BMJ Open

Does Preoperative Rehabilitation for Patients Planning to Undergo Joint Replacement Surgery Improve Outcomes? A Systematic Review and Meta-Analysis of Randomized **Controlled Trials**

Journal:	BMJ Open
Manuscript ID:	bmjopen-2015-009857
Article Type:	Research
Date Submitted by the Author:	28-Aug-2015
Complete List of Authors:	Wang, Li; McMaster University, Anesthesia Lee, Myeongjong; Konkuk university school of medicine, Department of anesthesiology and pain medicine Zhang, Zhe; Fuwai Hospital, Department of Anesthesiology Moodie, Jessica; University of Western Ontario, Centre for Medical Evidence, Decision Integrity and Clinical Impact (MEDICI) Cheng, Davy; University of Western Ontario, Department of Anesthesia & Perioperative Medicine Martin, Janet; London Health Sciences Centre, High Impact Technology Evaluation Centre
Primary Subject Heading :	Rehabilitation medicine
Secondary Subject Heading:	Sports and exercise medicine
Keywords:	REHABILITATION MEDICINE, INTERNAL MEDICINE, ORTHOPAEDIC & TRAUMA SURGERY
	SCHOLARONE [™] Manuscripts

Does Preoperative Rehabilitation for Patients Planning to Undergo Joint Replacement Surgery Improve Outcomes?

A Systematic Review and Meta-Analysis of Randomized Controlled Trials

Li Wang, PhD^{1, 2, 3}, Myeongjong Lee, MD⁴, Zhe Zhang, MD⁵, Jessica Moodie, MLIS¹, Davy Cheng, MD, FRCPC^{1, 6}, Janet Martin, PhD, MSc(HTA)^{1, 6, 7*}

- Centre for Medical Evidence, Decision Integrity and Clinical Impact (MEDICI), University of Western Ontario, London, ON, Canada
- 2. Michael G. DeGroote Institute for Pain Research and Care, McMaster University, Hamilton, Ontario, Canada
- 3. Chinese Cochrane Centre, West China Hospital, Sichuan University, Chengdu, China
- Konkuk university school of medicine, Department of anesthesiology and pain medicine, Chungju, South Korea.

BMJ Open: first published as 10.1136/bmjopen-2015-009857 on 2 February 2016. Downloaded from http://bmjopen.bmj.com/ on June 12, 2025 at Agence Bibliographique de Enseignement Superieur (ABES) .

Protected by copyright, including for uses related to text and data mining, Al training, and similar technologies

- Department of Anesthesiology, Fuwai Hospital, Chinese Academy of Medical Sciences and Peking Union Medical College, Beijing, China
- Department of Anesthesia & Perioperative Medicine, University of Western Ontario, London, ON, Canada
- Department of Epidemiology & Biostatistics, University of Western Ontario, London, ON, Canada

BMJ Open: first published as 10.1136/bmjopen-2015-009857 on 2 February 2016. Downloaded from http://bmjopen.bmj.com/ on June 12, 2025 at Agence Bibliographique de

Enseignement Superieur

(ABES)

ta mining, Al training, and similar technologies

to text

Protected by copyright, including for uses related

*Address correspondence to Dr. Janet Martin, Centre for Medical Evidence, Decision Integrity and Clinical Impact (MEDICI), University of Western Ontario, London, ON, N6A 5A5, Canada. Tel.: +1-519-685-8500, ext. 34482; Fax: +1-519-663-3161. E-mail address: jmarti83@uwo.ca

Abstract:

Objectives: Although claims suggest preoperative physiotherapy and exercise programs (prehabilitation) will improve recovery after joint replacement, their clinical impact remains controversial. This systematic review aimed to assess the clinical impact of prehabilitation before joint replacement.

Design: We searched PubMed, Embase, and Cochrane CENTRAL up to November 2014 for randomized trials comparing prehabilitation versus no prehabilitation before joint replacement surgery. Postoperative pain and function scores were converted to WOMAC pain and function subscales (0-100, high scores indicate worse outcome). Random effects meta-analysis was performed to calculate weighted mean differences (WMD, 95%CI), subgrouped by hip and knee surgery.

Primary and Secondary Outcomes: Postoperative pain scores [Visual Analogue Scale (VAS), or pain subcomponents of Western Ontario and McMaster Universities osteoarthritis index (WOMAC) or pain-related subdomains of other instruments], and patient functionality.

BMJ Open: first published as 10.1136/bmjopen-2015-009857 on 2 February 2016. Downloaded from http://bmjopen.bmj.com/ on June 12, 2025 at Agence Bibliographique de l Enseignement Superieur (ABES) . Protected by copyright, including for uses related to text and data mining, Al training, and similar technologies.

Results: Of 22 studies (1,492 patients), 18 had high risk of bias. Prehabilitation slightly reduced pain scores within 4 weeks postoperatively (WMD -6.1, 95%CI -10.6 to -1.6), but differences did not remain beyond 4 weeks. Prehabilitation slightly improved WOMAC function score at 6-8 weeks and 12 weeks (WMD -4.0, 95%CI -7.5 to -0.5), and time to climbing stairs (WMD -1.4 days, 95%CI -1.9 to -0.8 days), toilet use (-0.9 days, 95%CI -1.3 to -0.5 days), and chair use (WMD -1.2 days, 95%CI -1.7 to -0.8 days). Effects were similar for knee and hip surgery. Differences were not found for SF-36 scores, length of stay and total cost.

Conclusions: Existing evidence suggests that prehabilitation may slightly improve early postoperative pain and function among patients undergoing joint replacement; however, effects

remain too small to be considered clinically-important and did not affect outcomes of greatest interest (ie, length of stay, quality of life, costs).

Article Summary

Strengths and Limitations of Study

- The methodology was rigorous, and included a comprehensive systematic search without limits by language, date or publication status, which identified 7 RCTs not included in any previous systematic reviews.
- We went beyond previous systematic reviews published by analyzing the effect of prehabilitation by converting to a standardized measurement of WOMAC pain and function scores, and used different presentation methods to enhance interpretability and to improve ability to find potential signals in effect size through meta-analysis.
- This meta-analysis addressed all available clinically relevant outcomes, while previous reviews addressed only a few selected outcomes. Application of GRADE for rating quality of evidence provides improved context for interpreting the findings in light of inherent strengths and limitations of the included studies.
- There is a lack of large randomized controlled trials that have been conducted in this area
- Compliance with prehabilitation was problematic in some studies, and was not reported in a number of studies

Key words: Physiotherapy, Exercise, Prehabilitation, Joint Replacement, Meta-analysis

INTRODUCTION

Total joint replacement surgery is considered as one of the most successful medical interventions with significant pain relief and improvement in physical function and quality of life for patients with severe osteoarthritis¹. However, the recovery for a significant proportion of patients remains difficult, prolonged, and many never restore optimal functionality postoperatively ²⁻⁴. Therefore, researchers, clinicians and policy makers are still looking for better ways to improve the timelines and extent of recovery for patients undergoing total joint replacement.

Physiotherapy has been delivered to patients, traditionally after total joint replacement for rehabilitation. However, preoperative physiotherapy and exercise programs (also known as 'prehabilitation') have been proposed as a potential way to expedite recovery times and improve overall extent of recovery in patients planning to undergo joint replacement. One recently published review recommended preoperative exercise to maintain or improve function and pain ⁵; however, this recommendation was based on only one narrative systematic review with indeterminate effects ⁶. Although it seems intuitive that prehabilitation should improve patient disposition at the time of surgery, and may prepare patients for a better recovery after surgery, significant uncertainties remain about the overall balance of benefits and risks (and costs) for prehabilitation.

A number of related systematic reviews or meta-analyses have been published in the recent decade with inconsistent methods and varied conclusions ⁶⁻¹³. Two of them suggested that prehabilitation reduced pain for patients undergoing joint replacement^{8, 11}, and improved

BMJ Open: first published as 10.1136/bmjopen-2015-009857 on 2 February 2016. Downloaded from http://bmjopen.bmj.com/ on June 12, 2025 at Agence Bibliographique de l Enseignement Superieur (ABES) . Protected by copyright, including for uses related to text and data mining, Al training, and similar technologies.

physical function for patients undergoing hip replacement surgery, but not knee replacement surgery ⁸, while the remainder suggested prehabilitation did not clearly demonstrate beneficial effects or were unable to provide definitive conclusions ^{6, 7, 9, 10, 12, 13}.

Furthermore, significant methodological limitations or errors have been identified among the existing systematic reviews. Some of them only qualitatively summarized the results ^{6, 7, 9, 11-13}; another two meta-analyses ^{8, 10} are outdated, or mistakenly included some trials in which postoperative outcomes were not reported.

Thus, we conducted an updated methodologically rigorous systematic review with meta-analysis to clarify whether evidence supports prehabilitation for patients planning to undergo joint replacement.

METHODS

Eligibility criteria

We systematically searched three databases up to November 14, 2014, including PubMed, Embase, and Cochrane Central Register of Controlled Trials (CENTRAL). Eligible studies had to be randomized controlled trials comparing preoperative rehabilitation programs (ie, prescribed and supervised exercises or physiotherapy with or without co-interventions such as education, nutritional counseling, acupuncture, transcutaneous electrical nerve stimulation, etc.) versus no formal preoperative rehabilitation programs, reporting at least one clinically-relevant outcome of interest during the postoperative period. Clinical outcomes of interest included postoperative pain scores [Visual Analogue Scale (VAS), or pain subcomponents of Western Ontario and

McMaster Universities osteoarthritis index (WOMAC) or pain-related subdomains of other instruments], patient functionality (WOMAC function score, SF-36 physical functioning subdomain or other function-related instruments), time to resume activities of daily living, quality of life, patient satisfaction, infection, transfusions, stroke, death, or overall postoperative complications. Resource-related outcomes of interest included hospital length of stay, readmissions, and total hospital costs or total health system costs. Timeframes of relevance included in-hospital outcomes, as well as clinical or resource-related outcomes over the longerterm postoperatively.

Search terms included MeSH and keyword terms for exercise, prehabilitation, physiotherapy, physical therapy, activity, weight training, weight lifting, aquatic, swimming, strength training, endurance training, cycling, biking, kinesiotherapy, hydrotherapy, fitness, orthopedic surgery, and joint replacement and "random*". No limitations were placed on date of publication or language. Detailed search strategies are provided in the Appendix.

BMJ Open: first published as 10.1136/bmjopen-2015-009857 on 2 February 2016. Downloaded from http://bmjopen.bmj.com/ on June 12, 2025 at Agence Bibliographique de Enseignement Superieur (ABES)

Protected by copyright, including for uses related to text and data mining, Al training, and similar technologies

Literature screening and data extraction

Two reviewers (ML, ZZ) independently screened the articles by title and abstract using the predetermined eligibility criteria. Any disagreements were resolved by the third reviewer (LW). The third reviewer (LW) also checked all the reference lists of existing systematic reviews or meta-analyses and other reviews for potentially additional eligible articles.

Two reviewers (ML, JM) independently assessed the risk of bias of the included trials using the methods recommended by Cochrane Collaboration ¹⁴, including random sequence generation,

allocation concealment, missing or incomplete outcome data, and blinding of patients, study personnel, and outcome assessors. Any discrepancies were resolved by the third reviewer (LW).

Standardized data extraction forms were developed to specify the study characteristics, patient characteristics and outcomes. Three reviewers (ML, ZZ, and LW) extracted the data. Data was verified by a fourth reviewer (JM).

Statistical analysis

Meta-analysis was performed using the random effects model. For discrete outcomes, relative risk and 95% confidence intervals (RR, 95%CI) were calculated. For continuous outcomes, e.g. pain score and function score, weighted mean differences (WMD, 95%CI) were calculated after conversion to the Western Ontario and McMaster Universities osteoarthritis index (WOMAC) pain score (0-100) and WOMAC function score (0-100), in which a higher score indicates worse outcome. Sensitivity analysis was conducted by calculating standardized mean differences (SMD) and ratio of means (RoM).

If different pain scores were reported in one article (e.g. WOMAC pain, SF-36 pain score), the WOMAC pain score was preferentially used. If WOMAC pain score was not reported, the pain score reported in the study was converted to WOMAC pain scores to allow for comparison across studies, and to allow for estimation of overall effect size. If pain scores were reported at rest and during activity, the pain score during activity was preferentially used for analysis. If pain scores were reported during different types of activities, the largest change of pain score during the most active movement was used preferentially. If different function scores were

reported, the WOMAC function score was used preferentially for analysis. In the absence of WOMAC function scores, the alternate function score provided in the study was converted to a WOMAC function score. Two studies ^{15, 16} only reported total scores of Hospital for Special Surgery Knee Rating System (HSSK) and WOMAC respectively. Given the function score accounting for most of the total score and with similar trends of change over time as total score, we used the total score to replace the function score. To test whether this changed the effect size, sensitivity analysis was performed after removing the total scores from function measures to recalculate effect size.

To improve clinical relevance and interpretation of the results for postoperative pain and function improvement, we also converted continuous data from WOMAC pain score and WOMAC function score to a relative risk (RR) for achieving a "patient acceptable symptom state" (defined as the number of patients achieving the threshold pain score or function score at which patients consider themselves 'well' or 'satisfied') derived from previous research ¹⁷⁻²⁰. To calculate the RR, we assumed a normal distribution of WOMAC pain or function scores for the intervention and control groups, and we used a threshold of 30 on the WOMAC 0-100 scale to represent the threshold for the patient acceptable symptom state. The proportion of patients in the intervention and control groups with WOMAC pain or function \leq 30 was then calculated, and combined across studies to derive a pooled relative risk ^{21, 22}. Finally, to further add to clinical applicability of the patient reported outcomes we calculated the risk difference for the number of patients achieving this threshold of \leq 30 per 100 patients using the relative risk and median risk among the control groups in the included studies ²³. Subsequently, sensitivity analyses were performed to explore whether using different thresholds (20 and 40) changed the conclusions,

Protected by copyright, including for uses related to text and data mining, Al training, and similar technologies

since our threshold of 30 represents a compromise of 20 to 40 suggested in previous studies of hip or knee surgery over the short term or long-term.

Heterogeneity was estimated using the Chi-squared test and I² statistic. Pre-defined subgroup analyses included separate analysis for hip and knee surgery patients, to test the existing hypothesis from a previous systematic review that prehabilitation improves postoperative pain and function more among patients undergoing hip replacement than patients with knee replacement ⁸. Publication bias was explored using both visual inspection of funnel plots and Egger's test only when there were at least 10 studies included in the meta-analysis ¹⁴.

GRADE methodology was used to summarize certainty in estimates of effect (quality of evidence) in the critically important outcomes for decision-making ²³⁻²⁹, including WOMAC pain scores and function scores from early follow-up to 24 weeks after surgery.

RESULTS

Studies identified

Figure 1 outlines study inclusion and exclusion. A total of 319 titles and abstracts were screened for inclusion, of which 93 studies were collected in full-text for review. Of these, 71 were excluded for the following reasons: no prehabilitation arm (ie. education only or postoperative rehabilitation only, n=41), not randomized (n=17), duplicate studies (n=4), no postoperative outcomes data (n=7), no outcome of interest (n=1), and protocol only (n=1). In total, 22 randomized studies (1492 patients) of prehabilitation versus no prehabilitation met the inclusion

BMJ Open

criteria. Twenty studies provided usable data for the meta-analysis, and 22 studies contributed qualitative or quantitative data.

Description of included studies

Among 22 included studies, eight studies were of patients undergoing total hip replacement ^{16, 30-} ³⁶; 12 studies included patients undergoing total knee replacement ^{15, 37-47} and two studies included either hip or knee replacement ^{48, 49}. Most studies were conducted in developed countries (North American and Europe), except for three in developing countries (Serbia³⁴, Thailand ⁴⁵ and Turkey ³²). The median sample size of included studies was 54, ranging from 21 to 165 patients. Mean age ranged from 51 to 76 (Table 1).

Study Name	No. of	Type of	Countries	Mean	%	Mean	Total
	patients	surgery		age	Female	BMI%	OA %
Beaupre 2004	131	TKR	Canada	67	55	31.4	NR
Bitterli 2011	80	THR	Switzerland	66.9	38	27.4	NR
Brown 2012	32	TKR	USA	NR	NR	36.8	NR
D'Lima 1996	30	TKR	USA	69.8	46.6	NR	83.3
Evgeniadis 2008	48	TKR	Greece	68.3	76.3	34.1	100
Ferrara 2008	23	THR	Italy	63.4	60.8	NR	100
Gilbey 2003	76	THR	Australia	65.2	61.8	27.94	NR
Gocen 2004	60	THR	Turkey	51.3	35.5	NR	49
Gstoettner 2011	38	TKR	Australia	69.7	78.9	27.8	100
Hoogeboom 2010	21	THR	Netherland	76	66	NR	NR
Matassi 2014	122	TKR	Italy	66.5	48	28.5	NR
McKay 2012	22	TKR	Canada	61.3	59	34.3	100

Table 1 Characteristics of included RCTs

BMJ Open: first published as 10.1136/bmjopen-2015-009857 on 2 February 2016. Downloaded from http://bmjopen.bmj.com/ on June 12, 2025 at Agence Bibliographique de Enseignement Superieur (ABES) .

data mining, AI training, and similar technologies

Enseignement Super

Protected by copyright, including for uses related to text and

BMJ Open: first published as 10.1136/bmjopen-2015-009857 on 2 February 2016. Downloaded from http://bmjopen.bmj.com/ on June 12, 2025 at Agence Bibliographique de Enseignement Superieur (ABES) .

Protected by copyright, including for uses related to text and data mining, Al training, and similar technologies

Mitchell 2005	160	TKR	UK	70.3	57.9	NR	100
Oosting 2012	30	THR	Netherland	76	80	28.2	100
Rooks 2006	108	THR/TKR	USA	64.1	56	31.6	100
Торр 2009	54	TKR	USA	63.8	68	32.1	100
Tungtrongjit 2012	60	TKR	Thailand	64.5	83.3	24.8	100
Villadsen 2014	165	THR/TKR	Denmark	67	56	30.3	100
Vukomanovic 08	45	THR	Serbia	58.4	67	NR	100
Wang 2002	28	THR	Australia	67.1	64	NR	89
Weidenhielm 1993	39	TKR	Sweden	63.5	51.3	29.6	100
Williamson 2007	120	TKR	UK	69.8	52.9	32.7	100

TKR: total knee replacement; THR: Total hip replacement; USA: United States of America; UK: United

Kingdom; BMI: Body mass index; OA: Osteoarthritis; NR: not reported

Nine studies compared physiotherapist supervised exercise plus home exercise versus no intervention or usual care ^{16, 35, 36, 38, 40-42, 44, 46}. Five compared physiotherapist supervised exercise versus no intervention or usual care ^{15, 33, 37, 39, 50}. Two studies compared home exercise only versus no intervention ^{30, 45}. Three studies compared physiotherapist supervised exercise plus education versus no intervention ^{31, 32, 34}. One each compared physiotherapist supervised exercise plus education versus education ⁴⁸, kinesiologist supervised exercise versus placebo (kinesiologist supervised upper body exercise) ⁴³, and physiotherapist supervised exercise plus home exercise versus education plus home exercise ⁴⁷ respectively (Supplementary Table 1).

Risk of bias

Among 22 trials, adequate sequence generation was reported in 17 trials ^{15, 30-33, 36-43, 45-48}, allocation concealment in 8 trials ^{30, 33, 37, 39, 42, 43, 47, 49}. The patients were blinded in one study³⁹, health care providers were blinded in three studies ^{30, 39, 44}, and outcome assessors were blinded in 12 studies ^{30-33, 36, 37, 41, 44, 45, 47-49}. Seventeen studies ^{16, 30-34, 36-40, 42, 43, 46-49} reported loss to follow-up, ranging from 1.7% to 65.3%; among which the proportion of loss to follow up was more than 15% in 10 studies ^{30, 34, 36-39, 42, 43, 47, 48}. Ten out of 17 studies with incomplete data used intention to treat analysis ^{30, 33, 36, 37, 39, 42, 43, 47-49}. Overall, 4 out of 22 included trials were rated as low risk of bias ^{30, 33, 37, 39} and 18 trials as high risk of bias (Table 2)

BMJ Open: first published as 10.1136/bmjopen-2015-009857 on 2 February 2016. Downloaded from http://bmjopen.bmj.com/ on June 12, 2025 at Agence Bibliographique de

Enseignement Superieur (ABES)

Protected by copyright, including for uses related to text and data mining, Al training, and similar technologies

	Random	Allocation	Blinding of	Blinding of	Blinding of	Incomplete	Intention to	Risk of bias
	sequence	concealment	patients	health care	outcome assessors	outcome data	treat analysis	
	generation			providers				
Beaupre 2004	Yes	Yes	No	No	Yes	Yes, LTFU>15%	Yes	Low risk
Bitterli 2011	Yes	Yes	No	Yes	Yes	Yes, LTFU>15%	Yes	Low risk
Brown 2012	Yes	Unclear	No	Unclear	Unclear	Yes, LTFU>15%	No	High risk
D'Lima 1996	Yes	Unclear	Unclear	Unclear	Unclear	No	Not Applicable	High risk
Evgeniadis 2008	Yes	Yes	Yes	Yes	Unclear	Yes, LTFU>15%	Yes	Low risk
Ferrara 2008	Yes	Unclear	No	No	Yes	Yes	No	High risk
Gilbey 2003	Unclear	Unclear	Unclear	Unclear	No	Yes	No	High risk
Gocen 2004	Yes	Unclear	No	Unclear	Yes	Yes	No	High risk
Gstoettner 2011	Yes	No	Unclear	Unclear	Unclear	Yes	No	High risk
Hoogeboom 2010	Yes	Yes	No	No	Yes	Yes	Yes	Low risk
Matassi 2014	Yes	Unclear	No	No	Yes	No	Not Applicable	High risk
McKay 2012	Yes	Yes	Unclear	Unclear	Unclear	Yes, LTFU>15%	Yes	High risk
Mitchell 2005	Yes	Yes	No	No	Unclear	Yes, LTFU>15%	Yes	High risk
Oosting 2012	Yes	Unclear	No	No	Yes	Yes, LTFU>15%	Yes	High risk
Rooks 2006	Yes	Unclear	Unclear	Unclear	Yes	Yes, LTFU>15%	Yes	High risk
Торр 2009	Unclear	Unclear	No	Yes	Yes	No	Not Applicable	High risk

Fable 2:	Risk of	Bias for	Included	Studies
----------	----------------	----------	----------	---------

BMJ Open: first published as 10.1136/bmjopen-2015-009857 on 2 February 2016. Downloaded from http://bmjopen.bmj.com/ on June 12, 2025 at Agence Bibliographique de I
 Protected by cppytight-ing-tenents 2006 independents (Alberting, Alberting, Albertin

Page 15 of 82

BMJ Open

Tungtrongjit 2012	Yes	Unclear	No	No	Yes	No	Not Applicable	High risk	
Villadsen 2014	Unclear	Yes	No	No	Yes	Yes	Yes	High risk	
Vukomanovic 08	Unclear	Unclear	Unclear	Unclear	Unclear	Yes, LTFU>15%	No	High risk	
Wang 2002	Unclear	Unclear	Unclear	Unclear	No	No	Not Applicable	High risk	
Weidenhielm	Yes	Unclear	Unclear	Unclear	Unclear	Yes	No	High risk	
1993									
Williamson 2007	Yes	Yes	No	No	Yes	Yes, LTFU>15%	Yes	High risk	
LTFU: lost to follow-up booccead pa doba() المُراثينة المُراثينة المُراثينية المراثينية المراثين المراثينية المراثينية المراثين المراثينينينينينينينينينينينينينينينينينينين									

BMJ Open: first published as 10.1136/bmjopen-2015-009857 on 2 February 2016. Downloaded from http://bmjopen.bmj.com/ on June 12, 2025 at Agence Bibliographique de Enseignement Superieur (ABES) .

Protected by copyright, including for uses related to text and data mining, Al training, and similar technologies

Supplementary Table 2 qualitatively summarizes the major findings of included studies. In total, 22 studies described at least one clinical or resource-related benefit for prehabilitation versus control, and 18 studies ^{15, 30-37, 39, 40, 42-48} described no significant improvement for prehabilitation versus control. We conducted meta-analysis for pain scores, function scores, SF-36 PCS and MCS, hospital length of stay, and total costs based on the data availability.

Postoperative pain

Fifteen trials with 18 comparisons and 1046 patients reported postoperative pain scores using different instruments, i.e. WOMAC ^{31, 37, 40, 42, 43, 45, 48}, VAS ^{32, 34, 36, 44, 47}, Knee injury and Osteoarthritis Outcome Score (KOOS)/Hip disability and Osteoarthritis Outcome Score (HOOS)⁴⁹, and 10-graded scale ⁴⁶. Only two trials ^{31, 49} reported significant improvement in pain at early follow-up (\leq 3 months), including VAS pain at 3 months ³¹, and KOOS/HOOS pain at 6 weeks postoperatively, but not significant at 3 months ⁴⁹.

After converting to WOMAC pain 0-100, prehabilitation significantly reduced postoperative pain at 4 weeks or less (WMD -6.1, 95%CI -10.6 to -1.6, Figure 2, GRADE: low certainty in estimates, Table 4). Differences in WOMAC pain scores after 4 weeks were no longer statistically significant for prehabilitation versus control (WOMAC pain score at 6 to 8 weeks, WMD -1.4, 95%CI -5.5 to +2.6; at 12 weeks, WMD -2.9, 95%CI -6.2 to +0.3; at 24 weeks, -2.5, 95%CI -5.6 to +0.6; at 1 year, WMD -2.0, 95%CI -7.5 to +3.5; GRADE: low to moderate certainty in estimates, Table 4).

When expressed as a relative risk (RR), patients undergoing prehabilitation were more likely to achieve the acceptable pain state (WOMAC pain score \leq 30) with RR 1.09. When expressed as an absolute risk difference, 3.9% more patients with prehabilitation achieved the acceptable pain state (WOMAC pain score \leq 30) than patients without prehabilitation at 4 weeks (Supplementary table 3). However, this small difference would be considered clinically nominal.

Postoperative function

Of 16 trials reporting on postoperative function, only four reported significant improvement in function ^{16, 31, 41, 49}, including higher hip external rotation ³¹ or higher flexion range of motion (ROM) scores, WOMAC physical function and total score ¹⁶, and less time to reached 90° of knee flexion ⁴¹ and great improvement in activities of daily living (ADL) ⁴⁹ after surgery .

Sixteen trials (1118 patients) reported postoperative function scores using different instruments, i.e. WOMAC ^{16, 31, 37, 40, 42, 43, 45, 47, 48}, Harris hip score ^{32, 34}, SF-36 physical component summary (PCS) ³⁰, SF-36 physical functioning score ³⁸, HSSK score ¹⁵, HOOS function in daily living ³⁶, and KOOS/HOOS ADL⁴⁹. After converting function scores to WOMAC function score (0-100), the difference was slightly improved (but numerically small on a scale of 0-100) with prehabilitation versus no prehabilitation at early follow-up (WOMAC function score at 6 to 8 weeks, WMD -3.9, 95%CI-7.6 to -0.3, RR=1.10, Figure 3, GRADE: moderate certainty in estimates, Table 4), and at 12 weeks (WMD -4.0, 95%CI -7.5 to -0.5, RR=1.02, Figure 4, GRADE: very low certainty in estimates, Table 4). No significant difference for WOMAC function score was found after 12 weeks (at 24 weeks, WMD -0.5, 95%CI -5.8 to +4.7; at 1 year, WMD -0.6, 95%CI -2.6 to +1.5, GRADE: low certainty in estimates, Table 4).

BMJ Open: first published as 10.1136/bmjopen-2015-009857 on 2 February 2016. Downloaded from http://bmjopen.bmj.com/ on June 12, 2025 at Agence Bibliographique de Enseignement Superieur (ABES) .

When expressed as a relative risk for achieving the acceptable threshold, the relative increases were small (RR 1.10 at 6-8 weeks; 1.02 at 12 weeks). When expressed as an absolute difference in likelihood of achieving the acceptable threshold, the differences ranged from 1.3% to 5.4% more patients achieving a WOMAC function score ≤ 30 at 6-8 weeks and 12 weeks respectively (Supplementary table 3).

Resumption of activities of daily living

in likelihood of achieving the acceptable threshold, the differences ranged from 1.3% to 5.4%									
more patients achieving a WOMAC function score \leq 30 at 6-8 weeks and 12 weeks respectively									
(Supplementary table 3).					' copyright, inc				
Resumption of activities of daily livi	ng				luding				
Resumption of activities of daily living	g was rare	ly reported	. In the two studi	es (99]	patients) ^{32, 34}				
that reported activities of daily living,	meta-anal	ysis sugges	ted significantly	earlier	resumption of				
activities, including climbing stairs (W	/MD -1.4	days, 95%0	CI-1.9 to -0.8 day	/s), use	of toilet (-0.9				
day, 95%CI-1.3 to -0.5 days), use of c	hair (-1.2	days, 95%0	CI -1.7 to -0.8 day	ys), but	t not for time				
to first day of walking (-0.2 day, 95%	CI -0.4 to	+0.0 day),	(Table 3). Howe	ver, ba	sed on the				
total time-course of recovery, the diffe	erence was	small.			mining				
Table 3 Summary of results for prehabilitation vs. no prehabilitation									
Outcomes	No. of	No. of	heterogeneity	I ²	۳۵ WMD & 95%CI د.				
	studies	patients	test p value	(%)	milar t				
Pain at 4 weeks or less	4	213	0.08	55	-6.1 (-10.6 to -1.6) *				
Pain at 6 to 8 weeks	5	488	0.31	16	-1.4 (-5.5 to +2.6)				
Pain at 12 weeks	10	806	0.05	46	-2.9 (-6.2 to +0.3)				
Pain at 24 weeks	3	247	0.22	33	-2.5 (-5.6 to +0.6)				

Pain at 1 year or more	1	109	NA	NA	-2.0 (-7.5 to +3.5)
Function at 4 weeks or less	5	257	< 0.001	79	-3.6 (-7.7 to +0.5)
Function at 6 to 8 weeks	5	488	0.21	31	-3.9 (-7.6 to -0.3) *
Function at 12 weeks	12	836	< 0.001	69	-4.0 (-7.5 to -0.5) *
Function at 24 weeks	5	345	< 0.001	89	-0.5 (-5.8 to +4.7)
Function at 1 year or more	6	296	0.99	0	-0.6 (-2.6 to +145)
First days of climbing stairs (days)	2	99	0.44	0	-1.4 (-1.9 to -0.8) *
First days of walking (days)	2	99	0.24	29	-0.2 (-0.4 to +0.002
First days of use of toilet (days)	2	99	0.87	0	-0.9 (-1.3 to -0.5) *
First days of use of chair (days)	2	99	0.50	0	-1.2 (-1.7 to -0.8) *
SF-36 PCS at 6 weeks	1	19	NA	NA	2.7 (-9.4 to +14.7)
SF-36 PCS at 12 weeks	3	149	0.13	50	-0.3 (-5.4 to +4.7)
SF-36 PCS at 24 weeks	1	109	NA	NA	0.0 (-3.4 to +3.4)
SF-36 PCS at 1 year	1	109	NA	NA	-3.0 (-6.4 to +0.4)
SF-36 MCS at 6 weeks	1	17	NA	NA	-3.4 (-19.9 to +13.0
SF-36 MCS at 12 weeks	3	149	0.72	0	-0.4 (-3.7 to +2.9)
SF-36 MCS at 24 weeks	1	109	NA	NA	-1.0 (-4.9 to +2.9)
SF-36 MCS at 1 year	1	109	NA	NA	-2.0 (-5.1 to +1.1)
Length of stay (days)	7	507	0.68	0	-0.3 (-0.8 to + 0.1)
Total cost (Canadian dollars)	2	242	0.99	0	+5 (-384 to +393)
PCS: physical component summary; MC	S: mental	component	summary; WMD:	Weighte	d mean
difference; NA: not applicable;					
Pain and function scores were converted	to WOMA	C (Westerr	ontario and McM	laster Ur	niversities
osteoarthritis index) 0-100 subscales, and	d high scor	e indicates	more pain or dysfu	inction.	
		19			
For peer review only - http	n·//hmione	an hmi com	/site/about/quide	lines vh	tml

uses

For peer review only - http://bmjopen.bmj.com/site/abou

* p<0.05

Quality of life

Significant differences in quality of life were not found in 9 studies for SF-36 ^{30, 37, 39, 42, 43}, Quality of Well Being instrument ¹⁵, HOOS Hip-related quality of life ³⁶, KOOS/HOOS Quality of Life subscale ⁴⁹, and Patient Specific Complaints (PSC) questionnaire ^{33, 36}; while three trials reported significant difference in quality of life score ^{31, 38, 49}, including higher physical function score or physical composite score using SF-36 ^{31, 38} or better EuroQol 5 Dimension Health Questionnaire (EQ5D) ⁴⁹; however, the numeric differences were small ^{31, 38, 49} and the significance disappeared at 3 months ^{31, 49}.

Three studies including 149 patients reported SF-36 Physical Component Summary (SF-36 PCS) and Mental Component Summary (SF-36 MCS). Meta-analysis of SF-36 PCS and MCS did not detect significant differences at any time-point (from 6 weeks to 1 year, Table 3).

Length of hospital stay and total cost

Only one ⁴¹ out of 10 studies ^{15, 30, 32-34, 36, 37, 41, 42, 47} found a significant reduction in hospital length of stay (mean difference = -0.8 day). Meta-analysis of these studies did not detect significant differences in hospital length of stay for prehabilitation versus control (7 studies, 507 patients, WMD -0.3 days, 95%CI -0.8 to + 0.1 days, Figure 5).

Of the few studies ^{37, 42, 47} that reported on costs, none of them reported significant reduction of overall costs with prehabilitation, but one ⁴² described significantly increased physiotherapy

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

costs with prehabilitation (mean difference= $-\pounds$ 136.5). Even when total costs were converted to Canadian dollars and combined through meta-analysis, the results did not differ for prehabilitation versus none (2 studies, 242 patients, WMD + \$ 0.5, 95%CI - \$ 384 to + \$ 393).

Other outcomes

Other outcomes of interest, including patient satisfaction, stroke, cardiovascular events, and readmissions were inadequately reported for meta-analysis. Adverse events and discontinuations were rarely reported within the studies; however, in at least one study, there was concern about increased cardiovascular events and stroke, and poorer SF-36 general health, energy and mental health among the withdrawn patients although the author stated no evidence that study withdrawal varied by group ⁴². In some studies, there were reports of patient withdrawals due to adverse events ^{34, 42, 49}. Some studies reported no significant postoperative complications between groups ³⁵⁻³⁷, no serious adverse events ^{33, 35, 36} or no adverse events ⁴⁷.

