femoris stretch) **6. Patient education** 6.2 Home exercise program	N (NA)	None (unsupervised)	Self-guided (unsupervised)	Home
	No data	Control	NA [Instructed to continue usual activities until surgery]	NA	NA	NA	NA

Study, Year, PMID, Country	Intended Comparison	Arm	Components (Specific Exercises/Strategies)	Progression (Appropriate?)	Personnel	Mode of Delivery	Setting
Mat Eil Ismail, 2016, 26996450, Malaysia	Preoperative physiotherapy vs. No preoperative physiotherapy	Prehabilitation	**1. Strength** 1.31 Knee extension in sitting or supine (long arc quad) 1.32 Knee extension in sitting or supine (short arc quad) 1.43 Quad sets 1.58 Straight leg raises **3. Flexibility** 3.1 Ankle pumps 3.2 Bike (ROM) 3.5 Hamstring stretch in any position 3.6 Heel slides **7. Adjunctive modality** 7.2 Heat	N (NA)	NR	NR	NR
	No data	No prehabiltation	**NA** [No additional care preoperative; same postoperative as the intervention group]	N (NA)	NA	NA	NA
Mitchell, 2005, 15869558, UK	Pre- and post-operative physiotherapy at home vs. hospital outpatient post-operative physiotherapy	Home pre-operative and post-operative rehabilitation	**3. Flexibility** 3.10 Knee extension AROM (unclear) 3.11 Knee extension PROM in supine (unclear) 3.12 Knee extension PROM in prone (unclear) 3.13 Knee flexion AROM (unclear) 3.14 Knee flexion PROM in sitting or supine (unclear) 3.15 Knee flexion AROM in any position (rectus femoris stretch) (unclear) 3.16 Knee flexion PROM in prone (rectus femoris stretch) (unclear) **5. Task specific training** 5.8 Gait training **6. Patient education** 6.1 ADLs 6.4 Pain management **7. Adjunctive modality** 7.12 Massage/myofascial techniques for soft tissue	N (NA)	Physical therapist	In-person	Home
	No data	Hospital outpatient post-operative rehabilitation	**3. Flexibility** 3.10 Knee extension AROM (unclear) 3.11 Knee extension PROM in supine (unclear) 3.12 Knee extension PROM in prone (unclear) 3.13 Knee flexion AROM (unclear) 3.14 Knee flexion PROM in sitting or supine (unclear) 3.15 Knee flexion AROM in any position (rectus femoris stretch) (unclear) 3.16 Knee flexion PROM in prone (rectus femoris stretch) (unclear) **5. Task specific training** 5.8 Gait training **7. Adjunctive modality** 7.4 E-stim for pain (TENS) 7.5 E-stim for strength (NMES)	N (NA)	Physical therapist	In-person	Physical therapy/rehabilitation facility (outpatient)

Study, Year, PMID, Country	Intended Comparison	Arm	Components (Specific Exercises/Strategies)	Progression (Appropriate?)	Personnel	Mode of Delivery	Setting
Skoffer, 2016, 26713665, Denmark	Preoperative and postoperative progressive resistance training vs. postoperative progressive resistance training[B]	Preoperative progressive resistance training	**1. Strength** 1.11 Hip abduction in sidelying (position unclear) 1.12 Hip abduction in standing (position unclear) 1.13 Hip abduction in supine (position unclear) 1.14 Hip adduction in sidelying (position unclear) 1.15 Hip adduction in standing (position unclear) 1.16 Hip adduction in supine (position unclear) 1.17 Hip extension in sidelying (position unclear) 1.18 Hip extension in prone (position unclear) 1.19 Hip extension in standing (position unclear) 1.28 Knee extension machine (one-leg) 1.33 Knee flexion machine (Hamstring curl) one knee 1.38 Leg press (one leg) **3. Flexibility** 3.2 Bike (ROM) 3.10 Knee extension AROM (unclear) 3.11 Knee extension PROM in supine (unclear) 3.12 Knee extension PROM in prone (unclear) 3.13 Knee flexion AROM (unclear) 3.14 Knee flexion PROM in sitting or supine (unclear) 3.15 Knee flexion AROM in any position (rectus femoris stretch) (unclear) 3.16 Knee flexion PROM in prone (rectus femoris stretch) (unclear)	Y (N)	Physical therapist	In-person	Physical therapy/rehabilitation facility (outpatient)
	No data	Standard care preoperatively	NA [No training preoperatively; same postoperative progressive resistance training as intervention group]	NA	NA	NA	NA
Soeters, 2018, 29529614, USA	One-on-one preoperative physical therapy education and microsite vs. no preoperative physical therapy education	Preoperative physical therapy education (PreopPTEd)	**5. Task specific training** 5.1 Transfers 5.13 Sit-to-stand training 5.15 Stair training **6. Patient education** 6.1 ADLs		Physical therapist	In-person	NR (Unclear if home or outpatient)
	No data	No preoperative physical therapy education	NA [One preoperative group education class (usual care at the institution); postoperatively received the same physical therapy as the intervention group]	NA	NA	NA	NA

Study, Year, PMID, Country	Intended Comparison	Arm	Components (Specific Exercises/Strategies)	Progression (Appropriate?)	Personnel	Mode of Delivery	Setting
Soni, 2012, 22914302, UK	Combined acupuncture and physiotherapy vs. standard care	Acupuncture & exercise	**1. Strength** 1.32 Knee extension in sitting or supine (short arc quad) 1.36 Knee flexion in sitting or supine 1.43 Quad sets 1.48 Sit-to-stand 1.58 Straight leg raise **3. Flexibility** 3.2 Bike (ROM) 3.3 Calf stretch with knee bent (soleus) (unclear knee bent or straight) 3.4 Calf stretch with knee straight (gastric) (unclear knee bent or straight) **4. Balance-Motor Learning-Agility** 4.3 Balance on unstable surface **5. Task specific training** 5.15 Stair training **7. Adjunctive modality** 7.16 Dry needling (acupuncture)	N (NA)	Physical therapist	In-person	Physical therapy/rehabilitation facility (outpatient)
	No data	Exercise & advice leaflet	NA [Exercise and advice leaflet designed by the physiotherapy, orthopedic, and rheumatology departments]	N (NA)	NA	NA	NA

Study, Year, PMID, Country	Intended Comparison	Arm	Components (Specific Exercises/Strategies)	Progression (Appropriate?)	Personnel	Mode of Delivery	Setting
Topp, 2009, 19695525, USA	Prehabilitation vs. usual care	Prehabilitation exercise	**1. Strength** 1.11 Hip abduction in sidelying (position unclear) 1.12 Hip abduction in standing (position unclear) 1.13 Hip abduction in supine (position unclear) 1.14 Hip adduction in sidelying (position unclear) 1.15 Hip adduction in standing (position unclear) 1.16 Hip adduction in supine (position unclear) 1.17 Hip extension in sidelying (position unclear) 1.18 Hip extension in prone (position unclear) 1.19 Hip extension in standing (position unclear) 1.20 Hip flexion in sidelying (position unclear) 1.21 Hip flexion in sitting (position unclear) 1.22 Hip flexion in standing (position unclear) 1.31 Knee extension in sitting or supine (long arc quad) (long or short arc unclear) 1.32 Knee extension in sitting or supine (short arc quad) (long or short arc unclear) 1.35 Knee flexion in prone (position unclear) 1.36 Knee flexion in sitting or supine (position unclear) 1.37 Knee flexion in standing (position unclear) 1.49 Squats 1.52 Step down 1.53 Step down laterally 1.55 Step up – forward 1.56 Step up – lateral 1.63 Open chain ankle dorsiflexion/plantar flexion/inversion/eversion **3. Flexibility** 3.3 Calf stretch with knee bent (soleus) (unclear knees bent or straight) 3.4 Calf stretch with knee straight (gastric) (unclear knees bent or straight) 3.7 Hip extensor stretch (knee to chest) (unclear) 3.8 Hip flexor stretch (iliopsoas) (unclear) **5. Task specific training** [specific exercises not defined]	N (NA)	Other (research personnel); None (unsupervised)	In-person; Self-guided (unsupervised)	Physical therapy/rehabilitation facility (outpatient); Home
	No data	Usual care	NA [Continue normal activities until the TKA]	N (NA)	NA	NA	NA
Valtonen, 2015, CN-01126383, Finland	Preoperative progressive aquatic resistance training vs. Usual care [Abstract only]	Aquatic training	**1. Strength** [specific exercises not defined]	Y (N)	NR	In-person	Other (aquatic center)
	No data	Control	NA [Continued life as normal]	NA	NA	NA	NA

Study, Year, PMID, Country	Intended Comparison	Arm	Components (Specific Exercises/Strategies)	Progression (Appropriate?)	Personnel	Mode of Delivery	Setting
Villadsen, 2014, 23661494, Denmark	Preoperative neuromuscular exercise program plus standard education vs. standard education alone	Neuromuscular exercise (NEMEX-TJR) & standard education package	**1. Strength** 1.2 Bridges Two-legged (supine hip extension) 1.6 Core strengthening 1.12 Hip abduction in standing 1.15 Hip adduction in standing 1.31 Knee extension in sitting or supine (long arc quad) 1.36 Knee flexion in sitting or supine 1.41 Lunges 1.42 Lunges to side (lateral lunge) 1.52 Step down 1.55 Step up – forward **2. Aerobic** 2.2 Bike (Endurance) **3. Flexibility** 3.2 Bike (ROM) **4. Balance-Motor Learning-Agility** [specific exercises not defined] **5. Task specific training** 5.4 Gait backwards 5.8 Gait training 5.13 Sit-to-stand training	Y(Y)	Physical therapist	In-person	Physical therapy/rehabilitation facility (outpatient)
	No data	Standard education package	NA [No limitations regarding exercise habits or seeking other treatment]	NA	NA	NA	NA
Williamson, 2007, 17604311, UK	Preoperative acupuncture vs. preoperative physiotherapy (supervised exercise) vs. standard care	Acupuncture	**7. Adjunctive modality** 7.16 Dry needling (acupuncture)	N (NA)	Physical therapist	In-person	Physical therapy/rehabilitation facility (outpatient)
	No data	Physiotherapy (supervised exercise)	**1. Strength** 1.30 Knee extension AAROM in sitting or supine (short- or long arc quad) (long or short unclear) 1.31 Knee extension in sitting or supine (long arc quad) (long or short unclear) 1.43 Quad sets 1.48 Sit-to-stand 1.58 Straight leg raise **3. Flexibility** 3.2 Bike (ROM) 3.3 Calf stretch with knee bent (soleus) (unclear knees bent or straight) 3.4 Calf stretch with knee straight (gastric) (unclear knees bent or straight) **4. Balance-Motor Learning-Agility** 4.3 Balance on unstable surface **5. Task specific training** 5.15 Stair training	N (NA)	Physical therapist	In-person	Physical therapy/rehabilitation facility (outpatient)
	No data	Control	NA [Exercise and advice leaflet]	N (NA)	None (unsupervised)	None (unsupervised)	Home

Abbreviations: AAROM = assisted active range of motion, ADL = activities of daily living, AROM = active range of motion, NA = not applicable, NMES = neuromuscular electrical stimulation NR = not reported, PROM = passive range of motion, ROM = range of motion, TENS = transcutaneous electrical nerve stimulation, TKA = total knee arthroplasty.

A Where position was not specified, all positions were coded with a comment of 'position unclear'
B Only preoperative exercises were coded

Table C-1.3. KQ 1. Risk of bias assessment for primary studies – randomized controlled trials (RCTs)

Study, Year, PMID	Random	Allocation	Blinding, Participants	Blinding, Providers	Blinding, Outcome, Obj / Subj	Dropout	Reporting Bias	Other	Population	Intervention	Outcomes	Overall RoB
Calatayud, 2017, 26768606	Low	Low	High	High	Unsure	Low	Low	Low	No	No	No	Moderate
Huang, 2012, 22480863	Unsure	Unsure	High	High	Low	Low	Low	Low	No	No	No	High
Huber, 2015, 25925404	Low	Low	High	High	Low	Low	High	High[A]	No	No	No	High
Matassi, 2014, 23271039	Low	Unsure	High	High	Low	Low	Low	Low	No	No	No	Moderate
Mat Eli Ismail, 2016, 26996450	High	Unsure	High	High	High	Low	Low	Low	No	No	No	High
Mitchell, 2005, 15869558	Low	High	High	High	Unsure	Low	Low	Low	No	No	No	High
Skoffer, 2016, 26713665	Low	Low	High	High	Low	Low	Low	High[B]	No	No	No	Moderate
Soeters, 2018, 29529614	Low	Low	High	Low	Low	Low	Low	Low	No	No	No	Moderate
Soni, 2012, 22914302	Low	Low	High	High	Low	Low	Low	Low	No	No	No	Moderate
Topp, 2009, 19695525	Unsure	Unsure	High	Low	Unsure	Low	Low	Low	No	No	No	High
Valtonen, 2015, No PMID	Unsure	Unsure	Low	Low	Unsure	Unsure	Unsure	Low	No	Yes	Yes	High
Villadsen, 2014, 23661494	Low	Low	High	High	Low	High	Low	Low	No	No	No	High
Williamson, 2007, 17604311	Low	Low	High	Low	Low	Low	Low	Low	No	No	No	Moderate

PMID = Obj = objective, PubMed Identifier, Subj = subjective.
From the Cochrane Risk of Bias Tool (each item rated as Low, High, Unsure, or N/A). Ratings are color coded for emphasis only.

- Random: Random sequence generation (selection bias): Selection bias (biased allocation to interventions) due to inadequate generation of a randomized sequence;
- Allocation: Allocation concealment (selection bias): Selection bias (biased allocation to interventions) due to inadequate concealment of allocations prior to assignment;
- Blinding of participants (performance bias): Performance bias due to knowledge of the allocated interventions by participants during the study;
- Blinding of personnel/care providers (performance bias): Performance bias due to knowledge of the allocated interventions by personnel/care providers during the study;
- Blinding of outcome assessor (detection bias): Detection bias due to knowledge of the allocated interventions by outcome assessors;
- Dropout: Incomplete outcome data (attrition bias): Attrition bias due to amount, nature or handling of incomplete outcome data;
- Reporting Bias: Selective outcome reporting (outcome reporting bias): Bias arising from outcomes being selectively reported based on the direction and/or strength of the results;
- Other Bias: Bias due to problems not covered elsewhere in the table.

From the National Heart, Lung, and Blood Institute (NHLBI) Quality Assessment Tool (each item rated as No, Yes, or Unsure)

- Population: Eligibility criteria not prespecified and clearly described: potentially related to selection bias;
- Intervention: Intervention not clearly described and delivered consistently: potentially related to performance bias
- Outcomes: Outcomes not prespecified, clearly defined, valid, reliable, and assessed consistently: potentially related to detection bias.

Overall risk of bias assessed as **HIGH**, **MODERATE**, or **LOW**.

[A] The study failed to recruit the sample size planned (n=45 recruited vs. n=80 planned)
[B] The study failed to recruit the sample size planned (n=59 recruited vs. n=79 planned)

Key Question 2: Rehabilitation for Total Knee Arthroplasty

Table C-2.1. KQ 2. Design details and arms

Study[A], Year, PMID, Country	Funding Source	Risk of Bias	Eligibility Criteria	Intervention[B]	N, Enrolled	Mean Age, Years (SD)	Female, %	Mean BMI[C] (SD)	Prior Contralateral Athroplasty
Andersen, 2018, CN-01647420, Denmark	NR	High	INCLUSION: Patients who underwent TKR. EXCLUSION: NR	Technological assisted rehabilitation Comp: - AdjMod: - Set: H	155 (all participants)	NR	NR	NR	NR
	No data	No data	No data	Supervised rehabilitation Comp: 0 AdjMod: - Set: O	155 (all participants)	NR	NR	NR	NR
Artz, 2017, 27068368, UK	Non-industry	High	INCLUSION: Patients undergoing a primary TKR for OA were eligible for participation in the study. EXCLUSION: Exclusion criteria included: knee replacement for conditions other than osteoarthritis, revision knee surgery, inability to participate in exercise for any medical reason such as unstable cardiovascular or cardio-respiratory disease, diagnosis of severe neurological disorders, inability to provide informed consent.	6 outpatient group-based exercise sessions Comp: S-A-B-T-E AdjMod: - Set: O	23	70.0 (57, 81)	52%	NR	NR
	No data	No data	No data	Usual care Comp: - AdjMod: - Set: -	23	67.2 (51, 82)	52%	NR	NR
Avramidis, 2011, 21410130, Greece	NR	Moderate	INCLUSION: good mental health, unilateral knee osteoarthritis with Kellgren- Lawrence radiographic severity18 2, and age between 60 and 75 years. EXCLUSION: rheumatoid arthritis, symptomatic osteoarthritis of other big joints of the lower extremities, history of epilepsy, a cardiac pacemaker, poor understanding of the use of the stimulator, and lesions of the skin over the vastus medialis and lateral part of the thigh.	TENS plus Physiotherapy Comp: S-F-T AdjMod: NMES Set: I	38	70.54 (4.68)	80%	27.38 (2.65)	NR

Study[A], Year, PMID, Country	Funding Source	Risk of Bias	Eligibility Criteria	Intervention[B]	N, Enrolled	Mean Age, Years (SD)	Female, %	Mean BMI[C] (SD)	Prior Contralateral Athroplasty
	No data	No data	No data	Physiotherapy Comp: S-F-T AdjMod: - Set: I	38	70.66 (3.73)	83%	27.14 (3.31)	NR
Bade, 2017, 27813347, USA	Non-industry	Moderate	INCLUSION: Patients underwent a primary, unilateral TKA secondary to knee OA and were ages 50-85 years. EXCLUSION: Current smoker, current cancer treatment, uncontrolled diabetes mellitus (glycosylated haemoglobin level .7.0), body mass index .40 kg/m2, neurologic, vascular, or cardiac problems that limited function, discharge to location other than home after surgery (e.g., skilled nursing facility), or severe contra-lateral knee OA (pain level .5 of 10 with stair climbing) or other orthopaedic conditions that limited function and necessitated alternative concurrent intervention (e.g., severe lumbar spinal stenosis, severe hip or ankle OA).	High-intensity progressive rehabilitation Comp: S-A-F-B-T-E AdjMod: Massage, mobilization Set: O, H	84	63 (8)	54%	31 (5)	NR
	No data	No data	No data	Low-intensity rehabilitation Comp: S-A-F-B-T-E AdjMod: Massage, mobilization, heat, cold Set: O, H	78	64 (7)	56%	30 (5)	NR

Study[A], Year, PMID, Country	Funding Source	Risk of Bias	Eligibility Criteria	Intervention[B]	N, Enrolled	Mean Age, Years (SD)	Female, %	Mean BMI[C] (SD)	Prior Contralateral Athroplasty
Bily, 2016, 26763947, Austria	Non-industry	High	INCLUSION: Subjects scheduled for their first TKA. EXCLUSION: Patients who might face a high health risk during maximum strength measurement in the context of this study. Other specific exclusion criteria were body mass index >40kg/m2; previous knee replacement; pain in the contralateral leg >5 VAS recent deep vein thrombosis or any infection; myopathy; neurologic, pulmonary, or symptomatic cardiovascular diseases; vertigo or impaired cognitive function; recent or past cancer; rheumatism; or any other relevant limitations of the musculoskeletal system	Leg-press group Comp: S AdjMod: - Set: O, H	31	68.3 (6.7)	69%	28 (3.8)	NR
	No data	No data	No data	Physiotherapy group Comp: S-F-T AdjMod: Massage, mobilization Set: O, H	31	64.9 (6.0)	65%	28.7 (4.1)	NR
Bruun-Olsen, 2013, 23614370, Norway	Non-industry	Moderate	INCLUSION: Elective primary TKA at two local county hospitals in Norway. OA of the knee according to diagnostic criteria, residence close to the hospitals so as to be able to attend the training sessions. EXCLUSION: Other walking impairments than those related to their operated knee, patients with rheumatoid arthritis, severe osteoarthritis in the hips or contra lateral knee, neurological diseases, dementia, as well as those with a history of drug abuse	Walking-skill group Comp: S-A-F-B-T AdjMod: - Set: O	29	68 (8)	62%	28 (6)	NR
	No data	No data	No data	Usual physiotherapy care Comp: S AdjMod: - Set: O	28	69 (10)	50%	29 (5)	NR

Study[A], Year, PMID, Country	Funding Source	Risk of Bias	Eligibility Criteria	Intervention[B]	N, Enrolled	Mean Age, Years (SD)	Female, %	Mean BMI[C] (SD)	Prior Contralateral Athroplasty
Buhagiar , 2017, 28291891, Australia	Non-industry	Moderate	INCLUSION: >= 40 years with a primary diagnosis of OA and to undergo a primary, unilateral TKA. EXCLUSION: Predisposition to be discharged to an inpatient rehabilitation facility due to lack of social support (lack of an able caregiver); having other major coexisting physical impairments such as hemiplegia or amputation; and unable to perform a home exercise program without support from another person.	Home Program Comp: S-A-F-B-E AdjMod: - Set: H, self-guided	81	66.9 (9)	68%	34.8 (7)	NR
	No data	No data	No data	Hospital Inpatient Rehabilitation Comp: S-A-F-B-E AdjMod: - Set: H	84	66.9 (8)	69%	34.7 (7)	NR
Cai, 2018, 29239772, China	NR	Moderate	INCLUSION: post unilateral TKA for knee OA, >45 years, high level of kinesiophobia based on a score >37 on the Tamps Scale for Kinesiophobia (TSK). EXCLUSION: neurologic disorder, psychiatric or psychological disorder, prior knee surgery, history of patellar luxation, torn meniscus, or ligament injury, scheduled for revision know arthroplasty, had previously participated in a CBT intervention.	Cognitive behavioral therapy (CBT) plus standard care Comp: E AdjMod: mindfulness, stress/anxiety-reduction interventions Set: I	50	65.26 (8.30)	64%	26.52 (2.78)	NR
	No data	No data	No data	Standard care Comp: - AdjMod: - Set: -	50	66.18 (7.04)	60%	26.63 (4.74)	NR
Chan, 2018, 29372260, Singapore[D]	NR	Moderate	INCLUSION: Patients who underwent primary unilateral TKA and had a primary diagnosis of OA. EXCLUSION: Patients who underwent revision TKA or contralateral leg TKA within two years of primary TKA, or did not complete at least six months of follow-up	Discharge to home Comp: - AdjMod: - Set: H	103	67.2 (7.8)	78%	27.9 (4.8)	NR

Study[A], Year, PMID, Country	Funding Source	Risk of Bias	Eligibility Criteria	Intervention[B]	N, Enrolled	Mean Age, Years (SD)	Female, %	Mean BMI[C] (SD)	Prior Contralateral Athroplasty
	No data	No data	No data	Discharge to community hospitals Comp: - AdjMod: - Set: I	1,017	70.7 (7.6)	87%	27.3 (5.0)	NR
DeJong, 2020, 32360105 USA	Industry	High	INCLUSION: (1) had undergone an elective unilateral TKA and initiated outpatient PT ≤24 days post-TKA; (2) ≥40 yo; and (3) weighed less than 300 pounds (due to the weight limitation for the body weight-adjustable treadmill). EXCLUSION: (1) undergone a lower extremity joint replacement procedure, including a revision, second, or bilateral TKA or THA <1 yr prior to their current TKA; (2) whose payer was workers' compensation; (3) who were in litigation related to injury or disease associated with their current TKA; (4) who were pregnant or may be pregnant; (5) who had a medical history of neurologic disorders, RA, or gout (unless <6 mo since last exacerbation or flare up and under control medically); (6) who were under active cancer treatment with history of malignancy in either or both lower extremities, or with evidence of signs or symptoms of cancer, chemotherapy, or radiation <1 yr prior to their current TKA; (7) who developed DVT post-TKA; (8) who were unable to proceed or continue the planned outpatient program because of complications such as wound infection related to the TKA and severe orthostatic hypotension; (9) who required manipulation under anaesthesia post-TKA; and (10) who received >2 wks of other care in another post-acute setting prior to outpatient PT.	Body-weight adjusted treatment Comp: S-F-T Adj: Cold Set: O	76	64.9 (7.7)	58%	31.2 (6.4)	15.4

Study[A], Year, PMID, Country	Funding Source	Risk of Bias	Eligibility Criteria	Intervention[B]	N, Enrolled	Mean Age, Years (SD)	Female, %	Mean BMI[C] (SD)	Prior Contralateral Athroplasty
	No data	No data	No data	Recumbent bike & PENS Comp: S-F Adj: Cold, NMES Set: O	78	62.9 (8.0)	64%	32.2 (6.5)	15.6
	No data	No data	No data	Body-weight adjusted treadmill & PENS Comp: S-F-T Adj: Cold, NMES Set: O	70	62.7 (7.7)	59%	31.4 (5.7)	15.6
	No data	No data	No data	Recumbent bike Comp: S-F Adj: Cold Set: O	74	62.8 (8.3)	58%	31.5 (5.8)	22.8
Demircioglu, 2015, 26355656, Turkey	NR	High	INCLUSION: knee OA who were admitted to the Orthopaedia and Traumatology outpatient clinic for TKA of the Istanbul Physical Medicine and Rehabilitation Training Hospital, Istanbul, Turkey between 01-September-2006 and 01-April-2007. EXCLUSION: Symptomatic hip osteoarthritis, concomitant cardiac or internal diseases precluding surgical treatment, a history of epilepsy, the presence of a pacemaker, a skin lesion over the quadriceps muscle that required electrode application, muscle atrophy, or severe cognitive dysfunction.	NMES & exercise Comp: S-F AdjMod: Cold, NMES, mobilizations Set: O	30	66.2 (7.8)	93%	29.1 (3.9)	NR
	No data	No data	No data	Exercise Comp: S-F AdjMod: cold, mobilization Set: H	30	64.6 (6.6)	97%	30.1 (4.6)	NR
den Hertog, 2012, 22643801, Germany	Industry	Moderate	INCLUSION: Male and female patients (age range 40 85 years), admitted for elective TKA. EXCLUSION: Lack of cooperation capability, American Society of Anaesthesiologists (ASA) score [3, rheumatoid arthritis, cancer co-morbidity, alcohol or drug abuse, previous major surgery on the affected joint, neurologic or psychiatric dis- ease, pregnancy, and participation in other clinical studies	Fast-track rehabilitation program Comp: S-F-T-E AdjMod: - Set: I	74	68.25 (7.91)	73%	30.38 (6.05)	NR

