The value of total hip and knee arthroplasties for patients

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Contents

Chapter

General introduction

Osteoarthritis (OA) is a common joint condition, resulting in pain and stiffness, and having a substantial impact on functioning and quality of life of individuals. Hip, knee and hand OA are the most common forms of OA. Hip and knee OA constitute the most prevalent causes of global disability, with considerable societal consequences in terms of associated use of health care resources and costs related to productivity losses.[1]

Total hip and total knee arthroplasties (THA and TKA) are effective surgical treatments for end-stage hip or knee OA, leading to satisfactory improvement of pain, function and quality of life within a period of 1 year in 80-90% of the patients. The expression of the beneficial effects of surgery in terms of such patient reported outcomes (PROMs) is in line with the focus in health care being more and more on its outcomes in terms of value for patients. Thereby, a shift towards outcome measurements addressing what is most relevant for patients is taking place.[2] According to the three-tiered value-based health care model of Michael Porter, apart from health status achieved or retained (Tier 1) and sustainability of health (Tier 3), the process of recovery (Tier 2) is of utmost importance (Table 1).[2] This includes the time to recovery and time to return to normal activities, and disutilities of care or the treatment process.

The focus of this thesis is on particularly these aspects, as for THA and TKA, apart from knowledge on outcomes in terms of pain and function, insight into the process of recovery is limited.

This general introduction aims to give an overview of the pathophysiology and epidemiology of hip and knee OA and their treatment, in particular THA and TKA, and addresses current gaps in knowledge on the process of recovery.

Pathophysiology and epidemiology

OA is characterised by a slow and intermittently progressive loss of cartilage from the joints. In addition, there may be changes to the subchondral bone and proliferation of the bone at the margins of the joint (osteophyte formation). In addition, the synovial membrane can be periodically irritated, inducing inflammation of the joint.[3]

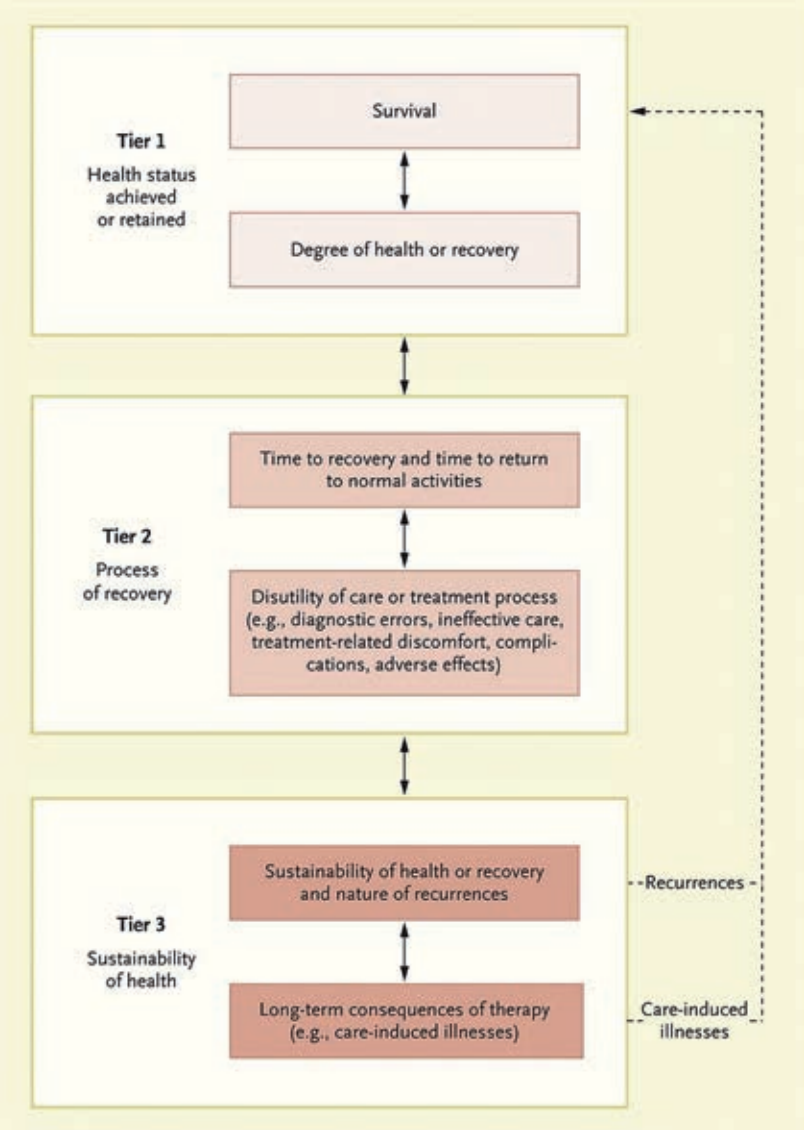

Figure 1. "Reproduced with permission from (Porter ME.What Is Value in Health Care? N Engl J Med 2010; 363:2477-2481).[2], Copyright Massachusetts Medical Society.

Hip, knee and hand OA are the most common forms of OA. In 2016 the numbers of people suffering from hip and knee OA in the Netherlands were estimated to be 396.500 (139.100 men and 257.400 women) and 571.600 (202.900 men and 368.700 women), respectively.[4] Regarding the yearly incidence of OA, in 2016 it was estimated that there were 34.300 patients newly diagnosed with hip OA

(12.700 men and 21.600 women) and 54.900 patients with knee OA (20.700 men and 34.200 women). Based on demographic trends alone, the absolute number of people with OA is expected to rise by almost 40 percent between 2011 and 2030. In view of the expected rise in the number of severely overweight people (Body Mass Index >30), the actual future prevalence of OA may be even higher.[5]

Risk factors for development and progression

OA is considered to be a multifactorial disorder, with both systemic and biomechanical factors influencing its development and progression.

Regarding systemic factors, overall the risk of developing OA increases with age, showing a peak around the age of 78 to 79 years.[5] In addition, OA is more common among women than among men. Moreover, ethnicity and certain genetic factors were also found to play a role in the development of OA of the hip/or knee.[6]

Local, biomechanical factors can be subdivided into intrinsic- and extrinsic local factors. Examples of intrinsic local factors are: factors which affect the load-bearing capacity of the joint, (e.g. previous trauma, or septic and/or reactive arthritis), congenital factors (e.g. congenital hip dysplasia, Perthes disease and femoral epiphysiolysis and surgery (e.g. meniscectomy, muscular weakness and laxity). Examples of extrinsic local factors are: overweight, strenuous profession (much lifting, squatting and kneeling), sports (esp. top level sports like soccer or ballet) and prolonged squatting (which influence the actual load borne by the joint).[6]

Regarding risk factors for progression, overweight is more important as a risk factor for in knee OA than in hip OA, whereas higher age, female sex and radiographic severity at the time of diagnosis are major risk factors particularly for the progression of OA of the hip.[7,8]

Radiographic and clinical characteristics

Radiographic characteristics of OA include joint space narrowing due to cartilage loss, the presence of osteophytes, sclerosis of the subchondral bone, and the formation of cysts. The severity of radiographic OA can be assessed by means of the Kellgren and Lawrence classification. This method distinguishes 5 grades (0-4), with grade 2 or higher indicating the presence of radiographic OA.[9]

Characteristic symptoms of OA of the hip and/or knee include pain and stiffness. In addition, patients may suffer from reduced joint mobility, reduced muscle strength and joint instability. It should be noted that radiographic abnormalities do not always correlate with the severity of symptoms. Some patients experience little pain in the presence of severe structural joint changes, whereas other patients report severe pain with milder structural joint changes.[10] The severity of radiographic OA has been found to explain <20% of the variance in pain intensity.[9,11]
Given the discrepancy between radiographic severity and clinical symptoms, it is generally acknowledged that by adequate history taking and physical examination alone a confident clinical diagnosis of hip or knee OA can be made.[12]

The symptoms of hip or knee OA may eventually lead to a decline in daily activities and societal participation. According to the International Classification of Functioning, Disability and Health (ICF) the consequences of hip and knee OA in terms of functioning on the level of body functions and structures and activities and participation are influenced by contextual factors, including both personal and environmental factors. (table 2). For OA specifically, an ICF Core Set has been defined, capturing those aspects of the ICF that are most relevant for patients with OA.[13,14]

Non-surgical management of hip and knee OA
The initial treatment of hip and knee OA is non-surgical, with education and exercise constituting the cornerstone of the management. Indeed, the Dutch Orthopaedic Association (NOV; Nederlandse Orthopaedische Vereniging) advocates the provision of adequate non-surgical care before surgery is being considered.[15,16] Currently, several national and international guidelines on the core non-surgical treatment of hip and knee OA are available, examples being the sets of recommendations or standards of care issued by EULAR (European League Against Rheumatism)[17], OARSI (Osteoarthritis Research Society International)[18], EUMUSCNET (European Musculoskeletal Conditions Surveillance and Information Network)[19], NICE (National Institute for Health and Care Excellence)[20], and NOV (Nederlandse Orthopaedische Vereniging)[21].
Despite the availability of multiple professional guidelines, there is underuse of non-surgical treatment options, so that planned, tailored strategies to enhance the uptake among the health care providers involved have been proposed.[22,23]

Table 2. ICF Core Set for osteoarthritis, adapted for osteoarthritis of the hip and/or knee

Body functions
- Energy and drive (b130)
- Sleep (b134)
- Emotional (b152)
- Proprioception (b260)*
- Sensation of pain (b280)
- Mobility of joint (b710)
- Stability of joint (b715)
- Mobility of bone (b720)
- Muscle power (b730)
- Muscle tone (b735)
- Muscle endurance (b740)
- Control of voluntary movement (b760)
- Gait pattern (b770)
- Sensations related to muscles and movement (b780)

Body structures
- Structure of pelvic region (s740)
- Structure of lower extremity (s750)
- Additional musculoskeletal structures related to movement (s770)
- Structures related to movement, unspecified (s799)

Activities
- Changing basic body position (d410)
- Maintaining a body position (d415)
- Transferring oneself (d420)*
- Walking (d450)
- Moving around (d455)
- Using transportation (d470)
- Moving around using equipment (d465)*
- Driving (d475)
- Washing oneself (d510)
- Toileting (d530)
- Dressing (d540)
- Acquisition of goods and services (d620)
- Doing housework (d640)
- Assisting others (d660)
- Intimate relationships (d770)

Participation
- Remunerative employment (d850)
- Non-remunerative employment (d855)*
- Community life (d910)
- Recreation and leisure (d920)

Environmental factors
- Products or substances for personal consumption (e110)
- Products and technology for personal use in daily living (e115)
- Products and technology for personal indoor and outdoor mobility and transportation (e120)
- Products and technology for employment (e135)
- Products and technology for culture, recreation, and sport (e140)*
- Design, construction, and building products and technology of buildings for public use (e150)
- Design, construction, and building products and technology of buildings for private use (e155)
- Climate (e225)
- Immediate family (e310)
- Friends (e320)
- Personal care providers and personal assistants (e340)
- Health professionals (e355)
- Individual attitudes of immediate family members (e410)
- Individual attitudes of health professionals (e450)
- Societal attitudes (e460)
- Transportation services, systems, and policies (e540)
- General social support services, systems, and policies (e575)
- Health services, systems, and policies (e580)

Personal factors*
- Age
- Sex
- Ethnicity
- Social background
- Education
- Profession
- Past and present experiences
- Comorbidity
- Personality traits
- Skills
- Lifestyle
- Habits
- Upbringing
- Coping
- Self-efficacy
- Disease perception

* added by development team of the Dutch physiotherapy guideline for hip and knee osteoarthritis (Peter WF, Jansen MJ, Hurkmans EJ, Bloo H, Dekker-Bakker LM, Dilling RG, Hilberdink WK, Kersten-Smit C, de Rooij M, Veenhof C, Vermeulen HM, de Vos I, Schoones JW, Vliet Vlieland TP. Physiotherapy in hip and knee osteoarthritis: development of a practice guideline concerning initial assessment, treatment and evaluation. Acta Reumatol Port. 2011:36:268-281).

Total hip and knee arthroplasty (THA and TKA)

THA and TKA are proven effective interventions to reduce pain and stiffness and improve the performance of daily activities and overall quality of life (QoL) in patients with end-stage hip or knee osteoarthritis.[24] In 2009, the numbers of patients undergoing total hip or knee arthroplasty were 1.6 and 1.2 per 1000 per year in Western countries. These numbers are expected to rise further in the coming years due to the abovementioned ageing society and the growing prevalence of obesity.[5,25] To monitor the safety and effectiveness of THA and TKA, national arthroplasty registers are instituted. Currently, 40 national, regional, or institutional registries are member of the International Society of Arthroplasty Registers (ISAR).[26] By tradition, arthroplasty registries mainly comprise procedure-related data, including the characteristics of the implants and surgical techniques as well as their functional outcomes, the focus regarding the latter being mainly on implant survival.[27] In the Netherlands, the Landelijke Registratie Orthopedische Implantaten (LROI, Dutch Implant Registry) was founded in 2007. In this register about 60.000 hip and knee prostheses are registered annually, with 100 contributing orthopaedic centers/ hospitals and the completeness being over 98%.[28,29]

Hip arthroplasty in the Netherlands

The annual number of primary THA in the Dutch Implant Register was 29.520 in 2016, whereas there were 3.836 hip arthroplasty revisions. The large majority (86%) of the patients underwent THA because of OA. The average age of THA patients in 2016 was 68.8 (SD: 10.5) years, with 65% of them being women. The most frequently used surgical approach was posterolateral (60%). Most procedures were uncemented (64%).[30]

Knee arthroplasty in the Netherlands

In 2016, the number of registered primary TKA was 27.918 whereas 2.886 knee revision arthroplasties were registered. The primary diagnosis leading to a primary knee arthroplasty was mainly OA (96%). The average age of the patients was 68.6 (SD 9.1) years and 64% of them were female[30]

Patient Reported Outcome Measures collected alongside national implant registries

As mentioned before, joint implant registries have long been mainly focused on technical aspects of the prosthesis in particular its survival. However, despite the overall favourable results, previous studies have estimated that between 7%-15%

of THA and 11-20% TKA patients are dissatisfied after surgery. Unfavourable pain outcome was reported in 9% or more of patients after hip and about 20% of patients after knee replacement. Since patient-perceived outcomes after THA and TKA are lower than implant survival rates, there is a growing recognition of the importance of the collection of patient-reported outcomes (PROMs) next to survival data within orthopedic arthroplasty registers.[31-36]

Currently, there are numerous examples of the registration of PROMs alongside orthopedic implant registries in Europe (Sweden, UK, Norway)[37,38], North and New Zealand.[39]

More and more it is acknowledged that PROMs should cover the domains of functioning that are relevant for OA patients as described in ICF core sets for OA (ICF, 2015). Recently the International Consortium for Health Outcomes Measurements (ICHOM) published a data collection reference guide with specific PROMs that should be included in joint arthroplasty registers[35]. The ICHOM Standard Set for Hip & Knee OA outcomes comprises the hip or knee functional status (HOOS-PS or KOOS-PS), pain (numeric or VAS scales), Quality of life (either the EQ-5D-3L, VR-12 or SF-12), work status (no specific questionnaire) and satisfaction with results (no specific questionnaire).[35]

Predictors of recovery after THA and TKA

Predictors of outcomes of THA and TKA in terms of worse recovery of hip or knee pain and/or function include higher age, female sex, morbid obesity (BMI >40), worse physical, mental and social functioning, multiple joint involvement and comorbidity.[6] The possible association between outcomes after THA and TKA and preoperative radiographic severity has been addressed repeatedly in the literature with conflicting results. [31,40-43] Although the results of most of the studies show some similarities, the designs of the studies are heterogeneous which makes it difficult to compare.

Fulfilment of expectations regarding return to normal activities after THA and TKA

With respect to dissatisfaction, evidence suggests that dissatisfaction seen in 10-20% of patients after THA or TKA is (at least partly) related to patients' expectations that are not fulfilled.[44] Treatment expectancy is defined as "improvements that clients believe will be achieved".[45] Several studies have assessed fulfilment of patients expectations regarding THA and/or TKA, however the majority only addressed a small selection of items (e.g. only expectations regarding pain), while evidence

shows that patients have a very wide range of expectations, in particular regarding daily activities.[44] Furthermore, a direct comparison of preoperative expectations regarding THA or TKA and their fulfilment in a general hospital setting was lacking.[44]

Return to work after THA and TKA

Currently, a substantial proportion of patients undergoing THA or TKA (15-45%) is of working age at the time these procedures are performed.[46]

These proportions are likely to increase as more and more women have a paid employment and the pensionable age is rising in line with the increasing life expectancy. Therefore, both from the perspective of the individual as well as from a socioeconomic point of view it is important to have insight into the rate and speed of return to work in this patient group. To date, only a limited number of studies on this topic have been published. A previous systematic review on work status in THA and TKA by Kuijer et al[47] aimed to describe determinants of return to work. The search in that review was restricted to studies published between 1998 and 2008 and concerned two bibliographic databases (Pubmed and Embase). In that review three studies, all concerning THA, were included. It was found that type of operation (2- incision or a mini-posterior approach for total hip arthroplasty), the provision of no movement restrictions and early, protocol-based patient discharge were associated with an earlier return to work after THA.[47]

Aims of this thesis

Given the lack of knowledge on the process of recovery after THA or TKA, the current thesis aims:

1. To evaluate the feasibility of a comprehensive set of PROMs, including measures of recovery to normal activities and work , after THA or TKA in a network of 7 collaborating hospitals, by means of a nested study within the Dutch Arthroplasty Register, LROI.

2. To determine the role of radiographic abnormalities as a predictor of recovery after THA and TKA.

3. To explore the fulfilment of patients' preoperative expectations regarding recovery to normal activities and the process of returning to work after THA or TKA as well as barriers and facilitators of return to work.

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Chapter

Feasibility of collecting multiple patient-reported outcome measures alongside the Dutch Arthroplasty Register

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ABSTRACT

Background:
The compliance rates with patient-reported outcome measures(PROMs) collected alongside arthroplasty registries vary in the literature. We aimed to describe the feasibility of a routinely collected set of PROMs alongside the Dutch Arthroplasty Register.

Methods:
The longitudinal Leiden Orthopaedics Outcomes of OsteoArthritis Study(LOAS) is a multicentre (7 Hospitals), observational study including patients undergoing total hip or total knee arthroplasty(THA or TKA). A set of PROMs: SF12, EQ5D, Hip/Knee injury and Osteoarthritis Outcome Score (H/KOOS), Oxford Hip/Knee Score was collected preoperatively and at 6, 12, 24 months and every 2 years thereafter. Participation rates (patients taking part in the study/invited patients), and response rates (patients returning the questionnaire/eligible patients) were recorded.

Results:
Between June 2012 and December 2014, 1796 THA and 1636 TKA patients were invited, of whom 1043 THA(58%; mean age 68 years(SD10)) and 970 TKA patients(59%; mean age 71 years(SD9.5)) participated in the study. At 6 months, 35 THA and 38 TKA patients were lost to follow-up. Response rates were 90% for THA (898/1000) and 89% for TKA (827/932) participants. At 1 and 2 years, 8 and 18 THA and 17 and 11 TKA patients were lost to follow-up, respectively. The response rates among those eligible were 87% (866/992) and 84% (812/972) for THA and 84% (771/917) and 83% (756/906) for TKA patients, respectively. The 2-year questionnaire was completed by 78.5% of the initially included THA patients and by 77.9% of the initial included TKA patients.

Conclusions:
About 60% of patients undergoing THA or TKA complete PROMs preoperatively, with more than 80% of them returning follow-up PROMs. To increase the participation rates, more efforts concerning the initial recruitment of patients are needed.

INTRODUCTION

Total hip and knee arthroplasty (THA and TKA) are effective interventions to reduce symptoms, improve daily activities and improve quality of life (QoL) in patients with end stage hip or knee osteoarthritis.[1] To monitor the safety and effectiveness of THA and TKA, national arthroplasty registers are instituted. Currently, 40 national, regional, or institutional registries are member of ISAR (International Society of Arthroplasty Registers).[2-5]

By tradition, arthroplasty registries mainly comprise procedure-related data on the characteristics of the implants and surgical techniques as well as their functional outcomes, the focus regarding the latter being mainly on implant survival.[6] However, since patient satisfaction as outcome scores after THA and TKA are lower than implant survival rates, there is a growing recognition of the importance of the collection of patient-reported outcomes (PROMs) next to survival data within orthopedic arthroplasty registers.[7-9] Currently, there are numerous examples of the registration of PROMs alongside orthopedic implant registries in Europe (Sweden, UK, Norway), North Americas [2;3] and New Zealand.[10]

The scientific value of the collected PROMs depends largely on the inclusion rates and completeness of collected data. Rolfson et al. presented an overview of inclusion and follow-up response rates specifically for THA and TKA, obtained in 3 national registries: The Swedish Hip Arthroplasty Register (SHAR), New Zealand Joint Registry (NZJR) and the National Joint Registry for England, Wales Northern Ireland and the Isle of Man (NJR).[8] Overall inclusion rates varied between 69-86%. Follow-up response rates were around 75% after 6 months, between 64 and 90% after 1 year and between 72 and 75% until 5 years.

Heterogeneity in completeness of inclusion and follow-up response rates is likely to be related to differences in clinical outcome measures and the logistic procedures of data collection.[11-13] This variation raises the question to what extent the collection of PROMs alongside an arthroplasty register or for that matter as a nested study within a national arthroplasty register is feasible in daily clinical practice. In addition, completed follow-up rates are often not mentioned, questioning the achievability of long-term follow-up of such data. The aim of the present study was to evaluate the feasibility of PROMs data collection up to 2-years after THA or TKA in a network

of 7 collaborating hospitals (as such a nested study within the Dutch Arthroplasty Register, LROI). A second aim was to evaluate the preoperative characteristics of the patients willing to provide PROMs.

MATERIALS AND METHODS

Study design

The longitudinal Leiden Orthopaedics Outcomes of OsteoArthritis Study (LOAS) has a multicenter, observational, prospective design (Trial ID NTR3348). Level of Evidence II. The study was approved by the Medical Ethics Committee of the Leiden University Medical Center (NTR3348) and all local hospital research committees in the participating hospitals. Funding was received from the Dutch Arthritis Foundation (LLP13). All patients in the study provided written informed consent. For the current analysis, the data (up to 30 November, 2015) from the patients enrolled during the first 30 recruitment months (June 2012 until December 2014) were used, with the data up to and including 24 months of follow-up being used.

Patients and recruitment

Hospitals were approached by the coordinating investigator. In return for their participation each participating hospital received a report on the results within their centre as well as anonymized data from the other centres (every 3 months), a website in Dutch for participating patients and health professionals (http://www.loas.nl), newsletters (every 3 months) and an annual meeting for the local investigators.

Patients

All patients undergoing primary THA or TKA in the participating centers, who were able to complete questionnaires in Dutch and are 18 years or older were considered eligible for participation in the LOAS study. Patients were invited by their treating orthopedic surgeon at their visit to the outpatient clinic prior to surgery. Every week, each hospital send a list of all patients who had been invited to participate in the study to the coordinating researcher, including an additional note if a patient refused to participate. Subsequently, patients who agreed to be approached for the study were further informed about the study by the coordinating researcher. They received an information package by mail, containing a patient information letter, the preoperative questionnaire and an informed consent form. Patients were included

in the study once written informed consent was obtained. Included patients were considered lost to follow-up in the study, if; (1) they did not return the questionnaires on 2 consecutive follow-up points, (2) on 2 consecutive follow-up points returned questionnaires that were less than half completed or (3) their contact details were no longer valid and could not be ascertained.

Outcome measures and study procedures in the LOAS study

A set of PROMs were collected in consecutive adult patients scheduled for THA or TKA preoperatively and 6, 12, and 24 months after surgery and every 2 year thereafter. The PROMs were collected alongside the data collection of The Dutch Arthroplasty Register (Landelijke Registratie Orthopedische Implantaten, LROI, http://www.lroi.nl/en/home).

Sociodemographic and clinical characteristics

The following data were gathered: age, sex; weight (kg) and length (m) to calculate the Body Mass Index (BMI); and work status (working/retired/housewife or -man/ unemployed and/or seeking work/receiving disability benefits).

PROMs as advised by the Dutch Orthopaedic Association

The Hip disability and Osteoarthritis Outcome Score (HOOS), the Knee injury and Osteoarthritis Outcome Score (KOOS) and the Oxford Hip Score (OHS) and the Oxford Knee Score (OKS) were used for the preoperative and postoperative assessment of pain, limitations-daily living, sport and recreation, joint function and joint related quality of life. We used the validated Dutch versions of the HOOS, KOOS and OHS and OKS. [12,14-16]

The Short Form-12 (SF12) and the EuroQol Visual Analogue Scale (EQ-VAS) were used to assess general health related quality of life. From the SF12 summary component scores for physical health (PCS) and mental health (MCS) were calculated. In this study, scores of a Dutch general population were used to standardize our scores in order to apply the norm-based scoring.[17;18]

The following additional assessments were also included for the LOAS cohort but are not reported in this study : (a) comorbidities assessed by means of the comorbidity questionnaire from the Dutch Central Bureau of Statistics[19]; (b) a self-developed questionnaire to assess work status; (c) physical activity determined by the Short

Questionnaire to Assess Health-enhancing physical activity (SQUASH) [20;21] or by the Dutch Norm of Healthy Exercise and Fitstandard; (d) expectations and satisfaction measured with the New York Hospital for Special Surgery Questionnaire[22]; (e) frailty assessed by means of the Groningen Frailty Index (GFI)[23] and (f) knee-instability assessed by a self-reported knee joint instability questionnaire according to the questionnaire of Felson et al[24] (g) status of living (living alone or with other people) and (h)smoking status (smoker/ non-smoker/ ex-smoker), .

Statistics

The feasibility of collecting multiple patient-reported outcome measures in the LOAS study alongside the Dutch Arthroplasty Register was determined by calculating the proportion of invited patients in the LOAS study that were included, the proportions of patients lost-to-follow-up, completion rates of questionnaires among eligible patients after 6, 12 and 24 months and overall response rates (patients initially included/patients returning a questionnaire) . Descriptive statistics were used for the preoperative baseline characteristics of included patients, with normally distributed data presented as mean and SD, data with a skewed distribution as median with ranges and categorical data as numbers with proportions. The age and sex distribution of patients included and not-included preoperatively were compared by means of unpaired t-test and Chi-Square tests, respectively.

RESULTS

Participation of hospitals and patient enrollment

From June 2012, the orthopaedic departments of 7 hospitals were invited to participate in the LOAS-study. The seven participating hospitals comprised one academic centre, one large teaching hospital and five general hospitals. The recruitment and inclusion of patients started in June 2012, within the subsequent 12 months all hospitals started the recruitment of patients.

Participation rates

Figure 1 describes the flow of patients. Of the 3631 identified and eligible patients who were admitted for THA/TKA surgery from June 2012 to December 2014, 1796/1893 THA (95%) and 1636/1738 TKA (94%) patients agreed to be contacted and were sent a set of PROMs. Of the 3432 invited patients, 1035/1796 THA (58%)

and 970/1636 TKA patients (59%) returned the preoperative questionnaire. Table 1 shows the variation of the included patients per hospital, the proportions ranged between 50-78% for THA and 50-80% for TKA.

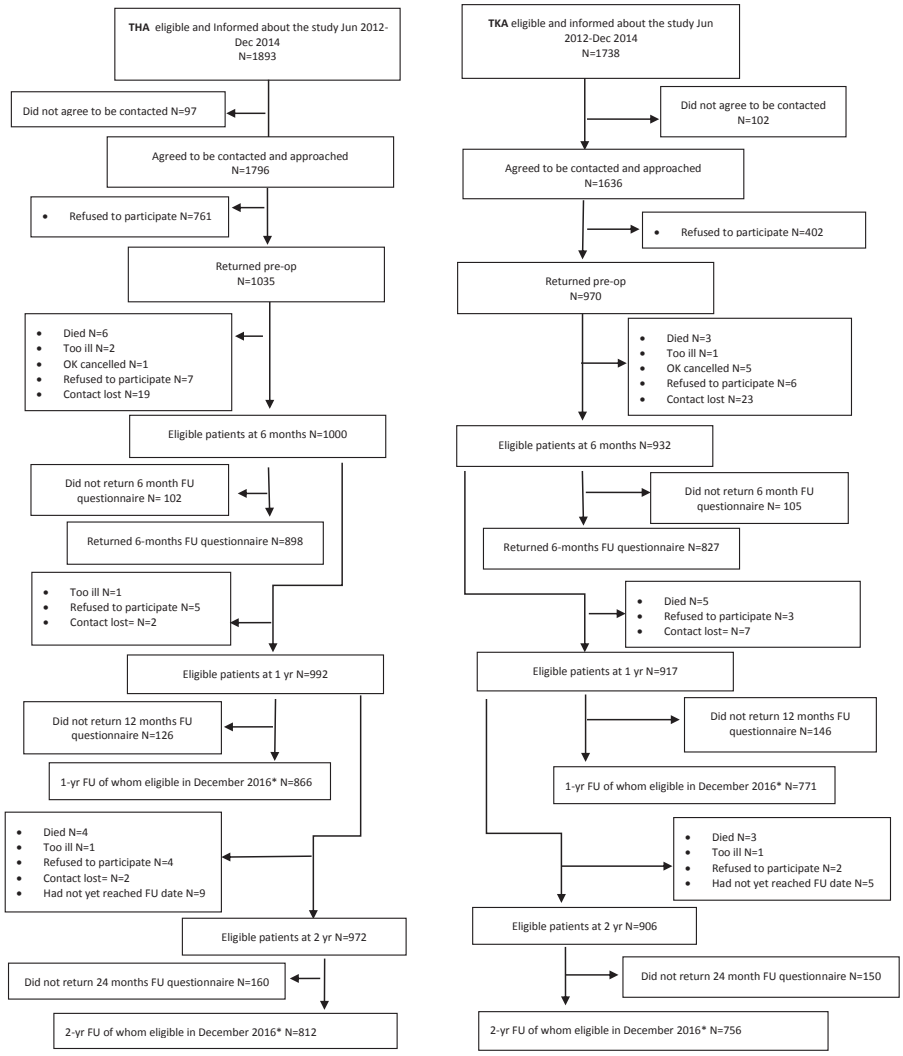

Fig 1. Flow Diagram

Table 1. Participating centres and the numbers of participating patients in the study on the collection of PROMS alongside the Dutch Arthroplasty Registry
PROMs = Patient Reported Outcome Measures; THA= Total Hip Arthroplasty; TKA= Total Knee Arthroplasty

Hospital	Total	1	2	3	4	5	6	7
Number of months including patients in study		30	29	29	12	28	24	11
Number of THA patients Informed about the study	1893	484	112	130	97	224	649	197
Agreed to be contacted and thus invited	1796	396	108	130	97	222	647	196
Included (included/invited)	1035 (57.6)	222 (56.1)	64 (59.3)	83 (63.8)	76 (78.4)	128 (57.7)	364 (56.3)	98 (50.0)
Number of TKA patients Informed about the study	1738	448	103	60	75	221	630	201
Agreed to be contacted and thus invited	1636	370	95	60	75	215	622	199
Included (included/invited)	970 (59.3)	214 (57.8)	62 (65.3)	30 (50.0)	60 (80.0)	142 (66.0)	350 (56.2)	112 (56.3)

Table 2. Response rates of the study population

	THA				TKA			
	Eligible (n)	Response (n)	Response rate Eligible patients (%)	Overall Response rate (%)	Eligible; n	Response; n	Response rate Eligible patients(%) %	Overall Response rate (%)
Pre-op	1796	1035	57.6	NA	1636	970	59.3	NA
6-month	1000	898	89.8	86.8	932	827	88.7	85.3
12-month	992	866	87.3	83.7	917	771	84.1	79.5
24-month	972	812	83.5	78.5	906	756	83.4	77.9

THA = Total Hip Arthroplasty
TKA = Total Knee Arthroplasty
Overall response rate= included patients/response

Response rates over time in eligible patients

At 6-month follow-up, 35 THA and 38 TKA patients were considered lost to follow-up. Therefore, 1000 THA (97%) and 932 (96%) TKA patients were eligible for 6-month follow-up. Of the eligible patients, 898/1000 THA patients (90%) and 827/932 TKA (89%) patients returned the follow-up questionnaire. Between 6 months and one year follow-up 8 THA and 15 TKA patients were lost to follow-up. The response rates at the one-year follow-up were 866 of the 992 eligible THA patients (87%) and 771 of the 917 eligible TKA patients (84%).
At two-year follow-up, with respect to one-year follow-up, 9 more THA and 6 more TKA patients were lost to follow-up. Furthermore, at the date of analysis, 9 THA and 5 TKA patients had not reached the two-year follow-up yet. Of the 972 eligible THA and 906 eligible TKA patients, 812 THA (84%) and 756 TKA patients (83%) completed the 2-year questionnaire (table 2).

Overall response rates over time

As expected the overall response rates decreased over time (table 2). The 2-year questionnaire was completed by 78.5% of the initially included THA patients and by 77.9% of the initial included TKA patients.

Characteristics of patients included at baseline

The baseline characteristics are depicted in table 3. The mean age of the included 1035 THA patients was 68 years (SD 10.0) and 71 years (SD 9.5) for the 970 TKA patients, the majority of the patients was female and approximately a quarter of the patients were employed (i.e. having a paid job)

Pre-operative PROMs

The mean (SD) HOOS and KOOS ADL, Pain, Quality of Life, Sport and Recreation and Symptoms scores ranged between 18 (SD 18.9) and 46 (SD 23.5) for patients undergoing THA and 11 (SD 14.2) and 44 (SD 18.5) for patients undergoing TKA. Furthermore, the OHS and OKS scores were 24 in both groups (SD 8.4 for OHS and SD 7.7 for OKS).

The mean EQ5D and EQ VAS scores were 0.60 (SD 0.26) and 66 (SD 18.5) for patients undergoing THA and 0.64 (SD 0.24) and 68 (SD 18.0) for patients undergoing TKA. In addition, the mean SF12 PCS score was 32 (SD 9.4 and 9.1, respectively) in both groups (table 3).

Included versus not-included patients

Regarding the comparison patients who were eligible and who did and who did not return a preoperative questionnaire, no differences were found in the sex distribution. In addition, the included patients were somewhat younger as compared to patients not returning the preoperative questionnaire (table 3).

Table 3. Preoperative characteristics of included and not-included patients undergoing Total Hip or Knee Arthroplasty (THA or TKA)

	THA	TKA
Included patients N=1035 and 970		
Sex, Female; n (%)	643 (62%)	642 (66%)
Age, years; mean (SD)	68 (10.0)	67 (9.0)
BMI; mean (SD)	28 (9.6)	29 (4.5)
Employed, yes; n (%)	248 (24%)	214 (23%)
HOOS or KOOS; mean (SD)		
Activity Daily Living	46 (23.5)	44 (18.5)
Pain	38 (18.9)	38 (18.2)
Quality of Life	33 (10.5)	34 (10.8)
Sport and Recreation	18 (18.9)	11 (14.2)
Symptoms	40 (18.9)	43 (13.2)
Oxford Knee/Hip Score; mean (SD)	24 (8.4)	24 (7.7)
EuroQol (EQ)5D score ; mean (SD)	0.60 (0.26)	0.64 (0.24)
EuroQol (EQ)5D VAS scale; mean (SD)	66 (18.5)	68 (18.0)
Short Form (SF)-12; mean (SD)		
Mental Component Score	55 (9.8)	55 (9.7)
Physical Component Score	32 (9.4)	32 (9.1)
Not included patients N=761 and 666†		
Sex, Female; n (%)	494 (65%)‡	474 (71%)‡
Age, years; mean (SD)	70 (10.2) §	69 (10.1) §

BMI = Body Mass Index
HOOS = Hip disability and Osteoarthritis Outcome Score
KOOS = Knee Injury and Osteoarthritis Outcome Score
†Eligible patients invited to participate not returning the preoperative questionnaire
‡ No statistically significant differences between patients included preoperatively or 6 months postoperatively (Chi-Square test)
§ Statistically significant different between patients included preoperatively or 6 months postoperatively (p-value=0.001 for THA as well as TKA, unpaired t-test)

DISCUSSION

The current study demonstrated that nearly 60% of patients undergoing THA or TKA completed a set of PROMs preoperatively, in addition each time the questionnaire was assessed more than 80% of the invited patients returned the questionnaire. After 2 years of follow-up the response rate was respectively 79% and 78% for THA and TKA patients.

