

# Osteoarthritis and Cartilage



## Anxiety and depressive symptoms before and after total hip and knee arthroplasty: a prospective multicentre study



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### SUMMARY

**Background:** A subset of patients with total hip arthroplasty (THA) or total knee arthroplasty (TKA) has suboptimal postoperative results in terms of Patient Reported Outcomes (PROs), and psychological factors could contribute to these suboptimal results.

**Objectives:** To examine the prevalence of anxiety and depressive symptoms in patients undergoing primary THA or TKA preoperatively and postoperatively, and the relationship between preoperative anxiety and depressive symptoms on PROs of THA and TKA.

**Design:** In this prospective study patients were measured preoperatively, and 3 and 12 months postoperatively. Patients filled in the Hospital Anxiety and Depression Scale, Knee injury and Osteoarthritis Outcome Score (KOOS) or Hip disability and Osteoarthritis Outcome Score (HOOS) and a satisfaction questionnaire.

**Results:** Data were obtained from 149 hip and 133 knee patients. The prevalence of anxiety symptoms decreased significantly from 27.9% to 10.8% 12 months postoperatively in hip patients, and from 20.3% to 14.8% in knee patients. Depressive symptoms decreased significantly from 33.6% to 12.1% 12 months postoperatively in hip patients, and from 22.7% to 11.7% in knee patients. In hip and knee patients, preoperative depressive symptoms predicted smaller changes in different HOOS or KOOS subscales and patients were less satisfied 12 months postoperatively.

**Conclusions:** Preoperatively, the prevalence of anxiety and depressive symptoms was high. At 3 and 12 months postoperatively, the prevalence of anxiety and depressive symptoms was decreased in both hip and knee patients. However, patients with preoperative anxiety and depressive symptoms had worse PROs 3 and 12 months after THA and TKA and were less satisfied than patients without anxiety or depressive symptoms.

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### Introduction

Osteoarthritis (OA) of the hip or knee is one of the most frequently occurring disorders of the locomotor system, and the leading cause of pain and disability in the older population. When

conservative treatment fails, total hip arthroplasty (THA) and total knee arthroplasty (TKA) are cost-effective surgical options for patients with end-stage OA<sup>1</sup>.

Surgical techniques and design of the prostheses have been improved, and the results after THA and TKA are generally good. However, a subset of patients has suboptimal postoperative results with respect to pain, physical functioning and quality of life (QOL), and may not be satisfied with the results of their THA or TKA<sup>2,3</sup>. These outcomes are described as Patient Reported Outcomes (PROs), which the FDA defines as "... a report of the status of a patient's health condition that comes directly from the patient, without interpretation of the patient's response by a clinician or anyone else"<sup>4</sup>.

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The suboptimal results of THA and TKA in terms of PROs<sup>5</sup> in subgroups of patients cannot be entirely explained by patients' physical characteristics, adverse events, physical co-morbidities or surgery itself, but seem to be related to other characteristics, including psychological symptoms<sup>6</sup>. PROs reflecting the patient perspective on interventions, are increasingly important in effectiveness evaluation. For instance, since 1 April 2009 all providers of care funded by the National Health Service (NHS) in England have been required to provide Patient Reported Outcome Measures (PROMs) in four elective surgical procedures: hip replacement, knee replacement, varicose vein surgery and hernia surgery<sup>7</sup>.

Psychological symptoms were found to be associated with lower scores on PROs like QOL and increased pain and symptom sensitivity<sup>8</sup>. In addition, psychological symptoms negatively influence patients' motivation, energy, coping with illness and adherence of patients. Therefore, psychological symptoms may have an important influence on the treatment results and recovery in terms of PROs following THA or TKA. Such an effect may be common as psychological symptoms are highly prevalent in the elderly, especially in those with chronic medical illnesses<sup>9</sup>. The question then arises whether patients with end-stage hip or knee OA, who have suffered chronic pain and disability for many years, have indeed an increased prevalence of psychological symptoms. Previous studies have reported a high prevalence of psychological symptoms in patients with end-stage knee OA<sup>10–15</sup>. It is also reported that patients with psychological symptoms report lower PROs<sup>8,16,17</sup>. However, the impact of THA and TKA on these psychological symptoms is still unclear. Will these psychological symptoms decrease when the source of chronic pain and disability has been removed after total joint arthroplasty (TJA)? We hypothesized that, the prevalence of psychological symptoms will be high in end-stage hip as well as knee OA patients, and that these symptoms would likely improve along with pain and disability after arthroplasty.