Study[A], Year, PMID, Country	Funding Source	Risk of Bias	Eligibility Criteria	Intervention[B]	N, Enrolled	Mean Age, Years (SD)	Female, %	Mean BMI[C] (SD)	Prior Contralateral Athroplasty
	No data	No data	No data	Standard care Comp: S-F-T AdjMod: - Set: I	73	66.58 (8.21)	69%	31.17 (5.82)	NR
Eymir, 2020, 32778907 Turkey	NR	High	INCLUSION: ≥ 30yo and were scheduled for unilateral primary TKA. EXCLUSION: required urgent intervention, had a previous orthopaedic, neurological, cardiac disorder or surgery that causes gait disturbance, had a BMI greater than 40 kg/m^2, or were planned for bilateral, revision or cementless TKA surgery.	Active heel-slide exercise & standard physical therapy Comp: S-F-T Adj: - Set: AI; H	58	68.9 (8.9)	85%	31.6 (4.5)	NR
	No data	No data	No data	Continuous passive motion & standard physical therapy Comp: S-F-T Adj: - Set: AI; H	55	68.9 (8.3)	91%	31.3 (4.3)	NR
Fransen, 2017, 27868384, Australia	Non-industry	Moderate	INCLUSION: 45 74 years, undergoing unilateral or bilateral primary TKR, and able to be discharged home from the orthopedic ward. EXCLUSION: Previous unicompartmental replacement or tibial osteotomy on the same knee, major comorbidity precluding aerobic exercise at 50 60% maximum heart rate, or a diagnosis of rheumatoid arthritis or a major neurologic condition.	Outpatient group exercise Comp: S-A-F-T-E AdjMod: - Set: O, H	210	64 (6.5)	54%	32.2 (5.6)	13%
	No data	No data	No data	Usual care Comp: - AdjMod: - Set: O, H	212	65.2 (6)	52%	31.7 (6.7)	17%

Study[A], Year, PMID, Country	Funding Source	Risk of Bias	Eligibility Criteria	Intervention[B]	N, Enrolled	Mean Age, Years (SD)	Female, %	Mean BMI[C] (SD)	Prior Contralateral Athroplasty
Hamilton, 2020, 33051212, UK	Non-industry	Moderate	INCLUSION: have undergone a primary TKA for OA, at risk for a poor outcome (defined as Oxford knee score ≤26 points completed at 6 wks postoperative assessment). EXCLUSION: unwilling to comply rehabilitation protocols, underwent arthroplasty purely for pain relief (ie, those with no expectation of mobilising postoperatively),required complex revision procedures, could not, or were unwilling to, attend their local outpatient department for rehabilitation, or had already received structured ongoing outpatient physiotherapy at six weeks post-surgery.	Outpatient therapist-led rehabilitation Comp: S-F-E AdjMod: - Set: H	163	66.8 (6.49)	59%	31.19 (5.30)	NR
	No data	No data	No data	Physiotherapy review & home exercises (standard of care) Comp: S-A-F-B-T-E AdjMod: - Set: O, H	171	68.2 (9.44)	62%	31.50 (6.18)	NR
Harmer, 2009, 19177536, Australia	Non-industry	Moderate	INCLUSION: Primary TKR. EXCLUSION: Postoperative deep joint infection, bilateral joint surgery or surgery planned for another joint within 6 months, and documented dementia or other neurologic condition that precluded informed consent	Water-based rehabilitation Comp: S-A-F-E AdjMod: - Set: H	53	68.7 (9.1)	57%	31.6 (5.8)	NR
	No data	No data	No data	Land-based rehabilitation Comp: F-B-E AdjMod: - Set: O, H	49	67.8 (6.3)	57%	30.6 (5)	NR

Study[A], Year, PMID, Country	Funding Source	Risk of Bias	Eligibility Criteria	Intervention[B]	N, Enrolled	Mean Age, Years (SD)	Female, %	Mean BMI[C] (SD)	Prior Contralateral Athroplasty
Heikkilä, 2017, 28119232, Finland	NR	High	INCLUSION: 1) diagnosed knee OA, 2) primary arthroplasty of the knee in question, and 3) age over 18 years. EXCLUSION:) other surgery for lower limbs planned to be carried out within 12 months, 2) dementia, 3) other serious co-morbidities preventing active training, and 4) difficulty in visiting a physiotherapist due to long travelling distance.	Home exercise Comp: S-F-B-E AdjMod: - Set: H, O	51	69 (8)	57%	Missing	28%
	No data	No data	No data	Control Comp: - AdjMod: - Set: -	53	Missing?	65%	69 (8)	31%
Iwakiri, 2020, 32373475 Japan	NR	High	INCLUSION: Unilateral TKAs EXCLUSION: Patients with renal insufficiency, a history of cardiac disease, deep vein thrombosis, or surgery of the knee joint; patients who were scheduled for simultaneous or staged bilateral TKA or for revision TKA.	Range of motion (post op day 1) Comp: F-T AdjMod: - Set: AI; H	55	75.0 (7.3)	82%	24.5 (4.2)	NR
	No data	No data	No data	Range of motion (post op day 7) Comp: F-T AdjMod: - Set: AI	54	75.6 (6.2)	82%	25.2 (3.7)	NR
Jin, 2018, CN-01617489, China	NR	High	INCLUSION: OA, unilateral TKA for the first time, informed content was obtained. EXCLUSION: Overweight (BMI>/= 30 kg/m2), severe osteoporosis, ligament injury or periprosthetic fracture occurring during TKA, Unstable vital signs, complications of incision healing, or clot formation in leg veins, Vision loss, hearing loss, or functional illiteracy.	VR plus usual care Comp: S-F-E AdjMod: biofeedback, mindfulness, stress reduction interventions Set: I	33	66.45 (3.49)	55%	24.52 (2.27)	NR
	No data	No data	No data	Usual care Comp: S-F-E AdjMod: mindfulness, dstress reduction interventions Set: I	33	66.30 (4.41)	61%	24.97 (2.52)	NR

Study[A], Year, PMID, Country	Funding Source	Risk of Bias	Eligibility Criteria	Intervention[B]	N, Enrolled	Mean Age, Years (SD)	Female, %	Mean BMI[C] (SD)	Prior Contralateral Athroplasty
Kauppila, 2010, 20354057, Finland	Non-industry	Moderate	INCLUSION: (1) diagnosis of primary osteoarthritis of the knee; (2) 60 80 years of age; and (3) primary unilateral total knee arthroplasty as a scheduled procedure. EXCLUSION: (1) severe cardiovascular or pulmonary disease (New York Heart Association III IV), (2) severe dementia (Mini-Mental State Examination 518),19 (3) rheumatoid arthritis, (4) primary total knee arthroplasty scheduled as treatment of an acute trauma of the knee, (5) planned use of a special endoprosthesis, and (6) major postoperative complication as a contraindication for intensive rehabilitation	Multidisciplinary rehabilitation Comp: S-A-F-T-E AdjMod: mindfulness, stress and anxiety reduction interventions Set: I, O, H	36	70.7 (5.7)	76%	32.9 (6.8)	18.2%
	No data	No data	No data	Control Comp: S-F-T-E AdjMod: - Set: I, O, H	39	70.6 (5.3)	79%	32 (4.4)	16.7%
Lenguerrand, 2020, 31033232, UK	Non-industry	Moderate	INCLUSION: National Health Services patients >= 18 years who are listed for primary TKR due to OA.EXCLUSION: Patients listed for TKR for reasons other than OA, patients listed for revision TKR, inability to participate in exercise for medical reasons such as unstable cardiovascular or severe neurological conditions, unable or unwilling to attend physiotherapy classes after surgery, post-operative complication(s) or interventions within the first 2 weeks.	Group-based outpatient physical therapy and standard care Comp: S-A-F-B-T-E AdjMod: - Set: O	89	69 (9)	56%	NR	NR
	No data	No data	No data	Standard care Comp: - AdjMod: - Set: NA	91	69 (9)	54%	NR	NR
Lenssen, 2006, 16942627, Netherlands	NR	Moderate	INCLUSION: scheduled in the 'Joint Care' program and signed an informed consent form. EXCLUSION: >85 years, comorbidity influencing gait, patients who did not speak dutch	Physiotherapy [twice daily (40 mins/day)] Comp: S-F-T AdjMod: - Set: I	21	70 (8.5)	71%	NR	NR

Study[A], Year, PMID, Country	Funding Source	Risk of Bias	Eligibility Criteria	Intervention[B]	N, Enrolled	Mean Age, Years (SD)	Female, %	Mean BMI[C] (SD)	Prior Contralateral Athroplasty
	.	.	.	Physiotherapy [once daily (20 mins/day)] Comp: S-F-T AdjMod: - Set: I	22	67 (7)	77%	NR	NR
Li, 2014, 23412304, China	Non-industry	High	INCLUSION: (1) no neural or muscular system disease, (2) unilateral OA knee joint TKR, and (3) able to walk safely and independently and functional ambulation (FAC) score C 3. EXCLUSION: (1) mental disease, dementia, and intelligence impairment before OA and a history of cerebral organic disease and of mental disorders (mini mental state evaluation score \ 23), (2) cardiopulmonary functional lability, (3) serious cardiac and renal dysfunction and hemopathicactive peptic ulcer, and (4) other medical and surgical diseases which may lead to hemorrhage	Robot-assisted training Comp: S-F-T AdjMod: NMES Set: I	60 (all participants)	NR	NR	NR	NR
	No data	No data	No data	Traditional rehabilitation training Comp: S-F-T AdjMod: NMES Set: I		NR	NR	NR	NR
Li, 2015, CN-01084888, China	NR	High	INCLUSION: Age between 55 and 75; the diagnosis was knee osteoarthritis with the Kellgren/Lawrence grade 4; the body mass index (BMI) was less than 35; affected by the unilateral knee OA undergoing primary knee TKA; living in Beijing. EXCLUSION: Infectious joint diseases; hip joint disease or ankle joint disease which affected the daily physical activities; comorbidities such as chronic obstructive pulmonary disease which affected the daily physical activities	Functional plus balance rehabilitation Comp: E AdjMod: - Set: H	25	71.43 (6.33)	75%	27.88 (5.02)	NR
	No data	No data	No data	No education Comp: - AdjMod: - Set: -	25	73.40 (7.04)	65%	26.97 (4.15)	NR

Study[A], Year, PMID, Country	Funding Source	Risk of Bias	Eligibility Criteria	Intervention[B]	N, Enrolled	Mean Age, Years (SD)	Female, %	Mean BMI[C] (SD)	Prior Contralateral Athroplasty
Li, 2017, CN-01419703, China	NR	Moderate	INCLUSION: (1) Patients undergoing TKR for the first time with a unilateral knee joint; (2) The surgery of the patients was performed by the same group of doctors and the same anesthesiologist, and the same manufacturer and the same material prosthesis were selected; (3) Other factors such as trauma, arthritis and other diseases were excluded; (4) Patients and their families indicate good medical compliance and strong willingness to participate. EXCLUSION: (1) Patients with sequelae of cerebrovascular disease; (2) Mental illness and intellectual disability cannot cooperate; (3) Patients with severe liver, kidney, heart, and lung insufficiency, tumors; (4) TKR has joint infection, joint tuberculosis or acute, Chronic osteomyelitis, or combined with serious medical diseases that restrict walking, and other joint diseases of the lower extremities cause severe deformities and restricted mobility	Gait training & usual care Comp: S-F-B-T AdjMod: Cold, massage for edema control Set: I	24	76.33 (5.28)	56%	NR	NR
	No data	No data	No data	Usual care Comp: S-F-B AdjMod: Cold, massage for edema control Set: I	22	78.47 (5.50)	51%	NR	NR

Study[A], Year, PMID, Country	Funding Source	Risk of Bias	Eligibility Criteria	Intervention[B]	N, Enrolled	Mean Age, Years (SD)	Female, %	Mean BMI[C] (SD)	Prior Contralateral Athroplasty
Li, 2019, 31003647, China	Non-industry	Moderate	INCLUSION: (a) clinical and radiographic evidence diagnosed with end- stage knee OA according to the diagnosis criteria and scheduled for primary unilateral TKA surgery; (b) 65-74 years of age; (c) no history of significant cardiovascular, pulmonary, metabolic, musculoskeletal, or other chronic diseases; (d) fully informed consent about the program; (e) a partner to oversee the entire exercise process to ensure safety; and (f) a normally active lifestyle. EXCLUSION: (a) a history of knee infection, a lesion involving bilateral knees, or any intra-articular hyaluronic acid injections in the 6 months prior to assessment; (b) serious medical conditions that limited his/her ability to safely participate in either the TCC or physical therapy programs; (c) inability to walk at least 150 m in 6 min due to some serious diseases (e.g., epilepsy, diminished mental capabilities); (d) previous experience with TCC or exercised regularly with other similar types of complementary and alternative medicine such as qi gong or yoga; or (e) inability to complete the study (e.g., not Chinese-speaking or intended to move out of the region)	Tai chi exercise Comp: S-F AdjMod: complementary and alternative therapies Set: NR	64	69.6 (4.3)	52%	23.7 (3.6)	NR
	No data	No data	No data	Control (traditional physical exercises) Comp: S-F AdjMod: - Set: NR	65	68.5 (3.5)	55%	24.2 (2.9)	NR
Liao, 2015, 25552523, Taiwan	Non-industry	High	INCLUSION: OA. EXCLUSION: NR	Functional rehabilitation & balance training Comp: S-A-F-B-T AdjMod: - Set: O	53	71.43 (6.33)	75%	27.88 (5.02)	NR

Study[A], Year, PMID, Country	Funding Source	Risk of Bias	Eligibility Criteria	Intervention[B]	N, Enrolled	Mean Age, Years (SD)	Female, %	Mean BMI[C] (SD)	Prior Contralateral Athroplasty
	No data	No data	No data	Functional rehabilitation Comp: S-A-F-T AdjMod: - Set: O	55	73.40 (7.04)	65%	26.97 (4.15)	NR
Liao, 2020, 31687984, Taiwan	Non-industry	Moderate	INCLUSION: (a) older women aged 60 and 85 yrs, (b) radiological diagnosis of KOA (Kellgren and Lawrence grade III or higher), and (c) scheduled to undergo a primary TKR. EXCLUSION: (a) uncontrolled hypertension, (b) any cardiovascular or pulmonary disease that would prevent them from engaging in an exercise study, and (c) neurological or cognitive impairment that may interfere with compliance with and adherence to a home-based exercise program.	Elastic resistance exercise training Comp: S-F AdjMod: - Set: O, H	28	72.22 (7.75)	100%	28.54 (3.88)	NR
	No data	No data	No data	Standard care Comp: - AdjMod: - Set: NR	27	69.79 (6.72)	100%	27.25 (4.36)	NR
Liebs, 2010, 20360503, Germany	Non-industry	Moderate	INCLUSION: Primary unilateral TKR on an elective basis after a diagnosis of OA or osteonecrosis. EXCLUSION: History of septic arthritis, a hip or knee fracture, an intraoperative complication, revision arthroplasty, RA, (6) lower extremity amputation, a malignant tumor. NB. Knee population reported here	Ergometer cycling Comp: S-F-B-T AdjMod: - Set: O	85	69.7 (8)	62%	29.7 (4.8)	NR
	No data	No data	No data	Control Comp: S-F-B-T AdjMod: - Set: O	74	69.9 (7.8)	52%	29.2 (4.4)	NR
Liebs, 2012, 22196125, Germany	Non-industry	Moderate	INCLUSION: Unilateral hip or knee replacement surgery at participating centers on an elective basis after diagnosis of OA. EXCLUSION: History of septic arthritis, hip or knee fracture, intraoperative complications, revision arthroplasty, RA, amputations, malignancy	Early aquatic therapy Comp: S-F-B-T AdjMod: - Set: O	66	68.5 (8.6)	61%	29.3 (5)	NR

Study[A], Year, PMID, Country	Funding Source	Risk of Bias	Eligibility Criteria	Intervention[B]	N, Enrolled	Mean Age, Years (SD)	Female, %	Mean BMI[C] (SD)	Prior Contralateral Athroplasty
	No data	No data	No data	Late aquatic therapy Comp: S-F-B-T AdjMod: - Set: O	69	70.9 (7.5)	72%	29.3 (4.6)	NR
Madsen, 2013, 23651717, Denmark	Non-industry	High	INCLUSION: 1) age 18 years or more, 2) primary TKA for osteoarthritis, 3) patient living in one of three municipalities, 4) patient able to travel to the rehabilitation centre independently. EXCLUSION: 1) neuromuscular or neurodegenerative diseases, 2) knee infection after TKA or other major complications (e.g. loosening or embolism excluding superficial thrombophlebitis), 3) problems related to mobility, muscle strength or excessive pain preventing the patient from following the rehabilitation program, 4) patient unable to understand the instructions due to dementia or language problems	Group-based rehabilitation Comp: S-A-F-B-E AdjMod: Set:O, H	47	66.9 (8.5)	47%	NR	NR
	No data	No data	No data	Supervised home-exercises Comp: S-A-B-E AdjMod: - Set: O, H	50	66.2 (8.2)	50%	NR	NR
Minns Lowe, 2012, 22180446, UK	No industry	High	INCLUSION: Patients undergoing elective primary total knee arthroplasty for OA. EXCLUSION: Bilateral arthroplasty, planned unicompartmental prosthesis, minimally invasive surgery, planned further joint surgery within 12 months, inflammatory arthritis, existing comorbidities preventing participation in treatment	Home-visit physiotherapy Comp: S-F-B-T AdjMod: - Set: H	56	67.84 (8.45)	57%	31.32 (6.28)	38.2%
	No data	No data	No data	Usual care Comp: - AdjMod:- Set:-	51	70.76 (9.45)	59%	29.27 (5.82)	43.1%

Study[A], Year, PMID, Country	Funding Source	Risk of Bias	Eligibility Criteria	Intervention[B]	N, Enrolled	Mean Age, Years (SD)	Female, %	Mean BMI[C] (SD)	Prior Contralateral Athroplasty
Mitchell, 2005, 15869558, UK	Non-industry	High	INCLUSION: primary unilateral TKA for OA. EXCLUSION: revision TKA, bilateral and unicondylar knee replacements, TKA for trauma, onset of serious comorbidity or terminal illness since patient placed on the waiting list, contralateral knee replacement within the preceding 12 months	Home rehabilitation Comp: F-T AdjMod: Massage Set: H	80	70.0 (7.2)	63%	NR	15.8%
	No data	No data	No data	Hospital rehabilitation Comp: F-T AdjMod: - Set: O	81	70.6 (8.2)	53%	NR	26.4%
Moffet, 2015, 26178888, Canada	Non-industry	Moderate	INCLUSION: Waiting for a primary TKA after a diagnosis of OA, returning home after hospital discharge, living in an area served by high-speed Internet services (at least 512 kb/s in upload), and living within a 1-hour driving distance from the treating hospital. EXCLUSION: Health conditions that could interfere with tests or the rehab program, including other lower-limb surgery in the last 9 months; were planning a second lower-limb surgery within 4 months; had cognitive or collaboration problems; had major post-op complications; or had weight-bearing restrictions for a period longer than 2 weeks after surgery.	In-home telerehabilitation Comp: S-B-T-E AdjMod: - Set: H	104	65 (8)	58%	34 (7)	NR
	No data	No data	No data	Standard home rehabilitation Comp: S-T-E AdjMod: - Set: H	101	67 (8)	45%	33 (6)	NR

Study[A], Year, PMID, Country	Funding Source	Risk of Bias	Eligibility Criteria	Intervention[B]	N, Enrolled	Mean Age, Years (SD)	Female, %	Mean BMI[C] (SD)	Prior Contralateral Athroplasty
Monticone, 2013, 23063624, Italy	NR	Moderate	INCLUSION: Primary TKA because of knee OA performed 7 to 10 days before admission to our rehabilitation unit, a good understanding of Italian, and aged >50 years. EXCLUSION: Cognitive impairment and all other causes of knee pain, such as previous lower limb surgery, infection, fracture, osteonecrosis or malignancy, and systemic or neuromuscular diseases. Any subjects receiving compensation for work-related disabilities or who had previously participated in a cognitive-behavioural intervention	Home-based functional exercises and kinesiophobia training Comp: S-F-B-T-E AdjMod: mindfulness, stress, anxiety reduction interventions Set: H, I	55	67 (6.1)	66%	28 (3.4)	NR
	No data	No data	No data	Usual care Comp: S-F-B-T AdjMod: - Set: I	55	68 (7.1)	62%	28.3 (5)	NR
Moutzouri, 2018, 29473481, Greece	Non-industry	Moderate	INCLUSION: Participants were that they had elected to undergo primary unilateral total knee replacement as a result of advanced osteoarthritis and they had been ambulatory at the time of surgery. EXCLUSION: (a) neurological conditions; (b) vestibular disorders that might affect balance; (c) other lower extremity orthopaedic problems	Early self-managed focal sensorimotor rehabilitative training Comp: S-A-F-B-T AdjMod: - Set: H	26	71.3 (5.3)	NR	NR	NR
	No data	No data	No data	Functional exercise training Comp: S-A-F-T AdjMod: - Set: H	25	72.3 (5.6)	NR	NR	NR
Naylor, 2017, 28899328, Australia	Non-industry	High	INCLUSION: awaiting arthroplasty secondary to OA, primary TKA, private insurance. EXCLUSION: patients referred to inpatient rehabilitation because of slow progress, and those who had conditions that would alter their typical recovery and rehabilitation pathway, such as simultaneous bilateral surgeries, as well as those who experienced a significant complication within 90 days of surgery	Inpatient rehabilitation Comp: - AdjMod: - Set: I	185	68.9 (8.9)	37%	30.6 (5.9)	NR

Study[A], Year, PMID, Country	Funding Source	Risk of Bias	Eligibility Criteria	Intervention[B]	N, Enrolled	Mean Age, Years (SD)	Female, %	Mean BMI[C] (SD)	Prior Contralateral Athroplasty
	No data	No data	No data	No inpatient rehabilitation Comp: - AdjMod: - Set: NR (assumed home)	147	67.2 (7.3)	51%	30.7 (5.1)	NR
Padgett, 2018, 29352683, USA[D]	NR	Moderate	INCLUSION: Patients undergoing primary unilateral TKA with a diagnosis of osteoarthritis with or without inflammatory disorders. EXCLUSION: Patients with a diagnosis of post-traumatic osteoarthritis	Discharged to home Comp: - AdjMod: - Set: H	1213	NR	NR	NR	NR
	No data	No data	No data	Discharged to long term care facility Comp: - AdjMod:- Set: I	1213	NR	NR	NR	NR
	No data	No data	No data	Discharged to inpatient rehabilitation Comp: - AdjMod:- Set: I	492	NR	NR	NR	NR
Petersen, 2018, 29294078, Netherlands	Non-industry	Moderate	INCLUSION: Hemi, or total, knee replacement and 18 70 years. EXCLUSION: Serious medical conditions that would influence rehabilitation (i.e., hip dysfunction, myocardial diseases, or inflammatory arthritis), current use of anticoagulants, infection	Exercise & acupuncture Comp: S-A-F-B-T AdjMod: Dry needling Set: O	87	56 (8)	56%	NR	NR
	No data	No data	No data	Exercise Comp: S-A-F-B-T AdjMod: - Set: O	85	56 (6.8)	61%	NR	NR

Study[A], Year, PMID, Country	Funding Source	Risk of Bias	Eligibility Criteria	Intervention[B]	N, Enrolled	Mean Age, Years (SD)	Female, %	Mean BMI[C] (SD)	Prior Contralateral Athroplasty
Petterson, 2009, 19177542, USA	Non-industry	High	INCLUSION: Ages 50-85 years scheduled to undergo unilateral TKA. EXCLUSION: 1) uncontrolled hypertension, 2) diabetes, 3) body mass index (BMI) 40 kg/m2 (20), 4) symptomatic OA in the contralateral knee (defined as self-reported knee pain >4 on a 10-point verbal analog scale), 5) other lower extremity orthopedic problems limiting function, 6) neurologic impairment, or 7) a residence outside of a 20-mile radius of the clinic	Exercise & NMES Comp: S-F-T AdjMod: NMES, massage, mobilizations Set: O	100	65.3 (8.3)	47%	29.67 (4.85)	NR
	No data	No data	No data	Exercise Comp: S-F-T AdjMod: Massage, mobilizations Set: O	100	65.2 (8.5)	45%	29.99 (3.90)	NR
Piqueras, 2013, 23474735, Spain	Industry	Moderate	INCLUSION: Successful primary TKA surgery; post-TKA active range of motion: flexion 80 degrees and extension 10 degrees, without signs of stiffness; ability to walk with the use of a walking aid. EXCLUSION: Sensory, cognitive and/or praxic impairment; concomitant medical conditions that may influence the rehabilitation process; discharge to destination other than home; patients with any local or systemic complication (e.g. surgical wound infection, suspicion of deep vein thrombosis) in the 3 month follow-up period	Interactive virtual telerehabilitation system Comp: S-F-T-E AdjMod: - Set: H	72	NR	63%	NR	NR
	No data	No data	No data	Conventional outpatient physical therapy Comp: S-F-T AdjMod: - Set: I, O	70	NR	83%	NR	NR