As compared to other registers, our inclusion rates were lower than the inclusion rates in the SHAR (86% for a set of PROMs consisting of the EQ-5D, Pain (VAS) and Satisfaction (VAS)), the NZJR (69% and collected the EQ-5D and the OHS/OKS) and NRJ (75%, collected the EQ-5D, OHS/OKS and satisfaction). Conversely, our postoperative participation rates were comparable as reported by the SHAR (90% after 6 months) and somewhat higher than reported in the NRJ (75-76% after 6 months and 64% after 1 year).[12;13]

A possible explanation for the higher inclusion rates of the SHAR is that our questionnaire was more extensive which possibly influenced the response rate. Another explanation for the different inclusion rates could be that patients in some of the aforementioned studies such as the SHAR[27] completed the preoperative questionnaires at the outpatient clinic, whereas in our study preoperative questionnaires were sent to patients' home addresses. This was done as we anticipated that anxiety might be present at the day of hospital admission. However, in retrospect, not using a personal approach may have led to a relatively large proportion of patients not completing the preoperative forms. A last possible explanation is that we did not contact the patients who did not respond to the invitation . Our aim was to create and investigate a non-invasive structure which would be easy to implement. Nevertheless, inclusion-rates would probably have been higher if we contacted all patients who did not respond to the preoperative questionnaire by telephone.

The hypothesis that response rates of questionnaires sent by regular mail are lower as compared to response rates of questionnaires completed at the outpatient clinic is supported by a comparison of our results with previous studies.[8] The aforementioned studies sent the follow-up questionnaires by regular mail as well, resulting in response rates similar to ours. In our study, solely patients who were willing

to return postal questionnaires were included, maintaining a high postoperative response-rate. In order to stimulate patients to continue participation we also have patient-partners within our LOAS governing board and we mail patients several times a year (e.g. LOAS Happy New year cards and newsletters).

Besides, we observed considerable differences between the inclusion rates of the hospitals. A possible explanation would be that some hospitals informed all patients about the study and sent them all to the coordinating researcher, whereas others informed only those probably participating in the study. A direct link with the registered patients in the Dutch Arthroplasty Register is necessary to get insight into these numbers. Another possible explanation would be discrepancies in the content and manner of the provided information to patients.

Concerning the mode of administration of the PROMs, the LOAS study only used pen-and-paper questionnaires during the inclusion period of the present analysis. Previous authors suggested that electronical questionnaires cannot replace pen-on-paper questionnaires,[28;29] but, like other registers[8] we are developing an Internet-based structure to collect the PROMs next to the traditional pen-and-paper questionnaires, to improve efficiency.

The selection of PROMs, to include in patient cohort studies necessitates the use of appropriate methodological techniques and the inclusion of both generic and condition-specific PROMs. Furthermore, the number of questions in the survey must be reasonable to provide a high patient-response rate.[8;30] Moreover, PROMs should cover the domains of functioning that are relevant for osteoarthritis patients as described in ICF core sets for osteoarthritis.[31] Recently the International Consortium for Health Outcomes Measurements (ICHOM) published a data collection reference guide with specific PROMs that should be included in joint arthroplasty registers.[32] The ICHOM Standard Set for Hip & Knee OA outcomes comprises the hip or knee functional status (HOOS-PS or KOOS-PS), pain (numeric or VAS scales), Quality of life (either the EQ-5D-3L, VR-12 or SF-12), work status (no specific questionnaire) and satisfaction with results (no specific questionnaire). The set of PROMs used in the present study is in line with this standard set.

This study has a number of limitations. First, from the registered patients in the Dutch Arthroplasty Register from the participating hospitals, we estimated that only

70-80% of the eligible patients were actually informed about the study. Reasons for this could be that the local orthopaedic surgeons excluded patients in an early stage (for reasons such as age, language, mental or physical health problems, or participation in a different THA or TKA study). Moreover, logistical problems, such as forgetting to inform the patients about the study or not registering patients interest to receive more LOAS study information on the list that is weekly sent to the coordinating researcher. Our goal is to attain a rate of 100% of potential eligible patients that can be informed about and invited for the study. More effort could be put in supporting the hospitals in logistic support to get all eligible patients informed about the study. Secondly, about 40% of patients did not fill in the preoperative questionnaire Possible reasons for this are not clear, but it could be that the information about the study was insufficient or absent, surgery date was too close, the number of PROMs too high, or personal health reasons such as not being interested, already participating in a scientific study or having mental or physical health problems).

In conclusion, with about 60% of all contacted patients in both THA and TKA being included in the present study, but relatively low attrition rates, in particular the initial inclusion of patients' needs attention.

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Chapter

Outcome of total hip arthroplasty, but not of total knee arthroplasty, is related tot the preoperative radiographic severity of osteoarthritis

A prospective cohort study of 573 patients

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Abstract

Background and purpose

There is no consensus on the impact of radiographic severity of hip and knee osteoarthritis (OA) on the clinical outcome of total hip arthroplasty (THA) and total knee arthroplasty (TKA). We assessed whether preoperative radiographic severity of OA is related to improvements in functioning, pain, and health-related quality of life (HRQoL) 1 year after THA or TKA.

Patients and methods

This prospective cohort study included 302 THA patients and 271 TKA patients with hip or knee OA. In the THA patients, preoperatively 26% had mild OA and 74% had severe OA; in the TKA patients, preoperatively 27% had mild OA and 73% had severe OA. Radiographic severity was determined according to the Kellgren and Lawrence (KL) classification. Clinical assessments preoperatively and 1 year postoperatively included: sociodemographic characteristics and patient-reported outcomes (PROMs): Oxford hip/knee score, hip/knee injury and osteoarthritis outcome score (HOOS/KOOS), SF36, and EQ5D. Change scores of PROMs were compared with mild OA (KL 0–2) and severe OA (KL 3–4) using a multivariate linear regression model.

Results

Adjusted for sex, age, preoperative scores, BMI, and Charnley score, radiographic severity of OA in THA was associated with improvement in HOOS "Activities of daily living", "Pain", and "Symptoms", and SF36 physical component summary ("PCS") scale. In TKA, we found no such associations.

Interpretation

The decrease in pain and improvement in function in THA patients, but not in TKA patients, was positively associated with the preoperative radiographic severity of OA.

The possible association between outcomes after THA and TKA, and preoperative radiographic severity has been addressed repeatedly. Nilsdotter et al.[1] found that in patients undergoing THA, the preoperative radiographic stage of osteoarthritis (OA) was not related to the postoperative outcome after 1 year. Cushnaghan et al.[2] reported that in TKA patients, improvement in physical function as measured with the Short Form (SF)-36 mean 7 years after surgery tended to be greater in patients with a higher Kellgren and Lawrence (KL) grade at baseline. Valdes et al.[3] found that a low radiographic grade of the index joint was associated with an increased risk of postoperative pain 3 years after THA and TKA. Dowsey et al.[4] reported that lower severity of radiographic OA was associated with poorer function and more pain after TKA. Keurentjes et al.[5] found that both THA patients and TKA patients with severe radiographic OA had a greater improvement in the SF-36 domain "Physical functioning" than patients with mild radiographic osteoarthritis after 2–5 years of follow-up.

Although the results of most of the studies show some similarities, the designs of the studies were heterogeneous, which makes it difficult to compare them. To overcome these limitations, we determined whether the preoperative radiographic severity of OA is related to improvement in functioning, pain, and HRQoL 1 year after THA or TKA in a prospective, well-defined cohort of patients, using multivariate analysis to account for possible confounding.

Patients and methods

Patients and recruitment

This prospective cohort study was performed at the Department of Orthopaedics, Rijnland Hospital, the Netherlands from October 2010 through September 2012.

We aimed to include all consecutive patients undergoing a primary THA or TKA because of OA, aged 18 years or older, who were able to read and understand Dutch and were mentally and physically capable of completing questionnaires.

Patients with revision of a THA or TKA, those undergoing a hemiarthroplasty, and those undergoing a THA or TKA because of tumor or rheumatoid arthritis were excluded.

1 day preoperatively, before they were admitted to hospital, all eligible patients were given oral and written information concerning the study from the treating orthopaedic surgeon. Each patient was asked to return the set of questionnaires and the informed consent form when he or she was admitted the next day, the day of surgery. For the patients who did not want to participate, only age, sex, and the type of operation (THA or TKA) were recorded.

In cases where a patient who was already included in the study underwent another joint replacement during the study period, he or she was not included for a second time.

745 patients were admitted for THA and 614 patients were admitted for TKA from October 2010 through September 2012. Primary THA for primary OA was performed in 665 patients. Primary TKA for primary OA was performed in 599 patients. These 1,264 patients met all of the selection criteria and were asked to complete a questionnaire 1 day preoperatively. Of these, 302 THA and 271 TKA patients were included in the present study (Figure 1).

Sociodemographic and clinical characteristics

Sociodemographic characteristics (only preoperatively) included: age; sex; length (cm) and weight (kg), to calculate the body mass index; level of education (low: primary school, lower vocational education; medium: lower general secondary school, intermediate vocational education; or high: higher general secondary school, higher vocational education, university); and marital status (living alone—yes/no). In addition, it was asked whether patients had a paid job (yes/no). If not, they were asked to indicate if they were: a pensioner, a housewife/ houseman, or unemployed. For comorbidity, the self-reported Charnley classification (A–C) was used. Due to an error in the preoperative knee questionnaires, we were not able to determine the Charnley classification in the TKA group.

Patient-reported outcomes (PROMs) were used to describe the clinical characteristics at baseline. The hip disability and osteoarthritis outcome score (HOOS), the knee injury and osteoarthritis outcome score (KOOS), the Oxford hip score (OHS) and the Oxford knee score (OKS) were used for the preoperative and postoperative assessment of limitations (daily living, sport and recreation, function, and health-related quality of life). We used the validated Dutch versions of the HOOS, KOOS, OHS, and OKS.[6-8]

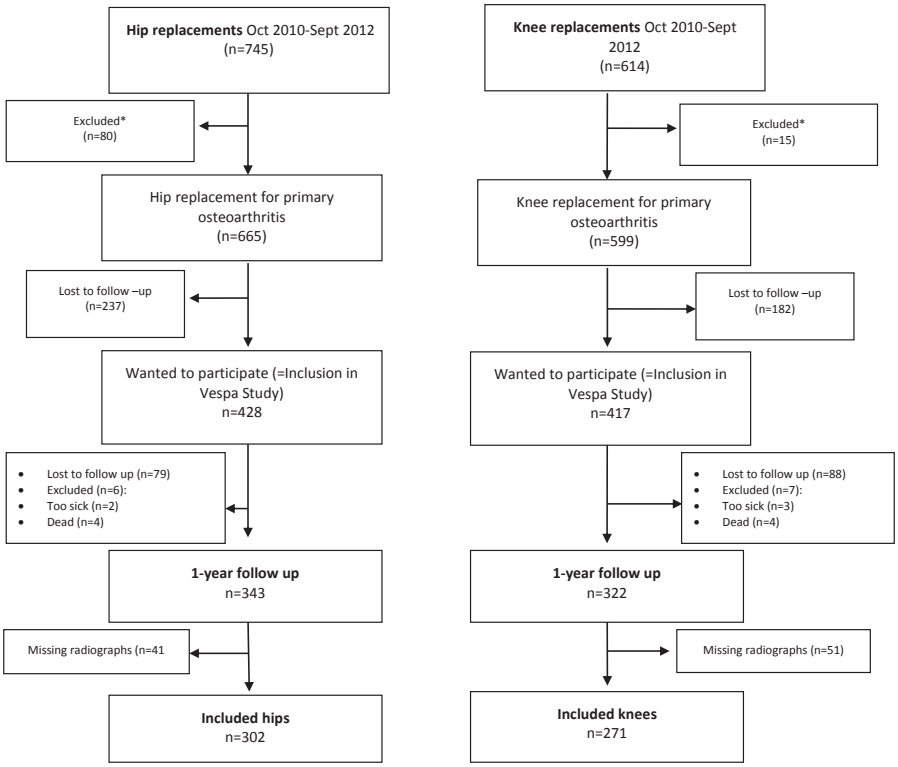

Figure 1. Flow diagram.

* Reasons for exclusion were patients who did not understand Dutch or werebeing physically or mentally able to complete questionnaires, patients with revision surgery, undergoing a hemi-arthroplasty, or undergoing a THA or TKA because of a tumor or rheumatoid arthritis.

The Short Form-36 survey (SF-36),[9,10] the EuroQol 5 dimensional (EQ5D), and the EuroQol visual analog scale (EQ-VAS) were used to assess general health-related quality of life. From the SF-36, summary component scores for physical health (PCS) and mental health (MCS) were calculated. In this study, scores from a general Dutch population were used to standardize our scores in order to apply the norm-based scoring.[11]

Preoperative radiographic severity

Preoperative supine radiographs of hips (anterior-posterior) and weight-bearing radiographs of the knees (posterioranterior) had been taken routinely in the participating centers for preoperative templating purposes. All radiographs were assessed by an experienced musculoskeletal radiologist (HMK), who was blinded regarding patient characteristics. The Kellgren and Lawrence (KL) grading system

was used to classify the severity of OA (grade 0: indicating no OA; grade 1: doubtful OA; grade 2: minimal OA; grade 3: moderate OA; and grade 4: severe OA).[12] 10% of the radiographs were scored twice: correlation between both readings was used to establish the intra-reader reliability (intra-class correlation, hip radiographs: 99% (95% CI: 85–93); intra-class correlation, knee radiographs: 95% (95% CI: 92–98)). The second reading was used for further statistical analyses. The KL grade in our study was classified as mild for KL 0–2 and severe for KL3–4.

Statistics

Comparisons between patient characteristics preoperatively that were included in the analysis and those that were excluded due to incomplete follow-up were performed with chi-squared tests (for categorical variables), or independent-samples t-tests or Mann-Whitney U-tests (for continuous variables). The choice between unpaired t-tests and Mann-Whitney U-tests was based on the distribution of the variables. For this purpose, we made normality plots of all continuous variables using the Kolgomorov-Smirnov test.

Comparisons of the preoperative characteristics and the change scores over time between the groups of patients with mild and severe OA were first done with ANOVA. Then multivariable linear regression analyses were performed, with the KL grade (mild/severe) as independent variable, for the following outcomes: the mean change in the HOOS/KOOS, OHS/OKS, SF subscales, SF summary scales, EQ score, and EQ-VAS scale. All analyses were adjusted for potential confounding factors (derived from the literature on determinants of outcome in THA and TKA and/or the above-mentioned crude analyses ($p > 0.10$, ANOVA)). Potential confounding factors considered were the KL grade (mild/severe); age (divided into the groups 0–65 years, 66–75 years, and ≥ 76 years); sex; BMI (categorized as 0–25, 26–30, and ≥ 31); and—only for the THA group—the Charnley classification (A, B, or C).

Outcome variables (dependent) were the mean change scores of the HOOS/KOOS, OHS/OKS, SF subscales, SF summary scales, EQ score, and EQ-VAS scale. Data were analyzed using the SPSS statistical package version 20.0. All statistical testing was performed with 2-tailed tests and the level of statistical significance was set at $p \leq 0.05$ for all analyses.

Ethics

The study protocol was reviewed and approved by the local hospital review board (Rijnland Hospital, Leiderdorp; registration number 10/07), which is affiliated to the

Medical Research Ethics Committee of Leiden University Medical Center, Leiden, the Netherlands. Written informed consent to participate in the study was obtained from all patients.

Results

Preoperative patient characteristics

There was no statistically significant difference between the preoperative characteristics of the patients who were included in the study and those of the 41 THA and 51 TKA patients who were not included because of missing radiographs (results not shown).

Preoperative characteristics of patients with mild or severe radiographic OA

Overall, there were no statistically significant differences between patients with mild or severe radiographic OA with respect to sex, age, BMI, preoperative HOOS/ KOOS, OHS/ OKS, EQ score, EQ-VAS score, or SF (all subscales), for both THA and TKA. The exceptions were a significantly higher preoperative KOOS "Sports" score and SF "MCS" score in the KL 3–4 group than in the KL 0–2 group, in both THA patients and TKA patients (Table 1).

Table 1. Characteristics of patients undergoing THA and TKA differences in severity of radiological damage

Variable	THA Patients KL grade 0-2 (N=77)	THA Patients KL grade 3-4 (N=225)	P	TKA Patients KL grade 0-2 (N=74)	TKA Patients KL grade 3-4 (N=197)	P
Gender, Female; no (%)	45 (58%)	132 (59%)	0.702	56 (76%)	135 (69%)	0.250
Age, years (mean, SD)	66.0, 10.6	68.0, 9.0	0.297	66.7, 10.1	67.2, 9.5	0.732
0-55	12 (16%)	17 (8%)	0.452	6 (8%)	22 (11%)	0.153
56-65	23 (30%)	71 (32%)		23 (31%)	61 (31%)	
66-75	29 (38%)	93 (41%)		31 (42%)	74 (38%)	
76-85+	13 (17%)	44 (20%)		14 (19%)	40 (20%)	
Body Mass Index (mean, SD)	27.8, 4.5	26.7, 4.4	0.055	29.9, 4.5	29.5, 4.7	0.524
Education level: no (%)						
Low	31 (40%)	81 (36%)		21 (68%)	90, (46%)	
Medium	22 (29%)	70 (31%)		19 (26%)	64 (33%)	
High	24 (31%)	74 (33%)		5 (7%)	43 (22%)	

Table 1. continued

Variable	THA Patients KL grade 0-2 (N=77)	THA Patients KL grade 3-4 (N=225)	P	TKA Patients KL grade 0-2 (N=74)	TKA Patients KL grade 3-4 (N=197)	P
Work status						
Working	18 (23%)	54 (24%)		13 (18%)	44 (22%)	
Preoperative HOOS or KOOS; mean (SD)						
ADL (0-100)	45.6, 17.3	44.2, 18.0	0.585	48.5, 19.0	48.9. 17.5	0.923
Pain (0-100)	41.2, 17.6	42.4, 18.5	0.640	41.5, 17.5	42.0, 16.3	0.959
Quality of life (0-100)	35.5, 11.8	34.5, 10.9	0.259	36.2, 10.8	34.7, 9.7	0.547
Sport (0-100)	20.6, 18.8	20.3, 19.5	0.776	10.2, 16.4	14.1, 15.8	0.048
Symptoms (0-100)	38.2, 17.6	37.4, 18.7	0.534	45.3, 14.0	45.4, 13.2	0.967
Preoperative EQ5D score (0-1)	0.6, 0.2	0.6, 0.3	0.549	0.6, 0.3	0.6, 0.2	0.878
Preoperative EQ5D VAS scale (0-100)	65.7, 16.8	67.0, 18.3	0.447	66.4, 23.0	71.8, 16.0	0.264
Preoperative Oxford Knee/Hip Score	24.1, 7.2	25.0, 7.3	0.523	24.9, 7.1	25.5, 6.8	0.533
Preoperative SF36 Subscale						
Physical Functioning	38.8, 17.9	34.7, 18.8	0.065	35.4, 19.0	36.5, 17.9	0.618
Role Physical	31.9, 41.4	31.1, 37.9	0.791	40.2, 43.8	39.6, 42.7	0.953
Bodily Pain	46.6, 17.1	45.2, 19.7	0.409	43.3, 21.8	42.8, 18.4	0.853
General Health	63.1, 19.8	66.3, 18.9	0.205	68.5, 16.6	68.6, 18.2	0.886
Vitality	51.9, 20.0	57.2, 20.9	0.059	61.2, 20.5	61.4, 19.7	0.942
Social Functioning	67.1, 23.7	68.1, 24.0	0.838	70.3, 27.8	70.1, 27.1	0.899
Role Emotional	62.9, 44.5	69.0, 40.7	0.426	63.1, 44.2	73.7, 38.2	0.125
Mental Health	71.5, 14.7	74.9, 16.4	0.096	75.5, 15.6	77.2, 16.7	0.299
Preoperative SF36 MCS (0-100)	48.7, 10.1	51.7, 10.2	0.027	52.5, 9.9	53.4, 10.1	0.615
Preoperative SF36 PCS (0-100)	40.9, 7.9	39.6, 7.1	0.170	40.8, 7.2	40.2, 7.6	0.397

* Comparison of patients with KL grade 0-2 and 3-4 at preoperative assessment by means of Mann-Whitney U or Chi Square tests where appropriate. Significance level < 0.05.

Crude and adjusted changes in health-related quality of life and functional outcome measurements in patients with mild or severe radiographic OA

The crude (unadjusted) mean change scores (postoperative scores minus preoperative score) in patients with mild or severe radiographic OA are shown in Tables 2a and 2b. In THA patients, the mean change scores were statistically significantly higher in patients with KL 3–4 than in patients with KL 0–2 with respect to HOOS "Symptoms", EQ score, SF "Physical functioning" and "Bodily pain"; and SF "PCS". In TKA patients, there were no statistically significant differences in change

scores between patients with KL 0–2 and patients with 3–4 for all of the PROMs (Table 2a and 2b).

Adjusting for sex, age, preoperative scores of PROMs, and BMI (and Charnley score in THA), in the THA group the severity of radiographic OA was related to 3 of 5 HOOS subscale scores ("ADL" (p = 0.002), "Pain" (p = 0.004), and "Symptoms" (p = 0.004)), the SF subscale score "Bodily pain" (p = 0.004) and the SF "PCS" (p = 0.01), but not to the HOOS "Sports" and "Quality of life" subscale scores, the EQ and EQ-VAS scales, the SF "MCS" and all the other SF subscales. In the TKA group, there was no association between radiographic severity and improvement in any of the PROMs (Table 2a and 2b).

Table 2a. Change scores of clinical outcome measures in 302 patients undergoing Total Hip Arthroplasty (THA) according to preoperative radiographic severity

			Difference between change scores of KL 1-2 versus KL 3-4		
	KL grade 0-2 (N=77) Mean Change (95%CI)	KL grade 3-4 (N=225) Mean Change (95%CI)	P-value Mann Whitney	B (95% CI) Multivariate Analysis	P-value Multivariate Analysis
HOOS; mean					
Activities of Daily Living	36.1 (29.1; 42.8)	42.3 (38.2; 45.8)	0.096	-7.5 (-12.1;-2.8)	0.002
Pain	41.8 (35.1; 48.1)	46.1 (42.2; 49.8)	0.391	-6.1 (-10.2; -2.0)	0.004
Quality of life	18.1 (12.7; 24.2)	22.4 (19.0; 25.6)	0.059	-3.8 (-9.0; 1.4)	0.153
Sport	38.3 (29.0; 47.4)	45.5 (40.3; 50.5)	0.260	-4.2 (-11.9; 3.6)	0.290
Symptoms	34.8 (27.8; 41.9)	45.7 (40.7; 50.7)	0.023	-8.4 (-14.1; -2.6)	0.004
EQ5D score	0.2 (0.1; 0.3)	0.3 (0.2; 0.4)	0.028	-0.1 (-0.1; 0.0)	0.052
EQ5D VAS scale	11.6 (6.6; 17.0)	13.6 (9.5; 17.6)	0.532	-1.3 (-6.3; 3.7)	0.598
Oxford Hip Score	15.8 (13.3; 18.4)	17.2 (15.4; 18.8)	0.587	-2.0 (-4.2; 0.2)	0.068
SF36 Subscale					
Physical Functioning	26.4 (19.0; 34.0)	36.5 (32.0; 40.9)	0.026	-6.1 (-12.9; 0.7)	0.076
Role Physical	40.4 (28.8; 53.9)	45.8 (37.4; 53.9)	0.446	-8.4 (-18.9; 2.2)	0.120
Bodily Pain	28.0 (21.5; 34.7)	40.4 (35.6; 44.8)	0.006	-9.3 (-15.4;-3.1)	0.004
General Health	2.6 (-2.3; 7.5)	3.3 (0.2; 6.4)	0.936	-2.7 (-7.6; 2.2)	0.280
Vitality	12.0 (6.8; 17.4)	12.4 (9.3; 15.7)	0.639	-2.9 (-7.6; 1.8)	0.220
Social Functioning	14.9 (8.5; 21.6)	17.3 (12.7; 22.0)	0.442	-3.8 (-9.7; 2.2)	0.211
Role Emotional	19.5 (4.9; 34.1)	19.9 (12.8; 27.2)	0.504	-5.1 (-13.6; 3.5)	0.244
Mental Health	7.1 (2.8; 11.4)	5.9 (3.5; 8.3)	0.568	-1.1 (-4.7; 2.5)	0.549
SF36 MCS	2.7 (-0.5; 5.8)	1.2 (-0.6; 2.7)	0.224	0.3 (-1.9; 2.5)	0.793
SF36 PCS	9.8 (7.1; 12.4)	13.7 (12.1; 15.2)	0.012	-2.9 (-5.2; -7.2)	0.010

* Comparison of patients with KL grade 0-2 and 3-4 at preoperative assessment by means of Mann-Whitney U test. Significance level < 0.05.
HOOS= Hip disability and Osteoarthritis Outcome Score, EQ5D= Euroqol 5 Dimensional questionnaire; EQ5D-VAS scale= Euroqol 5 Dimensional Visual Analogue Scale; SF36= Short Form 36; MCS=Mental Component Summary Scale; PCS=Physical Component Scale

Table 2b. Change scores of clinical outcome measures in 271 patients undergoing Total Knee Arthroplasty (TKA) according to preoperative radiographic severity

Variable	KL grade 0-2 (N=74) Mean Change (95%CI)	KL grade 3-4 (N=197) Mean Change (95%CI)	Difference between change scores of KL 1-2 versus KL 3-4		
			P-value Mann Whitney	B (95% CI) Multivariate Analysis	P-value Multivariate Analysis
Difference KOOS; mean					
ADL	33.2 (27.6; 39.4)	36.2 (32.7; 39.7)	0.587	-0.8 (-5.7; 4.1)	0.743
Pain	40.2 (33.9; 46.6)	43.5 (39.7; 47.0)	0.737	-0.8 (-5.7; 4.2)	0.757
Quality of life	13.8 (9.0; 18.9)	20.0 (17.0; 23.0)	0.295	-1.5 (-6.1; 3.1)	0.523
Sport	8.3 (3.6; 12.9)	9.5 (6.7; 12.4)	0.597	-0.5 (-5.3; 4.3)	0.834
Symptoms	27.6 (19.3; 36.9)	38.7 (33.8; 44.1)	0.096	-6.7 (-14.8; 1.5)	0.108
Difference EQ5D score	0.3 (0.2; 0.4)	0.2 (0.2; 0.3)	0.095	0.0 (-0.0; 0.1)	0.489
Difference EQ5D VAS scale	10.7 (3.9; 17.8)	9.6 (6.6; 12.3)	0.733	1.4 (-2.7; 5.5)	0.496
Difference Oxford Knee Score	15.3 (12.7; 18.2)	15.9 (14.5; 17.1)	0.318	-0.6 (-2.5; 1.3)	0.557
Difference SF36 Subscale					
Physical Functioning	31.5 (24.2; 39.6)	32.0 (27.9; 36.1)	0.149	-3.2 (-9.4; 3.0)	0.315
Role Physical	30.8 (17.9; 44.9)	31.3 (21.2; 40.0)	0.727	4.8 (-5.8; 15.5)	0.369
Bodily Pain	32.0 (23.1; 40.9)	35.3 (31.0; 40.0)	0.550	-5.4 (-5.4; 7.5)	0.739
General Health	-0.6 (-6.3; 5.0)	1.7 (-1.0; 4.8)	0.828	-1.1 (-5.7; 3.5)	0.639
Vitality	5.9 (0.6; 10.8)	9.1 (5.9; 12.2)	0.937	0.5 (-4.1; 5.2)	0.827
Social Functioning	16.3 (8.0; 25.0)	10.4 (5.7; 15.5)	0.780	3.7 (-2.4; 9.9)	0.235
Role Emotional	12.4 (-1.3; 24.4)	5.1 (-1.8; 12.2)	0.109	5.9 (-3.9; 15.8)	0.237
Mental Health	2.8 (-3.0; 8.4)	1.9 (-0.6; 4.2)	0.434	1.8 (-2.5; 6.1)	0.403
Difference SF36 MCS	-0.4 (-3.9; 17.8)	-1.9 (-3.3; -0.5)	0.357	1.5 (-1.1; 4.0)	0.249
Difference SF36 PCS	10.8 (7.9; 13.9)	12.1 (10.4; 13.8)	0.201	-0.6 (-3.1; 2.0)	0.667

* Comparison of patients with KL grade 0-2 and 3-4 at preoperative assessment by means of Mann-Whitney U test. Significance level < 0.05.
KOOS= Knee disability and Osteoarthritis Outcome Score, EQ5D= Euroqol 5 Dimensional questionnaire; EQ5D-VAS scale= Euroqol 5 Dimensional Visual Analogue Scale; SF36= Short Form 36; MCS=Mental Component Summary Scale; PCS=Physical Component Scale

Discussion

This prospective study in patients undergoing THA and TKA showed that changes in scores over time were greater in patients with more severe radiographic OA. The difference was statistically significant for a number of clinical outcomes in THA patients, but not in TKA patients.

Overall, our results are in line with the literature, with the majority of studies concluding that more severe radiographic OA preoperatively is associated with better outcomes in THA or TKA.[3-5] Concerning THA specifically, similar to the present study, Valdes et al.[3] reported greater improvements in pain 3 years after surgery in patients with severe radiographic OA preoperatively. Greater improvements in the SF subscale and summary scale scores were seen in patients with higher KL scores in a study by Keurentjes et al.[5], but the differences were not statisticaly significant.

Regarding TKA, our study did not show any statistically significant differences between the outcomes in patients with different grades of radiographic severity, although—as in the study by Cushnaghan et al.[2]—greater improvements were generally seen in patients with higher KL grades. In contrast, Valdes et al.[3] and Keurentjes et al.[5] found statistically significantly better outcomes in TKA patients with severe radiographic OA, and similar results were seen in some of the analyses in the study by Dowsey et al.[4] Comparisons with the literature are, however, hampered by the large diversity in study designs and analyses.

It is difficult to draw conclusions about the clinical relevance of the results of our study and of previous ones. Firstly, there are several factors associated with worse outcomes after THA/TKA, such as older age, female sex, obesity, worse general health, involvement of other joints, and a lower level of education.[13, 14] Only from large, prospective studies using a standardized set of preoperative characteristics and outcome assessments done at fixed time points can true prediction models including all potentially relevant determinants be derived, which afterwards need to be validated in multiple settings and countries. However, we can interpret the absolute change scores as observed in the different groups according to radiographic severity. A recent systematic review by Keurentjes et al.[15] found that overall minimally clinically important differences (MICDs) in HRQoL in THA/TKA have limited precision and are not validated using external criteria. The study which is most comparable to our study is that from Clement et al.[16] In that study, the MCID in OKS for the difference between preoperatively and 1 year postoperatively was 15.5 (95% CI: 14.7–16.4). In our study, generally patients in both the mild and severe OA groups achieved this improvement, indicating that the clinical relevance of a statistically significant difference may be limited.

A main strength of our study was the inclusion of a wide range of validated PROMs, covering all items of diseasespecific outcome measures in functioning, pain, and healthrelated quality of life. Using all these outcome measures, both measures of pain and daily activities, we observed differences between groups according to radiographic severity. Another strength was that all radiographs were read by a single observer with extensive experience, who was blinded regarding patient data. In addition, this was a prospective study with a relatively large cohort with only 20% loss to follow-up in the THA group and only 23% loss to follow-up in the TKA group. Our study also had a number of limitations. It only included KL grading applied to the anteroposterior and posteranterior radiographs from the preoperative hip and knee.

In the study by Dowsey et al.[4], not only KL grading but also the severity of joint space narrowing (JSN; 0–3) and osteophyte formation (0–3) using the Osteoarthritis Research Society International (OARSI) atlas, and the degree of bone attrition, were taken into account. In that study, radiographs showing advanced OA (KL 3–4) were further subdivided by including data from the individual score of JSN and bone attrition.

In addition, the patients included in the present study were a selection of all patients who underwent THA or TKA and it was carried out in 1 center in 1 country. However, the preoperative characteristics of the patients and their change scores over time are well in line with those observed in other large cohorts.[13, 16, 17]

In conclusion, this study shows that in patients who underwent THA, but not TKA, more severe radiographic OA preoperatively was associated with a better outcome regarding pain and function.

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Chapter

Unfulfilled expectations after total hip and knee arthroplasty surgery: there's a need for better preoperative patient information and education

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Abstract

Background:
The aims of this study were to assess patients' preoperative expectations of the outcome of total hip or knee arthroplasty (THA/TKA) regarding specific aspects of functioning and to determine to what extent each expectation was fulfilled after 1 year.

Methods:
This was a prospective cohort study. Preoperative expectations and their fulfillment after 1 year were measured with the Hospital for Special Surgery Hip/Knee arthroplasty Expectations Surveys. Preoperative and postoperative scores were subtracted to calculate whether expectations were unfulfilled, fulfilled, or exceeded.

Results:
A total of 343 THA and 322 TKA patients with complete follow-up were included. Preoperatively, >60% of patients (both THA/TKA) expected to get back to normal or have much improvement in 19 of 20 (THA) and 12 of 19 (TKA) items. Expectations were fulfilled or exceeded in >60% of patients in all 20 items for THA and 17 of 19 items for TKA. In THA, items with the largest proportions patients with unfulfilled expectations (>30%) were "improvement in walking ability: long distances" (31%), "walking stairs" (33%), and "improve ability to cut toenails" (38%). In TKA, expectations for 12 of 19 items were unfulfilled in >30% of patients, with the largest proportions seen for "being able to kneel down" (44%) and "being able to squat" (47%).

Conclusion:
Although for most items, >60% of THA and TKA patients indicated that their expectations were met or exceeded, there was a substantial number of patients, particularly TKA patients, having unfulfilled expectations. These need more attention in preoperative patient information and education.

Total hip arthroplasties (THAs) and total knee arthroplasties (TKAs) have proven to be successful surgical interventions for patients with hip or knee osteoarthritis. Despite the overall favorable results, previous studies have estimated that between 7%-15% of THA[1,2] and 11%-20%[3-5] TKA patients are dissatisfied after surgery. Evidence suggests that dissatisfaction is (at least partly) related to patients' expectations that are not fulfilled.[6,7] Several studies have assessed fulfillment of patients expectations, although the majority only assessed a small selection of items (eg, only expectations regarding pain)[1,4,5,8], while evidence shows that patients have a very wide range of expectations.[9]

Three studies included a range of expectations.[1,5,8] Nilsdotter et al[5] examined the relationship between expectations regarding the 5 different domains of the Knee Injury and Osteoarthritis Outcome Score (KOOS) and postoperative ability in 102 patients undergoing

TKA. The results show that, in general, preoperative expectations were higher than the actual postoperative ability after 5 years. In particular, in the sports and recreation domain, there was a large discrepancy between what patients expected and what they truly achieved.

Scott et al[8] examined the preoperative expectations and their postoperative fulfilment using the Hospital for Special Surgery (HSS) Hip Replacement and Knee arthroplasty Expectations Surveys[10] in 346 patients who had THA and 323 patients who underwent TKA. These results show that overall, in patients undergoing THA, expectations were fulfilled to a large extent, whereas TKA failed to meet expectations concerning kneeling, squatting, and stair climbing. The results of this study are difficult to interpret as modified versions of the questionnaires and their scoring methods were used.

Using the HSS Hip arthroplasty Expectations Survey, Palazzo et al[1] measured the preoperative expectations of 132 patients and their surgeons and the patient perceived fulfillment of expectations 1 year after THA surgery. Considering the fulfillment of expectations for each item individually, both patients' and surgeons' expectations were frequently unmet for cutting toenails, putting on shoes, sexual activity, sport and exercises, and being employed. The proportions of patients with unmet expectations were also high for using a cane and relieving night pain. The

latter study did not comprise patients undergoing TKA, considered a relatively small sample, and was performed in a tertiary care center. So, a direct comparison of preoperative expectations regarding THA or TKA and their fulfillment in a general hospital setting is, as far as we know, lacking. This is relevant because in the Netherlands, most of these operations are performed in this setting.
The aims of the present study were:

1. To assess patients' preoperative expectations of the outcome of THA or TKA regarding a number of aspects of functioning.
2. To determine to what extent each expectation is fulfilled 1 year after surgery in general hospital setting.

