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Review article

Function and employment after total hip replacement in older adults: A narrative review

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ABSTRACT

The burden of osteoarthritis (OA) has increased steadily due to an aging population, increasing life expectancy, obesity and lifestyle factors. Total hip replacement has become one of the most prevalent and successful operations globally and it is projected that demand will continue to grow as the incidence of OA continues to increase. Patients undergoing the operation expect much-improved function and pain relief but also increasingly need to return to work postoperatively, especially given the growing demand for the procedure and the encouragement of older people to continue working by most governments in the developed world. This review provides an overview of function and employment outcomes after hip arthroplasty. Despite the generally good success rate, some patients do not attain good functional outcomes and it is important that we develop ways to identify these patients preoperatively. We describe the effect of demographic, clinical and other factors on functional outcomes, as well as trajectories of physical function and pain recovery beyond the first few weeks after total hip replacement. Regarding employment outcomes, many people in work preoperatively are likely to resume to work after recovery; however, patients feel that they lack guidance from clinicians about returning to work post-operatively. Our review encompasses factors associated with return to work, timing of return to work, and potential temporary or permanent limitations that people might experience at work depending on type of employment.

1. Introduction

Osteoarthritis (OA) is the most common form of arthritis worldwide [1], causing joint pain, stiffness, and functional disability. The burden of disability caused by OA has been growing steadily over the last three decades [2] due to increasing life expectancy, rising prevalence of obesity and lifestyle factors. According to the Global Burden of Disease study, which described changes in morbidity and mortality levels between 1990 and 2019 for 369 conditions (diseases and injuries) across 204 countries, among people aged 50–74 years, OA went from the 24th most disabling condition in 1990 to the 18th in 2019. Indeed, the burden caused specifically by hip OA specifically increased during this period, mainly among people early in their seventh decade of life (60 to 64 years old) [3].

In the event of joint failure, and after trials of conservative therapies, total hip replacement (THR) may be offered. THR has been one of the most effective orthopaedic operations developed during the 20th century [4]. Estimates of the lifetime risk of undergoing THR have been found to vary by country, with rates ranging from 8.7 % to 15.9 % in women and 6.3 % to 8.6 % in men [5,6]. Since the earliest THRs, there have been improvements in implant-materials, surgical techniques and biomechanics which have produced very significant reductions in the failure of primary THRs (reducing the need for revision THR). Currently, the rate of revision of THR is estimated to be <1 % at one year follow-up. When failures occur, the three main causes are: aseptic loosening (42.3 %), pain (15.4 %); and dislocation/subluxation (14.7 %) [7]. Longer term, a meta-analysis pooling data from 44 case series and Finnish and Australian orthopaedic registries over 25-years of follow-up reported a survival rate of 58 % (95 % CI 57 %–59 %) and if data were limited to those from case series, the survival rate was 77 % (95 % CI 76 %–79 %) [8].

National and regional orthopaedic registries were introduced at the

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beginning of this century in response to concerns about long-term outcomes in relation to cemented arthroplasty survival [9]. More recently, many registries have also introduced collection of other types of outcomes than revision, particularly patient-reported outcome measures (PROMs) including pain and function [10].

This review focuses on employment and functional outcomes after THR in middle-aged people and does not consider short-term (peri-operative) outcomes. These are important given the aging population, the growing requirement for THR among people aged <65 years [11] and the fact that many countries have been introducing financial incentives and/or legislation to encourage workers to work beyond traditional state pension age.

2. Methods

Our focus was on mid- to longer-term outcomes after THR and therefore we did not consider papers published in the immediate peri-operative period. We identified studies published in the English Language from searches of the PubMed database from its inception until March 2022. The keywords used to run the search were combinations of "total hip replacement", "total hip arthroplasty", "return to work", "employment", "function", "pain", "trajectory" "mid-term" and "long-term". Included papers were systematic reviews; meta-analyses; case-control studies; observational studies (prospective and/or retrospective); or randomized control trials. Where available, we focused on the findings from systematic reviews or meta-analyses. Relevant studies published since the most recent systematic review were also included.