Subgroup analysis and sensitivity analysis

Effect sizes were similar between hip and knee replacement subgroups for WOMAC pain and function scores (supplementary table 3), as indicated by non-significant p-values for interaction.

Sensitivity analysis using SMD (instead of WMD), RoM, and different thresholds for defining patient acceptable symptom state (20 and 40, instead of 30), and replacing function sub-score with total score did not materially change the results (supplementary table 4 and 5).

While publication bias was not indicated for pain score; however, asymmetric funnel plots indicated the possibility of publication bias for function scores (supplementary figure 1 to figure 2, table 2).

INTERPRETATION

Main findings

Existing evidence from 22 randomized studies suggests that prehabilitation for patients planning to undergo joint replacement does not materially affect postoperative pain and function (and this is based on studies with significant limitations, providing very low certainty in estimates). While some differences reached statistical significance, the effects are too small to be considered clinically important (ie, an improvement of a few points on a scale of 0-100 is likely clinically irrelevant, and undetectable to patients). For example, prehabilitation reduced WOMAC pain score by 6 with 95%CI (-10.6 to -1.6) within 4 weeks, and with no difference remaining beyond 4 weeks, which is generally smaller than the minimal clinically important improvement (MCII) of at least 9.7 at 6 weeks even when the most optimistic extremes of the confidence intervals are considered in our analysis. Even when patient accepted pain state was defined as achieving ≤ 30 in WOMAC pain subscale 0-100, there was only an absolute increase of 3.9% of patients achieving this threshold. Similarly for function improvement, prehabilitation improved early function by 3.9 to 4.0 points on the WOMAC function subscale 0-100, which is much smaller than the threshold of minimally important difference ranged from 7.9 to 25.9⁵¹⁻⁵⁶, and only 1.3% to 5.4% more patients reached a WOMAC function score \leq 30. Although prehabilitation promoted patients to resume activities of daily living 0.9 to 1.4 days earlier than no formal prehabilitation, the difference is trivial, and importantly, very few studies reported on this time

BMJ Open

point (ie, 2 of 22 studies) which prevents definitive conclusions. Similarly, for the outcome of length of stay, there was no difference between groups, and if statistical significance had been achieved, the difference would have been only 0.3 days, which is a minimal difference. Jurisdictions considering implementation (or continuation) of prehabilitation services should consider whether resources could be better spent elsewhere on interventions of proven clinical benefit. Until sufficient evidence accrues to definitively conclude that prehabilitation provides meaningful benefit, investment in prehabilitation does not represent the best use of limited resources in a healthcare system where other opportunities with proven benefits could be funded instead.

Relation to prior reviews

Similar to this meta-analysis, most previous meta-analyses ^{10, 11} and systematic reviews ^{7, 9, 12} suggested that the impact of prehabilitation has not been proven by the existing evidence. In contrast to our analysis, Gill 2013 et al ⁸ suggested that exercise-based interventions reduce pain and improve physical function for people awaiting hip replacement surgery, but not knee replacement surgery. It is notable that there were some limitations in Gill 2013 ⁸, wherein some included trials did not report if the patients underwent surgery after the intervention ^{57, 58}, and/or failed to report postoperative outcomes ^{59, 60}, and one included trial allocated patients based on the geographic availability which may have introduced selection bias and unit of measurement errors. Furthermore, a total of 9 relevant trials ^{30, 34, 38, 40-42, 44, 45, 50} were not included in Gill 2013.

BMJ Open: first published as 10.1136/bmjopen-2015-009857 on 2 February 2016. Downloaded from http://bmjopen.bmj.com/ on June 12, 2025 at Agence Bibliographique de Enseignement Superieur (ABES)

Protected by copyright, including for uses related to text and data mining, Al training, and similar technologies

Strengths and limitations

Strengths of this review include rigorous methodology, including the comprehensive systematic search without limits by language, date or publication status, which identified 7 RCTs ^{30, 34, 38, 40,} ^{41, 45, 50} not included in any previous systematic reviews ⁶⁻¹³. Furthermore, we analyzed the effect

BMJ Open: first published as 10.1136/bmjopen-2015-009857 on 2 February 2016. Downloaded from http://bmjopen.bmj.com/ on June 12, 2025 at Agence Bibliographique de Enseignement Superieur (ABES)

Protected by copyright, including for uses related to text and data mining, Al training, and similar technologies

of prehabilitation by converting to a standardized measurement of WOMAC pain and function scores, and used different presentation methods to enhance interpretability and to improve ability to find potential signals in effect size through meta-analysis ⁶¹, which is beyond what other systematic reviews published. In addition, this meta-analysis addressed all available clinically relevant outcomes, while previous reviews addressed only a few selected outcomes. Application of GRADE for rating quality of evidence provides improved context for interpreting the findings in light of inherent strengths and limitations of the included studies ^{62, 63}.

There were a number of specific limitations in the existing clinical trials comparing prehabilitation with control. The most significant limitation is the lack of large randomized controlled trials that have been conducted in this area. Included studies were small (median 81 patient, ranging from 21 to 165), of relatively short duration of follow up (median 3 months, ranging from 4 weeks to 1 year), and many of them provided inadequate description of the frequency, intensity and duration of prehabilitation provided. Definitions for prehabilitation, and for outcomes measurements ,were heterogeneous across studies. Compliance with prehabilitation was problematic in some studies, about 75% in 3 studies ^{41, 42, 50}, about 90% or greater in only 7 studies ^{16, 30, 33, 35, 36, 43, 48}, and was not reported in a number of studies. In a number of studies, co-interventions were provided in the prehabilitation (e.g. education), and in some cases, these co-interventions were not provided in the control group ^{31, 32, 34}. Nevertheless, this would likely provide an overestimate of the potential benefit for prehabilitation; and despite this potential positive bias, still no differences were found for prehabilitation. The high risk of bias in the studies, combined with the selective reporting of important outcomes across the studies (ie, only

BMJ Open

two studies reported time to return of activities of daily living, and total costs) precludes definitive conclusions, despite at least 22 randomized studies being conducted.

CONCLUSION

Existing evidence suggests that the effect of prehabilitation (exercise/physiotherapy programs in the months prior to surgery) on pain and function among patients undergoing joint replacement are too small to be considered clinically-important, were not robust over time, and did not affect outcomes of greatest interest (ie, length of stay, quality of life, costs). Prehabilitation did not result in clinically important (or statistically significant) differences in most measures of patient recovery, quality of life, length of stay and costs. Future research of sufficient power to measure clinically-relevant outcomes is required to identify which, if any, form of prehabilitation achieves better outcomes than in these trials. Jurisdictions considering implementation of prehabilitation services should consider whether resources could be better spent elsewhere on interventions of proven clinical benefit.

BMJ Open: first published as 10.1136/bmjopen-2015-009857 on 2 February 2016. Downloaded from http://bmjopen.bmj.com/ on June 12, 2025 at Agence Bibliographique de Enseignement Superieur (ABES) .

Protected by copyright, including for uses related to text and data mining, Al training, and similar technologies

BMJ Open: first published as 10.1136/bmjopen-2015-009857 on 2 February 2016. Downloaded from http://bmjopen.bmj.com/ on June 12, 2025 at Agence Bibliographique de Enseignement Superieur (ABES)

Protected by copyright, including for uses related to text and data mining, AI training, and similar technologies

Funding: This study was supported by the MEDICI Centre, Department of Anesthesia & Perioperative Medicine, London Health Sciences Center, St Joseph's Healthcare London, Lawson Health Research Institute, and the Schulich School of Medicine & Dentistry, University of Western Ontario. In addition, funding was provided in part by "AMOSO Innovation Fund" (Project #INN 11-008, to Dr. J. Martin and Dr. D. Cheng). The funders had no role in the design and conduct of the study; in the collection, analysis, and interpretation of the data; or in the preparation, review, or approval of the manuscript.

Competing Interest Statement:

All authors have completed the ICMJE uniform disclosure form at http://www.icmje.org/coi_disclosure.pdf and declare; funding was provided in part by "AMOSO Innovation Fund" (Project #INN 11-008, to Dr. J. Martin and Dr. D. Cheng). The funders had no role in the design and conduct of the study; in the collection, analysis, and interpretation of the data; or in the preparation, review, or approval of the manuscript; no financial relationships with any organisations that might have an interest in the submitted work in the previous three years, no other relationships or activities that could appear to have influenced the submitted work [or describe if any]

Transparency Declaration

I Dr. Janet Martin affirm that the manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned (and, if relevant, registered) have been explained.

BMJ Open

BMJ Author License

"I Dr. Janet Martin The Corresponding Author of this article contained within the original manuscript which includes any diagrams & photographs within and any related or stand alone film submitted (the Contribution") has the right to grant on behalf of all authors and does grant on behalf of all authors, a licence to the BMJ Publishing Group Ltd and its licencees, to permit this Contribution (if accepted) to be published in the BMJ and any other BMJ Group products and to exploit all subsidiary rights, as set out in our licence set out at:

http://www.bmj.com/about-bmj/resources-authors/forms-policies-and-checklists/copyright-open-access-and-permission-reuse."

Please tick one or more boxes as appropriate:

- \Box I am the sole author of the Contribution.
- ☑ I am one author signing on behalf of all co-owners of the Contribution.
- The Contribution has been made in the course of my employment and I am signing as authorised by my employer.
- I am a US Federal Government employee acting in the course of my employment.
- I am not a US Federal Government employee, but some or all of my co-authors are.
- I am an employee of the UK Crown* acting in the course of my employment
- I am a US Federal Government employee acting in the course of my employment.
- I am not a US Federal Government employee, but some or all of my co-authors are.
- I am an employee of the UK Crown acting in the course of my employment
- □ I am not an employee of the UK Crown acting in the course of my employment but some/all of my co-authors are.*

Disclosure of conflicts of interest: None

Acknowledgements: The authors would like to thank Gord Guyatt for mentorship to Li Wang.

Authors' contribution: Li Wang contributed to the study conception and design, literature screening, acquisition of data, analysis and interpretation of data, drafting of the manuscript and revision based on the comments of coauthors. Myeongjong Lee and Zhe Zhang participated in the literature screening, data acquisition and critical revision of the manuscript. Jessica Moodie did the literature searching, article retrieval, and data acquisition. Davy Cheng contributed to study conception and design, and critical revision of the manuscript. Janet Martin guided the methodology, contributed to the study conception and design, data checking and interpretation, drafting and critical revision of the manuscript. All authors approved the version submitted for publication and agreed to act as guarantors of the work.

Data Sharing: No additional data

References:

1. Felson DT, Lawrence RC, Hochberg MC, et al. Osteoarthritis: New insights. part 2: Treatment approaches. *Ann Intern Med*. 2000;133(9):726-37.

2. Beswick AD, Wylde V, Gooberman-Hill R, et al. What proportion of patients report long-term pain after total hip or knee replacement for osteoarthritis? A systematic review of prospective studies in unselected patients. *BMJ Open.* 2012;2(1):e000435-2011-000435.

3. Vissers MM, Bussmann JB, Verhaar JA, et al. Recovery of physical functioning after total hip arthroplasty: Systematic review and meta-analysis of the literature. *Phys Ther.* 2011;91(5):615-29.

4. Nilsdotter AK, Toksvig-Larsen S, Roos EM. Knee arthroplasty: Are patients' expectations fulfilled? A prospective study of pain and function in 102 patients with 5-year follow-up. *Acta Orthop*.
2009;80(1):55-61.

5. Mak JC, Fransen M, Jennings M, et al. Evidence-based review for patients undergoing elective hip and knee replacement. *ANZ J Surg*. 2014;84(1-2):17-24.

6. Ackerman IN, Bennell KL. Does pre-operative physiotherapy improve outcomes from lower limb joint replacement surgery? A systematic review. *Australian Journal of Physiotherapy*. 2004;50(1):25-30.

7. Jordan RW, Smith NA, Chahal GS, et al. Enhanced education and physiotherapy before knee replacement; is it worth it? A systematic review. *Physiotherapy*. 2014.

BMJ Open

8. Gill S, McBurney H. Does exercise reduce pain and improve physical function before hip or knee replacement surgery? A systematic review and meta-analysis of randomized controlled trials. *Arch Phys Med Rehabil.* 2013;94:164-76.

9. Shoemaker MJ, Gibson C, Saagman S. Preoperative exercise in individuals undergoing total knee arthroplasty: State of the evidence. *Topics in Geriatric Rehabilitation*. 2013;29(1):2-16.

10. Hoogeboom T, Oosting E, Vriezekolk J, et al. Therapeutic validity and effectiveness of preoperative exercise on functional recovery after joint replacement: A systematic review and meta-analysis. *PLoS ONE*. 2012;7(5):e38031.

11. Wallis JA, Taylor NF. Pre-operative interventions (non-surgical and non-pharmacological) for patients with hip or knee osteoarthritis awaiting joint replacement surgery--a systematic review and meta-analysis. *Osteoarthritis Cartilage*. 2011;19(12):1381-95.

12. Barbay K. Research evidence for the use of preoperative exercise in patients preparing for total hip or total knee arthroplasty (structured abstract). *Orthopaedic Nursing*. 2009;28(3):127-33.

13. Lucas B. Does a pre-operative exercise programme improve mobility and function post-total knee replacement: A mini-review (structured abstract). *Journal of Orthopaedic Nursing*. 2004;8(1):25-33.

14. Higgins JPT, Green S (editors). Cochrane Handbook for Systematic Reviews of Interventions Version5.1.0 [updated March 2011]. The Cochrane Collaboration, 2011. Available from www.cochrane-handbook.org.

15. D'Lima D, Colwell C, Morris B, Hardwick M, Kozin F. The effect of preoperative exercise on total knee replacement outcomes. *Clin Orthop Relat Res.* 1996(326):174-82.

16. Gilbey H, Ackland T, Wang A, Morton A, Trouchet T, Tapper J. Exercise improves early functional recovery after total hip arthroplasty. *Clin Orthop Relat Res*. 2003(408):193-200.

 17. Tubach F, Ravaud P, Baron G, et al. Evaluation of clinically relevant states in patient reported outcomes in knee and hip osteoarthritis: The patient acceptable symptom state. *Ann Rheum Dis*. 2005;64(1):34-7.

18. Tubach F, Ravaud P, Martin-Mola E, et al. Minimum clinically important improvement and patient acceptable symptom state in pain and function in rheumatoid arthritis, ankylosing spondylitis, chronic back pain, hand osteoarthritis, and hip and knee osteoarthritis: Results from a prospective multinational study. *Arthritis Care Res (Hoboken)*. 2012;64(11):1699-707.

19. Escobar A, Gonzalez M, Quintana JM, et al. Patient acceptable symptom state and OMERACT-OARSI set of responder criteria in joint replacement. identification of cut-off values. *Osteoarthritis Cartilage*. 2012;20(2):87-92.

20. Maxwell JL, Felson DT, Niu J, et al. Does clinically important change in function after knee replacement guarantee good absolute function? the multicenter osteoarthritis study. *J Rheumatol*. 2014;41(1):60-4.

21. Anzures-Cabrera J, Sarpatwari A, Higgins J. Expressing findings from meta-analyses of continuous outcomes in terms of risks. *Stat Med.* 2011;30(25):2967-85.

22. Thorlund K, Walter S, Johnston B, et al. Pooling health-related quality of life outcomes in metaanalysis--a tutorial and review of methods for enhancing interpretability. *Research Synthesis Methods*. 2011;2(3):188-203.

23. Guyatt GH, Oxman AD, Santesso N, et al. GRADE guidelines: 12. preparing summary of findings tables-binary outcomes. *J Clin Epidemiol*. 2013;66(2):158-72.

24. Guyatt G, Oxman AD, Akl EA, et al. GRADE guidelines: 1. introduction-GRADE evidence profiles and summary of findings tables. *J Clin Epidemiol*. 2011;64(4):383-94.

25. Guyatt GH, Oxman AD, Montori V, et al. GRADE guidelines: 5. rating the quality of evidence-publication bias. *J Clin Epidemiol*. 2011;64(12):1277-82.

26. Guyatt GH, Oxman AD, Kunz R, et al. GRADE guidelines 6. rating the quality of evidence-imprecision. *J Clin Epidemiol*. 2011;64(12):1283-93.

27. Guyatt GH, Oxman AD, Kunz R, et al. GRADE guidelines: 7. rating the quality of evidence-inconsistency. *J Clin Epidemiol*. 2011;64(12):1294-302.

28. Guyatt GH, Oxman AD, Kunz R, et al. GRADE guidelines: 8. rating the quality of evidence-indirectness. *J Clin Epidemiol*. 2011;64(12):1303-10.

29. Guyatt GH, Thorlund K, Oxman AD, et al. GRADE guidelines: 13. preparing summary of findings tables and evidence profiles-continuous outcomes. *J Clin Epidemiol*. 2013;66(2):173-83.

30. Bitterli R, Sieben JM, Hartmann M, et al. Pre-surgical sensorimotor training for patients undergoing total hip replacement: A randomised controlled trial. *Int J Sports Med.* 2011;32(9):725-32.

31. Ferrara P, Rabini A, Maggi L, et al. Effect of pre-operative physiotherapy in patients with endstage osteoarthritis undergoing hip arthroplasty. *Clin Rehabil*. 2008;22(10-11):977-86.

32. Gocen Z, Sen A, Unver B, et al. The effect of preoperative physiotherapy and education on the outcome of total hip replacement: A prospective randomized controlled trial. *Clin Rehabil*. 2004;18(4):353-8.

33. Hoogeboom T, Dronkers J, van den Ende C, et al. Preoperative therapeutic exercise in frail elderly scheduled for total hip replacement: A randomized pilot trial. *Clin Rehabil*. 2010;24(10):901-10.

34. Vukomanović A, Popović Z, Durović A, et al. The effects of short-term preoperative physical therapy and education on early functional recovery of patients younger than 70 undergoing total hip arthroplasty. *Vojnosanit Pregl.* 2008;65(4):291-7.

35. Wang A, Gilbey H, Ackland T. Perioperative exercise programs improve early return of ambulatory function after total hip arthroplasty: Arandomized, controlled trial. *Am J Phys Med Rehabil.*2002;81(11):801-6.

36. Oosting E, Jans M, Dronkers J, et al. Preoperative home-based physical therapy versus usual care to improve functional health of frail older adultsscheduled for elective total hip arthroplasty: A pilot randomized controlled trial. *Arch Phys Med Rehabil*. 2012;93(4):610-6.

37. Beaupre L, Lier D, Davies D, et al. The effect of a preoperative exercise and education program on functional recovery, health related quality of life, and health service utilization following primary total knee arthroplasty. *J Rheumatol*. 2004;31(6):1166-73.

38. Brown K, Top R, Brosky JA, et al. Prehabilitation and quality of life three months after total knee arthroplasty: A pilot study. *Percept Mot Skills*. 2012;115(3):765-74.

39. Evgeniadis G, Beneka A, Malliou P, et al. Effects of pre- or postoperative therapeutic exercise on the quality of life, before and after total knee arthroplasty for osteoarthritis. *J Back Musculoskelet Rehabil*. 2008;21:161-9.

40. Gstoettner M, Raschner C, Dirnberger E, et al. Preoperative proprioceptive training in patients with total knee arthroplasty. *The Knee*. 2011;18(4):265-70.

41. Matassi F, Duerinckx J, Vandenneucker H, et al. Range of motion after total knee arthroplasty: The effect of a preoperative home exercise program. *Knee Surg Sports Traumatol Arthrosc.* 2014;22(3):703-9.

BMJ Open

43. McKay C, Prapavessis H, Doherty T. The effect of a prehabilitation exercise program on quadriceps strength for patients undergoing total knee arthroplasty: A randomized controlled pilot study. *PM R*. ;4(9):647-56.

44. Topp R, Swank A, Quesada P, et al. The effect of prehabilitation exercise on strength and functioning after total knee arthroplasty. *PM R*. 2009;1(8):729-35.

45. Tungtrongjit Y, Weing P, Saunkool P. The effect of preoperative quadriceps exercise on functional outcomes after total knee arthroplasty. *J Med Assoc Thai*. 2012;95(Suppl 10):S58-66.

46. Weidenhielm L, Mattsson E, Brostrom L, et al. Effect of preoperative physiotherapy in uncompartmental prosthetic knee replacement. *Scand J Rehab Med.* 1993;25:33-9.

47. Williamson L, Wyatt M, Yein K, et al. Severe knee osteoarthritis: A randomized controlled trial of acupuncture, physiotherapy (supervised exercise) and standard management for patients awaiting knee replacement. *Rheumatology (Oxford)*. 2007;46(9):1445-9.

48. Rooks D, Huang J, Bierbaum B, et al. Effect of preoperative exercise on measures of functional status in men and women undergoing total hip and knee arthroplasty. *Arthritis Rheum*. 2006;55(5):700-8.

49. Villadsen A, Overgaard S, Holsgaard-Larsen A, et al. Postoperative effects of neuromuscular exercise prior to hip or knee arthroplasty: A randomised controlled trial. *Ann Rheum Dis*. 2014;73(6):1130-37.

50. Villadsen A, Overgaard S, Holsgaard-Larsen A, et al. Immediate efficacy of neuromuscular exercise in patients with severe osteoarthritis of the hip or knee: A secondary analysis from a randomized controlled trial. *J Rheumatol.* 2014;41(7):1385-94.

51. Angst F, Aeschlimann A, Michel BA, et al. Minimal clinically important rehabilitation effects in patients with osteoarthritis of the lower extremities. *J Rheumatol.* 2002;29(1):131-8.

52. Ehrich EW, Davies GM, Watson DJ, et al. Minimal perceptible clinical improvement with the western ontario and McMaster universities osteoarthritis index questionnaire and global assessments in patients with osteoarthritis. *J Rheumatol.* 2000;27(11):2635-41.

53. Escobar A, Quintana JM, Bilbao A, et al. Responsiveness and clinically important differences for the WOMAC and SF-36 after total knee replacement. *Osteoarthritis Cartilage*. 2007;15(3):273-80.

54. Escobar A, Garcia Perez L, Herrera-Espineira C, et al. Total knee replacement; minimal clinically important differences and responders. *Osteoarthritis Cartilage*. 2013;21(12):2006-12.

55. Quintana JM, Escobar A, Bilbao A, et al. Responsiveness and clinically important differences for the WOMAC and SF-36 after hip joint replacement. *Osteoarthritis Cartilage*. 2005;13(12):1076-83.

56. Tubach F, Ravaud P, Baron G, et al. Evaluation of clinically relevant changes in patient reported outcomes in knee and hip osteoarthritis: The minimal clinically important improvement. *Ann Rheum Dis.* 2005;64(1):29-33.

57. Borjesson M, Robertson E, Weidenheilm L, et al. Physiotherapy in knee osteoarthrosis: Effect on pain and walking. *Physiother Res Int*. 1996;1:89-97.

BMJ Open

58. Nunez M, Nunez E, Segur J. The effect of an educational program to improve health-related quality of life in patients with osteoarthritis on waiting list for total knee replacement: A randomized study. *Osteoarthritis Cartilage*. 2006;14:279-85.

59. Aoki O, Tsumura N, Kimura A, et al. Home stretching exercise is effective for improving knee range of motion and gait in patients with knee osteoarthritis. *J Phys Ther Sci.* 2009;21:113-9.

60. Swank A, Kachelman J, Bibeau W. Prehabilitation before total knee arthroplasty increases strength and function in older adults with severe osteoarthritis. *J Strength COnd Res*. 2011;25:318.

61. Johnston BC, Bandayrel K, Friedrich JO, et al. Presentation of continuous outcomes in meta-analysis:A survey of clinicians' understanding and preferences. 21st Cochrane Colloquium, Quebec City, Canada 2013.

62. Guyatt GH, Oxman AD, Vist GE, et al. GRADE: An emerging consensus on rating quality of evidence and strength of recommendations. *BMJ*. 2008;336(7650):924-6.

63. Langer G, Meerpohl JJ, Perleth M, et al. GRADE guidelines: 1. introduction - GRADE evidence profiles and summary of findings tables. *Z Evid Fortbild Qual Gesundhwes*. 2012;106(5):357-68.
Table Legends

Table 1: Characteristics of included RCTs

Table 2: Risk of Bias for Included Studies

Table 3: Summary of results for prehabilitation vs. no prehabilitation

Table 4: GRADE Evidence Profile: prehabilitation vs no formal prehabilitation for total joint replacement

Supplementary table 1: Intervention characteristics of included RCTs

Supplementary Table 2: Description of RCTs of Prehabilitation versus No Prehabilitation for TKR/THR

Supplementary Table 3: Subgroup Analysis of TKR and THR

Supplementary Table 4 Sensitivity Analysis to test robustness of results after removing total score

Supplementary Table 5: Sensitivity analysis using different thresholds of patient acceptable symptom

state (PASS)

Figure Legend

Figure 1: PRISMA flow diagram of study selection

Figure 2. Pain score at 4 weeks or less (converted to WOMAC pain subscale 0-100) for prehabilitation vs no prehabilitation in joint replacement surgery

Figure 3. Function score at 6 to 8 weeks (converted to WOMAC function subscale 0-100) for prehab vs no prehab in joint replacement surgery

Figure 4. Function score at 12 weeks (converted to WOMAC function subscale 0-100) for prehabilitation

vs no prehabilitation in joint replacement surgery

Figure 5. Hospital length of stay (days) for prehabilitation vs no prehabilitation in joint replacement

surgery

Supplementary figure 1. Funnel plot to explore publication bias for pain scores

Supplementary figure 2. Funnel plot to explore publication bias for function scores

BMJ Open

Table 4 GRADE Evidence Profile: prehabilitation vs no formal prehabilitation for total joint replacement

Quality assessment							Summary of Findings		
Participants (studies) Follow up Pain score at 4 v	Risk of bias	Inconsistency asured with: WOMAC	Indirectness pain subscale 0-100	Imprecision ; Lower values inc	Publication bias	Overall quality of evidence	Relative effect or WMD (95% CI)	Anticipated abs Median risk with non- prehabilitation	olute effects Risk difference with prehabilitation (95% CI)
010			- 		-			42.00/	2 00/
213	Serious risk of	Serious	No serious	No serious	Uncertain	$\oplus \oplus \Theta \Theta$	WMD -6.1	43.8% patients	3.9% more
(4 studies)	bias ¹	inconsistency;	indirectness	imprecision	(only 4 studies)	LOW	(-10.6, -1.6)	achieved	patients achieving
≤4 weeks	Unclear	p-value on test for				due to risk of bias and		acceptable pain	acceptable pain
	concealment: 4	heterogeneity 0.08,				inconsistency		state of ≤ 30 on	state of \leq 30 on
	studies;	I ² = 55%						WOMAC pain	WOMAC pain (0-
	Outcome							(0-100) scale	100) scale
	assessors not								
	blinded: 1;								
	Missing data								
	>15%: 1								
Pain score at 6 t	to 8 weeks, measu	ared with: WOMAC pa	in subscale 0-100; I	lower values indica	ate less pain				
		6 50%	noor review of	ly o http://hmia	non hmi com/site/sh	out b uidelings shi			

48 18MJ Open: first published as 10.1136/pmjopen-2015.00857 on 2 February 2016. Downloaded from http://bmjopen.bmj.com/ on June 12, 2025 at Agence Bibliographique de I
 Enseignement Superieur (ABES) .
 Protected by copyrights.inglights.ing

400	Serious risk of	No serious	No serious	No serious	Uncertain	$\oplus \oplus \oplus \ominus$	WMD -1.4	62.2% patients	0% more patient
(5 studies)	bias ¹	inconsistency;	indirectness	imprecision ²	(only 5 studies)	MODERATE	(-5.5, +2.6)	achieved	achieved
6 to 8 weeks	Unclear	p-value on test for				due to risk of bias		acceptable pain	acceptable pain
	concealment: 3	heterogeneity 0.31,						state of ≤ 30 on	state of ≤ 30 on
	studies;	I ² = 16%						WOMAC pain	WOMAC pain
	outcome							scale (0-100)	scale (0-100)
	assessors not								
	blinded: 2;								
	Missing data								
	>15%: 3								
Pain score at 1	12 weeks, measured	d with: WOMAC pain	subscale 0-100; Lo	wer values indicat	e less pain		1		
Pain score at 1 806	12 weeks, measured Serious risk of	d with: WOMAC pain s	subscale 0-100; Lo	wer values indicat	Undetected;	⊕⊕⊖⊝	WMD -2.9	60.9% patients	1.2% more
Pain score at 1 806 (10 studies)	12 weeks, measured Serious risk of bias ¹	d with: WOMAC pain s Serious inconsistency;	subscale 0-100; Lo No serious indirectness	wer values indicat No serious imprecision	e less pain Undetected; Egger's test p=0.35	⊕⊕⊝⊝ LOW	WMD -2.9 (-6.2, +2.8)	60.9% patients achieved	1.2% more patients achieve
Pain score at 1 806 (10 studies) 12 weeks	 12 weeks, measured Serious risk of bias¹ Unclear 	d with: WOMAC pain a Serious inconsistency; p-value on test for	subscale 0-100; Lo No serious indirectness	wer values indicat No serious imprecision	e less pain Undetected; Egger's test p=0.35	$ \begin{array}{c} \oplus \oplus \ominus \ominus \\ \textbf{LOW} \\ \text{due to risk of bias and} \end{array} $	WMD -2.9 (-6.2, +2.8)	60.9% patients achieved acceptable pain	1.2% more patients achieve acceptable pain
Pain score at 1 806 (10 studies) 12 weeks	12 weeks, measured Serious risk of bias ¹ Unclear concealment: 5	d with: WOMAC pain a Serious inconsistency; p-value on test for heterogeneity 0.05,	subscale 0-100; Lo No serious indirectness	wer values indicat	e less pain Undetected; Egger's test p=0.35	⊕⊕⊖⊖ LOW due to risk of bias and inconsistency	WMD -2.9 (-6.2, +2.8)	60.9% patients achieved acceptable pain state of ≤30 on	1.2% more patients achieve acceptable pain state of \leq 30 on
Pain score at 1 806 (10 studies) 12 weeks	12 weeks, measured Serious risk of bias ¹ Unclear concealment: 5 studies;	d with: WOMAC pain : Serious inconsistency; p-value on test for heterogeneity 0.05 , $I^2 = 46\%$	subscale 0-100; Lo No serious indirectness	wer values indicat	e less pain Undetected; Egger's test p=0.35	 ⊕⊕⊖⊖ LOW due to risk of bias and inconsistency 	WMD -2.9 (-6.2, +2.8)	60.9% patients achieved acceptable pain state of ≤30 on WOMAC pain	1.2% more patients achieve acceptable pain state of ≤30 on WOMAC pain
Pain score at 1 806 (10 studies) 12 weeks	12 weeks, measured Serious risk of bias ¹ Unclear concealment: 5 studies; outcome	d with: WOMAC pain a Serious inconsistency; p-value on test for heterogeneity 0.05 , $I^2 = 46\%$	subscale 0-100; Lo	wer values indicat	e less pain Undetected; Egger's test p=0.35	 ⊕⊕⊖⊖ LOW due to risk of bias and inconsistency 	WMD -2.9 (-6.2, +2.8)	60.9% patients achieved acceptable pain state of ≤30 on WOMAC pain scale (0-100)	1.2% more patients achieve acceptable pain state of ≤30 on WOMAC pain scale (0-100)
Pain score at 1 806 (10 studies) 12 weeks	12 weeks, measured Serious risk of bias ¹ Unclear concealment: 5 studies; outcome assessors not	d with: WOMAC pain : Serious inconsistency; p-value on test for heterogeneity 0.05 , $I^2 = 46\%$	subscale 0-100; Lo	wer values indicat	e less pain Undetected; Egger's test p=0.35	⊕⊕⊖⊖ LOW due to risk of bias and inconsistency	WMD -2.9 (-6.2, +2.8)	60.9% patients achieved acceptable pain state of ≤30 on WOMAC pain scale (0-100)	1.2% more patients achieve acceptable pain state of ≤30 on WOMAC pain scale (0-100)
Pain score at 1 806 (10 studies) 12 weeks	12 weeks, measured Serious risk of bias ¹ Unclear concealment: 5 studies; outcome assessors not blinded: 4;	d with: WOMAC pain : Serious inconsistency; p-value on test for heterogeneity 0.05 , $I^2 = 46\%$	subscale 0-100; Lo	wer values indicat	e less pain Undetected; Egger's test p=0.35	⊕⊕⊖⊖ LOW due to risk of bias and inconsistency	WMD -2.9 (-6.2, +2.8)	60.9% patients achieved acceptable pain state of ≤30 on WOMAC pain scale (0-100)	1.2% more patients achieve acceptable pain state of ≤30 on WOMAC pain scale (0-100)
Pain score at 1 806 (10 studies) 12 weeks	12 weeks, measured Serious risk of bias ¹ Unclear concealment: 5 studies; outcome assessors not blinded: 4; Missing data	d with: WOMAC pain a Serious inconsistency; p-value on test for heterogeneity 0.05, I ² = 46%	subscale 0-100; Lo	wer values indicat	e less pain Undetected; Egger's test p=0.35	⊕⊕⊖⊖ LOW due to risk of bias and inconsistency	WMD -2.9 (-6.2, +2.8)	60.9% patients achieved acceptable pain state of ≤30 on WOMAC pain scale (0-100)	1.2% more patients achieve acceptable pain state of ≤30 on WOMAC pain scale (0-100)

BMJ Open: first published as 10.1136/bmjopen-2015-009857 on 2 February 2016. Downloaded from http://bmjopen.bmj.com/ on June 12, 2025 at Agence Bibliographique de I
 Protected by cppytights/ing/febelse/ingled ingle de indicate/ingled ingle de indicate/inglede ingle de indicate/ingled ingle de indicate/ingled ingle de in