Patients and Methods

Study Design

This study was part of a prospective cohort study on the outcomes of THA and TKA performed at the Department of Orthopedics of the Rijnland Hospital, the Netherlands, from October 2010 to September 2013 (inclusion of patients was done until September 2012) by 8 specialized hip and knee arthroplasty orthopedic surgeons. The study protocol was reviewed and approved by the local hospital Review Board of the Rijnland Hospital, Leiderdorp in the
Netherlands (registration number 10/07), which is affiliated with the Medical Research Ethics Committee of the Leiden University Medical Center, Leiden, the Netherlands. From all patients, written informed consent to participate in the study was obtained.

Patients and Recruitment

The prospective cohort study aimed to include all consecutive patients undergoing a primary THA or TKA because of osteoarthritis, aged 18 years or older, able to read and understand Dutch and being mentally and physically able to complete questionnaires. Excluded were patients with revision surgery, undergoing a hemiarthroplasty or undergoing a THA or TKA because of a tumor or rheumatoid arthritis.
One day preoperatively, before being admitted to the hospital, the treating orthopedic surgeon provided oral and written information about the study to

all eligible patients. The patients received an informed consent form and a set of questionnaires at the same moment, 1 day preoperatively. The patients were asked to return the set of questionnaires and informed consent form the next day, the day of the surgery, when admitted to the hospital. Those who did not want to participate were asked if they were willing to provide the main reason. Of these patients, age and gender were recorded.

Measurements

One day preoperatively and 12 months thereafter, questionnaires were administered to the participating patients in person (preoperative assessment) or by regular mail (follow-up). Sociodemographic and clinical characteristics were only gathered preoperatively.

Sociodemographic and Clinical Characteristics

Sociodemographic characteristics included age (years), gender, height (cm) and weight (kg) to calculate the body mass index, current smoking status (yes/no), level of education (low: primary school, lower vocational education, medium: lower general secondary school, intermediate vocational education or high: higher general secondary school, higher vocational education, university), and marital status (living alone; yes/no).

Patient-reported outcome measures were used to describe the clinical characteristics of the population at baseline. The Hip Disability and Osteoarthritis Outcome Score (HOOS)[10], the KOOS[11], and the Oxford Hip Score and the Oxford Knee Score[12,13] were used to assess pain, symptoms, activity limitations-daily living, sport and recreation, function, and hip- or knee-related quality of life.

The Short Form-36 survey[14], the EuroQol 5-dimensional questionnaire, and the EuroQol Visual Analogue Scale[15] were used to assess general health related quality of life. From the Short Form-36 survey, 2 summary component scores for physical health and mental health were calculated.

Expectations

One day preoperatively, all patients were asked to complete a validated Dutch translation of the HSS Hip arthroplasty and Knee Replacement Expectations Surveys.[9,16] The HSS Hip arthroplasty Expectations Survey included 20 items, and the HSS Knee arthroplasty Expectations Survey included 19 items. These items concerned the topics pain, other symptoms, daily activities, and societal participation.

For each item, patients could indicate their expectations on a 5-point Likert scale. One year postoperatively, the same questionnaire was completed, but at that time, patients were asked the perceived actual outcome of all the items listed in the preoperative expectation questionnaire, using the same answering categories (Appendix). Patients were not informed about their preoperative answers/scores at the follow-up assessment.

Surgical Techniques

In THA surgeries, 2 different surgical approaches were used: straight lateral in lateral position of the patient and the anterior approach (anterior supine intermuscular) in supine position of the patient. Only uncemented cups (RingLoc, Biomet) and uncemented stems were used (Mallory-Head and Taperloc, Biomet). The joint surface was polyethylene with a ceramic head, usually 28 mm. The total knee prosthesis used concerns are the NexGen (Zimmer), posterior stabilized; both the femoral and tibia component were cemented.

Statistical Analysis

Descriptive statistics were used for the preoperative sociodemographic and clinical characteristics, as well as for the scores on the expectation questionnaires. To assess potential selection due to attrition, baseline characteristics of patients with and without complete follow-up were compared by means of the Mann-Whitney U test or chi-square test. To compute fulfillment of expectations 1 year after surgery, for each item of the HSS expectation survey, the postoperative score was subtracted from the preoperative score for each individual patient. A negative fulfillment score indicated less improvement than expected, a score of zero indicated an outcome as expected, and a positive score indicated a greater improvement than expected. When a patient used the answering category "not applicable" in either the preoperative or postoperative questionnaire or both, a fulfilment score was not calculated for that item. For each HSS expectation item, the frequencies of unfulfilled, fulfilled, and exceeded expectations were calculated in both THA and TKA patients. All data were analyzed using the SPSS statistical package (version 20.0, SPSS, Chicago, IL). All analyses were performed separately for THA and TKA groups.

Results

Response

Figure 1 describes the flow of patients. Of 665 eligible patients undergoing THA and 599 patients undergoing TKA, 428 THA patients (64%) and 417 TKA (70%) patients agreed to participate and completed the survey 1 day preoperatively. After 1 year, 4 of the THA patients in the total cohort were deceased, 2 were too sick to fill in the questionnaire, and 79 were lost to follow-up or did not return the questionnaire. In the TKA group, 4 patients were deceased, 3 were too sick to fill in the questionnaire, and 88 were lost to follow-up or did not return the questionnaire. The 343 THA (80%) and 322 TKA (77%) patients who completed both the complete set of preoperative and the postoperative questionnaires are included in the current analyses.

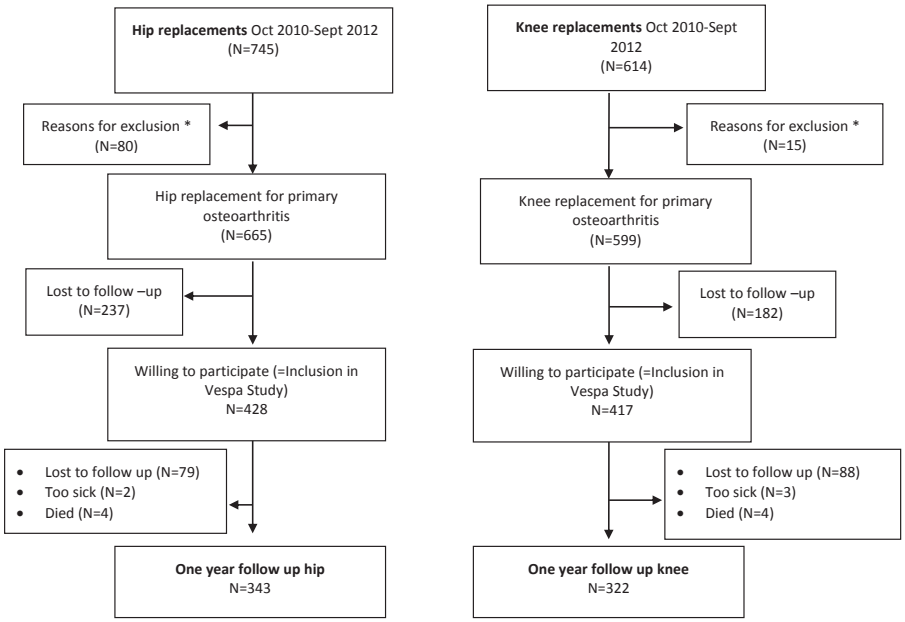

Figure 1. Flow Diagram

* Reasons for exclusion: patients who did not understand Dutch or being physically or mentally able to complete questionnaires, patients with revision surgery, undergoing a hemi-arthroplasty, or undergoing a THA or TKA because of a tumor or rheumatoid arthritis.

Preoperative Characteristics of Patients With and Without Follow-Up

Table 1 describes the preoperative characteristics of the patients with and without complete follow-up. In both the THA and TKA groups, most of the patients were female, and the mean age was 67 years. In the THA group, patients with incomplete follow-up (N=85) had higher body mass index scores, and their preoperative HOOS-activities of daily living, HOOS-pain, and HOOS-quality of life scores were lower. TKA patients with incomplete follow-up (N=95) had significantly higher KOOS quality of life and EuroQol 5-dimensional questionnaire scores.

Table 1. Characteristics of patients

	THA patients with follow-up (N=343)	**THA Patients** with incomplete follow up (N=85)	**P***	**TKA patients** with follow up (N=322)	**TKA Patients** with incomplete follow up (N=95)	**P***
Gender, Female; number (%)	197 (57)	61 (71.4)	.031	226 (70)	66 (70)	.872
Age, y (mean, SD)	67.2 (9.5)	65.1 (12.3)	.202	66.9 (9.5)	67.2 (10.1)	.917
Body Mass Index (mean, SD)	27.1 (4.4)	28.1 (4.5)	.043	29.5 (4.5)	29.5 (5.1)	.874
Education level; number (%)						
Low	127 (37)	41 (48)	.111	164 (51)	47 (49)	.386
Medium	103 (30)	24 (28)		100 (31)	34 (36)	
High	113 (33)	20 (24)		58 (18)	14 (15)	
Living status: Living Independently; number (%)	313 (91.3)	79 (92.9)	.322	298 (92.5)	78 (83.0)	.170
Work status: Working; number (%)	87 (25.4)	25 (29.8)	.865	75 (23.3)	23 (24.5)	.093
HOOS or KOOS (0-100); mean (SD)						
Activities of daily living	44.4 (17.6)	37.5 (18.0)	.009	48.7 (17.7)	45.3 (18.9)	.178
Pain	41.7 (18.2)	35.6 (16.9)	.016	41.6 (16.2)	40.8 (18.1)	.725
Quality of life	34.6 (10.6)	31.3 (8.8)	.003	35.0 (10.5)	32.1 (11.0)	.014
Sport	20.3 (18.9)	17.4 (17.5)	.283	13.2 (15.7)	15.9 (17.5)	.318
Symptoms	37.7 (18.2)	37.1 (19.5)	.775	44.9 (13.5)	42.5 (12.8)	.059
EQ5D score (0-1); mean (SD)	0.6 (0.3)	0.5 (0.3)	.060	0.6 (0.3)	0.5 (0.3)	.005
EQ5D VAS scale (0-100); mean (SD)	67.0 (18.3)	63.8 (19.1)	.177	70.1 (18.4)	65.7 (19.4)	.116
Oxford Knee/Hip Score (0-48); mean (SD)	24.7 (7.3)	22.6 (8.6)	.142	25.3 (6.8)	23.1 (9.0)	.067
SF36 MCS (1-100); mean (SD)	50.9 (10.3)	51.0 (10.4)	.076	52.8 (10.2)	49.9 (12.5)	.052
SF36 PCS (1-100); mean (SD)	39.9 (7.4)	39.8 (7.4)	.086	40.4 (7.4)	39.0 (7.4)	.161

THA,total hip arthroplasty; TKA, total knee arthroplasty; SD, standarddeviation; HOOS, Hip Disability and Osteoarthritis Outcome Score; KOOS, Knee Injury and Osteoarthritis Outcome Score; EQ5D, EuroQol 5-dimensional questionnaire; VAS, Visual Analogue Scale; SF36, Short form-36 survey; MCS, component score for mental health score; PCS, component score for physical health score.

* Comparison of working and non-working patients at preoperative assessment by means of Mann-Whitney U or Chi Square tests where appropriate. Significance level < 0.05.

Differences in Preoperative Expectations in Patients With and Without Complete Follow-Up

A comparison of the preoperative expectations of patients with and without complete follow-up showed that overall, in both the THA and TKA groups, the patients with complete follow-up had higher expectations, illustrated by higher frequencies of patients answering "back to normal" for most of the items and fewer missing values than patients with only preoperative scores (results not shown).

Preoperative Expectations and Postoperative Outcomes in Patients With Complete Follow-Up

Table 2 shows preoperative expectations in THA and TKA patients with complete follow-up. In THA and TKA, >60% of patients expected to get back to normal or have much improvement in 19 of 20 and 12 of 19 items, respectively. The items with the largest proportion (>60%) of patients expecting to get back to normal in the group of THA patients concerned "not in need of stick, crutch or walker" and "be able to independently put on shoes and socks." The item with the largest proportion (>5%) of patients expecting to only "slightly improve" (lowest expectation) was "improvement in walking ability: long distances (more than 1.5 km)." The largest proportions of patients undergoing TKA who indicated they expected that aspects would get back to normal (>50%) concerned "not in need of stick, crutch or walker" and "daily activities in and around the house." The items with the largest proportion (>5%) of patients expecting to only "slightly improve" (lowest expectation) were "improvement in walking ability: long distances (more than 1.5 km)," "be able to kneel down," and "be able to squat."

Fulfillment of Expectations

Table 2 shows the frequencies of unfulfilled, fulfilled, and exceeded expectations of improvement for each of the HSS items. Both in the THA and TKA groups, the outcome expectations for most items were fulfilled or exceeded by the large majority of patients.

Table 2 Total Hip Arthoplasty (THA) and Total Knee Arthroplasty (TKA): Baseline Expectations and Fulfillment of expectations.

	Baseline expectations				Fulfillment of expectations			
	Back to normal, %	Much improved, %	Moderate improvement, %	Slightly improved, %	Unfulfilled, %	Fulfilled, %	Exceeded, %	Fulfilled + exceeded, %
THA								
1a. Relieve of pain during the day (N=209)	41	43	3	1	21.5	58.4	20.1	78.5
1b. Relieve of pain during sleeping (N=197)	48	32	3	1	22.8	61.4	15.7	77.1
2a. Improvement walking ability: during short distances (in house) (N=190)	47	31	3	2	20.5	56.3	23.2	79.5
2b. Improvement walking ability: middle long distances (up to 1,5 km's) (N=186)	37	36	9	1	26.3	49.5	24.2	73.7
2c. Improvement walking ability: long distances (more than 1,5 km's) (N=175)	33	32	12	5	31.4	44.6	24.0	68.6
3. Not in need of stick, crutch, walker (N=118)	62	10	3	0	13.6	72.9	13.6	86.5
4. Be able to stand better (N=201)	58	23	5	0	26.4	54.7	18.9	73.6
5. Walking stairs (N=204)	54	27	4	1	33.3	51.0	15.7	66.7
6. Get rid of limp (N=186)	53	27	4	1	28.5	54.8	16.7	71.5
7. Getting in or out bed, chair or car (N=208)	53	28	5	1	29.8	51.9	18.3	70.2
8. Eliminate need for medication (pain) (N=120)	56	11	3	1	23.3	64.2	12.5	76.7
9. Be able to independently put on shoes and socks (N=192)	62	17	4	0	25.5	59.9	14.6	74.5
10. Be able to do paid work (N=55)	28	5	2	0	10.9	83.6	5.5	89.1
11. Join recreational activities (dancing, going out on trips) (N=154)	44	23	6	1	19.5	61.0	19.5	80.5
12. Improve ability daily activities in and around the house (gardening, housework) (N=204)	53	25	6	2	29.9	53.4	16.7	70.1
13. Improve ability to do sports (N=155)	30	32	11	2	25.8	55.5	18.7	74.2
14. Improve ability to cut toenails (N=175)	45	22	8	4	38.3	42.9	18.9	61.8
15. Social life (being able to take care for someone else or play with children) (N=164)	48	25	4	2	19.5	60.4	20.1	80.5
16. Sexual activities (N=122)	43	14	4	1	15.6	63.9	20.5	84.4
17. Psychological wellbeing (N=144)	52	12	3	2	22.9	63.2	13.9	77.1

TKA								
1a. Relieve of pain during the day (N=216)	26	52	7	1	28.8	48.6	22.5	71.1
2a. Improvement walking ability: during short distances (in house) (N=210)	34	41	6	2	32.7	49.1	18.2	67.3
2b. Improvement walking ability: middle long distances (up to 1,5 km's) (N=199)	24	44	12	3	39.6	44.1	16.3	60.4
2c. Improvement walking ability: long distances (more than 1,5 km's) (N=185)	19	40	16	5	36.7	40.4	22.9	63.3
3. Not in need of stick, crutch, walker (N=84)	51	10	6	1	14.0	70.9	15.1	86.0
4. Be able to stretch the knee (N=221)	46	30	7	2	21.0	53.6	25.4	79
5. Improve walking upstairs (N=236)	43	35	9	2	36.5	45.6	17.8	63.4
6. Improve walking downstairs (N=233)	39	37	10	2	38.2	44.5	17.2	61.7
7. Being able to kneel down (N=167)	16	29	23	13	47.4	26.3	26.3	53.6
8. Being able to squat (N=186)	17	26	24	16	43.9	30.7	25.4	56.1
9. Being able to travel by public transport (bus, tram or train) (N=147)	41	21	5	4	21.3	61.3	17.3	78.6
10. Be able to do paid work (N=58)	25	7	1	2	34.4	57.4	8.2	65.6
11. Join recreational activities (dancing, going out on trips) (N=150)	33	24	10	2	39.1	42.4	18.5	60.9
12. Daily activities in and around the house (getting dressed, housework) (N=217)	57	18	6	1	29.1	56.4	14.5	70.9
13. Being able to do sports (N=160)	22	39	12	4	34.8	43.9	21.3	65.2
14. Being able to change position (getting up, sitting down) (N=237)	39	40	9	2	34.9	44.8	20.3	65.1
15. Social life (being able to take care for someone else or play with children) (N=181)	36	26	12	2	32.1	46.2	21.7	67.9
16. Sexual activities (N=108)	33	8	6	2	24.8	59.6	15.6	75.2
17. Psychological wellbeing (N=148)	42	12	7	2	24.7	55.3	20.0	75.3

Discussion

Overall, the proportions of patients whose expectations were fulfilled or exceeded were somewhat lower in the TKA than in the THA group. Our results showed that in the THA group, exceeded expectations were seen in >20% of the patients for 6 items. In TKA patients, >20% of patients had exceeded expectations for 8 items. Still, as depicted in Table 2, there were some items where a substantial proportion (>30%) of patients had unfulfilled expectations, concerning "improvement in walking ability: long distances" (31%), "walking stairs" (33%), and "improve ability to cut toenails" (38%) in THA and "being able to kneel down" (44%) and "being able to squat" (47%) in TKA.

Preoperative Expectations

In this study, the preoperative expectations of patients on improvement in postoperative outcomes were higher in THA than in TKA for most studied variables. Moreover, in the group of patients undergoing THA, the number of outcomes for which 60% of the patients or more reported that their preoperative expectations were fulfilled or exceeded was larger than that in the TKA group. In the THA group, the largest proportions of patients with unfulfilled expectations (>30%) were seen for the items "walking stairs" and "improve ability to cut toenails" (38%). In the TKA group, the largest proportions of patients (>30%) with unfulfilled expectations were observed for "improvement walking ability middle long distances (up to 1.5 km's)" (40%), "being able to kneel down" (47%), and "being able to squat" (44%).

Our study clearly demonstrated that preoperatively, the outcome expectations of patients undergoing THA were more positive than those of patients undergoing TKA. This is in concordance with studies indicating that patients undergoing TKA have more challenging rehabilitation processes and worse mid and longterm outcomes compared with THA.[17] Nilsdotter et al[5] reported that TKA patients had higher expectations preoperatively for Activities of Daily Living functions compared with sport and recreational function and relief of pain. Our study shows the same results for TKA patients.

Although the expectation measurement approach by Scott et al[8] differed from ours (in their study, patients scored the importance of each outcome rather than the actual outcome expectations), results are fairly similar. The items which were rated very important by the vast majority of patients in the study by Scott et al were

quite similar to those yielding the most optimistic expectations in our study (ie, largest proportions "back to normal" and "much improved"). In THA, this was most apparent for the items "improving the ability to stand," "relief of daytime pain in the joint," and "improving the ability to walk." In the TKA group, similarities were seen for "relief of daytime pain in the joint" and "improving the ability to walk."

Fulfillment of Expectations

Regarding the fulfillment of expectations, methodologically, our study is best comparable to the study by Palazzo et al[1], although that study included only patients undergoing THA. That study found that expectations were frequently unmet for cutting toenails (53%), putting on shoes (50%), improving sexual activity (50%), sport and exercises (39%), and being employed (43%). The proportions of patients with unmet expectations were also relatively high for using a cane (40%) and relieving night pain (42%). In our study, expectations were unmet less frequently, except for cutting toenails (38%) where similar proportions were seen. This discrepancy may be partly explained by differences in measurement of the postoperative expectation fulfillment. In the study by Palazzo et al, the main question and answering options were adapted to assess the improvement that patients obtained from the surgery in each domain: "To what extent have you obtained a relief or improvement as a result of THA in the following areas?" (from 0: not at all; to 4: completely). The answer "not at all" (scoring 0) was separated from the answer "this question does not apply" (scoring 5). Furthermore, it may be that in our study, preoperative expectations were less optimistic, and therefore expectations were easier met, although we cannot be conclusive about this as Palazzo did not present preoperative expectation data.

Nilsdotter et al[5] showed that patients undergoing TKA were least satisfied with their sport and recreational function. In our study, the proportion of patients in whom expectation was not met for sport and recreational function was indeed large (35%), but similar proportions were seen for 11 other outcomes as well. Although a different methodology was used, Scott et al found that overall, in patients undergoing THA, expectations were fulfilled to a large extent, whereas TKA failed to meet more expectations, including those concerning kneeling, squatting, and stair climbing. The discrepancy between THA and TKA patients regarding the fulfillment of expectations is in line with the results of our study.

Limitations

A limitation of our study concerns the scoring of the HSS questionnaires. Both the HSS development study and studies using the HSS use different scoring systems.[1,8] The main issue is that one of the answering options in the HSS hip and knee questionnaire is "not applicable." Patients may have multiple reasons to fill in "not applicable" like not knowing what to answer, having lower expectations than possible to score in the answering options (eg, expecting to worsen or to not improve at all) or not doing a specific activity. It is unknown which implications this may have for our results. This answering option also makes it difficult to calculate sum scores for both expectations and their fulfillment. Palazzo et al[1] considered the "not applicable" answers automatically as being not applicable in the postoperative questionnaire as well. Another limitation is that the present study was performed in only one centre and in 1 country, so that cultural and demographic variability with regard to expectations and their fulfillment are not taken into account in our results, which limits generalizability. Another issue that potentially limits the generalizability is the somewhat selective drop out. Despite the effort to prevent loss to follow-up (sending reminders and contacting patients by phone) in THA patients 20% and in TKA patients 23% of the patients were lost to follow-up after 1 year. We found some differences in preoperative expectations between complete cases and patients who did not return the postoperative questionnaire and thus were lost to follow-up. Patients with complete follow-up showed higher preoperative expectations, that is, a higher proportion "back to normal" on some items. The differences in expectations may probably be related to differences in baseline characteristics of patients who did and who did not have complete follow-up. In addition, we were not able to relate the fulfillment of expectations to the occurrence of postoperative complications, as these were not recorded in the context of our study.

Finally, 8 specialized hip and knee arthroplasty orthopaedic surgeons performing the surgeries with 2 different surgical approaches (straight lateral in lateral position of the patient, and the anterior approach [anterior supine intermuscular] in supine position of the patient) may potentially have affected the outcomes and therefore fulfillment of expectations.

Implications

The observation from the present and previous studies that for some specific outcomes of THA or TKA, relatively large proportions of patients have unfulfilled expectations may have implications for the preoperative management. These findings underscore a need for patient education focused on realistic expectations specifically for those items (eg, walking stairs, cutting toenails, walking ability, kneeling down and squatting) that were found to be unfulfilled in many patients. Discussing these patient's expectations preoperatively may support patient-clinician communication, shared decision making, and might influence postoperative outcome as well.

Furthermore, to our knowledge, our study is the first that assessed whether and more specifically which expectations were exceeded for THA and TKA. In addition, in other medical fields, little attention has been given to this phenomenon. Investigating the role of exceeded expectations in outcomes such as satisfaction and general perceived effect on a postposed treatment (weather surgical or conservative) may bring us 1 step closer to resolving the debate on what the most optimal expectation is, high or low expectations that may be easily exceeded.

In conclusion, this study shows that THA and TKA patients have high expectations for different aspects of outcome of surgery. For THA patients, most of these expectations are met or even exceeded.

Specifically, in the pain-related domains and the "simple" function-related items, THAs are fulfilling patients' expectations. However, for TKA, expectations regarding daily activities and sports and recreation functions were less often fulfilled. The results of this study are relevant for preoperative patients' education. It would be of value to pay more attention to patients' expectations and setting realistic goals and aims.

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Chapter

Can optimism, pessimism, hope, treatment credibility and treatment expectancy be distinguished in patients undergoing Total Hip and Total Knee Arthroplasty?

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Abstract

Objectives:

The constructs optimism, pessimism, hope, treatment credibility and treatment expectancy are associated with outcomes of medical treatment. While these constructs are grounded in different theoretical models, they nonetheless show some conceptual overlap. The purpose of this study was to examine whether currently available measurement instruments for these constructs capture the conceptual differences between these constructs within a treatment setting.

Methods:

Patients undergoing Total Hip and Total Knee Arthroplasty (THA and TKA) (Total N= 361; 182 THA; 179 TKA), completed the Life Orientation Test-Revised for optimism and pessimism, the Hope Scale, the Credibility Expectancy Questionnaire for treatment credibility and treatment expectancy. Confirmatory factor analysis was used to examine whether the instruments measure distinct constructs. Four theory-driven models with one, two, four and five latent factors were evaluated using multiple fit indices and $\Delta\chi^2$ tests, followed by some posthoc models.

Results

The results of the theory driven confirmatory factor analysis showed that a five factor model in which all constructs loaded on separate factors yielded the most optimal and satisfactory fit. Posthoc, a bifactor model in which (besides the 5 separate factors) a general factor is hypothesized accounting for the commonality of the items showed a significantly better fit than the five factor model. All specific factors, except for the hope factor, showed to explain a substantial amount of variance beyond the general factor.

Conclusion

Based on our primary analyses we conclude that optimism, pessimism, hope, treatment credibility and treatment expectancy are distinguishable in THA and TKA patients. Postdoc, we determined that all constructs, except hope, showed substantial specific variance, while also sharing some general variance.

Introduction

Growing evidence supports the importance of psychological constructs in predicting outcomes of medical treatment including surgery.[1;10;15;16;26;34;44] Usually epidemiological studies investigating the relationship between psychological factors and outcome of treatment restrict their assessment to one or two psychological questionnaires. However, in order to disentangle their unique contribution to outcome, the roles of separate constructs need to be explored simultaneously [37]. It is therefore necessary that the instruments that aim to measure these constructs are able to discriminate between them.

Much attention has been given to the future oriented constructs 'optimism', and 'hope'.[1;2] Both these constructs reflect expectancies about one's future. More specifically, optimism has been defined as "generalized positive outcome expectancies" [32] and hope as "a cognitive set that is based on a reciprocally derived sense of successful agency (goal directed determination) and pathways (planning of ways to meet goals)".[40] Theory suggests that a hopeful person is more explicitly concerned with self-initiated actions that will enable him to achieve a favourable future while an optimistic person believes that somehow (through either internal or external factors) his future will be successful.[25] Substantial empirical work investigating optimism and hope has been done within mental health settings. But evidence suggests these constructs may also be related to outcomes in medical treatments like surgery. For example: optimism explains close to 10% of the variance in post-surgical pain after total hip arthroplasty (THA) and total knee arthroplasty (TKA).[30]

Besides these general future oriented constructs interest in treatment specific psychological constructs like 'treatment expectancy' and 'treatment credibility' has also grown.[36] Treatment expectancy is defined as "improvements that clients believe will be achieved" and treatment credibility as "how believable, convincing and logical the treatment is".[14] Conceptually, expectations for a given treatment may develop (at least partly) from how credible the treatment seems. Both these constructs may be related to treatment outcomes. For example it was found that expectancies about treatment outcome help predict return to work outcomes.[22]

While the abovementioned psychological constructs are grounded in different theoretical models, some studies have hypothesized that there is some conceptual

overlap between them.[1;7;8;25;32;33;40-42] Optimism, hope, treatment credibility and treatment expectancy have for instance all been conceptualized as an anticipatory state and beliefs about the future.[5;17;25;40] Others have emphasized the conceptual differences between the constructs. Some suggest hope is an emotional state, while optimism is a cognitive state.[4] Treatment credibility also has been defined as a cognitive concept, whereas treatment expectancy as a more affective or emotional concept, similar to hope.[14] Furthermore, treatment credibility and treatment expectancy are conceptualized to be situational (i.e. treatment specific), in contrast to hope and optimism which are dispositional.[14;39]

Multiple studies have empirically explored the distinction between the constructs optimism (and pessimism) and hope. A recent meta-analysis concluded that these constructs are positively associated but not redundant (rho <0.8) and that hope and optimism have differential relationships with outcomes like well-being or personality.[2] Treatment expectancy and treatment credibility however have not been included in studies examining the distinctiveness of future oriented constructs, yet. It may be that in medical situations like upcoming elective surgery patients answer items belonging to the hope and optimism questionnaires more in a situational way, referring to their treatment or illness. Consequently in medical treatments, and more specifically in the invasive treatments like surgery, optimism and hope could possibly show similarities to treatment credibility and treatment expectancy.

This study aims to examine whether the instruments for optimism, pessimism, hope treatment credibility and treatment expectancy measure distinct constructs in a population of patients scheduled for THA or TKA.

Materials and Methods

Participants and procedures

This study was part of a larger prospective cohort study on the outcomes of THA and TKA. It included consecutive patients undergoing a primary THA or TKA because of osteoarthritis in the Rijnland Hospital in Leiderdorp, the Netherlands between October 2010 and September 2012. Assessments were done pre-operatively and 12 months after surgery. Between July 2011 and September 2012 a subgroup of participants received additional questionnaires concerning optimism, hope and

expectancies pre-operatively. For the present analysis pre-operative data of this subgroup were used. The larger study, as well as the extension for the subgroup was approved by the Medical Ethical Committee of the Rijnland General Hospital, Leiderdorp, the Netherlands (registration number 10/07). All participants gave written informed consent.

Measurement

One day prior to surgery all participants completed a questionnaire including sociodemographic, disease characteristics, Quality of Life and the Life Orientation Test-Revised (LOT-R), the Hope Scale (HS) and the Credibility Expectancy Questionnaire (CEQ). Demographic characteristics included: age (years), sex and education level. Disease characteristics pain and functioning were measured using the Pain and ADL subscales of the HOOS (for THA patients) [12] and KOOS (for TKA patients) [11] questionnaires. Quality of Life was measured using the SF-36 questionnaire [45] from which mental component scores (MCS) and physical component scores (PCS) were derived.

Optimism (and Pessimism)

The Life Orientation Test- Revised[33] is a 10 item self-reported questionnaire that aims to measure optimism. The questionnaire consists of 3 positively formulated items (e.g. I'm always optimistic about my future), 3 negatively formulated items (e.g. I rarely count on good things happening to me) and 4 filler items (e.g. It's easy for me to relax), all items are answered on a 5 point Likert-type scale. The LOT-R was originally developed by Scheier and Carver in 1994[33] who called the LOT-R a unidimensional questionnaire in which the observed variables represent one latent factor called trait optimism. However others have argued that the items in the LOT-R represent two latent factors namely optimism and pessimism [18;20]. Hence, sumscores range from 3-15 when two subscale scores are calculated or from 3-30 when one total score is calculated. The factor structure of the Dutch version of the LOT-R was tested recently.[43] Results showed that the two factor model had the best fit.

Hope

The Hope Scale consists of 12 items of which 4 items measure 'pathways' (e.g. There are lots of ways around the problem), 4 items measure 'agency' (e.g. I meet the goals that I have set for myself) and 4 are filler items (e.g. I worry about my health).[40] All

items are answered on an 8 point scale with two anchors (1=totally disagree and 8= totally agree). The hope scale is considered to be a unidimensional scale in which agency and pathways together represent the construct 'trait hope'. Analysis of the Dutch version of the HS has shown good model fits for a one factor structure.[3] Hence, a sumscore which ranges from 8-64 points is derived by summing the 8 items of the HS.

Treatment Credibility and Treatment Expectancy

The Credibility Expectancy Questionnaire is a self-reported six item questionnaire that aims to measure treatment credibility and expectancy for improvement. Originally it was developed by Devilly et al in 2000[14], and validated in several groups. The Dutch translation was done by Smeets et al in 2008[36]. In both the original and the Dutch version three items (e.g. at this point, how successfully do you think the surgery will be in reducing your complaints) were found to load on the credibility factor and three items (e.g. at this point, how much do you really feel that the surgery will help to reduce your complaints) on the expectancy factor. Introductory instructions tell the patient that beliefs about how well the therapy might help contain both thoughts and feelings about the therapy and that these may be the same or different.[36] Items 1 to 3 and 5 are answered on a scale ranging from 1 (not at all) to 9 (very much), Items 4 and 6 are answered on a 0 (not at all) to 100% (very much). In accordance with Smeets et al scores on item 4 and 6 were transformed with a minimum of 1 and a maximum of 9, and a sum score was formed for each factor ranging from 3 to 27.

Statistical analysis

Confirmatory factor analysis (CFA) for ordered categorical items was used to examine whether the constructs optimism (LOT-R), pessimism (LOT-R), hope (HS), treatment credibility (CEQ credibility subscale) and treatment expectancy (CEQ expectancy subscale), are distinguishable. Because observed variables were all answered on ordinal scales, a matrix based on polychoric correlations was used for CFA. Negatively formulated items of the LOT-R were reverse scored prior to entry into the CFA models. Analyses were conducted using the weighted least squares mean and variance adjusted estimator (WLSMV) in Mplus 6.12. For the total group of THA and TKA patients four theory-driven models with five, four, two and one latent factors, in which the factors were allowed to correlate within the CFA models, were evaluated using multiple fit indices and compared using $\Delta\chi^2$

tests.[29] The following fit indices and thresholds were used to denote a satisfactory model: Tucker-Lewis index (TLI) >0.95; comparative fit index (CFI) >0.95 and the root mean square error of approximation (RMSEA) <0.06.[21] A significant $\Delta\chi^2$ test indicates that the model with the smallest χ^2 (in this case the least stringent model) has a significantly better fit.

Model 1 hypothesised a full differentiation between the five constructs treatment credibility, treatment expectancy, hope, optimism and pessimism. Thus items of each construct was forced to load on a separate factor. Model 2 hypothesised a differentiation between four constructs; the treatment credibility, treatment expectancy and hope items were still forced to load on separate factors, but in this model the optimism and reverse-scored pessimism items were forced to load on one factor as it is controversial whether LOT-R has a uni- or bidimensional structure.[18;20] Model 3 hypothesised a two factor structure in which the optimism, pessimism and hope (LOT-R and HS) items were forced to load on one factor representing 'generalized positive beliefs about the future' and the treatment credibility and treatment expectancy (CEQ) items were forced to load on one factor representing 'treatment specific beliefs about the future'. This model was tested because of the theoretical plausibility that patients may have general and situational, in this case treatment specific, beliefs about the future. Model 4 hypothesised that treatment credibility, treatment expectancy, hope, optimism and pessimism items load on a single underlying latent factor. This model was tested because when it is assumed that optimism, pessimism, hope, treatment credibility and treatment expectancy are not distinguishable at all, the data should fit this one factor model. If necessary (eg because of ambiguities or high correlations between factors) post-hoc models were tested. Guttman's lambda 2 was used to determine internal consistency reliability of each subscale. A value > 0.7 was considered indicative of good internal consistency reliability.[19;35] All the analyses above were done using the total sample of THA and TKA patients.

When using the same questionnaire in different groups Factorial Invariance (FI) should be established to show that the items of the questionnaire measure the particular latent construct similarly across groups. In our study both TKA and THA patients were included, and as patients with scheduled for knee arthroplasty may face different difficulties to patients scheduled for hip arthroplasty, the constructs measured in this study may also have different meanings for these groups.

Assessing factorial invariance involves a process of comparing the fit indices for a series of models with increasingly stringent constraints on the relationships between the model parameters. The best-fitting model for the total sample (TKA and THA) identified in the previous analysis was assessed in multigroup CFA's to test for factorial invariance across the TKA and THA groups.[28] Four multigroup CFA models with increasingly stringent model constraints were tested (Table 1):

- A baseline model (configural invariance): in which only the factor structure (number of factors and the pattern of the free and fixed loadings) was constrained to be equal across groups. In this model no equality constraints were imposed on the intercepts and factor loadings.
- A weak FI model: in which the factor structure and factor loadings were constrained to be equal across groups, intercepts were allowed to vary among groups and factor variances were fixed to one in both groups.
- A strong FI model: in which factor structure and loadings and intercepts (thresholds) were constrained to be equal across groups.
- A strict FI model: in which factor structure, factor loadings, intercepts and residual variances were constrained to be equal across groups.