3. Functional outcomes

Functional improvement post-THR can be assessed objectively using performance-based tests, or subjectively using disease-specific patient reported outcome measures (PROMs). These are validated and self-administered scoring tools developed to assess the impact of the operation from the patient's perspective by measuring changes in function and/or pain pre- and post-surgery. A meta-analysis exploring mid-term outcomes after THR found that whether measured using the total Harris Hip Score (HHS) [12], combined pain and physical function from the Western Ontario McMaster Universities Osteoarthritis Index (WOMAC) [13] and HHS, or other measures of health-related quality of life, patients were significantly better off in terms of pain and physical function, 3.6 to 7 years post-operatively than they were pre-operatively [14]. Despite this, a literature review [15] estimated that the proportion of patients who continued to experience long-term pain post-THR (6 months to a median of 43 months follow-up) ranged between 7 % and 23 %. Consistent with this were findings from another study which assessed whether patients had achieved normal function post-operatively using the Outcome Measures in Rheumatology – Osteoarthritis Research Society International (OMERACT-OARSI) criteria [16]. They studied 908 THR recipients and assessed change using WOMAC [17], and found that, although there was overall pain relief and function disability improvement, between 14 % - 36 % of recipients experienced either little or no improvement at follow-up after one year [17]. In a subsequent study following patients 5 years post-operatively, Judge et al. [18] reported that 2.3 % of participants had worse function by one year and 1.2 % did not show improvement by 5 years. Importantly, patients with worse functional pre-operative scores (Oxford Hip Score (OHS) < 5) showed the greatest improvement with a mean change score of OHS score of 28 points. Given that it appears a small proportion of people do not attain good outcomes after THR, it is important to be able to identify this group pre-operatively if possible.

3.1. Trajectories of function recovery

Many, but not all, THR recipients experience a steady recovery post-operatively followed by either a plateau or decline in function over time [19]. However, there is some variation in the time taken to reach best function post-THR (Table 1). Two studies with 12-months of follow-up [20,21], reported that patients experienced a steep functional improvement within the first three months, at which point they reached the best functional scores. The first of these studies, by Lenguerrand et al. [20] investigated recovery of physical function separately from symptoms of pain. Participants were categorised according to their pre-operative symptoms (more severe symptoms at baseline *versus* less severe symptoms at baseline) and their trajectories compared post-surgery. At 3 months post-surgery, both groups reported a similar level of pain relief and level of physical function, suggesting that arthroplasty had been more beneficial for people who were more limited pre-operatively. Furthermore, no further changes in pain or function were observed between 3 and 12 months post-operatively [20]. The second study [21] identified three different trajectories of recovery using the OHS in a sample of 6030 THA recipients. In the first and most common trajectory (87.7 % of participants) overall function improved quickly by 3 months post-THR, not showing any further improvement afterwards. In a second trajectory, (7.7 % of participants) there was a more gradual recovery in the first 3 months followed by a slight decline in function around 12-months post-operatively. Factors associated with this trajectory were older age (>75 years) or being less fit (ASA score III-IV) at the time of operation, obesity, smoking, direct lateral surgical approach, hybrid fixation, and poorer pre-operative perceived health. A third trajectory (4.6 % of participants) had no functional improvement at 3 months however function improved at 1-year post-THR. Factors associated with this third trajectory were female sex, BMI $\geq$ 30 kg/m^2 and cigarette smoking, however operation through an anterior approach incision had a protective effect.

Two further studies [22,23], followed patients for 5 years post-operatively but captured functional limitation and degree of pain at different follow-up times than the two previous studies which had only 1-year follow-up data. The authors reported that recovery of physical function and pain relief was experienced by most patients within the first 6 months post-surgery [22,23] but that the best function was achieved at one year and sustained over 5 years [23]. Analysis from the UK's National Joint Registry and including knee and hip patients identified two different trajectories over the first 5 years post-operatively. The first trajectory (70 % of patients) experienced marked improvement in pain/function which was sustained over 5 years. The other trajectory saw sustained improvement but at a more modest level. People with most pre-operative pain and worst pre-operative function were more likely to experience the second trajectory [23]. Additionally, it was possible to predict which trajectory an individual would follow based on their scores for pain and function at 6 months post-operatively.

3.2. Predictors of physical function

Given that some patients obtain better results from surgery than others, it is important to understand what factors might affect functional improvement or contribute towards function decline after THR. Predictors of function post-arthroplasty have been examined, with some studies focusing exclusively on pain or physical function domains as an outcome, whilst other studies have focused on overall function (Table 2). There have been three systematic reviews [24–26] which have examined predictors of functional outcomes following THR. However, although published around the same time, they differed in: inclusion criteria; the length of follow-up required in included studies; the proportion of missing data which was deemed acceptable; and whether or not the indication for THR was confined to primary OA only.

3.2.1. Demographic variables

Based on the results of the three systematic reviews, age may or may not predict outcomes after THR. In the review by Buirs et al. [26] 10 out of the 15 included studies found that undergoing THR at a younger age was associated with better functional outcomes post-operatively.

Table 1
Characteristics of studies that described trajectories of functional outcomes after total hip replacement.

