Physical activity interventions after hip or knee joint replacement: A systematic review

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Abstract

Background Studies show that following lower-limb joint replacement surgery most patients fail to achieve the recommended amount of physical activity. This study aims to describe and evaluate physical activity interventions in individuals that have undergone hip or knee joint replacement due to osteoarthritis.

Design A systematic review. Protocol registration PROSPERO CRD42016033498 (http://www.crd.york.ac.uk/PROSPERO/). Experimental and observational study designs investigating physical activity interventions after joint replacement were considered. The primary outcome was self-reported or objectively measured change in physical activity. Two reviewers extracted the data and appraised the methodological quality of the included studies.

Results 11873 studies were screened. Seven studies with 627 participants, aged 50 to 85 years met the review criteria. Five randomised control trial, one longitudinal quasi-experimental study with a control group and one pre/post-test study with control group. Interventions included health coaching, a walking programme, a behavioural change intervention and an alpine skiing intervention delivered between 6 and 24 weeks.

Two studies reported change in physical activity using patient activity diaries and five used objective accelerometer data. Statistical pooling of the study results was not possible. However, all studies showed an increase in time spent being physically active in the intervention groups. One study also reported an increase in vitality.

Conclusions Few studies have investigated physical activity interventions after hip or knee joint replacement, and evidence for the effectiveness of physical activity interventions post-replacement is low. High quality studies are needed in this area to explore the potential benefits presented within this review.

Keywords: physical activity, exercise, hip replacement, knee replacement, systematic review.

Introduction

Joint replacement is a surgical intervention reserved for the treatment of end-stage osteoarthritis (OA) after other non-surgical interventions have failed [1, 2]. Annually, about 160,000 total hip and knee joint replacements are carried out in England and Wales alone [3]. Projection estimates from the United Kingdom clinical research datalink revealed that by the year 2035, a staggering number of 439,097 and 1,219,362 total hip replacements and total knee replacements will be carried out respectively [4]. Following joint replacement procedures, most patients report having improved quality of life (QOL) due to reduced pain and improved mobility [5-7]. Additionally, there is the expectation of an increase in patients' post-replacement physical activity levels [8].

Some reports have indicated that most patients are not sufficiently physically active following hip or knee replacement surgery [8, 9]. Recent objective accelerometer data from the Osteoarthritis Initiative showed that only 5% of OA patients who have undergone knee joint replacement were reported to meet the physical activity guidelines of 150 minutes of moderate-intensity physical activity [10]. A critical review by Paxton reported that ten studies found an increase in patients' physical activity levels (between 6 months to 5 years after joint replacement) compared to the pre-operative levels of physical activity. Five additional studies reported no change or even decreased physical activity levels (between 2 weeks to 6 months post-operation) [9]. These contradictory findings are likely due to the measurement tools used; patient-reported measures frequently describe higher levels of physical activity, which are inconsistent with objective measures such as accelerometer data. Several barriers to

physical activity in this group have been reported, including a lack of patient education, fear of jeopardising recovery process, co-morbidities and a lack of specific physical activity interventions [11].

Physical activity confers a number of skeletal and neuromuscular health benefits to patients post joint replacement in terms of function and mobility [12, 13]. More importantly, however, is the effect on co-morbidities such as cardiovascular disease, obesity and diabetes, where physical activity is important for prevention and management [13]. Failure to increase physical activity in patients post-replacement may not modify the risk for increased mortality in this group [14].

Although complex, physical activity is a modifiable behaviour as shown by a number of systematic reviews in a range of patient and non-patient populations. [15]. A systematic review conducted by Müller and Khoo reported that non-face-to-face physical activity interventions--which include investigators phoning participants; the use of printed materials; and the use of media such as newspapers, TV, radio and website--were successful in increasing the physical activity levels of older adults [16]. Among patients with lower-limb OA, Williamson and colleagues showed that providing supervised exercise programs, educating patients about physical activity, and training them on how to develop self-management strategies resulted in a small but positive effect in increasing participants' physical activity [17]. However, to date, no review has evaluated physical activity interventions among patients who have undergone lower limb joint replacement.