To evaluate the degree of measurement invariance, the recommendations by Cheung and Rensvold[38] were followed, which state that the null hypothesis (invariance) is kept if the incremental change in comparative fit index (CFI) is equal to or smaller than 0.01.[9] Acceptance of the strong or the strict invariance model was sufficient to assume that the measurement instruments used measure the same constructs in all participants (both THA and TKA).

Missing data were incorporated by using the default option available in Mplus. For WLMSV estimation, Mplus computes polychoric correlations based on pairwise present data between two variables, treating missing data as missing completely at random (MCAR). Under MCAR, the missingness is assumed to occur entirely at random and not depend on observed covariates or on the response itself.

Table 1: levels of factorial invariance

FI Models	Model parameters constrained to be equal across groups
No FI	None
Weak FI	Factor loadings
Strong FI	Factor loadings and item intercepts (thresholds)
Strict FI	Factor loadings and item intercepts (thresholds) and residual item variances/covariances

Results

Characteristics of the sample and internal consistency reliability of the subscales
A total of 745 patients were admitted for THA and 614 patients were admitted for TKA from October 2010 to September 2012. Of these, 420 THA (63.2%) and 395 TKA (65.9%) patients consented to participate and completed the surveys. A subgroup of 184 THA and 191 TKA patients, the ones enrolled in the study between July 2011 and September 2012, received additional questionnaires including the LOT-R, the HS and the CEQ. Of these, 14 had missing responses on all items and were therefore excluded, leaving in total 361 patients for analysis (182 THA, 179 TKA). Characteristics of the subgroup of participants that completed the additional questionnaires and mean scores (sd) on the subscales of these questionnaires are presented in table 2 for THA and TKA groups separately. In both TKA and THA groups the majority of patients were females, the mean age was 67 years for both groups. The mean pain score was 41.9 for THA patients and 39.7 for TKA patients. The mean functioning score (HOOS/KOOS ADL) was 43.8 for THA patients and 45.6 for TKA patients. THA patients on average scored 23.7 on the credibility and 22.5 on the expectancy subscale of the CEQ, TKA patients scored 23.5 and 22.1 on these subscales respectively. HS scores were 43.2 for THA and 41.3 for TKA patients. Optimism was scored 9.9 for THA patients and 10.0 for TKA patients, Pessimism scores were 10.8 for THA and 10.4 for TKA patients. Internal consistency reliability (lambda 2) of each of the subscales was acceptable (Table 2). For 14 patients responses on all items were missing and therefore they were excluded from analysis. All the questionnaire items had missing responses, though in most items < 7% responses were missing. An exception was one of the HS items which had 42% missing responses (item 6) due to a printing error in the questionnaire. The amount of data in the pairwise coefficients ranged between 0.57 and 0.98.

Table 2: characteristics of the sample included in this study and lambda 2 values for the subscales included in the Confirmatory Factor Analysis.

	Total hip arthroplasty (N=182) mean (SD)/ %	Total knee arthroplasty (N=179) mean (SD)/%	Total sample N=361 Mean (SD)/%	Gutmann's lambda 2 for the total sample
Gender % female	58.1%	71.6%	64.8%	-
Age	67.1 (9.9))	67.6 (9.3)	67.4 (9.6)	-
Education level				-
Low	33.7%	50.3%	42.0%	
Medium	32.0%	31.2%	31.6%	
High	34.3%	18.5%	26.4%	
BMI	27.5 (4.7)	29.5 (4.8)	28.5 (4.9)	-
SF-36 Physical summary scale (range 0-100)	38.8 (7.1)	39.1 (7.7)	38.9 (7.4)	-
Sf-36 Mental summary scale (range 0-100)	51.8 (10.7)	52.2 (11.2)	52.0 (10.9)	-
HOOS/KOOS* pain (range 0 -100)	41.9 (17.8)	39.7 (16.7)	40.6 (17.2)	-
HOOS/KOOS* Activities of Daily Living (range 0-100)	43.8 (17.6)	45.6 (17.6)	44.7 (17.5)	-
CEQ Credibility (range 3-27)	23.7 (3.0)	23.5 (3.1)	23.6 (3.1)	0.714
CEQ Expectancy (range 3-27)	22.5 (3.0)	22.1 (3.0)	22.3 (3.0)	0.779
HS Hope (range 8-64)	43.2 (11.6)	41.3 (11.8)	42.2 (11.7)	0.941
LOT-R Optimism (range 3-15)	9.9 (2.9)	10.0 (2.8)	9.9 (2.8)	0.834
LOT-R Pessimism, reverse scored (range 3-15)	10.8 (2.8)	10.4 (2.7)	10.6 (2.8)	0.709

*The THA patients completed the HOOS questionnaire and the TKA patients completed the KOOS questionnaire

HOOS =the Hip injury and Osteoarthris Outcome Score, KOOS=the Knee injury and Osteoarthritis Outcome Score, CEQ= Credibility Expectancy Questionnaire, HS= Hope Scale, LOT-R= Life Orientation Test Revised

Confirmatory factor analysis

Table 3 shows the model fit indices for the five, four, two and one factor models, as well as $\Delta\chi^2$ tests comparing the five factor model with the four factor model, the four factor model with the two factor model, and the two factor model with the one factor model. The five factor model showed fit indices that satisfied the cut-off criteria determined by Hu and Bentler[21], whilst the models with four, two and one latent factor did not satisfy these criteria. Further, $\Delta\chi^2$ tests also indicated that the four factor model fit significantly worse than the five factor model, the two factor model fit significantly worse than the four factor model and the one factor model fit significantly worse than the two factor model. Thus, of the four models tested the five factor model is to be preferred based on all fit indices.

Table 3: χ2 difference tests and model fit indices for the models tested for the total group (THA and TKA)

	χ^2 *(df)*	*P -value*	$\Delta\chi^2$*(df)*	*P -value*	*TLI*	*CFI*	*RMSEA*
Five factor model	400.9 (160)	<0.01	237.1 (4) $	<0.01	0.981	0.984	0.065
Four factor model	1121.8(164)	<0.01	86.7 (5) #	<0.01	0.927	0.937	0.127
Two factor model	1220.4(169)	<0.01	271.1 (1) §	<0.01	0.922	0.930	0.131
One factor model	3081.9 (170)	<0.01			0.785	0.807	0.218

$ five factor model compared to four factor model model # four factor model compared to two factor model § two factor model compared to one factor TLI= Tucker-Lewis Index, CFI= comparative fit index, RMSEA=root mean square error of approximation.

The five factor model including the standardized factor loadings and correlations between factors is presented in Figure 1. In this five factor model a very strong correlation was seen between the treatment credibility and treatment expectancy factors, and a strong correlation between the optimism and hope factors.

Factorial Invariance testing (see Table 4) showed that the baseline model was well-fitting and thereby supported configural invariance. For the increasingly stringent models none of the subsequent null-hypotheses of measurement invariance were rejected using the recommendations of Cheung and Rensvold[9] which state that the null hypothesis (invariance) is not rejected if the incremental change in CFI is equal to or smaller than 0.01. Thus, strict invariance could be supported.

Table 4: model fit indices of the multigroup models for factorial invariance testing across THA and TKA

Factorial Invariance models	X^2 *(df)*	*P value*	*TLI*	*CFI*	*RMSEA*
Baseline model (configural invariance)	640.1 (415)	<0.01	0.986	0.985	0.055
Weak Invariance	653.6 (430)	<0.01	0.987	0.985	0.054
Strong Invariance	672.4 (405)	<0.01	0.983	0.982	0.060
Strict Invariance	718.6 (425)	<0.01	0.983	0.981	0.062

Because of the very strong correlation between treatment expectancy and treatment credibility, and between hope and optimism, three post-hoc analyses were performed. A four factor model with separate factors for hope, optimism and pessimism but in which expectancy and credibility items were forced to load on one factor (Additional figure 1) showed fit indices equal to the five factor model (TLI = 0.98, CFI =0.98, RMSEA = 0.06, χ^2 (df) = 412.5 (164)) The $\Delta\chi^2$ test indicated that the four factor model fit significantly worse than the five factor model ($\Delta\chi^2$ (df) = 16.1 (4) p<0.01)). A four factor model with separate factors for treatment expectancy, treatment credibility and pessimism but in which optimism and hope were forced to load on one factor (Additional figure 2), had a slightly worse fit compared to the five factor model (TLI = 0.97, CFI = 0.97, RMSEA = 0.08, χ^2 (df) = 568.7 (164)). The $\Delta\chi^2$

test indicated that the four factor model fit significantly worse than the five factor model ($\Delta\chi^2$ (df) =102.7 (4) p<0.01).

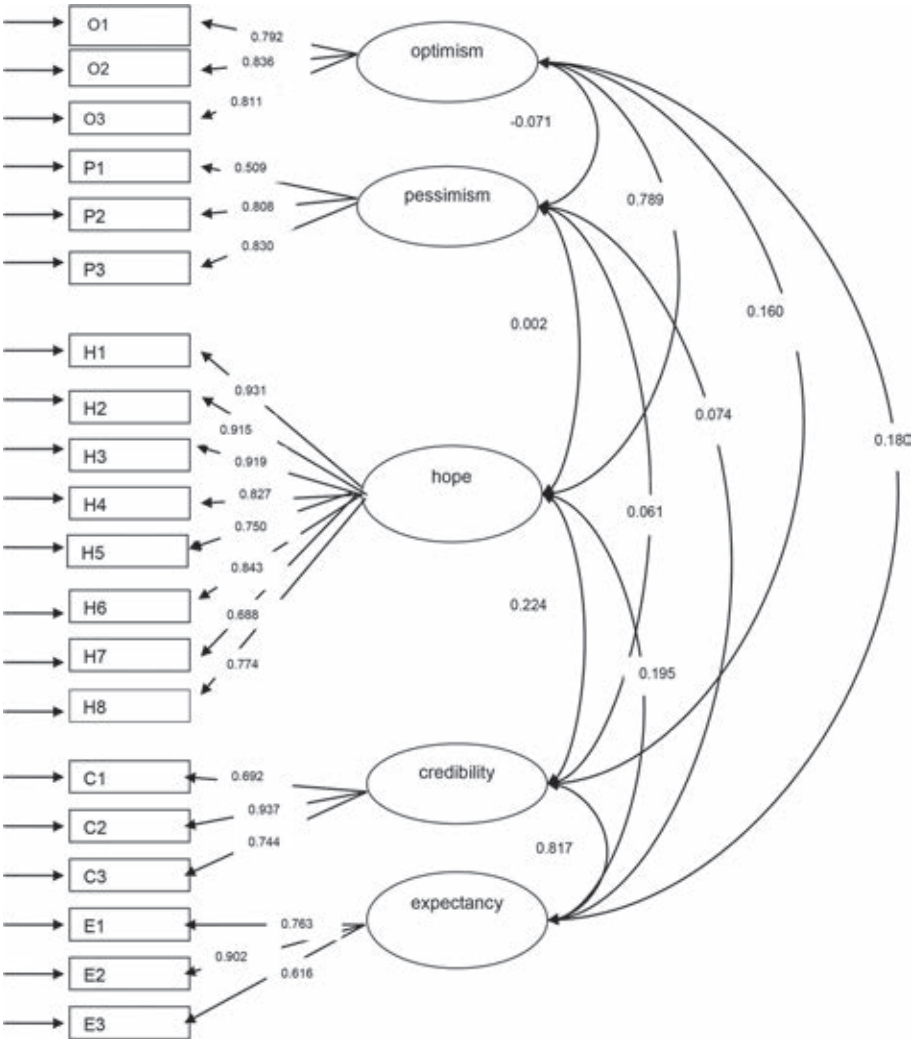


Fig 1. Path diagram and standardized factor loadings and correlations between factors for the 5 factor model.

O1—O3 = LOT-R optimism items 1 to 3,P1—P3 = LOT-R reverse scored pessimism items 1 to 3,H1—H8 = ADHS hope items 1 to 8,C1—C3 = CEQ credibility items 1 to 3,E1—E3 = CEQ expectancy items 1 to 3 ovals represent latent factors, squares represent observed variables, factor loadings are represented by the arrows between ovals and squares and correlations between factors are represented by the arrows between the ovals.

Further, a bifactor model in which (besides the 5 separate factors) there is a general factor (gf) that is hypothesized to account for the commonality of the items of the 5 separate constructs was tested (Additional figure 3). This bifactor model showed better fit indices than the 5 factor model and the four factor model in which the expectancy and credibility items were forced to load on one factor (TLI = 0.99, CFI = 0.99, RMSEA = 0.06, χ^2 (df) = 304.6 (140)). The $\Delta\chi^2$ test indicated that the bifactor model fit statistically significantly better than the five factor model ($\Delta\chi^2$ (df) = 86.8 (20) $p<0.01$). For the bifactor model we calculated the proportion of variance accounted for by all factors (ω_k), the proportion of variance accounted for by the general factor (ω_H). For each of the 5 separate factors we calculated the proportion of variance unique from the general factor (ω_{Nk}) (for example see [31;38]). For these unique proportions of variance a value of $\omega_{Nk} \geq 0.30$ was regarded as substantial, a value of $0.20 \leq \omega_{Nk} < 0.30$ was regarded as moderate, and a value of $\omega_{Nk} < 0.20$ was regarded low [38]. Table 5 shows that the total amount of variance accounted for by all factors is large (0.94). Also, a substantial amount of variance of all factors (ω_k) is accounted for by variation in the general factor (0.79). This suggest that all items indeed measure a common construct. However the specific factors differ in how much variance they account for unique from the general factor. Treatment expectancy, treatment credibility, optimism and pessimism explain a substantial amount of variance unique from the general factor, however hope does not explain a substantial amount of variance unique from the general factor (Table 5).

Table 5: the proportion of variance explained by all factors (ωk), the proportion of variance of the total scale explained by the general factor (ωH) and the proportion of variance of the separate constructs explained by the specific factors (ωNk)

Scale	ω_k	ω_H	ω_{Nk}
Total model (general factor)	0,942	0,787	
Separate constructs			
Treatment credibility	0,838		0,789
Treatment expectancy	0,809		0,782
Hope	0,956		0,015
Optimism	0,857		0,329
Pessimism	0,769		0,769

Discussion

This study examined whether the existing instruments for optimism, pessimism, hope, treatment credibility and treatment expectancy measure distinct psychological constructs in patients undergoing TKA or THA. Because it was not our purpose to develop new instruments or to revise the existing ones, we chose a confirmatory approach (CFA) in all our analyses instead of an exploratory approach (EFA). Moreover, we aimed to use all instruments in the same way as they are currently utilized in research and practice and therefore did not delete items with low factor loadings.

The results of the theory driven CFA showed that a five factor model in which optimism (LOT-R subscale optimism), pessimism (LOT-R subscale pessimism), hope (HS), treatment credibility (CEQ subscale credibility) and treatment expectancy (CEQ subscale expectancy) had the most optimal fit. However, there were two interesting observations. First, a strong correlation ($r = 0.82$) was observed between expectancy and credibility. Therefore a post-hoc analysis was performed in which a four factor model in which expectancy and credibility were forced to load on one factor was tested. Although fit indices were very similar as the five factor model, the $\Delta\chi^2$ test indicated the five factor model was the preferred model. Earlier studies found moderate to very high correlations between expectancy and credibility ($r = 0.56$ [36] , $r = 0.68$ [14] and $r = 0.83$ [14]), though exploratory as well as confirmatory factor analyses suggest expectancy and credibility are two separate factors [14;36]. Although the current study cannot provide the definite answer regarding the distinctiveness of the constructs treatment expectancy and treatment credibility in patients undergoing THA or TKA, it seems reasonable that the a-priori, theory driven 5 factor model is preferred. Additionally the five factor model is also supported by the results of those earlier studies on the constructs expectancy and credibility. Nevertheless, future studies should investigate the factorial structure of the CEQ and the distinctiveness of the constructs treatment credibility and treatment expectancy to determine if our findings are replicable or unique to our study sample.

Secondly, a strong correlation was also observed between optimism and hope ($r = 0.79$). A priori we hypothesized that these two factors would be correlated but still distinct because both are defined as general future oriented constructs

but do have considerable theoretical differences, though we did not expect such a strong correlation. We therefore also performed a post-hoc analysis to investigate the influence of the strong correlation between hope and optimism on model fit. Results showed that the five factor model had a significantly better fit than the four factor model in which optimism and hope were forced to load on one factor.
In a third post-hoc analysis we investigated the possibility that a model in which, besides the five separate factors, a general factor is included that accounts for shared variance in all items would fit the data. Results showed that this model fit the data better than any other model tested and that there is a strong general factor that accounts for a large amount of the variance of the total bifactor model. Thus, we suggest that there is a general 'outlook on future' factor that underlies each of the items. Separately, there are four more specific factors namely treatment credibility, treatment expectancy, optimism and pessimism that each account for unique variance above this general factor. Hope however did not account for a substantial amount unique variance above the general factor.

Our findings are consistent with previous factor analyses that have shown hope and optimism to be related but distinct constructs.[2;25] Our study has extended these findings by demonstrating this in patients undergoing THA and TKA as well as by additionally considering treatment specific future oriented psychological constructs. Our results however slightly differ from Magaletta and Olivers[25] study because we found that the five factor model which included pessimism as a separate factor showed better model fit compared a four factor model in which all items of the LOT-R loaded on one factor.This could be a result of the use of the Dutch translation of the LOT-R which has shown to have a two-dimensional structure [43] Similar to previous studies we found that optimism and hope are positively related and that both of these are negatively related to pessimism.[2;5]

Studying the conceptual overlap of psychological constructs seems to gain more importance. A reason for this is that many psychological measures have been developed in the last decades and all of them have individually shown to measure important constructs in medical care but considerable overlap may exist between these constructs (and measures), causing lack of conceptual clarity and confusion among researchers and care providers about which psychological measures to use in studies and daily practice. Therefore, studies investigating conceptual overlap or distinctiveness of these constructs within a medical care setting are important.

Recently, two of such studies have been published. De Rooij et al[13] investigated the conceptual overlap between cognitive concepts in patients with chronic widespread pain and found that 16 different cognitive subscales could be reduced to three factors namely 1. negative emotional cognitions, 2.active cognitive coping and 3.control belief and expectations of chronicity. Campbell et al[6] studied the conceptual overlap of psychological constructs in low back pain patients and found that 20 subscales of psychological questionnaires could be reduced into four factors namely 1.pain-related distress, 2.cognitive coping, 3.causal beliefs and 4.perceptions of the future. Our study also addresses this issue; however we had a slightly different approach. De Rooij et al and Campbell et al performed factor analyses on a subscale level thereby aiming to identify the most complete though comprehensive set of cognitive (de Rooij) or psychological (Campbell) constructs. We however assessed whether individual item of questionnaires measuring the constructs of interest indeed load on the factors as intended by the developers of the subscale. Our approach therefore, may be seen as the first in a two-step approach in examining overlap between constructs. Once distinctive measurement has been established on an item level, a next step could then be assessing overlap between subscales as de Rooij and Campbell did.

Strengths and Limitations

A strength of this study is that the most widely accepted measurement instruments that aim to measure the included constructs were used, ensuring comparability to future CFA's in other patient groups. A limitation of this study is the limited sample size for CFA's, which made us decide to test our primary hypotheses on the complete sample of THA and THA patients. A multigroup analysis was only done to test for factorial invariance between the THA and TKA group. Although the FI models converged well and results suggest that strict invariance holds for our data, we do recognize that these analyses may be slightly underpowered and therefore these results should be interpreted with caution. Factorial invariance testing showed similar factorial structures in both groups implying that the constructs measured in this study have the same meaning in both patient groups, thereby suggesting generalizability of our results. Another limitation is the high percentage of missing responses on one of the items of the HS, which was caused by a printing error in the questionnaire. The WLMSV estimator in Mplus statistical software incorporates missing data by pairwise presence, though this is under the assumption that missing data are missing completely at random (MCAR). Because of the reason of the

missing data and the fact that that participants with and without missing data (on item 6 of the HS) did not significantly differ on baseline characteristics we believe that the MCAR assumption may hold for our data.

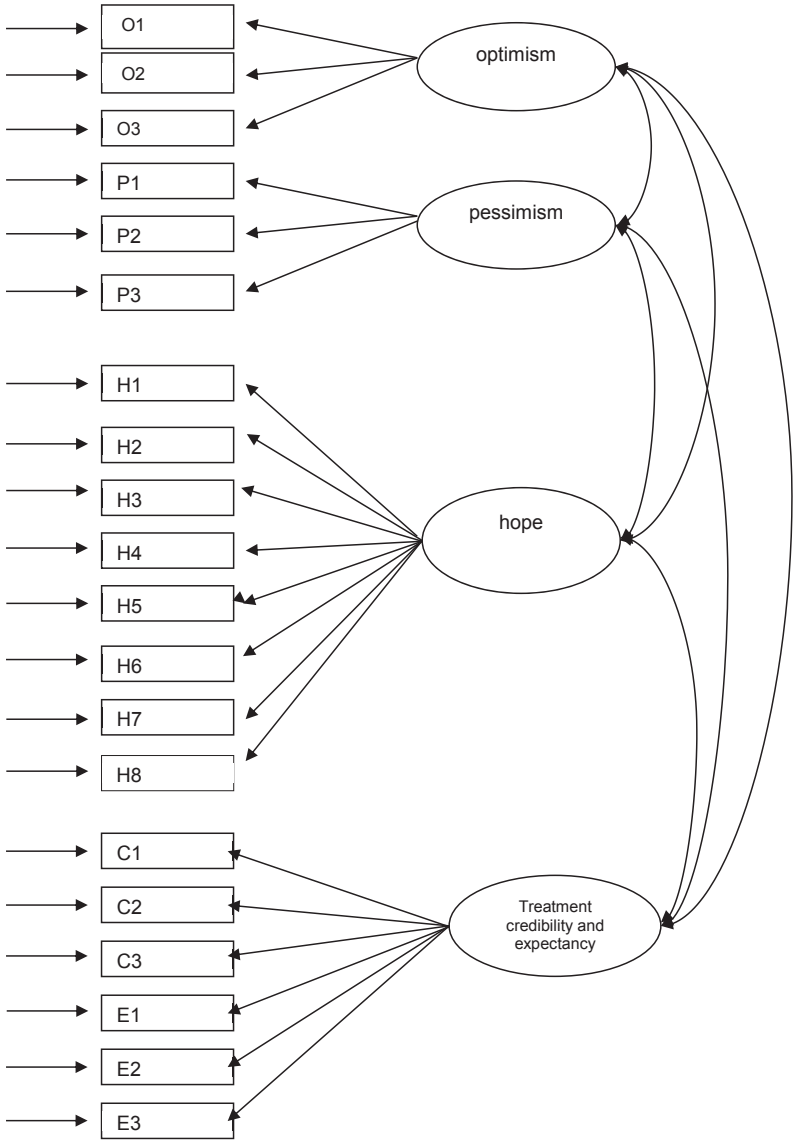
Furthermore, we used $\Delta\chi^2$-test to compare models, which is controversial as the χ^2 is influenced by sample size; therefore we also included other model fit statistics and based our conclusions on a combination of a-priori defined cut-points. CFA is a test of acceptance of a-priori defined models that are not data driven. A limitation of this method is however, that besides the theoretically plausible models tested in this study, there might be other models that show an even better fit to the data. Our results have furthermore not been validated in an external dataset we therefore encourage future research in TKA and THA and also in other patient groups.

Conclusions and Implications

Based on the results of the current study and previous work we suggest that the constructs treatment expectancy, treatment credibility, hope, optimism and pessimism are distinguishable in THA and TKA patients. Posthoc, a bifactor model in which (besides the 5 separate factors) a general factor is hypothesized accounting for the commonality of the items showed a significantly better fit than the five factor model. All specific factors, except for the hope factor, showed to explain a substantial amount of variance beyond the general factor. Future studies should investigate the factorial structure of the CEQ. Our results may be valuable for the design of clinical studies aiming to measure one or more of these constructs as well as for the evaluation of interventions focussed on altering treatment expectancy which have been initiated lately by several groups [23;24;27]. As optimism and hope have been hypothesized to be relatively stable traits, it is necessary for researchers evaluating interventions aimed at altering treatment expectancy, to measure the possibly alterable treatment expectancy distinct from optimism and hope.

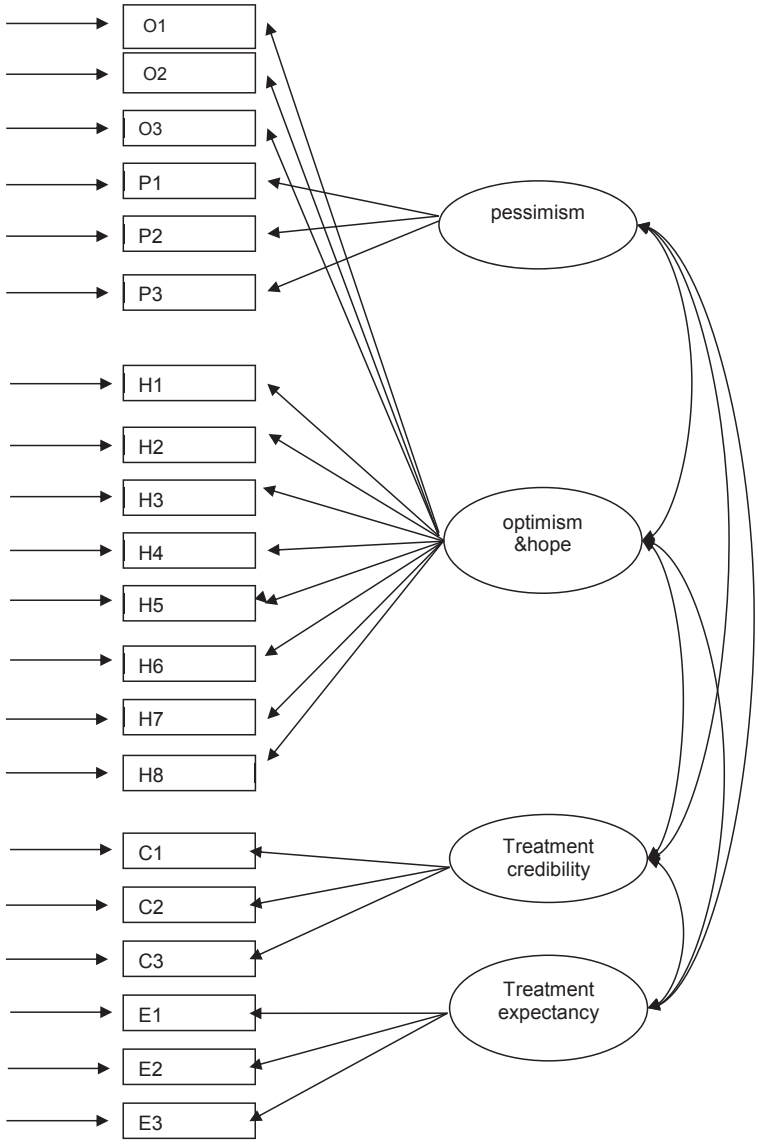
A next step in making these constructs of benefit for the patient undergoing THA and TKA is to investigate the relationships between these factors (e.g. Does optimism influence treatment specific expectancies?) and to find out which one or which combination of constructs predicts with more accuracy treatment outcomes after THA and TKA like pain, quality of life and physical well-being the best. In the future clinicians may use these constructs in addition to other tools, in order to identify patients with a high-risk for poor outcome in their decision for the type of intervention, either surgical or conservative.

Supporting Information



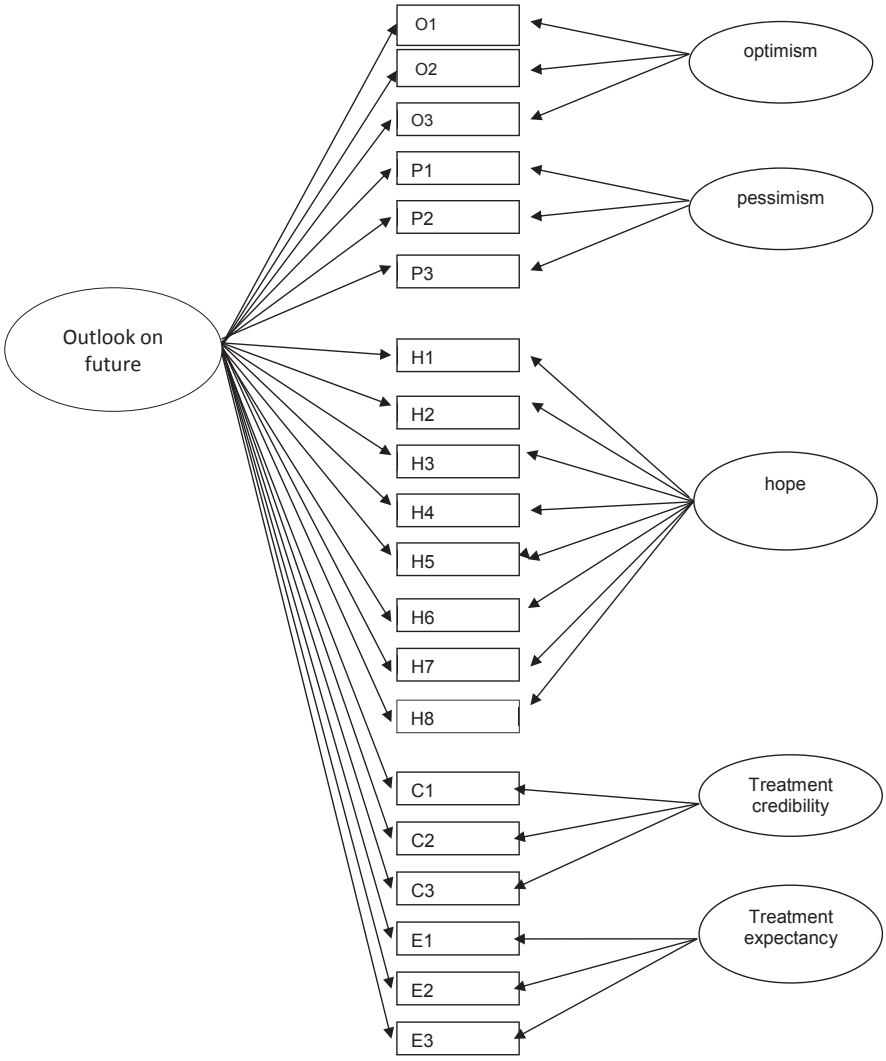
Additional file 1. Post-hoc model 1; four factor model in which the items of treatment credibility and treatment expectancy load on one factor.

O1—O3 = LOT-R optimism items 1 to 3, P1—P3 = LOT-R reverse scored pessimism items 1 to 3, H1—H8 = ADHS hope items 1 to 8, C1—C3 = CEQ credibility items 1 to 3, E1—E3 = CEQ expectancy items 1 to 3. Ovals represent latent factors, squares represent observed variables.



Additional file 2. Post-hoc model 2; four factor model in which the optimism and hope items load on one factor.

O1—O3 = LOT-R optimism items 1 to 3, P1—P3 = LOT-R reverse scored pessimism items 1 to 3, H1—H8 = ADHS hope items 1 to 8, C1—C3 = CEQ credibility items 1 to 3, E1—E3 = CEQ expectancy items 1 to 3. Ovals represent latent factors, squares represent observed variables.



Additional file 3. Post-hoc model 3; the bifactor model.

O1—O3 = LOT-R optimism items 1 to 3, P1—P3 = LOT-R reverse scored pessimism items 1 to 3, H1—H8 = ADHS hope items 1 to 8, C1—C3 = CEQ credibility items 1 to 3, E1—E3 = CEQ expectancy items 1 to 3. Ovals represent latent factors, squares represent observed variables.

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Chapter

Patients' pre-operative general and specific outcome expectations predict postoperative pain and function after total knee and total hip arthroplasties.

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Abstract

Background:

Previous studies have suggested there is an association between preoperative expectations about the outcome and outcomes of total knee and total hip arthroplasty (THA/TKA). However, expectations have been rarely examined on their clinical relevance relative to other well-known predictive factors. Furthermore expectations can be measured on a more generic level (eg: does one expect their symptoms to improve after surgery) or on a more specific level (eg. Does one expect to be able to squat again after surgery). Aim of this study was to examine whether patients' general and specific preoperative outcome expectations predict function and pain 12-months after TKA/THA, when assessed as one of the candidate predictive variables alongside other relevant clinical and sociodemographic variables. Moreover, we explored whether a more generic or a more specific assessment of expectations would better predict outcome.

Methods:

A prospective cohort study on consecutive TKA/THA patients, with assessments done preoperatively and 12-months postoperative. Primary outcomes were the Knee injury and Osteoarthritis Outcome Score (KOOS) and Hip injury and Osteoarthritis Outcome Score (KOOS) activities of daily living (ADL) and pain subscale scores at 12-months. The pain subscales consist of 9-(KOOS) and 10-(HOOS) items and the ADL of 17 items. Patients' preoperative outcome expectations were measured with the Credibility Expectancy Questionnaire (CEQ), which contains three items scored on a 0-9 scale and sum score 0-27 and the Hospital for Special Surgery expectations surveys (HSS expectation surveys) for 17 (TKA) or 18 (THA) outcomes on 0-4 scale. Other candidate predictors: preoperative pain and function as measured with HOOS/KOOS, sex, age, education level, Body Mass Index, Kellgren/Lawrence score, preoperative mental health and treatment credibility as measured with CEQ. Eight prediction models were constructed using multivariate linear regression analysis with a backward selection procedure.

Results:
The 146 TKA patients included in this study had a mean age of 66.9 years (SD 9.2) and 69% was female, The 148 THA patients had a mean age 67.2 (SD 9.5) and 57% was female. Mean outcomes: postoperative HOOS-ADL 84.3 (SD 16.6), Pain 88.2 (SD 15.4), KOOS-ADL 83.9 (SD 15.8) and Pain 83.6 (SD 17.1). CEQ-expectancy median was in THA 23 (IQR 21;24) and TKA 23 (IQR 20;24). HSS-expectation surveys function was for THA 21.0 (18.0;24.0) and 19.0 (14.0;22.0) in TKA. Patients' outcome expectations were consistently part of the combination of variables that best predicted outcomes for both TKA/THA 1-year post-operatively. Expectations alone explained between 17.0-30.3% of the variance in outcomes. The CEQ expectancy subscale explained more variance of postoperative function in TKA and of function and pain in THA as compared to the HSS expectation surveys.

Conclusion:
In planning of surgical treatment, orthopedic surgeons should take a range of variables into account of which the patient's expectations about outcome of surgery is one. The CEQ expectancy subscale predicted outcomes slightly better as the HSS expectation surveys, but differences in predictive value of the two measurements were too small to prefer between the two. Future studies are advised to replicate these findings and externally validate the models presented.

Introduction

There is strong evidence that total knee arthroplasty (TKA) and total hip arthroplasty (THA) are cost-effective procedures for alleviating pain and increasing physical function in osteoarthritis patients [1-3]. Although satisfaction rates are generally high, it is estimated that still 7-34% of patients are dissatisfied or report still having pain or physical limitations 6-12 months after surgery[4-6]. The majority of these remaining complaints cannot be explained by technical factors like loosening of the prosthesis. As an increase of the number of joint arthroplasties is expected for the upcoming years [7], absolute numbers of patients with remaining complaints will thus probably also increase. Another recent development is that patients' evaluations of care processes and outcomes play a prominent role in the financial compensations of hospitals. Both these trends make seeking pre-operative factors that can explain outcomes, resulting in a better selection of patients for surgery currently a priority in orthopedics.