Author, country, year	Type of study	Sample studied	Data collection – length of follow-up	Patient- reported outcome measures collected	Predictors of trajectories assessed
Lenguerrand et al., United Kingdom, 2016 [20]	Prospective	80 participants from the ADAPT cohort study who underwent THR mainly due to hip OA (92.5 %). Surgeries were performed between February 2010 and November 2011 at a mean age of 65 years (SD ± 11)	Pre-THR: at a mean 19 days before surgery Post-THR: at 3- and 12-months follow-up	WOMAC index. Analysis performed separately for pain and function subscales	Pain and function pre-arthroplasty
Hesseling et al., Netherlands, 2019 [21]	Retrospective	6030 patients from the Dutch Arthroplasty Register who underwent primary THR due to primary OA between January 2014 and December 2016	Preoperatively (maximum 182 days pre-arthroplasty), at 3 months post-THR (63 to 110 days), and at 12 months post-THR (323 to 407 days)	OHS	Age, sex, smoking, ASA grade, Charnley class, BMI, previous surgical procedure on the involved hip, preoperative EQ-5D items and EQ-5D VAS scores (except for EQ5D Mobility)
Repky et al., Germany, 2020 [22]	Prospective	420 unilateral THRs carried out between January 1995 and December 1996 due to primary OA Operations performed in 199 males at a median age of 59 years (IQR: 54–66), and in 221 females at a median age of 64 years (IQR: 56–70)	Preoperatively, at 6- and 12-months post-operation	FFbH Visual Analogue Scales WOMAC-physical function subscale WOMAC-pain subscale	–
Dainty et al., United Kingdom, 2021 [23]	Prospective	Patients from the NJR who returned OHS questionnaire at 6- and 12-months post-THR between 2009 and 2010 After exclusions 14,335 people were eligible to study pain trajectory and 14,366 to study function trajectory post-operatively	Preoperatively, at 6 months, one, three, and five years postoperatively	OHS function domain OHS pain domain	Pre-operative characteristics: age, BMI, sex, social deprivation, ethnicity, rural/urban location, and ASA grade. OHS score pre-surgery, and at 6-month and 1-year post-THR

ASA; American Society of Anesthesiologists, BMI; body mass index, EQ-5D; EuroQol-5 dimension, FFbH; Hannover Functionality Status Questionnaire, NJR; The National Joint Registry from England, Wales, Northern Island and Isle of Wright, OA; osteoarthritis, OHS; Oxford Hip Score, THR; total hip replacement, VAS; Visual Analogue Scale, WOMAC; Western Ontario and McMaster Universities Osteoarthritis Index.

Consistent with this, another review [25] reported that in 4 out of the 11 studies retrieved it was older THR recipients who had poorer functional outcomes or pain. However, a third review [24] found no conclusive evidence that age affected function post-arthroplasty. Regarding gender, one systematic review [26] found that in some studies male gender was a predictor of better function, whereas in other studies it was female gender. A second systematic review concluded that gender did not affect functional outcomes after THR [25].

3.2.2. Body mass index (BMI)

There is not a clear and consistent message from the literature about the effect of BMI on functional outcomes. Two systematic reviews [25,26] reported an association between higher BMI and worse post-operative functional or pain outcomes. Specifically, Vincent and colleagues [27] reported that obese patients (BMI $\geq$ 30 kg/m^2) at the time of THR had worse functional performance post-operatively, suggesting that although these patients benefitted from the surgery their physical function improvement might be poorer than that achieved by non-obese patients. However, a more recent meta-analysis revealed no differences in changes in functional scores when the authors compared non-obese (BMI < 25 kg/m^2) people with: severely obese (BMI > 35 kg/m^2) patients (0.04: 95 % CI 20.02–0.10), morbidly obese (BMI > 40 kg/m^2) patients (0.19 95 % CI, 20.08–0.46), and severely obese (BMI > 50 kg/m^2) patients (20.12 95 % CI 20.57–0.33) [28]. Likewise, in a cohort of 191 THR recipients, obesity was not related with hip function or pain at 10 years post-operatively [29].

3.2.3. Comorbidities

Evidence was consistent showing that preoperative comorbid conditions measured as number of comorbidities or specific medical conditions were associated with poorer outcomes post-operatively including overall function [25,26], pain and physical function [25].