Study[A], Year, PMID, Country	Funding Source	Risk of Bias	Eligibility Criteria	Intervention[B]	N, Enrolled	Mean Age, Years (SD)	Female, %	Mean BMI[C] (SD)	Prior Contralateral Athroplasty
Piva, 2017, 28217891, USA	Non-industry	Moderate	INCLUSION: Subjects who were ages 50 years, had unilateral TKR done 3 to 6 months prior to starting the study, had medical clearance from the knee surgeon to participate in the study, and were English speakers. EXCLUSION: Bilateral or revision TKR, previous hip or ankle joint replacement, regular participation in exercise programs (>2 times a week), inability to ambulate 30 meters without an assistive device, 2 or more falls within the past year, acute illness, severe visual impairment, lower-leg amputation, uncontrolled diabetes mellitus, and other neurologic, muscular, and cardiovascular diseases that could confound the results or prevent safe exercise participation	Comprehensive behavioral intervention Comp: S-A-F-B-T-E AdjMod: - Set: O, H	22	68.1 (7.5)	82%	31.2 (3.6)	NR
	No data	No data	No data	Standard care exercise Comp: S-A-F-E AdjMod: - Set: O, H	22	68.3 (5.5)	59%	29.3 (4.1)	NR
Piva, 2019, 30794296, USA	Non-industry	Moderate	INCLUSION: Unilateral primary TKR, >= 60 years, TKR 2-4 mo before screening, moderate functional limitations defined by a WOMAC-PF >=9, medical clearance to exercise. EXCLUSION: Contraindications to exercise, neuromuscular disorders of the lower extremities, inability to independently walk 50 m, terminal illness, intent to undergo another TKR.	Community-based exercise group Comp: S-A-F-B-T AdjMod: - Set: Gym, community centre	96	70 (7)	60%	31.3 (6.3)	NR
	No data	No data	No data	Clinic-based individual physical therapy exercise Comp: S-A-B-T-E AdjMod: - Set: O	96	69 (6)	62%	30.8 (5.3)	NR
	No data	No data	No data	Standard care Comp: - AdjMod: - Set: -	48	70 (7)	65%	31.5 (5.1)	NR

Study[A], Year, PMID, Country	Funding Source	Risk of Bias	Eligibility Criteria	Intervention[B]	N, Enrolled	Mean Age, Years (SD)	Female, %	Mean BMI[C] (SD)	Prior Contralateral Athroplasty
Pua, 2017, 27810379, Singapore[D]	Non-industry	Moderate	INCLUSION: Patients age >/=50 years who underwent a primary TKA and were discharged home non-missing follow-up (6 months). EXCLUSION: Patients who had a history of rheumatoid arthritis and patients with stroke or Parkinson's disease	Rehabilitation attendance: two or more sessions Comp: S-A-F-B-T-E AdjMod: cold, NMES Set: O	1386	67.1 (7.5); Median SUBVALUE(66.8)	76%	27.3 (4.4)	NR
	No data	No data	No data	Rehabilitation attendance: once Comp: S-A-F-B-T-E AdjMod: cold, NMES Set: O	86	70 (7.3); Median SUBVALUE(71.2)	77%	28.5 (4.9)	NR
	No data	No data	No data	Rehabilitation attendance: none Comp: - AdjMod: - Set: -	68	70.8 (8.1); Median SUBVALUE(71.5)	74%	27 (4.9)	NR
Rockstroh, 2010, 20533147, Germany	Industry	High	INCLUSION: age <= 85; had TKA and were treated with inpatient rehab at the Klinik Bavaria Kreischa. EXCLUSION: people with thrombosis, cardiopulmonary insufficiency, tumors, infections, skin diseases, rheumatism, alcohol or drug abuse, ongoing pension request, patients on diuretics, a reduced calorie diet, or lymphatic drainage, or those with mental or speech problems.	Physiotherapy & microcurrent Comp: S-F-T AdjMod: TENS Set: I	44	60)	NR	NR	NR
	No data	No data	No data	Physiotherapy Comp: S-F-T AdjMod: - Set: I	45	57)	NR	NR	NR

Study[A], Year, PMID, Country	Funding Source	Risk of Bias	Eligibility Criteria	Intervention[B]	N, Enrolled	Mean Age, Years (SD)	Female, %	Mean BMI[C] (SD)	Prior Contralateral Athroplasty
Sattler, 2019, 30994586, Australia	NR	Moderate	INCLUSION: Patients >/=18 years of age who were scheduled to undergo uni- lateral TKR for a primary diagnosis of osteoarthritis were eligible for inclusion. EXCLUSION: Patients were excluded if they (1) preoperatively planned to be discharged to an inpatient rehabilitation/hostel facility such that the home exercise program could not be completed independently, (2) declined to participate, or (3) were scheduled for a contralateral TKR within 4 months of the initial procedure.	Pedaling-based protocol Comp: F-T AdjMod: - Set: NR	30	66.0 (8.7)	40%	29.4 (4.4)	NR
	No data	No data	No data	Non-pedalling (multi-exercise protocol) Comp: S-F-T AdjMod: - Set: -	30	66.8 (6.7)	27%	29.3 (4.3)	NR
Schache, 2019, 31208916, Australia	NR	Moderate	INCLUSION: >=50 years and had undergone primary unilateral TKA for end-stage OA in the previous 2 weeks. EXCLUSION: Uncontrolled cardiovascular disease or uncontrolled diabetes; a history of ipsilateral hip replacement, ipsilateral hip OA or lateral hip pain; or neurological or any other conditions affecting strength or function of the lower limbs.	Standard rehab and hip strengthening exercises Comp: S-A-F-B-T-E AdjMod: massage, mobilization Set: I, O	54	70 (7)	72%	30 (6)	NR
	No data	No data	No data	Standard rehab plus general functional exercise Comp: S-A-F-B-T-E AdjMod: massage, mobilizations Set: I, O	51	69 (7)	58%	31 (6)	NR
Shanb, 2014, CN-01041112, Saudi Arabia	NR	High	INCLUSION: 58-67 years, cemented fixed and bore non constrained prosthesis, BMI<30, moderate activity. EXCLUSION: previous knee surgery with post op complications	Active exercise training program & biofeedback Comp: S AdjMod: mobilization, biofeedback devices Set: O	50 (all participants)	60.00 (0.89)	38%	25.28 (0.44)	NR

Study[A], Year, PMID, Country	Funding Source	Risk of Bias	Eligibility Criteria	Intervention[B]	N, Enrolled	Mean Age, Years (SD)	Female, %	Mean BMI[C] (SD)	Prior Contralateral Athroplasty
	No data	No data	No data	Active exercise training program Comp: S AdjMod: mobilization Set: O		60.6 (5.08)	30%	26.18 (0.45)	NR
Stevens-Lapsley, 2012, 22095207, USA	Non-industry	Moderate	INCLUSION: 50-85 years. EXCLUSION: Uncontrolled hypertension, uncontrolled diabetes, BMI > 35 kg/m2, significant neurologic impairments, contralateral knee OA (as defined by pain > than 4/10 with activity), or other unstable lower-extremity orthopaedic conditions.	Standard rehabilitation & NMES Comp: S-A-F-B-T-E AdjMod: cold, NMES, massage, mobilization Set: I, H, O	35	66.2 (9.1)	57%	27.1 (4.9)	NR
	No data	No data	No data	Standard rehabilitation Comp: S-A-F-B-T-E AdjMod: cold, massage, mobilization Set: I, H, O	31	64.8 (7.7)	52%	31.2 (4.2)	NR
Tousignant, 2011, 21398389, Canada	Non-industry	High	INCLUSION: Patients who had TKA. EXCLUSION: NR	Home telerehabilitation Comp: E AdjMod: - Set: H	21	66 (10)	NR	NR	NR
	No data	No data	No data	Conventional rehabilitation Comp: E AdjMod: - Set: O	20	66 (13)	NR	NR	NR
Tsukada, 2020, 31723080, Japan	Non-industry	Moderate	INCLUSION: unilateral TKA for knee OA, female, >50 years. EXCLUSION: lower limb amputation, lower limb surgery in the last 3 months, inability to walk without a cane or walker, inflammatory joint, rheumatoid, psoriatic arthritis, polymyalgia rheumatic, multiple sclerosis, neurodegenerative disorder, known neuropathy, uncontrolled diabetes, currently being treated for cancer, terminal illness, h/o myocardial infarction, use of supplemental oxygen, implanted cardiac pacemaker	Standard rehabilitation & hybride training system Comp: S-A-F-T-E AdjMod: cold, NMES Set: I	26	72.8 (8.2)	-	27.0 (4.7)	NR

Study[A], Year, PMID, Country	Funding Source	Risk of Bias	Eligibility Criteria	Intervention[B]	N, Enrolled	Mean Age, Years (SD)	Female, %	Mean BMI[C] (SD)	Prior Contralateral Athroplasty
	No data	No data	No data	Standard rehabilitation Comp: S-A-F-T-E AdjMod: cold Set: I	27	74.1 (8.6)	-	27.2 (4.6)	NR
Vuorenmaa, 2014, 24241606, Finland	Non-industry	Moderate	INCLUSION: (i) diagnosed knee OA; (ii) primary arthroplasty of the knee in question; and (iii) age over 18 years. EXCLUSION: (i) other surgery for the lower limbs planned to be performed within 12 months; (ii) dementia; (iii) fibro- myalgia; (iv) other serious co-morbidities preventing active training; and (v) difficulty visiting a physiotherapist due to a long travelling distance.	Home exercise Comp: S-F-E AdjMod: - Set: O, H	53	69 (8)	57%	31 (5)	28%
	No data	No data	No data	Control Comp: - AdjMod: - Set: H	55	69 (9)	65%	31 (6)	31%
Zapparoli, 2020, 32488010 Italy	Non-Industry	High	INCLUSION: (1) age comprised between 45 and 80 years old, (2) being enrolled in the local residential rehabilitation program. EXCLUSION: (1) presence of neurologic or neurodegenerative diseases, (2) on-going psychopharmacological treatments.	Motor imagery & rehabilitation Comp: S-F-B AdjMod: Mindfulness Set: AI	24	66.2 (8.0)	46%	38.4 (6.6)	NR
	No data	No data	No data	Rehabilitation Comp: S-F-B AdjMod: - Set: AI	24	66.6 (7.5)	71%	31.4 (6.7)	NR

Abbreviations: AI = acute inpatient, BMI = body mass index, DVT = deep vein thrombosis, H = home, mo = month, NA = not applicable, NMES = neuromuscular electrical stimulation, NR=not reported, O = outpatient physiotherapy center, OA = osteoarthritis, PMID = PubMed identifier, RA = rheumatoid arthritis, SD = standard deviation, SD = standard deviation, TENS = transcutaneous electrical nerve stimulation, THA = total hip arthroplasty, TJA = total joint arthroplasty, TKA = total knee arthroplasty, wks = weeks, yo = years old, yr = year.

A All randomized controlled trials, except as footnoted.
B Including Components (Comp); Adjunctive modalities (AdjMod); and Setting (Set).
Components: A = aerobic exercise, B= Balance-motor/Learning-agility exercise, E = patient education, F = flexibility exercise, S = strengthening exercise, T = task-specific training.
C kg/m^2
D Non-randomized controlled study

Table C-2.2. KQ 2. Rehabilitation component details

Study, Year, PMID, Country	Intended Comparison	Arm	Components (Specific Exercises/Strategies)	Progression (Appropriate?)	Personnel	Mode of Delivery	Setting
Andersen, 2018, CN-01647420, Denmark	Technological assisted rehabilitation vs. supervised rehabilitation (usual care) [Abstract only]	Technological assisted rehabilitation	[specific goals and exercises not defined; comparison of setting and method of delivery]	0 (NA)	Unclear	Unclear	Home
	No data	Supervised rehabilitation	[specific goals and exercises not defined; comparison of setting and method of delivery]	0 (NA)	Physical therapist	In-person	Physical therapy/rehabilitation facility (outpatient)
Artz, 2017, 27068368, UK	Group-based outpatient physiotherapy vs. usual care	Group-based exercise	**1. Strength** [specific exercises not defined] **2. Aerobic** [specific exercises not defined] **4. Balance-Motor Learning-Agility** [specific exercises not defined] **5. Task specific training** [specific exercises not defined] **6. Patient education** 6.2 Home exercise program	0 (NA)	Physical therapist	In-person	Physical therapy/rehabilitation facility (outpatient)
	No data	Usual care	NA [Routine post-operative care provided by the health service including an exercise booklet and individual referral to physiotherapy if indicated]	0 (NA)	NA	NA	NA
Avramidis, 2011, 21410130, Greece	Electric stimulation of the vastus medialis muscle and standard physiotherapy vs. physiotherapy only	Physiotherapy & electrical muscle stimulation	**1. Strength** 1.31 Knee extension in sitting or supine (long arc quad) (long or short unclear) 1.32 Knee extension in sitting or supine (short arc quad) (long or short unclear) 1.43 Quad sets 1.58 Straight leg raise **3. Flexibility** 3.4 Calf stretch with knee straight (gastroc) 3.11 Knee extension PROM in supine (position unclear) 3.12 Knee extension PROM in prone (position unclear) **5. Task specific training** 5.8 Gait training **7. Adjunctive modality** 7.5 E-stim for strength (NMES)	Y (N)	NR	In-person	Acute Inpatient; Physical therapy/rehabilitation facility (outpatient)
	No data	Physiotherapy	**1. Strength** 1.31 Knee extension in sitting or supine (long arc quad) (long or short unclear) 1.32 Knee extension in sitting or supine (short arc quad) (long or short unclear) 1.43 Quad sets 1.58 Straight leg raise **3. Flexibility** 3.4 Calf stretch with knee straight (gastroc)	Y (N)	NR	In-person	Acute Inpatient; Physical therapy/rehabilitation facility (outpatient)

Study, Year, PMID, Country	Intended Comparison	Arm	Components (Specific Exercises/Strategies)	Progression (Appropriate?)	Personnel	Mode of Delivery	Setting
			3.11 Knee extension PROM in supine (position unclear) 3.12 Knee extension PROM in prone (position unclear) **5. Task specific training** 5.8 Gait training				
Bade, 2017, 27813347, USA	High-intensity progressive rehabilitation vs. low-intensity rehabilitation	High-intensity progressive rehabilitation	**1. Strength** 1.3 Calf press (one-leg) 1.4 Calf press (two-legs) 1.5 Clamshells 1.8 Gluteal Sets 1.9 Heel raises – bilateral (calf raises) 1.11 Hip abduction in sidelying 1.12 Hip abduction in standing 1.14 Hip adduction in sidelying 1.15 Hip adduction in standing 1.19 Hip extension in standing 1.22 Hip flexion in standing 1.28 Knee extension machine (one-leg) 1.29 Knee extension machine (two-legs) 1.30 Knee extension AAROM in sitting or supine (short- or long arc quad) 1.31 Knee extension in sitting or supine (long arc quad) 1.33 Knee flexion machine (Hamstring curl) one knee 1.34 Knee flexion machine (Hamstring curl) two knees 1.37 Knee flexion in standing 1.38 Leg Press (one leg) 1.39 Leg Press (two legs) 1.41 Lunges 1.42 Lunges to side (lateral lunge) 1.43 Quad sets 1.48 Sit-to-stand 1.49 Squats 1.52 Step down 1.54 Step lateral 1.55 Step up – forward 1.56 Step up – lateral 1.58 Straight leg raise 1.61 Wall slides **2. Aerobic** 2.1 Aquatics (water aerobics, water walking) 2.2 Bike (Endurance) 2.3 Elliptical machine 2.7 Stepper (upright or sitting) 2.9 Walking **3. Flexibility** 3.1 Ankle pumps 3.2 Bike (ROM)	Y (Y)	Physical therapist	In-person	Physical therapy/rehabilitation facility (outpatient); Home

Study, Year, PMID, Country	Intended Comparison	Arm	Components (Specific Exercises/Strategies)	Progression (Appropriate?)	Personnel	Mode of Delivery	Setting
			3.4 Calf stretch with knee straight (gastroc) 3.5 Hamstring stretch in any position 3.6 Heel slides 3.11 Knee extension PROM in supine (position unclear) 3.12 Knee extension PROM in prone (position unclear) 3.15 Knee flexion AROM in any position (rectus femoris stretch) **4. Balance-Motor Learning-Agility** 4.3 Balance on unstable surface 4.6 Marching 4.8 Single leg stance 4.9 Standing weight shifts 4.10 Stepping multiple directions (grapevine) 4.13 Step lateral (side step) **5. Task specific training** 5.1 Transfers 5.8 Gait training 5.15 Stair training **6. Patient education** 6.2 Home exercise program 6.4 Pain management 6.6 Wound care management **7. Adjunctive modality** 7.11 Massage for scar mobility 7.13 Mobilizations – Tibiofemoral 7.14 Mobilizations – Patellar				
	No data	Low-intensity rehabilitation	**1. Strength** 1.5 Clamshells 1.8 Gluteal Sets 1.9 Heel raises – bilateral (calf raises) 1.32 Knee extension in sitting or supine (short arc quad) 1.36 Knee flexion in sitting or supine 1.37 Knee flexion in standing 1.43 Quad sets 1.47 Single leg stance 1.48 Sit-to-stand 1.49 Squats 1.51 Standing terminal knee extension 1.57 Stool scoots 1.58 Straight leg raise **2. Aerobic** 2.2 Bike (Endurance) 2.9 Walking **3. Flexibility** 3.1 Ankle pumps 3.2 Bike (ROM) 3.4 Calf stretch with knee straight (gastroc) 3.5 Hamstring stretch in any position	Y (N)	Physical therapist	In-person	Physical therapy/rehabilitation facility (outpatient); Home

Study, Year, PMID, Country	Intended Comparison	Arm	Components (Specific Exercises/Strategies)	Progression (Appropriate?)	Personnel	Mode of Delivery	Setting
			3.6 Heel slides 3.11 Knee extension PROM in supine (position unclear) 3.12 Knee extension PROM in prone (position unclear) 3.15 Knee flexion AROM in any position (rectus femoris stretch) **4. Balance-Motor Learning-Agility** 4.3 Balance on unstable surface 4.6 Marching 4.8 Single leg stance 4.9 Standing weight shifts **5. Task specific training** 5.1 Transfers 5.8 Gait training 5.15 Stair training **6. Patient education** 6.1 Activities of daily living 6.2 Home exercise program 6.4 Pain management 6.6 Wound care management **7. Adjunctive modality** 7.1 Cold 7.2 Heat 7.11 Massage for scar mobility 7.13 Mobilizations – Tibiofemoral 7.14 Mobilizations – Patellar				
Bily, 2016, 26763947, Austria	Leg-press training with moderate vibration vs. functional physiotherapy	Leg-press	**1. Strength** 1.38 Leg Press (one leg)	Y (N)	Unclear	In-person	Physical therapy/rehabilitation facility (outpatient)
	No data	Physiotherapy	**1. Strength** 1.11 Hip abduction in sidelying 1.12 Hip abduction in standing 1.13 Hip abduction in supine 1.31 Knee extension in sitting or supine (long arc quad)(short or long unclear) 1.32 Knee extension in sitting or supine (short arc quad) (short or long unclear) 1.35 Knee flexion in prone (position unclear) 1.36 Knee flexion in sitting or supine (position unclear) 1.37 Knee flexion in standing (position unclear) 1.43 Quad sets 1.49 Squats 1.55 Step up – forward 1.58 Straight leg raise **3. Flexibility** 3.2 Bike (ROM)	Y (Y)	Physical therapist	In-person	Physical therapy/rehabilitation facility (outpatient)

Study, Year, PMID, Country	Intended Comparison	Arm	Components (Specific Exercises/Strategies)	Progression (Appropriate?)	Personnel	Mode of Delivery	Setting
			5. Task specific training 5.8 Gait training **7. Adjunctive modality** 7.11 Massage for scar mobility 7.13 Mobilizations – Tibiofemoral 7.14 Mobilizations – Patellar				
Bruun-Olsen, 2013, 23614370, Norway	Walking-skill program vs. usual physiotherapy care	Walking-skill group	**1. Strength** 1.41 Lunges 1.42 Lunges to side (lateral lunge) 1.47 Single leg stance 1.48 Sit-to-stand 1.49 Squats 1.52 Step down 1.55 Step up – forward **2. Aerobic** 2.9 Walking **3. Flexibility** 3.3 Calf stretch with knee bent (soleus) (position unclear) 3.4 Calf stretch with knee straight (gastroc) (position unclear) 3.5 Hamstring stretch in any position 3.16 Knee flexion PROM in prone (rectus femoris stretch) **4. Balance-Motor Learning-Agility** 4.3 Balance on unstable surface 4.4 Balance with perturbations 4.8 Single leg stance 4.9 Standing weight shifts 4.11 Step down 4.13 Step lateral (side step) 4.14 Step up – forward **5. Task specific training** 5.1 Transfers 5.6 Gait on uneven surfaces 5.7 Gait sideways 5.8 Gait training 5.10 Gait with perturbations 5.12 Obstacle training 5.13 Sit-to-stand training 5.15 Stair training	Y (Y)	Physical therapist	In-person	Physical therapy/rehabilitation facility (outpatient)
	No data	Usual physiotherapy care	**1. Strength** [specific exercises not defined] [12 physiotherapy sessions by community physiotherapists; surveys after physiotherapy indicate that most exercises targeted range of motion and strengthening and primarily occurred in sitting]	N (NA)	Physical therapist	In-person	Physical therapy/rehabilitation facility (outpatient)
Buhagiar , 2017,	Monitored home program vs.	Home program	**1. Strength** 1.9 Heel raises – bilateral (calf raises)	Y (Y)	Physical therapist	In-person; Home	Home

Study, Year, PMID, Country	Intended Comparison	Arm	Components (Specific Exercises/Strategies)	Progression (Appropriate?)	Personnel	Mode of Delivery	Setting
28291891, Australia	inpatient rehabilitation plus monitored home program		1.19 Hip extension in standing 1.32 Knee extension in sitting or supine (short arc quad) 1.37 Knee flexion in standing 1.48 Sit-to-stand 1.55 Step up – forward 1.58 Straight leg raise 1.60 Upper extremity strengthening **2. Aerobic** 2.2 Bike (Endurance) 2.9 Walking **3. Flexibility** 3.3 Calf stretch with knee bent (soleus) 3.4 Calf stretch with knee straight (gastroc) 3.5 Hamstring stretch in any position 3.6 Heel slides 3.10 Knee extension AROM 3.14 Knee flexion PROM in sitting or supine **4. Balance-Motor Learning-Agility** 4.6 Marching 4.8 Single leg stance 4.15 Step up – lateral 5. Task specific training 5.13 Sit-to-stand training 5.15 Stair training 5.16 Treadmill gait **6. Patient education** 6.2 Home exercise program			(monitored; access to PT); Self-guided	
	No data	Hospital inpatient rehabilitation	**1. Strength** 1.9 Heel raises – bilateral (calf raises) 1.15 Hip adduction in standing 1.19 Hip extension in standing 1.31 Knee extension in sitting or supine (long arc quad) 1.32 Knee extension in sitting or supine (short arc quad) 1.36 Knee flexion in sitting or supine 1.37 Knee flexion in standing 1.48 Sit-to-stand 1.49 Squats 1.55 Step up – forward 1.56 Step up – lateral 1.58 Straight leg raise 1.60 Upper extremity strengthening **2. Aerobic** 2.2 Bike (Endurance) 2.8 Treadmill walking 2.9 Walking **3. Flexibility** 3.3 Calf stretch with knee bent (soleus) 3.4 Calf stretch with knee straight (gastroc)	Y (Y)	Physical therapist	In-person; Home	Acute inpatient (postoperative)