One of the factors that may contribute to the variability in outcomes of TKA and THA are patients' expectations about the outcome of surgery [8;9]. Patients' outcome expectations are defined as "improvements that patients believe will be achieved" [10]. Previously, studies in many fields have shown that these expectations are associated with outcomes[11-13]. In TKA and THA however, mixed results have been found in studies examining the relationship between expectations and outcomes[14;15]. In previous studies on patients' expectations for TKA and THA the aim has been either to describe and quantify patients' expectations[16;17] or to investigate the association between preoperative outcome expectations and postoperative outcomes[18-21], or the association between fulfilment of expectations and outcomes[22;23]. Statistical models presented in these articles have been mainly association models, in which the authors seek to estimate the relationship between expectations and outcomes as accurate as possible. For TKA and THA however many other factors have been found to be also associated with outcomes, for example pre-operative pain and function[24;25] mental health[25;26], body mass index[27], comorbidity[26;28], age[24;25], female gender[25;27] , radiological abnormalities[29] Probably a combination of these factors best identifies those at risk of poor outcome, rather than just one of these factors. So far, however, patient's expectations have rarely been included as a candidate variable in multivariable prediction models for outcomes of TKA and THA. The first aim of

this study therefore is to examine whether expectations have a predictive value when assessed as one of the candidate predictive variables alongside other clinical, demographic and psychosocial predictors that are commonly measured in clinical practice and have been shown to predict post-operative outcomes.

Patients' expectations are a multifaceted and complex construct[30;31], consequently measurement is challenging. Previous systematic reviews identified that patients' expectations for TKA and THA are measured in many different ways[14;32]. Some measurement methods are more targeted at very specific (functional) outcomes, while others assess expectations for outcome in a more general sense. Iles et al. [11] found the specificity of the expectation queried to be of influence on the strength of the association between expectations and outcomes. This may be one of the reasons of the variability in the results of the studies examining the relationship between expectations and outcomes in TKA and THA. Therefore, the second aim of this study is to assess whether specificity of the expected outcome assessed influences the predictive value of expectations on outcomes.

Methods

Participants and Procedures

This study was part of a larger prospective cohort study on patient reported outcomes of THA and TKA. The larger study included consecutive patients undergoing THA or TKA in the Rijnland Hospital in Leiderdorp, the Netherlands between October 2010 and September 2012.

Assessments were done preoperatively and 12 months after surgery. From July 2011 until September 2012 patients participating in that study received additional pre-operative questions concerning pre-operative expectations about the outcome of surgery, hope and optimism. The larger study, as well as the extension was reviewed and approved by the local hospital Review Board of the Rijnland Hospital, Leiderdorp in the Netherlands (registration number 10/07).

The current paper reports on analyses done with the subset of patients that answered the additional questions. Consecutive eligible patients undergoing a

primary TKA or THA were invited by their surgeon to participate in the study. Exclusion criteria were: revision surgery, hemi-arthroplasty, tumor or rheumatoid arthritis, a functioning limiting comorbidity (for example (hemi)paresis), being not sufficiently competent in Dutch to complete a written survey, not being able to manage themselves or not having home care after surgery. Informed consent was obtained from the participants at the time of recruitment.

Assessments

One day prior to surgery all participants completed a survey including a number of sociodemographic, disease characteristics, patient expectations questionnaires and a number of patient reported outcome measures (PROMs). Approximately 12 months after surgery a survey assessing the same PROMs as pre-operatively was sent to the patients' home address together with a pre-stamped return envelope. If the patient did not return the survey within 3 weeks, we attempted to contact the patient by phone and if necessary we sent another copy of the survey to the patient.

General outcome expectations and treatment credibility

Expectations about general recovery after surgery were assessed with the expectancy subscale of the Credibility Expectancy Questionnaire (CEQ) which contains three items that are scored on a 0-9 scale and hence the sum score ranges from 0-27[33;34]. An example of an item is "How much do you really feel that the surgery will help you to reduce your symptoms". Next to outcome expectations the CEQ also contains a credibility subscale. Credibility is defined as "how believable, convincing and logical the treatment is" this concept is closely related to outcome expectations. The credibility subscale also contains three items that are scored on a 0-9 scale.

Specific outcome expectations

Outcome expectations for 17 (TKA) or 18 (THA) specific outcomes with regard to function and pain of hip or knee (eg walking stairs, pain during daytime) were measured with the Hospital for Special Surgery Knee and Hip Replacement and Knee Replacement Expectations Surveys[35;36] , from here on referred to as the HSS expectation surveys (separate questionnaires for TKA and THA). Answering options for all items are scored on a 0-4 scale (4= back to normal, 3=much improvement, 2=somewhat improvement, 1=small improvement, 0= don't have this expectation). Principal component analysis with an oblique rotation was used to derive a coherent expectations for post-operative 'function' variable from the

items of the HSS expectation surveys. For THA items about walking stairs, getting rid of limp, getting in or out of bed chair or car, be able to put on shoes and socks, improve ability to do daily activities in and around the house and improve ability to cut toenails were summed into an 'expectations for function' scale. For THA the sum of two items namely relieve of pain during the day, relieve of pain during the night was used as the 'pain expectations' scale. Because this variable was highly skewed it was dichotomized in ≤6 and >7 points. For TKA the items about being able to stretch the knee, walking stairs, kneeling down, traveling with public transportation, improving ability to do daily activities in and around the house and being able to change position (sitting down, getting up etc.) were summed into an 'expectations for function' scale. For TKA the HSS expectation survey only contains one pain item which was used as 'pain expectations' scale, this item was highly skewed and therefore it was dichotomized in ≤3 and 4 points.

Pain and function

Pain and function were measured both pre-operatively and 12 months post-operatively with Dutch version of the Knee injury and Osteoarthritis Outcome Score (KOOS) [37] and the Hip injury and Osteoarthritis Outcome Score (HOOS) [38] pain and ADL subscales. The pain subscales consists of respectively 9 (KOOS) and 10 (HOOS) items and the ADL subscales consist of 17 items. Sum scores for each subscale are transformed to a 0–100 scale, with 0 representing extreme problems and 100 representing no problems[39] [38].

Mental health

Mental health was measured with the Short Form 36 (SF-36), from which the Mental Component Score (SF-36 MCS) was calculated[40;41] . Scores range from 0-100 with a higher score representing better mental health.

Preoperative radiological severity

Preoperative supine radiographs of hips (anterior-posterior) and weight-bearing radiographs of the knee (posterior-anterior) were collected from the patients' medical record. Radiographs were assessed by an experienced radiologist who was blinded for the side of operation and patient characteristics. The Kellgren and Lawrence (KL) grading system was used to classify the severity of OA. 10% of the radiographs were scored twice: the Intra-Class Correlation of the hip radiographs was 99% (95% CI: 85-93%); the Intra-Class Correlation of the knee radiographs was

95% (95% CI:92-98%)). The KL grade in our study was classified as mild in KL 0-2 and severe in KL3-4.

Sociodemographic variables and patient characteristics

Education level was scored on a 8-point scale with answering options representing the education levels in The Netherlands, scores were dichotomized in low level (no education to lower vocational education) versus high level (intermediate vocational education to university). Self-reported weight and height were used to calculate Body Mass Index (BMI)

Analysis

Multivariate linear regression analyses were employed with postoperative pain (KOOS/HOOS pain) and function (KOOS/HOOS function) as dependent variables. Besides the expectation related variables (general outcome expectations, specific outcome expectations and credibility) we selected 7 variables measured preoperatively as candidate predictors of outcome namely preoperative pain, preoperative function, gender, age, education level, BMI, Kellgren and Lawrence score (KL-score), mental health. The selection of these candidate predictors was based on discussions with orthopaedic surgeons about which predictors of outcome they consider in daily practice.

A backwards elimination method was used for these analyses. This procedure started with including all candidate variables in the model, subsequently the least significant variable was removed (the one with the highest p-value). The model was thereafter refitted without this variable, and again the least significant variable was removed. This process was repeated until all predictor variables in the model had a p-value < 0.10.

The models were first ran with the CEQ expectancy subscale as the expectations variable, in case that the CEQ expectancy subscale was included in the final model, this final model was repeated while replacing the CEQ expectancy subscale with the HSS expectation survey subscale corresponding to the outcome of that model (so the HSS expectation function score was used for the models with function as the dependent variable and the HSS expectation pain score was used for the models with pain as the dependent variable). If the CEQ expectancy subscale was not included in the final model, the backwards elimination procedure was completely repeated with the HSS expectation survey score as a candidate predictor instead of

the CEQ expectancy score. The R2 values of the final models were then compared to assess the differences between predictive ability of the models with generic CEQ expectancy subscale and the models with the more specific HSS expectation survey score. All analyses were performed with IBM SPSS Statistics 20 and were done separately for TKA and THA.

Results

Flow of patients and characteristics of the sample.

Between July 2011 to September 2012 189 THA and 186 TKA patients were enrolled in the study and completed the additional questions on outcome expectations. In the current study the patients from this subgroup that returned the follow-up questionnaires (146 TKA patients and 148 THA patients) are included. TKA patients included in this study had a mean age of 66.9 years (SD 9.2) and 69% was female, THA patients included in this study had a mean age 67.2 (SD 9.5) and 57% was female. Both the characteristics of the total sample and the subsample included in the current analyses are described in Table 1. The characteristics (age, gender, baseline HOOS and KOOS scores) of the subsample of patients included in current analyses did not differ from those of the total study sample.

The predictive value of outcome expectations for Total Knee Arthroplasty

Multivariate linear regression models identified BMI, better mental health (SF-36 mental component summary) baseline function (baseline KOOS ADL subscale) and patients' general expectations of outcome (CEQ expectancy) as significant predictors of a better (function) KOOS ADL score 12 months post TKA (Table 2). Higher (more positive) scores on the expectation measures predicted more favorable outcomes. The final model explained 30.3% (R^2 0.303) of the variance in outcome. When the CEQ expectancy score was replaced by the more specific expectations measure HSS expectation function subscale the explained variance decreased to 25.2% (R2 0.252).

For the outcome pain 12 months after TKA, BMI, mental health and patients' general expectations of outcome (CEQ expectancy) were identified as significant predictors (table 3). The final model explained 17% (R^2 0.170) of the variance of the postoperative pain. When the CEQ expectancy score was replaced by the more specific HSS expectation pain subscale the variance explained slightly improved to 17.7% (R^2 0.177).

Table 1. Patient characteristics and baseline questionnaire scores for the current study population and the overall VESPA study population

	TKA Expectation study (N=146)	TKA Overall VESPA study (N=322)	THA Expectation study (N=148)	THA Overall VESPA study (N=343)
Sex, Female; %	69.0%	70.0%	55.1%	57.0%
Age, mean years (SD)	66.9 (9.3)	66.9 (9.5)	67.5 (8.9)	67.2 (9.5)
Body Mass Index , mean (SD)	29.5 (4.6)	29.5 (4.5)	27.0 (4.5)	27.1 (4.4)
Education level; %				
Low	76.1%	73.5%	48.1%	52.0%
High	23.9%	26.5%	51.9%	48.0%
Baseline HOOS (THA) or KOOS (TKA)domain scores				
ADL mean (SD)	46.1 (16.9)	48.8 (17.8)	46.2 (17.7)	44.4 (17.6)
Pain mean (SD)	39.4 (16.2)	41.7 (16.3)	43.9 (18.1)	41.7 (18.2)
12 months post-op HOOS (THA) or KOOS (TKA)domain scores				
ADL mean (SD)	83.9 (15.8)	83.0 (17.6)	84.3 (16.6)	84.9 (17.0)
Pain mean (SD)	83.6 (17.1)	83.7 (18.0)	88.2 (15.4)	87.8 (15.4)
Credibility expectancy questionnaire (CEQ)				
Subscale expectancy, median (IQR)	23 (20;24)	n.a.	23 (21;24)	n.a.
Subscale credibility, median (IQR)	24 (22;26)	n.a.	24 (22;26)	n.a.
HSS hip and knee replacement expectation surveys subscale function (range 0-24)	19.0 (14.0;22.0)	18.0 (14.0;21.0)	21.0 (18.0;24.0)	21.0 (17.0;24.0)
HSS hip and knee replacement expectation surveys subscale pain (%) #				
Low	76.1%	69.8%	42.4%	43.8%
High	23.9%	30.2%	57.6%	56.2%
SF36 MCS, mean (SD)	52.8 (10.2)	52.7(10.3)	51.4 (10.0)	51.0 (10.4)
SF36 PCS , mean (SD)	39.4 (7.7)	40.4 (7.4)	39.9 (7.4)	39.9 (7.4)

HOOS= Hip injury and Osteoarthritis Outcome Score (HOOS), KOOS= Knee injury and Osteoarthritis Outcome Score (KOOS), CEQ=credibility expectancy questionnaire, HSS= hospital for special surgery expectation surveys, SF-36 MCS= short form 36 mental component summary, SF-36 PCS= short form 36 physical component summary

The predictive value of outcome expectations for Total Hip Arthroplasty

Multivariate linear regression models identified baseline function, the KL-score and patients' general expectations of outcome (CEQ expectancy) as significant predictors of function 12 months after THA (table 4). The final model explained 18.6% (R^2 0.186) of the variance in outcome. When the CEQ expectancy score was replaced by the more specific expectations measure (HSS expectation surveys function subscale) the explained variance slightly decreased to 17.7% (R^2 0.177). For the outcome pain 12 months after THA, baseline function, the KL-score and patients' general expectations of outcome (CEQ expectancy) were identified as significant predictors (table 5). The final model explained 18.4% (R^2 0.184) of variance in the outcome. When the CEQ expectancy score was replaced by the more specific expectations measure (HSS expectation surveys pain subscale) the explained variance was similar (18.3% (R^2 0.183)).

Table 2. TKA: Final prediction models for the outcome function (KOOS ADL subscale)

Final prediction model for the outcome function (general outcome expectations (CEQ))			
Variable	**B**	**p**	**95% CI**
preoperative function	0.16	0.04	-1.61;-0.52
BMI	-1.07	0.00	0.01;0.31
Mental health (SF-36 MSC)	0.41	0.00	0.16;0.65
Outcome expectations (CEQ expectancy)	1.18	0.00	0.39;1.96

R^2 for the final model:0.303

CEQ=credibility expectancy questionnaire, HSS= hospital for special surgery expectation surveys, KOOS= Knee injury and Osteoarthritis Outcome Score (KOOS), B= unstandardized Beta coefficient, 95%CI= 95% confidence interval.

Table 3. TKA: Final prediction models for the outcome pain (KOOS pain subscale)

Final prediction model for the outcome pain (general outcome expectations (CEQ))			
Variable	**B**	**p**	**95% CI**
BMI	-1.00	0.00	-1.63;-0.38
Mental health	0.42	0.04	0.14;0.71
Outcome expectations (CEQ expectancy)	0.80	0.09	-0.11;1.72

R^2 for the final model: 0.170

CEQ=credibility expectancy questionnaire, HSS= hospital for special surgery expectation surveys, KOOS= Knee injury and Osteoarthritis Outcome Score, ADL= activities of daily living B= unstandardized Beta coefficient, 95%CI= 95% confidence interval.

Table 4. THA: Final prediction models for the outcome function (HOOS ADL subscale)

Final prediction model for the outcome function in which the general outcome expectations (CEQ) score was included			
Variable	**B**	**p**	**95% CI**
Age	-0.34	0.042	-0.67 ; -0.01
Baseline function (HOOS ADL)	0.31	0.000	0.14 ; 0.48
Kellgren and Lawrence score	4.12	0.09	-0.63 ; 8.87
Outcome expectations (CEQ expectancy)	1.23	0.023	0.17 ; 2.29

R^2 for the final model:0.186

CEQ=credibility expectancy questionnaire, HSS= hospital for special surgery expectation surveys, HOOS= Hip injury and Osteoarthritis Outcome Score, ADL= activities of daily living, B= unstandardized Beta coefficient, 95%CI= 95% confidence interval.

Table 5. THA: Final prediction models for the outcome postoperative pain (HOOS Pain subscale)

Final prediction model for the outcome pain in which the general outcome expectations (CEQ) score was included			
variable	**B**	**p**	**95% CI**
Baseline function (HOOS ADL)	0.33	0.00	0.172;0.0477
Kellgren and Lawrence score	3.72	0.090	-0.592;8.021
Outcome expectations (CEQ expectancy)	0.98	0.049	0.004;1.958

R^2 for the final model: 0.184

CEQ=credibility expectancy questionnaire, HSS= hospital for special surgery expectation surveys, HOOS= Hip injury and Osteoarthritis Outcome Score, ADL= activities of daily living, B= unstandardized Beta coefficient, 95%CI= 95% confidence interval.

Final prediction model for the outcome function (specific outcome expectations (HSS))			
Variable	B	p	95% CI
preoperative function	0.14	0.07	-1.64;-0.51
BMI	-1.07	0.00	-0.01;0.30
Mental health (SF-36 MSC)	0.47	0.00	0.22;0.72
Outcome expectations (HSS Knee Replacement Expectations subscale function)	0.12	0.61	-0.35;0.60

R^2 for the final model:0.251

Final prediction model for the outcome function (specific outcome expectations (HSS))			
variable	B	p	95% CI
BMI	-1.07	0.00	-1.70;-0.43
Mental health	0.41	0.01	0.13;0.69
Outcome expectations (HSS Knee Replacement Expectations subscale pain)	6.41	0.05	0.04;12.77

R^2 for the final model: 0.177

Final prediction model for the outcome function in which the specific outcome expectations (HSS) score was included			
Variable	B	p	95% CI
Age	-0.34	0.042	-0.675 ; - 0.012
Baseline function (HOOS ADL)	0.32	0.000	0.149 ; 0.485
Kellgren and Lawrence score	4.10	0.093	-0.693 ; 8.886
Outcome expectations (HSS Hip Replacement Expectations subscale function)	0.732	0.014	0.014 ;1.449

R^2 for the final model:0.177

Final prediction model for the outcome pain in which the specific outcome expectations (HSS) score was included			
variable	B	p	95% CI
Baseline function (HOOS ADL)	0.34	0.000	0.191;0.496
Kellgren and Lawrence score	3.89	0.075	-0.399;8.185
Outcome expectations (HSS Hip Replacement Expectations subscale pain)	5.31	0.050	-0.010;10.620

R^2 for the final model: 0.183

Discussion

The primary findings of the analyses were 1) that patient expectations for the outcome of THA and TKA consistently are part of a prediction model that predicts the outcomes pain and function 1 year post-operative. 2) that the more general CEQ expectancy subscale explains slightly more variance in function in TKA and function and pain in THA as compared to the HSS total knee or total hip arthroplasty expectation surveys.

Comparisons with the literature

This study is, to the best of our knowledge, the first to assess the predictive value of expectations within a prediction model in which multiple other clinical and sociodemographic variables were entered; we however do want to discuss our results in the light of previous findings regarding patients' outcome expectations for TKA and THA. Several studies have been published that examine the association between pre-operative expectations and outcomes of TKA and THA. These studies analyze their data from an etiological perspective, the aim those studies is to determine whether a particular independent variable really affects the dependent variable, and to estimate the magnitude of that effect [42;43] . Thus, in such studies patients' expectations are the determinant of interest while other variables are regarded as confounders of the relationship between patients' expectations and outcomes. For these studies contradictive results are found; some studies show a positive associations which suggest that higher expectations are related to better outcomes, others find no association or even negative associations[44]. This variability in results of studies may be caused by the type of expectations examined, the measurement approach used, the outcome assessed, the timing of the outcome assessment or the use of univariate versus multivariate statistical methods[14]. These studies however do not answer the question as to whether patient's expectations can be used in clinical practice to predict the clinical course of the disorder. To answer this question one has to examine whether the predictive value increases by including the expectation variables in the regression analysis. Our study does answer that question by examining expectations within prediction models which "seek to get optimal predictions based on a linear combination of whatever variables are available" [43]. In our study we chose to include candidate variables in the multivariate models that mimic clinical routine, i.e. are easily accessible for professionals because they are already part of regular anamnesis and routine outcome measurement. Our

study showed that expectations consistently are part of the set of variables that together best predict the outcomes function and pain 1 year after TKA and THA. Post-hoc we assessed for each model what the amount of explained variance that could be attributed to the expectations measure by running the final prediction models again without the expectations variable and subtracting the R2 of these models from the R2 of the final models described in the results section. The amount of variance explained by expectations alone ranged from 1.3 to 6.5%. We suggest that in planning surgical treatment the orthopedic surgeon should take into account not only relative objective measures like age, degree of osteoarthritis and comorbidity but also what the patient thinks to achieve with this THA or TKA surgery. Although these factors seem important they only account for a limited amount of the variance in outcomes. Still, we think that routinely assessing patients' expectations in clinical practice is advisable because besides this predictive role discussing patients' expectations for TKA and THA has more functions in treatment setting. Assessing and discussing patient's expectations is also valuable for patient-practitioner communication and shared decision making[45]. It is further suggested that patients' expectations may be a factor that is causally related to treatment outcome[46]. This could imply that through altering expectations one would be able to achieve better treatment outcomes. Although experimental research with healthy volunteers seems to point in this direction [47;48], clinical research has not confirmed this as RCT's are scarce and observational studies have found mixed results and cannot fully establish causality[14]. Furthermore, it is still unclear what the most optimal expectation is in clinical situations. Should an expectation be high in order for the non-specific or placebo effects of the intervention to be optimal, or should high expectations for instance be tempered to prevent disappointment?

The second research question of this study examined whether the measurement approach used to measure expectations influenced the predictive value of expectations. Results showed that expectations that were measured with the more general CEQ expectancy subscale predicted most outcomes slightly better than the more outcome specific HSS expectation surveys, specifically for the outcome functioning. However, the differences in predictive value between the CEQ and HSS expectations survey are too small to give a definite answer to the question which one better predicts outcomes. Results do not correspond to those of[49] Iles et al who found that that the more specific the items of a questionnaire were, the better the predictive value for that outcome. A recent systematic review [32]

distinguished between measurement instruments that measured the importance of expectations and measurement instruments that measured the probability that certain events would happen. This review found that measurement instruments that measured probabilities showed better associations with outcomes. It seems like the construct patients' expectations has multiple dimensions that can be measured. In current measurement instruments different combinations of these dimensions are incorporated. Our study assessed whether variations in only one dimension of expectations (specificity of the expected outcome) accounted for differences in predictive values. Further research is needed to identify which dimensions of the construct 'patients' outcome expectations' need to be included in the optimal measurement instrument.

Strengths of the study

This study has several strengths. Firstly, all questionnaires used in this study are well known validated measures that are used in research as well as clinical practice. Secondly, patients were recruited consecutively from one general hospital in the Netherlands. The latter is the setting were most TKA and THA surgeries are performed. The characteristics of our sample are not only comparable to the THA and TKA population of the larger VESPA study) but also very similar to the overall Dutch population of TKA and THA patients in 2011 and 2012 registered in the Dutch Arthroplasty Registry [50] ensuring generalizability of our results.

We chose our candidate variables for the multivariate models based on two criteria, variables had to be associated with outcomes of TKA or THA in previous studies, furthermore they (which is recommended also by several authorities in orthopedics) had to be simple and reliable measures that are already commonly used in clinical practice.

Limitations of the study

A limitation of this study is that because of the sample size, the number of candidate variables that could be examined was limited. It may therefore be that we have missed important predictive variables. A strength of this study is the use of a continuous predictors and outcome measures. Although some may argue that for clinical practice it is more useful to use dichotomous outcomes and define cut off values for the predictors in the study several methodological studies also have

suggested that it is better to not dichotomize in prediction studies as continuous variables contain more information and model fit generally is better with continuous variables[51;52]. Further, because patient acceptable symptom states have not been established yet for the HOOS and KOOS measures and therefore any cut off point for the outcomes used in this study would be arbitrary. Lastly, to answer the second research question it was necessary to calculate a summary score for the pain and function expectation items of the HSS expectation surveys. However, these questionnaires were developed for the use of the individual item scores, and although in literature all items have been summed before into one total score, factor structures have not been developed officially yet. We therefore did exploratory factor analyses to derive comprehensive 'expectations about function' factors. As only one (THA) or two (TKA) items are about pain, we did not run a factor analyses for those items but dichotomized them to get a proper distribution of answers.

Conclusion

In conclusion, 1) patients' outcome expectations were consistently part of the combination of variables that best predicted function and pain 12 months postoperatively for both TKA and THA. However, the amount of variance explained by the expectation measures alone was limited. 2) The CEQ expectancy subscale predicted outcomes slightly better as compared to the HSS expectation surveys, but differences in predictive value of the two measurements were too small to recommend the use of one of the two for prediction purposes.

Implications

Given the observed importance of patients' outcome expectations, we suggest that in planning surgical treatment orthopedic surgeons should take these, in addition to a broader range of variables, into account of which the patient's expectations about outcome of surgery is one.

Because differences in predictive value of the CEQ expectancy subscale and HSS expectations surveys measurements were very small, future studies are advised to replicate the findings and externally validate the models presented.

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Chapter

Return to work after total hip and knee arthroplasty: a systematic review

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Abstract

Objectives.
The aim of this study was to describe work status and time to return to work in patients undergoing total hip arthroplasty (THA) or total knee arthroplasty (TKA) and to determine which factors are associated with work status.

Methods.
A systematic search strategy in various databases through April 2013 was performed. All clinical studies concerning patients undergoing THA or TKA providing quantitative information on work status before and after surgery were eligible for inclusion. Extracted were study characteristics, data on work status and determinants of return to work. The methodological quality was evaluated in three quality aspects (selection bias, information bias and statistical analysis bias).

Results.
Nineteen studies published between 1986 and 2013 were selected (4 on THA, 14 on TKA and 1 on THA and TKA). These studies included 3872 patients with THA and 649 patients with TKA. The proportions of patients returning to work ranged from 25 to 95% at 112 months after THA and from 71 to 83% at 36 months after TKA. The average time to return to work varied from 1.1 to 13.9 weeks after THA and from 8.0 to 12.0 weeks after TKA. Factors related to work status after THA and TKA included sociodemographic, health and job characteristics. Overall, the methodological quality of the studies was moderate to low.

Conclusion.
The majority of patients who are employed before THA and TKA return to work postoperatively. Comparisons of work status and the rate and speed of return to work between studies in THA and TKA are hampered by large variations in patient selection and measurement methods, underpinning the need for more standardization.

Introduction

In North America and Europe OA of the hip or knee is one of the most prevalent chronic diseases[1] and the most common reason for total joint replacement. By 2009, the number of patients undergoing total hip arthroplasty (THA) and total knee arthroplasty (TKA) increased to 1.6 and 1.2 per 1000 per year, respectively, in Western countries.[2] These numbers are expected to further increase in the coming years due to the ageing society and the growing prevalence of obesity.[2] Currently a substantial proportion of these patients (15-45%)[5-8] is working (age <65 years) at the time these procedures are performed. Both from the perspective of the individual as well as from a socioeconomic point of view it is important to have insight into the rate and speed of return to work in this patient group. To date, a substantial number of studies on this topic have been published. A previous systematic review on work status in THA and TKA by Kuijer et al.[3] aimed to describe determinants of return to work. The search in that review was restricted to studies published between 1998 and 2008 and concerned two bibliographic databases (PubMed and EMBASE).[3] In that review, three studies, all concerning THA, were included. It was found that the type of operation (two-incision or a mini-posterior approach for THA)[4], the provision of no movement restrictions[5] and early, protocol-based patient discharge[6] were associated with an earlier return to work after THA.

To the best of our knowledge, the literature has not been summarized with respect to actual work status before and after surgery, including the rate of and time to return to work in working patients undergoing THA and TKA. Therefore the aim of the present study was to perform a comprehensive, systematic literature review on the rate of and time to return to work after THA or TKA, as well as beneficial and limiting factors affecting return to work.

Methods

Search strategy

In cooperation with a trained librarian (J.W.M.P.), a search strategy was developed (see Supplementary data, available at Rheumatology Online). The search strategy consisted of the AND combination of two main concepts: Work Disability AND (THA OR TKA). The search strategy was developed for PubMed and subsequently

adapted for use in other databases. The following databases were used: PubMed, EMBASE (OVID version), Web of Science, Cochrane Library, CINAHL (Cumulative Index to Nursing & Allied Health Literature; EbscoHost version), PsycINFO (EbscoHost version), Academic Search Premier and ScienceDirect. Restrictions included papers in English, French, German or Dutch and studies of humans. The search was performed on 23 April 2013.

Data collection and analysis

Four steps in the selection of studies and data extraction were defined. All steps were performed by two of the authors independently (C.T. and W.S.) and any discrepancies were resolved by consensus. If consensus between the two authors was not achieved, a final decision was made by a third author (T.P.M.V.V.).

Step 1: screening of titles and abstracts

First, all duplicates were removed. For screening of the remaining titles and abstracts, the following criteria were used: (i) clinical study including a minimum of 10 patients undergoing THA and/or TKA and (ii) reporting on the patients' work status before and /or at least on one occasion after surgery.

Step 2: selection of full-text papers

Titles and abstracts identified as potentially eligible were selected for full-article review. If an abstract was not available, the full-text paper was requested. For the screening of the full-text papers the abovementioned criteria were again used, with the following specification regarding the reporting of work status: the study reported quantitative information on work status before and after THA and/or TKA, including working full time (yes/no), working part time (yes/no), number of hours working, early retirement, sick leave, unemployment, and/or permanent work disability (partial or full disability pension). Finally, the references of all selected papers and of systematic reviews included in the yield of the search strategy were checked for potentially eligible studies that were not identified with the original search strategy. The titles and abstracts of these references were screened using the abovementioned selection procedure.

Step 3: data extraction

With respect to the study characteristics, the following data were systematically extracted from the selected full-text papers: title, first author, year of publication, journal title, study design (retrospective, prospective or crosssectional) and country where the study was conducted. Regarding the patient characteristics, the number of subjects in the study, the recruitment or selection criteria, sociodemographic characteristics of the subjects (age, sex) and type of operation (THA and/or TKA) were recorded. In addition, the following outcomes were extracted: work status of patients prior to surgery and work status of patients after surgery, including the observation time (duration of follow-up), with work status before or after surgery comprising the number of patients working full time (yes/no), working part time (yes/no), being on early retirement, unemployed, on sick leave and/or being permanently work disabled (partial or full disability pension). Moreover, the number of hours working per week and/or time to return to work (weeks) were registered, as well as any factors described as having an impact on return to work, including the employment of univariate or multivariate analyses.

Step 4: assessment of methodological quality

To assess the methodological quality of the included studies, a quality checklist was developed based on items described in a review of tools for quality assessment[7] and on a review of the quality of prognostic studies in systematic reviews.[8] This quality checklist was employed in a previous systematic review on work disability in a rheumatic disease by our own group.[9] Two authors independently assessed the quality of each study by scoring 23 items (see Supplementary data, available at Rheumatology Online), divided into three categories: (i) selection bias (items 1-6), (ii) information bias (items 7-18) and (iii) statistical analysis of potential determinants of work status (items 19-23). Bias was considered present if the majority of the items within a category pointed in this direction. The quality of the study was rated as high if there was no evidence for selection bias, information bias or analysis bias. The quality of the study was rated as moderate if there was evidence of bias in one of the two categories in descriptive studies (statistical analysis of factors associated with return to work not applicable) or two of three categories in studies comprising an analysis of associations between various factors on the one side and work status on the other. The quality of the study was rated as low if there was evidence of bias in two categories in descriptive studies and all three categories in the other studies.

Results

Selection of papers

The bibliographic databases yielded 796 references in total (see Fig. 1). A total of 227 duplicates were excluded. The first screening of the remaining 569 titles and abstracts resulted in exclusion of 518 abstracts, because these did not concern a clinical study, did not include THA or TKA patients or provided no information on work status. Full-text screening of the 51 remaining potentially eligible papers resulted in exclusion of 32 papers because they did not meet the inclusion criteria. Finally, 19 papers were selected for inclusion.

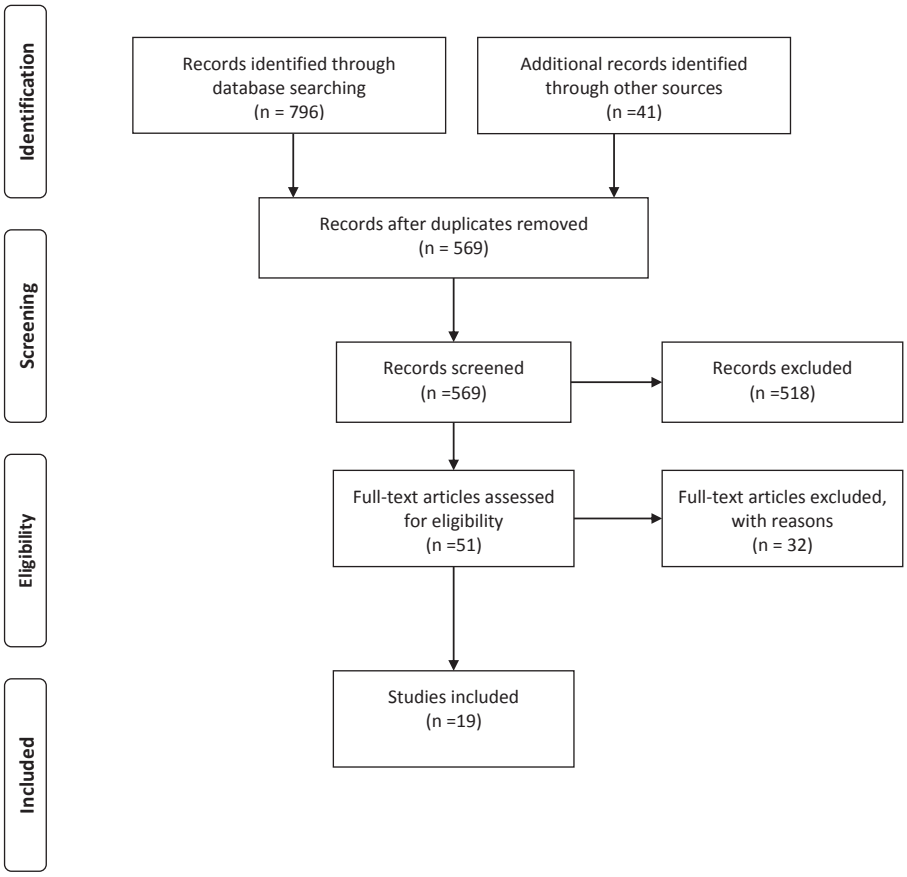

Fig 1 Flow Diagram.