The aims of this review are:

- To describe the physical activity interventions that have been trialled in individuals post hip or knee joint replacement

- To evaluate the effectiveness of physical activity interventions aimed at increasing physical activity in individuals who have undergone hip or knee joint replacement

Methods

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guideline was used for this review (and a PRISMA checklist [18] at Appendix 1). The protocol of this review has been prospectively registered with PROSPERO (International prospective register of systematic reviews) with the registration number CRD42016033498 (http://www.crd.york.ac.uk/PROSPERO/)

Search strategy

The following electronic databases were searched from their respective date of inception to the second week of February 2020: CINAHL (EBSCO), EMBASE, MEDLINE (OVID), PsycINFO (Ovid), SCOPUS (Elsevier), SPORT Discus (EBSCO) and Web of Science (search strategies for all the databases are contained in Appendix 2). The search strategy for the MEDLINE database was first developed after consultation with an experienced librarian and adapted for other databases with modification. Additionally, the reference lists of the included studies were screened for possible relevant articles.

The following search terms were used: physical activity, exercise, hip replacement, knee replacement, pedometer, accelerometer, step count and behavioural change theory.

Eligibility criteria

Studies

Health interventions are evaluated using different approaches and designs [19], and it is recognised that this will be the first review of physical activity interventions after joint replacement. Therefore, this review considered experimental and observational study designs. Furthermore, both published and unpublished studies were considered if the full text was made available by the authors.

Participants

Participants included persons aged 18 years and above that have undergone hip or knee joint replacement due to OA. Participants needed to have undergone the replacement for the first time, which might have involved one or both limbs.

Interventions

The review considered any “systematic approach to increase physical activity” as a physical activity intervention [20].

The approach could have been a physical activity program alone or a particular physical activity component as part of a wider program, which could have been facility-based, home-based or both, undertaken in diverse ways and situations [19, 21].

The interventions could have been compared with a comparison group or not. Examples of these interventions include supervised exercise programs, unsupervised exercise programs, or behavioural change approaches aimed at increasing physical activity.

147 Outcome measures

148 Studies must have included either objective or self-reported measures of physical
149 activity. Objective measures could include pedometers or accelerometers. Self-
150 reported measures could include physical activity diary (PAD) or questionnaires such
151 as International Physical Activity Questionnaire (I-PAQ).

152 Study selection

153 Studies identified were downloaded to EndNote Web (Thomas Reuters), where the
154 duplicates were removed. One reviewer screened the titles and abstracts of the
155 identified studies based on the study eligibility criteria identified above before retrieving
156 the full text, and further screening was carried out by the same reviewer. A second
157 reviewer screened the identified studies before inclusion into the review.
158 Disagreements were resolved by a third reviewer.

159 Data extraction

160 A data extraction sheet (Appendix 3) from the Cochrane public health group was
161 adapted. [22]

162 Two reviewers independently extracted the data from the included studies.
163 Disagreements were resolved by consensus or, if needed, a third reviewer. The
164 following data were extracted for this review: patient characteristics (age, gender, body
165 mass index, duration post-replacement), type of joint affected (knee or hip), study
166 design, sample size, description of interventions, description of control or comparator
167 interventions, country and study results.

168 Methodological assessment of individual studies

169 The Joanna Briggs Institute (JBI) critical appraisal tool for experimental studies was
170 used for assessing the quality of studies included. The appraisal tool was developed

for both randomised and quasi-randomised studies. The tool consists of 10 questions, which are presented in table 1.

Two reviewers independently assessed the quality of the included studies. Disagreements were resolved by consensus and, where a consensus could not be reached, a third reviewer decided. The studies were graded as either having 'Yes', 'No' or 'Unclear' on each of the domains [23]. Grades of Recommendation, Assessment, Development and Evaluation (GRADE) approach (see table 2) was used to summarise the overall risk of bias assessment and other quality makers for the studies included [24].

Synthesis of results

There was considerable heterogeneity in the study designs, interventions and outcome measures which precluded a meta-analysis being performed. Therefore, narrative syntheses of the included studies were presented.

Based on the data presented in the original articles, we compared percentage or mean and standard deviation (SD) values in the intervention group with that of the control group. Further evaluations were carried out with the pre- and post-intervention values in both groups.

Results

Study selection

In total, 11873 studies were identified after searching the databases. 6186 duplicates were removed, and 5687 records were screened based on titles and abstracts. Full texts of 9 studies were retrieved where further screening was carried out. 7 studies finally met the inclusion criteria.

Based on title and abstract screening, 2 other potential studies--one of which was a conference abstract [25], the other a PhD dissertation [26]--were identified, but an email sent to the author of the conference abstract requesting the full text was not delivered. As for the PhD dissertation, the effort made to retrieve the full text through the University of Nottingham interlibrary loans services was not successful. Two other studies that are at the protocol stage were identified [27, 28] No relevant unpublished studies were obtained. See flow diagram in Figure 1.