Study, Year, PMID, Country	Intended Comparison	Arm	Components (Specific Exercises/Strategies)	Progression (Appropriate?)	Personnel	Mode of Delivery	Setting
			3.5 Hamstring stretch in any position 3.6 Heel slides 3.10 Knee extension AROM 3.14 Knee flexion PROM in sitting or supine 3.16 Knee flexion PROM in prone (rectus femoris stretch) **4. Balance-Motor Learning-Agility** 4.6 Marching 4.8 Single leg stance 4.15 Step up – lateral 5. Task specific training 5.13 Sit-to-stand training 5.15 Stair training 5.16 Treadmill gait **6. Patient education** 6.2 Home exercise program				
Cai, 2018, 29239772, China	Cognitive behavioral therapy vs. standard care	Cognitive behavioral therapy & standard care	**6. Patient education** 6.1 Activities of daily living **7. Adjunctive modality** 7.17 Mindfulness, stress/anxiety-reduction interventions	N (NA)	Physical therapist; Other (Psychologist)	In-person	NR
	No data	Standard care	NA [Standard care including pain management and rehabilitative exercises]	N (NA)	NA	NA	NA
Chan, 2018, 29372260, Singapore[A]	Discharge to home vs. discharge to community hospitals	Discharge to home	[specific goals and exercises not defined; comparison of setting]	N (NA)	Physical therapist	In-person	Home
	No data	Discharge to community hospitals	[specific goals and exercises not defined; comparison of setting]	N (NA)	Physical therapist	In-person	Other inpatient facility
DeJong, 2020, 32360105 USA	Body-weight adjusted treatment vs. recumbent bike & PENS vs. Body-weight adjusted treadmill & PENS vs. Recumbent bike	Body-weight adjusted treatment	**1. Strength** [specific exercises not defined] **3. Flexibility** **5. Task specific training** 5.16 Treadmill gait **7. Adjunctive modality** 7.1 Cold 7.13 Mobilizations – Tibiofemoral	Y (N)	Physical therapist	In-person	Physical therapy/rehabilitation facility (outpatient)
	No data	Recumbent bike & PENS	**1. Strength** [specific exercises not defined] **3. Flexibility** 3.2 Bike (ROM) **7. Adjunctive modality** 7.1 Cold 7.5 E-stim for strength (NMES) 7.13 Mobilizations – Tibiofemoral	N (NA)	Physical therapist	In-person	Physical therapy/rehabilitation facility (outpatient)
	No data	Body-weight adjusted	**1. Strength** [specific exercises not defined] **3. Flexibility**	Y (N)	Physical therapist	In-person	Physical therapy/rehabilitation facility (outpatient)

Study, Year, PMID, Country	Intended Comparison	Arm	Components (Specific Exercises/Strategies)	Progression (Appropriate?)	Personnel	Mode of Delivery	Setting
		treadmill & PENS	**5. Task specific training** 5.16 Treadmill gait **7. Adjunctive modality** 7.1 Cold 7.5 E-stim for strength (NMES) 7.13 Mobilizations – Tibiofemoral				
	No data	Recumbent bike	**1. Strength** [specific exercises not defined] **3. Flexibility** 3.2 Bike (ROM) **7. Adjunctive modality** 7.1 Cold 7.13 Mobilizations – Tibiofemoral	N (NA)	Physical therapist	In-person	Physical therapy/rehabilitation facility (outpatient)
Demircioglu, 2015, 26355656, Turkey	Neuromuscular electrical stimulation plus standard rehabilitation (exercise) vs. standard rehabilitation (exercise)	Electrical stimulation (NMES) & exercise	**1. Strength** 1.11 Hip abduction in sidelying (position unclear) 1.12 Hip abduction in standing (position unclear) 1.13 Hip abduction in supine (position unclear) 1.14 Hip adduction in sidelying (position unclear) 1.15 Hip adduction in standing (position unclear) 1.16 Hip adduction in supine (position unclear) 1.30 Knee extension AAROM in sitting or supine (short- or long arc quad) 1.43 Quad sets 1.51 Standing terminal knee extension 1.58 Straight leg raises **3. Flexibility** 3.1 Ankle pumps 3.10 Knee extension AROM (extension/flexion not specified; just ROM) 3.13 Knee flexion AROM (extension/flexion not specified; just ROM) **7. Adjunctive modality** 7.1. Cold 7.5 E-stim for strength (NMES) 7.14 Mobilizations – Patellar	0 (NA)	Unclear	In-person for NMES	Physical therapy/rehabilitation facility (outpatient)
	No data	Exercise	**1. Strength** 1.11 Hip abduction in sidelying (position unclear) 1.12 Hip abduction in standing (position unclear) 1.13 Hip abduction in supine (position unclear) 1.14 Hip adduction in sidelying (position unclear) 1.15 Hip adduction in standing (position unclear) 1.16 Hip adduction in supine (position unclear) 1.30 Knee extension AAROM in sitting or supine (short- or long arc quad) 1.43 Quad sets 1.51 Standing terminal knee extension 1.58 Straight leg raises **3. Flexibility** 3.1 Ankle pumps	N (NA)	None (unsupervised)	Self-guided (unsupervised)	Home

Study, Year, PMID, Country	Intended Comparison	Arm	Components (Specific Exercises/Strategies)	Progression (Appropriate?)	Personnel	Mode of Delivery	Setting
			3.10 Knee extension AROM (extension/flexion not specified; just ROM) 3.13 Knee flexion AROM (extension/flexion not specified; just ROM) **6. Patient education** 6.2 Home exercise program **7. Adjunctive modality** 7.1. Cold 7.14 Mobilizations – Patellar				
den Hertog, 2012, 22643801, Germany	Fast-track rehabilitation ("Joint Care" program) vs. standard rehabilitation	Fast-track rehabilitation program	**1. Strength** [specific exercises not defined] **3. Flexibility** 3.11 Knee extension PROM in supine (position unclear) 3.12 Knee extension PROM in prone (position unclear) 3.14 Knee flexion PROM in sitting or supine **5. Task specific training** 5.8 Gait training 5.15 Stair training **6. Patient education** 6.1 Activities of daily living	N (NA)	Unclear	In-person	Acute inpatient
	No data	Standard care	**1. Strength** [specific exercises not defined] **3. Flexibility** 3.11 Knee extension PROM in supine (position unclear) 3.12 Knee extension PROM in prone (position unclear) 3.14 Knee flexion PROM in sitting or supine **5. Task specific training** 5.8 Gait training [Standard care consisted of similar exercises as the fast-track group, but different timing after surgery]	N (NA)	Unclear	In-person	Acute inpatient
Eymir, 2020, 32778907 Turkey	Active heel-slide exercise & standard physical therapy vs.	Active heel-slide exercise & standard physical therapy	**1. Strength** 1.8 Gluteal Sets 1.13 Hip abduction in supine 1.43 Quad sets 1.58 Straight leg raises **3. Flexibility** 3.1 Ankle pumps 3.6 Heel slides 3.10 Knee extension AROM 3.13 Knee flexion AROM **5. Task specific training** 5.1 Transfers 5.8 Gait training 5.15 Stair training **6. Patient education**	Y (Y)	Physical therapist; None (unsupervised)	In-person; self-guided	Acute inpatient; home

Study, Year, PMID, Country	Intended Comparison	Arm	Components (Specific Exercises/Strategies)	Progression (Appropriate?)	Personnel	Mode of Delivery	Setting
			6.2 Home exercise program				
	No data	Continuous passive motion & standard physical therapy	**1. Strength** 1.8 Gluteal Sets 1.13 Hip abduction in supine 1.43 Quad sets 1.58 Straight leg raises **3. Flexibility** 3.1 Ankle pumps 3.10 Knee extension AROM 3.13 Knee flexion AROM **5. Task specific training** 5.1 Transfers 5.8 Gait training 5.15 Stair training **6. Patient education** 6.2 Home exercise program **7. Adjunctive modality**	Y (Y)	Physical therapist; None (unsupervised)	In-person; self-guided	Acute inpatient; home
Fransen, 2017, 27868384, Australia	Post-acute group exercise program vs. usual care	Outpatient group exercise	**1. Strength** 1.2 Bridges Two-legged (supine hip extension) 1.9 Heel raises – bilateral (calf raises) 1.12 Hip abduction in standing 1.19 Hip extension in standing 1.31 Knee extension in sitting or supine (long arc quad) 1.32 Knee extension in sitting or supine (short arc quad) 1.41 Lunges 1.48 Sit-to-stand 1.49 Squats 1.52 Step down 1.54 Step lateral 1.55 Step up – forward 1.56 Step up – lateral 1.61 Wall slides **2. Aerobic** 2.2 Bike (Endurance) 2.8 Treadmill walking **3. Flexibility** 3.3 Calf stretch with knee bent (soleus) 3.4 Calf stretch with knee straight (gastroc) 3.5 Hamstring stretch in any position 3.10 Knee extension AROM 3.13 Knee flexion AROM **5. Task specific training** 5.4 Gait backwards 5.7 Gait sideways 5.8 Gait training 5.15 Stair training **6. Patient education** 6.2 Home exercise program	Y (Y)	Physical therapist	In-person	Physical therapy/rehabilitation facility (outpatient); Home

Study, Year, PMID, Country	Intended Comparison	Arm	Components (Specific Exercises/Strategies)	Progression (Appropriate?)	Personnel	Mode of Delivery	Setting
	No data	Usual care	[specific goals and exercises not defined] [Able to access acute rehabilitation management as provided by the hospital or recommended by the orthopedic surgeon; 85% received at least one face-to-face physiotherapy visit at some point post-TKA]	N (NA)	Physical therapist	In-person	Physical therapy/rehabilitation facility (outpatient); Home
Hamilton, 2020, 33051212, UK	Progressive outpatient physiotherapy vs. single physiotherapy review and home exercise based intervention	Outpatient therapist-led rehabilitation	**1. Strength** 1.31 Knee extension in sitting or supine (long arc quad) 1.38 Leg Press (one leg) (unclear one or two legs) 1.39 Leg Press (two legs) (unclear one or two legs) 1.43 Quad sets 1.50 Squats (one leg) 1.55 Step up – forward 1.56 Step up – lateral 1.58 Straight leg raises **2. Aerobic** 2.9 Walking **3. Flexibility** 3.2 Bike (ROM) 3.3 Calf stretch with knee bent (soleus) 3.4 Calf stretch with knee straight (gastroc) 3.5 Hamstring stretch in any position 3.11 Knee extension PROM in supine 3.13 Knee flexion AROM **4. Balance-Motor Learning-Agility** 4.3 Balance on unstable surface 4.8 Single leg stance 4.10 Stepping multiple directions (grapevine) 4.17 Tandem walking **5. Task specific training** 5.8 Gait training 5.10 Gait with perturbations 5.13 Sit-to-stand training **6. Patient education** 6.2 Home exercise program 6.4 Pain management	Y (Y)	Physical therapist; None (unsupervised)	In-person; Self-guided (unsupervised)	Physical therapy/rehabilitation facility (outpatient); Home
	No data	Physiotherapy review & home exercises (standard of care)	**1. Strength** [specific exercises not defined] **3. Flexibility** [specific exercises not defined] **6. Patient education** 6.2 Home exercise program 6.4 Pain management	N (NA)	None (unsupervised)	Self-guided (unsupervised)	Home
Harmer, 2009, 19177536, Australia	Water-based rehabilitation vs. land-based rehabilitation	Water-based rehabilitation	**1. Strength** **2. Aerobic** 2.1 Aquatics (water aerobics, water walking) **3. Flexibility**	Y (N)	Physical therapist	In-person	Other (pool); Home

Study, Year, PMID, Country	Intended Comparison	Arm	Components (Specific Exercises/Strategies)	Progression (Appropriate?)	Personnel	Mode of Delivery	Setting
			3.10 Knee extension AROM 3.13 Knee flexion AROM **6. Patient education** 6.2 Home exercise program				
	No data	Land-based rehabilitation	**3. Flexibility** 3.2 Bike (ROM) 3.10 Knee extension AROM 3.13 Knee flexion AROM **4. Balance-Motor Learning-Agility** [specific exercises not defined] **5. Task specific training** 5.13 Sit-to-stand training 5.15 Stair training 5.16 Treadmill gait **6. Patient education** 6.2 Home exercise program	Y (N)	Physical therapist	In-person	Physical therapy/rehabilitation facility (outpatient); Home
Heikkilä, 2017, 28119232, Finland	One-year progressive postoperative home exercise program vs. usual care	Home exercise	**1. Strength** 1.9 Heel raises – bilateral (calf raises) 1.10 Heel raises – unilateral 1.36 Knee flexion in sitting or supine 1.43 Quad sets 1.48 Sit-to-stand 1.49 Squats 1.54 Step lateral 1.61 Wall slides **3. Flexibility** 3.2 Bike (ROM) 3.3 Calf stretch with knee bent (soleus) 3.4 Calf stretch with knee straight (gastroc) 3.5 Hamstring stretch in any position 3.8 Hip flexor stretch (iliopsoas) **4. Balance-Motor Learning-Agility** 4.9 Standing weight shifts **6. Patient education** 6.2 Home exercise program	Y (N)	Physical therapist	In-person; Self-guided (unsupervised) - checked in at check-in visits	Home; Physical therapy/rehabilitation facility (outpatient)
	No data	Control	[no intervention after discharge] [Usual care consisting of the acute rehabilitation after surgery in the hospital and no additional guidance after discharge]	N (NA)	NA	NA	NA
Iwakiri, 2020, 32373475 Japan	Range of motion (post op day 7) vs. range of motion (post op day 7)	Range of motion (post op day 1)	**3. Flexibility** 3.10 Knee extension AROM 3.11 Knee extension PROM in supine (position unclear) 3.12 Knee extension PROM in prone (position unclear) 3.13 Knee flexion AROM 3.14 Knee flexion PROM in sitting or supine (position unclear) 3.15 Knee flexion AROM in any position (rectus femoris stretch) (position unclear)	N (NA)	Physical therapist	In-person	Acute inpatient

Study, Year, PMID, Country	Intended Comparison	Arm	Components (Specific Exercises/Strategies)	Progression (Appropriate?)	Personnel	Mode of Delivery	Setting
			3.16 Knee flexion PROM in prone (rectus femoris stretch) **5. Task specific training** 5.8 Gait training 5.15 Stair training				
	No data	Range of motion (post op day 7)	**3. Flexibility** 3.10 Knee extension AROM 3.11 Knee extension PROM in supine (position unclear) 3.12 Knee extension PROM in prone (position unclear) 3.13 Knee flexion AROM 3.14 Knee flexion PROM in sitting or supine (position unclear) 3.15 Knee flexion AROM in any position (rectus femoris stretch) (position unclear) 3.16 Knee flexion PROM in prone (rectus femoris stretch) **5. Task specific training** 5.8 Gait training 5.15 Stair training	N (NA)	Physical therapist	In-person	Acute inpatient
Jin, 2018, CN-01617489, China	Virtual reality plus conventional acute rehabilitation care vs. conventional acute rehabilitation care	Virtual reality plus usual care	**1. Strength** [specific exercises not defined] **3. Flexibility** 3.1 Ankle pumps 3.14 Knee flexion PROM in sitting or supine **6. Patient education** 6.4 Pain management **7. Adjunctive modality** 7.15 Biofeedback devices 7.17 Mindfulness, stress/anxiety-reduction interventions	N (NA)	Other (Research personnel)	In-person	Acute inpatient (postoperative)
	No data	Usual care	**1. Strength** [specific exercises not defined] **3. Flexibility** 3.1 Ankle pumps 3.14 Knee flexion PROM in sitting or supine **6. Patient education** 6.4 Pain management **7. Adjunctive modality** 7.17 Mindfulness, stress/anxiety-reduction interventions	N (NA)	Other (Research personnel)	In-person	Acute inpatient (postoperative)
Kauppila, 2010, 20354057, Finland	Multidisciplinary rehabilitation program vs. conventional care	Multidisciplinary rehabilitation	**1. Strength** 1.31 Knee extension in sitting or supine (long arc quad) 1.36 Knee flexion in sitting or supine 1.37 Knee flexion in standing **2. Aerobic** 2.1 Aquatics (water aerobics, water walking) 2.9 Walking	Y (N)	Physical therapist	In-person; Self-guided (unsupervised)	Acute inpatient (postoperative); Physical therapy/rehabilitation facility (outpatient); Home

Study, Year, PMID, Country	Intended Comparison	Arm	Components (Specific Exercises/Strategies)	Progression (Appropriate?)	Personnel	Mode of Delivery	Setting
			3. Flexibility [specific exercises not defined] **5. Task specific training** 5.1 Transfers 5.8 Gait training 5.15 Stair training **6. Patient education** 6.2 Home exercise program 6.3 Life-style change **7. Adjunctive modality** 7.17 Mindfulness, stress/anxiety-reduction interventions				
	No data	Control	**1. Strength** [specific exercises not defined] **3. Flexibility** [specific exercises not defined] **5. Task specific training** 5.1 Transfers 5.8 Gait training 5.15 Stair training **6. Patient education** 6.2 Home exercise program [Conventional care: pre-operative exercise recommendations, acute exercise program for lower extremity strength and joint mobility, and supervised exercise program at 2-month visit]	Y (N)	Physical therapist	In-person; Self-guided (unsupervised)	Acute inpatient (postoperative); Physical therapy/rehabilitation facility (outpatient); Home
Lenguerrand, 2020, 31033232, UK	Group-based outpatient physical therapy sessions plus usual care vs. usual care	Group-based outpatient physical therapy	**1. Strength** 1.31 Knee extension in sitting or supine (long arc quad) (unclear if long or short) 1.32 Knee extension in sitting or supine (short arc quad) (unclear if long or short) 1.35 Knee flexion in prone (position unclear) 1.36 Knee flexion in sitting or supine (position unclear) 1.41 Lunges 1.49 Squats 1.52 Step down 1.55 Step up – forward **2. Aerobic** 2.2 Bike (Endurance) 2.8 Treadmill walking **3. Flexibility** 3.2 Bike (ROM) 3.5 Hamstring stretch in any position 3.10 Knee extension AROM 3.13 Knee flexion AROM 3.15 Knee flexion AROM in any position (rectus femoris stretch) **4. Balance-Motor Learning-Agility** 4.3 Balance on unstable surface	Y (Y)	Physical therapist	In-person	Physical therapy/rehabilitation facility (outpatient)

Study, Year, PMID, Country	Intended Comparison	Arm	Components (Specific Exercises/Strategies)	Progression (Appropriate?)	Personnel	Mode of Delivery	Setting
			4.8 Single leg stance 4.11 Step down 4.14 Step up – forward **5. Task specific training** 5.1. Transfers 5.6 Gait on uneven surfaces 5.7 Gait sideways 5.8 Gait training 5.12 Obstacle training 5.13 Sit-to-stand training 5.15 Stair training 5.16 Treadmill gait **6. Patient education** 6.2 Home exercise program				
	No data	Standard care	NA [Usual care: Advice on knee-specific and function exercises and referral for outpatient PT as needed]	N (NA)	NA	NA	NA
Lenssen, 2006, 16942627, Netherlands	Two physical therapy sessions per day vs. one physical therapy session per day	Physiotherapy (twice daily; 40 mins/day)]	**1. Strength** [specific exercises not defined] **3. Flexibility** 3.10 Knee extension AROM 3.11 Knee extension PROM in supine 3.12 Knee extension PROM in prone 3.13 Knee flexion AROM 3.14 Knee flexion PROM in sitting or supine 3.15 Knee flexion AROM in any position (rectus femoris stretch) 3.16 Knee flexion PROM in prone (rectus femoris stretch) **5. Task specific training** 5.1 Transfers 5.8 Gait training 5.13 Sit-to-stand training 5.15 Stair training	N (NA)	Physical therapist	In-person	Acute Inpatient
	No data	Physiotherapy (once daily; 20 mins/day)]	**1. Strength** [specific exercises not defined] **3. Flexibility** 3.10 Knee extension AROM 3.11 Knee extension PROM in supine 3.12 Knee extension PROM in prone 3.13 Knee flexion AROM 3.14 Knee flexion PROM in sitting or supine 3.15 Knee flexion AROM in any position (rectus femoris stretch) 3.16 Knee flexion PROM in prone (rectus femoris stretch) **5. Task specific training** 5.1 Transfers 5.8 Gait training	N (NA)	Physical therapist	In-person	Acute Inpatient

Study, Year, PMID, Country	Intended Comparison	Arm	Components (Specific Exercises/Strategies)	Progression (Appropriate?)	Personnel	Mode of Delivery	Setting
			5.13 Sit-to-stand training 5.15 Stair training				
Li, 2014, 23412304, China	Lower-limb robot assisted training system vs. traditional rehabilitation training	Robot-assisted training	**1. Strength** 1.36 Knee flexion in sitting or supine 1.43 Quad sets **3. Flexibility** 3.1 Ankle pumps **5. Task specific training** 5.8 Gait training (robot) **7. Adjunctive modality** 7.5 E-stim for strength (NMES)	N (NA)	NR	In-person	Acute inpatient (postoperative)
	No data	Traditional rehabilitation training	**1. Strength** 1.36 Knee flexion in sitting or supine 1.43 Quad sets **3. Flexibility** 3.1 Ankle pumps **5. Task specific training** 5.8 Gait training (assistive devices) **7. Adjunctive modality** 7.5 E-stim for strength (NMES)	N (NA)	NR	In-person	Acute inpatient (postoperative)
Li, 2015, CN-01084888, China	Education for daily physical activity vs. no education [Abstract only]	Education	**6. Patient education** [specific elements of education not defined]	Y (N)	NR	Remote via telephone	Home
	No data	No education	NA [No additional education]	Y (N)	NR	NR	NR
Li, 2017, CN-01419703, China	Early gait training vs. basic rehabilitation	Gait training & usual care	**1. Strength** 1.32 Knee extension in sitting or supine (short arc quad) (unclear long or short arc) 1.33 Knee flexion machine (Hamstring curl) one knee (unclear long or short arc) 1.58 Straight leg raises **3. Flexibility** 3.1 Ankle pumps 3.10 Knee extension AROM 3.11 Knee extension PROM in supine (position unclear) 3.12 Knee extension PROM in prone (position unclear) 3.13 Knee flexion AROM 3.14 Knee flexion PROM in sitting or supine 3.15 Knee flexion AROM in any position (rectus femoris stretch) 3.16 Knee flexion PROM in prone (rectus femoris stretch) **4. Balance-Motor Learning-Agility** 4.9 Standing weight shifts **5. Task specific training** 5.8 Gait training **7. Adjunctive modality**	Y (N)	Unclear	In-person	Acute inpatient

Study, Year, PMID, Country	Intended Comparison	Arm	Components (Specific Exercises/Strategies)	Progression (Appropriate?)	Personnel	Mode of Delivery	Setting
			7.1. Cold 7.10 Massage for edema control				
	No data	Usual care (including gait training but later)	**1. Strength** 1.32 Knee extension in sitting or supine (short arc quad) 1.33 Knee flexion machine (Hamstring curl) one knee 1.58 Straight leg raises **3. Flexibility** 3.1 Ankle pumps 3.10 Knee extension AROM 3.11 Knee extension PROM in supine (position unclear) 3.12 Knee extension PROM in prone (position unclear) 3.13 Knee flexion AROM 3.14 Knee flexion PROM in sitting or supine 3.15 Knee flexion AROM in any position (rectus femoris stretch) 3.16 Knee flexion PROM in prone (rectus femoris stretch) **4. Balance-Motor Learning-Agility** 4.9 Standing weight shifts **5. Task specific training** 5.8 Gait training **7. Adjunctive modality** 7.1. Cold 7.10 Massage for edema control	Y (N)	Unclear	In-person	Acute inpatient
Li, 2019, 31003647, China	Tai chi chuan vs. Traditional physical exercises	Tai chi exercise	**1. Strength** 1.43 Quad sets 1.58 Straight leg raises **3. Flexibility** 3.6 Heel slides **7. Adjunctive modality** 7.18 Complementary and alternative therapies (Tai Chi)	N	Other	In-person	NR
	No data	Control (traditional physical exercises)	**1. Strength** 1.43 Quad sets 1.58 Straight leg raises **3. Flexibility** 3.6 Heel slides	N	NR	NR	NR
Liao, 2015, 25552523, Taiwan	General functional rehabilitation plus balance training vs. general functional rehabilitation alone	Functional rehabilitation & balance training	**1. Strength** 1.11 Hip abduction in sidelying (position unclear) 1.12 Hip abduction in standing (position unclear) 1.13 Hip abduction in supine (position unclear) 1.31 Knee extension in sitting or supine (long arc quad) 1.32 Knee extension in sitting or supine (short arc quad) 1.35 Knee flexion in prone	Y (N)	Physical therapist	In-person	Physical therapy/rehabilitation facility (outpatient)

Study, Year, PMID, Country	Intended Comparison	Arm	Components (Specific Exercises/Strategies)	Progression (Appropriate?)	Personnel	Mode of Delivery	Setting
			1.36 Knee flexion in sitting or supine 1.37 Knee flexion in standing 1.43 Quad sets **2. Aerobic** 2.2 Bike (Endurance) 2.8 Treadmill walking **3. Flexibility** 3.1 Ankle pumps 3.5 Hamstring stretch in any position 3.10 Knee extension AROM (unclear) 3.11 Knee extension PROM in supine (unclear) 3.12 Knee extension PROM in prone (unclear) 3.13 Knee flexion AROM (unclear) 3.14 Knee flexion PROM in sitting or supine (unclear) 3.15 Knee flexion AROM in any position (rectus femoris stretch) 3.16 Knee flexion PROM in prone (rectus femoris stretch) **4. Balance-Motor Learning-Agility** 4.3 Balance on unstable surface 4.10 Stepping multiple directions (grapevine) 4.13 Step lateral (side step) 4.17 Tandem walking **5. Task specific training** 5.4 Gait backwards 5.5 Gait downhill 5.7 Gait sideways 5.9 Gait uphill 5.10 Gait with perturbations 5.13 Sit-to-stand training 5.15 Stair training 5.16 Treadmill gait				
	No data	Functional rehabilitation	**1. Strength** 1.11 Hip abduction in sidelying (position unclear) 1.12 Hip abduction in standing (position unclear) 1.13 Hip abduction in supine (position unclear) 1.31 Knee extension in sitting or supine (long arc quad) 1.32 Knee extension in sitting or supine (short arc quad) 1.35 Knee flexion in prone 1.36 Knee flexion in sitting or supine 1.37 Knee flexion in standing 1.43 Quad sets **2. Aerobic** 2.2 Bike (Endurance) 2.8 Treadmill walking **3. Flexibility** 3.1 Ankle pumps 3.5 Hamstring stretch in any position	Y (N)	Physical therapist	In-person	Physical therapy/rehabilitation facility (outpatient)