Finally, it becomes relevant to examine whether we can relate preoperative psychological symptoms to the outcomes of THA or TKA. If such is the case, interventions aiming at a reduction of these psychological symptoms in these subgroups, either before or after THA or TKA, might increase the effectiveness of THA and TKA in terms of PRO. We showed earlier that patients with a lower mental health before THA and TKA had worse PROs post-surgery<sup>16,17</sup>. However, it was unclear whether anxiety and depressive symptoms had an influence on the outcome after THA and TKA. This is relevant as both mental symptoms can relatively easily be treated, for instance by using short term cognitive behavioural therapy<sup>18,19</sup>.

In summary: the primary aim of this study was to examine the prevalence of anxiety and depressive symptoms in patients prior to THA and TKA, and 3 and 12 months post-surgery to determine the impact of THA and TKA on these psychological symptoms. The second aim was to evaluate the influence of preoperative anxiety and depressive symptoms on the outcome 12 months after THA and TKA.

## Methods

This study was based on a prospective design with three assessment points. Patients were measured preoperatively while on the waiting list, 3 and 12 months after THA or TKA. Patients filled in three questionnaires at these three assessment points.

### Patients

All patients on the waiting list for primary THA or TKA at the department of Orthopaedics of Erasmus University Medical Center in Rotterdam, Reinier de Graaf Hospital in Delft, and St. Elisabeth Hospital in Tilburg in the period March 2009 and August 2010 were

eligible. This study was approved by the local Medical Ethics Committee.

### Measurements

Patients on the waiting list (baseline measurement) were measured without a fixed time point. Patients received the questionnaires by mail. In case of non-response a reminder was sent by mail after 3 weeks. If patients did not respond to the reminder, they were contacted by telephone 3 weeks later.

The main determinants were anxiety and depressive symptoms. These two symptoms were measured with the HADS, a validated questionnaire to screen anxiety and depressive symptoms. The HADS consists of 14 items, each rated from 0 to 3 according to the severity of distress experienced (0 indicates no distress and 3 indicates maximum distress). The HADS is divided into an Anxiety subscale and a Depression subscale, each with seven questions; each subscale score ranges from 0 to 21. Both subscales were used as independent variables to evaluate the influence of preoperative anxiety or depressive symptoms on the PROs after THA or TKA.

There are two methods to analyze the HADS data. First, raw scores can be summed for each subscale separately. Second, raw scores of the subscales can be used to classify patients into those with and without anxiety or depressive symptoms. The optimal cut-off score for the presence of both anxiety and depressive symptoms is  $\geq 8$ ; the sensitivity and specificity for this cut-off is about 0.80<sup>20–22</sup>.

The present study includes patients using antidepressants, or patients being treated by a psychologist or psychiatrist because of anxiety or depressive symptoms. Depression was defined using a cut-off of 8 or more on the HADS, or use of antidepressants or treatment by a mental health provider for anxiety or depression. The Hip disability and Osteoarthritis Outcome Score (HOOS)<sup>23,24</sup> and the Knee injury and Osteoarthritis Outcome Score (KOOS)<sup>25,26</sup> were used to evaluate hip and knee specific outcomes. The HOOS and KOOS questionnaires include five subscales: pain, symptoms, functioning in activities of daily living (ADL), functioning in sport and recreation, and hip or knee-related QOL. Standardized response options are given (5-point Likert scale), and each question is scored from 0 to 4. Then, a normalized score from 0 to 100 is calculated for each subscale (100 indicating no symptoms, and 0 indicating extreme symptoms)<sup>23–26</sup>.

Finally, patients filled in a general questionnaire about patient characteristics, use of pain medication, use of antidepressants, treatment by a psychologist or psychiatrist because of anxiety or depressive symptoms and patient satisfaction. Patient satisfaction was measured on a 5-point Likert scale 12 months postoperatively and included questions about the overall result, pain reduction, improvement in ADL and QOL. We dichotomized our satisfaction results as satisfied or unsatisfied on the basis of the Likert scale. The two responses 'very satisfied' and 'satisfied' were dichotomized to satisfied and 'neutral', 'unsatisfied' and 'very unsatisfied' were dichotomized to unsatisfied.

### Statistical analysis

Statistical analysis was performed using PASW Statistics (SPSS science Inc., Chicago, USA). Data of the hip and knee patients are presented separately.