Study characteristics

The characteristics of the selected studies are presented in Table 1. Nineteen studies, described in 14 papers on THA[4,5,10-21], 4 papers on TKA[6,22-25], and 1 paper on THA and TKA[6], including in total 3872 patients who underwent THA (2055 males, 53.1%) and 649 patients who underwent TKA (239 males, 36.8%) were selected. Eight studies had a prospective cohort design[4-6,11,17,18,21,24] and 11 studies had a retrospective cohort design.[10,12-16,19,20,22,23,25] Studies were published between 1984 and 2013. Of these 18 studies, 8 were performed in the USA[5,6,11,14,18,19,24,25], 4 in the UK[20-23] and the other 7 in Denmark[12] Finland[17], Sweden[16], Spain[10], Germany[13], Thailand[4] and Canada.[15] The average age of patients who underwent THA ranged from 46.9 to 69.7 years[4-6,10-21] and 54.1 to 69.7 years[6,22-25] in patients who underwent TKA. In studies on THA, six studies included only patients of working age[11,14,16,18,20,21], two studies included only patients who were working preoperatively[10,15] and four studies included the total cohort of operated patients.[5,12,13,17] In studies on TKA, three studies included only patients of working age[22-24] and one study included the total cohort of all operated patients.[25] In the study on THA and TKA, all operated patients were included.[6]

Table 1: Characteristics and study designs of 19 studies on work status in patients undergoing total hip and knee arthroplasty

THA							
First author, Country	**Study Design**	**Year**	**Number of patients**	**Main inclusion criteria**	**Age; years**	**Gender; n (%), male**	**Duration of follow up after surgery**
Nevitt et al. USA (14)	retrospective	1984	178 (of whom 139 were either employed at the time of THA or had worked regularly but were disabled at the time of THA)	Patients 60 years of age or less	49.7 (mean age at THA)	78 (43.8)	4 years
Jensen et al. Denmark (12)	retrospective	1985	387 (of whom 152 were working or on sick leave preoperatively)	All patients who were admitted for treatment of hip disease by THA over an 8 year period	Median 67 (range 21-89); 99 patients < 60 years and 162 patients 61-70 years	139 (35.9)	Median follow-up time 5 years (range 2-11)
Johnssson and Persson, Sweden (16)	retrospective	1986	118	Patients aged 60 years or less	Mean age 54 years (range 36-95)	76 (64.4)	2 years
Visuri et al. Finland (17)	retrospective	1987	539	All patients undergoing THA in a 7-year period	Mean age: 63.8 years 5 (0.9%) 25-34 13 (2.4%) 35-44 57 (10.5%) 45-54 174 (32.%) 55-64 244 (45.3) 65-74 46 (8.5%) 75-84	166 (30.8)	4.2 years
Suarez et al. Spain (10)	retrospective	1996	747	Patients aged 18-64 who worked before THA and attended a rehabilitation center after THA over a 15 year period.	Mean 46.9 (SD 0.3) (range 18-64)	80% males	6-7 weeks

Table 1: continued

THA							
First author, Country	Study Design	Year	Number of patients	Main inclusion criteria	Age; years	Gender; n (%), male	Duration of follow up after surgery
THA/ TKA Weingarten et al. USA (6)	prospective, pretest (baseline: 3 months)-post test (feedback intervention: 6 months) design; intervention was the active introduction of guidelines to identify low risk patients who may be suitable for earlier discharge or transfer from the acute care hospital	1998	214 THA (95 baseline period and 119 feedback intervention period) (plus 59 patients with hip fracture)	Patients with THA, hip fracture or TKA who were at low risk according to clinically derived and validated practice guidelines	THA: Baseline period: Mean age 67.0 (SD 11.5) Feedback intervention period: Mean age 64.9 (SD 12.8)	THA: Baseline period: 39% males Feedback intervention period: 39% males	90-150 days
Sarkar et al. Germany (13)	Retrospective	2001	37	Patients who underwent secondary THA (because of acetabular fractures) over an 18 years period	Median age 44 (range 20-74) 20-30: n=12; 30-40: n=4; 40-50: n=7; 50-60:n=5; 60-70:n=6; >70: n=4	30 (81)	48 months (range 15-168)
Berger et al. USA (18)	Prospective	2004	100	Patients aged between 40 and 75 years who underwent minimally invasive THA with a rapid rehabilitation protocol over a 2.5 year period	Mean age 56 years (range 41-75); <50 years: n=25 50-65 years: n=49 >65 years: n=26	74 (74)	3 months
Peak et al. USA (5)	Prospective randomized controlled trial; intervention: functional restrictions	2005	265 patients (303 hips)	All patient undergoing uncemented primary THA	Mean age 58.3 years (range 14-88)	139 (52.5)	Minimum of 6 months

Table 1: continued

THA							
First author, Country	**Study Design**	**Year**	**Number of patients**	**Main inclusion criteria**	**Age; years**	**Gender; n (%), male**	**Duration of follow up after surgery**
Tanavalee et al.Thailand (4)	Prospective, uncontrolled	2006	35 patients (40 hips) 2-incision THA 35 patients (36 hips) single-incision mini posterior THA	All patients undergoing 2-incision or single-incision mini posterior THA in a 26 month period	2-incision: mean age 53 years (range 34-75) mini-posterior: mean 54.9 years (range 38-76)	2-incision: 8 (23) males; mini-posterior: 20 (57) males	Minimum follow up 1 year; Actual follow-up awas 20.2 months (12-36 months)
Pagnano et al. USA (19)	Retrospective	2006	26	Patients with staged, bilateral THA over a 1 year period, one THA performed using 2-incision and the contralateral using min-posterior technique, and who had a successful outcome	Mean age 69 years (range 42-80)	10 (38)	Minimum of 6 months after the second THA; 1 year
Mobasheri et al. UK (20)	Retrospective	2006	86 patients (101 hips)	Patients ages <60 with unilateral THA	Mean age 51.4 years (range 29-60)	56 (65,1)	Mean follow up 3 years (range 0.5-10 years)
Bohm et al. Canada (15)	Prospective	2010	60 patients (of whom 54 were available for follow-up)	Patients who underwent THA and classified themselves as being in the workforce preoperatively	Mean age 49.9 years in patients who returned to work and 60.3 years in patients not returning to work	53% male (21/40) in patients who returned to work and 17% male (1/6) in patients not returning to work	1 year
Nunley et al. USA (11)	Retrospective, multicenter	2011	806 patients	Patients aged <60 (males) or 55 years (females), regularly participating in moderate activities who underwent THA in a 30-month period	Mean age 49.5 (SD 7.21)	531 (65.9)	2.31 years (SD 0.76)

Table 1: continued

THA							
First author, Country	**Study Design**	**Year**	**Number of patients**	**Main inclusion criteria**	**Age; years**	**Gender; n (%), male**	**Duration of follow up after surgery**
Cowie et al. UK (21)	Prospective	2013	239 patients 285 hip replacements	Patients aged <65 years who underwent THA over a 5 year period	Mean age 55.2 (SD 7.2)	84 (35.2)	Mean follow up 3.1 years (SD 0.97) (range 0.58- 5.42)
TKA							
First author, Country	**Study Design**	**Year**	**Number of patients**	**Main inclusion criteria**	**Age; years**	**Gender; No (%) male**	**Duration of follow up after surgery**
Lyall UK (22)	Retrospective	2009	56	All patients < 60 years old who underwent primary TKA over an 8 years period	Mean 57.9 years (range 48-60)	33 (58.9)	64 months (range 47-112)
Lombardi USA (25)	Prospective cohort study	2009	103 (compared with 103 patients with Unicompartimental knee arthroplasty UKA)	A matched selection of 103 patients (115 knees) treated with primary cruciate retaining TKA in a 12-month period (Matched with 103 patients receiving primary medial UKA)	Mean 62 years (SD 10.0. range 41-85)	38 (37)	32 months (SD 10.4, range 2 to 52)
Foote UK (23)	Retrospective	2010	41 (study also included 37 patients with patellofemoral replacement and 31 patients with UKA)	Patients <60 years of age receiving TKR (or PKR or UKR) over a 4 year period	Mean 54.1 years (range 44-59)	22 (37)	41.4 months (range 14-58)
Styron USA (24)	Prospective	2011	162 patients	Patients scheduled for primary total knee arthroplasty, aged18-69 years who were employed and intending to return to work postoperatively	Median 57 years (interquartile range 52-61)	51 (31.5%)	6 weeks, 3 months, 6 months

PFR: patellofemoral joint replacement; THA: total hip arthroplasty; TKA: total knee arthroplasty; TKR: total knee replacement; UKA: unicompartimental knee arthroplasty; UKR: unicompartmental knee replacement.

Measures of work status

Table 2 describes the measures of work status employed in the various studies as well as the related outcomes. There was great variability concerning the definition of work status before and after surgery among the studies, ranging from employed or working (yes/no)[6, 11-14, 18, 21-24] and type of profession (white collar, intermediate, or blue collar)[10] to mixed classifications, including household/light work/moderate work/heavy work/sick leave/retired[11, 12, 16, 21] and physical/mental/service trades/housework[16, 17] and the experience of working problems because of hip and knee complaints.[11, 11, 14, 15, 17, 20-22] The work status of the patients prior to surgery was described in 15 studies (10 studies on THA[5, 10-12, 14-18, 20], 3 studies on TKA[22-24] and 1 study on THA and TKA[6]).

The work status of patients after surgery, irrespective of its definition, was described in 15 studies (11 studies on THA[5, 10-17, 20, 21], 3 studies on TKA[22-24] and 1 study on THA and TKA[6]). In the studies describing return to work, the proportions of patients returning to work ranged from 25 to 95% at 1-12 months after THA (n=7 studies) and from 71 to 83% at 3-6 months after TKA (n=2 studies).

The time to return to work in patients who were working preoperatively was described in a limited number of studies. Return to work after THA (described in five studies) ranged from 1.1 to 10.5 weeks[5, 11, 18-20, 25] and after TKA (described in four studies) ranged from 8.0 to 12.0 weeks.[22-25] The other nine studies did not measure the time to return to work in weeks, but measured only working status at different time points.

Determinants of work status

Table 3 shows the results of 19 studies examining determinants of work status after THA and/or TKA. Less than half of the studies employed multivariate analyses. Fourteen papers reported on determinants of return to work after surgery in THA.[4-6, 10-17, 19-21] In papers using multivariate analyses[6, 11, 14, 17] it was found that female gender, older age, pain in joints other than the hips, failure of the procedure, physical work, unskilled work and being a farmer were associated with worse work outcomes.[11, 14, 17] In addition, younger age, more education, working 1 month preoperatively, mental work, primary coxarthrosis and having a better postoperative walking ability were associated with better work outcomes.[11, 14, 17] The type of prosthesis and surgical procedure[11] (dividing patients into five groups based on the bearing surface and

size of the femoral head), preoperative function[11] and the introduction of a practice guideline aimed at improving hospital length of stay by identifying 'low-risk patients'[6] were found not to be related to postoperative work status.

Three studies reported on determinants of work status after TKA[6, 22, 24], two of which employed a multivariate analysis.[6, 24] In one of these two studies the introduction of practice guidelines about appropriate lengths of stay was found not be associated with work status after TKA.[6] In another study[24], factors associated with a faster return to work were female sex, self-employment, higher mental and physical health scores, higher Functional Comorbidity Index (FCI) scores and a handicap accessible workplace. Factors associated with a slower return to work were having less pain preoperatively (a higher WOMAC pain score), having a more physically demanding job and having workers' compensation.[24]

Methodological quality

Table 4 summarizes the results of the methodological quality assessment. The methodological quality of studies was assessed by scoring the presence or likelihood of selection bias, information bias and statistical analysis bias. The methodological quality for studies on THA was rated high in one study[11], moderate in eight studies[5, 12, 14-17, 19, 20] and low in five studies.[4, 10, 13, 18] For studies on TKA, the methodological quality was rated high in one study[24] and moderate in three studies[22, 23, 25] The study on THA and TKA was rated high.[6]

Table 2: Outcomes of 19 studies describing work status before and after total hip and knee arthroplasty

Total Hip Arthroplasty					
	Definition of work status pre-operatively	Definition of work status postoperatively	Work situation prior to surgery	Work situation after surgery	Time to return to work
Nevitt et al. (14)	Work status:Employed at the time of THA (working) or working regularly before THA but disabled (disabled) when undergoing THA vs never worked regularly or stopped for non-health reasons Impact of hip disease on work (change of job or occupation, reduced work hours, missed work > 1 day/ month, limited in physical activities of work, limited in kind or amount of work)	Working vs disabled	139 working patients: 81 (58.3%) working and 58 (32.6%) disabled Impact on work status in 139 working patients: 38 (27.3%) change of job or occupation; 23 (16.5%) reduced hours of work; 23 (16.5%) missed work more than 1 day/month 104 (74.8%) limited in physical activities of work; 27 (19.4%) unable to work at 1 year presurgery; 58 (41.7%) unable to work at 1 month presurgery; 34 (24.5%) receiving disability benefits at 1 month presurgery	139 working patients: After 1 year: 95 (68.3%) working After 4 year: 87 (62.6%) working Impact on work status in the 107 persons who worked at all after surgery: 35% experienced limitations in the physical activities of their postsurgery work; 41% were limited in the kind or amount of work they could do	Not measured

Table 2: continued

Total Hip Arthroplasty					
	Definition of work status pre-operatively	Definition of work status postoperatively	Work situation prior to surgery	Work situation after surgery	Time to return to work
Jensen et al. (12)	a. working, b.sick-leave, c. invalidity pension, d. retired because of age	a. working, b.sick-leave, c. invalidity pension, d. retired because of age	387 patients: 102 working, 50 sick-leave, 41 invalidity pension, 194 age pension	After an average follow-up of 5 years: 119 working, 10 sick-leave, 45 invalidity pension, 213 age-pension. Follow-up work status of the 102 patients working preoperatively: 91 working, 1 sick leave, 7 invalidity pension, 3 age pension. Follow-up work status of the 50 patients on sick leave preoperatively: 28 working, 7 sick leave, 5 invalidity pension, 10 age pension.	Not measured
Johnssson et al. (16)	a. household, b. light work, c. moderate work, d. heavy work, e. sick leave, f. retired.	a. household, b. light work, c. moderate work, d. heavy work, e. sick leave, f. retired.	104 patients working and 14 retired before THR. Of the 104 working patients: 3 household; 12 light work; 39 moderate work; 50 heavy work. 56 working with sick leave duration 0-0.5 year before THR; 48 working with sick leave duration 0.5-2 years before THR.	After 2 years: 69 patients working, 7 sick leave, 42 retired (9 partial). Of the 69 working patients: 3 household, 19 light work, 32 moderate work, 15 heavy work	Not measured

Table 2: continued

Total Hip Arthroplasty					
	Definition of work status pre-operatively	Definition of work status postoperatively	Work situation prior to surgery	Work situation after surgery	Time to return to work
Visuri et al. (17)	Working/disabled/age pension Receiving a pension, main reason for retirement, ability to perform gainful work before and after surgery despite the old age pension	Working/disabled/age pension	Total sample: 112 working, 152 disabled, 266 age pension 83 Primary coxarthrosis working-age patients at operation: 39 working, 14 disabled, 30 age pension	After 4.2 years: Total sample: 59 working, 119 disabled, 352 age pension 83 Primary coxarthrosis working-age patients at operation: 23 working, 25 disabled, 35 age pension	Not measured
Suarez et al. (10)	Working yes/no Heavy/Moderate/Light work	Return to work (yes/no)	747 employed 100% (Only employed patients were included)	After 6-7 weeks: 25% returned to work	Not measured
Weingarten et al. (6)	Employed (yes/no)	Return to work within 30 days of admission	THA: Baseline period: 53 employed (24%) Feedback intervention period: 115 employed (48%)	THA: Baseline period: 89% return to work > 30 days Feedback intervention period : 83% return to work > 30 days	Not measured
Sarkar et al. (13)	Unknown	a. Returned to original jobs, b. Different employment, c. unemployment benefits, d. not fit for work declared by medical expertise and living on insurance payments, e. old age pension	Not measured	professional status at follow-up available for 33/37 patients on 7/33 (21%) returned to original jobs; 7/33 (21%) different employment,; 3/33 (9%) unemployment benefits; 8/33 (24%) not fit for work declared by medical expertise and living on insurance payments, 8/33 (24%) old age pension	Not measured
Berger et al. (18)	working (yes/no	working (yes/no)	78/100	Unknown	8 days (range 1-20 days)

Table 2: continued

Total Hip Arthroplasty					
	Definition of work status pre-operatively	Definition of work status postoperatively	Work situation prior to surgery	Work situation after surgery	Time to return to work
Peak et al. (5)	working (yes/no	Return to work < 6 weeks (yes/no) Mean time to return to work (weeks)	85/152 working in restricted group 98/151 working in unrestricted group (denominator refers to the number of hips, not patients)	16/85 returned to work < 6 weeks in the restricted group; 49/98 returned to work < 6 weeks in the unrestricted group (p<0.001)	9.5 weeks (range 0.7-20.0) in the restricted group; 6.5 weeks (range 1.0-32.0) in the unrestricted group, (P<0.001)
Tanavalee et al. (4)	Unknown	Return to work (postoperative weeks)	Not measured	Unknown	Two-incision: average time return to work 3 weeks (SD 1.3); mini-posterior : average time to return to work 5 weeks (SD 1.9) (P<0.01)
Pagnano et al. (19)	Unknown	Return to work (postoperative days)	Not measured	Unknown	Time to return to work: mini posterior THA: mean 38 days (14-90 days); two incision THA mean 42 days (9-56 days) (p=0.06)
Mobasheri et al. (20)	Working/not working	Working/not working Length of time taken to resume work Changes in working patterns Where relevant, reasons for not returning to work	81/85 available for follow-up: 51 employed prior to surgery 30 not employed, 12 of the 30 were unemployed because of hip pain (average duration of unemployment 26 weeks).	62/81 working after THA: 49/51 who were employed before THA returned to work 13/30 who were unemployed before THA regained employment. 13/62 changed occupation (6 adapted jobs of reduced physical intensity) 19/81 not working after THA: 5 had retired, 4 housewives 10 did not work for other reasons than hip pain	Patients working pre-operatively: 10.5 weeks to return to work. Patients not working pre-operatively: 35 weeks to gain employment. Those out of work because of hip pain: 28 weeks to regain employment.

Table 2: continued

Total Hip Arthroplasty					
	Definition of work status pre-operatively	Definition of work status postoperatively	Work situation prior to surgery	Work situation after surgery	Time to return to work
Bohm et al. (15)	Patients classifying themselves preoperatively as "being in the workforce"	Postoperatively returning to work (yes/no), off-work owing to their hip condition (yes/no), off-work owing to reasons other than their hip Income, weekly hours of work, ability to meet workplace physical demands (scale 0-100), and workplace productivity (scale 0-100).	All 60 patients were selected for this study because they classified themselves as being in the workforce 48 working 12 off work due to hip condition	54/60 patients available for follow-up (44 in preoperative working group and 10 in off work group) 38/44 (86%) working preoperatively were working 1 year after surgery (34/ 38 returned to same job); 1/44 (2%) stopped because of hip, 5/44 stopped for other reasons. 2/10 (20%) off work preoperatively returned to work after surgery; 5/10 (50%) did not return because of hip, 3/10 (30%) other reasons/ Income: 33% (95% CI: 20-50%) had an increase; Weekly hours of work decreased by -3.2 (95% CI -7.9 -1.5) hours; Ability to meet workplace demands +29 (95% CI 22-36); Productivity +27 (95% CI 17-37).	Not measured

Table 2: continued

Total Hip Arthroplasty					
	Definition of work status pre-operatively	Definition of work status postoperatively	Work situation prior to surgery	Work situation after surgery	Time to return to work
Nunley et al. (11)	Working for pay in the ***3 months*** before surgery (yes/ no), responders not were categorized into: unable to work, retired, keeping house, something else, looking for work or volunteering Working for pay in the ***month*** before surgery (yes/ no), amount of hours per week working before surgery, working their usual or different job, hip restrictions at work (yes/ no), duration of hip restrictions at work before surgery	Working for pay at some point after hip surgery (yes/ no); Returning to usual job (yes/ no) ; Temporary work restrictions because of hip recovery (yes/no and duration) Reasons for not returning to work among patients who did not work since hip surgery Number of weeks unable to work due to their hip surgery	705/806 (87.5%) working for pay 3 months before surgery 101/806(12.5%) not working (30 unable, 27 retired, 24 housekeeping, 14 something else, 5 looking for job, 1 volunteering) In the month before surgery 688 patients worked a mean of 41.6 hours (range 0-85) per week 666/688 (96.8%) working their usual job, 22(3.2%) working a different job.545 /681 patients (80%) reported no restrictions, 136 (20%) reported restrictions with a mean duration of 1.2 years.	714/790 (90.4%) working for pay at some time after THA; 672/714 (94.1%) returned to usual job, 42 (5.9%) returned to different job (12 because of hip); 185/714 (25.9%) had had temporary work restrictions (mean duration 7.3 weeks), 20/714 (2.8%) had permanent work restrictions. 76/790 (9.6%) not working after THA (30 retired, 21 housekeeping, 13 unable to work, 6 something else, 4 looking for job, 2 volunteering). In total, 13 (1,6%) permanently disabled after surgery.	Mean time 6.9 weeks (range 0-78 weeks)
Cowie et al. (21)	Unknown	Return to working (postoperative weeks); type of work (sedentary/ light physical/ heavy work); experiencing restrictions while returning to work	Not measured	170/239 (71.1%) working after THA: occupational status 80/170 (28.1%) sedentary, 37/170 (13.0%) light physical, 53/170 (18.6%) heavy work 78.1% of those who returned to work were able to return to work without experiencing any restrictions, 7.7% were redeployed to a less physically demanding job but experienced no other form of restriction, 1.2% experienced residual hip pain at work	Mean time 13.9 weeks (SD 7.7) (range 1-52 weeks)

Table 2: continued

Total Hip Arthroplasty					
	Definition of work status pre-operatively	Definition of work status postoperatively	Work situation prior to surgery	Work situation after surgery	Time to return to work
Total Knee Arthroplasty					
	Definition of work status pre-operatively	**Definition of work status postoperatively**	**Work situation prior to surgery**	**Work situation after surgery**	**Time to return to work**
THA/ TKA Weingarten et al. (6)	Employed (yes/no)	Return to work within 30 days of admission	TKA : Baseline period: 29 employed (25%) Feedback intervention period: 68 employed (40%)	TKA : Baseline period: 81% return to work > 30 days Feedback intervention period: 83% return to work > 30 days	Not measured
Lyall et al. (22)	Employment status: a. employed, b. unemployed (reasons: knee pain, retirement, other) Duration of unemployment preoperatively (months) Type of work usually performed (manual or non-manual)	Employment status (employed/unemployed) Length of time taken to resume work (weeks) .	41/56 employed (11 manual, 30 non-manual job) 15/56 patients unemployed (12 manual jobs, 3 non-manual jobs; 9 unemployed due to knee pain, 3 retired, 3other health problems); Average duration of preoperative unemployment 33 months (21-58 months),	40 of 41 preoperatively employed patients went back to work within 6 months; None of the 15 unemployed pre-operative, returned to work after surgery (1 for other reasons than knee complaints)	Average 10 weeks (range 6-25 weeks) in 40/41 who returned to work; All returned within 6 months.
Lombardi et al. (25)	Not measured	Recorded time elapsed to return to work (weeks)	Not measured	Not measured	Average 8.0 weeks (SD 5.6, range 0-32)

Table 2: continued

Total Hip Arthroplasty					
	Definition of work status pre-operatively	Definition of work status postoperatively	Work situation prior to surgery	Work situation after surgery	Time to return to work
Foote et al. (23)	Working prior to surgery (yes/no)	Working postoperatively (yes/no) Effect of TKA on ability to return to work (graded 1-5 with 1 being significant worsening to 5 being a significant improvement). Rating of physical intensity of postoperative occupation (less, same or more) Time from operation to return to work, performing normal duties	27/41 patients (65.9%) working before surgery	23/41 (56.1%) working after surgery (22 of the 27 (81%) who were working preoperatively). 6/41 patients (14.6%) rated the impact of surgery on their ability to work as (significantly) worse, 12 as no change (29.3%) and 23 as (some) improvement (56.1%). 5 patients rated work as less physically intense, 12 as the same and 1 as more intense.	median 12 weeks (range 4-52) (23 patients)
Styron et al. (24)	Occupational and physical demands; Ability to perform job responsibilities Motivation to return to work	Employment status (employed at least part-time or not employed at three months postoperatively); Time to return to work (length of time from patients' surgery to their return to any amount of work and to to working full-time)	All 162 patients were working, 10 were working <30 h/week and excluded from follow-up analyses Physical job demands: Low 44 (27.2%) Moderate 74 (45.7%) High 44 (27.2%) 26 (16.1%) self-employed 2 (1.2%) receiving workers compensation	Three months after surgery 117/152 patients (72.2%) had returned to work at least part-time 109/152 (71.7%) had returned to work fulltime	Median 8.9 weeks

THA: total hip arthroplasty; TKA: total knee arthroplasty.

Table 3: Determinants of return to work after total hip and knee arthroplasty in 19 studies

THA	
First autho and reference number	**Beneficial or limiting factors**
Nevitt et al. (14)	*Predictors of working 1 year or 4 years postoperatively: Patients being female and reporting some pain in joints other than hips were less likely to be working Patients with more education and working 1 month pre-surgery were more likely to be working *Predictor of working 1 year postoperatively: Patients with a failed procedure less likely to be working *Predictor* of working 4 years postoperatively: Patients with bilateral hip pain less likely to be working
Jensen et al. (12)	Age, the use of walking aids and the experience of pain were related to working capacity at follow-up.
Johnssson et al. (16)	Duration of preoperative sick leave was associated with postoperative retirement and postoperative sick leave.
Visuri et al. (17)	*Young age, mental work, and primary coxarthrosis , postoperative walking ability and upper and lower professionals were positively associated with return to work. *Physical work, "non-hip diseases", unskilled workers and farmers were negatively associated with return to work.
Suarez et al. (10)	Underlying illness, type of job before surgery, educational level, the preoperative ability to walk, kind of social security and environment (rural/urban) were univariately associated with return to work. Age, sex and family structure (single, married, widowed, divorced) were not associated with return to work in univariate analyses.
Weingarten et al. (6)	*No association between the intervention (introduction of practice guidelines to identify "low-risk" patients who may be suitable for earlier discharge or transfer from the acute care hospital) and return to work.
Sarkar et al. (13)	Younger age and a good rating according to Merle d'Áubigné and the Harris hip score were significantly associated with return to work.
Berger et al. (18)	Not measured
Peak et al. (5)	The use of postoperative functional restrictions after uncemented THA has a significant impact on duration of return to work and the proportion of patients returning to work < 6 weeks
Tanavalee et al. (4)	A mini-2-incision approach was associated with a faster return to work than a mini-posterior approach
Pagnano et al. (19)	No difference between 2-incision and mini-posterior approach within patients undergoing staged bilateral THA regarding speed of return to work
Mobasheri et al. (20)	Working pre-operatively and being male were associated with a faster return to work. Being self-employed rather than a salaried employee did not affect the time to return to work postoperatively. Being unemployed for over 1 year preoperatively was associated with a smaller chance of regaining employment postoperatively .
Bohm et al. (15)	Working preoperatively, younger age, better Oxford 12 hip scores and general physical function scores, fewer functional limitations due to comorbidities, not collecting disability insurance and lower job satisfaction were associated with return to work. No association between waiting time, being self-employed, job tenure, job motivation, workplace physical demand and workplace flexibility and return to work.

Table 3: continued

THA	
First autho and reference number	**Beneficial or limiting factors**
Nunley et al. (11)	*Type of prosthesis, surgical exposure and preoperative functional activity scores were not associated with work outcomes (except for lower activity scores being associated with difficulties to perform squatting activities at work). Female sex was associated with more time off work, working less hours after surgery, and reporting more problems with specific activities at work; Older patients reported more restrictions at work due to hip surgery, were less likely to be working at 1 year and reported more problems with specific activities at work than younger people.
Cowie et al. (21)	patient age and BMI were associated with the time taken to return to work
TKA	
Weingarten et al. (6)	*No association between the intervention (introduction of practice guidelines to identify "low-risk" patients who may be suitable for earlier discharge or transfer from the acute care hospital) and return to work.
Lyall et al. (22)	Being unemployed before TKA was associated with not returning to work; Being unemployed before TKA was associated with having manual work.
Lombardi et al. (25)	Not assessed ***within*** patients who were treated with TKA
Foote et al. (23)	Not assessed ***within*** patients who were treated with TKA
Styron et al. (24)	*Factors associated with ***faster*** return to work at least part-time and/or working full-time after 3 months were: Female sex, self-employment, higher mental health scores, higher physical function scores, higher functional comorbidity scores, and a handicap accessible workplace. *Factors associated with ***slower*** return to work at least part-time and/or working full-time after 3 months were: Having less pain preoperatively (a higher WOMAC pain score), having a more physically demanding job, and receiving workers' compensation.

*Multivariate analysis. THA: total hip arthroplasty; TKA: total knee arthroplasty.

Table 4: Methodological quality of 19 studies describing work status after THA and TKA

	selection bias present §	information bias present §	statistical analysis bias present §	Total score	Level of quality*
THA					
Nevitt et al. (14)	0	1	0	1/3	M
Jensen et al. (12)	0	1	1	2/3	M
Johnssson et al. (16)	0	1	1	2/3	M
Visuri et al. (17)	0	1	0	1/3	M
Suarez et al. (10)	1	1	1	3/3	L
Weingarten et al. (6)	0	0	0	0/3	H
Sarkar et al. (13)	1	1	1	3/3	L
Berger et al. (18)	1	1	1	3/3	L
Peak et al. (5)	1	0	0	1/3	M
Tanavalee et al. (4)	1	1	1	3/3	L
Pagnano et al. (19)	1	0	1	2/3	M
Mobasheri et al. (20)	0	1	1	2/3	M
Bohm et al. (15)	0	0	1	1/3	M
Nunley et al. (11)	0	0	0	0/3	H
Cowie et al. (21)	1	1	1	3/3	L
TKA					
Weingarten et al. (6)	See Hip				
Lyall et al. (22)	0	1	1	2/3	M
Lombardi et al. (25)	0	1	1	2/3	M
Foote et al. (23)	0	1	0	2/3	M
Styron et al. (24)	0	0	0	0/3	H

§ 1=bias present or unclear; 0= no bias present.
*H= high quality: no evidence for selection bias, information bias or analyses bias; M= moderate quality: one or two quality aspects rated as bias present or unclear; L= low quality: all three aspects rated as bias present or or unclear. THA: total hip arthroplasty; TKA: total knee arthroplasty

Discussion

This systematic review on work status after THA and TKA and its determinants shows that the literature on work status after THA is more extensive than for TKA. Overall, the majority of patients who are employed before THA or TKA return to work postoperatively. Factors related to work status after THA or TKA included sociodemographic, health and job characteristics. Overall, the methodological quality of the studies was moderate to low, and comparisons of rates and speed of return to work among and between studies on THA and TKA were hampered by large variations in patient selection and measurement methods. Regarding the overall favourable effect of THA and TKA on work status seen in the studies included in this review, we have no similar synthesis of the literature for comparison.

However, one of the studies included in this review provided an extensive overview of the literature on THA in its discussion[11], concluding that all of the four available studies[12, 15, 16, 26] were limited by one or more of the following flaws: (i) small patients cohorts (<120 patients in total), (ii) the average age in the study was >60 years, (iii) the study included low-demand patients, (iv) the study was reported in the literature >20 years ago and (v) the study was not designed to specifically look at returning to work. In contrast with that review, nowadays more studies, describing larger groups of patients are available.

However, we saw a relatively large variation with respect to the study designs, patient selection and, in particular, the measurement of work status, seriously hampering the comparisons among the studies in this review. International consensus on a minimum set of variables related to work status would enable national and international comparisons of studies and greatly increase knowledge in the field of the impact of THA and TKA on work status. It is questionable whether retrospective studies are suitable to measure work status before and after THA or TKA. Work status is a complex entity, with work disability including decreased work productivity while present at work, temporary absence or sick leave or not working at all due to health problems, with or without a full or partial disability pension. In addition, unemployment, (early) retirement and/or stopping work voluntarily, whether or not related to health status, may also occur. Apart from appropriate measurement methods, prospective cohort studies are needed to accurately describe productivity gains and losses over time in this continuum model.[9]

Regarding the analyses of determinants of return to work after TKA and THA, in 11 of the 16 studies including such analyses, only univariate methods were used[4, 5, 10, 12, 13, 15, 16, 19, 22], whereas 5 studies employed multivariate techniques.[6, 11, 14, 17, 24] Overall, in the studies using multivariate analyses, characteristics of the patient (sex, age, educational level), his or her health status (the involvement of joints other than the operated hip or knee, mental and physical health, failure of the procedure), preoperative work status (type of employment, working until surgery, characteristics of the workplace, reporting problems with activities at work) were found to be associated with work status after surgery.

With respect to gender, the results were contradictory. In the study by Styron et al.24, a higher FCI was associated with a faster return to work. This observation

seems to be counterintuitive and poses an interpretation challenge according to the authors. They suggest that it may be a result of the FCI simply not being an accurate predictor of returning to work, as it was intended to be a predictor of physical function.

The systematic review by Kuijer et al.[3] included only three articles[46] investigating the beneficial or restricting factors regarding return to work in patients undergoing THA or TKA. In only one of the three articles[6] was a multivariate analysis performed. The absence of multivariate analyses seriously limits the interpretability of the results, as many factors may have an impact on work status, so adjustment for confounders is indispensible. Overall, the methodological quality of the studies included in this review was moderate to low. The relatively often employed retrospective study designs and use of selfconstructed questions and questionnaires increased the risk of bias. Moreover, potential bias due to patient selection was also relatively frequently identified. This study has a number of limitations. First, we included only studies in English, French, German or Dutch, so that potentially eligible studies in other languages may have been missed. Second, we did not attempt to pool data, as studies were very heterogeneous concerning study designs, patient selection and measurement methods.

In conclusion, this systematic review shows that in general, work status improves after THA and TKA. However, there are fewer studies of TKA than THA and the methodological quality of the available studies is moderate to low. The conduct of large studies in unselected groups of patients, the standardization of measurements of work status in THA and TKA, as well as the conduct of multivariate statistical analyses to adjust for potential confounding in studies to describe determinants of work status postoperatively is recommended.

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Chapter

Return to work after total hip and knee arthroplasty: results from a clinical study

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Abstract

The aim of this study was to measure return to work and duration until return to work in patients undergoing total hip or knee arthroplasty (THA or TKA). This prospective study included patients under 65 years of age, undergoing THA or TKA, who provided information on their work status preoperatively (paid work yes/no and working hours) and 1 year thereafter (paid work yes/no, working hours and time until return to work). Seventy-one THA and 64 TKA patients had a paid job preoperatively. The employment rates 1 year postoperatively were 64/71 (90 %) after THA and 53/64 (83 %) after TKA. Of those who returned to work, 9/64 (14 %) of THA patients and 10/53 (19 %) of TKA patients worked less hours than preoperatively [mean decrease of 16 (SD 11.5) and 14 (SD 13.0) hours, respectively]. The mean time to return to work was 12.5 (SD 7.6) and 12.9 (SD 8.0) weeks in THA and TKA, respectively. The majority of working patients who underwent THA or TKA returned to work, after approximately 12 weeks. A considerable proportion of the patients returning to work worked less hours than preoperatively. More research into patients who do not return or decrease their working hours is needed.

Introduction

Total hip arthroplasty (THA) and total knee arthroplasty (TKA) are very effective procedures to improve pain and functioning in patients with hip and knee osteoarthritis.[1, 2] The numbers of patients undergoing THA and TKA surgery are substantial, the rate per 100.000 persons varying between 70 and 112 in northern European countries and the USA.[3–5] Although the rates reported in the literature vary, there are many studies showing that a considerable proportion of these patients (15–45 %[6, 7, 9]) is of working age and/or <65 years at the time of surgery.

With respect to return to work after THA or TKA, the number of studies is limited. A recent systematic review by Tilbury et al.[6], including studies from 1986 to 2013, found that the majority of patients who are employed before THA and TKA returned to work postoperatively. Only few of the studies included in this review reported the mean time to return to work, with the reported durations ranging from 1.1 to 10.5 weeks after THA[1, 7–11] and from 8.0 to 12.0 weeks after TKA.[2, 11, 12] As the study designs as well as the assessment methods varied largely among the studies, firm conclusions regarding the speed of return to work cannot be drawn.[6]

After this systematic review was completed, a study by Sankar et al.[13] was published, evaluating the return to work among 360 THA and TKA patients who were working preoperatively or on a short-term disability pension. It was found that 87 % of THA and 85 % of TKA patients had returned to work 1 year after surgery. This study did not report the mean time to return to work. Kievit et al.[14] examined the impact of TKA on patients' reintegration into the workplace, showing that 117 of 173 working patients (68 %) had returned to work 3.8 (1.3 SD) years after surgery. Lombardi et al.[15] found in a group of 494 patients who were employed before TKA that 98 % returned to work after on average 8.9 weeks (SD 9.1).

Concerning beneficial and limiting factors affecting return to work after surgery, Kuijer et al.[16] conducted a systematic review including studies published between 1998 and 2008. All of the three studies included in that review concerned THA, with the results suggesting that using a two-incision approach has a beneficial effect on return to work, whereas the provision of movement restrictions had a negative effect, and patient discharge guidelines had no effect on the time to return to work.

In the review by our own group, factors related to work status after THA and TKA included sociodemographic, health and job characteristics.[6]

For the appropriate timing of interventions aiming to foster return to work, insight into the course of work disability after THA and TKA is needed. Given the lack of knowledge on the time to return to work after joint arthroplasties, the aim of the present study was to describe the work status and the duration until return to work after THA and TKA. Moreover, characteristics of patients who did and did not return to work were compared.

Methods

Study design

This study on return to work was part of a prospective cohort study on the outcomes of THA and TKA performed at the Department of Orthopedics of the Alrijne Hospital (former Rijnland Hospital), the Netherlands, from October 2010 to September 2013 (inclusion of patients was done until September 2012). The study protocol was reviewed and approved by the local hospital Review Board of the Alrijne Hospital, Leiderdorp in the Netherlands (registration number 10/07), which is attached to the Medical Research Ethics Committee of the Leiden University Medical Center, Leiden, the Netherlands. Of all patients, written informed consent to participate in the study was obtained. Funding for the present study on return to work was received from the Anna Fonds, NOREF (Dutch Association Orthopaedic Research and Education Foundation) and the Dutch Arthritis Association LRR.