Study, Year, PMID, Country	Intended Comparison	Arm	Components (Specific Exercises/Strategies)	Progression (Appropriate?)	Personnel	Mode of Delivery	Setting
			3.10 Knee extension AROM (unclear) 3.11 Knee extension PROM in supine (unclear) 3.12 Knee extension PROM in prone (unclear) 3.13 Knee flexion AROM (unclear) 3.14 Knee flexion PROM in sitting or supine (unclear) 3.15 Knee flexion AROM in any position (rectus femoris stretch) 3.16 Knee flexion PROM in prone (rectus femoris stretch) **5. Task specific training** 5.4 Gait backwards 5.5 Gait downhill 5.7 Gait sideways 5.9 Gait uphill 5.13 Sit-to-stand training 5.15 Stair training 5.16 Treadmill gait				
Liao, 2020, 31687984, Taiwan	Elastic resistance exercise training vs. standard care	Elastic resistance exercise training	**1. Strength** 1.11 Hip abduction in sidelying (position unclear) 1.12 Hip abduction in standing (position unclear) 1.13 Hip abduction in supine (position unclear) 1.14 Hip adduction in sidelying (position unclear) 1.15 Hip adduction in standing (position unclear) 1.16 Hip adduction in supine (position unclear) 1.17 Hip extension in sidelying (position unclear) 1.18 Hip extension in prone (position unclear) 1.19 Hip extension in standing (position unclear) 1.20 Hip flexion in sidelying (position unclear) 1.21 Hip flexion in sitting (position unclear) 1.23 Hip flexion in supine (position unclear) 1.22 Hip flexion in standing (position unclear) 1.35 Knee flexion in prone 1.36 Knee flexion in sitting or supine 1.37 Knee flexion in standing 1.38 Leg Press (one leg) 1.39 Leg Press (two legs) 1.60 Upper extremity strengthening **3. Flexibility** [specific exercises not defined]	Y (Y)	Physical therapist	In-person; Self-guided (unsupervised)	Physical therapy/rehabilitation facility (outpatient); Home
	No data	Standard care	NA [Standard care consisted of knee osteoarthritis education, pharmacologic therapy, and conservative physical therapy without any resistance exercise training (active and passive range of motion, stretching, and functional conditioning), and maintenance of usually activity level]	NA	NR	In-person	NR

Study, Year, PMID, Country	Intended Comparison	Arm	Components (Specific Exercises/Strategies)	Progression (Appropriate?)	Personnel	Mode of Delivery	Setting
Liebs, 2010, 20360503, Germany	Ergometer cycling plus standard physiotherapy vs. standard physiotherapy alone	Ergometer cycling	**1. Strength** [specific exercises not defined] **3. Flexibility** 3.2 Bike (ROM) **4. Balance-Motor Learning-Agility** 4.3 Balance on unstable surface **5. Task specific training** 5.1 Transfers 5.6 Gait on uneven surfaces 5.8 Gait training 5.15 Stair training	N (NA)	Physical therapist	In-person	Physical therapy/rehabilitation facility (outpatient)
	No data	Control (standard daily physiotherapy)	**1. Strength** [specific exercises not defined] **3. Flexibility** [specific exercises not defined] **4. Balance-Motor Learning-Agility** 4.3 Balance on unstable surface **5. Task specific training** 5.1 Transfers 5.6 Gait on uneven surfaces 5.8 Gait training 5.15 Stair training	N (NA)	Physical therapist	In-person	Physical therapy/rehabilitation facility (outpatient)
Liebs, 2012, 22196125, Germany	Early aquatic therapy vs. late aquatic therapy	Early Aquatic therapy	**1. Strength** [specific exercises not defined] **3. Flexibility** [specific exercises not defined] **4. Balance-Motor Learning-Agility** 4.3 Balance on unstable surface **5. Task specific training** 5.1 Transfers 5.6 Gait on uneven surfaces 5.8 Gait training 5.15 Stair training	N (NA)	Physical therapist	In-person	Physical therapy/rehabilitation facility (outpatient)
	No data	Late Aquatic therapy (after wound healing)	**1. Strength** [specific exercises not defined] **3. Flexibility** [specific exercises not defined] **4. Balance-Motor Learning-Agility** 4.3 Balance on unstable surface **5. Task specific training** 5.1 Transfers 5.6 Gait on uneven surfaces 5.8 Gait training 5.15 Stair training	N (NA)	Physical therapist	In-person	Physical therapy/rehabilitation facility (outpatient)
Madsen, 2013, 23651717, Denmark	Group-based rehabilitation vs. individual supervised home training	Group-based rehabilitation	**1. Strength** 1.6 Core strengthening 1.28 Knee extension machine (one-leg) 1.29 Knee extension machine (two-legs) 1.33 Knee flexion machine (Hamstring curl) one knee	Y (Y)	Physical therapist	In-person; None (unsupervised)	Physical therapy/rehabilitation facility (outpatient); Home

Study, Year, PMID, Country	Intended Comparison	Arm	Components (Specific Exercises/Strategies)	Progression (Appropriate?)	Personnel	Mode of Delivery	Setting
			1.34 Knee flexion machine (Hamstring curl) two knees 1.38 Leg Press (one leg) 1.39 Leg Press (two legs) 1.49 Squats 1.60 Upper extremity strengthening **2. Aerobic** 2.2 Bike (Endurance) 2.9 Walking **3. Flexibility** 3.2 Bike (ROM) **4. Balance-Motor Learning-Agility** [specific exercises not defined] **6. Patient education** 6.2 Home exercise program				
	No data	Supervised home-exercises	**1. Strength** [specific exercises not defined] **2. Aerobic** 2.2 Bike (Endurance) 2.9 Walking **4. Balance-Motor Learning-Agility** [specific exercises not defined] **6. Patient education** 6.2 Home exercise program	N (N)	Physical therapist	In-person (planned visits); None (unsupervised)	Physical therapy/rehabilitation facility (outpatient); Home
Minns Lowe, 2012, 22180446, UK	Home visit physiotherapy visits vs. usual care	Home-visit physiotherapy	**1. Strength** 1.9 Heel raises – bilateral (calf raises) 1.10 Heel raises – unilateral 1.47 Single leg stance 1.48 Sit-to-stand 1.49 Squats 1.55 Step up – forward 1.61 Wall slides **3. Flexibility** 3.3 Calf stretch with knee bent (soleus) 3.4 Calf stretch with knee straight (gastroc) 3.5 Hamstring stretch in any position 3.15 Knee flexion AROM in any position (rectus femoris stretch) 3.16 Knee flexion PROM in prone (rectus femoris stretch) **4. Balance-Motor Learning-Agility** 4.6 Marching 4.8 Single leg stance 4.9 Standing weight shifts **5. Task specific training** 5.1 Transfers 5.6 Gait on uneven surfaces 5.8 Gait training 5.12 Obstacle training 5.13 Sit-to-stand training	Y (N)	Physical therapist	In-person	Home

Study, Year, PMID, Country	Intended Comparison	Arm	Components (Specific Exercises/Strategies)	Progression (Appropriate?)	Personnel	Mode of Delivery	Setting
			5.15 Stair training				
	No data	Usual care	NA [Usual care consisted of an advice booklet with gait training and exercise advice; referral to outpatient physiotherapy possible if recovery in acute was slow or if not achieving recovery targets at follow-up (less than 20% of patients)]	NA	NA	NA	NA
Mitchell, 2005, 15869558, UK[A]	Home pre-operative and post-operative physiotherapy vs. usual outpatient post-operative physiotherapy	Home rehabilitation	**3. Flexibility** 3.10 Knee extension AROM (unclear) 3.11 Knee extension PROM in supine (unclear) 3.12 Knee extension PROM in prone (unclear) 3.13 Knee flexion AROM (unclear) 3.14 Knee flexion PROM in sitting or supine (unclear) 3.15 Knee flexion AROM in any position (rectus femoris stretch) (unclear) 3.16 Knee flexion PROM in prone (rectus femoris stretch) (unclear) **5. Task specific training** 5.8 Gait training 6. Patient education 6.1 ADLs 6.4 Pain management **7. Adjunctive modality** 7.12 Massage/myofascial techniques for soft tissue	N (NA)	Physical therapist	In-person	Home
	No data	Hospital outpatient rehabilitation	**3. Flexibility** 3.10 Knee extension AROM (unclear) 3.11 Knee extension PROM in supine (unclear) 3.12 Knee extension PROM in prone (unclear) 3.13 Knee flexion AROM (unclear) 3.14 Knee flexion PROM in sitting or supine (unclear) 3.15 Knee flexion AROM in any position (rectus femoris stretch) (unclear) 3.16 Knee flexion PROM in prone (rectus femoris stretch) (unclear) **5. Task specific training** 5.8 Gait training 7. Adjunctive modality 7.4 E-stim for pain (TENS) 7.5 E-stim for strength (NMES)	N (NA)	Physical therapist	In-person	Physical therapy/rehabilitation facility (outpatient)
Moffet, 2015, 26178888, Canada	In-home telerehabilitation vs. face-to-face home rehabilitation	In-home telerehabilitation	**1. Strength** [specific exercises not defined] **4. Balance-Motor Learning-Agility** [specific exercises not defined] **5. Task specific training** [specific exercises not defined] **6. Patient education** 6.1 Activities of daily living	Y (Y)	Physical therapist	Remote via videoconfence	Home

Study, Year, PMID, Country	Intended Comparison	Arm	Components (Specific Exercises/Strategies)	Progression (Appropriate?)	Personnel	Mode of Delivery	Setting
			6.2 Home exercise program 6.4 Pain management				
	No data	Standard home rehabilitation	**1. Strength** [specific exercises not defined] 4. Balance-Motor Learning-Agility [specific exercises not defined] **5. Task specific training** [specific exercises not defined] **6. Patient education** 6.1 Activities of daily living 6.2 Home exercise program 6.4 Pain management	Y (Y)	Physical therapist	In-person	Home
Monticone, 2013, 23063624, Italy	Home-based functional exercises targeted at managing kinesiophobia vs. general advice of staying active	Home-based functional exercises and kinesiophobia training	**1. Strength** 1.37 Knee flexion in standing **3. Flexibility** 3.2 Bike (ROM) **4. Balance-Motor Learning-Agility** 4.3 Balance on unstable surface 4.6 Marching 4.10 Stepping multiple directions (grapevine) **5. Task specific training** 5.8 Gait training 5.12 Obstacle training 5.13 Sit-to-stand training 5.15 Stair training **6. Patient education** 6.1 Activities of daily living 6.2 Home exercise program 6.4 Pain management 6.5 Self-management **7. Adjunctive modality** 7.17 Mindfulness, stress/anxiety-reduction interventions	N (N)	Physical therapist	In-person; Remote via telephone	Other inpatient facility (rehabilitation centre); Home
	No data	Usual care	**1. Strength** 1.37 Knee flexion in standing **3. Flexibility** 3.2 Bike (ROM) **4. Balance-Motor Learning-Agility** 4.3 Balance on unstable surface 4.6 Marching 4.10 Stepping multiple directions (grapevine) **5. Task specific training** 5.8 Gait training 5.12 Obstacle training 5.13 Sit-to-stand training 5.15 Stair training	N (N)	Physical therapist	In-person	Other inpatient facility (rehabilitation center)
Moutzouri, 2018, 29473481, NR	Early self-managed focal sensorimotor training vs. functional	Early self-managed focal sensorimotor exercise training	**1. Strength** 1.31 Knee extension in sitting or supine (long arc quad)	Y (Y)	Physical therapist	Self-guided (unsupervised)	Home

Study, Year, PMID, Country	Intended Comparison	Arm	Components (Specific Exercises/Strategies)	Progression (Appropriate?)	Personnel	Mode of Delivery	Setting
	exercise training		1.32 Knee extension in sitting or supine (short arc quad) 1.48 Sit-to-stand 1.61 Wall slides **2. Aerobic** 2.2 Bike (Endurance) 2.9 Walking **3. Flexibility** 3.6 Heel slides 3.10 Knee extension AROM (unclear) 3.11 Knee extension PROM in supine (unclear) 3.12 Knee extension PROM in prone (unclear) 3.13 Knee flexion AROM (unclear) 3.14 Knee flexion PROM in sitting or supine (unclear) **4. Balance-Motor Learning-Agility** 4.3 Balance on unstable surface 4.6 Marching 4.10 Stepping multiple directions (grapevine) 4.13 Step lateral (side step) 4.17 Tandem walking **5. Task specific training** 5.10 Gait with perturbations 5.12 Obstacle training 5.15 Stair training				
	No data	Functional exercise training	**1. Strength** 1.9 Heel raises – bilateral (calf raises) 1.11 Hip abduction in sidelying 1.31 Knee extension in sitting or supine (long arc quad) 1.32 Knee extension in sitting or supine (short arc quad) 1.37 Knee flexion in standing 1.48 Sit-to-stand 1.58 Straight leg raises 1.61 Wall slides **2. Aerobic** 2.2 Bike (Endurance) 2.9 Walking **3. Flexibility** 3.1 Ankle pumps 3.6 Heel slides 3.10 Knee extension AROM (unclear) 3.11 Knee extension PROM in supine (unclear) 3.12 Knee extension PROM in prone (unclear) 3.13 Knee flexion AROM (unclear) 3.14 Knee flexion PROM in sitting or supine (unclear) **5. Task specific training** 5.15 Stair training	Y (Y)	Physical therapist	Self-guided (unsupervised)	Home

Study, Year, PMID, Country	Intended Comparison	Arm	Components (Specific Exercises/Strategies)	Progression (Appropriate?)	Personnel	Mode of Delivery	Setting
Naylor, 2017, 28899328, Australia	Discharge to inpatient rehabilitation vs. discharge to home (observational)	Inpatient rehabilitation	[specific goals and exercises not defined; comparison of setting]	NR	NR	NR	Other inpatient facility (not acute)
	No data	No inpatient rehabilitation	[specific goals and exercises not defined; comparison of setting]	NR	NR	NR	NR (other than not inpatient)
Padgett, 2018a, 29352683, USA	Discharge to home vs. discharge to inpatient rehabilitation Discharge to skilled nursing facility vs. discharge to inpatient rehabilitation	Home	[specific goals and exercises not defined; comparison of setting]	NR	NR	NR	Home
	No data	Long term care facility	[specific goals and exercises not defined; comparison of setting]	NR	NR	NR	Other inpatient facility (long term care facility)
	No data	Inpatient rehabilitation	[specific goals and exercises not defined; comparison of setting]	NR	NR	NR	Other inpatient facility (inpatient rehabilitation; not acute)
Petersen, 2018, 29294078, Netherlands	Acupuncture and exercise vs. exercise alone	Exercise & acupuncture	**1. Strength** [specific exercises not defined] **2. Aerobic** [specific exercises not defined] **3. Flexibility** [specific exercises not defined] **4. Balance-Motor Learning-Agility** [specific exercises not defined] **5. Task specific training** [specific exercises not defined] **7. Adjunctive modality** 7.16 Dry needling (acupuncture)	Y (Y)	Physical therapist	In-person	Physical therapy/rehabilitation facility (outpatient)
	No data	Exercise	**1. Strength** [specific exercises not defined] **2. Aerobic** [specific exercises not defined] **3. Flexibility** [specific exercises not defined] **4. Balance-Motor Learning-Agility** [specific exercises not defined] **5. Task specific training** [specific exercises not defined]	Y (Y)	Physical therapist	In-person	Physical therapy/rehabilitation facility (outpatient)
Petterson, 2009, 19177542, USA	Neuromuscular electrical stimulation plus progressive volitional strength	Exercise & NMES	**1. Strength** 1.11 Hip abduction in sidelying 1.31 Knee extension in sitting or supine (long arc quad)	Y (Y)	Physical therapist	In-person	Physical therapy/rehabilitation facility (outpatient)

Study, Year, PMID, Country	Intended Comparison	Arm	Components (Specific Exercises/Strategies)	Progression (Appropriate?)	Personnel	Mode of Delivery	Setting
	training program vs. progressive volitional strength training program alone		1.37 Knee flexion in standing 1.41 Lunges 1.43 Quad sets 1.51 Standing terminal knee extension 1.52 Step down 1.55 Step up – forward 1.58 Straight leg raises 1.61 Wall slides **3. Flexibility** 3.2 Bike (ROM) 3.11 Knee extension PROM in supine 3.12 Knee extension PROM in prone 3.14 Knee flexion PROM in sitting or supine **5. Task specific training** 5.8 Gait training 5.15 Stair training **7. Adjunctive modality** 7.5 E-stim for strength (NMES) 7.11 Massage for scar mobility 7.14 Mobilizations – Patellar				
	No data	Exercise	**1. Strength** 1.11 Hip abduction in sidelying 1.31 Knee extension in sitting or supine (long arc quad) 1.37 Knee flexion in standing 1.41 Lunges 1.43 Quad sets 1.51 Standing terminal knee extension 1.52 Step down 1.55 Step up – forward 1.58 Straight leg raises 1.61 Wall slides **3. Flexibility** 3.2 Bike (ROM) 3.11 Knee extension PROM in supine 3.12 Knee extension PROM in prone 3.14 Knee flexion PROM in sitting or supine **5. Task specific training** 5.8 Gait training 5.15 Stair training **7. Adjunctive modality** 7.11 Massage for scar mobility 7.14 Mobilizations – Patellar	Y (Y)	Physical therapist	In-person	Physical therapy/rehabilitation facility (outpatient)
Piqueras, 2013, 23474735, Spain	Interactive virtual telerehabilitation system vs. conventional outpatient physical therapy	Interactive virtual telerehabilitation system	**1. Strength** [specific exercises not defined] **3. Flexibility** [specific exercises not defined] **5. Task specific training** [specific exercises not defined] 5.8 Gait training	Y (N)	Physical therapist	In-person; Remote via app or telephone	Acute inpatient (postoperative); Home

Study, Year, PMID, Country	Intended Comparison	Arm	Components (Specific Exercises/Strategies)	Progression (Appropriate?)	Personnel	Mode of Delivery	Setting
			6. Patient education 6.1 Activities of daily living				
	No data	Conventional outpatient physical therapy	**1. Strength** [specific exercises not defined] **3. Flexibility** [specific exercises not defined] **5. Task specific training** [specific exercises not defined] 5.8 Gait training **6. Patient education** 6.1 Activities of daily living	N (NA)	Physical therapist	In-person	Acute inpatient (postoperative); Physical therapy/rehabilitation facility (outpatient)
Piva, 2017, 28217891, USA	Comprehensive Behavioral intervention (CBI) that combines intense exercises with an education program to promote health and physical activity vs. standard of care exercise program	Comprehensive behavioral intervention	**1. Strength** 1.11 Hip abduction in sidelying (position unclear) 1.12 Hip abduction in standing (position unclear) 1.13 Hip abduction in supine (position unclear) 1.17 Hip extension in sidelying (position unclear) 1.18 Hip extension in prone (position unclear) 1.19 Hip extension in standing (position unclear) 1.28 Knee extension machine (one-leg) (one or two legs unclear) 1.29 Knee extension machine (two-legs) (one or two legs unclear) 1.33 Knee flexion machine (Hamstring curl) one knee (one or two legs unclear) 1.34 Knee flexion machine (Hamstring curl) two knees (one or two legs unclear) 1.48 Sit-to-stand 1.49 Squats 1.50 Squats (one leg) **2. Aerobic** 2.8 Treadmill walking **3. Flexibility** 3.2 Bike (ROM) 3.3 Calf stretch with knee bent (soleus) 3.4 Calf stretch with knee straight (gastroc) 3.5 Hamstring stretch in any position 3.10 Knee extension AROM 3.13 Knee flexion AROM 3.16 Knee flexion PROM in prone (rectus femoris stretch) **4. Balance-Motor Learning-Agility** 4.3 Balance on unstable surface 4.6 Marching 4.10 Stepping multiple directions (grapevine) 4.13 Step lateral (side step) 4.17 Tandem walking **5. Task specific training** 5.4 Gait backwards 5.15 Stair training **6. Patient education**	Y (Y)	Physical therapist	In-person	Physical therapy/rehabilitation facility (outpatient); Home

Study, Year, PMID, Country	Intended Comparison	Arm	Components (Specific Exercises/Strategies)	Progression (Appropriate?)	Personnel	Mode of Delivery	Setting
			6.2 Home exercise program 6.3 Life-style change				
	No data	Standard care exercise	**1. Strength** 1.11 Hip abduction in sidelying (position unclear) 1.12 Hip abduction in standing (position unclear) 1.13 Hip abduction in supine (position unclear) 1.17 Hip extension in sidelying (position unclear) 1.18 Hip extension in prone (position unclear) 1.19 Hip extension in standing (position unclear) 1.28 Knee extension machine (one-leg) (one or two legs unclear) 1.29 Knee extension machine (two-legs) (one or two legs unclear) 1.33 Knee flexion machine (Hamstring curl) one knee (one or two legs unclear) 1.34 Knee flexion machine (Hamstring curl) two knees (one or two legs unclear) **2. Aerobic** 2.8 Treadmill walking **3. Flexibility** 3.2 Bike (ROM) 3.3 Calf stretch with knee bent (soleus) 3.4 Calf stretch with knee straight (gastroc) 3.5 Hamstring stretch in any position 3.10 Knee extension AROM 3.13 Knee flexion AROM 3.16 Knee flexion PROM in prone (rectus femoris stretch) **6. Patient education** 6.2 Home exercise program	Y (Y)	Physical therapist	In-person	Physical therapy/rehabilitation facility (outpatient); Home
Piva, 2019, 30794296, USA	Community-based group exercise vs. clinic-based individual physical therapy vs. usual medical care	Community-based group exercise	**1. Strength** [specific exercises not defined] **2. Aerobic** [specific exercises not defined] **3. Flexibility** [specific exercises not defined] **4. Balance-Motor Learning-Agility** [specific exercises not defined] **5. Task specific training** [specific exercises not defined]	N (NA)	Other (athletic trainer)	In-person	Gym or other community center
	No data	Clinic-based individual physical therapy exercise	**1. Strength** 1.17 Hip extension in sidelying (position unclear) 1.18 Hip extension in prone (position unclear) 1.19 Hip extension in standing (position unclear) 1.20 Hip flexion in sidelying (position unclear) 1.21 Hip flexion in sitting (position unclear) 1.22 Hip flexion in standing (position unclear) 1.23 Hip flexion in supine (position unclear) 1.30 Knee extension AAROM in sitting or supine (short- or long arc quad) (position unclear)	Y (Y)	Physical therapist	In-person	Physical therapy/rehabilitation facility (outpatient)

Study, Year, PMID, Country	Intended Comparison	Arm	Components (Specific Exercises/Strategies)	Progression (Appropriate?)	Personnel	Mode of Delivery	Setting
			1.31 Knee extension in sitting or supine (long arc quad) (position unclear) 1.32 Knee extension in sitting or supine (short arc quad) (position unclear) 1.35 Knee flexion in prone (position unclear) 1.36 Knee flexion in sitting or supine (position unclear) 1.37 Knee flexion in standing (position unclear) 1.49 Squats **2. Aerobic** 2.2 Bike (Endurance) 2.8 Treadmill walking **4. Balance-Motor Learning-Agility** [specific exercises not defined] **5. Task specific training** 5.8 Gait training 5.13 Sit-to-stand training 5.15 Stair training **6. Patient education** 6.2 Home exercise program				
	No data	Standard care	NA [Usual medical care with no interference from the study; waitlist for intervention after data collection]	NA	NA	NA	NA
Pua, 2017, 27810379, Singapore[A]	Rehabilitation attendance of 2 or more sessions vs. 1 session vs. 0 sessions	Rehabilitation attendance (2 or more sessions)	**1. Strength** 1.28 Knee extension machine (one-leg) 1.31 Knee extension in sitting or supine (long arc quad) (long or short unclear) 1.32 Knee extension in sitting or supine (short arc quad) (long or short unclear) 1.38 Leg Press (one leg) 1.43 Quad sets 1.48 Sit-to-stand 1.52 Step down 1.55 Step up – forward 1.58 Straight leg raises 1.62 Wall slides - Lateral (hip AB and ADductors) **2. Aerobic** 2.7 Stepper (upright or sitting) **3. Flexibility** 3.2 Bike (ROM) 3.5 Hamstring stretch in any position 3.11 Knee extension PROM in supine (seated) 3.13 Knee flexion AROM (unclear) 3.14 Knee flexion PROM in sitting or supine (unclear) **4. Balance-Motor Learning-Agility** 4.6 Marching 4.8 Single leg stance 4.13 Step lateral (side step)	Y (N)	Physical therapist	In-person	Physical therapy/rehabilitation facility (outpatient)