241	Serious risk of	No serious	No serious	No serious	Uncertain	$\oplus \oplus \oplus \ominus$	WMD -2.5	98% patients	0% patients
(3 studies)	bias ¹	inconsistency;	indirectness	imprecision	(only 3 studies)	Moderate	(-5.6, +0.6)	achieved	achieved
24 weeks	Unclear	p-value on test for				due to risk of bias		acceptable pain	acceptable pain
	concealment: 2	heterogeneity 0.22,						state of ≤30 on	state of ≤ 30 on
	studies;	I ² = 33%						WOMAC pain	WOMAC pain
	outcome							scale (0-100)	scale (0-100)
	assessors not								
	blinded: 0;								
	Missing data								
	>15%: 2								
Function scor	>15%: 2 re at 4 weeks or less	s, measured with: WOM	IAC function subsc	ale 0-100; Lower v	ralues indicate better function	on			
Function scor 257	>15%: 2 re at 4 weeks or less Serious risk of	s, measured with: WOM	IAC function subsc	ale 0-100; Lower v	values indicate better function	on ⊕⊕⊝⊝	WMD -3.6	26.8% patients	6.2% more
Function scor 257 (5 studies)	>15%: 2 re at 4 weeks or less Serious risk of bias ¹	s, measured with: WON Serious inconsistency;	IAC function subsc No serious indirectness	ale 0-100; Lower v No serious imprecision ²	uncertain (only 5 studies)	on ⊕⊕⊝⊝ LOW	WMD -3.6 (-7.7, +0.5)	26.8% patients achieved	6.2% more patients achieved
Function scor 257 (5 studies) <=4 weeks	>15%: 2 re at 4 weeks or less Serious risk of bias ¹ Unclear	s, measured with: WOM Serious inconsistency; p-value on test for	IAC function subsc No serious indirectness	ale 0-100; Lower v No serious imprecision ²	uncertain (only 5 studies)	on ⊕⊕⊝⊝ LOW due to risk of bias and	WMD -3.6 (-7.7, +0.5)	26.8% patients achieved acceptable	6.2% more patients achieved acceptable function
Function scor 257 (5 studies) <=4 weeks	>15%: 2 re at 4 weeks or less Serious risk of bias ¹ Unclear concealment: 5	s, measured with: WOM Serious inconsistency; p-value on test for heterogeneity <0.001,	IAC function subsc No serious indirectness	ale 0-100; Lower v No serious imprecision ²	uncertain (only 5 studies)	on ⊕⊕⊖⊖ LOW due to risk of bias and inconsistency	WMD -3.6 (-7.7, +0.5)	26.8% patients achieved acceptable function state	6.2% more patients achieved acceptable function state ≤30 on
Function scor 257 (5 studies) <=4 weeks	 >15%: 2 re at 4 weeks or less Serious risk of bias¹ Unclear concealment: 5 studies; 	s, measured with: WOM Serious inconsistency; p-value on test for heterogeneity <0.001, I^2 = 79%	IAC function subsc No serious indirectness	ale 0-100; Lower v No serious imprecision ²	values indicate better function Uncertain (only 5 studies)	on ⊕⊕⊖⊖ LOW due to risk of bias and inconsistency	WMD -3.6 (-7.7, +0.5)	26.8% patients achieved acceptable function state ≤30 on	6.2% more patients achieved acceptable function state ≤30 on WOMAC function
Function scor 257 (5 studies) <=4 weeks	 >15%: 2 Serious risk of bias¹ Unclear concealment: 5 studies; outcome 	s, measured with: WOM Serious inconsistency; p-value on test for heterogeneity <0.001, I ² = 79%	IAC function subsc No serious indirectness	ale 0-100; Lower v No serious imprecision ²	values indicate better function Uncertain (only 5 studies)	on ⊕⊕⊖⊖ LOW due to risk of bias and inconsistency	WMD -3.6 (-7.7, +0.5)	26.8% patients achieved acceptable function state ≤30 on WOMAC	6.2% more patients achieved acceptable function state ≤30 on WOMAC function scale (0-100)
Function scor 257 (5 studies) <=4 weeks	 >15%: 2 re at 4 weeks or less Serious risk of bias¹ Unclear concealment: 5 studies; outcome assessors not 	s, measured with: WOM Serious inconsistency; p-value on test for heterogeneity <0.001, I ² = 79%	IAC function subsc	ale 0-100; Lower v No serious imprecision ²	values indicate better function Uncertain (only 5 studies)	on ⊕⊕⊖⊖ LOW due to risk of bias and inconsistency	WMD -3.6 (-7.7, +0.5)	26.8% patients achieved acceptable function state ≤30 on WOMAC function scale	6.2% more patients achieved acceptable function state ≤30 on WOMAC function scale (0-100)
Function scor 257 (5 studies) <=4 weeks	 >15%: 2 re at 4 weeks or less Serious risk of bias¹ Unclear concealment: 5 studies; outcome assessors not blinded: 2; 	s, measured with: WOM Serious inconsistency; p-value on test for heterogeneity <0.001, I ² = 79%	IAC function subsc	ale 0-100; Lower v No serious imprecision ²	values indicate better functi Uncertain (only 5 studies)	on ⊕⊕⊖⊖ LOW due to risk of bias and inconsistency	WMD -3.6 (-7.7, +0.5)	26.8% patients achieved acceptable function state ≤30 on WOMAC function scale (0-100)	6.2% more patients achieved acceptable function state ≤30 on WOMAC function scale (0-100)

48 18MJ Open: first published as 10.1136/bmjopen-2015-009857 on 2 February 2016. Downloaded from http://bmjopen.bmj.com/ on June 12, 2025 at Agence Bibliographique de I
 70 28BG)
 71 2025 at Agence Bibliographique de I
 72 2025 at Agence Bibliographique de I
 74 2025 at Agence Bibliographique de I
 74 2025 at Agence Bibliographique de I
 74 2025 at Agence Bibliographique de I
 75 2025 at Agence Bibliographique de I
 76 2025 at Agence Bibliographication
 77 2025 at Agence Bibliographication
 78 2025 a

	>15%: 1								
Function score	e at 6 to 8 weeks, r	neasured with: WOMA	C function subscale	e 0-100; Lower val	ues indicate better function	1			<u> </u>
488	Serious risk of	No serious	No serious	No serious	Uncertain	$\oplus \oplus \oplus \ominus$	WMD -3.9	54.3% patients	5.4% more
(5 studies)	bias ¹	inconsistency;	indirectness	imprecision	(only 5 studies)	Moderate	(-7.6, -0.3)	achieved	patients achieved
6 to 8 weeks	Unclear	p-value on test for				due to risk of bias		acceptable	acceptable function
	concealment: 3	heterogeneity =0.21,						function state	state ≤30 on
	studies;	I ² = 30%	í A					≤30 on	WOMAC function
	outcome							WOMAC	scale (0-100)
	assessors not							function scale	
	blinded: 2;							(0-100)	
	Missing data								
	>15%: 3								
Function score	e at 12 weeks, mea	sured with: WOMAC fi	inction subscale 0-	100; Lower values	indicate better function	1		-1	1
836	Serious risk of	Serious	No serious	No serious	Serious;	000	WMD -4.0	62.6% patients	1.3% more
(12 studies)	bias ¹	inconsistency;	indirectness	imprecision	Asymmetry on funnel	VERY LOW	(-7.5, -0.5)	achieved	patients achieved
12 weeks	Unclear	p-value on test for			plot; Egger's test p=0.04	due to risk of bias,		acceptable	acceptable function
	concealment: 6	heterogeneity <0.001,				inconsistency and		function state	state ≤30 on
	studies;	$I^2 = 69\%$				publication bias		≤30 on	WOMAC function
	outcome							WOMAC	scale (0-100)
	assessors not							function scale	
	blinded: 4;							(0-100)	

BMJ Open: first published as 10.1136/bmjopen-2015-009857 on 2 February 2016. Downloaded from http://bmjopen.bmj.com/ on June 12, 2025 at Agence Bibliographique de I
 Protected by cppytights/ing/febelse/ingled ingle de indicate/ingled ingle de indicate/inglede ingle de indicate/ingled ingle de indicate/ingled ingle de in

	Missing data								
	>15%: 6								
Function scor	e at 24 weeks, mea	sured with: WOMAC fu	unction subscale 0-1	100; Lower values	indicate better function				
345	Serious risk of	Serious	No serious	No serious	Uncertain	$\oplus \oplus \ominus \ominus$	WMD -0.5	97.4% patients	0% more patients
(7 studies)	bias ¹	inconsistency;	indirectness	imprecision ²	(only 7 studies)	LOW	(-5.8, +4.7)	achieved	achieved
24 weeks	Unclear	p-value on test for				due to risk of bias and		acceptable	acceptable functio
	concealment: 4	heterogeneity <0.001,				inconsistency		function state	state ≤30 on
	studies;	I ² = 89%						≤30 on	WOMAC function
	outcome							WOMAC	scale (0-100)
	assessors not							function scale	
	blinded: 2;				Q 1			(0-100)	
	Missing data								
	>15%:2								
1. 1	None of studies in	n the meta-analyses b	linded patients an	d only 2 study bl	inded the care providers		•	-	
2. 1	We did not rate dov	vn due to imprecision al	though 95% confid	ence interval inclu	des no effect because either	extreme of the 95%CI	is too small to b	e clinically importa	int
diff	erence.								
		.səigolondər າ <u>ອີ່ມີຫຼາ</u>	i s b us conimicad	A.epitibri/epible	nenxardi pare(sitsash	ant emisphoiner ein	ected by cop	Prot	
lraphique de	t Agence Bibliog	<mark>/</mark> on June 12, 2025 a	moɔ.įmd.nəqoįm	ed from http://bi eur (S38A)	bruary 2016. Download Enseignement Superi	915-009857 on 2 Fel	36/bmjopen-	tt.0t ss bədzild	ע Open: first pu

For peer review only

Protected by copyrights including the uses is based to text and leading which and which and similar technologies.

I ab aupindaraphinary 2015. Downloaded from http://bmjopen.bmi.com/ on June 12, 2025 at Agence Bibliographique de I Enseignement Superieur (SBBA) . .

Appendix Search Strategies

PubMed

1	(((((((((((((((((((exercise[tiab] OR prehabilitation[tiab] OR prehab[tiab] OR "physical
	therapy"[tiab] OR physiotherapy[tiab] OR "therapeutic exercise"[tiab] OR "therapeutic
	activity"[tiab] OR activity[tiab] OR "preoperative rehabilitation"[tiab] OR "weight training"[tiab]
	OR "weight lifting"[tiab] OR aquatic[tiab] or swimming[tiab] Or "strength training"[tiab] OR
	"endurance training"[tiab] OR cycling[tiab] OR biking[tiab] OR "weight reduction"[tiab] OR
	"weight loss"[tiab] OR kinesiotherapy[tiab] OR hydrotherapy[tiab] OR fitness[tiab] OR "exercise
	therapy"[tiab])
2	(((Arthroplast*[tiab] OR replace*[tiab] OR "orthopedic surgery"[tiab]))) AND ((hip*[tiab] OR
	knee*[tiab]))
3	1 AND 2
4	(((((pre-operative[tiab] OR preoperative[tiab] OR pre-op[tiab] OR preop[tiab] OR preoperative
	care[MeSH Terms])
5	3 AND 4
6	random*
7	5 AND 6

Emabase

1	exercise.ti,ab.
2	Prehabilitation.ti,ab.
3	Physical therapy.ti,ab.

4	Physiotherapy.ti,ab.
5	Therapeutic exercise.ti,ab.
6	Therapeutic activity.ti,ab.
7	Activity.ti,ab.
8	Preoperative rehabilitation.ti,ab.
9	Weight training.ti,ab.
10	Weight lifting.ti,ab.
11	Aquatic.ti,ab.
12	Swimming.ti,ab.
13	Strength training.ti,ab.
14	Endurance training.ti,ab.
15	Cycling.ti,ab.
16	Biking.ti,ab.
17	Weight reduction.ti,ab.
18	Weight loss.ti,ab.
19	Kinesiotherapy.ti,ab.
20	Hydrotherapy.ti,ab.
21	Fitness.ti,ab.
22	Exercise therapy.ti,ab.
23	or/1-22
24	arthroplast*.ti,ab.
25	replacement.ti,ab.
26	resurfac*.ti.ab.

1
2
3
1
5
0
6
7
8
9
10
11
12
13
14
15
10
10
17
18
19
20
21
22
23
24
25
26
27
20
20
29
30
31
32
33
34
35
36
37
38
39
40
/1
12
ד∠ ⊿2
40
44 45
45
46
47
48
49
50
51
52
53
54
55
56
57
58
50
00

27	anthe second state
27	orthopedic surgery.ti,ab.
28	hip*.ti,ab.
29	knee*.ti,ab.
30	or/24-27
31	28 or 29
32	30 and 31
33	23 and 32
34	random*.mp.
35	33 and 34
36	exp animals/
37	exp human/
38	(dog or dogs or canine or canines or pig or pigs or porcine or rat or rats or cat or feline or
	felines or lamb or lambs or mouse or mice or rabbit or rabbits).ti,ab.
39	36 not 37
40	38 or 39
41	35 not 39
42	pre-operative.mp.
43	preoperative.mp.
44	preoperative care/
45	Preop*.mp.
46	Pre-op*.mp.
47	or/42-46
48	41 and 47

Cochrane CENTRAL

1	"exercise":ti,ab,kw (Word variations have been searched)
2	"prehabilitation":ti,ab,kw (Word variations have been searched)
3	"physical therapy":ti,ab,kw (Word variations have been searched)
4	"physiotherapy":ti,ab,kw (Word variations have been searched)
5	"therapeutic exercise":ti,ab,kw (Word variations have been searched)
6	"therapeutic activity":ti,ab,kw (Word variations have been searched)
7	"activity":ti,ab,kw (Word variations have been searched)
8	"Preoperative rehabilitation":ti,ab,kw (Word variations have been searched)
9	"weight training":ti,ab,kw (Word variations have been searched)
10	"weight lifting":ti,ab,kw (Word variations have been searched)
11	"aquatic":ti,ab,kw (Word variations have been searched)
12	"swimming":ti,ab,kw (Word variations have been searched)
13	"strength training":ti,ab,kw (Word variations have been searched)
14	"Endurance training":ti,ab,kw (Word variations have been searched)
15	"cycling":ti,ab,kw (Word variations have been searched)
16	"biking":ti,ab,kw (Word variations have been searched)
17	"weight reduction":ti,ab,kw (Word variations have been searched)
18	"weight loss":ti,ab,kw (Word variations have been searched)
19	"kinesiotherapy":ti,ab,kw (Word variations have been searched)
20	"hydrotherapy":ti,ab,kw (Word variations have been searched)

Page 47 of 82

BMJ Open

21	"fitness":ti,ab,kw (Word variations have been searched)
22	"Exercise therapy":ti,ab,kw (Word variations have been searched)
23	#1 or #2 or #3 or #4 or #5 or #6 or #7 or #8 or #9 or #10 or #11 of #12 or #13 or #14 or #15 or #16
	or #17 or #18 or #19 or #20 or #21 or #22
24	"arthroplasty":ti,ab,kw (Word variations have been searched)
25	"replacement":ti,ab,kw (Word variations have been searched)
26	"resurface":ti,ab,kw (Word variations have been searched)
27	"orthopedic surgery":ti,ab,kw (Word variations have been searched)
28	#24 or #25 or #26 or #27
29	"hip":ti,ab,kw (Word variations have been searched)
30	"knee":ti,ab,kw (Word variations have been searched)
31	#29 or #30
32	"preoperative":ti,ab,kw (Word variations have been searched)
33	"pre-operative":ti,ab,kw (Word variations have been searched)
34	"preop":ti,ab,kw (Word variations have been searched)
35	"pre-op":ti,ab,kw (Word variations have been searched)
36	#32 or #33 or #34 or #35
37	#28 and #31
38	#23 and #37
39	#36 and #38





Figure 1 PRISMA flow diagram 1117x1217mm (96 x 96 DPI)



Figure 2. Pain score at 4 weeks or less (converted to WOMAC pain subscale 0-100) for prehabilitation vs no prehabilitation in joint replacement surgery 1718x1109mm (96 x 96 DPI)

BMJ Open: first published as 10.1136/bmjopen-2015-009857 on 2 February 2016. Downloaded from http://bmjopen.bmj.com/ on June 12, 2025 at Agence Bibliographique de I Enseignement Superieur (ABES) . Protected by copyright, including for uses related to text and data mining, Al training, and similar technologies.

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

BMJ Open: first published as 10.1136/bmjopen-2015-009857 on 2 February 2016. Downloaded from http://bmjopen.bmj.com/ on June 12, 2025 at Agence Bibliographique de I Enseignement Superieur (ABES) . Protected by copyright, including for uses related to text and data mining, Al training, and similar technologies.



Figure 3. Function score at 6 to 8 weeks (converted to WOMAC function subscale 0-100) for prehab vs no prehab in joint replacement surgery 1726x1159mm (96 x 96 DPI)



Figure 4. Function score at 12 weeks (converted to WOMAC function subscale 0-100) for prehabilitation vs no prehabilitation in joint replacement surgery

BMJ Open: first published as 10.1136/bmjopen-2015-009857 on 2 February 2016. Downloaded from http://bmjopen.bmj.com/ on June 12, 2025 at Agence Bibliographique de l Enseignement Superieur (ABES) . Protected by copyright, including for uses related to text and data mining, Al training, and similar technologies.

BMJ Open: first published as 10.1136/bmjopen-2015-009857 on 2 February 2016. Downloaded from http://bmjopen.bmj.com/ on June 12, 2025 at Agence Bibliographique de I Enseignement Superieur (ABES) . Protected by copyright, including for uses related to text and data mining, Al training, and similar technologies.



Figure 5. Hospital length of stay (days) for prehabilitation vs no prehabilitation in joint replacement surgery 1749x1273mm (96 x 96 DPI)





BMJ Open: first published as 10.1136/bmjopen-2015-009857 on 2 February 2016. Downloaded from http://bmjopen.bmj.com/ on June 12, 2025 at Agence Bibliographique de I Enseignement Superieur (ABES) . Protected by copyright, including for uses related to text and data mining, Al training, and similar technologies.

Page 54 of 82

BMJ Open: first published as 10.1136/bmjopen-2015-009857 on 2 February 2016. Downloaded from http://bmjopen.bmj.com/ on June 12, 2025 at Agence Bibliographique de l Enseignement Superieur (ABES)

Protected by copyright, including for uses related to text and data mining, Al training, and similar technologies.





physiotherapist supervised				
	land based: strengthening, aerobic; supervised	all but 1 participant	usual care: regular	standard postoperativ
exercise	by physiotherapist; 3 times/week * 4 weeks +	completed the 12	activities and other	mobilization routine
	education	sessions	treatment at discretion	
			of physician	
home exercise	land based: strengthening and stretching,	exercises completed	no intervention	usual care (outpatient
	home exercises from 2 to 6 weeks, twice	on 91% of the days		rehabilitation or
	daily; 2 verbal and written instruction			rehabilitation clinic)
physiotherapist supervised	land based: strengthening and stretching,	not reported	usual care	not reported
exercise + home exercise	supervised by physiotherapist once a week +			
	home exercise 2 times/week * 8 weeks			
physiotherapist supervised	Intervention A: land based: strengthening,	not reported	no intervention	routine care
exercise	stretching.			
	Intervention B: land based and pool based:			
	strengthening, stretching, aerobic;			
	once a week * 8weeks			
	home exercise bhysiotherapist supervised exercise + home exercise bhysiotherapist supervised exercise	home exercise land based: strengthening and stretching, home exercises from 2 to 6 weeks, twice daily; 2 verbal and written instruction land based: strengthening and stretching, exercise + home exercise supervised by physiotherapist once a week + home exercise 2 times/week * 8 weeks physiotherapist supervised Intervention A: land based: strengthening, exercise stretching. Intervention B: land based and pool based: strengthening, stretching, aerobic; once a week * 8weeks	nome exercise land based: strengthening and stretching, exercises completed home exercises from 2 to 6 weeks, twice on 91% of the days daily; 2 verbal and written instruction obysiotherapist supervised land based: strengthening and stretching, not reported exercise + home exercise supervised by physiotherapist once a week + home exercise 2 times/week * 8 weeks obysiotherapist supervised Intervention A: land based: strengthening, not reported exercise stretching. Intervention B: land based and pool based: strengthening, stretching, aerobic; once a week * 8 weeks	nome exercise Iand based: strengthening and stretching, home exercises from 2 to 6 weeks, twice on 91% of the days no intervention home exercises from 2 to 6 weeks, twice on 91% of the days daily; 2 verbal and written instruction ohysiotherapist supervised Iand based: strengthening and stretching, not reported usual care exercise + home exercise supervised by physiotherapist once a week + home exercise 2 times/week * 8 weeks no intervention ohysiotherapist supervised Intervention A: land based: strengthening, not reported no intervention exercise Intervention B: land based and pool based: strengthening, stretching, aerobic; once a week * 8 weeks ince a week * 8 weeks

Evgeniadis	physiotherapist or	land based: strengthening (mostly upper limb	not reported	no intervention	standard rehabilitation
2008	orthopedist supervised	and trunk), 3 times/week * 3			
	exercise				
Ferrara 2008	physiotherapist supervised	land based: strengthening, aerobic; supervised	not reported	no intervention	postop rehabilitation
	exercise + education	by physiotherapist; 5 times/week * 4 weeks +			programme
		education			
Gilbey 2003	physiotherapist supervised	land based and pool based: strengthening,	97% of sessions	routine in-hospital	clinic-based
	exercise+ home exercise	stretching, aerobic, supervised by	complete	physical therapy	
		physiotherapist + home exercise: 2			
		times/week *8weeks			
Gocen 2004	physiotherapist supervised	land based: strengthening, stretching,	not reported	no intervention	postoperative and
	exercise + education	supervised by physiotherapist for 8 weeks;			education programme
		+education			
Gstoettner	physiotherapist supervised	land based: strengthening, stretching, balance;	not reported	no intervention	not reported
2011	exercise + home exercise	supervised by physiotherapist; once a week *			
		6 weeks +daily home training with written			
		instructions			
		instructions			

2010 ex Matassi 2014 ph ex McKay 2012 kir ex	xercise hysiotherapist supervised xercise + home exercise	+ education land based: increasing lower extremity muscle strengthening supervised by physiotherapist; once a week* 1 week+ home exercise 5 times/week * 6weeks+ written instructions	completed 79.4% completed	regular activities	protocol same physiotherapy routines
Matassi 2014 ph ex McKay 2012 kir ex	hysiotherapist supervised xercise + home exercise	land based: increasing lower extremity muscle strengthening supervised by physiotherapist; once a week* 1 week+ home exercise 5 times/week * 6weeks+ written instructions	79.4% completed	regular activities	same physiotherapy routines
ex McKay 2012 kin ex	xercise + home exercise	muscle strengthening supervised by physiotherapist; once a week* 1 week+ home exercise 5 times/week * 6weeks+ written instructions			routines
McKay 2012 kir ex	inesiologist supervised	physiotherapist; once a week* 1 week+ home exercise 5 times/week * 6weeks+ written instructions			
McKay 2012 kir ex	inesiologist supervised	exercise 5 times/week * 6weeks+ written instructions			
McKay 2012 kir ex	inesiologist supervised	instructions			
McKay 2012 kir ex	inesiologist supervised				
ex		land based: aerobic, strengthening, supervised	98% of the sessions	placebo (upper body	standard postop care
	kercise	by kinesiologist; 3 times/week * 6 weeks	completed	exercises)	
Mitchell 2005 ph	hysiotherapist supervised	land based: pain relief, increase knee flexion	73.6% sessions	preoperative	usual hospital
ex	xercise + home exercise	and extension, gait re-education ,supervised	completed	consultation	physiotherapy (post-
		by physiotherapist; 3 times/week * 8 weeks +			discharge only)
		home exercise 4 times/week * 8 weeks			
Dosting 2012 ph	hysiotherapist supervised	land based: "functional tasks exercise",	99% of the sessions	usual care (30min	not reported
ex	xercise +home exercise	supervised by physiotherapist; 2 times/week	completed	supervised class)	
		+ home exercise 4 times/week * 3 to 6 weeks			

Rooks 2006	physiotherapist supervised	land based and pool based: strengthening,	89% of sessions	education via leaflet	not reported
	exercise +education	stretching, aerobic, supervised by	completed	and telephone + 30-	
		physiotherapist; 3 times/week * 6 weeks;		60min supervised	
		+education on home modifications		class	
Торр 2009	physiotherapist supervised	land based: resistance training, flexibility,	13 sessions	no intervention	postop rehabilitatior
	exercise + home exercise	step training, supervised by physiotherapist,	completed (range 4		
		once a week + home exercise 2 times /week	to 23)		
Tungtrongjit	home exercise	land based: home quadriceps strengthening	Not reported	no intervention	postop rehabilitatior
2012		exercise for 3 weeks			
Villadsen	physiotherapist supervised	land based: standard preoperative educational	74% attended the	standard preoperative	postop rehabilitatior
2014	exercise	package + NEMEX programme; supervised	pre-specified goal of	educational package	
		by physiotherapist; 2 times/week * 8 weeks	12 or more exercise		
Vukomanovic 2008	physiotherapist supervised exercise +education	land based: physical therapy +education	not reported	no intervention	postop rehabilitation
Wang 2002	physiotherapist supervised	land based and pool based: strengthening,	97% of sessions	routine perioperative	postop rehabilitation
	exercise + home exercise	stretching, aerobic, supervised by	complete	care	
		physiotherapist+ home exercise; 2 times/week			

		* 8 weeks			
Weidenhielm	physiotherapist supervised	land based: strengthening, stretching, aerobic, n	not reported	no intervention	not reported
1993	exercise + home exercise	supervised by physiotherapist, 3 times/week			
		* 5 weeks; + home exercise daily			
Williamson	physiotherapist supervised	and based: strengthening, stretching, balance, n	not reported	education and leaflet	not reported
2007	exercise + home exercise	supervised by physiotherapist; 1 times/week *		+1 hour supervised	
		6 weeks + home exercise		class + home exercise	
idergonala eone	אס איז	reading (المراجع ا Bissigner (BES) . Bissigner (Altraining , Altraining , Altraining , Altraining , Altraining , Altraining , A	aə-i s no \cseuu-cru bəət \gribyb ənicari b i	Protected by copy	

Supplementary Table 2 Description of RCTs of Prehabilitation versus No Prehabilitation for TKR/THR

7										
8	Study	No. of	Type of	Comparison	Rehabilitation	Results				
9 10	Name	patients	surgery			Pain	Function improvement	Quality of Life	Resource use	others
11 12	Beaupre	131	TKR	PT supervised	Standard postop	WOMAC pain: NS	Knee ROM: NS;	SF-36: NS in each	Acute care LOS,	Postoperative
13 14	2004			exercise +	mobilization	SF-36 bodily pain:	Quadriceps strength: NS;	domains, PCS, and	transfer LOS,	complications:e.
15				postop education	routine	NS	Hamstring Strength: NS	MCS from 3mo. to 1 yr	readmission LOS,	g.
16 17				vs. usual care		from 3mo. to 1 year	WOMAC stiffness and	postoperatively	and total LOS: NS	pulmonary
18 19						postoperatively	function: NS;		(total LOS: -1.5 d)	emboli (n=2),
20 21							SF-36 physical functioning: NS			deep vein
22							from 3mo. to 1 year		Institutional costs,	thrombosis
23 24							postoperatively		homecare costs,	(n=9), infection
25 26									readmission costs,	(n=5),
27 28									total costs: NS	postoperative
29									(total cost: + \$33);	Angina:
31										NS
32 33	Bitterli	80	THR	Preoperative	Postop.	SF-36 pain: : NS after	SF-36 physical function: NS	SF-36: NS in each	LOS: NS (14.6 vs.	-
34 35	2011			sensorimotor	Standard	surgery (4mo.,1year)	after surgery (4mo,1 year)	domains after surgery	14.6 d)	
36 37				training at home	therapy protocol		WOMAC: NS after surgery	(4mo.,1year)		
38				(daily exercises	in hospital		(4mo, 1year)			
39 40				at home) vs. no						
41 42										
43										
44										
45										
46				səlbolonnaa 🖥	Riuis-Due Biinwe	anty contro://energiane	nxandi gane (ajtesah gut/guuida	ວ່າງອີນອີນກໍ່ມີປວ Ag para	51014	
47			_		linde hare waitale	erieur (ABES)	quS inemengiesn∃		· , U	_
48	I əb əupid	gergoildi£	l əɔnəpA i	ւ շուբ 12, 2025 a	io \moɔ.įmd.nəqo	oled from http://bmjo	on ک February 2016. Downld	96/bmjopen-2015-098	11.01 ss bədzildud	BMJ Open: first I
10										

Page 61 of 82

1

 Normal Same Interpreting interp				therapeutic modalities after					
arwa 32 TKR Prop. exercise - SF-36 pain : NS al SF-physical function score: SF-36.^2 in physical -				modalities after					
Brown 32 TKR Prop. exercise 5F-36 pain : NS at SF-physical function score: SF-36 în physical - <t< th=""><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th></t<>									
Brown 32 TKR Preop. exercise SF-36 pain : NS at SF-physical function score: SF-36:î in physical -				discharge					
Brown 32 TKR Preop. exercise SF-36 pain : NS at SF-physical function score: SF-36 în physical - - 2012 intervention vs. 3mo. after surgery ^(MD+27.1) function score (MD+27.1) D'Lima 30 TKR Preop physical - Hospital for Special Hospital for Special Surgery Quality of Well Being LOS: NS - 1996 TKR Preop physical - Hospital for Special Hospital for Special Surgery Quality of Well Being LOS: NS - 1996 TKR Preop physical - Rating pain(0-30):NS 52):NS from 3wk to 1yr Percentage intervention exercise vs. no intervention From 3wk 1yr intervention intervention measurement scale intervention intervention - - ILAS score: Ns after surgery2, SF-36: NS at 1 day - -									
2012 intervention vs. 3mo. after surgery î(MD+27.1) function score no (MD+27.1) (MD+27.1) (MD+27.1) prehabilitation prehabilitation NS in other domains . D'Lima 30 TKR Preop physical - Hospital for Special Hospital for Special Surgery Quality of Well Being LOS: NS - 1996 . therapy vs. Surgery Knee Knee Rating function (0- scores (0-1): . . 1996 . therapy vs. Rating pain(0-30):NS 52):NS from 3wk to 1yr Percentage . . . program with .	rown 32	TKR	Preop. exercise		SF-36 pain : NS at	SF-physical function score:	SF-36:↑ in physical	-	-
no mo mo <td< td=""><td>)12</td><td></td><td>intervention vs.</td><td></td><td>3mo. after surgery</td><td>↑(MD+27.1)</td><td>function score</td><td></td><td></td></td<>)12		intervention vs.		3mo. after surgery	↑(MD+27.1)	function score		
PLima 30 TKR Preop physical - Hospital for Special Hospital for Special Surgery Quality of Well Being LOS: NS - 1996 therapy vs. Surgery Knee Knee Rating function (0.0) scores (0-1): - - - 1996 eardiovascular Rating pain(0-30):NS 52):NS from 3wk to 1yr Percentage - - - 1996 eardiovascular from 3wk 1yr from 3wk 1yr improvement - NS - - - 1996 exercise vs. no exercise vs. no exercise vs. no exercise vs. no -			no				(MD+27.1)		
D'Lima 30 TKR Preop physical - Hospital for Special Hospital for Special Surgery Quality of Well Being LOS: NS - 1996 therapy vs. Image vs. Surgery Knee Knee Rating function (0- scores (0-1): -			prehabilitation				NS in other domains		
1996 therapy vs. Surgery Knee Knee Rating function (0- scores (0-1): scores (0-1): </td <td>Lima 30</td> <td>TKR</td> <td>Preop physical</td> <td>-</td> <td>Hospital for Special</td> <td>Hospital for Special Surgery</td> <td>Quality of Well Being</td> <td>LOS: NS</td> <td>-</td>	Lima 30	TKR	Preop physical	-	Hospital for Special	Hospital for Special Surgery	Quality of Well Being	LOS: NS	-
cardiovascular Rating pain(0-30):NS 52):NS from 3wk to 1yr Percentage conditioning from 3wk 1yr improvement - NS program with exercise vs. no Arthritis impact intervention resurement scale scores (0-10): Percentage improvement NS scores (0-10): Evgeniad TKR Preop.exercise - TKR Preop.exercise - (10.14/dr)) tio 2000 4% marga -	996		therapy vs.		Surgery Knee	Knee Rating function (0-	scores (0-1):		
conditioning from 3wk 1yr improvement - NS program with exercise vs. no Arthritis impact intervention measurement scale scores (0-10): Percentage improvement NS Percentage improvement NS - -			cardiovascular		Rating pain(0-30):NS	52):NS from 3wk to 1yr	Percentage		
program with exercise vs. no Arthritis impact intervention measurement scale scores (0-10): Percentage improvement NS improvement NS Evgeniad TKR Preop.exercise - ILAS score: NS after surgery(2, SF-36: NS at 1 day - -			conditioning		from 3wk 1yr		improvement - NS		
exercise vs. no Arthritis impact intervention measurement scale scores (0-10): Percentage improvement NS improvement NS Evgeniad TKR Preop.exercise - ILAS score: NS after surgery(2, SF-36: NS at 1 day - -			program with						
intervention measurement scale scores (0-10): Percentage improvement NS Evgeniad TKR Preop.exercise ILAS score: NS after surgery(2, SF-36: NS at 1 day			exercise vs. no				Arthritis impact		
Evgeniad TKR Preop.exercise - - ILAS score: NS after surgery(2, SF-36: NS at 1 day - - ix 2008 48 xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx			intervention				measurement scale		
Evgeniad TKR Preop.exercise - ILAS score: NS after surgery(2, SF-36: NS at 1 day - - in 2008 48 Improvement NS - - - - -							scores (0-10):		
Evgeniad TKR Preop.exercise - ILAS score: NS after surgery(2, SF-36: NS at 1 day - - is 2008 48 Improvement NS - - - - -							Percentage		
Evgeniad TKR Preop.exercise - ILAS score: NS after surgery(2, SF-36: NS at 1 day - - is 2008 48 - - (10, 14 m/m) - - -							improvement NS		
Evgeniad IKR Preop.exercise ILAS score: NS aller surgery(2, SF-50: NS at I day		тир	D			UAS come NS char come ()			
		IKK	Preop.exercise	-	-	(10.14.1.)	SF-30. INS at I day	-	-
is 2008 48 Vs. no 6, 10, 14wks) pervious to surgery	2008 48		vs. no			6, 10, 14wks)	pervious to surgery		
intervention Active ROM:NS after surgery (preop)			intervention			Active ROM:NS after surgery	(preop)		