Patients and recruitment

The prospective cohort study aimed to include all consecutive patients undergoing a primary THA or TKA because of osteoarthritis, aged 18 years or older, able to read and understand Dutch and being mentally and physically able to complete questionnaires. Excluded were patients with revision of a THA or TKA, undergoing a hemi-arthroplasty and undergoing a THA or TKA because of tumor or rheumatoid arthritis.

One day preoperatively, before being admitted to the hospital, the treating orthopedic surgeon provided oral and written information on the study to all eligible patients. For the present study on return to work, only the data from patients under the

age of 65 years (the retirement age in the Netherlands at the time the study was conducted) were used.

Assessments

The preoperative questionnaires were administered by the treating physician, and the postoperative questionnaire was sent by regular mail. A telephone interview was scheduled if the answers regarding work status in either the preoperative or follow-up questionnaires were incomplete. These telephone interviews were conducted by one of the researchers (CSL). Sociodemographic and general patient characteristics were only gathered preoperatively.

Sociodemographic and general patient characteristics

Sociodemographic characteristics were recorded preoperatively and included: age (years), sex, length (cm) and weight (kg) to calculate the body mass index, level of education (low: primary school, lower vocational education; medium: lower general secondary school, intermediate vocational education; or high: higher general secondary school, higher vocational education, university) and marital status (living alone; yes/no).

Work status

At the preoperative assessment, all patients were asked to indicate whether they had a paid job (yes/no). If not, they were asked to indicate whether they were pensioner, housewife/houseman or unemployed.

If they were working, they were requested to provide information on the following aspects of their working situation: (a) amount of hours currently working per week; (b) being self-employed or wage earner; (c) current complete or partial sick leave or complete or partial sick leave over the past 12 months, with sick leave defined as absenteeism related to the hip or knee complaints and reported to the employer; if yes, duration of 4 weeks or more (yes/no); (d) presence of work adaptions yes/no; if yes: change in tasks, performing fewer tasks, changes in working hours or other work-related adaptions or devices (all these questions could be answered with yes or no); (e) receipt of partial disability benefits related to hip or knee complaints (yes/no).

In the follow-up assessment, the same questions were used, with in addition: (f) working currently (yes/no); (g) duration until return to work for the first time (weeks); (h) number of hours working per week when starting to work for the

first time; and (i) numbers of hours working per week after 1 year. If the follow-up questionnaire was returned incomplete, patients were contacted by telephone to provide the required information.

Health related quality of life

The Short Form 36 Health Survey questionnaire (SF-36) is composed of 36 questions and standardized response choices, organized into eight multi-item scales: physical functioning (PF), role limitations due to physical health problems (RP), bodily pain (BP), general health perceptions (GH), vitality (VT), social functioning (SF), role limitations due to emotional problems (RE) and general mental health (MH). From these eight subscales, the SF-36 mental and physical component scales (MCS and PCS) were computed. For that purpose, the method of norm-based scoring was used.[17] In norm-based scoring, each scale is scored to have the same average (mean: 50) and the same standard deviation (SD: 10), meaning each point equals one-tenth of a standard deviation. In this study, scores of a Dutch general population[18] were used to standardize the scores according to the method of norm-based scoring. Lower scores represent worse health status.

The Euroqol-5 Dimension (EQ-5D) is an instrument designed to derive from five dimensions of health (mobility, self-care, usual activities, pain and mood), a single cardinal index for the quality weighting of QALYs. The EQ-5D uses valuations derived with the time trade-off method from a large general population survey to score the five-dimension health profile self-reported. The second part Euroqol visual analogue scale (EQ-VAS) consists of a 20-cm vertical visual analogue scale (VAS) ranging from 100 (best imaginable health state) to 0 (worst imaginable health state). The EQ-VAS gives a self-assessed measure of overall health state.[19]

Functional outcome measurement

Hip and knee functions were assessed by means of the following outcome measures: (a) The Hip disability and Osteoarthritis Outcome Score (HOOS), consisting of 40 items divided over five dimensions: pain (P) (10 items), symptoms (S) including stiffness and range of motion (5 items), activity limitations—daily living (A) (17 items), sport and recreation function (SP) (4 items) and hip-related quality of life (Q) (4 items)[20] The Knee injury and Osteoarthritis Outcome Score (KOOS) comprises 42 items and uses the same five subscales as the HOOS.[21] For the present study, validated Dutch versions of the HOOS and KOOS were used.[22]

(b) The Oxford Hip Score (OHS) and the Oxford Knee Score (OKS), which are short, twelve-item questionnaires developed for completion by patients undergoing THA and TKA.[23, 24] We used validated Dutch translations for the present study.[25, 26]

Preoperative radiological severity

Preoperative supine radiographs of hips (anterior–posterior) and weight-bearing radiographs of the knees (posterior–anterior) were collected from the patients' medical records. These radiographs were routinely made in the participating centers for preoperative templating purposes. All radiographs were assessed by an experienced musculoskeletal radiologist (HMK), who was blinded for the operated side and patient characteristics. The Kellgren and Lawrence (KL) grading system was used to classify the severity of OA (grade 0: no OA; grade 1: doubtful OA; grade 2: minimal OA; grade 3: moderate OA and grade 4: severe OA).[27] Ten percentage of the radiographs were scored twice: correlation between both readings was used to establish intra-reader reliability [intra-class correlation hip radiographs: 99 % (95 % CI 85–93 %); intra-class correlation knee radiographs: 95 % (95 % CI 92–98 %)]. The second reading was used for further statistical analyses. The KL grade in our study was classified as KL 0–1 (no OA), KL 2 (mild OA) and KL 3–4 (severe OA).

Statistical analyses

Descriptive statistics were used to present the characteristics of patients and their working status preoperatively and at follow-up. Comparisons of the baseline characteristics between working patients and patients who were not working at the preoperative assessment were made by means of the Mann–Whitney U test or Chi-square test. For all clinical outcome measures, change scores between the preoperative assessment and 1-year follow-up were computed with the 95 % confidence interval. Comparisons of working hours before and after surgery within the group of working patients were made by means of the Wilcoxon signedrank test. Sociodemographic and job characteristics and patient-reported outcomes (SF-36, EQ-5D, EQ5D-VAS and HOOS/KOOS) were compared between patients who were working preoperatively and did return to work and patients who did not, by means of the Mann–Whitney U test or Chi-square test, where appropriate. All data were analyzed using the SPSS statistical package (version 20.0, SPSS, Chicago, Illinois). The level of statistical significance was set at $p \leq 0.05$ for all analyses.

Results

In the larger study, 428 THA and 417 TKA patients were included of whom 343 THA (80 %) and 322 TKA (77 %) completed the postoperative questionnaire. Of these, 131 THA patients (38 %) and 126 of TKA patients (39 %) were under 65 years. Figure 1 describes the flow of the patients included in the present analysis. Information regarding preoperative work status of 69 THA patients (53 %) and 50 TKA patients (40 %) was incomplete or inconclusive; these 119 patients were approached for additional telephone interviews. Fifteen patients (13 %) could not be reached and were therefore excluded for the present analyses. This resulted in 122 THA patients (93 %) and 120 TKA patients (95 %) who were under 65 years and provided complete information on their work status preoperatively.

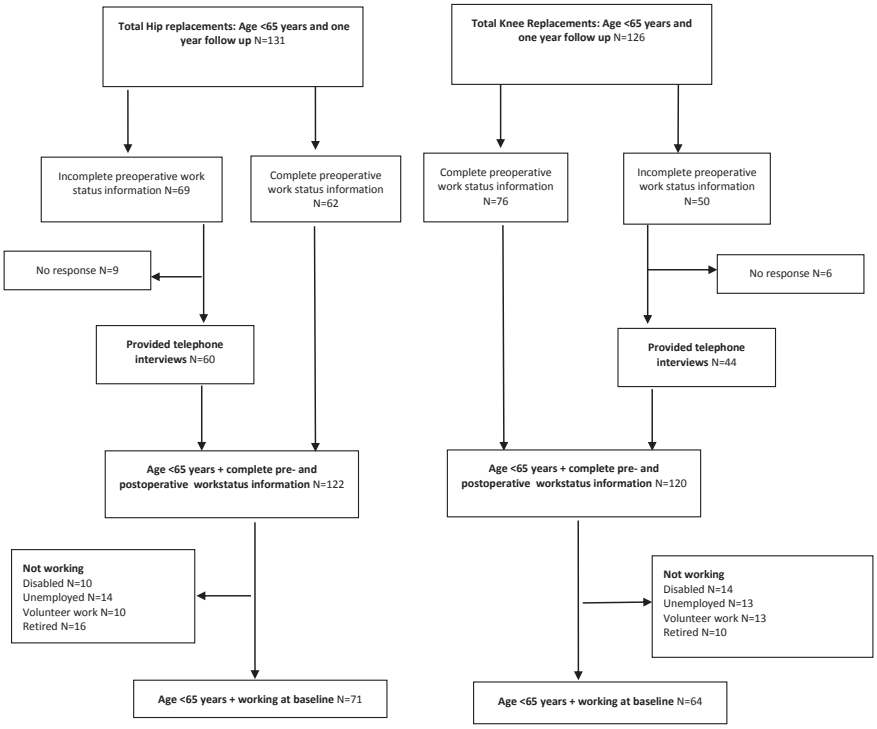

Fig 1. Flow Diagram of patients participating in a cohort study on outcomes of total hip and knee arthroplasty

Preoperative work status and characteristics of working and non-working patients

The preoperative work status of patients under 65 years is described in Table 1. The mean age of the 122 THA patients was 57.7 years (6.3 SD) and of the 120 TKA patients 57.4 years (5.8 SD). There were 70 females (57 %) in the THA group and 79 (66 %) in the TKA group. Preoperatively, 71 of 122 THA patients (58 %) and 64 of 120 TKA patients (53 %) were working; 14 THA patients (11 %) and 11 TKA patients (8 %) were unemployed and/ or looking for a job; 10 THA patients (8 %) and 14 TKA patients (12 %) were disabled, of those 10 THA patients (8 %) and 8 TKA patients (13 %) received a full disability pension; 2 THA patients (3 %) and 5 TKA patients (8 %) received disability benefits because of hip or knee impairments; 11 THA patients (9 %) and 18 TKA patients (15 %) were doing household and/ or volunteer work; and 16 THA patients (13 %) and 13 TKA patients (8 %) were retired (see Table 1).

Table 1 also describes the clinical characteristics of working and non-working patients undergoing THA and TKA. In the THA group, working patients were significantly more often male, though in the TKA group female. In both groups, the working patients were significantly younger than the non-working patients, whereas in the TKA group the working patients were higher educated and in the THA group the Oxford Hip Score was significantly lower in working patients. No other statistically significant differences regarding the characteristics of working and non-working patients were seen.

Characteristics of preoperative work situation in working patients

Table 2 describes the characteristics of preoperative work situation in the working 71 THA and 64 TKA patients. Both in THA and in TKA patients, most preoperatively working patients were wage earners. The mean number of working hours preoperatively was 32 h in THA patients (SD 12.7) and 31 h in TKA patients (SD 12.7). In the 63 and 55 THA and TKA patients in whom both the preoperative and postoperative number of working hours were known, paired comparisons showed a statistically significant decrease ($p = 0.04$ and $p = 0.02$). Of the working patients, 43 THA patients (61 %) and 36 TKA patients (56 %) had not been absent from work in the past year related to their hip or knee complaints. Twelve THA patients (17 %) and 12 TKA patients (19 %) had been absent from work for more than 4 weeks. Fifty-seven working THA patients (80 %) and 51 working TKA patients (80 %) indicated that their work had not been adjusted because of the hip or knee complaints preoperatively.

Table 1. Characteristics of patients < 65 years of age undergoing THA and TKA participating in a prospective cohort study

Variable	THA Patients employed (N=71)	THA Patients not working (unemployed/ looking for a job, disability pension, retired, volunteer work) (N=51)	P value	TKA Patients employed (N=64)	TKA Patients not working (unemployed/ looking for a job, disability pension, retired, volunteerwork) (N=56)	P value
Sex, Female; no (%)	34 (48%)	36 (71%)	0.012*	34 (53%)	45 (80%)	0.002*
Age (years, mean (SD))	56 (6.6)	60 (5.0)	0.000*	56.2 (5.8)	58.8 (5.7)	0.002*
Age, categories, N (%)						
18-45	8 (11%)	2 (4%)		4 (6%)	4 (7%)	
46-55	17 (24%)	5 (10%)		17 (27%)	6 (11%)	
56-65	46 (65%)	44 (86%)		42 (67%)	46 (82%)	
Body Mass Index; mean (SD)	27.8 (6.0)	26.8 (4.2)	0.739	29.9 (4.5)	30.5 (5.1)	0.690
BMI, categories, N (%)	20 (30%)	13 (29%)		6 (10%)	5 (10%)	
	32 (48%)	19 (42%)		22 (37%)	22 (43%)	
Normal 18.5-24.5	10 (15%)	12 (27%)		23 (39%)	16 (31%)	
Overweight 25-29.9	5 (7%)	1 (2%)		8 (14%)	8 (16%)	
Obese 30+						
Education level, n (%)						
Low	28 (40%)	30 (60%)	0.098	33 (52%)	42 (75%)	0.010*
Medium	19 (27%)	7 (14%)		12 (19%)	9 (16%)	
High	23 (33%)	14 (28%)		19 (30%)	5 (9%)	
Living status						
Living Independently, n (%)	71 (100%)	51 (100%)		63 (100%)	55 (100%)	
HOOS or KOOS; mean (SD)						
ADL	42 (17.5)	45 (19.0)	0.437	43.8 (16.1)	46.3 (16.1)	0.481
Pain	39 (20.3)	43 (17.1)	0.174	35.4 (14.8)	36.0 (12.9)	0.917
Quality of life	33 (9.1)	35 (8.8)	0.261	30.3 (9.2)	33.9 (8.7)	0.055
Sport	16 (17.6)	20 (15.8)	0.087	8.3 (10.6)	9.9 (12.4)	0.529
Symptoms	32 (18.9)	36 (17.7)	0.172	42.9 (14.5)	41.6 (14.2)	0.441
EQ5D score; mean (SD)	0.5 (0.3)	0.6 (0.3)	0.858	0.5 (0.3)	0.6 (0.3)	0.097
EQ5D VAS scale; mean (SD)	62 (18.7)	63 (20.2)	0.600	64.7 (18.3)	72.1 (18.1)	0.030*
Oxford Knee/Hip Score; mean (SD)	23 (7.0)	26 (6.9)	0.048*	24.0 (6.9)	23.3 (5.8)	0.655
SF36 MCS; mean (SD)	51 (10.5)	49 (11.8)	0.863	53.2 (9.8)	50.5 (13.0)	0.084
SF36 PCS; mean (SD)	40 (6.8)	41 (8.4)	0.571	38.5 (7.4)	40.8 (6.3)	0.381

HOOS Hip Disability and Osteoarthritis Outcome Score, KOOS Knee Injury and Osteoarthritis Outcome Score, ADL Activities limitations—Daily Living, EQ-5D EuroQol-5 Dimension, EQVAS EuroQol visual analogue scale, SF-36 MCS Short Form 36 Mental Component Summary Scale, SF-36 PCS Short Form 36 Physical Component Summary Scale

* Comparison of working and non-working patients at preoperative assessment by means of Mann-Whitney U or Chi Square tests where appropriate. *Significance level < 0.05.

The other patients either did different tasks, performed less tasks, worked different hours or received work-related adaptions or devices. Of the preoperatively working patients, slightly more than half had been in contact with an occupational physician about return to work either preoperatively or postoperatively.

Table 2 Characteristics of preoperative work situation in working patients undergoing Total Hip or Knee Arthroplasty (THA or TKA)

	THA (N=71)	TKA (N=64)
Self-employed; yes	12 (17%)	9 (16%)
Hours working per week preoperatively; mean, SD	32 (12.7)	31 (12.2)
Absence from work in connection with the hip/knee complaints in last year		
Not at all	43 (61%)	36 (56%)
Less than 4 weeks	7 (10%)	6 (9%)
More than 4 weeks	12 (17%)	12 (19%)
Unknown	9 (13%)	10 (16%)
Adaptions at work, N (%)		
None	37 (77%)	33 (52%)
Different tasks	3 (6%)	7 (11%)
Less tasks	6 (9%)	3 (5%)
Change of working hours	1 (2%)	4 (6%)
Work-related adaptions or devices	1 (2%)	2 (3%)
Unknown	-	15 (23%)
Receiving workers compensation, N (%)		
None	57 (80%)	51 (80%)
Yes, in connection with the hip/knee complaints	2 (3%)	4 (6%)
Yes, in connection with other health complaints	3 (4%)	3 (5%)
Unknown	9 (13%)	6 (9%)

Return to work and clinical outcomes

Table 3 describes the work status and changes in clinical outcome measures 1 year after THA or TKA in patients who were working preoperatively. Two and five patients who were working preoperatively were retired 1 year after surgery in the THA and TKA groups, respectively. For the 64 and 56 patients who were working both preoperatively and 1 year thereafter, the mean time to return to work was 12.5 weeks (SD 7.6; median 12; minimum 1; maximum 40 weeks) and 12.9 weeks (SD 8.0; median 12; minimum 1; maximum 36 weeks) in the THA and TKA groups, respectively. Of the 64 and 53 patients returning to work of whom the number of hours working per week 1 year postoperatively was known, 9 (14 %) and 10 (19 %) patients worked less hours than preoperatively in the THA and TKA groups (mean decrease of 16 (SD 11.5; minimum 5; maximum 35) and 14 (SD 12.5; minimum 2; maximum 38) hours, respectively). Comparison of working hours before and after surgery shows significant differences in both THA ($p = 0.044$) and TKA ($p = 0.018$).

All clinical outcome measures, except for the SF-36 MCS, showed a statistically significant change over time, both in the THA and in the TKA groups.

One year after surgery, there were seven patients (three and four in the THA and TKA groups, respectively) who were working but had not been gainfully employed preoperatively. The preoperative employment status of these patients included: receiving a disability pension (n = 1), unemployed (n = 1) and doing volunteer work (n = 1) in the THA group and receiving a disability pension (n = 1), being retired (n = 1), unemployed (n = 1) and doing volunteer work (n = 1) in the TKA group.

Table 3 Return to work 1 year postoperatively and change scores with the 95 % confidence interval (CI) of clinical outcomes in working patients undergoing total hip or knee arthroplasty (THA or TKA)

	THA (N=71)	TKA (n=64)
Working situation, N (%)		
Returned to work	64 (90%)	56 (89%)
Sick leave	2 (3%)	3 (5%)
Retired	2 (3%)	5 (8%)
Unknown	3 (4%)	0
Amount of weeks between operation and return to work		
Mean (SD)	12.5 (7.6)	12.9 (8.0)
Median (minimum-maximum)	12 (1-40)	12 (1-36)
Hours working per week postoperatively, mean (SD)		
Been in contact with the occupational physician about return to work, N (%)		
Yes	39 (55%)	39 (61%)
No	26 (37%)	13 (20%)
Unknown	6 (8%)	12 (19%)
HOOS or KOOS change scores, mean (95 % CI)	49 (44–54)*	36 (31–43)*
ADL	53 (47-58)*	43 (37-49)*
Pain	19 (15-24)*	16 (10-21)*
Quality of life	51 (44-59)*	34 (26-42)*
Sport	51 (45-58)*	7 (3-11)*
Symptoms		
Oxford Knee/Hip change score, mean (95 % CI)	20 (18-22)*	15 (13-18)*
EQ-5D change score, mean (95 % CI)	0.3 (0.2-0.4)*	0.3 (0.2-0.3)*
EQ5D-VAS scale change score, mean (95 % CI)	20 (14-26)*	13 (7-18)*
SF-36 MCS change score, mean (SD; min–max)	1.3 (-1.3-3.7)	-0.9 (-4-2)
SF-36 PCS change score, mean (SD; min–max)	14.9 (13-17)*	12 (9-15)*

HOOS Hip disability and Osteoarthritis Outcome Score, KOOS Knee injury and Osteoarthritis Score, ADL Activity limitations—Daily Living, SF-36 Short Form 36 * Comparison of clinical outcomes before and after surgery was made by means of paired t test

Characteristics of patients returning and not returning to work

A comparison of the sociodemographic (gender, age, BMI, education level, living status), job characteristics and patient-reported outcomes (preoperative SF-36, EQ-5D, EQ5D-VAS and HOOS/KOOS scores as well as change scores after 1 year) of

patients who were working preoperatively and had returned to work (n = 64 and n = 56) as compared to those who had not returned to work after 1 year and were not retired (n = 5 and n = 6), did not show any statistically significant differences for the THA and TKA patient groups, respectively.

Discussion

This prospective study in patients undergoing THA and TKA showed that the large majority of patients who were working preoperatively returned to work 1 year after surgery. The mean time to return to work was 12 weeks. About 15–20 % of the patients returning to work worked less hours as compared to their preoperative work status. Only few patients under 65 years who were not working preoperatively were gainfully employed after 1 year.

Regarding the rate of working THA and TKA patients returning to work postoperatively, a comparison with the literature is hampered by the limited number of available studies, as well as by differences in study designs, in particular with respect to the selection of patients and duration of follow-up. A systematic review of the literature performed by our own group[6] showed that in the studies describing return to work, the proportions of patients returning to work ranged from 25 to 95 % at 1–12 months after THA (n = 7 studies) and from 71 to 83 % at 3–6 months after TKA (n = 2 studies).[6] Only two studies included in this systematic review measured the proportion of patients returning to work at 1 year after surgery, both focused on THA patients. They showed that at 1 year after THA surgery 95/139 patients (68.3 %)[28] and 38/44 patients (86 %)[29] had returned to work, respectively. In addition, Sankar et al.[13] found that 87 % of working THA and 85 % of TKA patients had returned to work after 1 year. These results, from Bohm et al.[29] and Sankar et al.[13], are strikingly consistent with our results after 1 year (88 % in THA and 86 % in TKA). After the review was published, a retrospective study by Kievit et al.[14] showed that after a mean follow-up of 3.8 (1.3 SD) years after surgery 68 % of TKA patients had returned to work. It remains to be established to what extent this relatively lower proportion as compared to the present study was caused by patients not returning to work because of knee complaints or other reasons, such as the reaching the pensionable age. The most recent study, by Lombardi et al.[15], found a higher rate of 98 % of patients who underwent TKA returning to work. Even if

those data were only compared with the TKA patients in our study, comparisons are seriously hampered by the observation that Lombardi et al. selected patients between 18 and 60 years of age and excluded patients with extensive medical comorbidities that would limit their activity level.
In the aforementioned systematic review[6] and a recent study by Lombardi et al.[15], the time of return to work after THA and TKA ranged from 1.1 to 10.5 weeks after THA (five studies) and 8.0–12.0 weeks after TKA (five studies).[6] In comparison with these time periods, the mean time to return to work of 12 weeks as observed in the present study appears to be relatively long for THA. As the studies done so far were executed in different countries, it cannot be ruled out that the time of return to work may be dependent on the healthcare system as well as the social security system. In the Netherlands, sick leave from work is fully paid for during the first 2 years. Less favorable clinical outcomes are probably not likely to have played a role in the present study, as improvements of all clinical outcomes were in the same range as in other studies in unselected patients undergoing THA or TKA.[20, 30–32] To get more insight into the course of return to work in individual patients, more prospective studies measuring work status at multiple time points during the first year after surgery are needed.

Concerning the characteristics of patients who did and who did not return to work, no statistically significant differences were seen in the present study. On the one side, this could be related to the relatively small proportion of patients who did not return to work but is on the other hand consistent with the literature. A systematic review of the literature on determinants of return to work after THA and TKA found that only the surgical technique and the provision of movement restrictions to patients after surgery were related to return to work after THA.[16]

An interesting finding of the present study which was, to our knowledge, not addressed in the literature was that postoperatively a considerable proportion of the THA and TKA patients worked less hours than before surgery. This loss of productivity does not seem to be counterbalanced by the relatively small numbers of patients who worked more hours than preoperatively and the numbers of patients who did not work preoperatively but were gainfully employed after 1 year.

Our study showed some differences between working THA patients who did and who did not attain the number of hours they worked preoperatively. The number

of hours working preoperatively was one of the factors, which is probably related to the a priori higher chance of losing working hours in patients who work more hours. The higher mean amount of working hours was in part due to some patients filling in more than the common maximum number of working hours in the Netherlands (36–40 h per week), indicating that this group may form a specific subgroup of patients. Larger patient groups are needed to confirm the findings of the present study and study the role of other factors that may have an impact on return to work, such as the characteristics of the surgery and rehabilitation, job characteristics including replacement of the patient's position or tasks during his or her absence for the operation, or patient factors, such as a choice of the patient to stop working or decrease working hours (age close to retirement so patient decided to retire or work fewer hours). Given the growing number of relatively young and working patients undergoing THA or TKA, the absolute loss of work productivity on the national and international level could be considerable and warrants additional research involving multiple prospective cohorts in different countries on the reason for this loss of productivity at 1 year after THA and TKA surgery.

Our study showed that the characteristics of the total groups of patients undergoing THA and TKA were somewhat different, in particular with respect to BMI and educational level. It remains to be established to what extent the larger proportion of patients with a lower educational level in the TKA group (75/120; 63 %) as compared to the THA group (58/122; 48 %) is related to the physical demands of the job, in particular the knee demands. For that purpose, a study including an extensive assessment of the job characteristics and demands would be needed.

Our study has a number of limitations. The postoperative questionnaires were in a considerable proportion of patients returned incompletely, so that part of the data on postoperative work status needed to be gathered by means of a telephone interview. Moreover, irrespective of whether the data were obtained by questionnaire or telephone interview, the information was gathered partly retrospectively and is therefore prone to recall bias. Studies on return to work should preferably have a prospective design. We also employed 1 year as observation period, which is relatively long as compared to the average period of 12 weeks until return to work. In future research, applying more points for observation during the investigation period is advocated. In such research, information on postoperative complications such as infections, dislocations or deep venous thrombosis should also be recorded,

as such events may have a large impact on the time until patients are able to return to their previous job.

In addition, the study concerned only patients undergoing surgery in one hospital in the Netherlands, whereas a multicenter study would have been preferable. Given the baseline characteristics of the patients including their radiographic characteristics as well as the magnitude of their clinical improvements over time, they appear, however, to be a fairly representative group of all patients with OA undergoing THA or TKA.

The strengths of our study are that we included patients with TKA, where research on work status in this patient group is scanty. Moreover, we gathered information on the number of working hours, showing a loss of work productivity despite high return to work rates.

In conclusion, this study shows that the large majority of working patients undergoing THA or TKA returns to work, after approximately 12 weeks. The present study suggests that apart from the small group of patients not returning to work, there may also be a group of patients who do return to work, yet not completely. Therefore, on the societal level, the total loss of productivity could be substantial given the large absolute numbers of patients undergoing total joint arthroplasties and warrants further analysis and intervention.

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Chapter

General Discussion

This thesis focussed on the process of recovery after THA and TKA. It evaluated the feasibility of collecting PROMs including measures of activities and participation before and after joint surgery, the role of radiographic features as predictors of recovery and patients' preoperative expectations of recovery and their fulfilment after THA and TKA.

The expression of the beneficial effects of surgery in terms of PROMs is in line with the focus in health care being more and more on its outcomes in terms of value for patients. Thereby, a shift towards outcome measurements addressing what is most relevant for patients is taking place.[1] According to the three-tiered value-based health care model of Michael Porter, apart from health status achieved or retained (Tier 1) and sustainability of health (Tier 3), the process of recovery (Tier 2) is of utmost importance.[1] This includes the time to recovery and time to return to normal activities, and disutilities of care or the treatment process. Recently, based on this model, specifically for hip and knee osteoarthritis the International Consortium for Health Outcomes Measurement (ICHOM) Standard Set for Hip & Knee Osteoarthritis was published.[2] The studies described in this thesis were initiated before this latter publication, but include similar outcome dimension.

Collecting PROMS before and after TKA and THA

Based on the results of the LOAS (Leiden Orthopaedics Outcome of OsteoArthritis Study) we concluded that the prospective collection of a comprehensive set of PROMs can be done relatively successfully alongside a national arthroplasty register (Dutch Arthroplasty Register, Landelijke Registratie Orthopedische Implantaten, LROI) (Chapter 2). The data collection done in the LOAS differed from the set of PROMs imposed by the Dutch Orthopaedic Association (Nederlandse Orthopaedische Vereniging, NOV) and are thus mandatory for orthopaedic surgeons in The Netherlands. The LOAS data collection was more extensive, as it included outcome measures on the level of societal participation and health care usage, and it was more prolonged (longer than 12 months).

Despite the extent of the data collection, the participation rates were fairly comparable to those reported for some international registries[3] and those recently reported for the mandatory set of PROMS in The Netherlands.[4] The relatively high response rates, also during follow-up and despite the extent of the questionnaires, could probably be in part explained by our efforts to motivate patients. This was

done by keeping in touch with them several times per year by sending them updates (newsletters) and offering them the opportunity to use pen-and-paper questionnaires beside an Internet-based structure.

A weakness however was the considerable proportion of patients who were not invited to participate in the study. This finding suggests that more effort could be put in supporting the hospitals to inform all eligible patients timely about the study. A challenge in this respect Is the observation that , of those who were invited preoperatively, relatively many could not complete the preoperative questionnaires as their surgery was planned shortly thereafter.

As during the course of the LOAS study the collection of the mandatory basic set of PROMs became more and more implemented and largely executed electronically by means of software provided by specialized companies in the Netherlands, collecting the additional LOAS data became more easy over the years. However, as each hospital employed a unique strategy to collect these PROMs, with different software systems, adding the gathering of the LOAS data to the individual strategies of each hospital still appeared to be time consuming. In addition, the time points 3 months (THA) and 6 months (TKA) as imposed by the NOV did not completely coincide with the time points of the LOAS, warranting the need for amendments to the original study protocol. Finally, despite the streamlining with the mandatory data collecting preoperatively and at 3 or 6 and 12 months, gathering data at extra time points during after 1 year of follow-up will remain necessary over the next years as one of the strengths of the LOAS lies in the long-term follow up.

Predicting recovery after THA or TKA

Accurate prediction of patients who will and will not benefit from THA or TKA is very important in order study to prevent unnecessary (low-value) care. We examined one possible predictor of outcome of THA and TKA, i.e. preoperative radiographic abnormalities, with the results of our study showing that improvements over time were greater in patients with more severe radiographic OA. The difference was statistically significant for a number of clinical outcomes in THA patients, but not in TKA patients. Overall, our results are in line with the literature, with the majority of studies concluding that more severe radiographic OA preoperatively is associated with better outcomes in THA or TKA.[5-7]

So far, the prediction of outcomes of THA and TKA proved to be disappointing.[8,9] A systematic review by Hofstede et al.[9] included 35 studies. It considered preoperative function, radiological osteoarthritis, ages, gender, BMI, comorbidity, pain and quality of life and investigated their association with postoperative improvement. The authors of the review concluded that overall there is not enough evidence to draw succinct conclusions on preoperative predictors for postoperative outcome in THA, as results of studies are conflicting and the methodological quality is low. Results suggest to focus on preoperative function and radiological osteoarthritis to decide when THA will be most effective. The present mapping of current evidence on the relationship between patient related factors and outcomes provides better information compared to individual studies and may help to set patient expectations before surgery. In addition, these findings may contribute to discussions on how to achieve the best possible postoperative outcome for specific patient groups.[9]

In the absence of a valid prediction model to better select patients who will benefit most from surgery, yet a need for more standardization, several sets of indication criteria for THA or TKA are currently used in clinical practice. A systematic review on such sets of indication criteria by Gademan et al.[8] included 6 guidelines and 18 papers. This review identified 12 THA, 10 TKA and 2 THA/TKA sets of indication criteria. Indication criteria concerning THA/TKA consisted of the following domains: pain, function, radiological changes and failed conservative therapy. Specific cut-off values or ranges to support the decision for surgery were often not stated and the level of evidence was low. This review concluded that indication criteria for THA/TKA used in clinical practice are based on limited evidence.[8]

All of these findings clearly indicated that more empirical research is needed, especially regarding the development of prediction models, including domain specific cut-off values or ranges at which the best postoperative outcomes are achieved for patients, taking into account the limited lifespan of a prosthesis and the patients' life expectancy. This would thus imply the ability to distinguish different trajectories of outcome in individual patients, consensus on cut-off values for clinical success and failure[8]

Moreover, more research into unknown factors that are not yet taken into account in any of the models so far is needed. Such research would probably include qualitative approaches, in order to elicit relevant concepts that are not included in any sets of PROMS so far.

If, despite all those efforts, preoperative prediction appears to be unsuccessful, more efforts must be put into the early detection of unsuccessful recovery soon after surgery and appropriate management thereafter.

Expectations and their fulfilment

One factor that is generally considered to be decisive for recovery after THA or TKA concerns patient expectations. In Chapter 4 we determined to what extent a broad range of expectations were fulfilled one year after TKA and THA. For TKA and THA it was shown that expectations for the outcomes of surgery were in general very high, with most patients expecting to have large improvements or even return to their 'normal' level of ability. There were however some expectations that clearly stood out, concerning the relatively large proportion of patients that indicated that these expectations were not or insufficiently fulfilled. One possible intervention strategy may be to preoperatively better address these expectations, e.g. by improving preoperative education. Managing unrealistic preoperative expectations in general is also mentioned as a potentially effective intervention, however for that purpose more clarity about when expectations should be considered to be realistic or unrealistic is needed. In this respect, the observation that patients' and surgeons' expectations are not always aligned must be taken into account.[10] In addition, our study also showed that for many activities, despite relatively large proportions of patients in whom expectations were not or insufficiently fulfilled, there were also quite many patients in whom the expectation for that same activity was even exceeded. These finding suggests that managing a patient's preoperative expectations is a process that needs to be highly individualized.

Return to society – Work

Despite the increasing attention for functional recovery after THA or TKA, return to work is a relatively under researched area. Related to the raising pensionable age in many countries and to other societal factors, the proportion of people undergoing THA or TKA and have a paid job will increase. In the recently published ICHOM Standard Set for Hip & Knee Osteoarthritis work, based on the Value Based Health Care framework of Michael E. Porter and Elizabeth O. Teisberg, indeed work status is included.[1] However, that set is not yet fully implemented in orthopaedic practice.

Our literature review in Chapter 7 showed that overall, the majority of patients who are employed before THA or TKA return to work postoperatively, a finding that is in line with the results of our clinical study in Chapter 8. In all, the literature on work

status after THA was more extensive than for TKA and the methodological quality of the studies was moderate to low, hampering comparisons of rates and speed of return to work among and between studies on THA and TKA. Our clinical study however also found that in total, work productivity after THA and TKA is reduced, a finding warranting more attention in the future.

After all, the findings regarding some loss of productivity may be substantial on the societal level, given the large absolute numbers of patients undergoing total joint arthroplasties in the working age, in part related to the rising pensionable age. It thus warrants further analysis and intervention, such as a more extensive consideration of the type of work and the perceived and expected work limitations before and after surgery. For this purpose, A more intensive cooperation with occupational physicians and physical therapists might be warranted.
Work status is a complex entity, with work disability including decreased work productivity while present at work, temporary absence or sick leave or not working at all due to health problems, with or without a full or partial disability pension. In addition, unemployment, (early) retirement and/or stopping work voluntarily, whether or not related to health status, may also occur. Apart from consensus on definitions, appropriate measurement methods, prospective cohort studies are needed to accurately describe productivity gains and losses over time in this continuum model in THA and TKA.[11,12]

Overall, the studies in this thesis underline the importance of the process of recovery in THA and TKA, although this is evident, considering the extensive surgery with tissue damage, blood loss etc, this has seldom be addressed in these patient groups. The majority of studies focus on outcome, while the process to have a (un)favourable outcome for a specific patient has less attention. The feasibility of collecting outcomes relevant for this process of recovery was demonstrated. Although overall favourable outcomes regarding sustainability of health and return into society were seen, a number of areas for improvement were identified.

These areas include the better identification of patients with a likely perceived unsuccessful outcome or recovery, including return to work, either preoperatively or as early after surgery as possible. Early identification and subsequent appropriate interventions involving all relevant health care providers, may change the course of recovery of a THA and TKA in a more favourable way for the patient, thus adding value to the patient and not only "adding" an implant into a patient.