Study, Year, PMID, Country	Intended Comparison	Arm	Components (Specific Exercises/Strategies)	Progression (Appropriate?)	Personnel	Mode of Delivery	Setting
			4.16 Tandem standing **5. Task specific training** 5.8 Gait training 5.15 Stair training **6. Patient education** 6.2 Home exercise program 6.4 Pain management **7. Adjunctive modality** 7.1. Cold 7.5 E-stim for strength (NMES)				
	No data	Rehabilitation attendance (1 session)	**1. Strength** 1.28 Knee extension machine (one-leg) 1.31 Knee extension in sitting or supine (long arc quad) (long or short unclear) 1.32 Knee extension in sitting or supine (short arc quad) (long or short unclear) 1.38 Leg Press (one leg) 1.43 Quad sets 1.48 Sit-to-stand 1.52 Step down 1.55 Step up – forward 1.58 Straight leg raises 1.62 Wall slides - Lateral (hip abductors and adductors) **2. Aerobic** 2.7 Stepper (upright or sitting) **3. Flexibility** 3.2 Bike (ROM) 3.5 Hamstring stretch in any position 3.11 Knee extension PROM in supine (seated) 3.13 Knee flexion AROM (unclear) 3.14 Knee flexion PROM in sitting or supine (unclear) **4. Balance-Motor Learning-Agility** 4.6 Marching 4.8 Single leg stance 4.13 Step lateral (side step) 4.16 Tandem standing **5. Task specific training** 5.8 Gait training 5.15 Stair training **6. Patient education** 6.2 Home exercise program 6.4 Pain management **7. Adjunctive modality** 7.1. Cold 7.5 E-stim for strength (NMES)	Y (N)	Physical therapist	In-person	Physical therapy/rehabilitation facility (outpatient)
	No data	Rehabilitation attendance: none	NA	NA	NA	NA	NA

Study, Year, PMID, Country	Intended Comparison	Arm	Components (Specific Exercises/Strategies)	Progression (Appropriate?)	Personnel	Mode of Delivery	Setting
Rockstroh, 2010, 20533147, Germany	Microcurrent therapy plus conventional postoperative physiotherapy vs. sham plus conventional postoperative physiotherapy	Physiotherapy & microcurrent	**1. Strength** [specific exercises not defined] **3. Flexibility** [specific exercises not defined] **5. Task specific training** 5.8 Gait training **7. Adjunctive modality** 7.4 E-stim for pain (TENS)	N (NA)	Unclear	In-person	Acute Inpatient
	No data	Physiotherapy	**1. Strength** [specific exercises not defined] **3. Flexibility** [specific exercises not defined] **5. Task specific training** 5.8 Gait training	N (NA)	Unclear	In-person	Acute Inpatient
Sattler, 2019, 30994586, Australia	Pedaling-based exercise protocol vs. non-pedaling (multi-exercise) protocol	Pedaling-based protocol	**3. Flexibility** 3.2 Bike (ROM) 3.4 Calf stretch with knee straight (gastroc) 3.5 Hamstring stretch in any position **5. Task specific training** 5.8 Gait training	N (NA)	Physical therapist	In-person	Acute Inpatient
	No data	Non-pedaling (multi-exercise] protocol	**1. Strength** 1.9 Heel raises – bilateral (calf raises) 1.32 Knee extension in sitting or supine (short arc quad) 1.36 Knee flexion in sitting or supine 1.43 Quad sets 1.49 Squats 1.58 Straight leg raises **3. Flexibility** 3.1 Ankle pumps 3.4 Calf stretch with knee straight (gastroc) 3.6 Heel slides 3.10 Knee extension AROM 3.13 Knee flexion AROM **5. Task specific training** 5.8 Gait training	N (NA)	Physical therapist	In-person	Acute Inpatient
Schache, 2019, 31208916, Australia	Standard rehabilitation plus hip abductor strengthening vs. standard rehabilitation plus general functional exercise	Standard rehabilitation and hip strengthening exercises	**1. Strength** 1.9 Heel raises – bilateral (calf raises) 1.11 Hip abduction in sidelying 1.12 Hip abduction in standing 1.18 Hip extension in prone 1.24 Hip hikes in standing 1.35 Knee flexion in prone 1.37 Knee flexion in standing 1.39 Leg Press (two legs) 1.43 Quad sets 1.49 Squats 1.52 Step down	Y (Y)	Physical therapist	In-person	Acute inpatient (postoperative) (12 days); Physical therapy/rehabilitation facility (outpatient) (6 wks)

Study, Year, PMID, Country	Intended Comparison	Arm	Components (Specific Exercises/Strategies)	Progression (Appropriate?)	Personnel	Mode of Delivery	Setting
			1.54 Step lateral 1.55 Step up – forward **2. Aerobic** 2.2 Bike (Endurance) **3. Flexibility** 3.4 Calf stretch with knee straight (gastroc) 3.7 Hip extensor stretch (knee to chest) 3.11 Knee extension PROM in supine (sitting) 3.12 Knee extension PROM in prone 3.13 Knee flexion AROM (active or passive unclear) 3.14 Knee flexion PROM in sitting or supine (active or passive unclear) **4. Balance-Motor Learning-Agility** 4.6 Marching 4.11 Step down 4.14 Step up – forward **5. Task specific training** 5.7 Gait sideways 5.8 Gait training 5.13 Sit-to-stand training **6. Patient education** 6.2 Home exercise program **7. Adjunctive modality** 7.10 Massage for edema control (goal unclear) 7.11 Massage for scar mobility (goal unclear) 7.12 Massage/myofascial techniques for soft tissue (goal unclear) 7.13 Mobilizations – Tibiofemoral (joint unclear) 7.14 Mobilizations – Patellar (joint unclear)				
	No data	Standard rehabilitation plus general functional exercise	**1. Strength** 1.9 Heel raises – bilateral (calf raises) 1.35 Knee flexion in prone 1.37 Knee flexion in standing 1.39 Leg Press (two legs) 1.43 Quad sets 1.49 Squats 1.52 Step down 1.55 Step up – forward **2. Aerobic** 2.2 Bike (Endurance) **3. Flexibility** 3.4 Calf stretch with knee straight (gastroc) 3.7 Hip extensor stretch (knee to chest) 3.11 Knee extension PROM in supine (sitting) 3.12 Knee extension PROM in prone 3.13 Knee flexion AROM (active or passive unclear) 3.14 Knee flexion PROM in sitting or supine (active or passive unclear) **4. Balance-Motor Learning-Agility**	Y (Y)	Physical therapist	In-person	Acute inpatient (postoperative) (12 days); Physical therapy/rehabilitation facility (outpatient) (6 wks)

Study, Year, PMID, Country	Intended Comparison	Arm	Components (Specific Exercises/Strategies)	Progression (Appropriate?)	Personnel	Mode of Delivery	Setting
			4.6 Marching 4.11 Step down 4.14 Step up – forward **5. Task specific training** 5.8 Gait training 5.13 Sit-to-stand training **6. Patient education** 6.2 Home exercise program **7. Adjunctive modality** 7.10 Massage for edema control (goal unclear) 7.11 Massage for scar mobility (goal unclear) 7.12 Massage/myofascial techniques for soft tissue (goal unclear) 7.13 Mobilizations – Tibiofemoral (joint unclear) 7.14 Mobilizations – Patellar (joint unclear)				
Shanb, 2014, CN-01041112, Saudi Arabia	Active exercise training program plus biofeedback vs. active exercise training program	Active exercise training program & biofeedback	**1. Strength** 1.11 Hip abduction in sidelying 1.30 Knee extension AAROM in sitting or supine (short- or long arc quad) 1.31 Knee extension in sitting or supine (long arc quad) (long or short unclear) 1.32 Knee extension in sitting or supine (short arc quad) (long or short unclear) 1.35 Knee flexion in prone (position unclear) 1.36 Knee flexion in sitting or supine (position unclear) 1.37 Knee flexion in standing (position unclear) 1.51 Standing terminal knee extension 1.58 Straight leg raises 1.63 Open chain ankle dorsiflexion/plantar flexion/inversion/eversion **7. Adjunctive modality** 7.14 Mobilizations – Patellar 7.15 Biofeedback devices	Y (Y)	NR	In-person	Physical therapy/rehabilitation facility (outpatient)
	No data	Active exercise training program	**1. Strength** 1.11 Hip abduction in sidelying 1.30 Knee extension AAROM in sitting or supine (short- or long arc quad) 1.31 Knee extension in sitting or supine (long arc quad) (long or short unclear) 1.32 Knee extension in sitting or supine (short arc quad) (long or short unclear) 1.35 Knee flexion in prone (position unclear) 1.36 Knee flexion in sitting or supine (position unclear) 1.37 Knee flexion in standing (position unclear) 1.51 Standing terminal knee extension 1.58 Straight leg raises 1.63 Open chain ankle dorsiflexion/plantar flexion/inversion/eversion	Y (Y)	NR	In-person	Physical therapy/rehabilitation facility (outpatient)

Study, Year, PMID, Country	Intended Comparison	Arm	Components (Specific Exercises/Strategies)	Progression (Appropriate?)	Personnel	Mode of Delivery	Setting
			7. Adjunctive modality 7.14 Mobilizations – Patellar				
Stevens-Lapsley, 2012, 22095207, USA	Early neuromuscular electrical stimulation plus standard rehabilitation vs. standard rehabilitation	Standard rehabilitation & NMES	**1. Strength** 1.8 Gluteal Sets 1.11 Hip abduction in sidelying 1.13 Hip abduction in supine 1.30 Knee extension AAROM in sitting or supine (short- or long arc quad) 1.31 Knee extension in sitting or supine (long arc quad) 1.32 Knee extension in sitting or supine (short arc quad) 1.37 Knee flexion in standing 1.43 Quad sets 1.49 Squats 1.51 Standing terminal knee extension 1.52 Step down 1.55 Step up – forward 1.58 Straight leg raises 1.61 Wall slides **2. Aerobic** 2.2 Bike (Endurance) **3. Flexibility** 3.1 Ankle pumps 3.2 Bike (ROM) 3.6 Heel slides 3.10 Knee extension AROM 3.11 Knee extension PROM in supine (position unclear) 3.12 Knee extension PROM in prone (position unclear) 3.13 Knee flexion AROM 3.14 Knee flexion PROM in sitting or supine 3.17 Standing terminal knee extension **4. Balance-Motor Learning-Agility** 4.8 Single leg stance 4.11 Step down 4.14 Step up – forward **5. Task specific training** 5.1 Transfers 5.8 Gait training 5.13 Sit-to-stand training 5.15 Stair training **6. Patient education** 6.1 Activities of daily living 6.2 Home exercise program **7. Adjunctive modality** 7.1. Cold 7.5 E-stim for strength (NMES) 7.11 Massage for scar mobility 7.13 Mobilizations – Tibiofemoral	Y (Y)	Physical therapist	In-person; Home	Acute Inpatient; Home; Physical therapy/rehabilitation facility (outpatient)

Study, Year, PMID, Country	Intended Comparison	Arm	Components (Specific Exercises/Strategies)	Progression (Appropriate?)	Personnel	Mode of Delivery	Setting
			7.14 Mobilizations – Patellar				
	No data	Standard rehabilitation	**1. Strength** 1.8 Gluteal Sets 1.11 Hip abduction in sidelying 1.13 Hip abduction in supine 1.30 Knee extension AAROM in sitting or supine (short- or long arc quad) 1.31 Knee extension in sitting or supine (long arc quad) 1.32 Knee extension in sitting or supine (short arc quad) 1.37 Knee flexion in standing 1.43 Quad sets 1.49 Squats 1.51 Standing terminal knee extension 1.52 Step down 1.55 Step up – forward 1.58 Straight leg raises 1.61 Wall slides **2. Aerobic** 2.2 Bike (Endurance) **3. Flexibility** 3.1 Ankle pumps 3.2 Bike (ROM) 3.6 Heel slides 3.10 Knee extension AROM 3.11 Knee extension PROM in supine (position unclear) 3.12 Knee extension PROM in prone (position unclear) 3.13 Knee flexion AROM 3.14 Knee flexion PROM in sitting or supine 3.17 Standing terminal knee extension **4. Balance-Motor Learning-Agility** 4.8 Single leg stance 4.11 Step down 4.14 Step up – forward **5. Task specific training** 5.1 Transfers 5.8 Gait training 5.13 Sit-to-stand training 5.15 Stair training **6. Patient education** 6.1 Activities of daily living 6.2 Home exercise program **7. Adjunctive modality** 7.1. Cold 7.11 Massage for scar mobility 7.13 Mobilizations – Tibiofemoral 7.14 Mobilizations – Patellar	Y (Y)	Physical therapist	In-person; Home	Acute Inpatient; Home; Physical therapy/rehabilitation facility (outpatient)

Study, Year, PMID, Country	Intended Comparison	Arm	Components (Specific Exercises/Strategies)	Progression (Appropriate?)	Personnel	Mode of Delivery	Setting
Tousignant, 2011, 21398389, Canada	Home telerehabilitation vs. conventional rehabilitation	Telerehabilitation	[specific goals and exercises not defined beyond improving function and activities of daily living; comparison of setting & mode of delivery] **6. Patient education** 6.1 Activities of daily living	Y (N)	Physical therapist	Remote via web	Home
	No data	Conventional rehabilitation (Home care/outpatient clinic)	[specific goals and exercises not defined beyond improving function and activities of daily living; comparison of setting and mode of delivery] **6. Patient education** 6.1 Activities of daily living	Y (N)	Physical therapist	In-person	Physical therapy/rehabilitation facility (outpatient)
Tsukada, 2020, 31723080, Japan	Conventional rehabilitation plus a hybrid training system vs. conventional rehabilitation alone	Standard rehabilitation & hybrid training system	**1. Strength** 1.8 Gluteal Sets 1.13 Hip abduction in supine 1.31 Knee extension in sitting or supine (long arc quad) 1.35 Knee flexion in prone (position unclear) 1.36 Knee flexion in sitting or supine (position unclear) 1.37 Knee flexion in standing (position unclear) 1.43 Quad sets 1.58 Straight leg raises 1.63 Open chain ankle dorsiflexion/plantar flexion/inversion/eversion **2. Aerobic** 2.2 Bike (Endurance) 2.9 Walking **3. Flexibility** 3.1 Ankle pumps 3.2 Bike (ROM) 3.6 Heel slides 3.10 Knee extension AROM (active assisted) 3.11 Knee extension PROM in supine (active assisted) 3.12 Knee extension PROM in prone (active assisted) 3.13 Knee flexion AROM (active assisted) 3.14 Knee flexion PROM in sitting or supine (active assisted) 3.15 Knee flexion AROM in any position (rectus femoris stretch) (active assisted) 3.16 Knee flexion PROM in prone (rectus femoris stretch) (active assisted) 3.17 Standing terminal knee extension **5. Task specific training** 5.1 Transfers 5.8 Gait training 5.15 Stair training **6. Patient education** 6.1 Activities of daily living **7. Adjunctive modality**	Y (N)	Physical therapist	In-person	Acute inpatient

Study, Year, PMID, Country	Intended Comparison	Arm	Components (Specific Exercises/Strategies)	Progression (Appropriate?)	Personnel	Mode of Delivery	Setting
			7.1 Cold 7.5 E-stim for strength (NMES)				
	No data	Standard rehabilitation	**1. Strength** 1.8 Gluteal Sets 1.13 Hip abduction in supine 1.31 Knee extension in sitting or supine (long arc quad) 1.35 Knee flexion in prone (position unclear) 1.36 Knee flexion in sitting or supine (position unclear) 1.37 Knee flexion in standing (position unclear) 1.43 Quad sets 1.58 Straight leg raises 1.63 Open chain ankle dorsiflexion/plantar flexion/inversion/eversion **2. Aerobic** 2.2 Bike (Endurance) 2.9 Walking **3. Flexibility** 3.1 Ankle pumps 3.2 Bike (ROM) 3.6 Heel slides 3.10 Knee extension AROM (active assisted) 3.11 Knee extension PROM in supine (active assisted) 3.12 Knee extension PROM in prone (active assisted) 3.13 Knee flexion AROM (active assisted) 3.14 Knee flexion PROM in sitting or supine (active assisted) 3.15 Knee flexion AROM in any position (rectus femoris stretch) (active assisted) 3.16 Knee flexion PROM in prone (rectus femoris stretch) (active assisted) 3.17 Standing terminal knee extension **5. Task specific training** 5.1 Transfers 5.8 Gait training 5.15 Stair training **6. Patient education** 6.1 Activities of daily living **7. Adjunctive modality** 7.1 Cold	Y (N)	Physical therapist	In-person	Acute inpatient
Vuorenmaa, 2014, 24241606, Finland	Monitored home exercise program vs. normal care	Home exercise	**1. Strength** 1.9 Heel raises – bilateral (calf raises) 1.10 Heel raises – unilateral 1.31 Knee extension in sitting or supine (long arc quad) 1.32 Knee extension in sitting or supine (short arc quad)	Y (N)	Physical therapist	In-person; Home	Physical therapy/rehabilitation facility (outpatient); Home

Study, Year, PMID, Country	Intended Comparison	Arm	Components (Specific Exercises/Strategies)	Progression (Appropriate?)	Personnel	Mode of Delivery	Setting
			1.36 Knee flexion in sitting or supine 1.48 Sit-to-stand 1.49 Squats 1.55 Step up – forward 1.61 Wall slides **3. Flexibility** 3.2 Bike (ROM) 3.4 Calf stretch with knee straight (gastroc) 3.5 Hamstring stretch in any position 3.8 Hip flexor stretch (iliopsoas) 3.16 Knee flexion PROM in prone (rectus femoris stretch) **6. Patient education** 6.2 Home exercise program				
	No data	Control	[Normal care consisted of no additional guidance after baseline measures]	N (NA)	None	NA	Home
Zapparoli, 2020, 32488010 Italy	Motor imagery & rehabilitation vs. rehabilitation	Motor imagery & rehabilitation	**1. Strength** **3. Flexibility** 3.10 Knee extension AROM 3.11 Knee extension PROM in supine 3.12 Knee extension PROM in prone 3.13 Knee flexion AROM 3.14 Knee flexion PROM in sitting or supine 3.15 Knee flexion AROM in any position (rectus femoris stretch) 3.16 Knee flexion PROM in prone (rectus femoris stretch) **4. Balance-Motor Learning-Agility** **5. Task specific training** 5.8 Gait training **7. Adjunctive modality** 7.17 Mindfulness, stress/anxiety-reduction interventions	N (NA)	Physical therapist	In-person	Acute inpatient
	No data	Rehabilitation	**1. Strength** **3. Flexibility** 3.10 Knee extension AROM 3.11 Knee extension PROM in supine 3.12 Knee extension PROM in prone 3.13 Knee flexion AROM 3.14 Knee flexion PROM in sitting or supine 3.15 Knee flexion AROM in any position (rectus femoris stretch) 3.16 Knee flexion PROM in prone (rectus femoris stretch) **4. Balance-Motor Learning-Agility** **5. Task specific training** 5.8 Gait training	N (NA)	Physical therapist	In-person	Acute inpatient

[A] Non-randomized study

Abbreviations: AAROM = assisted active range of motion, ADL = activities of daily living, AROM = active range of motion, NA = not applicable, NMES = neuromuscular electrical stimulation, NR = not reported, PROM = passive range of motion, ROM = range of motion, TENS = transcutaneous electrical nerve stimulation, TKA = total knee arthroplasty.

Table C-2.3. KQ 2. Risk of bias assessment for primary studies – randomized controlled trials (RCTs)

Study, Year, PMID	Random	Allocation	Blinding, Participants	Blinding, Providers	Blinding, Outcome, Obj / Subj	Dropout	Reporting Bias	Other	Population	Intervention	Outcomes	Overall RoB
Andersen, 2018, No PMID	Unsure	Unsure	High	High	Low	Unsure	Low	Low	No	No	No	High
Artz, 2017, 27068368	Low	Low	High	High	Unsure	High	Low	Low	No	No	No	High
Avramidis, 2011, 21410130	Low	Low	High	High	Low	Low	Unsure	Low	No	No	No	Moderate
Bade, 2017, 27813347	Low	Low	Low	High	Low	Low	Unsure	Low	No	No	No	Moderate
Bily, 2016, 26763947	Unsure	Low	High	High	High	Low	Low	Low	No	No	No	High
Bruun-Olsen, 2013, 23614370	Low	Low	High	Low	Low	Low	Low	Low	No	No	No	Moderate
Buhagiar, 2017, 28291891	Low	Low	High	High	Low	Low	Low	Low	No	No	No	Moderate
Cai, 2018, 29239772	Low	Low	High	Low	Low	Low	Low	Low	No	No	No	Moderate
DeJong, 2020, 32360105	Low	Unsure	High	High	Unsure	Low	Low	Low	No	No	No	High
Demircioglu, 2015, 26355656	High	Unsure	Unsure	Unsure	Unsure	Low	Low	Low	No	No	No	High
den, 2012, 22643801	Low	Low	High	High	Unsure	Low	Low	Low	No	No	No	Moderate
Eymir, 2020, 32778907	Low	High	High	High	Unsure	Low	Low	Low	No	No	No	High
Fransen, 2017, 27868384	Low	Low	High	Low	High	Low	Low	Low	No	No	No	Moderate
Hamilton, 2020, 33051212	Low	Low	High	High	High	Low	Low	Low	No	No	No	Moderate
Harmer, 2009, 19177536	Low	Low	High	High	Low	Low	Low	Low	No	No	No	Moderate
Heikkilä, 2017, 28119232	Low	Unsure	High	High	High	Low	Unsure	Low	No	No	Unsure	High
Iwakiri, 2020, 32373475	Low	Unsure	High	High	Low	Low	Low	Low	No	No	No	High
Jin, 2018, CN-01617489	Low	Unsure	High	High	Unsure	Low	Low	Low	No	No	No	High
Kauppila, 2010, 20354057	Low	Low	High	High	High	Low	Low	Unsure	No	No	No	Moderate
Lenguerrand, 2020, 31033232	Low	Low	High	High	High	Low	Low	Low	No	No	No	Moderate
Lenssen, 2006, 16942627	Low	Low	High	Unsure	Low	Low	Low	Low	No	No	No	Moderate
Li, 2014, 23412304	Unsure	Unsure	High	High	Unsure	Low	Low	Low	No	No	No	High
Li, 2015, CN-01084888	Unsure	Unsure	High	High	Unsure	Low	Low	Low	No	No	No	High

Study, Year, PMID	Random	Allocation	Blinding, Participants	Blinding, Providers	Blinding, Outcome, Obj / Subj	Dropout	Reporting Bias	Other	Population	Intervention	Outcomes	Overall RoB
Li, 2019, 31003647	Low	Low	High	High	Unsure	Low	Low	Low	No	No	No	Moderate
Li, 2017, No PMID	Low	Low	High	High	Low	Low	Low	Low	No	No	No	Moderate
Liao, 2015, 25552523	Low	Unsure	High	High	Unsure	Low	Low	Low	No	No	No	High
Liao, 2020, 31687984	Low	Low	High	High	Low	Low	Low	Low	No	No	No	Moderate
Liebs, 2010, 20360503	Low	Low	High	High	High	Low	Low	Low	No	No	No	Moderate
Liebs, 2012, 22196125	Low	Low	High	High	High	Low	Low	Low	No	No	No	Moderate
Madsen, 2013, 23651717	Unsure	Low	High	High	Unsure	Low	Low	Low	No	No	No	High
Minns Lowe, 2012, 22180446	Low	Low	High	High	Low	Low	Low	High	No	No	No	High
Mitchell, 2005, 15869558	Low	High	High	High	Unsure	Low	Low	Low	No	No	No	High
Moffet, 2015, 26178888	Low	Low	High	High	High	Low	Low	Low	No	No	No	Moderate
Monticone, 2013, 23063624	Low	Low	High	High	Low	Low	Low	Low	No	No	No	Moderate
Moutzouri, 2018, 29473481	Low	Low	High	High	Unsure	Low	Low	Low	No	No	No	Moderate
Petersen, 2018, 29294078	Low	Low	Unsure	Low	Low	Low	Low	Low	No	No	No	Moderate
Petterson, 2009, 19177542	Unsure	Unsure	High	High	Low	High	Low	Low	No	No	No	High
Piqueras, 2013, 23474735	Low	Low	High	High	Low	Low	Low	Low	No	No	No	Moderate
Piva, 2017, 28217891	Low	Low	Low	High	Low	Low	Low	Low	No	No	No	Moderate
Piva, 2019, 30794296	Low	Low	High	Low	Low	Low	Low	Low	No	No	No	Moderate
Rockstroh, 2010, 20533147	Low	Unsure	High	Unsure	High	Low	Unsure	Low	No	No	No	High
Sattler, 2019, 30994586	Low	Low	High	High	High	Low	Low	Low	No	No	No	Moderate
Schache, 2019, 31208916	Low	Low	High	Low	Low	Low	Low	Low	No	No	No	Moderate
Shanb, 2014, No PMID	High	High	High	Low	High	Low	Low	Low	Yes	Yes	Yes	High
Stevens-Lapsley, 2012, 22095207	Low	Low	High	High	High	Low	Low	Low	No	No	No	Moderate
Tousignant, 2011, 21398389	Low	Low	High	High	Unsure	Low	High	Low	Unsure	No	No	Moderate
Tsukada, 2020, 31723080	Low	Low	High	High	Unsure	Low	Low	Low	No	No	No	Moderate

Study, Year, PMID	Random	Allocation	Blinding, Participants	Blinding, Providers	Blinding, Outcome, Obj / Subj	Dropout	Reporting Bias	Other	Population	Intervention	Outcomes	Overall RoB
Vuorenmaa, 2014, 24241606	Low	Low	High	High	Low	Low	Low	Low	No	No	No	Moderate
Zapparoli, 2020, 32488010	Low	Unsure	High	High	Low	Low	Low	Low	No	No	No	High

PMID = Obj = objective, PubMed Identifier, Subj = subjective.