3.2.4. Pre-operative function (physical function and pain)

Level of function deterioration before THR is a moderate to strong predictor of functional outcomes post-arthroplasty. Patients with more severe pain/function before surgery are more likely to achieve worse pain/function outcomes post-operatively [18,25], similarly people with better preoperative physical function are more likely to reach better physical functional performance after replacement [26]. Additionally, studies reporting changes in pre- and post-surgical function scores have consistently suggested that patients with better pre-operative function, and less severe radiological OA benefit from less changes in pre- and post-operative function, however these patients obtained better functional scores post-arthroplasty [24,25].

3.2.5. General health and mental health

The review by Lungu and colleagues [25] found that poor THR outcomes in terms of function, pain or a combination of function and pain were associated with worse reported general health in 4 out of 4 studies. In one study, people with good mental health reached better physical function post-THR after follow-up over 72 months [26]. However, Geeske et al. [30] collected mental health status in a cohort of middle-aged women in the 13 years prior to surgery to assess the impact of mental health on physical function and pain post-arthroplasty. The authors concluded that both women with poor and good mental health obtained similar benefit from the surgery up to 10 years post-THR.

3.2.6. Social support

Pooled data from two studies comprising 2022 lower limb arthroplasty recipients suggested that patients who had social support at one-year post-THR benefitted in terms of their function measured as WOMAC score [31].

3.2.7. Other predictors

Other factors have been less well studied. Buirs et al. [26] concluded that there was weak evidence for a role of level of education and pre-

Table 2
Characteristics of systematic reviews that reported functional outcomes after total hip replacement.

Author, country, year	Type of studies identified in the systematic reviews	Eligibility criteria	Outcome	Follow-up	Patient- reported outcome measures collected used in the studies retrieved	Prognostic factors examined
Vincent et al., United States, 2012 [27]	23 studies (5 retrospective,18 prospective) published between 1965 and January 2011 Studies retrieved were conducted in the United States, Europe, Canada and Australia	Studies that examined the relationships between obesity or BMI and physical function post-THR. Physical function measurement collected a minimum of 6 months post-surgery Estimates of obesity reported either as BMI, body fat percentage or fat mass Full text published in English	Functional outcomes in obese (BMI ≥ 30 kg/m^2) and non-obese (BMI < 30 kg/m^2) patients	1 to 20 years	HHS, OHS, WOMAC score or other survey-based tools of physical function	BMI
Buirs et al., Netherlands, 2016 [26]	33 observational studies retrieved until June 2015	Studies written in English that assessed physical function among THR patients At least one variable examined as predictor of physical function No restriction in length of follow-up	Function including physical function sub-domain and general function	From 3 to 72 months with an average of 18 months	HHS, LEFS, OHS, SF-36 (PF), TUG test and WOMAC score.	Age, gender, BMI, comorbidities, pre-operative physical function, and other predictors
Hofstede et al., Netherlands, 2016 [24]	35 prospective studies searched up to August 2014	Prospective studies comprising patients who underwent THR due primary hip OA, with functional or clinical outcomes collected pre- and post-arthroplasty and a minimum of 1-year follow-up Studies were not eligible if they included metal on metal implants; osteotomies prior to THR; were exclusively focused on bilateral THR; and the prevalence of secondary OA was >5 %	Functional or clinical outcomes post-THR	Between 1 and 12 years	SF-36, SF-36 domains (PF, RP, BP, GH, VT, SF, RE, MH), change in SF-36 (correlated physical summary score (PCS)), SF-12 PCS, HHS, WOMAC score, WOMAC (physical function and pain) EQ-5D, EQ VAS, OHS, OHS (pain/ function), HHS, HOOS (subscales pain, ADL, sports, QOL), EQ-5D index, EQ VAS, Pain VAS, Satisfaction VAS	Age gender, BMI, socio-economic status/ education, comorbidities, function, radiological OA severity, expectations, pain, health related quality of life, and mental well-being
Lungu et al., Canada, 2016 [25]	22 studies identified from database inception to April 2015. Studies were conducted in Europe, the United States, Canada and Australia	Studies that comprised primary unilateral THRs due to hip OA in which patients were followed between 3 and 24 months post-THR. Additionally, studies were eligible if function and/or pain was measured through a disease specific validated PROM, multivariate analyses were used to identify determinants of pain and disability, and full text was published in English or French	Pain and/or physical function	Between 3 and 24 months	HHS HOOS LEFS OHS WOMAC score	Age, gender, living arrangements, level of education, socioeconomic status, psychosocial determinants, general health, severity of radiographic OA, BMI, pre-operative pain and function, other clinical variables and waiting times for arthroplasty
Ponnusany et al., Canada, 2019 [28]	Meta-analysis including 33 studies identified from databases inception to August 2016	Studies that examined primary THR outcomes by BMI used as a categorical variable, with BMI ≥ 35 kg/m^2 as the highest BMI category used	Change in pre/post-operation functional score, reoperation, and revision rates in non-obese (BMI < 30 kg/m^2) and obese patients (BMI ≥ 30 kg/m^2)	Not specified. Some studies with short-term follow-up (<1 year), and other studies with longer follow-up (≥1 year)	HHS, OHS EQ-5D, WOMAC score	BMI
Wylde et al., United Kingdom, 2019 [31]	56 studies retrieved from database inception to April 2019 of which 13 were included in meta-analysis and 43 in a narrative synthesis	Studies on adults undergoing primary THR, TKR or other type of procedures if results for THR and TKR were provided separately The outcome had to	PROMs that evaluated pain, function, satisfaction, or general health	–	SF-36 or SF-12 total or subscale scores, Functional Independence Measure, OHS, OKS, Yale Physical Activity Scale, IRES questionnaire, HOOS/KOOS,	Social support