Differences between hip and knee patients, and differences between the study population and patients lost to follow-up, were analyzed using independent *t*-tests (Student's *t*-test). Differences between the preoperative, 3 and 12 months postoperative data were analyzed with dependent *t*-tests. Effect sizes were calculated to examine the effect of THA or TKA on anxiety or depressive

symptoms 3 and 12 months postoperatively. Effect sizes were calculated as mean of the 3 or 12 months results minus the mean of the baseline (preoperative) data divided by the standard deviation (SD) of the baseline results.

To evaluate the influence of preoperative anxiety or depressive symptoms on the PROs after THA or TKA multivariable linear regression analysis was used. Dependent variables were the change scores of the HOOS or KOOS subscales between 12 months postoperative and preoperative scores. The independent variables were preoperative anxiety and depressive HADS score (dichotomized as  $<8$  and  $\geq 8$ ). This relationship was adjusted for age, gender, time spent on waiting list preoperative score on HOOS and KOOS subscale and unbalanced characteristics between study population and patients lost to follow-up. To check for linearity we plot the standardized residuals of the used variables against the standardized predicted values.

To evaluate the influence of preoperative anxiety or depressive symptoms on patient satisfaction multivariable logistic regression analysis was used. Dependent variable was patient satisfaction. Independent variables were preoperative anxiety and depressive HADS score (dichotomized as  $<8$  and  $\geq 8$ ). This relationship was adjusted for age, gender, time spent on waiting list and unbalanced characteristics between study population and patients lost to follow-up.

## Results

Between March 2009 and August 2010, 451 patients were eligible to participate in the study and received questionnaires by mail. Of these eligible patients, baseline results of 384 patients

were available (response rate 85%). Of 268 patients (response rate 70%) both baseline, 3 and 12 months postoperative data were available. These results were used in the present analysis (Fig. 1). To evaluate whether lost patients introduced selection bias we compared baseline characteristics of the study population with the patients lost to follow-up.

Table I presents the baseline characteristics of the study population and of patients lost to follow-up. There were no significant differences between the study population and patients lost to follow-up with respect to the primary outcome measures 'prevalence of anxiety and depressive symptoms' (Table I). For hip patients, the presence of familial depression, time on the waiting list and the outcome of the subscale symptoms on the HOOS-score were unbalanced characteristic between the study population and the patients lost to follow-up. For knee patients, gender was an unbalanced characteristic. Consequently, we adjusted the regression analyses for these variables.

## Prevalence

Table II presents the preoperative, 3 and 12 months postoperative HADS score for hip and knee patients. The preoperative prevalence of depressive symptoms was significantly higher in hip than in knee patients (33.6% vs 22.7%;  $P$ -value = 0.047). For hip patients the mean HADS anxiety and depression score showed a significant decrease 3 and 12 months postoperatively compared to baseline ( $P < 0.0001$ ). In this group less patients had anxiety or depressive symptoms 3 and 12 months postoperatively ( $P < 0.0001$ ).

For knee patients the mean HADS anxiety and depression score showed almost a similar pattern, except that the number of