						(2, 10, 14wks)			
Ferrara	23	THR	Educational and	Postop. 4weeks	VAS: \downarrow at 1, 3 mo.	ROM external rotation: ↑at	SF-36 PCS: ↑at 1 mo,	-	-
2008			PT supervised	standard	(MD -1.8, -0.97)	15days, 1 and 3 mo. after	but NS at 3 mo		
			physiotherapy	exercise		surgery	(MD +7.1 at 1 mo)		
			program vs. no	protocol	WOMAC pain: NS at	(MD +7.69, +0.14)			
			intervention		3 mo.		SF-36 MCS: NS		
						Harris Hip Score: NS at 1 and			
						3mo			
						Barthel Index: NS at 1 and 3mo			
						WOMAC stiffness and			
						function: NS at 3mo			
Gilbey	76	THR	8wks customized	Postop. Exercise	WOMAC pain: NS	Mean ROM at 3, 12, 24wks:↑		-	-
2003			exercise	program (until		(MD+6,+11,+12)			
			program vs. no	12wks after		Hip strength mean Z score			
			exercise	surgery) VS		after surgery (12, 24wks): 1			
				routine in-		(MD+0.35, +0.6)			
				hospital PT		WOMAC total score after			
						surgery (3,12,24wks):^(MD+8,			
						+9, +9)			
						WOMAC stiffness: NS,			
						3,12,24wks			
			ar technologies.	limisedin Quinne	aufa epidina, (sissi bus	hyperophysical and the second states in the second	cteq pλ copyrightering	Prote	
əp ənb	pliographi	liB əɔnəpA	, 15 202, גו פֿוע מ	o /moɔ.įmd.nəqo	etieur (ABES) . etieur (ABES) .	on ک February 2016. Downld an 2 for an 2016 Downld	28600-2102-nəqoįmd\ð	511.01 ss bəda	Dpen: first publi

						WOMAC function: \uparrow 3, 12,			
						24wks			
Gocen	60	THR	Physiotherapy	Routine postop.	VAS at rest at	Hip adduction at discharge: NS -		LOS: NS	-
2004			and educational	Exercise and	discharge: NS (MD-	(MD-0.1)			
			program vs. no	educational	0.12)				
			exercise or	program	VAS at activity at	Harris Hip Score: NS at 3mo, 2			
			education		discharge: NS (MD-	years after surgery			
					0.06)	(MD+0.9,+4)			
Gstoettn	38	TKR	PT supervised	-	WOMAC pain: NS;	KSS: NS; -		-	-
er 2011			exercise vs. no		6wk postoperatively	KSS function: NS;			
			exercise			WOMAC stiffness: NS;			
						WOMAC function: NS;			
						Gait speed (60m):NS;			
						Gait speed (stairs up):NS;			
						Gait speed (stairs down): NS;			
						Knee stability (OSI): NS;			
						Knee stability (MLSI) : NS;			
						6wk postoperatively			
						Knee stability (APSI) : \downarrow (MD			
						-0.6) 6wkpostoperatively			
			rtechnologies.	Simisoona aquinna	eniA. epinini (enelido)	enxernir.cevesis)adatione	red by copyright	Protec	

Page 64 of 82

BMJ Open

Hoogebo	21	THR	Therapeutic	Postop. usual	HOOS pain: NS	Functional recovery: NS	Patient-specific	LOS: NS	2 postoperative
om 2010			exercise program	care protocol	VAS: NS	HOOS (in all domains): NS	complaints (PSK): NS	6 vs. 6 days	complications i
			vs. usual care	till discharge	At baseline and preop,	LASA physical activity	At baseline and preop		exercise group:
						questionnaire (all domains): NS			femur fracture
						At baseline and preop			and intestinal
									obstruction.
									no serious AE
Matassi	122	TKR	Preoperative	Same postop.		Mean time to reach 90° of	-	LOS:↓	-
2014			home exercise	physiotherapy		knee ROM: \downarrow (MD -1.1 day)		(MD -0.8 day)	
			program vs.	routine		Active knee flexion: NS at			
			regular activities			6wks. 6mo, 1yr			
						Passive knee flexion: NS at			
						6wks. 6mo, 1yr			
						Knee score or patient function			
						score (Knee Society Clinical			
						Rating System): NS at 6wks, 6			
						mos. 1 yrs.			
McKay	22	TKR	Lower-body	Standard	WOMAC pain: NS,	SF-36 PSC: NS	SF-36 (PCS, MCS):	-	-
2012			strength training	postop. care	MD+0.7, +0.9 at 6	Quadriceps strength: NS	NS after surgery		
			program vs.		and 12wks.	50-foot walk: NS			
			nonspecific			Stair test: NS			
			upper-body			Arthritis self-efficacy			

48 I ab aupidargolidig asnage as 7202, 21 anul no /mos.jmd.naqojmd//:q11 most babsolrwol. af 202. Com/ on 2025 at Agence Bibliographique de l 48

			strength training			(including pain, physical			
			program			function, and other symptoms):			
			(placebo)			NS			
Mitchell	160	TKR	PT supervised	Postop home	WOMAC pain: NS	WOMAC physical function:	SF-36: NS in each	LOS: NS (MD -	45 withdray
005			pre- & postop	exercise or	SF-36 bodily pain:	NS;	domains	0.4d)	patients ha
			home exercise	hospital PT	NS	WOMAC stiffness: NS;	SF-6D: NS		significant
			(home PT) vs.		at 12wk	SF-36 physical function: NS	Patient satisfaction	Cost of PT:	poor score
			no pre-op			at 12wk	with PT: NS (86% in	NS(MD + £1.4)	the SF-36
			exercise + usual				both groups)		general he
			hospital PT				at 12wk	Total cost:	energy, an
			postop					NS(MD + £4.7)	more repo
									heart prob
									and stroke
Oosting	30	THA	PT supervised	-	HOOS pain: NS	TUG: NS;	HOOS hip-related	LOS: NS (MD -	No severe
012			exercise vs.		VAS: NS	CRT: ↓ (MD -9.2s);	quality of life: NS	0.3d)	adverse ev
			usual care		6wk changes from	6MWT: NS;			
					baseline.	PSC: NS;	Patient Specific	Nursing home	Complica
						HOOS other symptoms,	Complaints (PSC)	after discharge:	e.g. Wour
						function in daily living,	questionnaire score:	NS	delirium.
						function in sport and recreation:	NS		of sensati
						NS;			decubitus
						LAPAQ: NS;			
									ulcers, and

Rooks 108 2006	THA+	PT supervised			from baseline	obstruction) N
Rooks 108 2006	THA+	PT supervised				
2006			-	For THR:	For both THR and TKR:	-
	TKA	exercise+educati		WOMAC pain: NS	WOMAC function: NS;	
		on vs. education		SF-36 pain: NS	SF-36 physical function: NS	
				8wk and 26wk	SF-36 role limitation physical:	
				postoperatively	NS;	
					1-repetition maximum: NS;	
				For TKR:	Timed up and go: NS;	
				WOMAC pain: NS	8wk and 26wk postoperatively	
				8wk and 26wk	Functional reach: NS ;	
				postoperatively	8wk and 26wkpostoperatively	
				SF-36 pain: NS		
				8wk postoperatively		
				SF-36 pain:		
				↑(MD+11.5) 26wk		
				changes from baseline		
Topp 54	TKA	PT supervised	Postoperative	Pain in Sit-to-stand,	Sit-to-stand: NS?	-
2009		exercise vs.	rehabilitation	6MWT, Ascent and	6MWT: NS?	
		usual care		descent stairs: NS?	Ascent and descent stairs: NS?	
				at 1, 3mo.	Maximum extension strength of	

Page 67 of 82

1

10

					post	operatively	the surgical knee, nonsurgical
					No	between-group	knee: ?
					com	iparison	Maximum extension strength of
							the surgical knee:?
							at 1, 3mo. postoperatively
							No between-group comparison
Tungtro	on 60)	TKA	Quadriceps	- Moo	dified WOMAC	Total Modified WOMAC
gjit 201	2			exercise vs.	pair	n score:↓(MD -	score: \downarrow (MD -26.7)
				usual care	6.3)		Modified WOMAC stiffness
					VA	S:↓(MD -0.9)	score: \downarrow (MD -2.5)
					at 1	mo	Modified WOMAC function
					nosi	toperatively	secret (MD 17.7)
					pos	operativery	score. \checkmark (MD -17.7)
							Quadriceps strength:
					Moo	dified WOMAC	↑(MD+1.5)
					pair	score: \downarrow (MD -	at 1 mo postoperatively
					5.2)	J	
					37.4	$\mathbf{S} = (\mathbf{M} \mathbf{D} - 1)$	
					VA	5. ↓ (MD -1)	Total Modified WOMAC
					at 3	mo	score: \downarrow (MD -17.7)
					post	toperatively	Modified WOMAC stiffness
							score: \downarrow (MD -2)
					Мо	dified WOMAC	
					With		Modified WOMAC function
				ar recunologies.	านกระดูกระดูกุษยาก	6hittni/keesione	LOIGCIGA BY CARY(19/19/19/19/19/19/19/19/19/19/19/19/19/1
on ont		60000	2011261			oerieur (SBBA)	

1		
2		
3 4	pain score: \downarrow (MD -	score: \downarrow (MD -10.3)
5	2.3)	Ouadricens strength:
6)	
/ ጸ	VAS: NS	↑(MD+2.2)
9	at 6 mo	at 3 mo postoperatively
10		
11	postoperatively	
12		Total Modified WOMAC
14		
15		score: NS
16		Modified WOMAC stiffness
1/		score: NS
19		SCOLE. INS
20		Modified WOMAC function
21		score: NS
22		
23 24		Quadriceps strength: NS
25		at 6 mo postoperatively
26		
27		
28		Knee Flexion: NS
29 30		
31		Knee Extension: NS
32		Total knee ROM: NS
33		at 1.2.6 ma nastanarativaly
34 35		at 1, 5, 6 mo postoperativery
36		
37		
38		
39 40		
41		
42		
43		
44 45		
40 46	100 Rotoward For poor region only control //bmio	nen ami com/site/about/suidelings.shtmle (=
47	ופער (אאבא) . ומומומיויים, או יואמותיותם, מת ל ב וmikar technologies.	רסטר א ארים אין אריד ארים אין אין אריד אין אריד אריז אין איז אין איז אין
48	l əb əupidqrıpoildig əprəgA is 2202, 21 ənuL no \mop.imd.nəqoimd\\:qiif at hgence Bibliographique de I	Deolower: first published as 10.136/mjopen-2015-009857 on 2 February 2016. Download

10

BMJ Open

Villadse	165	TH A+	PT supervised	Postoperative	For THR+TKR.	For both THR+TKR or For	For both THR+TKR or	One patient wit
villause	105	IIIA	I I supervised	1 ostoperative	FOI IIIX+IKK.		For bour mik TKK of -	One patient wi
n 2014		TKA	exercise +	rehabilitation	KOOS/HOOS Pain: \downarrow	TKR:	For TKR:	hip OA
			education vs.		(MD -5.4)	KOOS/HOOS ADL: \uparrow at	EQ5D VAS: \downarrow (MD -	discontinued th
			education			6wkpostop, but NS at 3mo	7.6) at 6wk postop, but	exercise due to
					For THR:	postop	NS at 3mo postop	an increase in
					KOOS/HOOS Pain:		For THR:	pain.
					NS changes at 6wk	For THR:	EQ5D VAS: NS	
					and 3mo postop from	KOOS/HOOS ADL: NS at 6wk	At 6wk and 3mo	2 patients from
					base line	and 3mo postop	postop	the control
								group develope
					For TKR:	For THR+TKR or THR or	For TKR:	deep
					KOOS/HOOS Pain: \downarrow	TKR:	EQ5D VAS: \downarrow (MD -	periprosthetic
					(MD -8)	KOOS/HOOS symptoms: NS	8.8) changes at 6wk	infection.
						KOOS/HOOS sport and	postop from baseline,	
						recreation: NS	but NS changes at 3mo	
						At 6wk or 3 mo postop changes	postop from baseline	
						from baseline.		
						Single-joint hip extension and	For THR+TKR or THR	
						hip abduction: \uparrow (~15% and	or TKR:	
						35% improvement)	EO5D index: NS	
			ເຮົາເດີດເດເມເວລາ	Forupcerurestiew	only chttp://bmione	n ami com/site/about/swick	lines shtale (a personal i	

48 I sh shinging single single

1

10

-							Chair stand: NS	KOOS/HOOS QOL:		
							20-m walk: NS	NS		
							Knee bends: NS	At 6wk or 3 mo postop		
							Contra: NS	changes from baseline.		
							at 3mo			
	Vukoma	45	THA	PT supervised	Postoperative	Pain at rest (VAS):	First day of activities – use of	-	LOS: NS (- MD	Five patients
	novic 08			exercise	rehabilitation	NS	toilet \downarrow (MD -0.9d), use of		+0.4d)	were excluded
				+education vs.		Pain on movement	chair \downarrow (MD -1.05d), and			postoperatively
				no interventions		(VAS): NS	walking up and down stairs: \downarrow		Class with the	because of
						at discharge postop	(MD 1 67d)		therapist: \downarrow (MD-	complications
							(MD -1.07d)		1.65)	during and pos
									,	operation
							Changing position in bed:			operation.
							1 (MD) (0.05)			
							(MD +0.93)			
							Changing position on the edge:			
							↑(MD +0.9)			
							From sitting to standing: ↑(MD			
							+1.05)			
							Standing: \uparrow (MD +1.1)			
							3			
							Changing position to lying:			
							(MD + 1.15)			
							(1012 + 1.13)			
							Walking: ↑(MD +1.15)			
				rechnologies.		aueidere//enerione	nxandi teensestis)ereeniorek	crea by copyrightan	Prote	
						erieur (ABES)	dns າກອຸກອຸກອຸກອຸກອຸກອຸກອຸກອຸກອຸກອຸກອຸກອຸກອຸກ			

48 I ab aupidgrgoildig asnapd is 3202, 21 anul no /mos.imd.naqoimd//:qiit moi babsolnwol. 300. Jownloads from http://www.anuloadship.com/ on June de LMB

BMJ Open

Use of toilet: \uparrow (MD +1.9)
Use of Chair: 1 (MD +1.9)
Walking up and down stairs:
(MD + 1.8)
Endurance while walking:
(MD + 1)
at the 3rd day postoperatively
Changing position in bed:
↑(MD +0.4)
Changing position on the edge:
changing position on the edge.
↑(MD +0.45)
From sitting to standing: ↑(MD
± 0.45)
10.45)
Standing: 1 (MD +0.45)
Changing position to lying:
(MD + 0.45)
Walking: \uparrow (MD +0.5)
Use of toilet: \uparrow (MD +1)
Use of Chair: $+(MD+1.25)$
Walking up and down stairs:

48 18MJ Open: first published as 10.1136/bmjopen-2015-009857 on 2 February 2016. Downloaded from http://bmjopen.bmj.com/ on June 12, 2025 at Agence Bibliographique de I
 78 Enseignement Superieur (ABES) .
 79 Protected by cppytightainedignering for use to the final data protection of the straining for the strain of the straining for the straining for use to the straining of the straining of
	(MD + 1.85)	
	Endurance while walking:	
	\uparrow (MD +1)	
	at the discharge	
$\frac{2}{3}$	Flexion of the hip flexed knee:	
	NS	
3	Flexion of the hip extended	
, 3	knee: NS	
	Abduction: NS	
	Harris hin score: NS	
<u>}</u>		
, 4 -	JOA nip score: NS	
› }	At discharge postoperatively	
7		
))	Oxford Hip Score: NS	
) 	At 15 mo postoperatively	
Wang 28 THA PT supervised Postoperative	- Cadence (steps/min): ↑(MD -	- Complications:
2002 pre- & post- exercise or	+18)	NS
b operative usual care	Stride length: \uparrow (MD +0.06m)	no wound
exercise vs. PT	Gait velocity: \uparrow (MD +0.28)	infections,
supervised pre-	At 2 will negative anticipation	ioint
& post-operative	At 5 wk postoperativery	<i>J</i> = = = = = = = = = = = = = = = = = = =
3		
- 4 -		
ງ ວັງ ເຊຍຄິດເດເມເລລາ ອົນໃນນີ້ຂອງຜູ້ເຫັນໃນແມ	anty shttp://boxiaponyami.com/site/about/suidelines.shtmls.com	2014
reining and eimiler tochnologies	of individual to the second of	

1 2							
3 4				usual care			dislocations,
5 6						Cadence (steps/min): ^(MD)	complications
7 8						+9)	requiring
9 10						Stride length: NS	return to the
11						Gait velocity: 1 (MD +0.2)	operating
12						At 12 wk postoperatively	room,
14 15							or major
16 17						Cadence (steps/min): 1 (MD	medical
18 19						+10)	complications
20						Stride length: NS	complications
22						Gait velocity: ↑(MD +0.21)	
23 24						At 24 wk postoperatively	
25 26							
27 28						6MWT: NS	
29 30						At 12 wk postoperatively	
31							
33						6MWT: ↑(MD +64m)	
34 35						At 24 wk postoperatively	
36 37	Weidenh	39	ТКР	PT supervised -	VRS (no, mild,	Passive ROM: NS -	-
38 39	ielm			exercise vs. no	moderate, and severe	No. patients grading the knee as	
40 41	1993			exercise	pain): NS	stable or unstable: NS	
42 42							
43							
45 46				.ceipolondoot <u>າຣີ່ມີຫຼາຍລູດເຊື້ອ</u> ທູລູ ຜູກູ່ມ	ស់គមរៀង , ខេព្តព្រះភុ(ផ្ទាន)ទំនាន	Protected by copyrights including the legestic bated to the test of	
47 48	l əb əupid	ibliograp	A gence B	n.b 2202, 21 ənuL no \moo.imd.n	aded from http://bmjope erieur (ABES)	olowod .8105 Peruary 200-2102-n9ojmd/3611.01 Dugu Sinement Enseignement Super	ss bədailduq first published as
10							

					Pain at walk: NS	Isokinetic quadriceps strength			
					At 3mo.	(at 30 and 90 degree): NS			
						Walking speed (self-selected			
						and maximal): NS			
						at 3 mo postoperatively			
Williams	120	TKR	PT supervised		VAS: NS (MD -0.09	OKS: NS (MD +1.61)	HAD score anxiety: NS	HLOS: NS (MD -	No adverse
on 2007			exercise vs.		at 3mo postop)	50-m walk: NS (MD +2.51s)	(MD +1.84)	1.27d)	responses
			education leaflet			WOMAC: NS (MD+1.33) at	HAD score depression:	Cost of PT: £9 per	
						3mo postop	NS (MD -0.25)	patient	
	LASA: : medio index; l	Longitu -lateral st PCS: phys	dinal Aging Stu tability index; N sical componen	idy Amsterdam NS: not significa it summary; pos	; LOS: length of st ant; OA: Osteoarth stop: postoperative	ay; MCS: mental compone ritis; OKS: Oxford Knee S ; preop: preoperative; PT:	ent summary; MD: m Score questionnaire; (physical therapist; R(ean difference; DSI: overall stab OM: range of me	MLSI ility otion;
	THR: to	otal hip re	eplacement; TK	P: total knee re	placement; TUG: 7	Fimed Up & Go; VAS: vis	sual analogue scale; V	/RS: verbal ratir	ıg
	scale; V	VOMAC:	: Western Ontar	rio and McMast	er Universities Art	hritis Inde			
				Sor poor region.	only chitp://bmion	an han i com/site/about/suid	lolings, white is a second		
i an anhiur	dargona	ດ ລາມຈິດ	ar technologies.	slimi a -bas aniqis	erieur (S38A) . Stieur (S38A) . Stiener (S38A) .	omwod or oz (abraci z no i oduč inomongiozna sitxoti otobatelo i eloko to itoribi	cted by copyriabtainet.	Professioner Profe	d agus suga an
l ah annihi	ihliouran	A enerA	te ACOC CL anil. (no imo imd nand	imd// attd most hebe	olawof Atns visurdaa S no S	782000-710C-n9noimd\88	rr or se hadsildu	n terit inenO LM

1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	
21	
22	
23	
24	
25	
26	
27	
28	
29	
30	
31	
32	
33	
34	
35	
36	
37	
38	
39	
40	
41	
42	
43	
44	
45	
46	Protected by copyrighting incurrenting the uses is also in the standing in thing. A line in the standing and substanting in the change of the standing in the control of the standing in the standing in the standing in the standing in the control of the standing in the standing i
47	Enseignement Superieur (ABES)
48	I ab aupidgraphical action of the start publication on the start of th
10	

Outcomes	Sub-	No. of	No. of	Hetero-	I ²	WMD (95%CI)	interaction
	group	studies	patients	geneity test	(%)		p value
				p value			
Pain at 4 weeks or	TKR	2	114	0.04	75	-8.6 (-15.0 to -2.3)	0.26
less	THR	2	99	0.93	0	-0.9 (-7.5 to +5.8)	
Pain at 6 to 8	TKR	4	164	0.04	64	-2.7 (-11.7 to +6.3)	0.88
weeks	THR	3	159	0.92	0	-1.3 (-6.5 to +4.0)	
Pain at 12 weeks	TKR	9	534	0.02	55	-3.2 (-7.1 to +0.7)	0.24
	THR	2	107	0.86	0	-3.0 (-9.8 to +3.9)	
Pain at 24 weeks	TKR	3	198	0.54	0	-4.1 (-7.1 to -1.0)	0.47
	THR	1	59	NA	NA	+0.5 (-3.6 to +4.6)	
Function at 4	TKR	3	90	0.004	82	+0.7 (-12.1 to +13.5)	0.47
weeks or less	THR	3	167	0.009	79	-0.5 (-9.1 to -1.4)	
Function at 6 to 8	TKR	4	164	0.004	64	-6.3 (-13.9 to +1.3)	0.34
weeks	THR	3	157	0.119	45	-1.7 (-6.9 to +3.5)	

BMJ Open: first published as 10.1136/bmjopen-2015-009857 on 2 February 2016. Downloaded from http://bmjopen.bmj.com/ on June 12, 2025 at Agence Bibliographique de I
 Protected by cppytight-ing-tenents 2006 independents (Alberting, Alberting, Albertin

 BMJ Open

Function at 12	TKR	9	470	0.04	51	-2.4 (-7.0 to +2.2)	0.14
weeks	THR	5	301	0.16	39	-7.2 (-10.7 to -3.8)	
Function at 24	TKR	5	228	0.12	45	-4.1 (-7.1 to -1.2)	0.22
weeks	THR	2	117	< 0.001	93	+0.5 (-3.6 to +4.6)	
Function at 1 year	TKR	3	139	0.87	0	-0.5 (-4.2 to +3.3)	0.85
or more	THR	2	117	0.21	35	+0.2 (-3.8 to +4.2)	

Protected by copyright of the instant of the prediction of the protection of the pro

BMJ Open: first published as 12, 2025 at Agence Bibliographique de low http://bmjopen.bmj.com/ on June 12, 2025 at Agence Bibliographique de l Enseignement Superieur (ABES)

1.

C

Supplementary Table 4 S	sensitivity Analysis to test ro	bustness of results afte	r removing total score
			WMD (95%CI)
Outcomes	SMD (95%CI)	RoM (95%CI)	after removing total
			score
Pain at 4 weeks or less	-0.70 (-1.46 to +0.06)	0.74 (0.68 to 0.81)	NR
Pain at 6 to 8 weeks	-0.17 (-0.38 to +0.05)	0.88 (0.73 to 1.06)	NR
Pain at 12 weeks	-0.20 (-0.40 to 0.00)	0.87 (0.76 to 1.01)	NR
Pain at 24 weeks	-0.26 (-0.56 to +0.04)	0.78 (0.60 to 1.02)	NR
Pain at 1 year or more	-0.14 (-0.51 to +0.24)	0.90 (0.68 to 1.20)	NR
Function at 4 weeks or less	-0.58 (-1.45 to +0.29)	0.90 (0.79 to 1.04)	-5.0 (-9.4 to - 0.6)
Function at 6 to 8 weeks	-0.27 (-0.49 to -0.05)	0.86 (0.76 to 1.00)	NR
Function at 12 weeks	-0.48 (-0.91 to -0.05)	0.82 (0.67 to 1.00)	-4.5 (-7.9 to -1.1)
Function at 24 weeks	-0.49 (-1.47 to +0.49)	0.87 (0.56 to 1.33)	+0.1 (-4.1 to +4.3)
Function at 1 year or more	-0.01 (-0.24 to +0.22)	1.01 (0.88 to 1.15)	-0.4 (-2.6 to +1.8)

SMD: Standardized mean difference; RoM: Ratio of mean; WMD: Weighted mean difference; NR: not

relevant since total score was not included

BMJ Open: first published as 10.1136/bmjopen-2015-009857 on 2 February 2016. Downloaded from http://bmjopen.bmj.com/ on June 12, 2025 at Agence Bibliographique de I Enseignement Superieur (ABES) . Protected by copyright, including for uses related to text and data mining, Al training, and similar technologies.

otable) RD	J Open: first published as 10.1136/bm Protected
6.1% 0.9% 4.0% 3.4% 3.3% 7.8% 13.3% 0.8% 19.9%	jopen-2015-009857 on 2 February 2016. Downloaded from http://bmjopen.bmj.com/ on June 12, 2025 at Agence Bibliograp Enseignement Superieur (ABES) . by copyright, including for uses related to text and data mining, Al training, and similar technologies.

que de l

BN

Page 79 of 82		BMJ Open							
1 2 3 4 5 6 8 8 9 8 9 9	entary Table 5 state (PASS)	Sensitivity	analysis	using	different	threshold	s of I	patient acce	ptable
10 Outcomes		PASS <=3	30		PASS <=4	10		PASS <=2	0
12 13	RR	median	RD	RR	median	RD	RR	median	RD
14 15		baseline			baseline			baseline	
16 17 18		risk			risk			risk	
19 20 Pain at 4 weeks or 1	ess 1.09	43.8%	3.9%	1.04	94.1%	3.8%	1.76	8.0%	6.1%
21 22 Pain at 6 to 8 weeks	s 1.00	62.2%	0%	1.00	78.3%	0%	1.02	45.0%	0.9%
23 24 Pain at 12 weeks 25	1.02	60.9%	1.2%	1.01	79.2%	0.8%	1.10	40.2%	4.0%
²⁶ 27 Pain at 24 weeks	1.00	98.0%	0%	1.00	99.9%	0%	1.04	84.7%	3.4%
28 29 Function at 4 weeks 30	s or less 1.23	26.8%	6.2%	1.10	71.7%	7.2%	1.67	4.9%	3.3%
³¹ Function at 6 to 8 w	veeks 1.10	54.3%	5.4%	1.02	69.1%	1.4%	1.20	38.8%	7.8%
$^{33}_{34}$ Function at 12 week 35	xs 1.02	62.6%	1.3%	1.02	79.8%	1.6%	1.34	39.2%	13.3%
36 Function at 24 week 37	ks 1.00	97.4%	0%	1.00	99.9%	0%	1.01	84.7%	0.8%
$^{38}_{39}$ Function at 1 year o	or more 0.97	88.1%	-2.6%	0.97	98.1%	-2.9%	1.30	66.4%	19.9%
41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60									



PRISMA 2009 Checklist

4 5 Section/topic 6	#	Checklist item	Reported on page #
7 TITLE			
9 Title	1	Identify the report as a systematic review, meta-analysis, or both.	1
12 Structured summary 13 14	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	3-4
17 Rationale	3	Describe the rationale for the review in the context of what is already known.	5
18 19 Objectives 20	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	6
27 23 Protocol and registration 24	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	6-7
25 Eligibility criteria 26 27	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	6-7
28 28 Information sources 29	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	6-7
30 Search 31	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	Appendix
32 33 Study selection 34	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	7-8
35 Data collection process 36 37	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	7-8
38 Data items 39	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	16-21
40 Risk of bias in individual 41 studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	13-15
43 Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	8-10
44 45 46	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I ²) for each meta-analysis.	10
49 1 ab ənpinqraphiodidi Bənədə 1 a	4 16 2202 20125 at A	irst published from http://moi.open.com/ors.log/acidate from http://moi.com/on.June.12, 1.2.1 is beitside from http://moi.com/ors.log/acidate from http://www.com/ors.log/acidate/interventerventer/ors.log/acidate/intervent	ት :nəqO LMB

Page 81 of 82



PRISMA 2009 Checklist

		Page 1 of 2	
Section/topic	#	Checklist item	Reported on page :
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	13-15
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	10
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	11
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	11-12
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	13-15
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	Suppl Table 2
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	16-21
			Table 3
			Table 4
}))			Suppl Table 3
2			Suppl Table 4
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	13-15
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	21-22
DISCUSSION	<u> </u>		
) Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	22-23
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	23-25
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	25
		For near region only others //hmignen hmi com/site/about/suidelines shtml.	1

48 BA Open: first published as 202, 21 anuL no /mos.imd.nagoimd/.ctth mon babaolnowod. 2016. Downloads for a first public as 202, 202, as Definition and Definition of the second state of th 10



PRISMA 2009 Checklist

4 F 5 6	unding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	26
7 8 ^{Fi}	<i>rom:</i> Moher D, Liberati A, Tetzlaff	J, Altm	an DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med	6(6): e1000097.
9 da	bi:10.1371/journal.pmed1000097		For more information, visit: www.prisma.statement.org	
10			Tor more mormation, visit. www.prisma-statement.org.	
11			Page 2 of 2	
12				
13				
14 15				
10				
17				
18				
19				
20				
21				
22				
23				
24				
25 26				
20 27				
28				
29				
30				
31				
32				
33				
34				
35				
36				
31 32				
30				
40				
41				
42				
43				
44				
45				
46		.səipc	Protected by comparing hereitign and the second for the second for the state of the second second second second	
4/	n au aupinda igonora aonaga i	P C707	ו אין געמאינענע (BBA) איז	
40 40	- ob envideereelldig eeren 4	~ 300C	Ct can't ac lance iand acapiand//.attd acrt hoheolawor. 2t0C vremdad C ac TA8000.2t0C-acapiand/2Ctt 0t se hedsilding tari	,

BMJ Open

Does Preoperative Rehabilitation for Patients Planning to Undergo Joint Replacement Surgery Improve Outcomes? A Systematic Review and Meta-Analysis of Randomized Controlled Trials

Journal:	BMJ Open
Manuscript ID	bmjopen-2015-009857.R1
Article Type:	Research
Date Submitted by the Author:	24-Nov-2015
Complete List of Authors:	Wang, Li; Chinese Cochrane Centre, West China Hospital, Sichuan University; McMaster University, Michael G. DeGroote Institute for Pain Research and Care Lee, Myeongjong; Konkuk university school of medicine, Department of anesthesiology and pain medicine Zhang, Zhe; Fuwai Hospital, Department of Anesthesiology Moodie, Jessica; University of Western Ontario, Centre for Medical Evidence, Decision Integrity and Clinical Impact (MEDICI) Cheng, Davy; University of Western Ontario, Department of Anesthesia & Perioperative Medicine Martin, Janet; London Health Sciences Centre, High Impact Technology Evaluation Centre
Primary Subject Heading :	Rehabilitation medicine
Secondary Subject Heading:	Sports and exercise medicine
Keywords:	REHABILITATION MEDICINE, ORTHOPAEDIC & TRAUMA SURGERY, PAIN MANAGEMENT, JOINT REPLACEMENT, META-ANALYSIS

SCHOLARONE[™] Manuscripts

Does Preoperative Rehabilitation for Patients Planning to Undergo Joint Replacement Surgery Improve Outcomes?

A Systematic Review and Meta-Analysis of Randomized Controlled Trials

Li Wang, PhD^{1, 2, 3}, Myeongjong Lee, MD⁴, Zhe Zhang, MD⁵, Jessica Moodie, MLIS¹, Davy Cheng, MD, FRCPC^{1, 6}, Janet Martin, PharmD, MSc(HTA)^{1, 6, 7*}

- Centre for Medical Evidence, Decision Integrity and Clinical Impact (MEDICI), University of Western Ontario, London, ON, Canada
- 2. Chinese Cochrane Centre, West China Hospital, Sichuan University, Chengdu, China

BMJ Open: first published as 10.1136/bmjopen-2015-009857 on 2 February 2016. Downloaded from http://bmjopen.bmj.com/ on June 12, 2025 at Agence Bibliographique de Enseignement Superieur (ABES)

Protected by copyright, including for uses related to text and data mining, Al training, and similar technologies

- Michael G. DeGroote Institute for Pain Research and Care, McMaster University, Hamilton, Ontario, Canada
- Konkuk university school of medicine, Department of anesthesiology and pain medicine, Chungju, South Korea.
- 5. Department of Anesthesiology, Fuwai Hospital, Chinese Academy of Medical Sciences and Peking Union Medical College, Beijing, China
- Department of Anesthesia & Perioperative Medicine, University of Western Ontario, London, ON, Canada
- Department of Epidemiology & Biostatistics, University of Western Ontario, London, ON, Canada

*Address correspondence to Dr. Janet Martin, Centre for Medical Evidence, Decision Integrity and Clinical Impact (MEDICI), University of Western Ontario, London, ON, N6A 5A5, Canada. Tel.: +1-519-685-8500, ext. 34482; Fax: +1-519-663-3161. E-mail address: jmarti83@uwo.ca

Keywords: Physiotherapy, Exercise, Prehabilitation, Joint Replacement, Meta-analysis

Word Count: 4,215

Abstract:

Objectives: The clinical impact of preoperative physiotherapy on recovery after joint replacement remains controversial. This systematic review aimed to assess the clinical impact of prehabilitation before joint replacement.

Design: We searched PubMed, Embase, and Cochrane CENTRAL up to November 2015 for randomized controlled trials comparing prehabilitation versus no prehabilitation before joint replacement surgery. Postoperative pain and function scores were converted to Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) pain and function subscales (0-100, high scores indicate worse outcome). Random effects meta-analysis was performed to calculate weighted mean differences (WMD, 95%CI), subgrouped by hip and knee surgery.
Primary and Secondary Outcomes: Postoperative pain and function scores, time to resume activities of daily living, quality of life, length of hospital stay, total cost, patient satisfaction, postoperative complications, any adverse events and discontinuations..

BMJ Open: first published as 10.1136/bmjopen-2015-009857 on 2 February 2016. Downloaded from http://bmjopen.bmj.com/ on June 12, 2025 at Agence Bibliographique de Enseignement Superieur (ABES) . Protected by copyright, including for uses related to text and data mining, Al training, and similar technologies.

Results: Of 22 studies (1,492 patients), 18 had high risk of bias. Prehabilitation slightly reduced pain scores within 4 weeks postoperatively (WMD -6.1 points, 95%CI -10.6 to -1.6 points, on a scale of 0-100), but differences did not remain beyond 4 weeks. Prehabilitation slightly improved WOMAC function score at 6-8 weeks and 12 weeks (WMD -4.0, 95%CI -7.5 to -0.5), and time to climbing stairs (WMD -1.4 days, 95%CI -1.9 to -0.8 days), toilet use (-0.9 days, 95%CI -1.3 to -0.5 days), and chair use (WMD -1.2 days, 95%CI -1.7 to -0.8 days). Effects were similar for knee and hip surgery. Differences were not found for SF-36 scores, length of stay and total cost. Other outcomes of interest were inadequately reported.

Conclusions: Existing evidence suggests that prehabilitation may slightly improve early postoperative pain and function among patients undergoing joint replacement; however, effects

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

remain too small and short-term to be considered clinically-important, and did not affect key outcomes of interest (ie, length of stay, quality of life, costs).