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Table 2 (*continued*)

Author, country, year	Type of studies identified in the systematic reviews	Eligibility criteria	Outcome	Follow-up	Patient- reported outcome measures collected used in the studies retrieved	Prognostic factors examined
		assess pain, function, satisfaction, or general health using PROMs at 3 months or longer post-operatively, and assessment of social support was performed pre-operatively or within the first 6 weeks of surgery Studies that used surgeon administered tools were excluded			Nottingham Health Profile, EQ-5D, EQ-5D VAS, Instrumental Activity of Daily Living, pain VAS, satisfaction VAS, WHOQOL-100, and WOMAC score	
Lemos et al., United States, 2021 [32]	82 studies of which 18 examined associations between frailty and post-operative outcomes. The search was performed up to December 2020	Studies that reported orthopaedic surgical outcomes in patients characterised as frail using any tool to measure frailty A minimum level of evidence of Level IV (per the Oxford Centre for Evidence-Based Medicine) Full text published in English	2/18 studies assessed function post-arthroplasty	–	WOMAC score, HOOS	Frailty

BMI; body mass index, EQ-5D; EuroQol-5 dimension, HHS; Harris Hip Score, HOOS; hip disability and osteoarthritis outcome score, IRES; Indicators of the Rehabilitation Status questionnaire, KOOS; knee injury and osteoarthritis outcome score, LEFS; lower extremity functional scale, OHS; Oxford Hip Score, PROM; patient-reported outcome measure, SF-12; The 12-item Short Form Health Survey; SF-36: The 36-item Short Form Health Survey; PF: physical functioning; RP: physical role; BP: bodily pain; GH; general health; VT: vitality; SF: social functioning; RE: role-emotional; MH: mental health; MCS: mental component, TUG test; Timed Up and Go, THR; total hip replacement, TKR; total knee replacement, VAS: the Visual Analogue Scale, WOMAC; Western Ontario and McMaster Universities Osteoarthritis Index, WHOQOL-100; World Health Organization Quality of Life-100.

operative quadriceps strength and very limited evidence regarding any effect of alcohol intake, vitamin D insufficiency and allergies on THR functional outcomes. On the other hand, 3 studies from the review performed by Lungu et al. found that lower level of education was associated with worse pain and or function at 3 to 24 months post-operatively [25]. One study by Vergara et al. [27] found that patients waiting longer than 6 months for their THR experienced less improvement in function 1 year post-operatively, when compared with the benefits experienced by those who had waited for <3 months. A systematic review [32] reported a relationship between frailty and poorer functional outcomes at 3 year follow-up post-THR (1 out of 2 studies).

4. Work outcomes

Approximately 20 % of THRs are performed on people below of 60 years of age [33], therefore for these younger patients it is important to have information about the effect of arthroplasty on employment. Work-related outcomes are not routinely collected by clinicians, however some surgeons as part of the decision to perform the arthroplasty may ask patients about their occupation [34]. Most patients who are working pre-operatively will intend to return to work (RTW) post-operatively [35] and will need advice about when they can expect to RTW. Patients may also need advice regarding specific demands of their job *e.g.*, physically demanding activities and/or loading or driving. Unfortunately, guidelines for clinicians are lacking. Qualitative research with patients has suggested that when occupational advice is offered to patients this generally relates to time needed off work rather than strategies to facilitate RTW effectively [36] and sustain employment post-operatively. In the absence of current guidance this section describes relevant epidemiological evidence focused on employment outcomes after hip replacement. The main characteristics of the studies discussed hereafter are shown in Table 3.