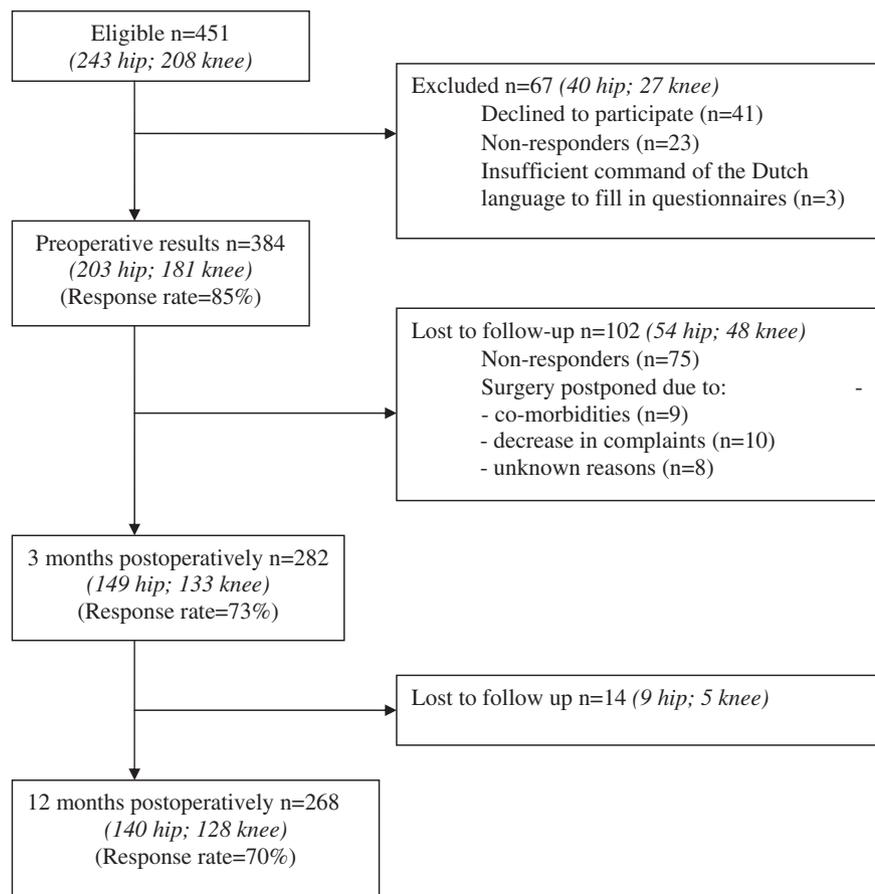


Fig. 1. Flow chart of the study population.

**Table I**  
Baseline characteristics of the study patients and of patients lost to follow-up

	Hip		Knee	
	Study population <i>n</i> = 140	LTFU <i>n</i> = 63	Study population <i>n</i> = 128	LTFU <i>n</i> = 53
<b>Age, years</b>	67.9 ± 9.6	66.5 ± 13.6	66.2 ± 9.7	66.2 ± 9.5
<b>Gender, women <i>n</i>, (%)</b>	89 (63.6)	33 (52.4)	72 (56.3)	40 (75.5)*
<b>Education</b>				
Less than high school, <i>n</i> (%)	40 (28.8)	16 (25.8)	35 (27.6)	19 (35.8)
<b>Time on waiting list at baseline measurement, weeks</b>	9.1 ± 12.6	13.6 ± 17.5*	14.6 ± 16.6	18.6 ± 18.3
<b>Total time spent on waiting list, weeks</b>	22.7 ± 20.6	29.6 ± 23.5*	31.0 ± 22.9	34.1 ± 27.3
<b>HOOS/KOOS, score 0–100; 100 best score</b>				
Pain	32.7 ± 17.7	36.0 ± 20.6	35.9 ± 17.2	35.8 ± 21.0
Symptoms	50.5 ± 10.8	47.2 ± 11.8*	43.3 ± 20.5	41.1 ± 20.5
ADL	29.9 ± 17.8	33.4 ± 21.9	37.8 ± 19.7	35.7 ± 21.4
Sport	14.3 ± 17.8	19.4 ± 27.0	8.8 ± 17.5	13.4 ± 24.0
QOL	21.4 ± 16.7	20.0 ± 19.2	17.7 ± 14.9	20.9 ± 17.2
<b>History of depressive disorders, <i>n</i> (%)</b>	26 (18.6)	12 (21.1)	24 (18.8)	6 (13.6)
<b>Familial depression, <i>n</i> (%)</b>	32 (22.9)	3 (5.3)*	14 (10.9)	4 (9.1)
<b>HADS depressive symptoms</b>				
≥8, <i>n</i> (%)	37 (26.4)	23 (36.5)	26 (20.3)	13 (24.5)
Use of antidepressants, <i>n</i> (%)	15 (10.8)	3 (5.4)	7 (5.5)	4 (8.5)
Treatment, <i>n</i> (%)†	2 (1.5)	1 (1.9)	2 (1.7)	0
Total, <i>n</i> (%)‡	47 (33.6)	23 (36.5)	29 (22.7)	14 (26.4)
<b>HADS anxiety symptoms</b>				
≥8, <i>n</i> (%)	31 (22.1)	11 (17.5)	23 (18.0)	9 (17.0)
Use of antidepressants, <i>n</i> (%)	15 (10.8)	3 (5.4)	7 (5.5)	4 (8.5)
Treatment, <i>n</i> (%)†	2 (1.5)	1 (1.9)	2 (1.7)	0
Total, <i>n</i> (%)‡	39 (27.9)	12 (19.0)	26 (20.3)	10 (18.9)

Values are presented as mean ± standard deviation, unless otherwise indicated.

Abbreviations: LTFU, lost to follow-up.

\* *P* < 0.05, variables were inserted in the multivariable model to test for unbalanced characteristics.

† Patients under treatment of a psychologist or psychiatrist.