Article Summary

Strengths and Limitations of Study

- The methodology was rigorous, and included a comprehensive systematic search without limits by language, date or publication status, which identified 7 randomized controlled trials (RCTs) not included in any previous systematic reviews.
- We went beyond previous systematic reviews published by analyzing the effect of prehabilitation by converting to a standardized measurement of WOMAC pain and function scores, and used different presentation methods to enhance interpretability and to improve ability to find potential signals in effect size through meta-analysis.
- This meta-analysis addressed all available clinically relevant outcomes, while previous reviews addressed only a few selected outcomes. Application of GRADE for rating quality of evidence provides improved context for interpreting the findings in light of inherent strengths and limitations of the included studies.
- Compliance with prehabilitation was problematic in some studies, and was not reported in a number of studies

Key words: Physiotherapy, Exercise, Prehabilitation, Joint Replacement, Meta-analysis

INTRODUCTION

Total joint replacement surgery is considered as one of the most successful medical interventions with significant pain relief and improvement in physical function and quality of life for patients with severe osteoarthritis ¹. However, the recovery for a significant proportion of patients remains difficult, prolonged, and many never restore optimal functionality postoperatively ²⁻⁴. Therefore, researchers, clinicians and policy makers are still looking for better ways to improve the timelines and extent of recovery for patients undergoing total joint replacement.

Physiotherapy has been delivered to patients, traditionally after total joint replacement for rehabilitation. However, preoperative physiotherapy and exercise programs (also known as 'prehabilitation') have been proposed as a potential way to expedite recovery times and improve overall extent of recovery in patients planning to undergo joint replacement. One recently published review recommended preoperative exercise to maintain or improve function and pain ⁵; however, this recommendation was based on only one narrative systematic review with indeterminate effects ⁶. Although it seems intuitive that prehabilitation should improve patient disposition at the time of surgery, and may prepare patients for a better recovery after surgery, significant uncertainties remain about the overall balance of benefits and risks (and costs) for prehabilitation.

A number of related systematic reviews or meta-analyses have been published in the recent decade with inconsistent methods and varied conclusions ⁶⁻¹³. Two of them suggested that prehabilitation reduced pain for patients undergoing joint replacement ^{8, 11}, and improved

BMJ Open: first published as 10.1136/bmjopen-2015-009857 on 2 February 2016. Downloaded from http://bmjopen.bmj.com/ on June 12, 2025 at Agence Bibliographique de Enseignement Superieur (ABES) . Protected by copyright, including for uses related to text and data mining, Al training, and similar technologies.

physical function for patients undergoing hip replacement surgery, but not knee replacement surgery ⁸, while the remainder suggested prehabilitation did not clearly demonstrate beneficial effects or were unable to provide definitive conclusions ^{6, 7, 9, 10, 12, 13}. Furthermore, significant methodological limitations or errors have been identified among the existing systematic reviews. Some of them only qualitatively summarized the results ^{6, 7, 9, 11-13}; another two meta-analyses ^{8,} ¹⁰ are outdated, or mistakenly included some trials in which postoperative outcomes were not reported. Thus, we conducted an updated methodologically rigorous systematic review with meta-analysis to clarify whether evidence supports prehabilitation for patients planning to undergo joint replacement.

METHODS

Eligibility criteria

We systematically searched three databases up to November 10, 2015, including PubMed, Embase, and Cochrane Central Register of Controlled Trials (CENTRAL). Eligible studies had to be randomized controlled trials comparing preoperative rehabilitation programs (ie, prescribed and supervised exercises or physiotherapy with or without co-interventions such as education, nutritional counseling, acupuncture, transcutaneous electrical nerve stimulation, etc.) versus no formal preoperative rehabilitation programs, reporting at least one clinically-relevant outcome of interest during the postoperative period. Clinical outcomes of interest included postoperative pain scores [Visual Analogue Scale (VAS), or pain subcomponents of Western Ontario and McMaster Universities osteoarthritis index (WOMAC) or pain-related subdomains of other instruments], patient functionality (WOMAC function score, SF-36 physical functioning subdomain or other function-related instruments), time to resume activities of daily living,

BMJ Open

quality of life, patient satisfaction, infection, transfusions, stroke, death, or overall postoperative complications. Resource-related outcomes of interest included hospital length of stay, readmissions, and total hospital costs or total health system costs. Timeframes of relevance included in-hospital outcomes, as well as clinical or resource-related outcomes over the longer-term postoperatively.

Search terms included MeSH and keyword terms for exercise, prehabilitation, physiotherapy, physical therapy, activity, weight training, weight lifting, aquatic, swimming, strength training, endurance training, cycling, biking, kinesiotherapy, hydrotherapy, fitness, orthopedic surgery, and joint replacement and "random*". No limitations were placed on date of publication or language. Detailed search strategies are provided in the Appendix.

Literature screening and data extraction

Two reviewers (ML, ZZ) independently screened the articles by title and abstract using the predetermined eligibility criteria. Any disagreements were resolved by the third reviewer (LW). The third reviewer (LW) also checked all the reference lists of existing systematic reviews or meta-analyses and other reviews for potentially additional eligible articles. BMJ Open: first published as 10.1136/bmjopen-2015-009857 on 2 February 2016. Downloaded from http://bmjopen.bmj.com/ on June 12, 2025 at Agence Bibliographique de Enseignement Superieur (ABES)

Protected by copyright, including for uses related to text and data mining, Al training, and similar technologies

Two reviewers (ML, JM) independently assessed the risk of bias of the included trials using the methods recommended by Cochrane Collaboration ¹⁴, including random sequence generation, allocation concealment, missing or incomplete outcome data, and blinding of patients, study personnel, and outcome assessors. Any discrepancies were resolved by the third reviewer (LW).

BMJ Open: first published as 10.1136/bmjopen-2015-009857 on 2 February 2016. Downloaded from http://bmjopen.bmj.com/ on June 12, 2025 at Agence Bibliographique de Enseignement Superieur (ABES)

Protected by copyright, including for uses related to text and data mining, Al training, and similar technologies

Standardized data extraction forms were developed to specify the study characteristics, patient characteristics and outcomes. Three reviewers (ML, ZZ, and LW) extracted the data. Data was verified by a fourth reviewer (JM).

Statistical analysis

Meta-analysis was performed using the random effects model. For discrete outcomes, relative risk and 95% confidence intervals (RR, 95%CI) were calculated. For continuous outcomes, e.g. pain score and function score, weighted mean differences (WMD, 95%CI) were calculated after conversion to the Western Ontario and McMaster Universities osteoarthritis index (WOMAC) pain score (0-100) and WOMAC function score (0-100), in which a higher score indicates worse outcome. Sensitivity analysis was conducted by calculating standardized mean differences (SMD) and ratio of means (RoM).

If different pain scores were reported in one article (e.g. WOMAC pain, SF-36 pain score), the WOMAC pain score was preferentially used. If WOMAC pain score was not reported, the pain score reported in the study was converted to WOMAC pain scores to allow for comparison across studies, and to allow for estimation of overall effect size ¹⁵. If pain scores were reported at rest and during activity, the pain score during activity was preferentially used for analysis. If pain scores were reported during different types of activities, the largest change of pain score during the most active movement was used preferentially. If different function scores were reported, the WOMAC function score was used preferentially for analysis. In the absence of WOMAC function scores, the alternate function score provided in the study was converted to a WOMAC function score ¹⁵. Two studies ^{16, 17} only reported total scores of Hospital for Special

Surgery Knee Rating System (HSSK) and WOMAC respectively. Given the function score accounting for most of the total score and with similar trends of change over time as total score, we used the total score to replace the function score. To test whether this changed the effect size, sensitivity analysis was performed after removing the total scores from function measures to recalculate effect size.

To improve clinical relevance and interpretation of the results for postoperative pain and function improvement, we also converted continuous data from WOMAC pain score and WOMAC function score to a relative risk (RR) for achieving a "patient acceptable symptom state" (defined as the number of patients achieving the threshold pain score or function score at which patients consider themselves 'well' or 'satisfied') derived from previous research ¹⁸⁻²¹. To calculate the RR, we assumed a normal distribution of WOMAC pain or function scores for the intervention and control groups, and we used a threshold of 30 on the WOMAC 0-100 scale to represent the threshold for the patient acceptable symptom state. The proportion of patients in the intervention and control groups with WOMAC pain or function ≤ 30 was then calculated, and combined across studies to derive a pooled relative risk ^{15, 22}. Finally, to further add to clinical applicability of the patient reported outcomes we calculated the risk difference for the number of patients achieving this threshold of \leq 30 per 100 patients using the relative risk and median risk among the control groups in the included studies²³. Subsequently, sensitivity analyses were performed to explore whether using different thresholds (20 and 40) changed the conclusions, since our threshold of 30 represents a compromise of 20 to 40 suggested in previous studies of hip or knee surgery over the short term or long-term.

BMJ Open: first published as 10.1136/bmjopen-2015-009857 on 2 February 2016. Downloaded from http://bmjopen.bmj.com/ on June 12, 2025 at Agence Bibliographique de Enseignement Superieur (ABES)

Protected by copyright, including for uses related to text and data mining, Al training, and similar technologies

BMJ Open: first published as 10.1136/bmjopen-2015-009857 on 2 February 2016. Downloaded from http://bmjopen.bmj.com/ on June 12, 2025 at Agence Bibliographique de Enseignement Superieur (ABES)

Protected by copyright, including for uses related to text and data mining, Al training, and similar technologies

Heterogeneity was estimated using the Chi-squared test and I² statistic. Pre-defined subgroup analyses included separate analysis for hip and knee surgery patients, to test the existing hypothesis from a previous systematic review that prehabilitation improves postoperative pain and function more among patients undergoing hip replacement than patients with knee replacement ⁸. Publication bias was explored using both visual inspection of funnel plots and Egger's test only when there were at least 10 studies included in the meta-analysis ¹⁴.

GRADE methodology was used to summarize certainty in estimates of effect (quality of evidence) in the critically important outcomes for decision-making ²³⁻²⁹, including WOMAC pain scores and function scores from early follow-up to 24 weeks after surgery.

RESULTS

Studies identified

Figure 1 outlines study inclusion and exclusion. A total of 399 titles and abstracts were screened for inclusion, of which 110 studies were collected in full-text for review. Of these, 88 were excluded for the following reasons: no prehabilitation arm (ie. education only or postoperative rehabilitation only, n=46), not randomized (n=21), duplicate studies (n=4), no postoperative outcomes data (n=9), no outcome of interest (n=2), conference abstracts (n=3) and protocol only (n=3). In total, 22 randomized controlled trials (1492 patients) of prehabilitation versus no prehabilitation met the inclusion criteria. Twenty studies provided usable data for the meta-analysis, and 22 studies contributed qualitative or quantitative data.

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

Among 22 included studies, eight studies were of patients undergoing total hip replacement ^{16, 30-36}; 12 studies included patients undergoing total knee replacement ^{15, 37-47} and two studies included either hip or knee replacement ^{48, 49}. Most studies were conducted in developed countries (North American and Europe), except for three in developing countries (Serbia ³⁴, Thailand ⁴⁵ and Turkey ³²). The median sample size of included studies was 54, ranging from 21 to 165 patients. Mean age ranged from 51 to 76 (Table 1).

Study Name	No. of	Type of	Countries	Mean	%	Mean	Total
	patients	surgery		age	Female	BMI%	OA %
Beaupre 2004	131	TKR	Canada	67	55	31.4	NR
Bitterli 2011	80	THR	Switzerland	66.9	38	27.4	NR
Brown 2012	32	TKR	USA	NR	NR	36.8	NR
D'Lima 1996	30	TKR	USA	69.8	46.6	NR	83.3
Evgeniadis 2008	48	TKR	Greece	68.3	76.3	34.1	100
Ferrara 2008	23	THR	Italy	63.4	60.8	NR	100
Gilbey 2003	76	THR	Australia	65.2	61.8	27.94	NR
Gocen 2004	60	THR	Turkey	51.3	35.5	NR	49
Gstoettner 2011	38	TKR	Australia	69.7	78.9	27.8	100
Hoogeboom 2010	21	THR	Netherland	76	66	NR	NR
Matassi 2014	122	TKR	Italy	66.5	48	28.5	NR
McKay 2012	22	TKR	Canada	61.3	59	34.3	100
Mitchell 2005	160	TKR	UK	70.3	57.9	NR	100
Oosting 2012	30	THR	Netherland	76	80	28.2	100
Rooks 2006	108	THR/TKR	USA	64.1	56	31.6	100
Торр 2009	54	TKR	USA	63.8	68	32.1	100
Tungtrongjit 2012	60	TKR	Thailand	64.5	83.3	24.8	100

BMJ Open: first published as 10.1136/bmjopen-2015-009857 on 2 February 2016. Downloaded from http://bmjopen.bmj.com/ on June 12, 2025 at Agence Bibliographique de l Enseignement Superieur (ABES)

Protected by copyright, including for uses related to text and data mining, Al training, and similar technologies

	Table 1	Characteristics	of included	RCTs
--	---------	-----------------	-------------	------

BMJ Open: first published as 10.1136/bmjopen-2015-009857 on 2 February 2016. Downloaded from http://bmjopen.bmj.com/ on June 12, 2025 at Agence Bibliographique de Enseignement Superieur (ABES) .

Protected by copyright, including for uses related to text and data mining, Al training, and similar technologies

Villadaan 2014	165		Donmark	67	56	20.2	100
v mausen 2014	105		Dennark	07	50	50.5	100
Vukomanovic 08	45	THR	Serbia	58.4	67	NR	100
Wang 2002	28	THR	Australia	67.1	64	NR	89
Weidenhielm 1993	39	TKR	Sweden	63.5	51.3	29.6	100
Williamson 2007	120	TKR	UK	69.8	52.9	32.7	100

TKR: total knee replacement; THR: Total hip replacement; USA: United States of America; UK: United

dy mass me. Kingdom; BMI: Body mass index; OA: Osteoarthritis; NR: not reported

Nine studies compared physiotherapist supervised exercise plus home exercise versus no intervention or usual care ^{16, 35, 36, 38, 40-42, 44, 46}. Five compared physiotherapist supervised exercise versus no intervention or usual care ^{15, 33, 37, 39, 50}. Two studies compared home exercise only versus no intervention ^{30, 45}. Three studies compared physiotherapist supervised exercise plus education versus no intervention ^{31, 32, 34}. One each compared physiotherapist supervised exercise plus education versus education ⁴⁸, kinesiologist supervised exercise versus placebo (kinesiologist supervised upper body exercise) ⁴³, and physiotherapist supervised exercise plus home exercise versus education plus home exercise ⁴⁷ respectively (Supplementary Table 1).

Risk of bias

Among 22 trials, adequate sequence generation was reported in 17 trials ^{15, 30-33, 36-43, 45-48}, allocation concealment in 8 trials ^{30, 33, 37, 39, 42, 43, 47, 49}. The patients were blinded in one study³⁹, health care providers were blinded in three studies ^{30, 39, 44}, and outcome assessors were blinded in 12 studies ^{30-33, 36, 37, 41, 44, 45, 47-49}. Seventeen studies ^{16, 30-34, 36-40, 42, 43, 46-49} reported loss to follow-up, ranging from 1.7% to 65.3%; among which the proportion of loss to follow up was more than 15% in 10 studies ^{30, 34, 36-39, 42, 43, 47, 48}. Ten out of 17 studies with incomplete data used intention to treat analysis ^{30, 33, 36, 37, 39, 42, 43, 47-49}. Overall, 4 out of 22 included trials were rated as low risk of bias ^{30, 33, 37, 39} and 18 trials as high risk of bias (Table 2)

BMJ Open: first published as 10.1136/bmjopen-2015-009857 on 2 February 2016. Downloaded from http://bmjopen.bmj.com/ on June 12, 2025 at Agence Bibliographique de

Enseignement Superieur (ABES)

Protected by copyright, including for uses related to text and data mining, Al training, and similar technologies

	Random	Allocation	Blinding of	Blinding of	Blinding of	Incomplete	Intention to	Risk of bias
	sequence	concealment	patients	health care	outcome assessors	outcome data	treat analysis	
	generation			providers				
Beaupre 2004	Yes	Yes	No	No	Yes	Yes, LTFU>15%	Yes	Low risk
Bitterli 2011	Yes	Yes	No	Yes	Yes	Yes, LTFU>15%	Yes	Low risk
Brown 2012	Yes	Unclear	No	Unclear	Unclear	Yes, LTFU>15%	No	High risk
D'Lima 1996	Yes	Unclear	Unclear	Unclear	Unclear	No	Not Applicable	High risk
Evgeniadis 2008	Yes	Yes	Yes	Yes	Unclear	Yes, LTFU>15%	Yes	Low risk
Ferrara 2008	Yes	Unclear	No	No	Yes	Yes	No	High risk
Gilbey 2003	Unclear	Unclear	Unclear	Unclear	No	Yes	No	High risk
Gocen 2004	Yes	Unclear	No	Unclear	Yes	Yes	No	High risk
Gstoettner 2011	Yes	No	Unclear	Unclear	Unclear	Yes	No	High risk
Hoogeboom 2010	Yes	Yes	No	No	Yes	Yes	Yes	Low risk
Matassi 2014	Yes	Unclear	No	No	Yes	No	Not Applicable	High risk
McKay 2012	Yes	Yes	Unclear	Unclear	Unclear	Yes, LTFU>15%	Yes	High risk
Mitchell 2005	Yes	Yes	No	No	Unclear	Yes, LTFU>15%	Yes	High risk
Oosting 2012	Yes	Unclear	No	No	Yes	Yes, LTFU>15%	Yes	High risk
Rooks 2006	Yes	Unclear	Unclear	Unclear	Yes	Yes, LTFU>15%	Yes	High risk
Торр 2009	Unclear	Unclear	No	Yes	Yes	No	Not Applicable	High risk

Table 2. Dick of Dice for Included Studi

BMJ Open: first published as 10.1136/bmjopen-2015-009857 on 2 February 2016. Downloaded from http://bmjopen.bmj.com/ on June 12, 2025 at Agence Bibliographique de I
 Protected by cppytight-ing-tenent Superieur (ABES)
 Protected by cppytight-ing-tenents/militing, Altraiting, Altraiting, Altraiting, February 2015, 2025 at Agence Bibliographique de I

Page 15 of 81

BMJ Open

Tungtrongjit 2012	Yes	Unclear	No	No	Yes	No	Not Applicable	High risk
Villadsen 2014	Unclear	Yes	No	No	Yes	Yes	Yes	High risk
Vukomanovic 08	Unclear	Unclear	Unclear	Unclear	Unclear	Yes, LTFU>15%	No	High risk
Wang 2002	Unclear	Unclear	Unclear	Unclear	No	No	Not Applicable	High risk
Weidenhielm	Yes	Unclear	Unclear	Unclear	Unclear	Yes	No	High risk
1993								
Williamson 2007	Yes	Yes	No	No	Yes	Yes, LTFU>15%	Yes	High risk
€βence Bibliographides	12, 2025 at sejeolonda sejeolonda	ot no \moɔ.jmd. ອາ າ <u>ຣ</u> ມີແກ່ ງວຽ ແຊ.ຜູນ	iýnieðu]Ą∧.epiųti S: Internation	mort bebsolnwod .č	57 on 2 February 2016 Enseigner Maing/for/jor/jor/ Maing/for/jor/ Maing/for/ Maing/for/ Maing/for/ Maing/ M	600-3102-nəqoįmd/ð bijjetiųtajo bij bijjetiųtajo bij bij bij bij bij bij bij bij bij bij	юггг.0г ав bərləildı. bəforq	Jud feni first pu

BMJ Open: first published as 10.1136/bmjopen-2015-009857 on 2 February 2016. Downloaded from http://bmjopen.bmj.com/ on June 12, 2025 at Agence Bibliographique de Enseignement Superieur (ABES)

Protected by copyright, including for uses related to text and data mining, Al training, and similar technologies

Supplementary Table 2 qualitatively summarizes the major findings of included studies. In total, 22 studies described at least one clinical or resource-related benefit for prehabilitation versus control, and 18 studies ^{15, 30-37, 39, 40, 42-48} described no significant improvement for prehabilitation versus control. We conducted meta-analysis for pain scores, function scores, SF-36 PCS and MCS, hospital length of stay, and total costs based on the data availability.

Postoperative pain

Fifteen trials with 18 comparisons and 1046 patients reported postoperative pain scores using different instruments, i.e. WOMAC ^{31, 37, 40, 42, 43, 45, 48}, VAS ^{32, 34, 36, 44, 47}, Knee injury and Osteoarthritis Outcome Score (KOOS)/Hip disability and Osteoarthritis Outcome Score (HOOS)⁴⁹, and 10-graded scale ⁴⁶. Only two trials ^{31, 49} reported significant improvement in pain at early follow-up (\leq 3 months), including VAS pain at 3 months ³¹, and KOOS/HOOS pain at 6 weeks postoperatively, but not significant at 3 months ⁴⁹.

After converting to WOMAC pain 0-100, prehabilitation significantly reduced postoperative pain at 4 weeks or less; however, the reduction of pain was clinically nominal (4 trials, 213 patients, WMD -6.1, 95%CI -10.6 to -1.6, Figure 2, GRADE: low certainty in estimates, Table 3 & Table 4). Differences in WOMAC pain scores after 4 weeks were no longer statistically significant for prehabilitation versus control (WOMAC pain score at 6 to 8 weeks, 5 trials, 488 patients, WMD -1.4, 95%CI -5.5 to +2.6; at 12 weeks, 10 trials, 806 patients, WMD -2.9, 95%CI -6.2 to +0.3; at 24 weeks, 3 trials, 247 patients, -2.5, 95%CI -5.6 to +0.6; at 1 year,1 trial, 109 patients, WMD -2.0, 95%CI -7.5 to +3.5; GRADE: low to moderate certainty in estimates, Table 3 & Table 4).

BMJ Open

When expressed as a relative risk (RR), patients undergoing prehabilitation were more likely to achieve the acceptable pain state (WOMAC pain score \leq 30) with RR 1.09. When expressed as an absolute risk difference, 3.9% more patients with prehabilitation achieved the acceptable pain state (WOMAC pain score \leq 30) than patients without prehabilitation at 4 weeks (Supplementary table 3). However, this small difference would be considered clinically nominal.¹⁸⁻²¹

Quitaomas	No. of	No. of	heterogeneity	I ²	
Outcomes	studies	patients	test p value	(%)	
Pain at 4 weeks or less	4	213	0.08	55	-6.1 (-10.6 to -1.6) *6
Pain at 6 to 8 weeks	5	488	0.31	16	-1.4 (-5.5 to +2.6) ** and
Pain at 12 weeks	10	806	0.05	46	-2.9 (-6.2 to +0.3)
Pain at 24 weeks	3	247	0.22	33	-2.5 (-5.6 to +0.6)
Pain at 1 year or more	1	109	NA	NA	-2.0 (-7.5 to +3.5)
Function at 4 weeks or less	5	257	<0.001	79	-3.6 (-7.7 to +0.5)
Function at 6 to 8 weeks	5	488	0.21	31	-3.9 (-7.6 to -0.3) *
Function at 12 weeks	12	836	<0.001	69	-4.0 (-7.5 to -0.5) *
Function at 24 weeks	5	345	< 0.001	89	-0.5 (-5.8 to +4.7)
Function at 1 year or more	6	296	0.99	0	-0.6 (-2.6 to +145)
First days of climbing stairs (days)	2	99	0.44	0	-1.4 (-1.9 to -0.8) *
First days of walking (days)	2	99	0.24	29	-0.2 (-0.4 to +0.002)

Table 3 Summary of results for prehabilitation vs. no prehabilitation

First days of use of toilet (days)	2	99	0.87	0	-0.9 (-1.3 to -0.5) *
First days of use of chair (days)	2	99	0.50	0	-1.2 (-1.7 to -0.8) *
SF-36 PCS at 6 weeks	1	19	NA	NA	2.7 (-9.4 to +14.7)
SF-36 PCS at 12 weeks	3	149	0.13	50	-0.3 (-5.4 to +4.7)
SF-36 PCS at 24 weeks	1	109	NA	NA	0.0 (-3.4 to +3.4)
SF-36 PCS at 1 year	1	109	NA	NA	-3.0 (-6.4 to +0.4)
SF-36 MCS at 6 weeks	1	17	NA	NA	-3.4 (-19.9 to +13.0)
SF-36 MCS at 12 weeks	3	149	0.72	0	-0.4 (-3.7 to +2.9)
SF-36 MCS at 24 weeks	1	109	NA	NA	-1.0 (-4.9 to +2.9)
SF-36 MCS at 1 year	1	109	NA	NA	-2.0 (-5.1 to +1.1)
Length of stay (days)	7	507	0.68	0	-0.3 (-0.8 to + 0.1)
Total cost (Canadian dollars)	2	242	0.99	0	+5 (-384 to +393)

PCS: physical component summary; MCS: mental component summary; WMD: Weighted mean

difference; NA: not applicable;

Pain and function scores were converted to WOMAC (Western Ontario and McMaster Universities

osteoarthritis index) 0-100 subscales, and high score indicates more pain or dysfunction.

* p<0.05

Table 4 GRADE Evidence Profile: prehabilitation vs no formal prehabilitation for total joint replacement

			Quality asse	ssment				Summary of Find	lings
Participants (studies) Follow up	Risk of bias	Inconsistency	Indirectness	Imprecision	Publication bias	Overall quality of evidence	Relative effect or WMD (95% CI)	Anticipated abs Median risk with non- prehabilitation	olute effects Risk difference with prehabilitation (95% CI)
Pain score at 4	weeks or less, me	easured with: WOMAC	pain subscale 0-10	0; Lower values ind	licate less pain			<u> </u>	
213 (4 studies)	Serious risk of bias ¹	Serious inconsistency:	No serious	No serious imprecision	Uncertain (only 4 studies)		WMD -6.1 (-10.6, -1.6)	43.8% patients achieved	3.9% more
≤4 weeks	Unclear concealment: 4 studies; Outcome assessors not blinded: 1; Missing data >15%: 1	p-value on test for heterogeneity 0.08, I ² = 55%				due to risk of bias and inconsistency	(-10.0, -1.0)	acceptable pain state of ≤30 on WOMAC pain (0-100) scale	acceptable pain state of ≤30 on WOMAC pain (0- 100) scale
Pain score at 6	to 8 weeks, meas	ured with: WOMAC pa	in subscale 0-100;	Lower values indic	19	อดมป/สามเดืองไทยธารกับ	พื้นว่า (ด กลาวลา		

48 I ab aupidergoidig active 12, 2025 at Agence Bibliographique de l'om http://omjopen.bij.com/ on June 12, 2025 at Agence Bibliographique de l 84 42 Enseignement Superieur (ABES)

488	Serious risk of	No serious	No serious	No serious	Uncertain	$\oplus \oplus \oplus \ominus$	WMD -1.4	62.2% patients	0% more patients
(5 studies)	bias ¹	inconsistency;	indirectness	imprecision ²	(only 5 studies)	MODERATE	(-5.5, +2.6)	achieved	achieved
5 to 8 weeks	Unclear	p-value on test for				due to risk of bias		acceptable pain	acceptable pain
	concealment: 3	heterogeneity 0.31,						state of ≤ 30 on	state of ≤30 on
	studies;	I ² =16%						WOMAC pain	WOMAC pain
	outcome							scale (0-100)	scale (0-100)
	assessors not								
	blinded: 2;								
	Missing data								
	>15%: 3								
Pain score at 1	2 weeks, measured	with: WOMAC pain s	subscale 0-100; Low	ver values indicate	e less pain				
Pain score at 1	2 weeks, measured	l with: WOMAC pain s	subscale 0-100; Low	ver values indicate	e less pain				
Pain score at 1 306	2 weeks, measured Serious risk of	I with: WOMAC pain s	Subscale 0-100; Low	ver values indicate	Undetected;		WMD -2.9	60.9% patients	1.2% more
Pain score at 1 306 10 studies)	2 weeks, measured Serious risk of bias ¹	I with: WOMAC pain s Serious inconsistency;	subscale 0-100; Low No serious indirectness	ver values indicate No serious imprecision	e less pain Undetected; Egger's test p=0.35		WMD -2.9 (-6.2, +2.8)	60.9% patients achieved	1.2% more patients achieved
Pain score at 1 306 10 studies) 2 weeks	2 weeks, measured Serious risk of bias ¹ Unclear	I with: WOMAC pain s Serious inconsistency; p-value on test for	Subscale 0-100; Low No serious indirectness	ver values indicate	Undetected; Egger's test p=0.35	⊕⊕⊖⊖ LOW due to risk of bias and	WMD -2.9 (-6.2, +2.8)	60.9% patients achieved acceptable pain	1.2% more patients achieved acceptable pain
Pain score at 1 306 10 studies) 2 weeks	2 weeks, measured Serious risk of bias ¹ Unclear concealment: 5	I with: WOMAC pain s Serious inconsistency; p-value on test for heterogeneity 0.05, 1 ² - 46%	Subscale 0-100; Low No serious indirectness	ver values indicate No serious imprecision	Undetected; Egger's test p=0.35	 ⊕⊕⊖⊖ LOW due to risk of bias and inconsistency 	WMD -2.9 (-6.2, +2.8)	60.9% patients achieved acceptable pain state of ≤30 on	1.2% more patients achieved acceptable pain state of \leq 30 on
Pain score at 1 106 10 studies) 2 weeks	2 weeks, measured Serious risk of bias ¹ Unclear concealment: 5 studies;	with: WOMAC pain s Serious inconsistency; p-value on test for heterogeneity 0.05 , $I^2= 46\%$	Subscale 0-100; Low	ver values indicate	Undetected; Egger's test p=0.35	⊕⊕⊖⊖ LOW due to risk of bias and inconsistency	WMD -2.9 (-6.2, +2.8)	60.9% patients achieved acceptable pain state of ≤30 on WOMAC pain scale (0-100)	1.2% more patients achieved acceptable pain state of \leq 30 on WOMAC pain scale (0-100)
Pain score at 1 06 10 studies) 2 weeks	2 weeks, measured Serious risk of bias ¹ Unclear concealment: 5 studies; outcome	with: WOMAC pain s Serious inconsistency; p-value on test for heterogeneity 0.05 , $I^2= 46\%$	subscale 0-100; Low No serious indirectness	ver values indicate	e less pain Undetected; Egger's test p=0.35	⊕⊕⊖⊖ LOW due to risk of bias and inconsistency	WMD -2.9 (-6.2, +2.8)	60.9% patients achieved acceptable pain state of ≤30 on WOMAC pain scale (0-100)	1.2% more patients achieved acceptable pain state of ≤30 on WOMAC pain scale (0-100)
Pain score at 1 06 10 studies) 2 weeks	2 weeks, measured Serious risk of bias ¹ Unclear concealment: 5 studies; outcome assessors not blinded: 4:	with: WOMAC pain s Serious inconsistency; p-value on test for heterogeneity 0.05 , $I^2 = 46\%$	subscale 0-100; Low No serious indirectness	ver values indicate	e less pain Undetected; Egger's test p=0.35	⊕⊕⊖⊖ LOW due to risk of bias and inconsistency	WMD -2.9 (-6.2, +2.8)	60.9% patients achieved acceptable pain state of ≤30 on WOMAC pain scale (0-100)	1.2% more patients achieved acceptable pain state of ≤30 on WOMAC pain scale (0-100)
Pain score at 1 06 10 studies) 2 weeks	2 weeks, measured Serious risk of bias ¹ Unclear concealment: 5 studies; outcome assessors not blinded: 4; Missing data	with: WOMAC pain s Serious inconsistency; p-value on test for heterogeneity 0.05 , $I^2 = 46\%$	subscale 0-100; Low No serious indirectness	ver values indicate	e less pain Undetected; Egger's test p=0.35	⊕⊕⊖⊖ LOW due to risk of bias and inconsistency	WMD -2.9 (-6.2, +2.8)	60.9% patients achieved acceptable pain state of ≤30 on WOMAC pain scale (0-100)	1.2% more patients achieved acceptable pain state of ≤30 on WOMAC pain scale (0-100)
Pain score at 1 306 10 studies) 2 weeks	2 weeks, measured Serious risk of bias ¹ Unclear concealment: 5 studies; outcome assessors not blinded: 4; Missing data >15%: 4	with: WOMAC pain s Serious inconsistency; p-value on test for heterogeneity 0.05 , $I^2 = 46\%$	subscale 0-100; Low No serious indirectness	ver values indicate	e less pain Undetected; Egger's test p=0.35	⊕⊕⊖⊖ LOW due to risk of bias and inconsistency	WMD -2.9 (-6.2, +2.8)	60.9% patients achieved acceptable pain state of ≤30 on WOMAC pain scale (0-100)	1.2% more patients achieved acceptable pain state of ≤30 on WOMAC pain scale (0-100)

BMJ Open: first published as 10.1136/bmjopen-2015-009857 on 2 February 2016. Downloaded from http://bmjopen.bmj.com/ on June 12, 2025 at Agence Bibliographique de I
 Protected by cppytights/ing/febelse/ingled ingle de indicate/ingled ingle de indicate/inglede ingle de indicate/ingled ingle de indicate/ingled ingle de in