4.1. Return to work and time off paid work

Hoorntje and colleagues [37] systematically reviewed studies that examined rates of RTW until October 2017 and time taken off sick by THR recipients. Pooled data from 23 THR studies showed that the mean rate of RTW for people working pre-operatively was 69 %, whereas when studies rated as high quality were considered the mean rate was 83 %. Even a subsequent study based on 408 employees from the Finnish Public sector reported that 94 % THR recipients returned to work at 3 months post-operatively [38]. Furthermore, THR can be beneficial for some people who are unable to work pre-operatively but who are fit for work post-operatively [39–41]. Most people go to back to the same type of occupation pre-operatively, however people in more physically-demanding jobs might need to change to less strenuous jobs. In the study by Cowie et al. 13/169 (7.7 %) of those who worked after arthroplasty changed to a less physical job [42]. Similarly 6 out of 62 THR recipients from another study moved to jobs with lower physical demands [41]. Nunley et al. reported that 42/672 people did not RTW after their THR however in 12 out of these 42 people the operated hip was mainly the reason not to RTW [43].

In terms of time taken off work post-arthroplasty, there is wide variation reported with a mean duration ranging between 1 and 17 weeks (7 studies) [37]. Pooled data from these studies estimated that the mean time off work is 8.9 weeks, or the mean is 11.4 weeks if only the results of high-quality studies are considered.

4.2. Predictors of resuming work

Four reviews have summarised the evidence about factors which determine RTW after THR [37,44–46]. Kuijer et al. highlighted the scarcity of literature published between 1998 and 2008 on predictors of RTW after lower limb arthroplasty. The authors found that restricting movement during the early post-operative period could limit RTW

Table 3
Characteristics of studies that evaluated return to work after total hip replacement.

Author, country, year	Type of study	Sample studied	Eligibility criteria	Follow-up	Outcome	Prognostic factors assessed in relation to employment outcomes
Mobasheri et al., United Kingdom, 2006 [41]	Retrospective	101 primary THRs in 86 patients who were 51.4 years (range, 29–60 years) at the time of the operation The main indication for surgery was primary OA (67 %)	Primary THRs carried out between 1993 and 2003 in patients below 60 years of age by a surgical team in the UK	6 months - 10 years post-THR Mean: time: 3 years	RTW	Bearing surface and size of femur head
Kuijer et al., Netherlands, 2009 [44]	Systematic review	3 studies: 2 prospective, and 1 matched case-control study	Studies published from March 1998 to 2008 on primary THR/TKR or revision of THR/TKR that a) described RTW after surgery or employment status, and factors that affected RTW, and b) were written in English, French, German or Dutch language	Minimum: 150 days after hospital admission Maximum: 20.2 months (13–36) post-surgery	Factors that affected RTW	Surgical approach: two-incision *versus* mini-posterior approach Movement restrictions post-operation
Nunley et al., United States, 2011 [43]	Retrospective	806 people (682 THRs, 124 SAs) of whom 65.9 % were male (431 THRs, 100 SAs), and 34.1 % female (251 THRs, 24 SAs) Mean age at the time of surgery was 49.5 years (±7.21), with OA (88.6 %) as the main indication to have hip surgery	Consecutive THRs or surface arthroplasties carried out in 5 centres between January 2005 and June 2007 Patients were eligible if: a) they had pre-symptomatic UCLA score ≥ 6, b) age at operation was 18–60 years in males and 18–55 in females, c) indication for surgery was OA, posttraumatic arthritis, avascular necrosis, or hip dysplasia, and d) bearing surfacing was: highly cross-linked polyethylene against metal, ceramic, or oxinium/ceramic on ceramic; or metal on metal People were excluded if post-operative complications occurred (*e.g.*, revision surgery), one of the implant components was cemented or patients had comorbidities that limited their level of activity (*i.e.*, inflammatory arthritis, sickle cell)	2.3 years post-surgery	RTW, time to RTW, number of hours worked post-operatively	None
Cowie et al., United Kingdom, 2013 [42]	Retrospective	259 cemented THRs (239 people) and 26 hip resurfacings in patients operated at an average age of 55.2 years (SD ±7.2) 155 participants were female (64.8 %) and primary OA was the main indication for surgery in the majority of THR recipients (91 %)	THRs performed in a university teaching hospital between September 2005 and September 2009 among patients who were <65 years of age at the time of the arthroplasty Bilateral procedures included only if there was at least 6 months between consecutive operations Simultaneous THR procedures were excluded	3.1 years post-THR (SD ± 0.97), range (0.58–5.42)	Rate of RTW and RTS post-THR	None
Sankar et al., Canada, 2013 [47]	Prospective	190/437 people who underwent THR and completed a questionnaire pre-surgery and additionally chose to participate in the workforce post-surgery Mean age at the time of THR: 56.1 years (SD ± 9.9)	Patients from a cohort of primary THR/TKR recipients due to OA, who were recruited between 2005 and 2008 across four tertiary-care centres in Canada Eligible participants were 18 to 65 years of age at the time of the operation, with English proficiency to be able to complete the consent form and the questionnaires People were excluded if they had a revision or hemiarthroplasty procedure, or the indication for	2 weeks pre-surgery and at 1-, 3-, 6- and 12- months post-operatively	RTW (full time or part-time), and the Workplace Activity Limitations scale post-surgery	None