‡ HADS score ≥8 or use of antidepressants or treatment by a psychologist or psychiatrist.

patients with anxiety symptoms 12 months postoperatively was not significant lower than preoperative. Between 3 and 12 months postoperatively the HADS anxiety and depression scores (mean and prevalence) did not change significant for both hip and knee patients (Table II). The effect size of THA and TKA on anxiety symptoms was 0.31 and 0.28. The effect size of THA and TKA on depressive symptoms was 0.48 and 0.32.

#### Influence on PROs

In hip patients, preoperative anxiety and depressive symptoms both predicted lower change scores on the HOOS subscales pain, ADL, and QOL. Anxiety symptoms predicted also a lower change score on the HOOS subscale sport. These relationships were

independent of age, gender, preoperative score on the HOOS subscale, and the unbalanced characteristics time on waiting list and familial depression (Table III). Tested in the same way, in knee patients preoperative anxiety symptoms predicted lower changes scores of the ADL, sport and QOL subscales of the KOOS questionnaire at 12 months postoperative. Depressive symptoms predicted a lower change score on the KOOS subscales pain, ADL and QOL. These relationships were independent for age, gender and the preoperative score on the KOOS subscale (Table IV).

#### Influence on patient satisfaction

Hip patients with preoperative anxiety symptoms were less satisfied 12 months postoperatively, compared to patients without

**Table II**  
Preoperative and 3- and 12-month postoperative prevalence of anxiety and depressive symptoms of the patients who completed all measurements for hip and knee

	Hip ( <i>n</i> = 140)			Knee ( <i>n</i> = 128)		
	Preoperative	3 months postoperative	12 months postoperative	Preoperative	3 months postoperative	12 months postoperative
<b>HADS anxiety symptoms</b>						
Score, mean ± SD	4.6 ± 4.2	3.1 ± 3.5†	3.3 ± 3.3†	4.2 ± 3.6	3.1 ± 3.5†	3.2 ± 3.6*
≥8, <i>n</i> (%)	31 (22.1)	14 (10.9)†	13 (9.4)*	23 (18.0)	14 (10.9)*	17 (13.3)
Antidepressants, <i>n</i> (%)	15 (10.8)	6 (4.7)	3 (2.1)†	7 (5.5)	6 (4.7)	2 (1.6)
Treatment†, <i>n</i> (%)	2 (1.5)	2 (1.6)	1 (0.7)	2 (1.7)	2 (1.6)	0
Total, <i>n</i> (%)	39 (27.9)	18 (14.1)†	15 (10.8)†	26 (20.3)	18 (14.1)*	19 (14.8)
<b>HADS depressive symptoms</b>						
Score, mean ± SD	5.1 ± 4.0	3.3 ± 3.3†	3.2 ± 3.3†	4.3 ± 3.8	3.4 ± 3.4†	3.1 ± 3.4†
≥8, <i>n</i> (%)	37 (26.4)	11 (7.1)†	14 (10.0)†	26 (20.3)	18 (14.1)*	14 (10.9)*
Antidepressants, <i>n</i> (%)	15 (10.8)	10 (7.1)	3 (2.1)†	7 (5.5)	6 (4.7)	2 (1.6)
Treatment†, <i>n</i> (%)	2 (1.5)	3 (2.1)	1 (0.7)	2 (1.7)	2 (1.6)	0
Total, <i>n</i> (%)	47 (33.6)	18 (12.9)†	17 (12.1)†	29 (22.7)	21 (16.4)*	15 (11.7)*

Values are presented as mean ± standard deviation, unless otherwise indicated. Significant *P*-values are presented in bold.

Abbreviations: SD, standard deviation.

\* Significant difference with preoperative score *P* < 0.05.

† Significant difference with preoperative score *P* < 0.0001.

‡ Patients under treatment of a psychologist or psychiatrist or using antidepressants.