Studies characteristics

Methods

Morishima et al. (2014), Paxton et al. (2018), Van der Walt et al. (2018), Hoorntje et al. (2020) and Losina et al. (2018) conducted randomised controlled trials (RCTs) which were delivered over 12, 12, 6, 24 and 24 week periods respectively [29-33]. Harnirattisai and Johnson (2005) used a longitudinal quasi-experimental study design with a control group to investigate the effectiveness of a behavioural change intervention. The intervention lasted for 6 weeks [34]. Würth et al (2015) investigated alpine skiing using pre-test, post-test with a control group design which was delivered over a period of 12 weeks [35]. All the studies were published in the English language.

Participants

The included studies had 627 participants in total with about 51% being male. The ages of all the participants in the included studies range from 50 to 85 years. The main inclusion criterion for these studies was having undergone hip or knee joint replacement for OA.

Intervention

There is variation in the physical activity interventions delivered within the included studies. The study conducted by Morishima et al., consisted of unsupervised walking at different intervals and levels of intensity. The intervention stipulated that the participants walk for 5 or more sets of low-level intensity (40% of VO_2max) followed by high level intensity (more than 70% but less than 85% VO_2peak). These targets were reviewed by physical therapists every two weeks and when the targets were not met, the therapists encouraged participants to increase their efforts [29]. The other four RCTs included in this study investigated the use of goal setting strategies with a feedback component among individuals that had undergone joint replacement [30-33]. Harnirattisai and Johnson's study was based on social cognitive theory, which includes nurse-patient interaction regarding the success and failure of physical activity and exercise. Goals for physical activity and exercise were set between 1 to 2 weeks and 3 to 6 weeks postoperatively, and patients were encouraged to engage in physical activity and exercise according to their capability. Additionally, family members were educated on the importance of (and their role in) engaging in physical activity and exercise. Information prompts about physical activity and exercise regime were also provided in week 1 to 2 (get started) and in week 3 to 6 (get stronger) postoperatively [34]. The study conducted by Würth et al investigated alpine skiing. The participants were divided into two groups, with one instructor per group [35].

Outcomes

All the randomised control trial studies used an objective physical activity measure which was an accelerometer-based activity monitor. PAD and the short version of I-PAQ [36], which are self-report measures, were used in the other three included

241 studies. Participants' QOL was explicitly reported in 3 of the included studies in our
242 review [31, 33, 35].

243 A tabulated description of the study characteristics is provided in Table 3.

244 Methodological quality assessment of individual studies

245 The risk of bias and other quality markers for the individual studies are shown in Table
246 4. In three or more of the quality domains, all the studies scored "NO" with the
247 exception of Van der Walt et al. study which scored only two "NO". Although it was
248 reported as "NO", it was recognised that it was not possible to blind participants to the
249 treatment allocation. The possibility of attrition bias was higher in two studies [29, 35].
250 Data from the participants that withdrew from these studies were not included in the
251 final analysis. The greatest methodological issue was the use of PAD to measure
252 change in physical activity by the two studies included [34, 35]. An overall quality
253 assessment based on the GRADE approach showed that the level of evidence is low,
254 with most of the studies downgraded due to study design [24].

255 Synthesis of results

256 Table 5 shows the effects of the interventions on physical activity, QOL and any
257 adverse events reported.

258 Self-reported physical activity

259 Würth et al. (2015) and Harnirattisai and Johnson (2005) reported a positive effect
260 based on self-reported physical activity measures [34, 35]. Among the two studies, one
261 study was based on a theoretical model (Bandura's social cognitive theory), and it was
262 aimed at improving participants' self-efficacy. This was combined with an
263 unsupervised exercise program. The study reported that a higher percentage (93%)

of the participants in the intervention group walked 20 minutes daily, which is significantly greater than that of the control group (46%) [34]. In the other study, the participants undertook recreational alpine skiing. The greatest positive effect was recorded during the skiing days where the participants in the intervention group spent more time being active (mean±SD: 122.3±32.4 minutes per day) compared to the control (mean±SD: 75.1±21.3 minutes per day). However, during other days when participants are not skiing, the difference between the two groups was minimal (mean±SD: intervention -48.8±25.1 minutes per day; control -44.6±27.2 minutes per day) [35]. The intensity of contact and duration of intervention differs between the two studies.

Objective measures of physical activity

Morishima et al. (2014), implemented walking at a low intensity followed by high intensity. The study reported a non-significant effect in the overall total energy expenditure between the intervention and control group (Means±SE: Intervention-13824±1495 (O2 ml/kg/wk); control -10258±1827 (O2 ml/kg/wk); p≥0.05). However, there was a significant difference in the time spent in fast (high intensity) interval walking training between the two groups (Means±SE: Intervention is 127±18 minutes per week; control is 75±17. Van der Walt (2018) reported a significantly higher mean step count at all review points in the intervention group compared with the control group with a moderate size effect (Cohen's d 0.4-0.5). Losina et al. (2018), reported the weekly mean change of 39 (SD 11) minutes in the intervention arm compared to the control, and Paxton et al. (2018) reported that the intervention group recorded 20% increase (baseline: 5754 ± 2714, post-intervention: 6917 ± 3445) in daily step count following physical activity intervention, which was significantly higher compared to the control group (baseline: 5011 ± 2038, post-intervention: 5291 ± 2298).

289 Quality of life

290 One study used SF-36 to report participants' QOL [29]. The instrument has 8 domains
291 [37]. The study reported a significant increase in only the vitality score of the
292 intervention group (values changed from 45±3 to 52±2; p=0.005) but not in the control
293 group (values change from 48±3 to 52±3; p=0.19) [29].

294 Adverse events

295 All the studies reported no adverse events related to the interventions [29-35].

296 **Discussion**

297

298 The evidence supporting the need for physical activity interventions after joint
299 replacement is overwhelming [9, 11]. However, within the literature, few studies have
300 investigated physical activity interventions after hip or knee joint replacement due to
301 OA.

302 To the best of our knowledge, this is the first systematic review to evaluate the changes
303 in physical activity and QOL following physical activity interventions among OA
304 patients that have undergone hip or knee joint replacement. Of the 11873 studies
305 screened, only 7 studies were included [29-35].

306 Summary of evidence

307 The present review provides low quality evidence (based on GRADE approach) for
308 the effectiveness of physical activity interventions after hip or knee joint replacement
309 due to OA.

310 Types of intervention

311 To increase participants' physical activity, all the studies implemented unsupervised,
312 specified programs. Although, most of the included studies make use of different

motivational strategies to enable participants to attain set goals (such as number of steps per day) as part of the intervention, only one study explicitly based its intervention on a well-researched behavioural change model [34]. This study used motivational strategies, which are based on social cognitive theory, to improve participants' self-efficacy. Mastery experience, verbal persuasion, family support and specifying the outcome expectations are components of the effective program that shaped participants' self-efficacy and outcome expectation, thereby bringing about the desired change.

Theoretical frameworks provide the basis for explaining how an intervention can influence a behaviour (such as physical activity) and the probable pathway for the change in the behaviour [38,39,40]. They can also inform the design, development and execution of physical activity interventions [40,41]. Therefore, interventions aimed at increasing physical activity after joint replacement should be guided by theoretical frameworks.

The interventions differ in frequency, intensity and duration, which might have been affected by the length of time since joint replacements. For instance, in one of the studies [34], the participants were recruited 4 days postoperatively, while in two other studies [29,35], the interventions were delivered to participants who had their joint replaced up to 15 years previously. Therefore, there is a lack of sufficient evidence to reliably state which delivery approach is more successful. The interventions were delivered for no more than 24 weeks with less contact between the participants and providers. For advancement into clinical practice, investigation should be conducted on the effectiveness of supervised versus unsupervised interventions as well as the cost and benefits associated with these interventions.

Physical activity measurement and methodology

There is lack of agreement on the research methodology particularly with regards to physical activity measurement. In two studies [34,35], an important shortcoming was the use of self-reported minutes of physical activity which might not capture the four domains of physical activity (domestic, transportation, leisure and occupation) [42,43]. The use of validated physical activity measures may provide detailed information across physical activity domains [42].

The use of objective physical activity measures, which could include wearing portable devices such as accelerometers, provide a possible way for individuals to self-monitor behavioural change and physical activity daily. An additional advantage that may be derived from integrating self-monitoring and wearable devices is an improvement in the evaluation of interventions that require less contact and in areas that are remote. Five of the included studies in the present review did make use of this methodology. However, these devices can be costly, requiring proper infrastructure for gathering and analysing the data [44].

The included studies in the current review did not follow up on the interventions delivered beyond 6 months. For precise quantification of health outcomes and cost-effectiveness, previous epidemiological modelling studies recommend that evaluation of outcome should persist beyond five years [45]. However, study attrition and limited funding make it challenging in practice for outcomes to be measured over a prolonged follow-up.

There is need for a consensus in the measurement of physical activity interventions after joint replacement and length of follow-up.

Effectiveness of physical activity interventions post-replacement

The present review identified a significant increase based on self-reported measure (PAD) in participants' physical activity. Among the two studies that used this measure, Harnirattisai and Johnson (2005) reported that a significant percentage of the participants in the intervention group (93%) were physically active, and this number is higher when compared with the control participants (46%) [34]. In the other study, the greatest positive effect was recorded during the skiing days on which the participants in the intervention group spent more time active (mean±SD: 122.3±32.4 minutes per day) when compared to the control (mean±SD: 75.1±21.3 minutes per day). However, during other days, when participants were not skiing, the difference between the two groups was minimal (mean±SD: intervention is 48.8±25.1 minutes per day; control is 44.6±27.2 minutes per day) [35]. Müller and Khoo (2014) reported a significant physical activity increase, based on self-reported measures of respective physical activity interventions, for older adults included within their review. This is comparable to our findings.

Small to moderate significant change in physical activity levels were reported in all studies that objectively assessed physical activity interventions following joint replacement [29-33]. These studies used accelerometer-based activity monitors to quantify participants' physical activity. For example, following an unsupervised, tailored exercise program, a non-significant difference in total energy expenditure could be seen between the intervention (means±SE: 13824±1495-O2 ml/kg/wk) and control group (means±SE: 10258±1827 -O2 ml/kg/wk). However, the time spent in fast walking by the intervention group (22 minutes per week) was significantly different from that of the control group (10 minutes per week) [29]. Two previous studies using a similar training program reported that adults without any joint replacement spent 22

to 27 minutes of fast walking time per day [46, 47]. Among sedentary individuals, 16 minutes per day of fast interval walking training has been reported to confer cardiovascular benefits [48]. Another included study within our review reported weekly mean change of 39 (SD 11) minutes [33].

Quality of life

Physical activity interventions have been reported to improve the QOL of sedentary older adults [49]. Within the present review, three studies measured participants' QOL using SF-36 [29] and EuroQol-5D [31, 33]. One study reported a significant increase in the vitality score of the intervention group [29]. Future physical activity intervention studies among OA patients post-replacement should consider including QOL measures to explore such improvements.

Adverse events

All the studies included in our review recorded no adverse events. Most experts recommend avoidance of high impact loading activities due to safety concerns. However, regardless of the potential consequences, patients do engage in such activities [50]. Therefore, rather than being dissuaded from engaging in such activities, patients should be individually assessed and made aware of the potential consequences [50]. This could help in promoting physically active lifestyles post-joint replacement.

Limitations of the included studies

The sample size of one of the included studies was small. Small sample size causes statistical analyses to be underpowered and can negatively affect the results of a study by obscuring the true effect [51]. This could make the findings of studies with low statistical power unreliable [51].

Most of the participants were recruited from a particular cultural [29, 34] or social group [35], which may affect the external validity of interventions investigated.

Changes to physical activity behaviour can be lost over a period of time [52] and none of the studies followed up on the interventions beyond 6 months. So, it is unclear whether the findings of those studies can be maintained over a long period of time.

Limitations of the review

Even though we hold the view that a thorough search was conducted, the present review includes only studies that are reported in English, and our search was limited to electronic databases. So, given the possible existence of other studies reported in different languages as well as those in the grey literature, the findings of the present review need to be interpreted with caution.

Furthermore, the results of this review may have a limited generalizability to the whole of OA-patients post-replacement in different clinical settings due to the small sample size.

Conclusion

Implication for practice

Painful lower-limb OA is associated with physical disability, which is a significant risk factor for CVD and increased mortality. The use of joint replacements for end–stage OA is largely successful for relieving pain and improving function. However, in terms of physical activity, there is evidence that patients do not increase their physical activity following total knee/hip replacement and do not meet the recommended physical activity guidelines for health. Therefore, promoting physical activity in this group is an important health goal.

Additionally, there is a lack of high-quality evidence relating to physical activity interventions among OA patients following hip or knee replacement. However, the low-quality evidence available suggests that physical activity interventions resulted in an increase in physical activity levels of OA patients, which in turn may potentially lead to health benefits. Moreover, these interventions may be safe among this population as there were no reported cases of adverse events.

Implication for research

The potential benefits presented within this review need further investigations. Most of the physical activity interventions were not based on behavioural change models. Interventions that are based on theoretical models have been reported to be more successful in influencing physical activity behaviour [15]. The included studies were of poor methodological quality. Moreover, most of the outcome measures used have poor reliability and are not validated among arthroplasty populations. Future studies--such as high quality, large-scale, randomised, controlled trials--should consider addressing these issues. We have also identified two randomised, controlled trials [27, 28] that are at the protocol stage which could add credence to the evidence regarding effective physical activity interventions.

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This project is not funded.

Conflict of interest

None declared

Author Contributions

Timothy Ishaku and Michelle Hall were involved in the conception and design of the study.

Timothy Ishaku, Shi-Mah Min and Michelle Hall were involved in the acquisition, analysis and interpretation of data. Also, all the authors were involved in the drafting of the article and the final approval of the version to be submitted.

Figure 1 PRISMA 2009 Flow Diagram

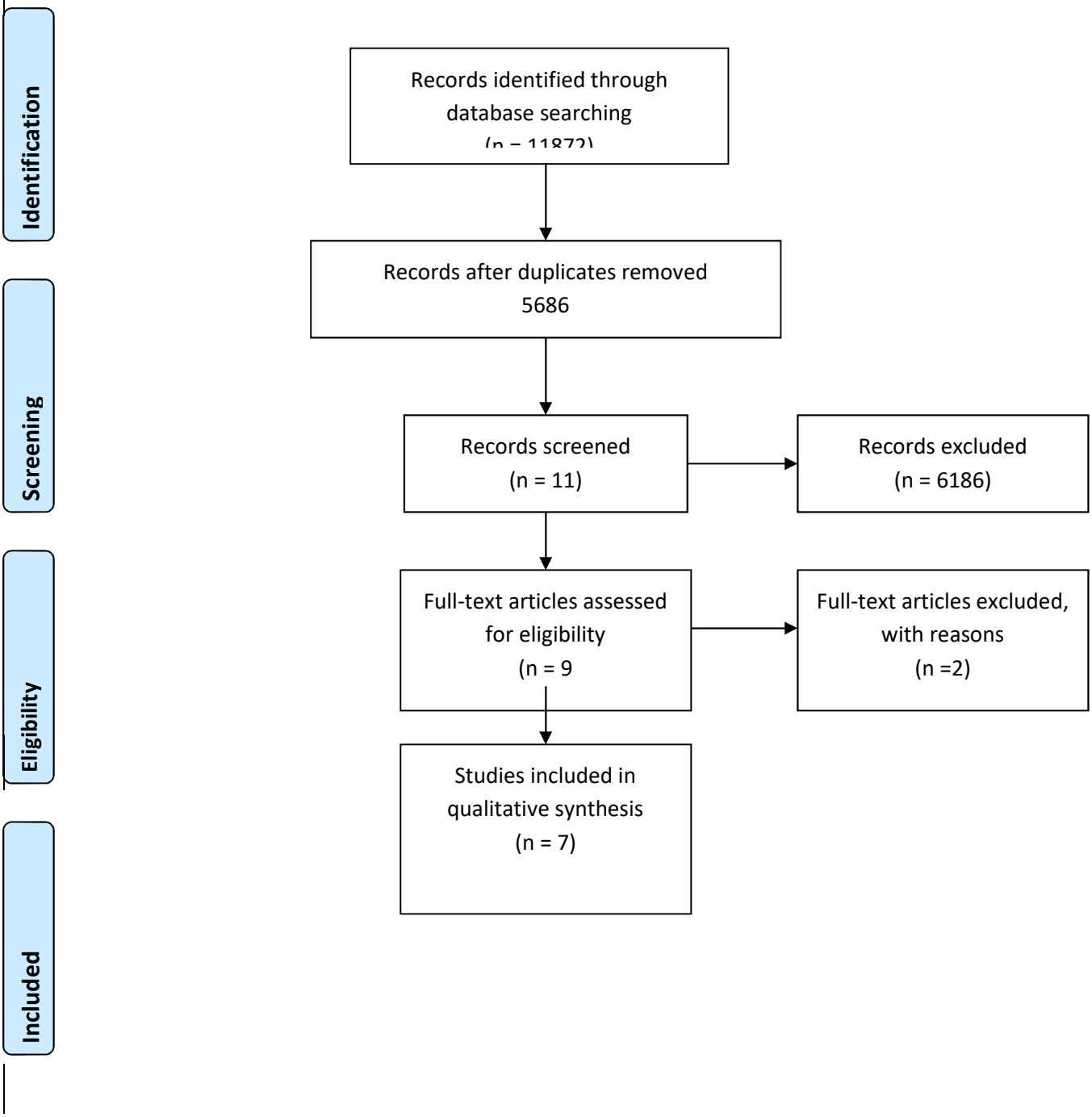

Table 1: JBI appraisal tool

Q1	Was the assignment to treatment groups truly random?
Q2	Were participants blinded to treatment allocation?
Q3	Was allocation to treatment groups concealed from the allocator?
Q4	Were the outcomes of people who withdrew described and included in the analysis?
Q5	Were those assessing the outcomes blind to the treatment allocation?
Q6	Were control and treatment groups comparable at entry?
Q7	Were groups treated identically other than for the named interventions?
Q8	Were outcomes measured in the same way for all groups?
Q9	Were outcomes measured in a reliable way?
Q10	Was appropriate statistical analysis used?

Q=question

Table 2: Level of overall quality according to GRADE approach

Definitions	Quality rating
Further research is very unlikely to change our confidence in the estimate of effect.	High
Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.	Moderate
Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.	Low
Any estimate of effect is very uncertain	Very low

Table 3: Study characteristics

References	Study designs	Participants	Duration post-replacement	Intervention description	Dosage	Comparator
Würth et al., 2015	pretest-posttest with control group design	27(DA); TKA; 60-80 years;	1 to 5 years	Guided skiing	2–3 days skiing per week	Same lifestyle
Morishima et al., 2014	Randomised controlled trial	28(F=28); THA; 52-74 years;	2 to 181 months	Unsupervised Exercise programmes	5 or more sets of 2- to 3-minutes low-intensity walking intervals, followed by a 3-minutes interval of high-intensity walking, totalling fast walking time per week of ≥60 minutes	Same lifestyle
Harnirattisai et al., 2005	longitudinal quasi-experimental study with a control group	63(M=4, F=59); TKA; 60-85 years	4 days	Face to face patient-nurse interaction, goal setting, education and discussion, family-patient-nurse interaction, and Information prompts in the form of leaflets given to the patients, describing of physical activity and exercise regime.	25 minutes each session.	Usual care.
Paxton et al., 2018	A feasibility randomized controlled trial study	45 (M=21, F=24), TKR, 50-75 years	6-8weeks	Goal settings, Visual feedback on daily steps. Weekly motivational phone calls. Monthly face-to-face meetings for mutual support in attaining physical activity level goals	Weekly and monthly	Standard care for arthroplasty patients
Van der Walt et al., 2018	Randomised controlled trial	163 (M=163), THR, TKR, 66-67years	1 day	feedback from a commercial activity tracker with a	Remote/periodically (not more than 3 weeks)	No feedback and goals but worn

				daily step goal		activity monitor
Pozzi et al., 2017	Case series	2, (M=1, F = 1), THR, 62 years	7-8 months	Health coaching including follow-up phone calls, goal setting, visual feedback	One hour of 18 session over 6 weeks period.	Not applicable
Hoorntje et al., 2018	Randomised controlled trial	97 (M=41, F=56) TKR <65 years of age	DA	Goal Attainment Scaling (GAS) rehabilitation including personal activity goals	individualized rehabilitation schedule	regular outpatient physical therapy
Losina et al., 2018	Randomised controlled trial	202 (M=87, F=115), TKR, Mean age is 65 years (SD 8)	DA	telephonic health coaching including motivational interviewing techniques, financial incentives to encourage higher attainment of physical activity,	Remotely on regular basis 14 phone calls over 24 weeks	attention control calls conveying general message of recovery

M=male, F=female, TKA= total knee arthroplasty, THA=total hip arthroplasty, DA= Data not available

Table 4

References	Was the assignment to treatment groups truly random?	Were participants blinded to treatment allocation?	Was allocation to treatment groups concealed from the allocator?	Were the outcomes of people who withdrew described and included in the analysis?	Were those assessing the outcomes blind to the treatment allocation?	Were control and treatment groups comparable at entry?	Were groups treated identically other than for the named interventions?	Were outcomes measured in the same way for all groups?	Were outcomes measured in a reliable way?	Was appropriate statistical analysis used?	Total score
Würth et al., 2015	No	No	No	No	No	Yes	Yes	Yes	No	Yes	**4**
Morishima et al., 2014	Yes	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	**7**
Harnirattisai et al., 2005	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	**6**
Paxton et al., 2018	Yes	No	No	Yes	No	Yes	Yes	Yes	Yes	Yes	**7**
Van der Walt et al., 2018	Yes	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	**8**
Hoorntje et al., 2018	Yes	No	No	Yes	No	Yes	Yes	Yes	Yes	Yes	**7**
Losina et al., 2018	Yes	No	No	Yes	No	Yes	Yes	Yes	Yes	Yes	**7**

Yes: Indicates that the study has fulfilled the criteria, No: Indicates that the study has not fulfilled the criteria, Unclear: Indicates that it is not possible to judge based on the available information.

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Appendix 1:PRISMA 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.	2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	3
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	4
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.	5
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
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.	5
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	5
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
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

Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	6
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.	7,8
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	NA
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.	8
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).	8
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	NA
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.	8
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.	9
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).	11
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.	11
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	11, 12
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	11

Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	
DISCUSSION			
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).	13
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).	17
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	18
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	19

Appendix 2: Search strategy

Databases	Search strategy	Number of hits
Medline from inception to second week of February 2020	**S1** (exercise or physical activ*) OR (Physical Exertion or Heart Rate) OR (accelerometer or accelerometry or actigraphy) OR (Ambulatory or activity monitor) OR (Walking or Step count or Pedometer) OR (Health Education or Health Promotion or Behavioural change theory) Search modes - Find all my search terms **S2** (arthroplasty or replacement or knee) OR (arthroplasty or replacement or hip) **S3** ((arthroplasty or replacement or knee) OR (arthroplasty or replacement or hip)) AND (S1 AND S2)	1,982
PsycINFO (Ovid)	**S1** AB (physical activity or exercise or fitness or physical exercise) OR AB (accelerometer or accelerometry or actigraphy) OR AB (pedometer or activity monitor or daily steps or step count or walking) OR AB (health education or health promotion or behavioural change theory) **S2** AB (hip replacement or hip arthroplasty or hip replacement surgery or thr) OR AB (knee replacement or knee arthroplasty or knee surgery or total knee or tkr) **S3** (AB (hip replacement or hip arthroplasty or hip replacement surgery or thr) OR AB (knee replacement or knee arthroplasty or knee surgery or total knee or tkr)) AND (S1 AND S2)	1338
EMBASE	1. sport/ or exercise/ or physical activity/ or fitness/ or physical activ*.mp. or education/ or lifestyle/ 2. knee replacement.mp. or knee arthroplasty/ 3. hip replacement.mp. or hip arthroplasty/ 4. 2 or 3 5. 1 and 4	1730
CINAHL (EBSCO)	S1 AB (physical activity or exercise or fitness or physical exercise) OR AB (accelerometer or accelerometry or actigraphy) OR AB (pedometer or activity monitor or daily steps or step count or walking) OR AB (health education or health promotion or behavioural change theory)	

	S2 AB (hip replacement or hip arthroplasty or hip replacement surgery or thr) OR AB (knee replacement or knee arthroplasty or knee surgery or total knee or tkr) S3 AB (hip replacement or hip arthroplasty or hip replacement surgery or thr) OR AB (knee replacement or knee arthroplasty or knee surgery or total knee or tkr) AND (S1 AND S2)	1302
SPORT Discus (EBSCO)	S1 AB (physical activity or exercise or fitness or physical exercise) OR AB (accelerometer or accelerometry or actigraphy) OR AB (pedometer or activity monitor or daily steps or step counts or walking) OR AB (health education or health promotion or behavioural change theory) OR AB (physical activity interventions or programs or strategies) S2 AB (hip replacement or hip arthroplasty or hip replacement surgery or thr) OR AB (knee replacement or knee arthroplasty or knee surgery or total knee or tkr) S3 (AB (hip replacement or hip arthroplasty or hip replacement surgery or thr) OR AB (knee replacement or knee arthroplasty or knee surgery or total knee or tkr)) AND (S1 AND S2)	1842
SCOPUS (Elsevier)	(TITLE-ABS-KEY ("physical activity") OR TITLE-ABS-KEY ("exercise") AND TITLE-ABS-KEY ("knee replacement") OR TITLE-ABS-KEY ("hip replacement"))	1797
Web of Science	#3 #2 AND #1 #2 TOPIC: (hip replacement) OR TOPIC: (knee replacement) OR TOPIC: (arthroplasty) #1 TOPIC: (physical active*) OR TOPIC: (pedometer) OR TOPIC: (accelerometer) OR TOPIC: (accelerometry) OR TOPIC: (activity monitor) OR TOPIC: (step count) OR TOPIC: (exercise) OR TOPIC: (behavioural change theory)	1882