From the Cochrane Risk of Bias Tool (each item rated as Low, High, Unsure, or N/A). Ratings are color coded for emphasis only.

- Random: Random sequence generation (selection bias): Selection bias (biased allocation to interventions) due to inadequate generation of a randomized sequence;
- Allocation: Allocation concealment (selection bias): Selection bias (biased allocation to interventions) due to inadequate concealment of allocations prior to assignment;
- Blinding of participants (performance bias): Performance bias due to knowledge of the allocated interventions by participants during the study;
- Blinding of personnel/care providers (performance bias): Performance bias due to knowledge of the allocated interventions by personnel/care providers during the study;
- Blinding of outcome assessor (detection bias): Detection bias due to knowledge of the allocated interventions by outcome assessors;
- Dropout: Incomplete outcome data (attrition bias): Attrition bias due to amount, nature or handling of incomplete outcome data;
- Reporting Bias: Selective outcome reporting (outcome reporting bias): Bias arising from outcomes being selectively reported based on the direction and/or strength of the results;
- Other Bias: Bias due to problems not covered elsewhere in the table.

From the National Heart, Lung, and Blood Institute (NHLBI) Quality Assessment Tool (each item rated as No, Yes, or Unsure)

- Population: Eligibility criteria prespecified and clearly described: potentially related to selection bias;
- Intervention: Intervention clearly described and delivered consistently: potentially related to performance bias;
- Outcomes: Outcomes prespecified, clearly defined, valid, reliable, and assessed consistently: potentially related to detection bias.

Overall risk of bias assessed as **HIGH**, **MODERATE**, or **LOW**.

Table C-2.4. KQ 2. Risk of bias assessment for primary studies – nonrandomized comparative studies (NRCSs) – assessment of confounding and selection bias

Study, Year, PMID	1.1 Potential for any confounding?	1.2 Potential for time-varying confounding?	1.3 Intervention Switches Related to ProgLowstic Factors?	1.4 Appropriate analysis method for confounding?	1.5 Appropriate confounding variables used?	1.6 Inappropriate control of post-intervention variables?	Judgement – Risk of bias related to confounding	2.1 Participant selection based on post-intervention variables?	2.2 Post-intervention variables associated with intervention?	2.3 Post-intervention variables associated with outcome?	2.5 Appropriate adjustment for selection bias	Judgement – Risk of bias related to selection bias	Overall RoB
Chan, 2018, 29372260	Yes	No	No	Yes	Yes	No	Low	No	N/A	N/A	N/A	Low	Moderate
Naylor, 2017, 28899328	Yes	No	No	Yes	Yes	No	Low	No	N/A	N/A	N/A	Low	Moderate
Padgett, 2018, 29352683	Yes	No	No	Yes	Yes	No	Low	No	N/A	N/A	N/A	Low	Moderate
Pua, 2017, 27810379	Yes	No	No	Yes	Yes	No	Low	No	N/A	N/A	N/A	Low	Moderate

- PMID = PubMed Identifier, Responses to Risk of Bias in Non-randomized Studies of Interventions (ROBINS-I) signaling questions 1.1 to 1.6 and 2.1 to 2.5 are in regular font. Each item rated as High, PY (probably High), NI (Low information), PN (probably Low), Low, or N/A (Not applicable).
- Judgments about confounding and selection bias are in **bold font** and each item is rated as Low, **Moderate**, **Serious**, or **Critical**. Ratings are color coded for emphasis only.

Key Question 3: Prehabilitation for Total Hip Arthroplasty

Table C-3.1. KQ 3. Design details and arms

Study[A], Year, PMID, Country	Funding Source	Overall RoB	Eligibility Criteria	Intervention[B]	N, Enrolled	Mean Age, Years (SD)	Female, %	Mean BMI[C] (SD)	Prior Contralateral Arthroplasty
Bitterli, 2011, 21630176, Switzerland	NR	Moderate	INCLUSION: Unilateral arthrosis or femoral head necrosis, first and unilateral THA. EXCLUSION: Previous surgery on the affected joint, who had been fitted with hip, knee or ankle joint prostheses, for whom a double-sided TKA had been planned, surgery < 3 weeks, able to follow the training program for < 15 days, suffering from neurological complaints.	Pre-operative home exercise sensorimotor training program Comp: S-E AdjMod: - Set: H	41	65.4 (10.8) Range (37, 85)	46%	27.6 (3.6) Range (20, 40)	NR
	No data	No data	No data	Control Comp: - AdjMod: - Set: -	39	68.4 (9.7) Range (40, 86)	31%	27.1 (3.6) Range (18, 36)	NR
Holsgaard-Larsen, 2020, 32376477, Denmark	NR	Moderate	INCLUSION: ≥50 yo, scheduled THA due to primary OA. Minimum participation in 80% of training (no more than 2 sequential skipped sessions. EXCLUSION: Uremia, cancer, systemic treatment with glucocorticoid >3mo in the last 5 yrs with a daily dose >5mg. Fracture of the hip (ipsi or contralateral). Other fracture of the lower extremities within the last year. Other condition with reduced function.	Preoperative progressive resistance training Comp: S AdjMod: - Set: O	40	70.0 (7.7)	27%	28.2 (5.3)	NR
	No data	No data	No data	Control Comp: - AdjMod: - Set: -	40	70.8 (7.5)	25%	27.4 (3.8)	NR
Pour, 2007, 17768187, USA	Industry	High	INCLUSION: 18-75 yo, diagnosis of OA. EXCLUSION: BMI >30 kg/m^2, cognitive impairment or severe psychiatric illness that would preclude participation in the protocol-mandated procedures.	Accelerated rehabilitation Comp: T AdjMod: - Set: O	46	60.4(NR)*	48%	25.5 (NR)*	NR
	No data	No data	No data	Standard rehabilitation Comp: - AdjMod: - Set: -	48	61.1(NR)[D]	50%	26.4(NR)[d]	NR
Rooks, 2006, 17013852, USA	NR	Moderate	INCLUSION: Unilateral, primary THA, advanced OA, interval of 8-12 weeks between enrolment and surgery. EXCLUSION: Inflammatory arthritis (i.e., RA, systemic lupus erythematosus), Parkinsons disease, or any medical condition in which a moderate level of exercise was contraindicated (i.e., uncontrolled diabetes or hypertension), bilateral joint replacement or an extended out-of-town vacation during the 6 wks prior to surgery.	Preoperative exercise Comp: S-A-F AdjMod: - Set: Gym or other community center	32	65 (11)	63%	28.4 (5.3)	NR

Study[A], Year, PMID, Country	Funding Source	Overall RoB	Eligibility Criteria	Intervention[B]	N, Enrolled	Mean Age, Years (SD)	Female, %	Mean BMI[C] (SD)	Prior Contralateral Arthroplasty
	No data	No data	No data	Preoperative education Comp: - AdjMod: - Set: -	31	59 (7)	52%	30.3 (9.1)	NR
Soeters, 2018, 29529614, USA	NR	Moderate	INCLUSION: 18-85yo, scheduled unilateral TJA (THA or TKA), able to independently ambulate a half a block or more with or without an assistive device, able to independently perform nonreciprocal stairs with or without assistive devices, and planned to be discharged home after surgery. EXCLUSION: Patients who did not undergo scheduled surgery, underwent a procedure other than primary TJA, or were discharged to inpatient rehabilitation centers.	Preoperative physical therapy (PreopPTEd) Comp: T-E AdjMod: - Set: NR	31	61 (9); Range (37-98)[E]	44%	29 (6); Range (19-46)	NR
	No data	No data	No data	No preoperative physical therapy education Comp: - AdjMod: - Set: -	32	62 (8); Range (45-85)	29%	29 (6); Range (17-48)	NR
Vukomanović, 2008, 18499950, Serbia	NR	High	INCLUSION: <70yo, primary and secondary OA, ability to walk up and down stairs, no need for using crutches while walking, no experience in walking with crutches (because of opposite hip arthroplasty or some other reasons), no coexisting morbidity such as a history of severe cardiovascular, respiratory, neuromuscular, rheumatic disease or mental confusion. EXCLUSION: intraoperative (femoral or acetabular fracture), postoperative complications (postoperative disorientation, anemia, circulatory collapse, orthostatic hypotension, chest pain, sustained hypertension, deep venous thrombosis, pulmonary embolism, hip dislocation) which compromised or delayed the beginning of physical therapy after the operation	Short-term preoperative physical therapy and education Comp: T-E AdjMod: - Set: NR	23	60.1 (11.0); Range (30-70)	70%	NR	NR
	No data	No data	No data	Control Comp: - AdjMod: - Set: -	22	56.2 (18.5); Range (19-70)	80%	NR	NR

Abbreviations: BMI = H = home, NA = not applicable, NMES = neuromuscular electrical stimulation, NR=not reported, O = outpatient physiotherapy center, OA = osteoarthritis, PMID = PubMed identifier, RA = rheumatoid arthritis, RoB = risk of bias, SD = standard deviation, SD = standard deviation, TENS = transcutaneous electrical nerve stimulation, THA = total hip arthroplasty, TJA = total joint arthroplasty, TKA = total knee arthroplasty, yo = years old.
Components: A = aerobic exercise, B= Balance-motor/Learning-agility exercise, E = patient education, F = flexibility exercise, S = strengthening exercise, T = task-specific training.

[A] All randomized controlled trials, except as footnoted.
[B] Including Components (Comp)); Adjunctive modalities (AdjMod); and Setting (Set).
[C] kg/m^2

[D] Calculated
[E] Reported age, gender, BMI data for total joint replacement population (TKA and THA) combined

Table C-3.2. KQ 3. Prehabilitation component details

Study, Year, PMID	Intended Comparison	Arm	Components (Specific Exercises/Strategies)	Progression (Appropriate?)	Personnel	Mode of Delivery	Setting
Bitterli, 2011, 21630176, Switzerland	Pre-operative sensorimotor training vs. no therapy	Pre-operative home exercise sensorimotor training program	**1. Strength** 1.2 Bridges two-legged (supine hip extension) 1.8 Gluteal Sets 1.12 Hip abduction in standing 1.13 Hip abduction in supine 1.36 Knee flexion in sitting or supine 1.43 Quad sets 1.49 Squats **6. Patient education** 6.2 Home exercise program	N (NA)	NR (who delivered the instruction for the home exercise program); None (unsupervised)	In-person; Self-guided (unsupervised)	Home
	No data	Control	NA [No therapy]	NA	NA	NA	NA
Holsgaard-Larsen, 2020, 32376477, Denmark	Preoperative explosive type progressive resistance training vs. care as usual	Preoperative progressive resistance training	**1. Strength** 1.19 Hip extension in standing 1.28 Knee extension machine (one-leg) 1.33 Knee flexion machine (Hamstring curl) one knee 1.38 Leg press (one leg)	Y (Y)	Physical therapist	In-person	Physical therapy/rehabilitation facility (outpatient)
	No data	Control	NA [Care as usual including no formal exercise]	NA	NA	NA	NA
Pour, 2007, 17768187, USA	Accelerated preoperative protocol vs. standard preoperative protocol	Accelerated rehabilitation	**5. Task specific training** 5.8 Gait training	N (NA)	Physical therapist	In-person	Physical therapy/rehabilitation facility (outpatient)
	No data	Standard rehabilitation	NA [No preoperative rehabilitation; standard pre-operative appointment to discuss procedure and post-operative rehabilitation expectations]	NA	NA	NA	NA

Study, Year, PMID	Intended Comparison	Arm	Components (Specific Exercises/Strategies)	Progression (Appropriate?)	Personnel	Mode of Delivery	Setting
Rooks, 2006, 17013852, USA	Short preoperative rehabilitation intervention vs. Education intervention	Preoperative exercise	**1. Strength** 1.6 Core strengthening 1.38 Leg Press (one leg) 1.39 Leg Press (two legs) 1.60 Upper extremity strengthening **2. Aerobic** 2.2 Bike (Endurance) 2.3 Elliptical machine **3. Flexibility** 3.1 Ankle pumps 3.3 Calf stretch with knee bent (soleus) 3.4 Calf stretch with knee straight (gastroc) 3.7 Hip extensor stretch (knee to chest) 3.8 Hip flexor stretch (iliopsoas) 3.10 Knee extension AROM (unclear) 3.11 Knee extension PROM in supine (unclear) 3.12 Knee extension PROM in prone (unclear) 3.13 Knee flexion AROM (unclear) 3.14 Knee flexion PROM in sitting or supine (unclear) 3.15 Knee flexion AROM in any position (rectus femoris stretch) (unclear) 3.16 Knee flexion PROM in prone (rectus femoris stretch) (unclear)	Y (N)	Physical therapist	In-person	Gym or other community center
	No data	Preoperative education	NA [handout about home modifications and preparation for surgery and hospital stay, no advice on exercise; attention control]	NA	NA	NA	NA
Soeters, 2018, 29529614, USA	One-time preoperative physical therapy education session with practice plus microsite vs. no preoperative physical therapy education	Preoperative physical therapy education (PreopPTEd)	**5. Task specific training** 5.1 Transfers 5.13 Sit-to-stand training 5.15 Stair training **6. Patient education** 6.1 ADLs	NR	Physical therapist	In-person	NR (Unclear if home or outpatient)
	No data	No preoperative physical therapy education	NA [One group education class regarding surgery specific information]	NA	NA	NA	NA
Vukomanović, 2008, 18499950, Serbia	Preoperative physical therapy and education vs. no physical therapy or education	Short-term preoperative physical therapy and education	**5. Task specific training** 5.1 Transfers 5.8 Gait training 5.13 Sit-to-stand training 5.15 Stair training **6. Patient education** 6.1 ADLs 6.2 Home exercise program	N (NA)	Physical therapist	In-person	NR
	No data	Control	[No additional care]	NA	NA	NA	NA

Abbreviations: ADL = activities of daily living, AROM = active range of motion, NA = not applicable, NMES = neuromuscular electrical stimulation, NR = not reported, PROM = passive range of motion, ROM = range of motion, TENS = transcutaneous electrical nerve stimulation.

Table C-3.3. KQ 3. Risk of bias assessment for primary studies – randomized controlled trials (RCTs)

Study, Year, PMID	Random	Allocation	Blinding, Participants	Blinding, Providers	Blinding, Outcome, Obj / Subj	Dropout	Reporting Bias	Other	Population	Intervention	Outcomes	Overall
Bitterli, 2011, 21630176	Low	Low	High	Low	Low	Low	High	Low	No	No	No	Moderate
Holsgaard-Larsen, 2020, 32376477	Low	Low	High	High	High	Low	Low	Low	No	No	No	Moderate
Pour, 2007, 17768187	Unsure	Unsure	High	High	Low	Low	Low	Low	No	No	No	High
Rooks, 2006, 17013852	Low	Unsure	High	Low	Unsure	Low	Low	Low	No	No	No	Moderate
Soeters, 2018, 29529614	Low	Low	High	Low	Low	Low	Low	Low	No	No	No	Moderate
Vukomanović, 2008, 18499950	Unsure	Unsure	High	High	Unsure	Low	Low	Low	No	No	No	High

PMID = Obj = objective, PubMed Identifier, Subj = subjective.

From the Cochrane Risk of Bias Tool (each item rated as Low, High, Unsure, or N/A). Ratings are color coded for emphasis only.

- Random: Random sequence generation (selection bias): Selection bias (biased allocation to interventions) due to inadequate generation of a randomized sequence;
- Allocation: Allocation concealment (selection bias): Selection bias (biased allocation to interventions) due to inadequate concealment of allocations prior to assignment;
- Blinding of participants (performance bias): Performance bias due to knowledge of the allocated interventions by participants during the study;
- Blinding of personnel/care providers (performance bias): Performance bias due to knowledge of the allocated interventions by personnel/care providers during the study;
- Blinding of outcome assessor (detection bias): Detection bias due to knowledge of the allocated interventions by outcome assessors;
- Dropout: Incomplete outcome data (attrition bias): Attrition bias due to amount, nature or handling of incomplete outcome data;
- Reporting Bias: Selective outcome reporting (outcome reporting bias): Bias arising from outcomes being selectively reported based on the direction and/or strength of the results;
- Other Bias: Bias due to problems not covered elsewhere in the table.

From the National Heart, Lung, and Blood Institute (NHLBI) Quality Assessment Tool (each item rated as No, Yes, or Unsure)

- Population: Eligibility criteria prespecified and clearly described: potentially related to selection bias;
- Intervention: Intervention clearly described and delivered consistently: potentially related to performance bias;
- Outcomes: Outcomes prespecified, clearly defined, valid, reliable, and assessed consistently: potentially related to detection bias.

Overall risk of bias assessed as **HIGH**, **MODERATE**, or **LOW**.

Key Question 4: Rehabilitation for Total Hip Arthroplasty

Table C-4.1. KQ 4. Design details and arms

Study[A], Year, PMID, Country	Funding Source	Overall RoB	Eligibility Criteria	Intervention[B]	N, Enrolled	Mean Age, Years (SD)	Female, %	Mean BMI[C] (SD)	Prior Contralateral Arthroplasty
Austin, 2017, 28419032, USA	NR	Moderate	INCLUSION: 18-80 yo, primary, THA for OA. EXCLUSION: Those with inflammatory or posttraumatic arthritis, those with a history of septic arthritis of the involved hip, and those undergoing revision THA or conversion THA with removal of previously implanted components. Additionally, patients requiring discharge to an acute rehabilitation center, skilled nursing facility, convalescent home, or long-term care facility	Home exercise Comp: E AdjMod: - Set: H	60	62.3[d] (12.7)	26%	28.2 (7.0)	NR
	No data	No data	No data	Formal Physical Therapy Comp: - AdjMod: - Set: H, O	60	61.2 (8.4)	21%	30.4 (5.2)	NR
Beck, 2019, 30782304, Germany	Non-industry	High	INCLUSION: ≥18yo, general medical eligibility for hip rehab sports therapy, a stable implant. EXCLUSION: acute or chronic diseases and severe pain in the affected hip joint.	Sports therapy Comp: S-A-F-B-T-E AdjMod: Massage Set: O	80	Median (59.0); Range (51.1-69.7)	53%	Median (26.4) Range (23.8, 28.6)	NR
	No data	No data	No data	Control Comp: - AdjMod: - Set: -	80	Median 61.9; Range (52.5,70.0)	64%	Median: 25.9; Range (23.7, 30.4))	NR
Coulter, 2017, 28506775, Australia	NR	High	INCLUSION: ≥18 yo, having a primary elective THA. EXCLUSION: Metastatic disease, pathological fractures, infection, or acute trauma; revision THA; University of California, Los Angeles (UCLA) activity scale level <2 preoperatively; being able to bear weight postoperatively; requiring inpatient rehabilitation postoperatively	Unsupervised home-based exercises Comp: S-F-E AdjMod: - Set: H	42	Median (63); IQR (53, 87); Range (21, 86)	50%	NR	NR
	No data	No data	No data	Supervised rehabilitation & unsupervised home-based exercises Comp: S-F-T-E AdjMod: - Set: O	56	Median 66; IQR (57, 88); Range (34, 88)	64%	NR	NR

Study[A], Year, PMID, Country	Funding Source	Overall RoB	Eligibility Criteria	Intervention[B]	N, Enrolled	Mean Age, Years (SD)	Female, %	Mean BMI[C] (SD)	Prior Contralateral Arthroplasty
Giaquinto 2010, 19282040, Italy	NR	Low	INCLUSION: (i) patients referred from district hospitals; (ii) short interval from surgical intervention (less than 10 days); (iii) good general conditions. EXCLUSION: (i) presence of a physical or mental acute illness; (ii) cognitive deterioration; (iii) inability to complete questionnaires; (iv) no compliance	Hydrotherapy Comp: S-F AdjMod: - Set: Other inpatient facility	31	70.1 (8.5)	68%	Median (25.5)	NR
	No data	No data	No data	No hydrotherapy Comp: - AdjMod: Massage Set: Other inpatient facility	33	70.6 (8.4)	67%	Median (26.4)	NR
Heiberg, 2012, 22170790, Norway	Non-industry	Moderate	INCLUSION: Diagnosis of OA of the hip joint. EXCLUSION: Had OA in a knee or the contralateral hip that restricted their walking, a neurologic disease, dementia, heart disease, drug abuse	Walking skill training program Comp: S-A-B-T AdjMod: - Set: O	35	65; 95% CI (63, 68)	60%	27 (95% CI 26, 29)	NR
	No data	No data	No data	Standard care Comp: - AdjMod: - Set: -	33	66; 95% CI (63, 69)	42%	27 (95% CI 25, 28)	NR
Liebs, 2010, 20360503, Germany	Non-industry	Moderate	INCLUSION: Primary unilateral total hip or knee replacement on an elective basis after a diagnosis of OA or osteonecrosis. EXCLUSION: History of septic arthritis, a hip or knee fracture, an intraoperative complication, revision arthroplasty, RA, lower extremity amputation, a malignant tumor.	Ergometer cycling Comp: S-F-B-T AdjMod: - Set: -	99	67.2 (10.3)	62%	26.5 (4.1)	NR
	No data	No data	No data	Control Comp: S-F-B-T AdjMod: - Set: O	104	67.2 (8.5)	63%	27.4 (4.5)	NR
Liebs, 2012, 22196125, Germany	Non-industry	Moderate	INCLUSION: Unilateral hip or knee replacement surgery at participating centers on an elective basis after diagnosis of OA. EXCLUSION: History of septic arthritis, hip or knee fracture, intraoperative complications, revision arthroplasty, RA, amputations, malignancy	Early aquatic therapy Comp: S-F-B-T AdjMod: - Set: O	138	66.7 (10.3)	64%	27.6 (4.4)	NR
	No data	No data	No data	Late aquatic therapy (after wound healing) Comp: S-F-B-T AdjMod: - Set: O	142	69.1 (9.8)	62%	26.8 (4.6)	NR
Łyp, 2016, 27455419, Poland	NR	High	INCLUSION: Patients after THR. EXCLUSION: NR	Kinesiotherapy, low-frequency magnetic field and water exercises Comp: S-F AdjMod: Complimentary and alternative therapy Set: O	32	59.84 (6.00)	NR	27.7 (5.1)	NR

Study[A], Year, PMID, Country	Funding Source	Overall RoB	Eligibility Criteria	Intervention[B]	N, Enrolled	Mean Age, Years (SD)	Female, %	Mean BMI[C] (SD)	Prior Contralateral Arthroplasty
	No data	No data	No data	Kinesiotherapy, low-frequency magnetic field, without water exercises Comp: S AdjMod: Complimentary and alternative therapy Set: O	32	63.5 (10.0)	NR	27.1 (4.6)	NR
	No data	No data	No data	Control Comp: - AdjMod: - Set: O	32	63.7 (9.8)	NR	27.2 (4.6)	NR
Mikkelsen, 2014, 25305374, Denmark	Non-industry	Moderate	INCLUSION: Primary unilateral THA for hip OA, preoperative HOOS ADL 67, age > 18 years, willing to participate in training twice a week for 10 weeks. EXCLUSION: Resurfacing hip implant, body mass index (BMI) >35, pre-planned supervised rehabilitation, pre-planned contralateral THA within 6 months, mental or physical conditions impeding the intervention	Early supervised progressive resistance training Comp: S-F-E AdjMod: Set:	32	64.8 (8)	44%	27.5 (4)	25%
	No data	No data	No data	Unsupervised home-based exercise Comp: S-F-E AdjMod: Set:	30	65.1 (10)	40%	25.4 (4)	23%
Monticone, 2014, 24459172, Italy	NR	Moderate	INCLUSION: Patients had to have undergone primary traditional uncemented total hip replacement because of osteoarthritis in the dominant leg 4-7 days before admission to our Rehabilitation Unit, be in the impossible-to-go- home group after discharge from the Orthopaedic Unit because of multiple comorbidities (e.g. cardiac, respiratory, or endocrine diseases), still requiring medical care and/or insufficient home support (e.g. living alone, absence of familiar, and social helps, or lack of transportation in order to access outpatient services), be aged >50 years, and have a good understanding of Italian. EXCLUSION: Cognitive impairment and all other causes of hip pain, such as previous lower limb surgery, infection, fracture, osteonecrosis or malignancy, and systemic or neuromuscular diseases; any subjects receiving compensation for work-related disabilities	Task-oriented exercises Comp: S-F-B-T-E AdjMod: - Set: G; H	50	69.5 (7.5)	64%	27.7 (4.2)	NR
	No data	No data	No data	Open chain kinetic exercise Comp: S-T AdjMod: - Set: Other inpatient facility	50	68.8 (8.1)	56%	27.4 (3.0)	NR

Study[A], Year, PMID, Country	Funding Source	Overall RoB	Eligibility Criteria	Intervention[B]	N, Enrolled	Mean Age, Years (SD)	Female, %	Mean BMI[C] (SD)	Prior Contralateral Arthroplasty
Naylor, 2018, 30021552, Australia[E]	Non-industry	Moderate	INCLUSION: Primary surgery, no further arthroplasty planned within 3-months, and the ability to understand the protocol and be followed-up by telephone for 1 year, being privately insured. EXCLUSION: Publicly insured patients, the privately insured patients referred to inpatient rehabilitation due to slow progress, inadequate social supports (e.g living alone or without the help of an able carer), and those with conditions that would alter their rehabilitation pathway (e.g bilateral surgery or significant complication (defined below) up to 90-days post-surgery).	Inpatient rehabilitation Comp: - AdjMod: - Set: Other inpatient facility	123	67.8 (10.0)	36%	27.8 (4.8)	NR
	No data	No data	No data	No inpatient rehabilitation Comp: - AdjMod: - Set: Home	123	66.9 (10.6)	32%	28.0 (5.1)	NR
Nelson, 2020, 32026820, Australia	Non-industry	Moderate	INCLUSION: Undergoing primary elective THR, could attend five in-person appointments. EXCLUSION: Comorbidities preventing participation in rehabilitation, were undergoing revision THR, experienced intraoperative complications that prevented participation in the Queensland Health inpatient THR clinical pathway, or were unable to mobilize full weight-bearing.	Telerehabilitation Comp: S-T-E AdjMod: - Set: H	35	62 (9)	66%	NR	NR
	No data	No data	No data	In-person usual care Comp: S-T-E AdjMod: - Set: H, O	35	67 (11)	60%	NR	NR
Rao, 2021, 33863614 USA	Industry	High	INCLUSION: older than 18 years of age undergoing primary, unilateral THA for osteoarthritis. EXCLUSION: inflammatory or post-traumatic arthritis or underwent revision THA	Home physical therapy Comp: S-F AdjMod: - Set: H	75	56.0 (10.7)	63%	28.0 (5.0)	NR
	No data	No data	No data	Formal physical therapy Comp: S-F-E AdjMod: - Set: O; H	72	54.3 (11.2)	60%	28.0 (5.4)	NR
Smith, 2009, 19876883, UK	NR	Moderate	INCLUSION: Patients undergoing unilateral primary THR, aged 18 years-old or over of either gender. EXCLUSION: Unable to undertake assessment and treatment procedures, could not independently mobilise with or without walking aids, required to be non-weight- bearing post-operatively, complex primary THRs requiring bone grafting and/or acetabulum screw fixation	Gait re-education program and bed exercises Comp: S-F AdjMod: - Set: AI	30	66.2 (11.3)	70%	NR	NR

Study[A], Year, PMID, Country	Funding Source	Overall RoB	Eligibility Criteria	Intervention[B]	N, Enrolled	Mean Age, Years (SD)	Female, %	Mean BMI[C] (SD)	Prior Contralateral Arthroplasty
	No data	No data	No data	Gait re-education program only Comp: T AdjMod: - Set: AI	30	68.1 (10.5)	63%	NR	NR
Winther, 2020, 31977324, Norway	NR	Moderate	INCLUSION: Scheduled for THA. Diagnosis of primary osteoarthritis as the main cause for elective THA. ASA score of I-III (stable).EXCLUSION: Severe hip osteoarthritis of the contralateral hip, not fully recovered from a previous THA, or any illness/disease that could influence the ability to accomplish training and/or physical testing performance, such as muscular diseases, rest symptoms from stroke, and paralysis of the peroneus muscles.	Strengthening exercise Comp: S AdjMod: - Set: O	27	60 (NR)	52%	28	NR
	No data	No data	No data	Standard care Comp: - AdjMod: - Set: -	27	66 (NR)	44%	27	NR

Blue coloring is only to visually separate different studies.

Abbreviations: AI = acute inpatient, BMI = body mass index, G = gym or other community center (outpatient); H = home, NA = not applicable, NMES = neuromuscular electrical stimulation, NR=not reported, O = outpatient physiotherapy center, OA = osteoarthritis, PMID = PubMed identifier, RA = rheumatoid arthritis, RoB = risk of bias, SD = standard deviation, SD = standard deviation, TENS = transcutaneous electrical nerve stimulation, THA = total hip arthroplasty, TJA = total joint arthroplasty, TKA = total knee arthroplasty, yo = years old.

[A] All randomized controlled trials, except as footnoted.
[B] Including Components (Comp)); Adjunctive modalities (AdjMod); and Setting (Set).
Components: A = aerobic exercise, B= Balance-motor/Learning-agility exercise, E = patient education, F = flexibility exercise, S = strengthening exercise, T = task-specific training.
[C] kg/m^2
[D] Reported age, gender, BMI data for patients included in final analysis only (n=54 for both home exercise and formal physical therapy groups)
[E] Non-randomized study

Table C-4.2. KQ 4. Rehabilitation component details

Study, Year, PMID	Intended Comparison	Arm	Components (Specific Exercises/Strategies)	Progression (Appropriate)	Personnel	Mode of Delivery	Setting
Austin, 2017, 28419032, USA	Self-directed home exercise program vs. standard home and outpatient physical therapy	Home exercise	[specific goals and exercises not defined] **6. Patient education** 6.2 Home exercise program	NR	None	Self-guided (unsupervised)	Home
	No data	Formal Physical Therapy	[specific goals and exercises not defined] [Conventional home and outpatient physical therapy – specific interventions not described]	NR	Physical therapist	In-person	Home (2wks); Physical therapy/rehabilitation facility (outpatient) (8wks)
Beck, 2019, 30782304, Germany	Intensive sport rehabilitation vs. control	Sports therapy	**1. Strength** 1.49 Squats **2. Aerobic** 2.2 Bike (Endurance) 2.9 Walking **3. Flexibility** 3.8 Hip flexor stretch (iliopsoas) **4. Balance-Motor Learning-Agility** 4.3 Balance on unstable surface **5. Task specific training** 5.8 Gait training **6. Patient education** [specific education not defined] **7. Adjunctive modality** 7.12 Massage/myofascial techniques for soft tissue	N (NA)	Other ("rehabilitation sports therapy providers"; unspecified)	In-person	Physical therapy/rehabilitation facility (outpatient)
	No data	Control	NA [No hip rehabilitation sports therapy]	N (NA)	NA	NA	NA
Coulter, 2017, 28506775, Australia	Unsupervised home-based physiotherapy vs. supervised outpatient physiotherapy	Unsupervised home-based exercises	**1. Strength** [specific exercises not defined] **3. Flexibility** [specific exercises not defined] **6. Patient education** 6.2 Home exercise program	Y (N)	None (unsupervised)	Self-guided (unsupervised)	Home

Study, Year, PMID	Intended Comparison	Arm	Components (Specific Exercises/Strategies)	Progression (Appropriate)	Personnel	Mode of Delivery	Setting
		Supervised rehabilitation & unsupervised home-based exercises	**1. Strength** 1.2 Bridges Two-legged (supine hip extension) 1.12 Hip abduction in standing 1.13 Hip abduction in supine 1.19 Hip extension in standing 1.31 Knee extension in sitting or supine (long arc quad) (unclear long or short) 1.32 Knee extension in sitting or supine (short arc quad) (unclear long or short) 1.48 Sit-to-stand 1.55 Step up – forward **3. Flexibility** 3.2 Bike (ROM) **5. Task specific training** 5.8 Gait training 5.13 Sit-to-stand training 5.15 Stair training **6. Patient education** 6.2 Home exercise program	Y (Y)	Physical therapist	In-person	Physical therapy/rehabilitation facility (outpatient)
Giaquinto, 2010 19282040, Italy	Hydrotherapy vs. Land therapy	Hydrotherapy	**1. Strength** [specific exercises not defined] **3. Flexibility** [specific exercises not defined]	N (NA)	Unclear	In-person	Other inpatient facility
	No data	No hydrotherapy	**7. Adjunctive modality** 7.11 Massage for scar mobility [Land therapy followed by scar mobility]	N (NA)	Unclear	In-person	Other inpatient facility

Study, Year, PMID	Intended Comparison	Arm	Components (Specific Exercises/Strategies)	Progression (Appropriate)	Personnel	Mode of Delivery	Setting
Heiberg KE, 2012, 22170790, Norway	Walking skill training program vs. control	Walking skill training program	**1. Strength** 1.41 Lunges 1.42 Lunges to side (lateral lunge) 1.47 Single leg stance 1.48 Sit-to-stand 1.49 Squats 1.52 Step down 1.55 Step up – forward **2. Aerobic** 2.9 Walking 3.3 Calf stretch with knee bent (soleus) (position unclear) 3.4 Calf stretch with knee straight (gastroc) (position unclear) 3.5 Hamstring stretch in any position **4. Balance-Motor Learning-Agility** 4.3 Balance on unstable surface 4.4 Balance with perturbations 4.8 Single leg stance 4.11 Step down 4.13 Step lateral (side step) 4.14 Step up – forward **5. Task specific training** 5.6 Gait on uneven surfaces 5.10 Gait with perturbations 5.12 Obstacle training 5.15 Stair training	Y (Y)	Physical therapist	In-person	Physical therapy/rehabilitation facility (outpatient)
	No data	Standard care	"The control group did not attend any supervised physiotherapy programs during the same time period, but were encouraged to continue with the exercises"	N (NA)	NA	NA	NA
Liebs, 2010, 20360503, Germany	Ergometer cycling plus standard physiotherapy vs. standard physiotherapy alone	Ergometer cycling	**1. Strength** [specific exercises not defined] **3. Flexibility** 3.2 Bike (ROM) **4. Balance-Motor Learning-Agility** 4.3 Balance on unstable surface **5. Task specific training** 5.1 Transfers 5.6 Gait on uneven surfaces 5.8 Gait training 5.15 Stair training	N (NA)	Physical therapist	In-person	Physical therapy/rehabilitation facility (outpatient)

Study, Year, PMID	Intended Comparison	Arm	Components (Specific Exercises/Strategies)	Progression (Appropriate)	Personnel	Mode of Delivery	Setting
	No data	Control	**1. Strength** [specific exercises not defined] **3. Flexibility** [specific exercises not defined] **4. Balance-Motor Learning-Agility** 4.3 Balance on unstable surface **5. Task specific training** 5.1 Transfers 5.6 Gait on uneven surfaces 5.8 Gait training 5.15 Stair training	N (NA)	Physical therapist	In-person	Physical therapy/rehabilitation facility (outpatient)
Liebs, 2012, 22196125, Germany	Early aquatic therapy vs. late aquatic therapy	Early aquatic therapy	**1. Strength** [specific exercises not defined] **3. Flexibility** [specific exercises not defined] **4. Balance-Motor Learning-Agility** 4.3 Balance on unstable surface **5. Task specific training** 5.1 Transfers 5.6 Gait on uneven surfaces 5.8 Gait training 5.15 Stair training	N (NA)	Physical therapist	In-person	Physical therapy/rehabilitation facility (outpatient)
	No data	Late Aquatic therapy (after wound healing)	**1. Strength** [specific exercises not defined] **3. Flexibility** [specific exercises not defined] **4. Balance-Motor Learning-Agility** 4.3 Balance on unstable surface **5. Task specific training** 5.1 Transfers 5.6 Gait on uneven surfaces 5.8 Gait training 5.15 Stair training	N (NA)	Physical therapist	In-person	Physical therapy/rehabilitation facility (outpatient)
Łyp, 2016, 27455419, Poland	Kinesiotherapy, low-frequency magnetic field and water exercises vs. kinesiotherapy and low-frequency magnetic field vs. control group	Kinesiotherapy, low-frequency magnetic field and water exercises	**1. Strength** [specific exercises not defined] **3. Flexibility** [specific exercises not defined] **7. Adjunctive modality** 7.18 Complementary and alternative therapies	N (NA)	Unclear	In-person	Physical therapy/rehabilitation facility (outpatient)
	No data	Kinesiotherapy, low-frequency magnetic field, without water exercises	**1. Strength** [specific exercises not defined] **7. Adjunctive modality** 7.18 Complementary and alternative therapies	N (NA)	Unclear	In-person	Physical therapy/rehabilitation facility (outpatient)
	No data	Control	[Awaiting rehabilitation and instructed not to do activities that aggravated pain]				

Study, Year, PMID	Intended Comparison	Arm	Components (Specific Exercises/Strategies)	Progression (Appropriate)	Personnel	Mode of Delivery	Setting
Mikkelsen, 2014, 25305374, Denmark	Early supervised progressive resistance training vs. unsupervised home-based exercise	Early supervised progressive resistance training	**1. Strength** 1.11 Hip abduction in sidelying (position unclear) 1.12 Hip abduction in standing (position unclear) 1.13 Hip abduction in supine (position unclear) 1.17 Hip extension in sidelying (position unclear) 1.18 Hip extension in prone (position unclear) 1.19 Hip extension in standing (position unclear) 1.20 Hip flexion in sidelying (position unclear) 1.21 Hip flexion in sitting (position unclear) 1.22 Hip flexion in standing (position unclear) 1.23 Hip flexion in supine (position unclear) 1.28 Knee extension machine (one-leg) 1.30 Knee extension AAROM in sitting or supine (short- or long arc quad) (position unclear) 1.31 Knee extension in sitting or supine (long arc quad) (position unclear) 1.32 Knee extension in sitting or supine (short arc quad) (position unclear) 1.35 Knee flexion in prone (position unclear) 1.36 Knee flexion in sitting or supine (position unclear) 1.37 Knee flexion in standing (position unclear) 1.38 Leg Press (one leg) **3. Flexibility** 3.2 Bike (ROM) **6. Patient education** 6.2 Home exercise program	Y (Y)	Physical therapist; None (unsupervised)	In-person; Self-guided (unsupervised)	Gym or other community center (outpatient); Home
	No data	Unsupervised home-based exercise	**1. Strength** 1.11 Hip abduction in sidelying (position unclear) 1.12 Hip abduction in standing (position unclear) 1.13 Hip abduction in supine (position unclear) 1.17 Hip extension in sidelying (position unclear) 1.18 Hip extension in prone (position unclear) 1.19 Hip extension in standing (position unclear) 1.20 Hip flexion in sidelying (position unclear) 1.21 Hip flexion in sitting (position unclear) 1.22 Hip flexion in standing (position unclear) 1.23 Hip flexion in supine (position unclear) 1.30 Knee extension AAROM in sitting or supine (short- or long arc quad) (position unclear) 1.31 Knee extension in sitting or supine (long arc quad) (position unclear) 1.32 Knee extension in sitting or supine (short arc quad) (position unclear) 1.35 Knee flexion in prone (position unclear) 1.36 Knee flexion in sitting or supine (position unclear) 1.37 Knee flexion in standing (position unclear) **3. Flexibility** 3.2 Bike (ROM) **6. Patient education** 6.2 Home exercise program	Y (N)	None (unsupervised)	Self-guided (unsupervised)	Home

Study, Year, PMID	Intended Comparison	Arm	Components (Specific Exercises/Strategies)	Progression (Appropriate)	Personnel	Mode of Delivery	Setting
Monticone, 2014, 24459172, Italy	Task-oriented exercise with early full weight bearing vs. open chain kinetic exercise with partial weight bearing	Task-oriented exercises	**1. Strength** 1.17 Hip extension in sidelying (sitting; option not available) 1.18 Hip extension in prone 1.19 Hip extension in standing 1.21 Hip flexion in sitting 1.37 Knee flexion in standing **3. Flexibility** 3.2 Bike (ROM) **4. Balance-Motor Learning-Agility** 4.3 Balance on unstable surface 4.10 Stepping multiple directions (grapevine) **5. Task specific training** 5.8 Gait training 5.10 Gait with perturbations 5.12 Obstacle training 5.13 Sit-to-stand training 5.15 Stair training **6. Patient education** 6.1 Activities of daily living	Y (N)	Physical therapist	In-person	Other inpatient facility
	No data	Open chain kinetic exercise	**1. Strength** 1.13 Hip abduction in supine 1.17 Hip extension in sidelying 1.18 Hip extension in prone 1.23 Hip flexion in supine 1.26 Hip rotation external (lateral) 1.31 Knee extension in sitting or supine (long arc quad) 1.32 Knee extension in sitting or supine (short arc quad) 1.36 Knee flexion in sitting or supine 1.43 Quad sets **5. Task specific training** 5.8 Gait training	N (NA)	Physical therapist	In-person	Other inpatient facility
Naylor, 2018, 30021552, Australia	Discharge to inpatient rehabilitation vs. discharge to home	Inpatient rehabilitation	[specific goals and exercises not defined; comparison of setting]	NR	NR	In-person	Other inpatient facility
	No data	No inpatient rehabilitation	[specific goals and exercises not defined; comparison of setting]	NR	NR	NR	Home

Study, Year, PMID	Intended Comparison	Arm	Components (Specific Exercises/Strategies)	Progression (Appropriate)	Personnel	Mode of Delivery	Setting
Nelson, 2020, 32026820, Australia	Telerehabilitation and technology-based home exercise program vs. in-person physiotherapy care and paper-based home exercise program	Telerehabilitation	**1. Strength** 1.11 Hip abduction in sidelying (position unclear) 1.12 Hip abduction in standing (position unclear) 1.13 Hip abduction in supine (position unclear) 1.17 Hip extension in sidelying (position unclear) 1.18 Hip extension in prone (position unclear) 1.19 Hip extension in standing (position unclear) 1.20 Hip flexion in sidelying (position unclear) 1.21 Hip flexion in sitting (position unclear) 1.22 Hip flexion in standing (position unclear) 1.23 Hip flexion in supine (position unclear) 1.28 Knee extension machine (one-leg) (position unclear) 1.29 Knee extension machine (two-legs) (position unclear) 1.30 Knee extension AAROM in sitting or supine (short- or long arc quad) (position unclear) 1.31 Knee extension in sitting or supine (long arc quad) (position unclear) 1.32 Knee extension in sitting or supine (short arc quad) (position unclear) **5. Task specific training** 5.8 Gait training **6. Patient education** 6.2 Home exercise program	N (NA)	Physical therapist	Remote via telephone	Home
	No data	In-person usual care	**1. Strength** 1.11 Hip abduction in sidelying (position unclear) 1.12 Hip abduction in standing (position unclear) 1.13 Hip abduction in supine (position unclear) 1.17 Hip extension in sidelying (position unclear) 1.18 Hip extension in prone (position unclear) 1.19 Hip extension in standing (position unclear) 1.20 Hip flexion in sidelying (position unclear) 1.21 Hip flexion in sitting (position unclear) 1.22 Hip flexion in standing (position unclear) 1.23 Hip flexion in supine (position unclear) 1.28 Knee extension machine (one-leg) (position unclear) 1.29 Knee extension machine (two-legs) (position unclear) 1.30 Knee extension AAROM in sitting or supine (short- or long arc quad) (position unclear) 1.31 Knee extension in sitting or supine (long arc quad) (position unclear) 1.32 Knee extension in sitting or supine (short arc quad) (position unclear) **5. Task specific training** 5.8 Gait training **6. Patient education** 6.2 Home exercise program	N (NA)	Physical therapist	Self-guided (unsupervised); In-person	Home; Physical therapy/rehabilitation facility (outpatient)

Study, Year, PMID	Intended Comparison	Arm	Components (Specific Exercises/Strategies)	Progression (Appropriate)	Personnel	Mode of Delivery	Setting
Rao, 2021, 33863614 USA	Home physical therapy vs. formal physical therapy	Home physical therapy	**1. Strength** 1.2 Bridges Two-legged (supine hip extension) 1.12 Hip abduction in standing **3. Flexibility** **3**.10 Knee extension AROM **6. Patient education** 6.2 Home exercise program	Y (N)	None (unsupervised)	Self-guided	Home
	No data	Formal physical therapy	**1. Strength** **3. Flexibility** **6. Patient education** 6.2 Home exercise program	Y (Y)	Physical therapist; None (unsupervised)	In-person; self-guided	Physical therapy/rehabilitation facility (outpatient); home
Smith, 2009, 19876883, UK	Standard gait re-education program and bed exercises vs. standard gait re-education program alone	Gait re-education program & bed exercises	**1. Strength** 1.8 Gluteal Sets 1.23 Hip flexion in supine 1.43 Quad sets **3. Flexibility** 3.1 Ankle pumps 3.6 Heel slides 5. Task specific training 5.8 Gait training 5.15 Stair training	Y (Y)	Physical therapist	In-person	Acute inpatient (postoperative)
	No data	Gait re-education program only	**5. Task specific training** 5.8 Gait training 5.15 Stair training	Y (Y)	Physical therapist	In-person	Acute inpatient (postoperative)
Winther, 2020, 31977324, Norway	Maximal strength training vs. conventional rehabilitation	Strengthening exercise	**1. Strength** 1.12 Hip abduction in standing 1.38 Leg Press (one leg)	Y (Y)	Physical therapist	In-person	Physical therapy/rehabilitation facility (outpatient)
	No data	Standard care	[Range of exercises suggested but not standardized or described in sufficient detail to code; includes strength exercises and warm up on cycle, step, or treadmill]	N (NA)	Physical therapist	In-person	Physical therapy/rehabilitation facility (outpatient)

Abbreviations: AAROM = assisted active range of motion, ADL = activities of daily living, AROM = active range of motion, NA = not applicable, NR = not reported, PROM = passive range of motion, ROM = range of motion.

Table C-4.3. KQ 4. Risk of bias assessment for primary studies – randomized controlled trials (RCTs)

Study, Year, PMID	Random	Allocation	Blinding, Participants	Blinding, Providers	Blinding, Outcome, Obj / Subj	Dropout	Reporting Bias	Other	Population	Intervention	Outcomes	Overall
Austin, 2017, 28419032	Low	Low	High	High	High	Low	Low	Low	No	No	No	Moderate
Beck, 2019, 30782304	Low	High	High	High	Unsure	Low	Low	Low	No	No	No	High
Coulter, 2017, 28506775	Low	High	High	High	Low	Low	Low	Unsure	No	No	No	High
Giaquinto, NR, 19282040	Low	Low	Low	Low	Unsure	Low	Low	Low	No	No	No	Low
Heiberg, 2012, 22170790	Low	Low	High	High	Low	Low	Low	Low	No	No	No	Moderate
Liebs, 2010, 20360503	Low	Low	High	High	High	Low	Low	Low	No	No	No	Moderate
Liebs, 2012, 22196125	Low	Low	High	High	High	Low	Low	Low	No	No	No	Moderate
Łyp, 2016, 27455419	Low	Unsure	High	High	Unsure	Low	Low	Low	No	No	No	High
Mikkelsen, 2014, 25305374	Low	Low	High	High	Low	Low	Low	Low	No	No	No	Moderate
Monticone, 2014, 24459172	Unsure	Low	Low	High	Low	Low	Low	Low	No	No	No	Moderate
Nelson, 2020, 32026820	Low	Low	High	High	Low	Low	Low	Low	No	No	No	Moderate
Rao, 2021, 33863614	Low	High	High	High	Unsure	Low	Low	Low	No	No	No	High
Smith, 2009, 19876883	Low	Low	High	Low	Low	Low	Low	Low	No	No	No	Moderate
Winther, 2020, 31977324	Low	Low	Low	High	Unsure	Low	Low	Low	No	No	No	Moderate

PMID = Obj = objective, PubMed Identifier, Subj = subjective.

From the Cochrane Risk of Bias Tool (each item rated as Low, High, Unsure, or N/A). Ratings are color coded for emphasis only.

- Random: Random sequence generation (selection bias): Selection bias (biased allocation to interventions) due to inadequate generation of a randomized sequence;
- Allocation: Allocation concealment (selection bias): Selection bias (biased allocation to interventions) due to inadequate concealment of allocations prior to assignment;
- Blinding of participants (performance bias): Performance bias due to knowledge of the allocated interventions by participants during the study;
- Blinding of personnel/care providers (performance bias): Performance bias due to knowledge of the allocated interventions by personnel/care providers during the study;
- Blinding of outcome assessor (detection bias): Detection bias due to knowledge of the allocated interventions by outcome assessors;
- Dropout: Incomplete outcome data (attrition bias): Attrition bias due to amount, nature or handling of incomplete outcome data;
- Reporting Bias: Selective outcome reporting (outcome reporting bias): Bias arising from outcomes being selectively reported based on the direction and/or strength of the results;
- Other Bias: Bias due to problems not covered elsewhere in the table.

From the National Heart, Lung, and Blood Institute (NHLBI) Quality Assessment Tool (each item rated as No, Yes, or Unsure)

- Population: Eligibility criteria prespecified and clearly described: potentially related to selection bias;
- Intervention: Intervention clearly described and delivered consistently: potentially related to performance bias;
- Outcomes: Outcomes prespecified, clearly defined, valid, reliable, and assessed consistently: potentially related to detection bias.

Overall risk of bias assessed as **HIGH**, **MODERATE**, or **LOW**.

Table C-4.4. KQ 4. Risk of bias assessment for primary studies – nonrandomized comparative studies (NRCSs) – assessment of confounding and selection bias

Study, Year, PMID	1.1 Potential For Any Confounding?	1.2 Potential For Time-Varying Confounding?	1.3 Intervention Switches Related To Prognostic Factors?	1.4 Appropriate Analysis Method For Confounding?	1.5 Appropriate Confounding Variables Used?	1.6 Inappropriate Control Of Post-Intervention Variables?	Judgement – Risk Of Bias Related To Confounding	2.1 Participant Selection Based On Post-Intervention Variables?	2.2 Post-Intervention Variables Associated With Intervention?	2.3 Post-Intervention Variables Associated With Outcome?	2.5 Appropriate Adjustment For Selection Bias	Judgement – Risk Of Bias Related To Selection Bias	Overall RoB
Naylor, 2018, 30021552	No	No	No	No	N/A	No	Low	No	N/A	N/A	N/A	Low	Moderate

- PMID = PubMed Identifier, Responses to Risk of Bias in Nonrandomized Studies of Interventions (ROBINS-I) signaling questions 1.1 to 1.6 and 2.1 to 2.5 are in regular font. Each item rated as High, PY (probably High), NI (Low information), PN (probably Low), Low, or N/A (Not applicable).
- Judgments about confounding and selection bias are in **bold font** and each item is rated as **Low**, **Moderate**, **Serious**, or **Critical**. Ratings are color coded for emphasis only.