**Table III**  
Relationship between baseline anxiety or depressive symptoms and changes in HOOS for hip OA patients

Hip	Anxiety symptoms				Depressive symptoms							
	HADS		HADS		Adjusted relationship*		HADS		HADS		Adjusted relationship*	
	<8	≥8	<8	≥8			<8	≥8	<8	≥8		
	n = 115	n = 38	n = 115	n = 38	n = 103	n = 50	n = 103	n = 50				
HOOS	12 months postoperative score		Change in score at 12 months vs preoperative		Beta	95% CI	12 months postoperative score		Change in score at 12 months vs preoperative		Beta	95% CI
Pain	84.5 ± 18.9	74.9 ± 25.7	50.5 ± 22.8	44.8 ± 28.4	+	-7.6 (-13.1; -2.1)	85.5 ± 18.3	75.3 ± 24.8	50.3 ± 22.3	46.6 ± 28.2	+	-9.1 (-14.1; 4.0)
Symptoms	57.1 ± 11.5	55.4 ± 12.6	6.6 ± 14.9	8.3 ± 15.1	-	-4.5 (-9.8; 0.7)	57.1 ± 11.7	55.7 ± 12.0	5.5 ± 14.7	10.1 ± 15.0	+	-6.2 (-10.9; -1.4)
ADL	77.7 ± 20.2	67.0 ± 25.0	46.6 ± 22.8	37.8 ± 27.9	+	-9.5 (-15.1; -4.0)	78.7 ± 19.9	67.7 ± 24.1	46.4 ± 23.0	40.4 ± 26.7	+	-10.2 (-15.3; -5.1)
Sport	59.7 ± 28.8	51.2 ± 27.3	43.8 ± 29.1	37.3 ± 28.6	+	-9.1 (-17.7; -0.4)	60.7 ± 28.0	51.4 ± 29.0	43.8 ± 28.1	39.1 ± 30.9	-	-4.7 (-12.5; 3.2)
QOL	70.0 ± 23.8	56.6 ± 25.7	48.2 ± 26.3	37.0 ± 25.8	+	-11.2 (-18.1; -4.3)	70.4 ± 23.7	58.8 ± 25.8	46.8 ± 26.1	42.5 ± 27.3	+	-9.0 (-15.4; -2.6)

Values are presented as mean ± standard deviation.

+ Significant independent relationship between baseline anxiety or depressive symptoms and change in outcome.

- No significant independent relationship.

\* Relationship between preoperative anxiety or depressive symptoms and change in scores of the HOOS subscales, adjusted for age, gender and preoperative score of the HOOS subscale and unbalanced characteristics (waiting time, HOOS symptoms score and familial depression) between study population and patients lost to follow-up.

anxiety symptoms, about pain reduction, overall result, improvement of ADL and QOL. Hip patients with depressive symptoms were less satisfied about improvement of QOL.

Knee patients with preoperative depressive or anxiety symptoms were both less satisfied about the improvement in QOL (Table V).

## Discussion

We found in this study a high prevalence of anxiety and depressive symptoms in a population with end-stage hip and knee OA. After surgery a significant decrease of the prevalence of anxiety and depressive symptoms for both hip and knee patients was seen. In hip as well as knee patients, preoperative depressive symptoms predicted a lower PRO after surgery. Hip and knee patients with preoperative anxiety or depressive symptoms were less satisfied postoperatively.

We hypothesized that, because of the close relationship between psychological symptoms and pain and disability, the prevalence of psychological symptoms would be high in end-stage hip and knee OA patients. Preoperatively, we found a higher prevalence of depressive symptoms in hip than in knee OA patients. This might be a result of the difference in ability to perform their ADL preoperatively. But to confirm this hypothesis, more research needs to be done.

Compared to other chronic diseases the prevalence of depressive symptoms in hip OA patients was relatively high (33.6% compared to

16–24% in patients with coronary heart disease, diabetes or breast cancer)<sup>27–29</sup>. The prevalence of anxiety symptoms was relatively low in our population compared to other chronic diseases<sup>27–29</sup>. However, it should be mentioned that prevalence of depressive and anxiety symptoms is dependent of age, gender, and disability.

The HADS has been used in previous studies screening OA populations, but these studies screened heterogeneous populations existing of patients with hip, knee, ankle or CMC-1 OA<sup>30,31</sup>. This is the first study screening homogeneous hip and knee OA populations separately. That means our data are unique, and therefore it was not possible to compare our results to a completely similar population. In a general Dutch population of similar age mean HADS anxiety and depression scores of 3.9 ± 3.6 and 4.6 ± 3.6, respectively, were reported<sup>22</sup>.

So, it appears that the prevalence of depressive symptoms is relatively high in our population and the prevalence of anxiety symptoms is somewhat lower.