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Chapter

Summary

Osteoarthritis (OA) is a common joint condition, resulting in pain and stiffness and having a substantial impact on functioning and quality of life of individuals. Hip and knee OA are among the most prevalent forms of OA with, given their interference with mobility, considerable societal consequences in terms of costs related to health care usage and productivity losses.[1]

Total hip and total knee arthroplasties (THA or TKA) are effective treatments for end stage hip or knee OA, leading to satisfactory improvement of pain and function in 80-90% of the patients within the first 12 months after surgery.[2] Overall, knowledge regarding a broader range of clinical outcomes, over a prolonged period, as advocated by international organizations such as the International Consortium for Health Outcomes Measurement (ICHOM)[3] is scarce. Such outcomes are related to the process of recovery and sustainability of health, and include e.g. societal participation or fulfilment of specific expectations regarding the resumption of daily activities.[3] To gain more insight into such aspects, the frequent and systematic administration of a comprehensive set of outcome measures, over a prolonged period of time, is needed. Such research is however scanty, as it is costly in terms of the required time and resources. By its efforts to systematically gather and analyse a broad set of clinical data in patients undergoing THA or TKA, this thesis contributes to the body of knowledge on the process of recovery and sustainability of health after surgery.

Aims of this thesis

Given the lack of knowledge on the process of recovery and sustainability of health after THA or TKA, the current thesis aims:

1. To evaluate the feasibility of a comprehensive set of Patient Reported Outcome Measures (PROMs), including measures of recovery to normal activities and work , after THA or TKA in a network of 7 collaborating hospitals, by means of a nested study within the Dutch Arthroplasty Register (Landelijke Registratie Orthopedische Implantaten, LROI).

2. To determine the role of radiographic abnormalities as a predictor of recovery after THA and TKA.

3. To explore the fulfilment of patients' preoperative expectations regarding recovery to normal activities and the process of returning to work after THA or TKA as well as barriers and facilitators of return to work.

1. Feasbility of collecting a comprehensive set of PROMs alongside a national joint arthroplasty register

Chapter 2 describes the feasibility of collecting patient-reported outcome measures alongside the Dutch Arthroplasty Register. For this purpose, the longitudinal Leiden Orthopaedics Outcomes of OsteoArthritis Study (LOAS) was set up. It is a multicentre (7 Hospitals), observational study including patients undergoing THA or TKA, starting in June 2012. A comprehensive set of PROMs including the mandatory PROMs as imposed by the Dutch Orthopaedic Association (NOV; Nederlandse Orthopaedische Vereniging) plus additional outcomes related to paid employment and health care usage was collected preoperatively and at 6, 12, 24 months and every 2 years thereafter.

The proportions of invited patients taking part in the study (participation rates) and the proportions of patients returning the questionnaires (response rates) were recorded.

Between June 2012 and December 2014, 1796 THA and 1636 TKA patients were invited, of whom 1035 THA (58%; mean age 68 years (SD 10), 62% female) and 970 TKA (59%; mean age 67 years (SD 9.0), 66% female) participated in the study. At 6 months, 35 THA and 38 TKA patients were lost to follow-up. The response rates among those eligible at 1 and 2 years were 87% (866/992) and 84% (812/972) for THA and 84% (771/917) and 83% (756/906) for TKA patients, respectively.
In conclusion, the prospective collection of a comprehensive set of PROMs can successfully be accomplished alongside a traditional arthroplasty register. In particular to increase the participation rates, more efforts concerning the initial recruitment of patients are needed.

2. **The role of radiographic abnormalities as a predictor of recovery after THA and TKA**

Chapter 3 describes the impact of radiographic severity of hip and knee OA on improvements in functioning, pain, and health-related quality of life (HRQoL) 1 year after THA or TKA.

It concerned a prospective cohort study including 302 THA patients and 271 TKA patients. Radiographic severity was determined according to the Kellgren and Lawrence (KL) classification. Clinical assessments preoperatively and 1 year postoperatively included: sociodemographic characteristics and PROMs: SF36, EQ5D, H/KOOS, and the OHS/OKS) OHS/OKS. In addition, age, sex, Body Mass Index (BMI) and comorbidity (Charnley score) were recorded. Change scores of PROMs were compared between patients with with mild OA (KL 0-2) and severe OA (KL 3-4) using a multivariate linear regression model.

In the THA patients 77 (26%) had mild OA and 225 (74%) had severe OA preoperatively; in the TKA patients, 74 (27%) had mild OA and 197 (73%) had severe OA. Adjusted for sex, age, BMI, Charnley score and preoperative clinical scores, radiographic severity of OA was statistically significantly associated with improvement in the HOOS subscales "Activities of daily living", "Pain", and "Symptoms", and the SF36 physical component summary ("PCS") scale in THA patients. In TKA, no statistically significant associations were seen. Given these findings, it was concluded that the decrease in pain and improvement in function in THA patients, but not in TKA patients, was positively associated with the preoperative radiographic severity of OA.

3. **The fulfilment of patients' preoperative expectations regarding recovery to normal activities and the process of returning to work after THA or TKA**

Chapter 4 describes patients' preoperative expectations of outcomes of THA or TKA regarding specific aspects of functioning and determined to what extent each expectation was fulfilled after 1 year.

Within a the same cohort study as described in Chapter 3, preoperative expectations and their fulfilment after 1 year were measured with the Hospital for Special Surgery Hip/Knee arthroplasty Expectations Surveys. Preoperative and postoperative scores were subtracted to calculate whether expectations were unfulfilled, fulfilled, or exceeded.

In total 343 THA and 322 TKA patients with complete follow-up were included. Preoperatively >60% of patients (both THA/TKA) expected to get back to normal or have much improvement in 19 of 20 (THA) and 12 of 19 (TKA) items. Expectations were fulfilled or exceeded in >60% of patients in all 20 items for THA and 17 of 19 items for TKA. In THA, items with the largest proportions patients with unfulfilled expectations (>30%) were "improvement in walking ability: long distances" (31%), "walking stairs" (33%), and "improve ability to cut toenails" (38%). In TKA, expectations for 12 of 19 items were unfulfilled in >30% of patients, with the largest proportions seen for "being able to kneel down" (44%) and "being able to squat" (47%).

This study concluded that, although for most items >60% of THA and TKA patients indicated that their expectations were met or exceeded, there was a substantial number of patients, particularly TKA patients, having one or more unfulfilled expectations. These findings indicate that expectation patterns and their fulfilment need more attention in preoperative patient information and education.

Chapter 5 describes whether measurement instruments used to assess the conceptually related constructs optimism, pessimism, hope treatment credibility and treatment expectancy truly measure distinct constructs in patients undergoing THA or TKA.

This study concerned the same cohort as described in chapters 3 and 4. In that study, 182 THA and 179 TKA patients completed the Life Orientation Test-Revised for optimism and pessimism, the Hope Scale, the Credibility Expectancy Questionnaire (CEQ) for treatment credibility and treatment expectancy before surgery. Confirmatory factor analysis was used to examine whether the instruments measured distinct constructs. Theory-driven models with one, two, four and five latent factors were evaluated using multiple fit indices and $\Delta\chi 2$ tests, followed by some posthoc models. The results of the theory driven confirmatory factor analysis showed that a five-factor model in which all constructs loaded on separate factors yielded the most optimal and satisfactory fit. Posthoc, a bifactormodel in which (besides the 5 separate factors) a general factor is hypothesized accounting for the commonality of the items showed a significantly better fit than the five factor model. Treatment expectancy, treatment credibility, optimism and pessimism explained a substantial amount of variance unique from the general factor, however hope did not.

This study concluded that the constructs treatment expectancy, treatment credibility, hope, optimism and pessimism are distinguishable in THA and TKA patients. Postdoc, we determined that all constructs, except hope, showed substantial specific variance unique from the general factor.

In Chapter 6, the predictive value of patients' pre-operative general and specific outcome expectations on postoperative pain and function after total knee and total hip arthroplasties was studied.

It concerned the same cohort as described in Chapters 3-5, with this analysis including 148 THA and 146 TKA patients completing measurements preoperatively and 12 months after surgery. Primary outcomes for the present analysis were the KOOS and HOOS activities of daily living and pain subscale scores at 12 months After surgery. Patients' preoperative outcome expectations were measured with the Credibility Expectancy Questionnaire (CEQ) and the Hospital for Special Surgery expectations surveys (HSS). Other candidate predictors of outcome were: preoperative pain and function, gender, age, education level, BMI, Kellgren and Lawrence score, mental health and treatment credibility.

Multivariate linear regression analyses were employed with postoperative pain (KOOS/HOOS pain) and function (KOOS/HOOS function) as dependent variables. Besides the CEQ and HSS, we selected the candidate predictors of outcome. A backwards elimination method was used for these analyses. This procedure started with including all candidate variables of outcome in the model, subsequently the least significant variable was removed (the one with the highest p-value). The model was thereafter refitted without this variable, and again the least significant variable was removed. This process was repeated until all predictor variables in the model had a p-value < 0.10.

Patients' outcome expectations were consistently part of the combination of variables that best predicted outcomes for both TKA and THA. The amount of variance explained by the prediction models ranged between 17.0% and 30.3%, with higher scores on the expectation measures predicting better outcomes. However, the amount of variance explained by the expectation measures alone was limited. Therefore, it was suggested that with the consideration of total joint replacement, orthopaedic surgeons should take a range of variables into account,

including the patient's expectations about outcome. Although the CEQ expectancy subscale predicted outcomes slightly better as compared to the HSS expectation surveys, differences in predictive value of the two measurements were too small to recommend the use of one over the other for prediction purposes.

Chapter 7 concerns a systematic literature study on work status and time to return to work and its determinants in patients undergoing THA or TKA.
For this purpose a systematic search in various databases through April 2013 was performed. All clinical studies concerning patients undergoing THA or TKA providing quantitative information on work status before and after surgery were included. Study characteristics, data on work status and determinants of return to work were extracted and the methodological quality was evaluated regarding three quality aspects (selection bias, information bias and statistical analysis bias).

Nineteen studies (published between 1986 and 2013) were selected (4 on THA, 14 on TKA and 1 on THA and TKA), including 3872 patients with THA and 649 patients with TKA. The proportions of patients returning to work ranged from 25 to 95% at 1-12 months after THA and from 71 to 83% at 3-6 months after TKA. The average time to return to work varied from 1.1 to 13.9 weeks after THA and from 8.0 to 12.0 weeks after TKA. Factors related to work status after THA and TKA included sociodemographic, health and job characteristics. Overall, the methodological quality of the studies was moderate to low.

This study concluded that the majority of patients who are employed before THA and TKA return to work postoperatively. Comparisons of work status and the rate and speed of return to work between studies in THA and TKA are hampered by large variations in patient selection and measurement methods, underpinning the need for more standardization.

Chapter 8 describes a prospective cohort study on return to work and duration until return to work in patients undergoing THA or TKA. It included patients under 65 years of age, who provided information on their work status preoperatively (paid work yes/no and working hours) and 1 year thereafter (paid work yes/no, working hours and time until return to work).

Seventy-one THA and 64 TKA patients had a paid job preoperatively. The employment rates 1 year postoperatively were 64 patients (90%) after THA and 53 patients (83%) after TKA. Of those who returned to work, 9/16 (14%) of THA patients and 10/53 (19%) of TKA patients worked less hours than preoperatively (mean decrease 16 (SD 11.5) and 14 (SD 13.0) hours, respectively). The mean time to return to work was 12.5 (SD 7.6) and 12.9 (SD 8.0) weeks in THA and TKA, respectively.

In conclusion, the majority of working patients who underwent THA or TKA returned to work, after approximately 12 weeks. A considerable proportion of the patients returning to work worked less hours than preoperatively. More research into patients who do not return or decrease their working hours is needed.

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Chapter

Summary in Dutch
(Nederlandse samenvatting)

Samenvatting

Artrose is de meest voorkomende gewrichtsaandoening, met pijn, stijfheid en bewegingsbeperkingen van het gewricht als belangrijkste klinische kenmerken. De gewrichtsklachten leiden bij veel mensen met artrose tot beperkingen van de uitvoering van dagelijkse activiteiten en de maatschappelijke participatie en een verminderde kwaliteit van leven. Heup- en knie artrose behoren tot de meest voorkomende vormen van artrose. Heup- en knieartrose leiden, gezien de er mee gepaard gaande klachten en de belangrijke invloed op de mobiliteit, tot een aanzienlijk zorggebruik. Daarnaast kunnen heup- en knieartrose tot een verlies aan arbeidsproductiviteit leiden, waarmee de impact van de aandoening vanuit maatschappelijk perspectief groot is.

Totale heup- en knieprothese operaties (THP en TKP) zijn effectieve behandelmethoden voor patiënten met eindstadium artrose van heup of knie. Onderzoek heeft aangetoond dat 80-90% van de patiënten binnen 12 maanden na operatie een vermindering van pijn en verbetering van dagelijkse activiteiten ervaart. Tot op heden is de kennis schaars over een breder aantal klinische uitkomsten op lange termijn, zoals deze bijvoorbeeld specifiek voor heup en knieartrose zijn beschreven door het International Consortium for Health Outcomes Measurement (ICHOM). Een dergelijke brede set van uitkomstmaten is gebaseerd op de principes van Value Based Health Care (VBHC), waarin de waarde van zorg voor de patiënt centraal staat.

Een multidimensionele set van uitkomstmaten voor THP en TKP omvat, naast heup- of knieklachten en daaraan gerelateerde aspecten van het dagelijkse functioneren, ook het herstelproces en de duurzaamheid van de bereikte gezondheidstoestand, waaronder maatschappelijke participatie of het voldoen aan verwachtingen over functioneel herstel. Om meer inzicht te krijgen in deze uitkomstmaten, is het nodig deze systematisch, relatief frequent en over langere periode bij patiënten te meten. Dergelijk onderzoek is echter schaars, gezien de daarmee gepaard gaande hoge kosten en tijdsbeslag.

Het onderzoek dat beschreven wordt in dit proefschrift sluit aan bij de behoefte aan meer inzicht in de waarde van totale heup- en knieprothesen voor de patiënt. Hiertoe heeft het onderzoek in belangrijke mate bestaan uit systematisch verzamelen

van een brede set van uitkomstmaten bij patiënten die een THP of TKP operatie ondergaan.

Doelstellingen proefschrift

Gezien de schaarste aan kennis op het gebied van waarde voor de patiënt in de zin van het herstelproces en de duurzaamheid van de gezondheid na een THP of TKP en de verwachtingen en beleving van de patiënt hiervan, zijn de doelstellingen van dit proefschrift:

1. Bepalen van de haalbaarheid van het afnemen van een uitgebreide set Patient Reported Outcome Measures (PROMs), waaronder metingen van herstel naar normale activiteiten en werk, na een THP of TKP in een netwerk van 7 deelnemende ziekenhuizen, in samenhang met de Landelijke Registratie Orthopedische implantaten (LROI).

2. Bepalen in welke mate radiologische afwijkingen geassocieerd zijn met het herstel na THP en TKP.

3. Bepalen van de mate waarin voldaan wordt aan verwachtingspatronen van patiënten die een THP of een TKP ondergaan, op het gebied van herstel naar normale activiteiten en het proces van terugkeer naar werk.

1. Haalbaarheid van een uitgebreide set Patient Reported Outcome Measures (PROMs) vervlochten in de Landelijke Registratie Orthopedische implantaten

Hoofdstuk 2 beschrijft de haalbaarheid van het afnemen van een uitgebreide set Patient Reported Outcome Measures (PROMs) in samenhang met de Landelijke Registratie Orthopedische Implantaten (LROI). Hiervoor is het LOAS onderzoek (Longitudinal Leiden Orthopaedics Outcomes of OsteoArthritis Study) opgezet. Dit is een multicentre (7 ziekenhuizen) observationeel onderzoek, waarvoor alle patiënten die een THP of TKP operatie ondergaan in aanmerking komen. Het onderzoek is gestart in juni 2012. Een uitgebreide set PROMs, zoals geadviseerd door de Nederlandse Orthopaedische Vereniging (NOV), met daarnaast aanvullende

uitkomstmetingen betreffende werkstatus en gebruik van gezondheidszorg, en verwachtingen over de operatie en het uitkomen daarvan, werden preoperatief en postoperatief na 6, 12, en 24 maanden en vervolgens elke 2 jaar afgenomen.

Tussen juni 2012 en december 2014 werden 1796 THP en 1636 TKP patiënten uitgenodigd. 1043 THP (58%; gemiddelde leeftijd 68 jaar (SD 10), 62% vrouw) en 970 TKP (59%; gemiddelde leeftijd 71 jaar (SD 9.5), 66% vrouw) patiënten namen deel aan het onderzoek. Na 6 maanden waren 35 THP en 38 TKP patiënten lost to follow-up. De deelname na 1 en 2 jaar was respectievelijk 87% (866/992) en 84% (812/972) bij THP en 84% (771/917) en 83% (756/906) bij TKP patiënten.

Concluderend bleek het prospectief verzamelen van een uitgebreide set PROMs, in samenhang met de verzamelde data ten behoeve van de LROI, haalbaar. Om het inclusiepercentage te verhogen moet er mogelijk meer inspanning worden geleverd bij het recruteren van patiënten. Daarnaast blijft het belangrijk om uitval tijdens volop zoveel mogelijk te beperken. Bijvoorbeeld door meer inspanning leveren in het steunen van ziekenhuizen om alle geschikte patiënten tijdig te informeren over het onderzoek.

2. De mate van radiologische afwijkingen als voorspeller van herstel na THP en TKP

Hoofdstuk 3 beschrijft de impact van de mate radiologische afwijkingen bij heup- en knieartrose op de verbeteringen in functioneren, hoeveelheid pijn en kwaliteit van leven één jaar na THP en TKP.

Hiervoor is een prospectief cohortonderzoek uitgevoerd, met daarin 302 THP en 271 TKP patiënten. De mate van radiologische schade werd bepaald met het scoringssysteem volgens Kellgren en Lawrence (KL). Patiënten vulden preoperatief en 1 jaar postoperatief vragenlijsten in, die bestonden uit sociodemografische karakteristieken en PROMs: The Short Form 36 questionnaire (SF36), The Euroqol 5 Dimensions questionnaire (EQ5D), The Hip disability/ Knee injury and Osteoarthritis Outcome Score (H/KOOS) and the Oxford Hip/Knee Score (OHS/OKS). Daarnaast werd leeftijd, geslacht, Body Mass Index (BMI) en comorbiditeiten (Charnley score) genoteerd. De veranderscores van de PROMs werden, met behulp van een meervoudige lineaire regressie analyse vergeleken tussen patiënten met milde artrose (KL 0-2) en ernstige artrose (KL 3-4).

Preoperatief hadden 77 THP patiënten (26%) en 74 (27%) TKP patiënten milde artrose en 225 (74%) THP patiënten en 197 (73%) TKP patiënten ernstige artrose. Gecorrigeerd voor geslacht, leeftijd, BMI, Charnley score en preoperatieve klinische scores, was de mate van radiologische afwijkingen statistisch significant geassocieerd met de verbetering in de HOOS subschalen "functioneren in het dagelijks leven", "pijn" en "symptomen"; en de SF36 Physical Component Score ("PCS") binnen de groep THP patiënten. Binnen de groep TKP patiënten werden geen statistisch significante associaties gezien.

Concluderend liet deze studie zijn dat bij THP patiënten een meer ernstige graad artrose geassocieerd was met betere uitkomsten betreffende afname van pijn en verbetering in functioneren. Dit verband werd niet aangetoond bij TKP patiënten.

Tot op heden is het voorspellen van uitkomsten na THP en TKP teleurstellend geweest. Ook de mate van radiologische afwijkingen lijkt maar in zeer mate aan de voorspelling van uitkomsten bij te dragen. Hiermee samenhangend zijn indicatiecriteria voor THP/TKP, die momenteel in de praktijk gebruikt worden, gebaseerd op relatief zwak wetenschappelijk bewijs.

Er is dus meer onderzoek nodig naar de ontwikkeling van preoperatieve predictiemodellen, met daarin per domein gerichte afkapwaarden of minimale en maximale waarden om te zien bij welke kenmerken van patiënten de best postoperatieve uitkomsten bereikt worden. Als, ondanks al deze inspanning, preoperatieve predictiemodellen nog steeds niet succesvol blijken, is een optie om meer aandacht te besteden aan de vroege detectie van patiënten die geen succesvol herstel hebben na de operatie, om hen vervolgens intensievere postoperatieve zorg te kunnen bieden.

3. Het voldoen aan verwachtingspatronen van patiënten die binnenkort een THP of een TKP ondergaan, op het gebied van herstel naar normale activiteiten en het proces van terugkeer naar werk

Hoofdstuk 4 beschrijft de preoperatieve verwachtingen van patiënten die binnenkort een TKA of een THA ondergaan en de mate waarin aan deze verwachtingen is voldaan 1 jaar na de operatie. Deze groep patiënten betreft dezelfde populatie als die beschreven in hoofdstuk 3. In totaal 343 THP en 322 TKP patiënten vulden een vragenlijst over verwachtingen in vóór de operatie (Hospital for Special Surgery

(HSS) Hip and Knee Replacement Expectations Surveys). Deze vragenlijst bevat de verwachte resultaten van de operatie voor 19 (TKA) en 20 (THA) specifieke functies en activiteiten van het dagelijkse leven. Eén jaar na de operatie vulden de patiënten dezelfde vragenlijst opnieuw in. Maar, in plaats van het verwachte resultaat, vulden ze nu het daadwerkelijke resultaat in. Preoperatief verwachtte meer dan 60% van de THA patiënten veel verbetering op 19 van de 20 items, terwijl meer dan 60% van de TKA patiënten voor 12 van de 19 items veel verbetering verwachtte.

Postoperatief werd er voor méér dan 60% van de patiënten aan de verwachtingen 19 van de 20 items voldaan voor THA en voor 17 van de 19 items voor TKA. Voor THA werd aan de verwachtingen voor "het lopen van lange afstanden", "traplopen" "teennagels knippen" het vaakst niet voldaan (>30% van de patiënten). Voor TKA werd er het meest frequent (>30%) niet voldaan aan de verwachtingen voor "knielen" en "squatten".

Hoewel bij een deel van de patiënten de verwachtingen werden overtroffen, kunnen onvervulde verwachtingen leiden tot ontevredenheid van patiënten over het behaalde resultaat. Daarom is het belangrijk om tijdens het preoperatief consult de verwachtingen van de patiënt en hetgeen men van op grond van praktijkervaring en wetenschappelijk onderzoek van de uitkomsten van een THP of TKP kan verwachten, kan verwachten, goed op elkaar af te stemmen. Daarbij moet extra aandacht worden geschonken aan de specifieke functies en activiteiten van het dagelijks leven waarvoor de verwachtingen voor een grote groep patiënten onvervuld bleven. Mogelijk kan de informatievoorziening voor patiënten hierop worden aangepast.

In Hoofdstuk 5 wordt onderzocht of de meetinstrumenten die de constructen verwachtingen, geloofwaardigheid, optimisme, pessimisme en hoop beogen te meten, maar conceptueel overlappend zijn, of deze constructen daadwerkelijk van elkaar te onderscheiden zijn bij patiënten die een THP of TKP operatie ondergaan. Deze groep patiënten betrof hetzelfde cohort als beschreven in hoofdstukken 3 en 4. 182 THP en 179 TKP patiënten vulden preoperatief de volgende vragenlijsten in: the Life Orientation Test-Revised for optimism and pessimism, the Hope Scale, the Credibility Expectancy Questionnaire (CEQ) for treatment credibility and treatment expectancy before surgery. Confirmatieve factoranalyse (CFA) werd gebruikt om te onderzoeken of de meetinstrumenten daadwerkelijk verschillende

constructen meten. Gebaseerd op eerdere theorieën werden vier verschillende modellen geëvalueerd met fit-indices en $\Delta\chi 2$ tests; een één factor model, een twee factoren model, een vier factoren model en een vijf factoren model. Gebaseerd op de resultaten van deze vier modellen werd er post-hoc nog een aantal modellen getest. De resultaten van de op de theorie gebaseerde modellen lieten zien dat een vijf factoren model waarin alle constructen op verschillende factoren laadden het model was dat de data het best paste. Echter, post-hoc analyses lieten zien dat een bi-factor model, waarin naast de vijf verschillende factoren, ook een generieke factor werd meegenomen die de gedeelde variantie tussen de factoren vertegenwoordigt, significant beter op de data paste dan het vijf factoren model.

Concluderend, alle constructen, behalve hoop, verklaarden een substantieel deel van de specifieke variantie, maar alle factoren samen verklaarden ook een substantieel deel van de generieke variantie. Gebaseerd op de primaire analyses zijn de vijf constructen voldoende onderscheidend te meten. Dit kan van pas komen bij het invoeren van specifieke interventies bijvoorbeeld gericht op het optimaliseren van verwachtingen (interventies zijn pas te testen als je zeker weet dat je het juiste construct van elkaar kan onderscheiden).

In hoofdstuk 6 wordt een studie naar de toegevoegde voorspellende waarde van patiëntverwachtingen bij het voorspellen van de uitkomsten (pijn en functioneren) van TKA en THA gepresenteerd. Daarnaast onderzochten we in dit hoofdstuk of de voorspellende waarde van op een meer specifieke manier gemeten verwachtingen (verwachtingen ten aanzien van specifieke functies en activiteiten) hoger was dan de voorspellende waarde van de op een meer generieke manier gemeten verwachtingen (verwachtingen ten aanzien van het algemene resultaat van de behandeling).

De groep patiënten betrof hetzelfde cohort als beschreven in hoofdstukken 3-5.

Primaire uitkomstmaten waren de KOOS en HOOS subschalen 'functioneren in dagelijks leven' en 'pijn'. Preoperatieve verwachtingen werden gemeten met de Credibility Expectancy Questionnaire (CEQ) en the Hospital for Special Surgery expectations surveys (HSS expectation surveys). Andere mogelijke predictoren waren: preoperatieve pijn en functie gemeten met de HOOS/KOOS, geslacht, leeftijd, opleidingsniveau, BMI, Kellgren/Lawrence score, preoperatieve mentale

gezondheid en treatment credibility gemeten met de CEQ. Acht predictiemodellen werden opgesteld, waarbij gebruikt gemaakt is van multivariate lineaire regressie analysen met een backward selection procedure.

De resultaten van de analyses lieten zien dat preoperatieve verwachtingen consistent deel uitmaakten van de set van preoperatieve variabelen die de uitkomst van TKA en THA voorspelden. De volledige modellen verklaarden tussen de 17.0% en 30.3% van de uitkomsten. Het gedeelte hiervan dat alleen door verwachtingen werd verklaard was echter relatief klein. De verschillen in hoeveelheid variantie die verklaard werd door generieke ten opzichte van specifieke verwachtingen was zeer klein. We kunnen daardoor geen voorkeur uitspreken voor één van de twee meetmethoden. Klinische implicatie hiervan is dat het onderdeel verwachtingen helaas niet veel toevoeging lijkt te geven aan het voorspellen van de uitkomsten na THA en TKA operaties. De vraag die dan rijst is of het zinvol is deze nog toe te voegen in de standaard set PROMs onder THA en TKA patiënten?

Hoofstuk 7 beschrijft een systematisch literatuuronderzoek naar de werksituatie en duur tot terugkeer naar werk onder patiënten die een THP of TKP operatie ondergaan, en naar factoren die van invloed waren op behoud van of terugkeer naar werk.

Hiervoor is een systematische zoekmethode toegepast binnen diverse elektronische databanken tot April 2013. Geïncludeerd werden alle klinische studies die betrekking hadden op patiënten die een THP of TKP operatie ondergingen, en waarbij de werksituatie vóór en na de operatie werd gerapporteerd. Uit de geselecteerde studies werden kenmerken van de studie, gegevens over de werksituatie voor en na de operatie en determinanten van werkhervatting verzameld. De methodologische kwaliteit werd geëvalueerd op basis van drie kwaliteitsaspecten (selectiebias, informatiebias en statistische analyse bias).

Negentien studies (gepubliceerd tussen 1986 en 2013) werden geselecteerd (4 betroffen THP, 14 betroffen TKP en 1 studie betrof zowel THP als TKP patiënten). In totaal werden hierin 3872 patiënten met THP en 649 met TKP beschreven. Vijfentwintig tot 95% van de patiënten met betaald werk keerden terug na THP variërend van 1-12 maanden en 71 tot 83% na TKP na 3-6 maanden. De gemiddelde tijd tot werkhervatting varieerde van 1.1 tot 13.9 weken na THP en van

8.0 tot 12.0 weken naar TKP. Dus de zin hiervoor betreft de duur van de follow up Factoren gerelateerd aan werkstatus na THP en TKP betroffen sociodemografische, gezondheids- en baankarakteristieken. De methodologische kwaliteit van onderzoeken was middelmatig tot laag.

Concluderend, de meerderheid van patiënten die betaald werk hebben voorafgaand aan een THP of TKP operatie, keert na de operatie terug naar het werk. Vergelijkingen tussen studies worden beperkt door grote variatie in selectie van patiënten en meetmethoden. Meer standaardisatie van de manier en de tijdstippen gedurende de follow-up waarop de werksituatie wordt geregistreerd is essentieel. In het recent gepubliceerde ICHOM Standard Set for Hip & Knee Osteoarthritis work, gebaseerd op het "Value Based Health Care framework" van Michael E. Porter en Elizabeth O. Teisberg, is werkstatus toegevoegd. Hierbij moet opgemerkt worden dat het vastleggen van de werksituatie, waaronder het aantal gewerkte uren, ziekteverzuim en arbeidsongeschiktheid, en de aanwezigheid van aanpassingen, uitermate complex is.

Hoofdstuk 8 beschrijft een prospectief cohortonderzoek naar werkhervatting en de duur tot werkhervatting bij patiënten die een THP of TKP operatie ondergaan. Het betrof een deel van de patiënten beschreven in hoofdstukken 3-6. In het onderzoek naar betaald werk werden uitsluitend patiënten betrokken met een leeftijd onder de 65 jaar, die middels vragenlijsten informatie hadden gegeven over hun werkstatus vóór de operatie (betaald werk ja/nee en aantal uren werkzaam) en één jaar daarna (betaald werk ja/nee, aantal uren werkzaam en aantal weken duur tot werkhervatting).

71 THP en 64 TKP patiënten hadden vóór de operatie betaald werk. Het aantal mensen met betaald werk na één jaar betrof 64 patiënten (90%) na THP en 53 patiënten (83%) na TKP operatie. Van degenen die terugkeerden naar werk, werkten 9/16 (14%) van THP patiënten en 10/53 (19%) van TKP patiënten minder uren dan vóór de operatie (gemiddelde daling 16 (SD 11.5) uren bij THP en 14 (SD 13.0) uren bij TKP). De duur tot terugkeer naar werk was gemiddeld 12.5 (SD 7.6) weken bij THP en 12.9 (SD 8.0) weken bij TKP.

Concluderend, de meerderheid van werkende patiënten die een THP of TKP operatie ondergaan, keert terug naar werk na ongeveer 12 weken. Een aanzienlijk deel van de patiënten die terugkeren naar werk, gaat minder uren werken.

Verlies van productiviteit heeft op maatschappelijk niveau bij deze grote aantallen patiënten, die een THP of TKP operaties ondergaan op werkende leeftijd, een behoorlijk effect. Toekomstig mogelijke interventies zouden zich kunnen richten op dit verlies in productiviteit binnen verschillende soorten type werkzaamheden, het verwachte en de ervaren beperkingen vóór en na operatie. Hiervoor is intensieve samenwerking nodig met bedrijfsartsen en fysiotherapeuten.

Daarnaast is werkstatus een complex begrip. Beperkingen op werk kunnen inhouden verminderde productiviteit terwijl aanwezig op werk, tijdelijke afwezigheid, ziekteverlof of geheel niet werken als gevolg van gezondheidsproblemen. Daarnaast, werkeloosheid, (vervroegd) pension, stoppen met werk vrijwillig, wel of niet gerelateerd aan de gezondheidsproblemen kunnen ook voorkomen. Toekomstige onderzoeken zouden zich moeten richten op het formuleren van éénduidige definities van werkstatus. Hiervoor zijn adequate meetmethoden in prospectieve cohortstudies nodig om duidelijk te beschrijven wat de productiviteitstoenames en verliezen zijn binnen THP en TKP groepen.

Conclusie proefschrift

De onderzoeken in dit proefschrift betreffen het herstelproces en de bereikte gezondheidstoestand na THP en TKP operaties. Hoewel er al veel onderzoek verricht is naar de uitkomsten van THP en TKP in de zin van pijn en fysiek functioneren, is het onderzoek naar de mate waarin de uitkomsten aan de verwachtingen van patiënten voldoen en terugkeer in de maatschappij (betaald werk) relatief schaars. Juist deze gebieden zijn in het kader van het hanteren van de principes van waarde gedreven zorg (value based health care) van groot belang.

Om hierin meer inzicht te verkrijgen, is het meten van een breed scala aan uitkomsten over langere tijd noodzakelijk. Onderzoek bestaande uit een grote, multicenter cohortstudie liet zien dat het verzamelen van een brede set van uitkomsten over langere tijd haalbaar is, hoewel er blijvend aandacht moet zijn aan het optimaliseren van inclusie en voorkomen van uitval om selectiebias zoveel mogelijk te voorkomen of verminderen..

Gemiddeld genomen waren de uitkomsten op het gebied van terugkeer in de maatschappij en voldoen aan verwachtingen gunstig.

Op het gebied van behoud van of terugkeer naar betaald werk blijkt er echter bij een deel van de patiënten een significant verlies aan arbeidsproductiviteit op te treden, dat nadere aandacht behoeft. Wellicht kan met preventie of vroeg onderkennen en behandelen van arbeidsproblematiek winst worden behaald.

Daarnaast werden een aantal dagelijkse activiteiten geïdentificeerd, waarvoor bij een aanzienlijk deel van de patiënten de verwachtingen niet of niet geheel waargemaakt werden. Door hieraan meer aandacht te besteden in de aanloop naar de operatie, bv. in voorlichtingsmateriaal, kunnen de verwachtingen mogelijk worden bijgesteld.

In het algemeen lieten de analyses waarin voorspellers van de uitkomsten van THP en TKP werden onderzocht zien dat de mate waarin de uitkomsten kunnen worden voorspeld zeer beperkt is. Dat betekent dat het nog niet goed mogelijk is om patiënten die (de meeste) baat zullen hebben bij de operatie te kunnen selecteren. Wellicht zijn factoren die het meest voorspellend zijn (nog) niet gemeten of in de modellen meegenomen. Hierbij kan gedacht worden aan aspecten als pijn, preoperatief functioneren, radiologische veranderingen en gefaalde conservatieve (niet-operatieve) zorg. Een andere mogelijkheid voor toekomstig onderzoek is het vroeg identificeren van patiënten met een onvolledig of achterblijvend herstelproces, en het bieden van intensievere postoperatieve zorg om het beloop van herstel na THP en TKP in een positieve manier voor de patiënt beïnvloeden en daardoor echt een waarde leveren voor de patiënt.

Chapter

Publications

List of publications

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Curriculum Vitae

Claire Tilbury was born on the 8th of March, 1986 in Alberton, South-Africa and raised in Utrecht and Loosdrecht, The Netherlands. She graduated from secondary school (VWO) in 2004 at the Alberdingk Thijm College in Hilversum. In 2004 she started her medical training at the Leiden University Medical Center in Leiden. After obtaining her medical degree in 2011 she worked for 6 months as a resident in general surgery in ziekenhuis Rivierenland in Tiel. In 2011 she started her PhD project on health related outcomes after total hip and knee arthroplasty surgery at the department of Orthopaedics at the Leiden University Medical Center in Leiden, under supervision of Prof. Dr. T.P.M. Vliet Vlieland and Prof. Dr. R.G.H.H. Nelissen.

In 2012 she received a project grant from the Stichting Anna Fonds, NOREF for her research on work disability after total hip and knee arthroplasty. She presented her research at multiple national and international scientific conferences. During her PhD trajectory she worked part-time as a forensic medical examiner at the GGD Flevoland, The Netherlands from 2012 till 2014.

In 2014 she started her Orthopaedic Surgery training at the University Medical Center Groningen in Groningen, commencing with the General Surgery training at the Deventer Hospital in Deventer. After careful consideration she decided to continue her medical career in a different direction and in September 2016 she started her training to become a General Practitioner at the Academic Medical Center in Amsterdam which she hopes to finish in December 2019. She currently lives in Loosdrecht, The Netherlands with her husband and two children (Willem and Abby).