247	Serious risk of	No serious	No serious	No serious	Uncertain	$\oplus \oplus \oplus \ominus$	WMD -2.5	98% patients	0% patients
(3 studies)	bias ¹	inconsistency;	indirectness	imprecision	(only 3 studies)	Moderate	(-5.6, +0.6)	achieved	achieved
24 weeks	Unclear	p-value on test for				due to risk of bias		acceptable pain	acceptable pain
	concealment: 2	heterogeneity 0.22,						state of ≤30 on	state of ≤ 30 on
	studies;	I ² = 33%						WOMAC pain	WOMAC pain
	outcome							scale (0-100)	scale (0-100)
	assessors not								
	blinded: 0;								
	Missing data								
	>15%: 2				0.				
257	Serious risk of	Serious	No serious	No serious	Uncertain		WMD -3.6	26.8% patients	6.2% more
				2					
(5 studies)	bias ¹	inconsistency;	indirectness	imprecision ²	(only 5 studies)	LOW	(-7.7, +0.5)	achieved	patients achieved
(5 studies) <=4 weeks	bias ¹ Unclear	inconsistency; p-value on test for	indirectness	imprecision ²	(only 5 studies)	LOW due to risk of bias and	(-7.7, +0.5)	acceptable	acceptable function
(5 studies) <=4 weeks	bias ¹ Unclear concealment: 5	inconsistency; p-value on test for heterogeneity <0.001,	indirectness	imprecision ²	(only 5 studies)	LOW due to risk of bias and inconsistency	(-7.7, +0.5)	acceptable function state	patients achieved acceptable function state ≤ 30 on
(5 studies) <=4 weeks	bias ¹ Unclear concealment: 5 studies;	inconsistency; p-value on test for heterogeneity <0.001, $I^2 = 79\%$	indirectness	imprecision ²	(only 5 studies)	LOW due to risk of bias and inconsistency	(-7.7, +0.5)	achieved acceptable function state ≤30 on	patients achieved acceptable function state ≤30 on WOMAC function
(5 studies) <=4 weeks	bias ¹ Unclear concealment: 5 studies; outcome	inconsistency; p-value on test for heterogeneity <0.001, I ² = 79%	indirectness	imprecision ²	(only 5 studies)	LOW due to risk of bias and inconsistency	(-7.7, +0.5)	achieved acceptable function state ≤30 on WOMAC	patients achieved acceptable function state ≤30 on WOMAC function scale (0-100)
(5 studies) <=4 weeks	bias ¹ Unclear concealment: 5 studies; outcome assessors not	inconsistency; p-value on test for heterogeneity <0.001, I ² = 79%	indirectness	imprecision ²	(only 5 studies)	LOW due to risk of bias and inconsistency	(-7.7, +0.5)	achieved acceptable function state ≤30 on WOMAC function scale	patients achieved acceptable function state ≤30 on WOMAC function scale (0-100)
(5 studies) <=4 weeks	bias ¹ Unclear concealment: 5 studies; outcome assessors not blinded: 2;	inconsistency; p-value on test for heterogeneity <0.001, I ² = 79%	indirectness	imprecision ²	(only 5 studies)	LOW due to risk of bias and inconsistency	(-7.7, +0.5)	achieved acceptable function state ≤30 on WOMAC function scale (0-100)	patients achieved acceptable function state ≤30 on WOMAC function scale (0-100)
(5 studies) <=4 weeks	bias ¹ Unclear concealment: 5 studies; outcome assessors not blinded: 2; Missing data	inconsistency; p-value on test for heterogeneity <0.001, I ² = 79%	indirectness	imprecision ²	(only 5 studies)	LOW due to risk of bias and inconsistency	(-7.7, +0.5)	achieved acceptable function state ≤30 on WOMAC function scale (0-100)	patients achieved acceptable function state ≤30 on WOMAC function scale (0-100)
(5 studies) <=4 weeks	bias ¹ Unclear concealment: 5 studies; outcome assessors not blinded: 2; Missing data	inconsistency; p-value on test for heterogeneity <0.001, I ² = 79%	indirectness	imprecision ²	(only 5 studies)	LOW due to risk of bias and inconsistency	(-7.7, +0.5)	achieved acceptable function state ≤30 on WOMAC function scale (0-100)	patients achieved acceptable function state ≤30 on WOMAC function scale (0-100)
(5 studies) <=4 weeks	bias ¹ Unclear concealment: 5 studies; outcome assessors not blinded: 2; Missing data	inconsistency; p-value on test for heterogeneity <0.001, I ² = 79%	indirectness	imprecision ²	(only 5 studies)	LOW due to risk of bias and inconsistency	(-7.7, +0.5)	achieved acceptable function state ≤30 on WOMAC function scale (0-100)	patients achieved acceptable function state ≤30 on WOMAC function scale (0-100)

Function score	e at 6 to 8 weeks, n	neasured with: WOMA	C function subscal	le 0-100; Lower va	lives indicate better function				
488	Serious risk of	No serious	No serious	No serious	Uncertain	$\oplus \oplus \oplus \ominus$	WMD -3.9	54.3% patients	5.4% more
(5 studies)	bias ¹	inconsistency;	indirectness	imprecision	(only 5 studies)	Moderate	(-7.6, -0.3)	achieved	patients achieved
6 to 8 weeks	Unclear	p-value on test for				due to risk of bias		acceptable	acceptable function
	concealment: 3	heterogeneity =0.21,						function state	state ≤30 on
	studies;	I ² = 30%						≤30 on	WOMAC function
	outcome							WOMAC	scale (0-100)
	assessors not							function scale	
	blinded: 2;							(0-100)	
	Missing data								
	>15%: 3								
Function score	e at 12 weeks, mea	sured with: WOMAC fi	Inction subscale 0	-100; Lower value	s indicate better function				
0.00		a :	A						1.00/
836	Serious risk of	Serious	No serious	No serious	Serious;	$\oplus \Theta \Theta \Theta$	WMD -4.0	62.6% patients	1.3% more
(12 studies)	bias ¹	inconsistency;	indirectness	imprecision	Asymmetry on funnel	VERY LOW	(-7.5, -0.5)	achieved	patients achieved
12 weeks	Unclear	p-value on test for			plot; Egger's test p=0.04	due to risk of bias,		acceptable	acceptable function
	concealment: 6	heterogeneity <0.001,				inconsistency and		function state	state ≤30 on
	studies;	$I^2 = 69\%$				publication bias		≤30 on	WOMAC function
	outcome							WOMAC	scale (0-100)
	assessors not							function scale	
	blinded: 4;							(0-100)	

	Missing data								
	>15%: 6								
Function scor	e at 24 weeks, mea	sured with: WOMAC fu	unction subscale 0-1	100; Lower values	indicate better function				
345	Serious risk of	Serious	No serious	No serious	Uncertain	$\oplus \oplus \ominus \ominus$	WMD -0.5	97.4% patients	0% more patients
(7 studies)	bias ¹	inconsistency;	indirectness	imprecision ²	(only 7 studies)	LOW	(-5.8, +4.7)	achieved	achieved
24 weeks	Unclear	p-value on test for				due to risk of bias and		acceptable	acceptable functio
	concealment: 4	heterogeneity <0.001,				inconsistency		function state	state ≤30 on
	studies;	I ² = 89%						≤30 on	WOMAC function
	outcome			C>				WOMAC	scale (0-100)
	assessors not							function scale	
	blinded: 2;				Q			(0-100)	
	Missing data								
	>15%: 2				6				
1.	None of studies in	n the meta-analyses b	linded patients an	d only 2 study bl	inded the care providers				
2.	We did not rate dow	vn due to imprecision al	though 95% confide	ence interval includ	les no effect because either	extreme of the 95%CI	is too small to b	e clinically importa	int
diff	erence								
					23				
		niliar technologies.	i s b us conione du	A.epinin/(enebie	 Depxaroirpape(aits/sh	ant amiguance and	ected by copp	Prot	
lraphique de	t Agence Bibliog	/ ou June 12, 2025 a	moɔ.imd.nəqoim	ed from http://bi eur (S∃8A) rue	oruary 2016. Download Enseignement Superi	194 S no 788600-8100	36/bmjopen-	rr.0r as bədzild -	IJ Open: first pu

BMJ Open: first published as 10.1136/bmjopen-2015-009857 on 2 February 2016. Downloaded from http://bmjopen.bmj.com/ on June 12, 2025 at Agence Bibliographique de l Enseignement Superieur (ABES) . Protected by copyright, including for uses related to text and data mining, Al training, and similar technologies.

Postoperative function

Of 16 trials reporting on postoperative function, only four reported significant improvement in function ^{16, 31, 41, 49}, including higher hip external rotation ³¹ or higher flexion range of motion (ROM) scores, WOMAC physical function and total score ¹⁶, and less time to reached 90° of knee flexion ⁴¹ and great improvement in activities of daily living (ADL) ⁴⁹ after surgery .

Sixteen trials (1118 patients) reported postoperative function scores using different instruments, i.e. WOMAC ^{16, 31, 37, 40, 42, 43, 45, 47, 48}, Harris hip score ^{32, 34}, SF-36 physical component summary (PCS) ³⁰, SF-36 physical functioning score ³⁸, HSSK score ¹⁵, HOOS function in daily living ³⁶, and KOOS/HOOS ADL⁴⁹. After converting function scores to WOMAC function score (0-100), the difference was slightly improved (but numerically small on a scale of 0-100) with prehabilitation versus no prehabilitation at early follow-up (WOMAC function score at 6 to 8 weeks,5 trials, 488 patients, WMD -3.9, 95%CI-7.6 to -0.3, RR=1.10, Figure 3, GRADE: moderate certainty in estimates, Table 3 & Table 4), and at 12 weeks (12 trials, 836 patients, WMD -4.0, 95%CI -7.5 to -0.5, RR=1.02, Figure 4, GRADE: very low certainty in estimates, Table 3 & Table 4). No significant difference for WOMAC function score was found after 12 weeks (at 24 weeks, 5 trials, 345 patients, WMD -0.5, 95%CI -5.8 to +4.7; at 1 year, 6 trials, 296 patients, WMD -0.6, 95%CI -2.6 to +1.5, GRADE: low certainty in estimates, Table 3 & Table 4).

When expressed as a relative risk for achieving the acceptable threshold, the relative increases were small (RR 1.10 at 6-8 weeks; 1.02 at 12 weeks). When expressed as an absolute difference

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml
in likelihood of achieving the acceptable threshold, the differences ranged from 1.3% to 5.4% more patients achieving a WOMAC function score \leq 30 at 6-8 weeks and 12 weeks respectively (Supplementary table 3).

Resumption of activities of daily living

Resumption of activities of daily living was rarely reported. In the two studies (99 patients) ^{32, 34} that reported activities of daily living, meta-analysis suggested significantly earlier resumption of activities, including climbing stairs (2 trials, 99 patients, WMD -1.4 days, 95%CI-1.9 to -0.8 days), use of toilet (2 trials, 99 patients, -0.9 day, 95%CI-1.3 to -0.5 days), use of chair (2 trials, 99 patients, -1.2 days, 95%CI -1.7 to -0.8 days), but not for time to first day of walking (2 trials, 99 patients, -0.2 day , 95%CI -0.4 to +0.0 day), (Table 3). However, based on the total time-course of recovery, the difference was small.

Quality of life

Significant differences in quality of life were not found in 9 studies for SF-36 ^{30, 37, 39, 42, 43}, Quality of Well Being instrument ¹⁵, HOOS Hip-related quality of life ³⁶, KOOS/HOOS Quality of Life subscale ⁴⁹, and Patient Specific Complaints (PSC) questionnaire ^{33, 36}; while three trials reported significant difference in quality of life score ^{31, 38, 49}, including higher physical function score or physical composite score using SF-36 ^{31, 38} or better EuroQol 5 Dimension Health Questionnaire (EQ5D) ⁴⁹; however, the numeric differences were small ^{31, 38, 49} and the significance disappeared at 3 months ^{31, 49}.

BMJ Open: first published as 10.1136/bmjopen-2015-009857 on 2 February 2016. Downloaded from http://bmjopen.bmj.com/ on June 12, 2025 at Agence Bibliographique de Enseignement Superieur (ABES) . Protected by copyright, including for uses related to text and data mining, Al training, and similar technologies.

Three studies including 149 patients reported SF-36 Physical Component Summary (SF-36 PCS) and Mental Component Summary (SF-36 MCS). Meta-analysis of SF-36 PCS and MCS did not detect significant differences at any time-point (from 6 weeks to 1 year, Table 3).

Length of hospital stay and total cost

Only one ⁴¹ out of 10 studies ^{15, 30, 32-34, 36, 37, 41, 42, 47} found a significant reduction in hospital length of stay (mean difference = -0.8 day). Meta-analysis of these studies did not detect significant differences in hospital length of stay for prehabilitation versus control (7 studies, 507 patients, WMD -0.3 days, 95%CI -0.8 to + 0.1 days, Figure 5).

Of the few studies ${}^{37, 42, 47}$ that reported on costs, none of them reported significant reduction of overall costs with prehabilitation, but one 42 described significantly increased physiotherapy costs with prehabilitation (mean difference= $-\pounds$ 136.5). Even when total costs were converted to Canadian dollars and combined through meta-analysis, the results did not differ for prehabilitation versus none (2 studies, 242 patients, WMD + \$ 0.5, 95%CI - \$ 384 to + \$ 393).

Other outcomes

Other outcomes of interest, including patient satisfaction, stroke, cardiovascular events, and readmissions were inadequately reported for meta-analysis. Adverse events and discontinuations were rarely reported within the studies; however, in at least one study, there was concern about increased cardiovascular events and stroke, and poorer SF-36 general health, energy and mental health among the withdrawn patients although the author stated no evidence that study withdrawal varied by group ⁴². In some studies, there were reports of patient withdrawals due to

BMJ Open

adverse events ^{34, 42, 49}. Some studies reported no significant postoperative complications between groups ³⁵⁻³⁷, no serious adverse events ^{33, 35, 36} or no adverse events ⁴⁷.

Subgroup analysis and sensitivity analysis

Effect sizes were similar between hip and knee replacement subgroups for WOMAC pain and function scores (supplementary table 3), as indicated by non-significant p-values for interaction.

Sensitivity analysis using SMD (instead of WMD), RoM, and different thresholds for defining patient acceptable symptom state (20 and 40, instead of 30), and replacing function sub-score with total score did not significantly change the results (supplementary table 4 and 5).

While publication bias was not indicated for pain score; asymmetric funnel plots indicated the possibility of publication bias for function scores (supplementary figure 1 to figure 2, table 2).

INTERPRETATION

Main findings

Existing evidence from 22 randomized controlled trials suggests that prehabilitation for patients planning to undergo joint replacement does not affect postoperative pain and function to a degree that would be considered clinically relevant; however, this is based on studies with significant limitations, providing very low certainty in estimates. While some differences reached statistical significance, the effects are too small to be considered clinically important (ie, an improvement of a few points on a scale of 0-100 is likely clinically irrelevant, and undetectable to patients). Our analysis shows that prehabilitation reduced WOMAC pain score

BMJ Open: first published as 10.1136/bmjopen-2015-009857 on 2 February 2016. Downloaded from http://bmjopen.bmj.com/ on June 12, 2025 at Agence Bibliographique de Enseignement Superieur (ABES) . Protected by copyright, including for uses related to text and data mining, Al training, and similar technologies.

by 6 with 95%CI (-10.6 to -1.6) within 4 weeks, and with no difference remaining beyond 4 weeks, which is generally smaller than the minimal clinically important improvement (MCII) of at least 9.7 at 6 weeks ^{51,52} even when the most optimistic extremes of the confidence intervals are considered in our analysis. Even when the 'patient accepted pain state' was defined as achieving < 30 in WOMAC pain subscale 0-100¹⁸⁻²⁰, there was only an absolute increase of 3.9% of patients achieving this threshold. Similarly for function improvement, prehabilitation improved early function by 3.9 to 4.0 points on the WOMAC function subscale 0-100, which is much smaller than the threshold of minimally important difference ranged from 7.9 to 25.9⁵¹⁻⁵⁶. and only 1.3% to 5.4% more patients reached a WOMAC function score \leq 30. Although prehabilitation promoted patients to resume activities of daily living 0.9 to 1.4 days earlier than no formal prehabilitation, the difference is trivial, and importantly, very few studies reported on this time point (ie, 2 of 22 studies) which prevents definitive conclusions. Similarly, for the outcome of length of stay, there was no difference between groups, and if statistical significance had been achieved, the difference would have been only 0.3 days, which is a minimal difference. Jurisdictions considering implementation (or continuation) of prehabilitation services should consider whether resources could be better spent elsewhere on interventions of proven clinical benefit. Until sufficient evidence accrues to definitively conclude that prehabilitation provides meaningful benefit, investment in prehabilitation does not represent the best use of limited resources in a healthcare system where other opportunities with proven benefits could be funded instead.

Relation to prior reviews

Similar to this meta-analysis, most previous meta-analyses ^{10, 11} and systematic reviews ^{7, 9, 12} suggested that the impact of prehabilitation has not been proven by the existing evidence. In

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

contrast to our analysis, Gill 2013 et al ⁸ suggested that exercise-based interventions reduce pain and improve physical function for people awaiting hip replacement surgery, but not knee replacement surgery. It is notable that there were some limitations in Gill 2013 ⁸, wherein some included trials did not report if the patients underwent surgery after the intervention ^{57, 58}, and/or failed to report postoperative outcomes ^{59, 60}, and one included trial allocated patients based on the geographic availability which may have introduced selection bias and unit of measurement errors. Furthermore, a total of 9 relevant trials ^{30, 34, 38, 40-42, 44, 45, 50} were not included in Gill 2013.

Strengths and limitations

Strengths of this review include rigorous methodology, including the comprehensive systematic search without limits by language, date or publication status, which identified 7 RCTs ^{30, 34, 38, 40, 41, 45, 50} not included in any previous systematic reviews ⁶⁻¹³. Furthermore, we analyzed the effect of prehabilitation by converting to a standardized measurement of WOMAC pain and function scores, and used different presentation methods to enhance interpretability and to improve ability to find potential signals in effect size through meta-analysis ⁶¹, which is beyond what other systematic reviews published. In addition, this meta-analysis addressed all available clinically relevant outcomes, while previous reviews addressed only a few selected outcomes. Application of GRADE for rating quality of evidence provides improved context for interpreting the findings in light of inherent strengths and limitations of the included studies ^{62, 63}.

BMJ Open: first published as 10.1136/bmjopen-2015-009857 on 2 February 2016. Downloaded from http://bmjopen.bmj.com/ on June 12, 2025 at Agence Bibliographique de Enseignement Superieur (ABES) . Protected by copyright, including for uses related to text and data mining, Al training, and similar technologies.

There were a number of specific limitations in the existing clinical trials comparing prehabilitation with control. The most significant limitation is the lack of large randomized controlled trials that have been conducted in this area. Included studies were small (median 81 patient, ranging from 21 to 165), of relatively short duration of follow up (median 3 months,

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

BMJ Open: first published as 10.1136/bmjopen-2015-009857 on 2 February 2016. Downloaded from http://bmjopen.bmj.com/ on June 12, 2025 at Agence Bibliographique de Enseignement Superieur (ABES) . Protected by copyright, including for uses related to text and data mining, Al training, and similar technologies.

ranging from 4 weeks to 1 year), and many of them provided inadequate description of the frequency, intensity and duration of prehabilitation provided. Definitions for prehabilitation, and for outcomes measurements, were heterogeneous across studies. Patient compliance with prehabilitation was reported as 75% in 3 studies ^{41, 42, 50}, and 90% or greater in 7 studies ^{16, 30, 33}, ^{35, 36, 43, 48}, and was not reported in the remainder of the studies. Most studies provided an inadequate description of the components of the prehabilitation programs provided, and few described the fidelity of program implementation.⁶⁴ Future studies in this area should follow current guidelines for intervention description (TIDieR checklist) to enable transparent evaluation and replication of programs⁶⁵. In a number of studies, co-interventions were provided in the prehabilitation (e.g. education), and in some cases, these co-interventions were not provided in the control group ^{31, 32, 34}. Nevertheless, this would likely provide an overestimate of the potential benefit for prehabilitation; and despite this potential positive bias, still no differences were found for prehabilitation. Considered together, the heterogeneity of the included studies in types of prehabilitation programs, control group interventions, compliance and fidelity within the programs, and systematic differences in the study population likely impacted the ability to detect differences, if any exist. Although we performed subgroup analysis for hip versus knee replacement surgery, this failed to explain the heterogeneity across studies. Due to the limited numbers of studies, meta-analysis was not performed for the effect of different types of prehabilitation (e.g. exercise only vs exercise plus education). Publication bias was not detected; however, the methodologic quality of included studies is very low, which was the major reason that we downgraded the overall quality of evidence. The high risk of bias, combined with the selective reporting of important outcomes across the studies (for example,

BMJ Open

CONCLUSION

Existing evidence suggests that, in patients undergoing joint replacement, the effect of prehabilitation (exercise/physiotherapy programs in the months prior to surgery) on pain and function are too small to be considered clinically-important and were not robust over time. Prehabilitation did not result in clinically important (or statistically significant) differences in most measures of patient recovery, quality of life, length of stay and costs. Future research of sufficient power to measure clinically-relevant outcomes is required to identify which, if any, form of prehabilitation achieves better outcomes than in these trials. Jurisdictions considering implementation of prehabilitation services should consider whether resources could be better spent elsewhere on interventions of proven clinical benefit.

BMJ Open: first published as 10.1136/bmjopen-2015-009857 on 2 February 2016. Downloaded from http://bmjopen.bmj.com/ on June 12, 2025 at Agence Bibliographique de

Enseignement Superieur

(ABES

data mining, AI training, and similar technologies

Protected by copyright, including for uses related to text and

BMJ Open: first published as 10.1136/bmjopen-2015-009857 on 2 February 2016. Downloaded from http://bmjopen.bmj.com/ on June 12, 2025 at Agence Bibliographique de Enseignement Superieur (ABES) . Protected by copyright, including for uses related to text and data mining, Al training, and similar technologies.

Funding: This study was supported by the MEDICI Centre, Department of Anesthesia & Perioperative Medicine, London Health Sciences Center, St Joseph's Healthcare London, Lawson Health Research Institute, and the Schulich School of Medicine & Dentistry, University of Western Ontario. In addition, funding was provided in part by "AMOSO Innovation Fund" (Project #INN 11-008, to Dr. J. Martin and Dr. D. Cheng). The funders had no role in the design and conduct of the study; in the collection, analysis, and interpretation of the data; or in the preparation, review, or approval of the manuscript.

Competing Interest Statement:

None declared.

Transparency Declaration

I Dr. Janet Martin affirm that the manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned (and, if relevant, registered) have been explained.

BMJ Author License

"I Dr. Janet Martin The Corresponding Author of this article contained within the original manuscript which includes any diagrams & photographs within and any related or stand alone film submitted (the Contribution") has the right to grant on behalf of all authors and does grant on behalf of all authors, a licence to the BMJ Publishing Group Ltd and its licencees, to permit this Contribution (if accepted) to be published in the BMJ and any other BMJ Group products and to exploit all subsidiary rights, as set out in our licence set out at:

http://www.bmj.com/about-bmj/resources-authors/forms-policies-and-checklists/copyright-open-access-and-permission-reuse."

Please tick one or more boxes as appropriate:

I am the sole author of the Contribution.

BMJ Open

 $\mathbf{\nabla}$ I am one author signing on behalf of all co-owners of the Contribution. The Contribution has been made in the course of my employment and I am signing as authorised by my employer. I am a US Federal Government employee acting in the course of my employment. I am not a US Federal Government employee, but some or all of my co-authors are. I am an employee of the UK Crown* acting in the course of my employment I am a US Federal Government employee acting in the course of my employment. I am not a US Federal Government employee, but some or all of my co-authors are. I am an employee of the UK Crown acting in the course of my employment

□ I am not an employee of the UK Crown acting in the course of my employment but some/all of my co-authors are.*

Disclosure of conflicts of interest: None

Acknowledgements: The authors would like to thank Gordon Guyatt, MD, for mentorship to Li Wang on methodology, and Amy Newitt, MLIS, for her contributions to the search updates and manuscript preparation. We are also thankful to "National Natural Science Foundation of China" (Project # 71073105) for supporting Dr. L. Wang in the methodology training. Authors' contribution: Li Wang contributed to the study conception and design, literature screening, acquisition of data, analysis and interpretation of data, drafting of the manuscript and revision based on the comments of coauthors. Myeongjong Lee and Zhe Zhang participated in the literature screening, data acquisition and critical revision of the manuscript. Jessica Moodie did the literature searching, article retrieval, and data acquisition. Davy Cheng contributed to

study conception and design, and critical revision of the manuscript. Janet Martin guided the methodology, contributed to the study conception and design, data checking and interpretation, drafting and critical revision of the manuscript. All authors approved the version submitted for publication and agreed to act as guarantors of the work.

Data Sharing: No additional data

References:

1. Felson DT, Lawrence RC, Hochberg MC, et al. Osteoarthritis: New insights. part 2: Treatment approaches. *Ann Intern Med.* 2000;133(9):726-37.

- Beswick AD, Wylde V, Gooberman-Hill R, et al. What proportion of patients report long-term pain after total hip or knee replacement for osteoarthritis? A systematic review of prospective studies in unselected patients. *BMJ Open*. 2012;2(1):e000435-2011-000435.
- 3. Vissers MM, Bussmann JB, Verhaar JA, et al. Recovery of physical functioning after total hip arthroplasty: Systematic review and meta-analysis of the literature. *Phys Ther*. 2011;91(5):615-29.
- Nilsdotter AK, Toksvig-Larsen S, Roos EM. Knee arthroplasty: Are patients' expectations fulfilled? A prospective study of pain and function in 102 patients with 5-year follow-up. *Acta Orthop*. 2009;80(1):55-61.
- Mak JC, Fransen M, Jennings M, et al. Evidence-based review for patients undergoing elective hip and knee replacement. *ANZ J Surg.* 2014;84(1-2):17-24.
- Ackerman IN, Bennell KL. Does pre-operative physiotherapy improve outcomes from lower limb joint replacement surgery? A systematic review. *Australian Journal of Physiotherapy*. 2004;50(1):25-30.
- 7. Jordan RW, Smith NA, Chahal GS, et al. Enhanced education and physiotherapy before knee replacement; is it worth it? A systematic review. *Physiotherapy*. 2014.
- Gill S, McBurney H. Does exercise reduce pain and improve physical function before hip or knee replacement surgery? A systematic review and meta-analysis of randomized controlled trials. *Arch Phys Med Rehabil.* 2013;94:164-76.
- 9. Shoemaker MJ, Gibson C, Saagman S. Preoperative exercise in individuals undergoing total knee arthroplasty: State of the evidence. *Topics in Geriatric Rehabilitation*. 2013;29(1):2-16.
- Hoogeboom T, Oosting E, Vriezekolk J, et al. Therapeutic validity and effectiveness of preoperative exercise on functional recovery after joint replacement: A systematic review and meta-analysis. *PLoS ONE*. 2012;7(5):e38031.

BMJ Open

11. Wallis JA, Taylor NF. Pre-operative interventions (non-surgical and non-pharmacological) for
patients with hip or knee osteoarthritis awaiting joint replacement surgerya systematic review and
meta-analysis. Osteoarthritis Cartilage. 2011;19(12):1381-95.
12. Barbay K. Research evidence for the use of preoperative exercise in patients preparing for total hip or
total knee arthroplasty (structured abstract). Orthopaedic Nursing. 2009;28(3):127-33.
13. Lucas B. Does a pre-operative exercise programme improve mobility and function post-total knee
replacement: A mini-review (structured abstract). Journal of Orthopaedic Nursing. 2004;8(1):25-33.
14. Higgins JPT, Green S (editors). Cochrane Handbook for Systematic Reviews of Interventions Version
5.1.0 [updated March 2011]. The Cochrane Collaboration, 2011. Available from www.cochrane-
handbook.org.
15. Thorlund K, Walter S, Johnston B, et al. Pooling health-related quality of life outcomes in meta-
analysis a tutorial and review of methods for enhancing interpretability. Research Synthesis
Methods. 2011;2(3):188-203.
16. D'Lima D, Colwell C, Morris B, Hardwick M, Kozin F. The effect of preoperative exercise on total
knee replacement outcomes. Clin Orthop Relat Res. 1996(326):174-82.
17. Gilbey H, Ackland T, Wang A, Morton A, Trouchet T, Tapper J. Exercise improves early functional
recovery after total hip arthroplasty. Clin Orthop Relat Res. 2003(408):193-200.
18. Tubach F, Ravaud P, Baron G, et al. Evaluation of clinically relevant states in patient reported
outcomes in knee and hip osteoarthritis: The patient acceptable symptom state. Ann Rheum Dis.
2005;64(1):34-7.
19. Tubach F, Ravaud P, Martin-Mola E, et al. Minimum clinically important improvement and patient
acceptable symptom state in pain and function in rheumatoid arthritis, ankylosing spondylitis, chronic
back pain, hand osteoarthritis, and hip and knee osteoarthritis: Results from a prospective

multinational study. Arthritis Care Res (Hoboken). 2012;64(11):1699-707.

20. Escobar A, Gonzalez M, Quintana JM, et al. Patient acceptable symptom state and OMERACT-OARSI set of responder criteria in joint replacement. identification of cut-off values. *Osteoarthritis Cartilage*. 2012;20(2):87-92.

- Maxwell JL, Felson DT, Niu J, et al. Does clinically important change in function after knee replacement guarantee good absolute function? the multicenter osteoarthritis study. *J Rheumatol*. 2014;41(1):60-4.
- 22. Anzures-Cabrera J, Sarpatwari A, Higgins J. Expressing findings from meta-analyses of continuous outcomes in terms of risks. *Stat Med.* 2011;30(25):2967-85.
- 23. Guyatt GH, Oxman AD, Santesso N, et al. GRADE guidelines: 12. preparing summary of findings tables-binary outcomes. *J Clin Epidemiol*. 2013;66(2):158-72.
- 24. Guyatt G, Oxman AD, Akl EA, et al. GRADE guidelines: 1. introduction-GRADE evidence profiles and summary of findings tables. *J Clin Epidemiol*. 2011;64(4):383-94.
- 25. Guyatt GH, Oxman AD, Montori V, et al. GRADE guidelines: 5. rating the quality of evidence-publication bias. *J Clin Epidemiol*. 2011;64(12):1277-82.
- 26. Guyatt GH, Oxman AD, Kunz R, et al. GRADE guidelines 6. rating the quality of evidence-imprecision. *J Clin Epidemiol*. 2011;64(12):1283-93.
- Guyatt GH, Oxman AD, Kunz R, et al. GRADE guidelines: 8. rating the quality of evidenceindirectness. *J Clin Epidemiol*. 2011;64(12):1303-10.
- 29. Guyatt GH, Thorlund K, Oxman AD, et al. GRADE guidelines: 13. preparing summary of findings tables and evidence profiles-continuous outcomes. *J Clin Epidemiol*. 2013;66(2):173-83.
- 30. Bitterli R, Sieben JM, Hartmann M, et al. Pre-surgical sensorimotor training for patients undergoing total hip replacement: A randomised controlled trial. *Int J Sports Med.* 2011;32(9):725-32.
- Ferrara P, Rabini A, Maggi L, et al. Effect of pre-operative physiotherapy in patients with endstage osteoarthritis undergoing hip arthroplasty. *Clin Rehabil*. 2008;22(10-11):977-86.

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

BMJ Open

	outcome of total hip replacement: A prospective randomized controlled trial. Clin Rehabil.
	2004;18(4):353-8.
33.	Hoogeboom T, Dronkers J, van den Ende C, et al. Preoperative therapeutic exercise in frail
	elderly scheduled for total hip replacement: A randomized pilot trial. Clin Rehabil. 2010;24(10)
	10.
34.	Vukomanović A, Popović Z, Durović A, et al. The effects of short-term preoperative physical th
	and education on early functional recovery of patients younger than 70 undergoing total hip
	arthroplasty. Vojnosanit Pregl. 2008;65(4):291-7.
35.	Wang A, Gilbey H, Ackland T. Perioperative exercise programs improve early return of ambula
	function after total hip arthroplasty: Arandomized, controlled trial. Am J Phys Med Rehabil.
	2002;81(11):801-6.
36.	Oosting E, Jans M, Dronkers J, et al. Preoperative home-based physical therapy versus usual car
	improve functional health of frail older adultsscheduled for elective total hip arthroplasty: A pile
	randomized controlled trial. Arch Phys Med Rehabil. 2012;93(4):610-6.
37.	Beaupre L, Lier D, Davies D, et al. The effect of a preoperative exercise and education program
	functional recovery, health related quality of life, and health service utilization following primar
	total knee arthroplasty. J Rheumatol. 2004;31(6):1166-73.
38.	Brown K, Top R, Brosky JA, et al. Prehabilitation and quality of life three months after total kn
	arthroplasty: A pilot study. Percept Mot Skills. 2012;115(3):765-74.
39.	Evgeniadis G, Beneka A, Malliou P, et al. Effects of pre- or postoperative therapeutic exercise of
	quality of life, before and after total knee arthroplasty for osteoarthritis. J Back Musculoskelet
	<i>Rehabil</i> . 2008;21:161-9.
40.	Gstoettner M, Raschner C, Dirnberger E, et al. Preoperative proprioceptive training in patients v
	total knee arthroplasty. The Knee. 2011;18(4):265-70.

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

41. Matassi F, Duerinckx J, Vandenneucker H, et al. Range of motion after total knee arthroplasty: The effect of a preoperative home exercise program. *Knee Surg Sports Traumatol Arthrosc*. 2014;22(3):703-9.

- 42. Mitchell C, Walker J, Walters S, et al. Costs and effectiveness of pre- and postoperative home physiotherapy for total knee replacement: randomizedcontrolled trial. *J Eval Clin Pract.* 2005;11(3):283-92.
- 43. McKay C, Prapavessis H, Doherty T. The effect of a prehabilitation exercise program on quadriceps strength for patients undergoing total knee arthroplasty: A randomized controlled pilot study. *PM R*. ;4(9):647-56.
- 44. Topp R, Swank A, Quesada P, et al. The effect of prehabilitation exercise on strength and functioning after total knee arthroplasty. *PM R*. 2009;1(8):729-35.
- 45. Tungtrongjit Y, Weing P, Saunkool P. The effect of preoperative quadriceps exercise on functional outcomes after total knee arthroplasty. *J Med Assoc Thai*. 2012;95(Suppl 10):S58-66.
- 46. Weidenhielm L, Mattsson E, Brostrom L, et al. Effect of preoperative physiotherapy in uncompartmental prosthetic knee replacement. *Scand J Rehab Med.* 1993;25:33-9.
- 47. Williamson L, Wyatt M, Yein K, et al. Severe knee osteoarthritis: A randomized controlled trial of acupuncture, physiotherapy (supervised exercise) and standard management for patients awaiting knee replacement. *Rheumatology (Oxford)*. 2007;46(9):1445-9.
- 48. Rooks D, Huang J, Bierbaum B, et al. Effect of preoperative exercise on measures of functional status in men and women undergoing total hip and knee arthroplasty. *Arthritis Rheum.* 2006;55(5):700-8.
- 49. Villadsen A, Overgaard S, Holsgaard-Larsen A, et al. Postoperative effects of neuromuscular exercise prior to hip or knee arthroplasty: A randomised controlled trial. *Ann Rheum Dis*. 2014;73(6):1130-37.
- 50. Villadsen A, Overgaard S, Holsgaard-Larsen A, et al. Immediate efficacy of neuromuscular exercise in patients with severe osteoarthritis of the hip or knee: A secondary analysis from a randomized controlled trial. *J Rheumatol*. 2014;41(7):1385-94.