The results of the study also confirm our second hypothesis that, when pain and disability decreases after THA or TKA, the prevalence of psychological symptoms also decreases. The decrease was larger in hip than in knee patients. At 12 months postoperative no further decrease was seen in the prevalence of anxiety and depressive symptoms compared to 3 months postoperative. So it seems that there is a significant improvement in these factors that is maintained until at least 12 months. In a systematic review we evaluated the influence of psychological symptoms on the outcome of THA or

**Table IV**  
Relationship between baseline anxiety and depressive symptoms and changes in KOOS for knee OA patients

Knee	Anxiety symptoms				Depressive symptoms							
	HADS		HADS		Adjusted relationship*		HADS		HADS		Adjusted relationship*	
	<8	≥8	<8	≥8			<8	≥8	<8	≥8		
	n = 114	n = 27	n = 114	n = 27	n = 109	n = 32	n = 109	n = 32				
KOOS	12 months postoperative score		Change in score at 12 months vs preoperative		Beta	95% CI	12 months postoperative score		Change in score at 12 months vs preoperative		Beta	95% CI
Pain	84.2 ± 17.5	75.0 ± 20.3	47.7 ± 21.5	47.4 ± 23.4	-	-6.8 (-14.4; 0.8)	85.0 ± 16.1	73.4 ± 22.7	48.3 ± 20.2	45.5 ± 26.8	+	-10.0 (-17.1; -3.0)
Symptoms	79.2 ± 17.0	72.0 ± 18.9	35.2 ± 21.8	38.0 ± 19.4	-	-4.6 (-11.5; 2.4)	79.9 ± 16.3	71.1 ± 20.1	35.7 ± 21.7	35.6 ± 20.1	-	-6.4 (-12.9; 0.1)
ADL	81.0 ± 18.6	71.4 ± 16.2	42.8 ± 23.6	40.0 ± 20.2	+	-8.3 (-16.0; -0.6)	81.8 ± 17.0	70.6 ± 20.7	42.9 ± 23.0	40.1 ± 23.0	+	-9.7 (-16.8; -2.6)
Sport	45.8 ± 31.1	32.6 ± 27.4	37.6 ± 34.2	22.2 ± 28.3	+	-14.1 (-27.6; -0.6)	44.1 ± 30.8	41.1 ± 31.2	36.0 ± 34.2	30.6 ± 31.8	-	-3.5 (-16.1; 9.1)
QOL	69.2 ± 23.5	57.2 ± 25.0	50.1 ± 27.1	47.0 ± 24.7	+	-11.2 (-21.5; -0.8)	69.4 ± 23.3	58.4 ± 25.4	50.4 ± 27.1	46.7 ± 25.0	+	-10.1 (-19.8; -0.4)

Values are presented as mean ± standard deviation.

+ Significant independent relationship between baseline anxiety or depressive symptoms and change in outcome.

- No significant independent relationship.

\* Relationship between preoperative anxiety or depressive symptoms and change in scores of the KOOS subscales, adjusted for age, gender and preoperative score of the KOOS subscale and unbalanced characteristics (gender) between study population and patients lost to follow-up.

**Table V**  
Relationship between baseline anxiety and depressive symptoms and patient satisfaction 12 months postoperative

HADS-anxiety	Hip		Knee					
	<8 (n = 117)	≥8 (n = 41)	Adjusted relationship*		<8 (n = 115)	≥8 (n = 26)	Adjusted relationship*	
			Adjusted OR	95% CI			Adjusted OR	95% CI
Satisfied†								
Overall, n (%)	101 (86)	27 (66)	+	0.24 (0.10; 0.62)	96 (83)	20 (77)	–	0.64 (0.23; 1.83)
Pain reduction, n (%)	105 (90)	29 (71)	+	0.30 (0.11; 0.81)	101 (88)	20 (77)	–	0.46 (0.15; 1.37)
Improvement in ADL, n (%)	96 (82)	24 (59)	+	0.32 (0.13; 0.76)	98 (85)	19 (73)	–	0.47 (0.96; 1.06)
Improvement in QOL, n (%)	103 (88)	28 (68)	+	0.22 (0.08; 0.59)	103 (90)	17 (65)	+	0.20 (0.07; 0.57)
HADS-depression	<8 (n = 104)	≥8 (n = 54)	Adjusted relationship*		<8 (n = 115)	≥8 (n = 26)	Adjusted relationship*	
Satisfied†								
Overall, n (%)	89 (86)	39 (72)	–	0.44 (0.18; 1.05)	92 (80)	24 (92)	–	0.65 (0.24; 1.76)
Pain reduction, n (%)	93 (89)	41 (76)	–	0.38 (0.14; 1.01)	96 (83)	25 (96)	–	0.56 (0.90; 1.00)
Improvement in ADL, n (%)	84 (81)	36 (67)	–	0.58 (0.26; 1.31)	94 (79)	23 (88)	–	0.50 (0.19; 1.34)
Improvement in QOL, n (%)	91 (88)	40 (74)	+	0.37 (0.14; 0.96)	97 (84)	23 (88)	+	0.35 (0.13; 0.98)

+ Significant independent relationship between baseline anxiety or depressive symptoms and change in outcome.