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Table 3 (*continued*)

Author, country, year	Type of study	Sample studied	Eligibility criteria	Follow-up	Outcome	Prognostic factors assessed in relation to employment outcomes
			arthroplasty was trauma or malignancy. Participants were also excluded if they were retired, unemployed, did not participate in the workforce, or had a long-term disability pre-operatively			
Malviya et al., United Kingdom, 2014 [45]	Systematic review	57 qualitative and quantitative studies published from 1987 to 2013	Not clearly reported. THR and TKR studies that detailed employment outcomes	Not specified	RTW in relation to factors influencing on resuming work	Age, comorbidities, motivation, nature of job, employment pre- and post-arthroplasty, and expectations from the operation
Tilbury et al., Netherlands, 2014 [46]	Systematic review	19 studies published between 1984 and April 2013: 14 on THR (3872 patients of whom 2055 were males), 4 on TKR, and 1 paper on TKR and THR Average age of THR patients ranged from 46.9 to 69.7 years	Studies that examined THR or TKR in relation to employment outcomes (RTW, work capacity, work ability, sick leave, or productivity), and were published in English, French, German or Dutch language	Minimum 6–7 weeks and maximum 4.2 years post-surgery	Rate and timing to RTW, and predictors of returning to work	Factors related to work status after THR and TKR included sociodemographic, health and job characteristics.
Hoorntje et al., Netherlands, 2018 [37]	Systematic review	37 studies (23 on RTW and 14 on RTS) published between 1965 and 2016: 3 case–control studies, 1 cross sectional study, 6 prospective, 24 retrospective, 2 non-randomized controlled studies, and 1 randomized prospective study	Observation or intervention studies focused on THR patients due to hip OA, who engaged in sports or work prior arthroplasty and had the intention to resume sport or work after surgery No restrictions in terms of year or language of publication were used	3.8 years, range (0.25–11)	Rate of RTS and/or RTW, and the timing of RTS/RTW. Level of activity measured as the UCLA and the Grimby scale	None
Laasik et al., Finland, 2019 [38]	Prospective	408 hip replacements (73 % women) identified from The Finnish Public Sector (FPS) study Arthroplasties were performed at an average age of 54 years (32–67)	The Finnish Public Sector (FPS) study is a nationwide register (n = 151,901) that covers a wide range of occupations. Participants from this study were eligible they underwent unilateral THR between 1996 and 2011 and completed a survey pre-operatively	From hospital discharge to either date of returning to work, perceiving a disability pension/old-age pension, died, or end of follow-up.	Factors associated with RTW post-arthroplasty	Age, sex, marital status, obesity, current smoking, alcohol intake, comorbidities, psychological distress, self-rated health, pre-operative occupation leisure-time physical activity, preoperative sickness and year of the surgery
Al-Hourani et al., United Kingdom, 2021 [39]	Prospective	91 out of 195 total joint arthroplasties were THRs carried out at a median age of 59 years [IQR, 54–62] and 46.2 % of participants were male	Unilateral total joint arthroplasties undertaken in people ≤65 years of age and performed from January to November 2018 in a National Health Service institution in the UK People were excluded if they underwent partial knee arthroplasty, bilateral and revision procedures, or they if had retired pre-arthroplasty for other reasons than joint disability	1-year post-THR	RTW after THR	Age, sex, BMI, SIMD, medical comorbidities and musculoskeletal comorbidities, employment, and PROMS (OHS, OKS, Oxford APQ, EQ-5D VAS pain, Satisfaction)
Zaballa et al., United Kingdom, 2022 [40]	Retrospective	411 participants (206 men and 205 women) who underwent THR due to primary (71 %) or secondary OA and provided detailed information on occupational history post-THR. Median age to have surgery: 64 years (IQR: 57–68)	Elective unilateral THRs from the Geneva Hip Arthroplasty Register performed between December 1996–December 2012, and from the Clinical outcomes in Arthroplasty study performed between April 2010–December 2013 Patients were included if aged 18 to 64 years at the time of primary THR, and they had been followed a minimum of 5 years since operation Bilateral procedures were excluded	Median 7.5 years (IQR: 6.2–12.1)	Rate of RTW and stopping work due to the hip replaced post-THR	Physically-demanding occupational activities (standing, walking, kneeling/squatting, carrying/lifting, digging, climbing ladders and climbing stairs), and leisure-time physical activities

APQ; Activity and Participation Questionnaire, BMI; body mass index, EQ-5D; EuroQol-5 dimension, IQR; interquartile range; OHS, Oxford Hip Score; OKS, Oxford knee score, PROMs; patient-reported outcome measures, RTS; return to sport, RTW; return to work, SIMD, Scottish Index of Multiple Deprivation THR; total hip replacement, TKR; total knee replacement, VAS; Visual Analogue Scale.

whereas following guidelines to discharge THR patients had no effect on timing to resume to work [44]. Systematic reviews published subsequently have reported that age was not found associated with RTW in some studies, but that some studies found that younger patients were more likely to RTW [37,45,46]. Similarly, most studies have not found an association between sex and likelihood of RTW, as was reported in the review by Hoorntje and colleagues (10 out of the 12 studies) [37]. However, THR recipients were less likely to RTW if they were on sick leave either at the time of surgery [37,45] or >30 days in the year prior to arthroplasty [38]. There is some evidence that having attained higher levels of educational qualifications is associated with both a higher rate of RTW and less time taken to RTW [37] but this may relate to these individuals having availability of less physically demanding and more flexible types of work. Certainly, Laasik et al. [38] reported that people in non- physically demanding occupations (*e.g.* physician or teacher) were twice as likely to RTW compared with manual workers. It not surprising therefore that it takes longer to RTW for people with occupations that entail higher physical demands as compared with those in jobs with no physical demands [37]. Other predictors that have been examined to a small extent in the literature are self-employed *versus* employed; availability of a disability pension; job satisfaction; and surgical approach however the existing evidence is scarce, and no conclusions can be made.

4.3. Workability post-operatively

Currently it is unclear whether people can sustain physically-demanding jobs or whether certain activities should be avoided post-operatively. Return to work can be part of successful rehabilitation but, in some cases, a phased RTW with modification of tasks or hours may be required [43]. Sankar et al. found that some occupational activities which are difficult or impossible to perform pre-operatively can become possible post-operatively but that some THR recipients continued to experience difficulties with lifting, carrying and moving objects, crouching and kneeling [47]. In a more recent study [40], 7 % of the 411 THR patients who worked post-operatively reported that they had stopped working partly or mainly due to problems with their operated hip. Standing $\geq$4 h, kneeling/squatting and carrying/lifting$\geq$10 kg on an average day at work were strongly associated with having to stop work post-operatively.

5. Conclusion

In summary some studies have described different trajectories of physical function and pain recovery for up to 5 years post-arthroplasty, showing that most people achieve good results from surgery. Pre-operative function and severity of radiological OA may be important determinants of the risk of a poor outcome. However, the evidence about other predictors (*e.g.* age, gender) is conflicting and no reliable predictive model is as yet available. Among people working pre-operatively, most RTW post-THR, however being on sick leave pre-operatively can be associated with reduced odds of return to work. Conversely, it seems that attainment of a higher level of education, which obviously is not unrelated to the nature of the job to which someone needs to return, is a predictor of better chances of RTW.

6. Clinical implications and need for research

Although THR is a very successful procedure some recipients fail to achieve physical function improvement and pain relief. More research that might enable prediction of those likely to have poor outcomes pre-operatively is indicated. Now that PROMs are collected more regularly through arthroplasty registries [10] (*i.e.* The American Joint Replacement Registry, The Australian Orthopaedic Association National Joint Replacement Registry and Swedish National Registry), more data will be available to better understand the functional outcomes after THR in the mid- to long-term (beyond 10-year follow-up) as well as which factors contribute towards a decline in function.

Arthroplasty recipients who need to RTW post-operatively should receive occupational advice and support covering how long it might take to RTW and taking account of the nature of their job, and also the types of occupational activities involved. Future research should address whether more physically-demanding jobs may affect work sustainability, or function in the mid- to long-term post-operation.

Contributors

Elena Zaballa participated in the conception of the paper, performed a literature search, and drafted the manuscript.

Elaine Dennison participated in the conception of the paper and revised the manuscript.

Karen Walker-Bone participated in the conception of the paper, edited and revised the manuscript.

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Declaration of competing interest

The authors declare that they have no competing interest.

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