BMJ Open

51. Ehrich EW, Davies GM, Watson DJ, et al. Minimal	perceptible clinical improvement with the
western ontario and McMaster universities osteoarth	ritis index questionnaire and global assessments
in patients with osteoarthritis. J Rheumatol. 2000; 2	7(11):2635-41.
52. Escobar A, Quintana JM, Bilbao A, et al. Responsiv	eness and clinically important differences for the
WOMAC and SF-36 after total knee replacement. C	steoarthritis Cartilage 2007; 15(3):273-80.
53. Angst, F, Aeschlimann A, Michel BA, et al. Minima	I clinically important rehabilitation effects in
patients with osteoarthritis of the lower extremities.	J Rheumatol. 2002; 29(1):131-8.
54. Escobar A, Garcia Perez L, Herrera-Espineira C, et	al. Total knee replacement; minimal clinically
important differences and responders. Osteoarthritis	<i>Cartilage</i> . 2013;21(12):2006-12.
55. Quintana JM, Escobar A, Bilbao A, et al. Responsiv	eness and clinically important differences for the
WOMAC and SF-36 after hip joint replacement. Os	teoarthritis Cartilage. 2005;13(12):1076-83.
56. Tubach F, Ravaud P, Baron G, et al. Evaluation of c	linically relevant changes in patient reported
outcomes in knee and hip osteoarthritis: The minima	al clinically important improvement. Ann Rheum
Dis. 2005;64(1):29-33.	
57. Borjesson M, Robertson E, Weidenheilm L, et al. P	nysiotherapy in knee osteoarthrosis: Effect on
pain and walking. Physiother Res Int. 1996;1:89-97	
58. Nunez M, Nunez E, Segur J. The effect of an education	ional program to improve health-related quality
of life in patients with osteoarthritis on waiting list	or total knee replacement: A randomized study.
Osteoarthritis Cartilage. 2006;14:279-85.	
59. Aoki O, Tsumura N, Kimura A, et al. Home stretchi	ng exercise is effective for improving knee range
of motion and gait in patients with knee osteoarthrit	is. J Phys Ther Sci. 2009;21:113-9.
60. Swank A, Kachelman J, Bibeau W. Prehabilitation	before total knee arthroplasty increases strength
and function in older adults with severe osteoarthrit	s. J Strength COnd Res. 2011;25:318.
61. Johnston BC, Bandayrel K, Friedrich JO, et al. Pres	entation of continuous outcomes in meta-analysis:
A survey of clinicians' understanding and preference	es. 21st Cochrane Colloquium, Quebec City,
Canada 2013.	

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

BMJ Open: first published as 10.1136/bmjopen-2015-009857 on 2 February 2016. Downloaded from http://bmjopen.bmj.com/ on June 12, 2025 at Agence Bibliographique de

Enseignement Superieur

(ABES)

to text

ata mining, Al training, and similar technologies

Protected by copyright, including for uses related

- 62. Guyatt GH, Oxman AD, Vist GE, et al. GRADE: An emerging consensus on rating quality of evidence and strength of recommendations. *BMJ*. 2008;336(7650):924-6.
- 63. Langer G, Meerpohl JJ, Perleth M, et al. GRADE guidelines: 1. introduction GRADE evidence profiles and summary of findings tables. *Z Evid Fortbild Qual Gesundhwes*. 2012;106(5):357-68.
- 64. Taylor KL, Weston M, Batterham AM. Evaluating intervention fidelity: an example from a highintensity interval training study. PLoS One. 2015;10(4):e0125166.
- 65. Hoffmann TC, Glasziou PP, Boutron I, Milne R, Perera R, Moher D, et al. Better reporting of interventions: template for intervention description and replication (TIDieR) checklist and guide.
 BMJ. 2014;348 :g1687.

Table Legends

Table 1: Characteristics of included RCTs

Table 2: Risk of Bias for Included Studies

Table 3: Summary of results for prehabilitation vs. no prehabilitation

Supplementary table 1: Intervention characteristics of included RCTs

Table 4: GRADE Evidence Profile: prehabilitation vs no formal prehabilitation for total joint replacement

Supplementary Table 2: Description of RCTs of Prehabilitation versus No Prehabilitation for TKR/THR
Supplementary Table 3: Subgroup Analysis of TKR and THR
Supplementary Table 4 Sensitivity Analysis to test robustness of results after removing total score
Supplementary Table 5: Sensitivity analysis using different thresholds of patient acceptable symptom state (PASS)
Figure Legend
Figure 2. Pain score at 4 weeks or less (converted to WOMAC pain subscale 0-100) for prehabilitation vs no prehabilitation in joint replacement surgery
Figure 3. Function score at 6 to 8 weeks (converted to WOMAC function subscale 0-100) for prehab vs no prehab in joint replacement surgery
Figure 4. Function score at 12 weeks (converted to WOMAC function subscale 0-100) for prehabilitation vs no prehabilitation in joint replacement surgery

Figure 5. Hospital length of stay (days) for prehabilitation vs no prehabilitation in joint replacement surgery

Supplementary figure 1. Funnel plot to explore publication bias for pain scores

Supplementary figure 2. Funnel plot to explore publication bias for function scores

BMJ Open: first published as 10.1136/bmjopen-2015-009857 on 2 February 2016. Downloaded from http://bmjopen.bmj.com/ on June 12, 2025 at Agence Bibliographique de I Enseignement Superieur (ABES) . Protected by copyright, including for uses related to text and data mining, Al training, and similar technologies.



Figure 1 PRISMA flow diagram of study selection

Figure 1 PRISMA flow diagram of study selection 215x279mm (300 x 300 DPI)



Figure 2. Pain score at 4 weeks or less (converted to WOMAC pain subscale 0-100) for prehabilitation vs no prehabilitation in joint replacement surgery 1718x1109mm (96 x 96 DPI)

BMJ Open: first published as 10.1136/bmjopen-2015-009857 on 2 February 2016. Downloaded from http://bmjopen.bmj.com/ on June 12, 2025 at Agence Bibliographique de I Enseignement Superieur (ABES) . Protected by copyright, including for uses related to text and data mining, Al training, and similar technologies.

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

BMJ Open: first published as 10.1136/bmjopen-2015-009857 on 2 February 2016. Downloaded from http://bmjopen.bmj.com/ on June 12, 2025 at Agence Bibliographique de I Enseignement Superieur (ABES) . Protected by copyright, including for uses related to text and data mining, Al training, and similar technologies.



Figure 3. Function score at 6 to 8 weeks (converted to WOMAC function subscale 0-100) for prehab vs no prehab in joint replacement surgery 1726x1159mm (96 x 96 DPI)



Figure 4. Function score at 12 weeks (converted to WOMAC function subscale 0-100) for prehabilitation vs no prehabilitation in joint replacement surgery

BMJ Open: first published as 10.1136/bmjopen-2015-009857 on 2 February 2016. Downloaded from http://bmjopen.bmj.com/ on June 12, 2025 at Agence Bibliographique de I Enseignement Superieur (ABES) . Protected by copyright, including for uses related to text and data mining, Al training, and similar technologies.



Figure 5. Hospital length of stay (days) for prehabilitation vs no prehabilitation in joint replacement surgery 1749x1273mm (96 x 96 DPI)





BMJ Open: first published as 10.1136/bmjopen-2015-009857 on 2 February 2016. Downloaded from http://bmjopen.bmj.com/ on June 12, 2025 at Agence Bibliographique de I Enseignement Superieur (ABES) . Protected by copyright, including for uses related to text and data mining, Al training, and similar technologies.

Page 48 of 81

BMJ Open: first published as 10.1136/bmjopen-2015-009857 on 2 February 2016. Downloaded from http://bmjopen.bmj.com/ on June 12, 2025 at Agence Bibliographique de l Enseignement Superieur (ABES)

Protected by copyright, including for uses related to text and data mining, Al training, and similar technologies.





Beaupre 2004	physiotherapist supervised				
	1 × 1 1 ···	land based: strengthening, aerobic; supervised	all but 1 participant	usual care: regular	standard postoperativ
	exercise	by physiotherapist; 3 times/week * 4 weeks +	completed the 12	activities and other	mobilization routine
		education	sessions	treatment at discretion	
				of physician	
Bitterli 2011	home exercise	land based: strengthening and stretching,	exercises completed	no intervention	usual care (outpatient
		home exercises from 2 to 6 weeks, twice	on 91% of the days		rehabilitation or
		daily; 2 verbal and written instruction			rehabilitation clinic)
Brown 2012	physiotherapist supervised	land based: strengthening and stretching,	not reported	usual care	not reported
	exercise + home exercise	supervised by physiotherapist once a week +			
		home exercise 2 times/week * 8 weeks			
D'Lima 1996	physiotherapist supervised	Intervention A: land based: strengthening,	not reported	no intervention	routine care
	exercise	stretching.			
		Intervention B: land based and pool based:			
		strengthening, stretching, aerobic;			
		once a week * 8weeks			

208ordspedist supervised cerciseoftrumk) 3 times/week * 3Ferrar 208physiotherapist supervised cercise + educationInd based: strengthening, aerobic; supervised to physiotherapist; 5 times/week * 4 weeks + educationno interventionpostop rehabilitation pogrammeGilbey 200physiotherapist supervised exercise + home exerciseInd based: strengthening, aerobic; supervised by times/week * Sweeksoff versessions completerutine in-hospital physical therapyelinic-based physical therapyGoen 2004 cercise + educationphysiotherapist supervised physiotherapist supervised physiotherapist + home exercise : 2 times/week * Sweeksnot reported no interventionpostoperative and educationGoen 2004 cercise + educationphysiotherapist supervised physiotherapist cercise : 2 times/week * Sweeksnot reported not reportedno intervention postoperative and education programme educationGoene 2004 cercise + educationphysiotherapist strengthening, stretching, balanei tercitie tercitienot reported no interventionno intervention tercitie tercitieno intervention tercitie tercitieGoene 2004 cercise + educationphysiotherapist stretching, balanei tercitie tercitieno interventionno intervention tercitie tercitieno interventionGuene 2004 cercise + home exercise tercise + home exercise tercitie tercitieno intervention tercitie tercitie tercitie tercitieno intervention tercitie tercitie tercitie tercitieno intervention tercitie tercitie tercitieGuene 200	Evgeniadis	physiotherapist or	land based: strengthening (mostly upper limb	not reported	no intervention	standard rehabilitation
exercise indexed::::::::::::::::::::::::::::::::::	2008	orthopedist supervised	and trunk), 3 times/week * 3			
Ferrara 2008 physiotherapist supervised exercise + education land based: strengthening, aerobic; supervised by physiotherapist; 5 times/week * 4 weeks + education no intervention postop rehabilitation programme Gilbey 2003 physiotherapist supervised exercise + home exercise toretching, aerobic, supervised by exercise + home exercise times/week *8weeks 97% of sessions routine in-hospital clinic-based Goeen 2004 physiotherapist supervised exercise + education land based: strengthening, stretching, supervised by physiotherapist for 8 weeks; +education no intervention postoperative and education programme education programme education programme Gstoettner physiotherapist supervised exercise + home exercise + education land based: strengthening, stretching, balance; eucrise + bome exercise + education no intervention postoperative and education programme education programme education Gstoettner physiotherapist supervised exercise + home exercise = home exercise = home exercise = home exercise land based: strengthening, stretching, balance; eucrise + ducation no intervention no intervention 011 exercise + home exercise = home exercise = home exercise = home exercise = home exercise = home exercise ind based: strengthening, with written instructions not reported = home exercise = home exercise		exercise				
exercise + educationby physiotherapist; 5 times/week * 4 weeks + educationprogramme programmeGilbey 2003physiotherapist supervised exercise + home exerciseIand based and pool based: strengthening, stretching, aerobic, supervised by physiotherapist + home exercise: 2 times/week *8weeks97% of sessions completeroutine in-hospital physical therapyelinic-based elinic-basedGocen 2004physiotherapist supervised exercise + educationIand based: strengthening, stretching, supervised by physiotherapist for 8 weeks; +educationno interventionpostoperative and education programme education programme educationGoteet termphysiotherapist supervised supervised by physiotherapist for 8 weeks; +educationno interventionno interventionGoteet termphysiotherapist supervised supervised by physiotherapist; once a week *no interventionno interventionGoteet termphysiotherapist supervised supervised by physiotherapist; once a week *interventionno interventionGoteet termintervised by physiotherapist; once a week *interventionno interventionno intervention2011exercise + home exercise istructionsintervised by physiotherapist; once a week *intervise istructionsintervise istructionsintervise istructions	Ferrara 2008	physiotherapist supervised	land based: strengthening, aerobic; supervised	not reported	no intervention	postop rehabilitation
Gilbey 2003 physiotherapist supervised land based and pool based: strengthening, or power is and based and pool based: strengthening, or power is and based and pool based: strengthening, or power is and based and pool based: strengthening, areobic, supervised by physiotherapist - home exercise: 2 times/week *8weeks or power is and based and pool based: strengthening, is and based and pool based: strengthening, stretching, areobic, supervised by physiotherapist - home exercise: 2 times/week *8weeks not reported not intervention postoperative and education programme education programme education Gocen 2004 physiotherapist supervised land based: strengthening, stretching, balance; home exercise + education not reported no intervention postoperative and education programme education programme education Goteet term physiotherapist supervised land based: strengthening, stretching, balance; how exercise no intervention not reported Goteet term physiotherapist supervised land based: strengthening, stretching, balance; how exercise no intervention not reported Goteet term physiotherapist supervised land based: strengthening, stretching, balance; how exercise no intervention not reported goteet term exercise + home exercise supervised by physiotherapist; once a week * no intervention not reported goteet term exercise + dauily home training with written <br< td=""><td></td><td>exercise + education</td><td>by physiotherapist; 5 times/week * 4 weeks +</td><td></td><td></td><td>programme</td></br<>		exercise + education	by physiotherapist; 5 times/week * 4 weeks +			programme
Gilbey 2003 physiotherapist supervised exercise + home exercise land based and pool based: strengthening, stretching, aerobic, supervised by physiotherapist + home exercise: 2 times/week *8weeks 97% of sessions routine in-hospital clinic-based Gocen 2004 physiotherapist supervised exercise + education land based: strengthening, stretching, supervised by physiotherapist for 8 weeks; +education not reported no intervention postoperative and education programme reducation Gstoettner physiotherapist supervised land based: strengthening, stretching, balance; exercise + home exercise not reported no intervention not reported 2011 exercise + home exercise instructions instructions instructions not reported no intervention not reported			education			
exercise+ home exercisestretching, aerobic, supervised by physiotherapist + home exercise: 2 times/week *8weekscompletephysical therapyGocen 2004physiotherapist supervised exercise + educationland based: strengthening, stretching, uphysiotherapist for 8 weeks; +educationnot reportedno interventionpostoperative and education programme education programme is upervised by physiotherapist; once a week *Cocen 2004physiotherapist supervised uphysiotherapist supervisedland based: strengthening, stretching, balance; uphysiotherapist; once a week *no interventionpostoperative and education programme is upervised by physiotherapist; once a week *Coten 2004physiotherapist supervised uphysiotherapist supervisedland based: strengthening, stretching, balance; is upervised by physiotherapist; once a week *no interventionno interventionCoten 2004physiotherapist supervised uphysiotherapist; once a week *interventionno interventionno treported	Gilbey 2003	physiotherapist supervised	land based and pool based: strengthening,	97% of sessions	routine in-hospital	clinic-based
Gocen 2004 physiotherapist supervised land based: strengthening, stretching, not reported no intervention postoperative and education programme reducation Gstoettner physiotherapist supervised land based: strengthening, stretching, balance; not reported no intervention not reported no intervention Gstoettner physiotherapist supervised land based: strengthening, stretching, balance; not reported no intervention no intervention 2011 exercise + home exercise supervised by physiotherapist; once a week * 6 weeks + daily home training with written instructions		exercise+ home exercise	stretching, aerobic, supervised by	complete	physical therapy	
Gocen 2004 physiotherapist supervised exercise + education Iand based: strengthening, stretching, supervised by physiotherapist for 8 weeks; +education no intervention postoperative and education programme Gstoettner physiotherapist supervised Iand based: strengthening, stretching, balance; +education no intervention no intervention 2011 exercise + home exercise + home exercise Iand based: strengthening, stretching, balance; + education no intervention no intervention instructions instructions instructions instructions instructions			physiotherapist + home exercise: 2			
Gocen 2004 physiotherapist supervised land based: strengthening, stretching, not reported no intervention postoperative and education programme gstoettner physiotherapist supervised land based: strengthening, stretching, balance; not reported no intervention no intervention 2011 exercise + home exercise supervised by physiotherapist; once a week * 6 weeks + daily home training with written instructions			times/week *8weeks			
exercise + education supervised by physiotherapist for 8 weeks; +education education programme Gstoettner physiotherapist supervised land based: strengthening, stretching, balance; not reported no intervention not reported 2011 exercise + home exercise supervised by physiotherapist; once a week * 6 weeks +daily home training with written instructions	Gocen 2004	physiotherapist supervised	land based: strengthening, stretching,	not reported	no intervention	postoperative and
Gstoettner physiotherapist supervised land based: strengthening, stretching, balance; not reported no intervention not reported 2011 exercise + home exercise supervised by physiotherapist; once a week * 6 weeks +daily home training with written instructions		exercise + education	supervised by physiotherapist for 8 weeks;			education programme
Gstoettner physiotherapist supervised land based: strengthening, stretching, balance; not reported no intervention not reported 2011 exercise + home exercise supervised by physiotherapist; once a week * 6 weeks +daily home training with written instructions			+education			
2011 exercise + home exercise supervised by physiotherapist; once a week * 6 weeks + daily home training with written instructions	Gstoettner	physiotherapist supervised	land based: strengthening, stretching, balance;	not reported	no intervention	not reported
6 weeks +daily home training with written instructions	2011	exercise + home exercise	supervised by physiotherapist; once a week *			
instructions			6 weeks +daily home training with written			
			instructions			
		F			l den a l	
		n <mark>d s</mark> imilar technologies.	וseignemer superieur (אובה). אירפואנקאנאנאנאטאטאטאטאיאטאיאטאיאטאיאטאיאטאיאטאי	na 9383091\Øribut>nietoloi	Protected by copyr	

Hoogeboom	physiotherapist supervised	land based: strengthening, aerobic, functional;	91% of the sessions	usual care + education	postop usual care
2010	exercise	+ education	completed		protocol
Matassi 2014	physiotherapist supervised	land based: increasing lower extremity	79.4% completed	regular activities	same physiotherapy
	exercise + home exercise	muscle strengthening supervised by			routines
		physiotherapist; once a week* 1 week+ home			
		exercise 5 times/week * 6weeks+ written			
		instructions			
McKay 2012	kinesiologist supervised	land based: aerobic, strengthening, supervised	98% of the sessions	placebo (upper body	standard postop care
	exercise	by kinesiologist; 3 times/week * 6 weeks	completed	exercises)	
Mitchell 2005	physiotherapist supervised	land based: pain relief, increase knee flexion	73.6% sessions	preoperative	usual hospital
	exercise + home exercise	and extension, gait re-education ,supervised	completed	consultation	physiotherapy (post-
		by physiotherapist; 3 times/week * 8 weeks +			discharge only)
		home exercise 4 times/week * 8 weeks			
Oosting 2012	physiotherapist supervised	land based: "functional tasks exercise",	99% of the sessions	usual care (30min	not reported
	exercise +home exercise	supervised by physiotherapist; 2 times/week	completed	supervised class)	
		+ home exercise 4 times/week * 3 to 6 weeks			

Rooks 2006	physiotherapist supervised	land based and pool based: strengthening,	89% of sessions	education via leaflet	not reported
	exercise +education	stretching, aerobic, supervised by	completed	and telephone + 30-	
		physiotherapist; 3 times/week * 6 weeks;		60min supervised	
		+education on home modifications		class	
Торр 2009	physiotherapist supervised	land based: resistance training, flexibility,	13 sessions	no intervention	postop rehabilitation
	exercise + home exercise	step training, supervised by physiotherapist,	completed (range 4		
		once a week + home exercise 2 times /week	to 23)		
Tungtrongjit	home exercise	land based: home quadriceps strengthening	Not reported	no intervention	postop rehabilitation
2012		exercise for 3 weeks			
Villadsen	physiotherapist supervised	land based: standard preoperative educational	74% attended the	standard preoperative	postop rehabilitation
2014	exercise	package + NEMEX programme; supervised	pre-specified goal of	educational package	
		by physiotherapist; 2 times/week * 8 weeks	12 or more exercise		
Vukomanovic 2008	physiotherapist supervised exercise +education	land based: physical therapy +education	not reported	no intervention	postop rehabilitation
Wang 2002	physiotherapist supervised	land based and pool based: strengthening,	97% of sessions	routine perioperative	postop rehabilitation
	exercise + home exercise	stretching, aerobic, supervised by	complete	care	
		physiotherapist+ home exercise; 2 times/week			

48 I ab aupindergoildia analoge at Agence Bibliographic and the indication of the in

		* 8 weeks			
Weidenhielm	physiotherapist supervised	land based: strengthening, stretching, aerobic, n	not reported	no intervention	not reported
1993	exercise + home exercise	supervised by physiotherapist, 3 times/week			
		* 5 weeks; + home exercise daily			
Williamson	physiotherapist supervised	and based: strengthening, stretching, balance, n	not reported	education and leaflet	not reported
2007	exercise + home exercise	supervised by physiotherapist; 1 times/week *		+1 hour supervised	
		6 weeks + home exercise		class + home exercise	
idergonala eone	אס איז	reading (المراجع ا Bisergeneration (Alterione (Alterione) Bisergeneration (Alterione)	aə - 2 no 78800-610 papt aniqueri ti	Protected by copy	

Supplementary Table 2 Description of RCTs of Prehabilitation versus No Prehabilitation for TKR/THR

7 <u>.</u> 3	Study	No. of	Type of	Comparison	Rehabilitation	Results				
9 10	Name	patients	surgery			Pain	Function improvement	Quality of Life	Resource use	others
11 - 12	Beaupre	131	TKR	PT supervised	Standard postop	WOMAC pain: NS	Knee ROM: NS;	SF-36: NS in each	Acute care LOS,	Postoperative
3	2004			exercise +	mobilization	SF-36 bodily pain:	Quadriceps strength: NS;	domains, PCS, and	transfer LOS,	complications:e.
14 15				postop education	routine	NS	Hamstring Strength: NS	MCS from 3mo. to 1 yr	readmission LOS,	g.
6 7				vs. usual care		from 3mo. to 1 year	WOMAC stiffness and	postoperatively	and total LOS: NS	pulmonary
8 9						postoperatively	function: NS;		(total LOS: -1.5 d)	emboli (n=2),
0							SF-36 physical functioning: NS			deep vein
1 2							from 3mo. to 1 year		Institutional costs,	thrombosis
3 4							postoperatively		homecare costs,	(n=9), infection
25									readmission costs,	(n=5),
27									total costs: NS	postoperative
28 29									(total cost: + \$33);	Angina:
80 81										NS
2 3	Bitterli	80	THR	Preoperative	Postop.	SF-36 pain: : NS after	SF-36 physical function: NS	SF-36: NS in each	LOS: NS (14.6 vs.	-
4	2011			sensorimotor	Standard	surgery (4mo.,1year)	after surgery (4mo,1 year)	domains after surgery	14.6 d)	
6				training at home	therapy protocol		WOMAC: NS after surgery	(4mo.,1year)		
7 8				(daily exercises	in hospital		(4mo, 1year)			
9 .0				at home) vs. no						
1 -										
3										
4 5										
·6 7				r technologies.	IJŢŢĨ <mark>is b</mark> us QŢĬIJĬs	erieur (S38A) . Buldi epitan (pita) . Buldi epitan (pita)	urs fremengisera Balangi perestisi ang tertikan ing	ອງເມື່ອຢູ່ເອີຍໃຊ້ເຊິ່ງເຊື້ອເກີຍ	Prote	
8	l əb əupid	3ibliograpl	a 90090A	ւ Ղոոе 12, 2025 at	o \moɔ.įmd.nəqo	eded from http://bmj	on 2 February 2016. Downlo	28900-2102-n9qoįmd\98	CIT.OI 26 b9Asilduo	MJ Oben: first p

Page 55 of 81

BMJ Open

Rom 32 TKR Prop. exercise SP-36 pair. NS at SP-shysical function serces SP-362 în in NS at SP				therapy	Usual care					
 roval 32 TKR Prop. exercise isclarg interventions TKR Prop. exercise isclarg interventions TKR Prop. exercise isclarg <					therapeutic					
Mown 32 TKR Preop. exercise SF-36 pain : NS at SF-physical function score: SF-36 în physical					modalities after					
32 TKR Preop. exercise SF-36 pain : NS at SF-physical function score: SF-36 î în physical - - 012 intervention vs. Jmo. alter surgery f(MD+27.1) function score - - - 012 no - (MD+27.1) NS in other domains -					discharge					
1111 32 TKR Preop.exercise - SP-30 paint : Ns at SP-30 paint : Ns at </td <td>)</td> <td>22</td> <td>ТИР</td> <td>Droop oversion</td> <td></td> <td>SE 26 noin : NS of</td> <td>SE physical function scores</td> <td></td> <td></td> <td></td>)	22	ТИР	Droop oversion		SE 26 noin : NS of	SE physical function scores			
012 intervention vs. 3mo. after surgery T(MD+27.1) function score no prehabilitation prehabilitation NS in other domains NS in other domains 97Lima 30 TKR Proop physical - Hospital for Special Hospital for Special Surgery Quality of Well Being LOS: NS - 996 V therapy vs. Surgery Knee Knee Rating function (0- scores (0-1): - - 996 eardiovascular Rating pain(0-30):NS 52):NS from 3wk to lyr Percentage - - 996 eardiovascular rom 3wk lyr improvement - NS - <	SIOWII	32	IKK	Preop. exercise	Ö	Sr-30 pain . NS at	Sr-physical function score.	SF-36: in physical	-	-
no MD+27.1) prehabilitation NS in other domains 996 TKR Proop physical - 100 therapy vs. Surgery Knee Knee Rating function (0.0 scores (0-1): - 996 FKR Proop physical - Main pain(0-30):NS 52):NS from 3wk to 1yr Percentage - 996 FKR Froop physical - Rating pain(0-30):NS 52):NS from 3wk to 1yr Percentage - - 996 FKR Froop physical - Froop month -	2012			intervention vs.		3mo. after surgery	↑(MD+27.1)	function score		
Prehabilitation NS in other domains P1.ima 30 TKR Preop physical - Hospital for Special Hospital for Special Surgery Quality of Well Being LOS: NS - 996 therapy vs. therapy vs. Surgery Knee Knee Rating function (0- scores (0-1): - - 996 therapy vs. Rating pain(0-30):NS 52):NS from 3wk to 1yr Percentage - - 996 onditioning rom 3wk 1yr improvement - NS - <td< td=""><td></td><td></td><td></td><td>no</td><td></td><td></td><td></td><td>(MD+27.1)</td><td></td><td></td></td<>				no				(MD+27.1)		
211ma 30 TKR Preop physical - Hospital for Special Mospital for Special Surgery Quality of Well Being LOS: NS - 996 therapy vs. Gardiovascular Rating pain(0-30):NS 52):NS from 3wk to 1yr Percentage - - 996 conditioning from 3wk 1yr Grom 3wk 1yr improvement - NS - - - 997 exercise vs. no conditioning Form 3wk 1yr Arthritis impact - - - 998 exercise vs. no conditioning Form 3wk 1yr Arthritis impact - - - 999 intervention resercise vs. no Conditioning Form 3wk 1yr neasurement scale -<				prehabilitation				NS in other domains		
996 herapy vs. Surgery Knee Rating function (0. scores (0.1): ardiovascular Rating pain (0-30): S 52): NS from 3wk to 1yr Percentage conditioning from 3wk 1yr Arthritis impact Program with exercise vs. no Control Program with intervention Program with Surgery Knee Program with Program with From State Stat	D'Lima	30	TKR	Preop physical	-	Hospital for Special	Hospital for Special Surgery	Quality of Well Being	LOS: NS	-
cardiovascular Rating pain(0-30):NS 52):NS from 3wk to 1yr Percentage conditioning from 3wk 1yr improvement - NS program with exercise vs. no Arthritis impact intervention scores (0-10): Precentage - stypeniad TKR Preop.exercise - typeniad TKR Preop.exercise - vs. no - 6,10,14wks) pervisus to surgery intervention - 6,10,14wks) pervisus to surgery	1996			therapy vs.		Surgery Knee	Knee Rating function (0-	scores (0-1):		
conditioning from 3wk 1yr improvement - NS program with exercise vs. no Arthritis impact intervention measurement scale scores (0-10): Percentage improvement NS Percentage intervention improvement NS - Evgeniad TKR Proop.exercise - x 2008 48 vs. no 6, 10, 14wks) pervious to surgery intervention intervention - -				cardiovascular		Rating pain(0-30):NS	52):NS from 3wk to 1yr	Percentage		
program with exercise vs. no Arthritis impact intervention measurement scale scores (0-10): Percentage improvement NS improvement NS Svgeniad TKR Preop.exercise - 8 2008 48 vs. no 6,10,14wks) pervious to surgery intervention intervention finance -				conditioning		from 3wk 1yr		improvement - NS		
exercise vs. no intervention intervention intervention TKR Preop.exercise vs. no intervention TKR Preop.exercise ILAS score: NS after surgery(2, SF-36: NS at 1 day 6,10,14wks) intervention Kuenolise				program with						
intervention Reasurement scale scores (0-10): Percentage improvement NS TKR Preop.exercise NILAS score: NS after surgery(2) SF-36: NS at 1 day s 2008 48 vs. no intervention Vs. no 6, 10, 14wks) pervious to surgery (preop)				exercise vs. no				Arthritis impact		
Evgeniad TKR Preop.exercise - ILAS score: NS after surgery(2, SF-36: NS at 1 day s 2008 48 vs. no 6, 10, 14wks) pervious to surgery - intervention Active ROM:NS after surgery (preop) (preop)				intervention				measurement scale		
Evgeniad TKR Preop.exercise - ILAS score: NS after surgery(2) SF-36: NS at 1 day s 2008 48 vs. no 6, 10, 14wks) pervious to surgery intervention Active ROM:NS after surgery (preop)								scores (0-10):		
Evgeniad TKR Preop.exercise - ILAS score: NS after surgery(2, SF-36: NS at 1 day - s 2008 48 vs. no 6, 10, 14wks) pervious to surgery intervention Active ROM:NS after surgery (preop)								Percentage		
Evgeniad TKR Preop.exercise - ILAS score: NS after surgery(2, SF-36: NS at 1 day - - s 2008 48 vs. no 6, 10, 14wks) pervious to surgery - - intervention Active ROM:NS after surgery (preop) - -								improvement NS		
s 2008 48 vs. no 6, 10, 14wks) pervious to surgery intervention Active ROM:NS after surgery (preop)	Evgeniad		TKR	Preop.exercise	-	-	ILAS score: NS after surgery(2.	SF-36: NS at 1 day	-	-
intervention Active ROM:NS after surgery (preop)	s 2008	48		vs no			6 10 14wks)	pervious to surgery		
Active Kolv. NS alter surgery (prop)	13 2000	10		intervention			Active POM:NS after surgery	(preop)		
				intervention			Active ROM. NS after surgery	(preop)		
				ເຮຍເດີດເດເມເວລາ 🖡	Of Dealth Chicane	anly chittp://bmiape	n kan i com/site/about/suick	มีเมต _{ิอเ} สิปส์สปา (a กาะก	2014	

						(2, 10, 14wks)			
Ferrara	23	THR	Educational and	Postop. 4weeks	VAS: \downarrow at 1, 3 mo.	ROM external rotation: 1	SF-36 PCS: ↑at 1 mo,	-	-
2008			PT supervised	standard	(MD -1.8, -0.97)	15days, 1 and 3 mo. after	but NS at 3 mo		
			physiotherapy	exercise		surgery	(MD +7.1 at 1 mo)		
			program vs. no	protocol	WOMAC pain: NS at	(MD +7.69, +0.14)			
			intervention		3 mo.		SF-36 MCS: NS		
						Harris Hip Score: NS at 1 and			
						3mo			
						Barthel Index: NS at 1 and 3mo			
						WOMAC stiffness and			
						function: NS at 3mo			
Gilbey	76	THR	8wks customized	Postop. Exercise	WOMAC pain: NS	Mean ROM at 3, 12, 24wks:↑		-	-
2003			exercise	program (until		(MD+6,+11,+12)			
			program vs. no	12wks after		Hip strength mean Z score			
			exercise	surgery) VS		after surgery (12, 24wks): 1			
				routine in-		(MD+0.35, +0.6)			
				hospital PT		WOMAC total score after			
						surgery (3,12,24wks):^(MD+8,			
						+9, +9)			
						WOMAC stiffness: NS,			
						3,12,24wks			
			ar technologies.	limiseona aqiinia	aufa.epitim/frishibbe	hyperse esserie) area in the second second	ទាល់ទស់ស្រុកស្រុកស្រុកស្រុកសំរុកសំរុកសំរុកសំរុកសំរុកសំរុកសំរុកសំ	Prote	
l əb əupir	bliograpł	ia əonəpA	յե 2025 ,21 ənuէ ո	o /moɔ.įmd.nəqo	o <mark>ded from http://bmjo</mark> erieur (ABES) .	olowod .ðto2 February ک016. Downlo quS fnemengiesn∃	28600-2102-nəqoįmd\ð	Ett.Ot as bedzil) Open: first pub

BMJ Open

						WOMAC function: 1, 12,	
						24wks	
Gocen	60	THR	Physiotherapy	Routine postop.	VAS at rest at	Hip adduction at discharge: NS -	LOS: NS -
2004			and educational	Exercise and	discharge: NS (MD-	(MD-0.1)	
			program vs. no	educational	0.12)		
			exercise or	program	VAS at activity at	Harris Hip Score: NS at 3mo, 2	
			education		discharge: NS (MD-	years after surgery	
					0.06)	(MD+0.9,+4)	
Gstoettn	38	TKR	PT supervised	-	WOMAC pain: NS;	KSS: NS; -	
er 2011			exercise vs. no		6wk postoperatively	KSS function: NS;	
			exercise			WOMAC stiffness: NS;	
						WOMAC function: NS;	
						Gait speed (60m):NS;	
						Gait speed (stairs up):NS;	
						Gait speed (stairs down): NS;	
						Knee stability (OSI): NS;	
						Knee stability (MLSI) : NS;	
						6wk postoperatively	
						Knee stability (APSI) : \downarrow (MD	
						-0.6) 6wkpostoperatively	
			r technologies.	i ini s bus chinne	anh epitan (the bar	ອນຊອກວ່າອອກອຸໂອເຊສອອກອາປະເພາະປະການເອົາການ	Protected by e