– No significant independent relationship.

Abbreviations: HADS; Hospital Anxiety and Depression Scale.

(All patients who completed baseline and the 12-month measurement were included in this analysis).

\* Relationship between preoperative anxiety or depressive symptoms and patient satisfaction, adjusted for age, gender, and unbalanced characteristics (waiting time, HOOS symptoms score and familial depression) between the study population and patients lost to follow-up.

† Satisfaction was scored on a 5-point Likert scale. Values were dichotomised: very unsatisfied, unsatisfied and moderately satisfied were classified as unsatisfied; and satisfied and very satisfied were classified as satisfied.

TKA. We found that global preoperative mental health and pain catastrophizing do influence the outcome after THA or TKA<sup>17</sup>. Less convincing evidence was found for the influence of anxiety or depressive symptoms on outcome. Our systematic review did not elucidate whether the influence of psychological symptoms differed between knee and hip patients. However, results of the present study suggest that the influence of anxiety or depressive symptoms on PRO does differ after THA and TKA. For hip patients, preoperative anxiety symptoms have more influence on these outcomes, whereas for knee patients preoperative depressive symptoms have more influence on outcome 12 months post-surgery.

The identification of individuals at risk for poor post-surgical outcome may be important for optimizing the results after THA and TKA. Treating patients with anxiety disorders or depression with psychotherapy before surgery may possibly lead to better results after THA or TKA. Additional studies are required to explore these hypotheses.

Some limitations of this study need to be addressed. First, the percentage patients lost to follow-up was relatively high (30%). The hip patients differed on the time spent on the waiting list (shorter) and the prevalence of familial depression (higher) of those lost to follow-up. The knee OA patients were less often female. However, the prevalence of anxiety and depressive symptoms was similar of the study patients and those lost to follow-up. So we assume that selection bias did not affect our results and conclusions.

Second, we did not assess the number of needed patients before the start of our study. When we started our study no data of adequate studies were available to base our calculation on, and consequently our sample size calculation would be based on assumptions. After data collection we performed a power calculation. We have used the pain, ADL and QOL subscales of the HOOS and KOOS score after 12 months to assess the power of the different comparisons. The range of the power to determine a significant difference was 0.80–0.98 for the different subscales.

Third, preoperative measurements were not taken at a fixed time point. The length of time patients were on the waiting list for surgery varied. The present study does not allow to conclude whether the prevalence of anxiety or depressive symptoms changes during the waiting period. Furthermore, we did not adjust

our analysis for co-morbidities. As shown in a recent study of Hawker *et al.* is co-morbidity an important predictor for TJA outcome<sup>32</sup>. The current design of the study was approved by the local Medical Ethics Committee. Because the data was collected by questionnaires signed informed consent was not required. Consequently we had no permission to use data of medical records of the patients. Hence we had no data of co-morbidity of patients. This could have influenced our results.

Finally, having anxiety or depressive symptoms is not the same as having an anxiety disorder or depression. The HADS questionnaire is a tool for screening on anxiety or depressive symptoms. Having an anxiety disorder or depression has to be diagnosed by a specialist. Therefore, we assume that the prevalence of anxiety or depressive symptoms is an overestimation of the actual prevalence of anxiety disorders or depression.

In conclusion, the results of the present study show a high prevalence of depressive symptoms in patients with end-stage hip and knee OA compared to other chronic diseases. The prevalence of depressive symptoms was higher in hip than in knee patients and the influence of anxiety or depressive symptoms on the post-operative outcome differed after THA and TKA. At 12 months post-surgery, the prevalence of anxiety or depressive symptoms was significantly decreased in both hip and knee patients. However, patients with preoperative anxiety or depressive symptoms had worse outcomes 12 months after THA and TKA than patients without these symptoms. The findings of our study should be confirmed in other populations with end-stage knee or hip OA indicated for a total joint replacement.

#### Author contributions

T Duivenvoorden designed the study, acquired data, performed data-analysis and critically revised the manuscript, MM Vissers designed the study, acquired data, performed data-analysis and wrote the manuscript, JJV Busschbach shared his expertise on the field of PROs and critically reviewed the manuscript, JAN Verhaar designed the study and critically reviewed the manuscript, T Gosens and RM Bloem coordinated the study in their centre and critically reviewed the manuscript, SMA Bierma-Zeinstra shared

her expertise on the field of OA and critically reviewed the manuscript, M Reijman designed the study and critically revised the manuscript.

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### Conflict of interest

The authors report no conflict of interest.

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