Page 58 of 81

BMJ Open

loogebo	21	THR	Therapeutic	Postop. usual	HOOS pain: NS	Functional recovery: NS	Patient-specific	LOS: NS	2 postoperative
om 2010			exercise program	care protocol	VAS: NS	HOOS (in all domains): NS	complaints (PSK): NS	6 vs. 6 days	complications i
			vs. usual care	till discharge	At baseline and preop,	LASA physical activity	At baseline and preop		exercise group:
						questionnaire (all domains): NS			femur fracture
						At baseline and preop			and intestinal
									obstruction.
									no serious AE
Matassi	122	TKR	Preoperative	Same postop.	-	Mean time to reach 90° of	-	LOS:↓	-
2014			home exercise	physiotherapy		knee ROM: \downarrow (MD -1.1 day)		(MD -0.8 day)	
			program vs.	routine		Active knee flexion: NS at			
			regular activities			6wks. 6mo, 1yr			
						Passive knee flexion: NS at			
						6wks. 6mo, 1yr			
						Knee score or patient function			
						score (Knee Society Clinical			
						Rating System): NS at 6wks, 6			
						mos. 1 yrs.			
ЛсКау	22	TKR	Lower-body	Standard	WOMAC pain: NS,	SF-36 PSC: NS	SF-36 (PCS, MCS):	-	-
2012			strength training	postop. care	MD+0.7, +0.9 at 6	Quadriceps strength: NS	NS after surgery		
			program vs.		and 12wks.	50-foot walk: NS			
			nonspecific			Stair test: NS			
			upper-body			Arthritis self-efficacy			

BMJ Open

			strength training			(including pain, physical			
			program			function, and other symptoms):			
			(placebo)			NS			
Mitchell	160	TKR	PT supervised	Postop home	WOMAC pain: NS	WOMAC physical function:	SF-36: NS in each	LOS: NS (MD -	45 withdray
2005			pre- & postop	exercise or	SF-36 bodily pain:	NS;	domains	0.4d)	patients ha
			home exercise	hospital PT	NS	WOMAC stiffness: NS;	SF-6D: NS		significant
			(home PT) vs.		at 12wk	SF-36 physical function: NS	Patient satisfaction	Cost of PT:	poor score
			no pre-op			at 12wk	with PT: NS (86% in	NS(MD + £1.4)	the SF-36
			exercise + usual				both groups)		general he
			hospital PT				at 12wk	Total cost:	energy, an
			postop					NS(MD + £4.7)	more repor
									heart prob
									and stroke.
Oosting	30	THA	PT supervised	-	HOOS pain: NS	TUG: NS;	HOOS hip-related	LOS: NS (MD -	No severe
012			exercise vs.		VAS: NS	CRT: ↓ (MD -9.2s);	quality of life: NS	0.3d)	adverse ev
			usual care		6wk changes from	6MWT: NS;			
					baseline.	PSC: NS;	Patient Specific	Nursing home	Complicat
						HOOS other symptoms,	Complaints (PSC)	after discharge:	e.g. Woun
						function in daily living,	questionnaire score:	NS	delirium.
						function in sport and recreation:	NS		of sensatio
						NS;			decubitus
						LAPAQ: NS;			uccubitus
									ulcers, and

					6wk post-discharge changes	bowel
					from baseline	obstruction) 1
Rooks 108	3 THA+	PT supervised	-	For THR:	For both THR and TKR:	-
2006	TKA	exercise+educati		WOMAC pain: NS	WOMAC function: NS;	
		on vs. education		SF-36 pain: NS	SF-36 physical function: NS	
				8wk and 26wk	SF-36 role limitation physical:	
				postoperatively	NS;	
					1-repetition maximum: NS;	
				For TKR:	Timed up and go: NS;	
				WOMAC pain: NS	8wk and 26wk postoperatively	
				8wk and 26wk	Functional reach: NS;	
				postoperatively	8wk and 26wkpostoperatively	
				SF-36 pain: NS		
				8wk postoperatively		
				SF-36 pain:		
				↑(MD+11.5) 26wk		
				changes from baseline		
Горр 54	TKA	PT supervised	Postoperative	Pain in Sit-to-stand,	Sit-to-stand: NS?	-
2009		exercise vs.	rehabilitation	6MWT, Ascent and	6MWT: NS?	
		usual care		descent stairs: NS?	Ascent and descent stairs: NS?	
				at 1, 3mo.	Maximum extension strength of	
Page 61 of 81

1

10

			postoperatively	the surgical knee, nonsurgical
			No between-group	knee: ?
			comparison	Maximum extension strength of
				the surgical knee:?
				at 1, 3mo. postoperatively
				No between-group comparison
n 60	TKA	Quadriceps -	Modified WOMAC	Total Modified WOMAC
		exercise vs.	pain score: ↓ (MD -	score: ↓ (MD -26.7)
		usual care	6.3)	Modified WOMAC stiffness
			VAS:↓(MD -0.9)	score: \downarrow (MD -2.5)
			at 1 mo	Modified WOMAC function
			postoperatively	score: ↓ (MD -17.7)
				Quadriceps strength:
			Modified WOMAC	↑(MD+1.5)
			pain score: \downarrow (MD -	at 1 mo postoperatively
			5.2)	
			VAS: ↓ (MD -1)	Total Modified WOMAC
			at 3 mo	seere: (MD 17.7)
			nostoperatively	
			postoperativery	Modified WOMAC stiffness
			Modified WOMAC	score: \downarrow (MD -2)
			Modified WOMAC	Modified WOMAC function
		ເຂຍເບັດເດັກເວລາ ເຂົ້າເປັນຜູ	eoridenioneonty chitto://benione	nyami gam/site/about/suide/inesish/mba (a parana)
		seinelenden telimis	erieur (S38A) . Bae mainiert IA nainina etek bae	du2 inomongiesn3 • • • • • • • • • • • • • • • • • • •
	. 60	- 60 TKA	α 60 ΤΚΑ Quadriceps exercise vs. usual care	postoperatively No between-group comparison 60 TKA Quadriceps - Modified WOMAC exercise vs. usual care 6.3 VAS: ↓ (MD - 0.9) at 1 mo postoperatively Modified WOMAC pain score: ↓ (MD - 5.2) VAS: ↓ (MD -1) at 3 mo postoperatively Modified WOMAC

1		
2		
3	pain score: \downarrow (MD ·	score: \downarrow (MD -10.3)
4 5		
6	2.3)	Quadriceps strength:
7	VAS: NS	(MD+2, 2)
8		
9	at 6 mo	at 3 mo postoperatively
10	postoperatively	
12		
13		Total Modified WOMAC
14		score: NS
15		50010. 145
16		Modified WOMAC stiffness
17		score: NS
19		SCOLE. INS
20		Modified WOMAC function
21		reare: NS
22		score. NS
23		Quadriceps strength: NS
24 25		at 6 ma postaporativaly
26		at 6 mo postoperativery
27		
28		Kree Elevier NC
29		Knee Flexion: NS
30		Knee Extension: NS
31 32		Total Imag DOM: NS
33		Total knee ROM: NS
34		at 1, 3, 6 mo postoperatively
35		
36		
37		
39		
40		
41		
42		
43		
44 15		
40 46	For poor region only other //bmic	nen bmi com/site/about/suidolings.shtml.
47	ut (אשבט) . אמומנא אומיטיאן או גאפומימה מחלביומיואר לפכhnologies.	ב normania series by convrights including to the series of the series o
48	ed from http://mjopen.md/.com/ on June 12, 2025 at Agence Bibliographique de I	Den Open: first published as 10.136/bmjopen-2015-009857 on 2 February 2016. Download

10

BMJ Open

Villadse	165	TH A+	PT supervised	Postonerative	For THR+TKR.	For both THR+TKR or For	For both THR+TKR or -	One patient wit
villause	105	IIIA	1 I supervised	Tostoperative	FOI IIIK TKK.			One patient wi
n 2014		TKA	exercise +	rehabilitation	KOOS/HOOS Pain: \downarrow	TKR:	For TKR:	hip OA
			education vs.		(MD -5.4)	KOOS/HOOS ADL: ↑ at	EQ5D VAS: \downarrow (MD -	discontinued th
			education			6wkpostop, but NS at 3mo	7.6) at 6wk postop, but	exercise due to
					For THR:	postop	NS at 3mo postop	an increase in
					KOOS/HOOS Pain:		For THR:	pain.
					NS changes at 6wk	For THR:	EQ5D VAS: NS	
					and 3mo postop from	KOOS/HOOS ADL: NS at 6wk	At 6wk and 3mo	2 patients from
					base line	and 3mo postop	postop	the control
								group develope
					For TKR:	For THR+TKR or THR or	For TKR:	deep
					KOOS/HOOS Pain: \downarrow	TKR:	EQ5D VAS: \downarrow (MD -	periprosthetic
					(MD -8)	KOOS/HOOS symptoms: NS	8.8) changes at 6wk	infection.
						KOOS/HOOS sport and	postop from baseline,	
						recreation: NS	but NS changes at 3mo	
						At 6wk or 3 mo postop changes	postop from baseline	
						from baseline.		
						Single-joint hip extension and	For THR+TKR or THR	
						hip abduction: \uparrow (~15% and	or TKR:	
						35% improvement)	EO5D index: NS	
						. ,	202	
			ເຂຍແກດເດຍເອກ	ຼ Entursonie Giana	only chittp://bmione	n ani can/site/spout/suick	ອາຍຸດອາຍຸດ ມາ ເປັນເປັນເປັນເປັນເປັນເປັນເປັນເປັນເປັນເປັນ	

48 I sh shinging single single

1

2										
3 4							Chair stand: NS	KOOS/HOOS QOL:		
5							20-m walk: NS	NS		
5 7							Knee bends: NS	At 6wk or 3 mo postop		
8 9							Contra: NS	changes from baseline.		
10							at 3mo			
12	Vukoma	45	THA	PT supervised	Postoperative	Pain at rest (VAS):	First day of activities – use of	-	LOS: NS (- MD	Five patients
13 14	novic 08			exercise	rehabilitation	NS	toilet↓ (MD -0.9d) use of		+0.4d)	were excluded
15 16	10,10,00			+education vs		Pain on movement				nostoperatively
17				no interventions		(VAS): NS	chair \downarrow (MD -1.05d), and		Close with the	because of
18 19				no interventions		(VAS). NS	walking up and down stairs: \downarrow		Class with the	because of
20 21						at discharge postop	(MD -1.67d)		therapist: \downarrow (MD-	complications
22									1.65)	during and post
23 24							Changing position in bed:			operation.
25 26							↑(MD +0.95)			
27							Changing position on the adge:			
28 29							Changing position on the edge.			
30							T(MD +0.9)			
32							From sitting to standing: ↑ (MD			
33 34							+1.05)			
35							Standing: \uparrow (MD +1.1)			
36 37							Changing position to lying:			
38 39							↑(MD +1 15)			
40							(IIID 11.13)			
41 42							Walking: $T(MD+1.15)$			
43 44										
45										
46 47				ar technologies.	ilimisoona aquimie	eneur (8885), winne eueiter/pable	hyding teensonan an	eted by copyrightaine	Prote	
48	l əb əupir	ibliograph	Agence B	16 June 12, 2025 at	no \moɔ.[md.nəqo	olmd//:diji moji bebeo	on 2 February 2016. Downlo	98600-2102-n9qoįmd\8	Ctt.0t ss bedeildu	BMJ Open: first p

BMJ Open

	Use of toilet: \uparrow (MD +1.9)
	Use of Chair: ↑(MD +1.9)
	Walking up and down stairs:
	\uparrow (MD +1.8)
	Endurance while walking:
	(MD + 1)
	at the 3rd day postoperatively
	Changing position in bed:
	↑(MD +0.4)
	Changing position on the edge:
	↑(MD +0.45)
	From sitting to standing: \uparrow (MD)
	Tom owing to ownang. (the
	+0.45)
	Standing: 1 (MD +0.45)
	Changing position to lying
	(MD +0.45)
	Walking: ↑(MD +0.5)
	Use of toilet: $^{(MD+1)}$
	Use of torict. $+(IVID \pm I)$
	Use of Chair: 1 (MD +1.25)
	Walking up and down stairs:

48 18MJ Open: first published as 10.1136/bmjopen-2015-009857 on 2 February 2016. Downloaded from http://bmjopen.bmj.com/ on June 12, 2025 at Agence Bibliographique de I
78 Enseignement Superieur (ABES) .
79 Protected by cppytightainedignering for use to the final data protection of the straining for the strain of the straining for the straining for use to the straining of the straining of

2								
3 4							↑(MD +1.85)	
5 6							Endurance while walking:	
7							↑(MD +1)	
8 9							at the discharge	
10								
12								
13 14							Flexion of the hip flexed knee:	
15							NS	
16 17							Flexion of the hip extended	
18							knee: NS	
19 20							Abduction:: NS	
21 22							Harris hip score: NS	
23 24							JOA hip score: NS	
25							At discharge postoperatively	
26 27								
28							Oxford Hip Score: NS	
30							At 15 mo postoperatively	
31 32	Wang	28	THA	PT supervised	Postoperative	-	Cadence (steps/min): ↑(MD	Complications:
33 34	2002			pre- & post-	exercise or		+18)	NS
35 36				operative	usual care		Stride length: \uparrow (MD +0.06m)	no wound
37 38				exercise vs. PT			Gait velocity: ↑(MD +0.28)	infections,
39 40				supervised pre-			At 3 wk postoperatively	joint
41 42				& post-operative				
43								
44 45								
46				ar technologies.	unisoona andrad	aleidaey/esebiene	rotected by copyrighteninghingting and estimated in the second second second second second second second second	d
47 48	l əb əupir	bliograph	ia əənəpA	16 202, 21 9nuL r	ıo \moɔ.įmd.nəqoji	aded from http://bm erieur (ABES)	nowol ، ا¢013,00357 on ک February که ۵۰۱6. Downlo uv 3 کاله الم ۲۹۵۹ کاله کاله کاله کاله کاله کاله کاله کاله	01 ss bədzilduq tərif :nəqO LMB

1 2							
3 4				usual care			dislocations,
5 6						Cadence (steps/min): ^(MD)	complications
7 8						+9)	requiring
9 10						Stride length: NS	return to the
11						Gait velocity: 1 (MD +0.2)	operating
12						At 12 wk postoperatively	room,
14 15							or major
16 17						Cadence (steps/min): 1 (MD	medical
18 19						+10)	complications
20						Stride length: NS	complications
22						Gait velocity: ↑(MD +0.21)	
23 24						At 24 wk postoperatively	
25 26							
27 28						6MWT: NS	
29 30						At 12 wk postoperatively	
31							
33						6MWT: ↑(MD +64m)	
34 35						At 24 wk postoperatively	
36 37	Weidenh	39	ТКР	PT supervised -	VRS (no, mild,	Passive ROM: NS -	-
38 39	ielm			exercise vs. no	moderate, and severe	No. patients grading the knee as	
40 41	1993			exercise	pain): NS	stable or unstable: NS	
42 42							
43							
45 46				.ceipolondoot <u>າຣີ່ມີຫຼາຍລູດເຊື້ອ</u> ທູລູ ຜູກູ່ມ	ស់គមរៀង , ខេព្តព្រះភុ(ផ្ទាន)ទំនាន	Protected by copyrights including the legestic bated to the test of	
47 48	l əb əupid	ibliograp	A gence B	n.b 2202, 21 ənuL no \moo.imd.n	aded from http://bmjope erieur (ABES)	olowod .8105 Peruary 200-2102-n9ojmd/3611.01 Dugu Sinement Enseignement Super	ss bədailduq first published as
10							

Will on 2	liams 2007	120 TKR	PT supervised - exercise vs. education leaflet	Pain at walk: NS At 3mo. VAS: NS (MD -0.09 at 3mo postop)	Isokinetic quadriceps strength (at 30 and 90 degree): NS Walking speed (self-selected and maximal): NS at 3 mo postoperatively OKS: NS (MD +1.61) 50-m walk: NS (MD +2.51s)	HAD score anxiety: NS	HLOS: NS (MD -	
Will on 2	liams 2007	120 TKR	PT supervised - exercise vs. education leaflet	At 3mo. VAS: NS (MD -0.09 at 3mo postop)	(at 30 and 90 degree): NS Walking speed (self-selected and maximal): NS at 3 mo postoperatively OKS: NS (MD +1.61) 50-m walk: NS (MD +2.51s)	HAD score anxiety: NS	HLOS: NS (MD -	
Will on 2	liams 2007	120 TKR	PT supervised - exercise vs. education leaflet	VAS: NS (MD -0.09 at 3mo postop)	Walking speed (self-selected and maximal): NS at 3 mo postoperatively OKS: NS (MD +1.61) 50-m walk: NS (MD +2.51s)	HAD score anxiety: NS	HLOS: NS (MD -	
Will on 2	liams 2007	120 TKR	PT supervised - exercise vs. education leaflet	VAS: NS (MD -0.09 at 3mo postop)	and maximal): NS at 3 mo postoperatively OKS: NS (MD +1.61) 50-m walk: NS (MD +2.51s)	HAD score anxiety: NS	HLOS: NS (MD -	
Will on 2	liams 2007	120 TKR	PT supervised - exercise vs. education leaflet	VAS: NS (MD -0.09 at 3mo postop)	at 3 mo postoperatively OKS: NS (MD +1.61) 50-m walk: NS (MD +2.51s)	HAD score anxiety: NS	HLOS: NS (MD -	
Will on 2	liams 2007	120 TKR	PT supervised - exercise vs. education leaflet	VAS: NS (MD -0.09 at 3mo postop)	OKS: NS (MD +1.61) 50-m walk: NS (MD +2.51s)	HAD score anxiety: NS	HLOS: NS (MD -	
on 2	2007		exercise vs. education leaflet	at 3mo postop)	50-m walk: NS (MD +2.51s)			No adverse
			education leaflet			(MD +1.84)	1.27d)	responses
					WOMAC: NS (MD+1.33) at	HAD score depression:	Cost of PT: £9 per	
					3mo postop	NS (MD -0.25)	patient	
		LASA: Longitu : medio-lateral s index; PCS: phy	udinal Aging Study Amsterdam stability index; NS: not signific ysical component summary; po	n; LOS: length of st ant; OA: Osteoarth stop: postoperative;	ay; MCS: mental componentitis; OKS: Oxford Knee S ; preop: preoperative; PT: ;	ent summary; MD: m Score questionnaire; (physical therapist; R(ean difference; l DSI: overall stab DM: range of mo	MLSI ility otion;
		THR: total hip r	replacement; TKP: total knee re	eplacement; TUG: 7	Timed Up & Go; VAS: vis	sual analogue scale; V	/RS: verbal ratin	ıg
		scale; WOMAC	2: Western Ontario and McMas	ter Universities Art	thritis Inde			
				Anto 600000/0000000000000000000000000000000	enxarrii gane(aits/shqut/suuid	screa py copyrights	91014	
l əb e			· · · · · · · · · · · · · · · · · · ·	aded from http://bmjo erieur (ABES)	Von z rebruary zono. Downod von solo solo solo solo solo solo solo so	cseuu-cruz-naqo(ma/ac		

1	
2	
3	
4	
5	
6	
7	
1	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	
21	
22	
23	
24	
25	
26	
27	
28	
29	
30	
31	
32	
33	
24	
25	
30 20	
30	
31	
38	
39	
40	
41	
42	
43	
44	
45	
46	Protected by copyrights undergraphing the best is based in the destanding in the stating and simple rechnologies.
47	Enseignement Superieur (ABES)
48	I ab aupidgraphiad as 2015.00% at Agence Bibliographic Downloaded from http://bmjopen.bmj.com/ on June 12, 2025 at Agence Bibliographique de I
10	

Outcomes	Sub-	No. of	No. of	Hetero-	I ²	WMD (95%CI)	interaction
	group	studies	patients	geneity test	(%)		p value
				p value			
Pain at 4 weeks or	TKR	2	114	0.04	75	-8.6 (-15.0 to -2.3)	0.26
less	THR	2	99	0.93	0	-0.9 (-7.5 to +5.8)	
Pain at 6 to 8	TKR	4	164	0.04	64	-2.7 (-11.7 to +6.3)	0.88
weeks	THR	3	159	0.92	0	-1.3 (-6.5 to +4.0)	
Pain at 12 weeks	TKR	9	534	0.02	55	-3.2 (-7.1 to +0.7)	0.24
	THR	2	107	0.86	0	-3.0 (-9.8 to +3.9)	
Pain at 24 weeks	TKR	3	198	0.54	0	-4.1 (-7.1 to -1.0)	0.47
	THR	1	59	NA	NA	+0.5 (-3.6 to +4.6)	
Function at 4	TKR	3	90	0.004	82	+0.7 (-12.1 to +13.5)	0.47
weeks or less	THR	3	167	0.009	79	-0.5 (-9.1 to -1.4)	
Function at 6 to 8	TKR	4	164	0.004	64	-6.3 (-13.9 to +1.3)	0.34
weeks	THR	3	157	0.119	45	-1.7 (-6.9 to +3.5)	

BMJ Open: first published as 10.1136/bmjopen-2015-009857 on 2 February 2016. Downloaded from http://bmjopen.bmj.com/ on June 12, 2025 at Agence Bibliographique de I
Protected by cppytight-ing-tenents 2006 independents (Alberting, Alberting, Albertin

BMJ Open

Function at 12	TKR	9	470	0.04	51	-2.4 (-7.0 to +2.2)	0.14
weeks	THR	5	301	0.16	39	-7.2 (-10.7 to -3.8)	
Function at 24	TKR	5	228	0.12	45	-4.1 (-7.1 to -1.2)	0.22
weeks	THR	2	117	< 0.001	93	+0.5 (-3.6 to +4.6)	
Function at 1 year	TKR	3	139	0.87	0	-0.5 (-4.2 to +3.3)	0.85
or more	THR	2	117	0.21	35	+0.2 (-3.8 to +4.2)	
TKR: total knee rep	olacement	; THR: total h	nip replacer	nent; NA: no	ot app	blicable	

BMJ Open: first published as 10.1136/bmjopen-2015-009857 on 2 February 2016. Downloaded from http://bmjopen.bmj.com/ on June 12, 2025 at Agence Bibliographique de I Enseignement Superieur (ABES) . Protected by copyright, including for uses related to text and data mining, Al training, and similar technologies.

Supplementary Table 4	sensitivity Analysis to test ru	obustness of results afte	r removing total score
			WMD (95%CI)
Outcomes	SMD (95%CI)	RoM (95%CI)	after removing total
			score
Pain at 4 weeks or less	-0.70 (-1.46 to +0.06)	0.74 (0.68 to 0.81)	NR
Pain at 6 to 8 weeks	-0.17 (-0.38 to +0.05)	0.88 (0.73 to 1.06)	NR
Pain at 12 weeks	-0.20 (-0.40 to 0.00)	0.87 (0.76 to 1.01)	NR
Pain at 24 weeks	-0.26 (-0.56 to +0.04)	0.78 (0.60 to 1.02)	NR
Pain at 1 year or more	-0.14 (-0.51 to +0.24)	0.90 (0.68 to 1.20)	NR
Function at 4 weeks or less	-0.58 (-1.45 to +0.29)	0.90 (0.79 to 1.04)	-5.0 (-9.4 to - 0.6)
Function at 6 to 8 weeks	-0.27 (-0.49 to -0.05)	0.86 (0.76 to 1.00)	NR
Function at 12 weeks	-0.48 (-0.91 to -0.05)	0.82 (0.67 to 1.00)	-4.5 (-7.9 to -1.1)
Function at 24 weeks	-0.49 (-1.47 to +0.49)	0.87 (0.56 to 1.33)	+0.1 (-4.1 to +4.3)
Function at 1 year or more	-0.01 (-0.24 to +0.22)	1.01 (0.88 to 1.15)	-0.4 (-2.6 to +1.8)

SMD: Standardized mean difference; RoM: Ratio of mean; WMD: Weighted mean difference; NR: not

relevant since total score was not included

table	MJ Open: first published as 10.113 Prote
RD	6/bmjopen-2015-0 cted by copyright
5.1%	009857 , inclu
).9%	on 2 F ding fo
4.0%	ebrua Ens or uses
3.4%	ry 201 seigner s relate
3.3%	6. Dow ment S d to te
7.8%	nload Superie ext and
13.3%	ed fron ∍ur (AE I data r
).8%	n http:/ IES) . nining
19.9%	//bmjop , Al trai
	en.bmj.com/ on June 12, 2025 at Agence Bibliographique de l ning, and similar technologies.

ω

Supplementary Table 5 Sensitivity analysis using different thresholds of patient acceptation symptom state (PASS)

10 Outcomes		PASS <=3	30		PASS <=4	0		PASS <=2	0
11 12 13	RR	median	RD	RR	median	RD	RR	median	RD
14 15 16		baseline			baseline			baseline	
17 18		risk			risk			risk	
19 20 Pain at 4 weeks or less	1.09	43.8%	3.9%	1.04	94.1%	3.8%	1.76	8.0%	6.1%
21 22 Pain at 6 to 8 weeks 23	1.00	62.2%	0%	1.00	78.3%	0%	1.02	45.0%	0.9%
24 Pain at 12 weeks 25	1.02	60.9%	1.2%	1.01	79.2%	0.8%	1.10	40.2%	4.0%
26 27 Pain at 24 weeks	1.00	98.0%	0%	1.00	99.9%	0%	1.04	84.7%	3.4%
28 29 Function at 4 weeks or less 30	1.23	26.8%	6.2%	1.10	71.7%	7.2%	1.67	4.9%	3.3%
³¹ Function at 6 to 8 weeks	1.10	54.3%	5.4%	1.02	69.1%	1.4%	1.20	38.8%	7.8%
33 34 Function at 12 weeks	1.02	62.6%	1.3%	1.02	79.8%	1.6%	1.34	39.2%	13.3%
36 Function at 24 weeks 37	1.00	97.4%	0%	1.00	99.9%	0%	1.01	84.7%	0.8%
³⁸ Function at 1 year or more	0.97	88.1%	-2.6%	0.97	98.1%	-2.9%	1.30	66.4%	19.9%
40 41						0,			
42									
43									
44 45									
46									
47									
48									
49									

BMJ Open: first published as 10.1136/bmjopen-2015-009857 on 2 February 2016. Downloaded from http://bmjopen.bmj.com/ on June 12, 2025 at Agence Bibliographique de I Enseignement Superieur (ABES) . Protected by copyright, including for uses related to text and data mining, Al training, and similar technologies.

Appendix Search Strategies

Search Updated: November 10th, 2015

PubMed

1	(((((((((((((((((((((((((((((()))) OR prehabilitation[tiab] OR prehab[tiab] OR "physical
	therapy"[tiab] OR physiotherapy[tiab] OR "therapeutic exercise"[tiab] OR "therapeutic
	activity"[tiab] OR activity[tiab] OR "preoperative rehabilitation"[tiab] OR "weight training"[tiab]
	OR "weight lifting"[tiab] OR aquatic[tiab] or swimming[tiab] Or "strength training"[tiab] OR
	"endurance training"[tiab] OR cycling[tiab] OR biking[tiab] OR "weight reduction"[tiab] OR
	"weight loss"[tiab] OR kinesiotherapy[tiab] OR hydrotherapy[tiab] OR fitness[tiab] OR "exercise
	therapy"[tiab])
2	(((Arthroplast*[tiab] OR replace*[tiab] OR "orthopedic surgery"[tiab]))) AND ((hip*[tiab] OR
	knee*[tiab]))
3	1 AND 2
4	(((((pre-operative[tiab] OR preoperative[tiab] OR pre-op[tiab] OR preop[tiab] OR preoperative
	care[MeSH Terms])
5	3 AND 4
6	random*
7	5 AND 6

Emabase

1	exercise.ti,ab.
2	Prehabilitation.ti,ab.
3	Physical therapy.ti,ab.
4	Physiotherapy.ti,ab.
5	Therapeutic exercise.ti,ab.
6	Therapeutic activity.ti,ab.
7	Activity.ti,ab.
8	Preoperative rehabilitation.ti,ab.
9	Weight training.ti,ab.
10	Weight lifting.ti,ab.
11	Aquatic.ti,ab.
12	Swimming.ti,ab.
13	Strength training.ti,ab.
14	Endurance training.ti,ab.
15	Cycling.ti,ab.
16	Biking.ti,ab.
17	Weight reduction.ti,ab.
18	Weight loss.ti,ab.
19	Kinesiotherapy.ti,ab.
20	Hydrotherapy.ti,ab.
21	Fitness.ti,ab.
22	Exercise therapy.ti,ab.

BMJ Open: first published as 10.1136/bmjopen-2015-009857 on 2 February 2016. Downloaded from http://bmjopen.bmj.com/ on June 12, 2025 at Agence Bibliographique de I Enseignement Superieur (ABES) . Protected by copyright, including for uses related to text and data mining, Al training, and similar technologies.

23	or/1-22
24	arthroplast*.ti,ab.
25	replacement.ti,ab.
26	resurfac*.ti,ab.
27	orthopedic surgery.ti,ab.
28	hip*.ti,ab.
29	knee*.ti,ab.
30	or/24-27
31	28 or 29
32	30 and 31
33	23 and 32
34	random*.mp.
35	33 and 34
36	exp animals/
37	exp human/
38	(dog or dogs or canine or canines or pig or pigs or porcine or rat or rats or cat or feline or
	felines or lamb or lambs or mouse or mice or rabbit or rabbits).ti,ab.
39	36 not 37
40	38 or 39
41	35 not 39
42	pre-operative.mp.
43	preoperative.mp.

45	Preop*.mp.
46	Pre-op*.mp.
47	or/42-46
48	41 and 47

Cochrane CENTRAL

1	"exercise":ti,ab,kw (Word variations have been searched)
2	"prehabilitation":ti,ab,kw (Word variations have been searched)
3	"physical therapy":ti,ab,kw (Word variations have been searched)
4	"physiotherapy":ti,ab,kw (Word variations have been searched)
5	"therapeutic exercise":ti,ab,kw (Word variations have been searched)
6	"therapeutic activity":ti,ab,kw (Word variations have been searched)
7	"activity":ti,ab,kw (Word variations have been searched)
8	"Preoperative rehabilitation":ti,ab,kw (Word variations have been searched)
9	"weight training":ti,ab,kw (Word variations have been searched)
10	"weight lifting":ti,ab,kw (Word variations have been searched)
11	"aquatic":ti,ab,kw (Word variations have been searched)
12	"swimming":ti,ab,kw (Word variations have been searched)
13	"strength training":ti,ab,kw (Word variations have been searched)
14	"Endurance training":ti,ab,kw (Word variations have been searched)
15	"cycling":ti,ab,kw (Word variations have been searched)
16	"biking":ti,ab,kw (Word variations have been searched)
17	"weight reduction":ti,ab,kw (Word variations have been searched)
L	1

Page 78 of 81

18	"weight loss":ti,ab,kw (Word variations have been searched)
19	"kinesiotherapy":ti,ab,kw (Word variations have been searched)
20	"hydrotherapy":ti,ab,kw (Word variations have been searched)
21	"fitness":ti,ab,kw (Word variations have been searched)
22	"Exercise therapy":ti,ab,kw (Word variations have been searched)
23	#1 or #2 or #3 or #4 or #5 or #6 or #7 or #8 or #9 or #10 or #11 of #12 or #13 or #14 or #15 or #16
	or #17 or #18 or #19 or #20 or #21 or #22
24	"arthroplasty":ti,ab,kw (Word variations have been searched)
25	"replacement":ti,ab,kw (Word variations have been searched)
26	"resurface":ti,ab,kw (Word variations have been searched)
27	"orthopedic surgery":ti,ab,kw (Word variations have been searched)
28	#24 or #25 or #26 or #27
29	"hip":ti,ab,kw (Word variations have been searched)
30	"knee":ti,ab,kw (Word variations have been searched)
31	#29 or #30
32	"preoperative":ti,ab,kw (Word variations have been searched)
33	"pre-operative":ti,ab,kw (Word variations have been searched)
34	"preop":ti,ab,kw (Word variations have been searched)
35	"pre-op":ti,ab,kw (Word variations have been searched)
36	#32 or #33 or #34 or #35
37	#28 and #31
38	#23 and #37
39	#36 and #38

PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	1
ABSTRACT	•		
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	3-4
INTRODUCTION	•		
Rationale	3	Describe the rationale for the review in the context of what is already known.	5
) Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	6
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	6-7
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	6-7
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	6-7
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	Appendix
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	7-8
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	7-8
3 Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	16-21
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	13-15
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	8-10
Synthesis of results	14 	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I ²) for each meta-analysis.	10
Agence Bibliographique de ا	2025 at A	irst published as 10.136/md/monione. 2 February 2016. Downloaded from http://bmjopen.bm.com/ on June 12, Enseignement Superieur (ABES)	f :nəqO LMB



PRISMA 2009 Checklist

Page	1	of 2	
I auc			

		Page 1 of 2	
Section/topic	#	Checklist item	Reported on page #
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	13-15
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	10
5 Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	11
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	11-12
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	13-15
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	Suppl Table 2
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	16-21
5 6			Table 3
ł			Table 4
⁸ ዓ ቀ			Suppl Table 3
1 2 3			Suppl Table 4
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	13-15
6 Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	21-22
DISCUSSION	•		
9 Summary of evidence 0	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	22-23
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	23-25
4 Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	25
6 FUNDING	.səipo	Protected by copyrights include the uses is based in the use of the hand withing. A last within and an acching the connor	
A l eb eupidengoildia en alternatives de l'alternatives de la supidendation de la supid supidendation de la supidendation	16 2202	rst published trom http://md.naqojmd/i.0f1 in Developed trom http://md.open.com/ on John John John John John Jo (SEBA) الموداولا (SEBA) الموداولا (SEBA) in State is a second of the second of the second of the second of the s	it :neqO LMB

Page 81 of 81

BMJ Open

	IN PLAN AND
1	in which which
2	
2	

PRISMA 2009 Checklist

3			
4	Funding 27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the	26
0 6		systematic review.	
7 7			
8 /	From: Moher D, Liberati A, Tetzlaff J, Altm	han DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med	6(6): e1000097.
9 (For more information, visit: www.prisma-statement.org.	
10			
11			
12			
14			
15			
16			
17			
18			
19			
∠∪ 21			
22			
23			
24			
25			
26			
27 29			
20 29			
30			
31			
32			
33			
34 35			
36			
37			
38			
39			
40			
41 42			
4∠ ⊿२			
44			
45			
46	າວຄາຍເວັ້າ	ค.เอเธอเธต py copy(เติมนอยกุศษกุศกุศกุศษกุรศรรรมุร)ณิธษายุณิศาสตุศิลทิกุศุศษกุกุศุภาพกุศภาษามีการที่ การกาวเอ	
47		Enseignement Superieur (ABES)	
48	2025 at Agence Bibliographique de l	3. St and. no \mos.imd.nagoimd\\:attd mort babsolnwoQ.3t0S vreutda1 S no 788000-2t0S-nagoimd\85t1.0t as badsildug tsri	BWJ Open: