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Do symptoms of anxiety and/or depression and pain intensity before primary Total knee arthroplasty influence reason for revision? Results of an observational study from the Dutch arthroplasty register in 56,233 patients

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ABSTRACT

Objective: Anxiety, depression and greater pain intensity before total knee arthroplasty (TKA) may increase the probability of revision surgery for remaining symptoms even without clear pathology or technical issues. We aimed to assess whether preoperative anxiety/depression and pain intensity are associated with revision TKA for less clear indications.

Methods: Less clear indications for revision were defined after a Delphi process in which consensus was reached among 59 orthopaedic knee experts. We performed a cox regression analyses on primary TKA patients registered in the Dutch Arthroplasty Registry (LROI) who completed the EuroQol 5D 3 L (EQ5D-3 L) anxiety/depression score to examine associations between preoperative anxiety/depression and pain (Numeric Rating Scale (NRS)) with TKA revision for less clear reasons. These analyses were adjusted for age, BMI, sex, smoking, ASA score, EQ5D-3 L thermometer and OKS score.

Results: In total, 25.9% patients of the 56,233 included patients reported moderate or severe symptoms of anxiety/depression on the EQ5D-3 L anxiety/depression score. Of those, 615 revisions (45.5%) were performed for less clear reasons for revision (patellar pain, malalignment, instability, progression of osteoarthritis or arthrofibrosis). Not EQ5D-3 L anxiety/depression score, but higher NRS pain at rest and EQ5D-3 L pain score were associated with revision for less clear reason (HR: 1.058, 95% CI 1.019–1.099 & HR: 1.241, 95% CI 1.044–1.476, respectively).

Conclusion: Our findings suggest that pain intensity is a risk factor for TKA revision for a less clear reason. The finding that preoperative pain intensity was associated with reason for revision confirms a likely influence of subjective, personal factors on offer and acceptance of TKA revision. The association between anxiety/depression and reason for revision after TKA may also be found when including more specific outcome measures to assess anxiety/depression and we therefore hope to encourage further research on this topic with our study, ideally in a prospective setting.

Study design: Longitudinal Cohort Study Level III, Delphi Consensus

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1. Introduction

Knee arthroplasty can decrease pain and improve function in people with advanced osteoarthritis of the knee [1,2]. Primary knee arthroplasty is defined as the first implantation of a prosthesis in the knee. It is a common surgical procedure of which the number of procedures continues to rise; 1.27 million primary total knee arthroplasties (TKAs) are predicted to be performed in the United States in 2025 [3]. Comparably high numbers of over 25,000 primary knee arthroplasties are performed in the Netherlands each year, a country with a population of over 17.5 million [4,5].

It is recognized that 1 in 5 patients rate themselves dissatisfied after knee arthroplasty (the so-called unhappy knee) [6,7]. In some of these dissatisfied patients, revision surgery may be considered. Revision surgery is defined as any exchange (placement, replacement, or removal) or addition of 1 or more components of the prosthesis (e.g. patella resurfacing) [8]. Approximately 12% of knee arthroplasties are revised within 10 years [9]. The clinical burden of revision surgery is enormous as it is technically challenging with lower success rates than primary arthroplasty. To minimize the risk for revision surgery, understanding relevant risk factors associated with worse outcome after knee arthroplasty is paramount [10].

Some patients undergo revision surgery after TKA based on clear reasons such as a periprosthetic fracture or patellar dislocation. However, others may receive revision surgery for less clear reasons such as a small technical issue, a perceived technical issue, or the idea that there is a low grade infection [11,12]. Currently, there is no consensus on which indications are clear or less clear reasons. In this study, we will first characterize reasons for revision surgery in categories clear indication and less clear indication by carrying out a Delphi consensus approach among experienced knee and arthroplasty surgeons.

Risk stratification by identifying preoperative factors leading to revision surgery for less clear reasons may help inform orthopaedic surgeons and patients considering TKA. Preoperative symptoms of anxiety or depression are associated with worse patient-reported outcome measures following TKA [13–16]. Also, worse postoperative pain and function outcome scores are seen in patients with greater preoperative pain and worse preoperative function [17], knowing that symptoms of anxiety and depression are correlated with pain intensity [18–22]. Therefore, higher levels of preoperative symptoms of anxiety and/or depression in combination with greater preoperative pain intensity may lead to worse postoperative outcome and dissatisfaction after TKA without pathology or technical issues, resulting in revision surgery without a clear indication.

Our aim is to assess the influence of preoperative symptoms of anxiety and/or depression and pain intensity before primary TKA on subsequent revision surgery for less clear indications.

2. Methods

2.1. Data source

We queried the Dutch Arthroplasty Register (LROI) [4], a national registry covering all Dutch hospitals performing arthroplasties, between 2014 and 2019. The overall data completeness for all primary knee arthroplasties was 96% in 2014, up to 99% in 2019 [4]. Data completeness for registering revision TKAs was 93% in 2014, up to 97% in 2019 [4].

2.2. Population

Of 144,682 primary TKA patients between 2014 and 2019, 56,233 (39% response rate) filled out the preoperative EuroQol 5D-3 L (EQ5D-3 L) anxiety/depression score and were eligible for analysis (Supplement I). We extracted baseline demographics from the LROI database (Table 1) including the American Society of Anaesthesiologists (ASA) score and the Charnley score, which classifies the degree of osteoarthritis involvement (single knee (A), bilateral knees (B1), knee prosthesis on contralateral knee (B2) or more than one joint involved or chronic disease influencing qualitity of life (C)) [23]. In addition to the questionnaires assessing pain, we also included four other patient reported outcome measures (PROMs). The preoperative Knee injury and Osteoarthritis Outcome Score – Physical Function Short Form (KOOS-PS) is converted from 0 to 100, with lower scores representing higher levels of functional status [24]. The preoperative Oxford Knee Score (OKS) ranges from 0 (worst outcome) to 48 (best outcome) [25]. Health state was calculated with scores of the EQ5D-3 L questionnaire, resulting in EQ5D index (0–1), and the EQ5D thermometer (0−100), with higher scores representing better experience of state of health [26].

2.3. Assessment of symptoms of anxiety and depression

Symptoms of anxiety and/or depression were assessed with the anxiety/depression question of the EQ5D-3 L questionnaire [26]. The EQ5D has been shown to be a well validated questionnaire for patients undergoing TKA to evaluate health related quality of life [27]. Patients reported if they perceived symptoms of anxiety and/or depression: no symptoms (1), moderate symptoms (2), severe symptoms (3). According to the user guide of the EQ5D-3 L questionnaire, which recommends to dichotomize the EQ5D-3 L when it is more convenient to dichotomize levels into “no symptoms” (level 1) and “any symptoms” (level 2 and 3), we classified patients with an EQ5D-3 L anxiety/depression score of 1 as “patients without symptoms of anxiety or depression” and as “patients with symptoms of anxiety and/or depression” with an EQ5D-3 L anxiety/depression score ≥ 2.

2.4. Pain assessment

Preoperative pain at rest and during activity was measured using the numeric rating scale (NRS), an 11-point numeric scale rating pain from “0” (no pain) to “10” (worst pain) [28]. As a sensitivity analyses, the 3-point Likert scale EQ5D-3 L pain score was used to measure preoperative pain of patients undergoing knee arthroplasty [no (1)/moderate (2) or severe (3) pain/discomfort] [26].

2.5. Outcome measures

Our primary outcome measure was revision surgery for less clear reason after knee arthroplasty (yes/no on the date of closure of the dataset (December 31, 2019)). Time of survival was defined as time between the primary TKA and date of revision (years) or end to follow up. Patients with a negative survival time (less than zero, due to wrong registration of either the operation date of the primary surgery or the date of the revision procedure) were excluded from our analyses as survival time was not expected to be missing at random and could therefore not be imputed.

Revisions (change, addition or removal of one of the prosthesis components [4]) after TKA were registered by the LROI. In case of revision surgery, we obtained the reason for revision surgery from the LROI database. We classified a reason for revision according to the results of a Delphi consensus process. In short, 59 experienced knee and arthroplasty surgeons categorized reasons for revision in categories clear reason for revision and less clear reason for revision. A more detailed description of our Delphi consensus process can be found in the addendum of this article.

If one or more clear reasons for revisions were indicated, the reason for revision was defined as clear (even if also less clear reasons were indicated for the same revision). If only less clear reasons were indicated, the revision was classified as less clear reason. Revisions which were performed for only “other” reasons or reason for revision missing were classified in separated groups.

Table 1
Baseline characteristics of study population, n = 56,233.

	EQ5D-3 L anxiety/ depression score = 1 n = 41,660	EQ5D-3 L anxiety/ depression score ≥ 2 n = 14,573	p value	SMD
Age (years) mean (SD)	68.83 (8.61)	68.81 (9.18)	0.773	0.002
Female gender (%)	24,835 (59.6)	10,560 (72.4)	**0.000**	
Smoking (%)	3111 (7.5)	1398 (9.6)	**0.000**	
Body Mass Index mean (SD)	29.51 (4.82)	30.29 (5.67)	**0.000**	**0.154**
Side of surgery			0.307	
Left (%)	19,841 (47.6)	7704 (52.9)		
Right (%)	21,819 (52.4)	6869 (47.1)		
ASA score			**0.000**	
I (%)	5618 (13.5)	1244 (8.5)		
II (%)	28,007 (67.2)	9512 (65.3)		
III-IV (%)	8035 (19.3)	3817 (26.2)		
Charnley score			**0.000**	
A (%)	16,996 (40.8)	6024 (41.3)		
B1 (%)	14,065 (33.8)	5345 (36.7)		
B2 (%)	9171 (22.0)	2638 (18.1)		
C (%)	1428 (3.4)	566 (3.9)		
Previous surgery on affected knee				
None (%)	28,626 (68.7)	10,738 (73.7)	**0.000**	
Meniscectomy (%)	9859 (23.7)	2808 (19.3)	**0.000**	
Osteotomy (%)	1416 (3.4)	376 (2.6)	**0.000**	
ACL repair (%)	672 (1.6)	163 (1.1)	**0.000**	
Open reduction internal fixation (%)	415 (1.0)	128 (0.9)	0.371	
Synovectomy (%)	347 (0.8)	90 (0.6)	**0.025**	
Arthroscopy (%)	7309 (17.5)	2110 (14.5)	**0.000**	
Patella realignment procedure (%)	218 (0.5)	60 (0.4)	0.278	
Other (%)	990 (2.4)	277 (1.9)	**0.005**	
Approach			0.054	
Medial parapatellar (%)	40,448 (97.1)	14,128 (96.9)		
Lateral parapatellar (%)	234 (0.6)	107 (0.7)		
Vastus (mid/sub) (%)	958 (2.3)	327 (2.2)		
Other (%)	20 (0.1)	11 (0.1)		
Type of femoral component			0.145	
Posterior stabilized (%)	23,574 (56.6)	5930 (40.1)		
Cruciate retaining (%)	16,755 (40.2)	418 (2.9)		
Other (%)	1331 (3.2)	8225 (56.4)		
Fixation			0.056	
Uncemented	1746 (4.2)	657 (4.5)		
Cemented	38,493 (92.4)	13,495 (92.6)		
Hybrid (only femoral, tibial and/or patellar component cemented)	1421 (3.4)	421 (2.9)		
Patellar component			0.705	
Yes (%)	8793 (21.1)	3054 (21.0)		
NRS pain rest (SD)	5.02 (2.57)	5.71 (2.56)	**0.000**	**0.269**
NRS pain activity (SD)	7.11 (2.06)	7.70 (1.87)	**0.000**	**0.293**
EQ5D thermometer (SD)	71.08 (18.05)	59.34 (18.68)	**0.000**	**0.226**
EQ5D pain (SD)	2.10 (0.53)	2.35 (0.54)	**0.000**	**0.469**
EQ5D index (SD)	0.625 (0.14)	0.406 (0.17)	**0.000**	**1.476**
KOOS-PS baseline (SD)	49.78 (14.67)	57.11 (16.13)	**0.000**	**0.487**
OKS baseline (SD)	24.19 (7.33)	19.28 (7.35)	**0.000**	**0.683**

EQ5D-3 L = EuroQol 5D-3 L questionnaire; n = number; SMD = standardized mean difference; SD = standard deviation; % = percentage; ASA = American Society of Anaesthesiologists; ACL = anterior cruciate ligament; NRS = numeric rating scale; KOOS = Knee injury and Osteoarthritis Outcome Score, physical score subscale; OKS = Oxford Knee Score.
P < 0.05 was considered significant.

2.6. Statistical analysis

We presented variables with frequencies and percentages for dichotomous and categorical variables and as mean with standard deviation (SD) for normally distributed continuous variables. We compared patients with an EQ5D-3 L anxiety/depression score of 1 to patients with an EQ5D-3 L score of ≥2 by the Chi-squared test for ordinal data and a student *t*-test for normally distributed continuous variables. The standardized mean difference (SMD) with a cut-off of 0.1 was calculated to assess clinical relevance of differences in continuous variables between groups at baseline [29].

We assessed the representativeness of our study population by comparing the baseline characteristics of patients who were included in the study with those of the patients who did not fill out the EQ5D-3 L anxiety/depression question at baseline by using a Chi-squared test for ordinal data or a student t-test for normally distributed continuous variables (Supplement II (presented without p values as lower p values are expected with such large sample sizes even if there is no clinical significant difference)). To address partial or missing responses, multiple data imputation was performed using the missing values add-on of SPSS for baseline characteristics and questionnaires to impute variables with <30% missing data which were missing completely at random [30]. Rates of missingness were as followed: age 0.0%, gender 0.0%, smoking 0.0%, BMI 0.2%, ASA classification 0.0%, Charnley classification 0.6%, approach 0.0%, type of femoral component 3.5%, type of fixation 0.0%, patellar component 0.0%, NRS pain rest 5.5%, NRS pain activity 5.6%, EQ5D thermometer 1.3%, EQ5D-3 L pain 0.2%, KOOS-PS 2.6% and OKS 13.7%.

A Kaplan-Meier survival curve was plotted for event-free survival on the event "revision", used by the log Rank (Mantel-Cox, 95% confidence interval (CI)) test to compare patients with and without symptoms of anxiety and/or depression (Supplement III). Censoring occurred at time of death or at time of closure of the dataset at December 2019. To determine the associations between preoperative symptoms of anxiety and/or depression or pain with revision surgery for less clear reasons after primary TKA we performed Cox regression analyses with adjustment for confounding variables (age, BMI, sex, smoking, ASA score, EQ5D-3 L thermometer and OKS score). Moreover, to assess whether the influence of preoperative pain on revision for less clear reason was modified by anxiety and/or depression we included an interaction term (pain * EQ5D-3 L anxiety/depression) to the regression models [31]. Finally, we performed all Cox regression models on only the complete case analyses as sensitivity analyses which we presented as supplements to our manuscript (Supplement IV-VIII).

2.7. Software

Data pre-processing and analysis were performed using SPSS version 21.0 (IBM Corp. Armonk, New York, USA). The Delphi consensus was carried out using Survey Monkey (Momentive Inc. San Mateo, California, USA, https://www.surveymonkey.com).

3. Results

Among the 56,233 patients included in our study, 41,660 (74.1%) patients reported no symptoms of anxiety/depression and 14,543 (25.7%) reported moderate or severe symptoms of anxiety/depression on the EQ5D-3 L anxiety/depression question preoperatively. Patients with symptoms of anxiety and/or depression were more often female, smoked more often, had a higher BMI, a higher ASA score, and lower rate of previous surgery on affected knee (Table 1). In addition, there was a clinical relevant difference for all PROMs in favour of patients without symptoms of anxiety or depression (SMD > 0.1) (Table 1).

Table 2
Preoperative EQ5D-3 L anxiety/depression score, revision risks and reason for revision after primary TKA, n = 56,233.

	Total	EQ5D-3 L anxiety/depression score = 1	EQ5D-3 L anxiety/depression score ≥ 2	p value	SMD
	n = 56,233	n = 41,660	n = 14,573		
State					
Revision, n (%)	1353 (2.4)	978 (2.3)	375 (2.6)	0.126	
Revision within one year after primary TKA, n (%)	558 (1.0)	403 (1.0)	155 (1.1)	0.308	
Duration until revision, years (SD)	2.05 (1.3)	2.05 (1.3)	2.06 (1.3)	0.383	0.008
Reason for revision in all revisions, n = 1353					
One or more clear reasons for revision (%)	642 (1.1)	469 (1.1)	173 (1.2)	0.549	
Only less clear reasons for revision (%)	615 (1.1)	440 (1.1)	175 (1.2)	0.148	
Only "other" reason for revision (%)	78 (0.1)	53 (0.1)	25 (0.2)	0.216	
Reason for revision missing (%)	18 (0.0)	16 (0.0)	2 (0.0)	0.153	

EQ5D-3 L = EuroQol 5D-3 L questionnaire; n = number; SMD = standardized mean difference; % = percentage; TKA = total knee arthroplasty; SD = standard deviation. Imputed dataset.

3.1. Less clear reasons for revision

Patellar pain, malalignment, instability, progression of osteoarthritis and arthrofibrosis were classified as less clear reason for revision according to the Delphi consensus process among the expert panel (see addendum).

3.2. Preoperative EQ5D-3 L anxiety/depression score and revision rate after primary TKA

In total, 1353 (2.4%) patients received revision surgery (duration till revision 0.00–6.00 years, median 2.76 years) and 615 patients (1.1% of the total group and 45.5% of the revision cases) were having only less clear reasons for revision (Table 2). The overall risk of revision was not lower for patients without symptoms of anxiety or depression (Table 2 and Supplement III).

Our Cox regression analysis did not represent an association between the EQ5D-3 L anxiety/depression score before primary TKA and revision for less clear reason (HR (hazard ratio) 0.968, 95% CI (confidence interval) 0.803–1.167 and HR 0.967, 95% CI 0.802–1.166), depending on adjusting for NRS pain at rest (Table 3a) or during activity (Table 3b), respectively.

3.3. Preoperative NRS pain score and EQ5D-3 L pain score associated with revision after primary TKA

A higher NRS pain at rest and EQ5D-3 L pain score before primary TKA were associated with a higher risk of revision for less clear reason (HR: 1.058, 95% CI 1.019–1.099 (Table 3a) & HR: 1.241, 95% CI 1.044–1.476 (Appendix), respectively). We found no association between preoperative NRS pain during activity and risk of revision for less clear reason (HR 1.024, 95% CI 0.976–1.074) (Table 3b). The interaction term (pain*EQ5D-3 L anxiety/depression) in the Cox regression models showed that patients with higher preoperative NRS pain at rest, NRS pain during activity or EQ5D-3 L pain score in combination with higher EQ5D-3 L anxiety/depression score did not receive more revisions for less clear reason, which means we did not observe effect modification by the EQ5D-3 L anxiety/depression score (Table 3a, Table 3b and Appendix).

Table 3a
Cox regression analyses – NRS pain at rest and EQ5D-3 L anxiety/depression score associated with less clear reason for revision.

	Metric	Hazard ratio, Exp (B)	95% CI	
			Lower	Upper
Model 1	$EQ5D_{a/d}$	1.131	0.949	1.347
Model 2	NRS_{rest}	1.100	1.064	1.137
Model 3	$EQ5D_{a/d}$	1.062	0.890	1.267
	NRS_{rest}	1.099	1.063	1.136
Model 4*	$EQ5D_{a/d}$	0.968	0.803	1.167
	NRS_{rest}	1.058	1.019	1.099
Model 5*	$EQ5D_{a/d}$	1.078	0.652	1.783
	NRS_{rest}	1.063	1.019	1.109
	$EQ5D_{a/d}$ x NRS_{rest}	0.982	0.909	1.062

CI: Confidence Interval; $EQ5D_{a/d}$: EQ5D-3 L anxiety/depression score; NRS_{rest}: NRS pain during rest;
Multivariate Cox regression models with imputed dataset.
Model 1: univariate regression on anxiety/depression; model 2: univariate regression on pain at rest; model 3: multivariate regression on anxiety/depression & pain; model 4: multivariable regression on anxiety/depression & pain adjusted for confounders*; model 5: multivariable regression on anxiety/depression & pain & interaction anxiety/depression and pain adjusted for confounding.
* Confounders: age, BMI, sex, smoking, ASA score, EQ5D thermometer (generic health) and OKS score.

Table 3b
Cox regression analyses - NRS pain during activity and EQ5D-3 L anxiety/depression score associated with less clear reason for revision.

	Metric	Hazard ratio, Exp (B)	95% CI	
			Lower	Upper
Model 1	$EQ5D_{a/d}$	1.131	0.949	1.347
Model 2	NRS_{act}	1.082	1.035	1.130
Model 3	$EQ5D_{a/d}$	1.086	0.91	1.296
	NRS_{act}	1.079	1.032	1.128
Model 4*	$EQ5D_{a/d}$	0.967	0.802	1.166
	NRS_{act}	1.024	0.976	1.074
Model 5*	$EQ5D_{a/d}$	1.311	0.574	2.994
	NRS_{act}	1.034	0.979	1.093
	$EQ5D_{a/d}$ x NRS_{act}	0.961	0.866	1.067

CI: Confidence Interval; $EQ5D_{a/d}$: EQ5D-3 L anxiety/depression score; NRS_{act}: NRS during activity;
Multivariate Cox regression models with imputed dataset.
Model 1: univariate regression on anxiety/depression; model 2: univariate regression on pain during activity; model 3: multivariate regression on anxiety/depression & pain; model 4: multivariable regression on anxiety/depression & pain adjusted for confounders*; model 5: multivariable regression on anxiety/depression & pain & interaction anxiety/depression and pain adjusted for confounding.
* Confounders: age, BMI, sex, smoking, ASA score, EQ5D thermometer (generic health) and OKS score.

4. Discussion

We investigated the association of preoperative symptoms of anxiety and/or depression and pain in patients undergoing primary TKA and the risk of revision surgery for less clear reason.

4.1. Findings

An important strength of our study is the large patient group of 56,233 patients due to the registration of the Dutch TKA's by the LROI. Therefore this is, to our knowledge, the largest study assessing the influence of symptoms of anxiety and/or depression and pain intensity in patients undergoing primary TKA and the risk for revision surgery. The prevalence of symptoms of anxiety/depression (25.6%) in our study group falls within the range of previous studies assessing patients undergoing TKA (10% to 58.6%) [32–34]. The findings of our baseline characteristics are in line with previous studies, in which is shown that gender [35], smoking [36] and BMI [37] are associated with symptoms of anxiety and/or depression. In addition, our study shows that patients with symptoms of anxiety and/or depression have a worse ASA score and lower rate of previous surgeries on the affected knee. As smaller *p* values are expected with larger samples sizes, we also calculated SMD's for continue variables. Except for age, all SMD's were calculated >0.1, which represented a clinical relevance of difference for all continue variables before surgery in disadvantage of patients with symptoms of anxiety and/or depression.

To our knowledge, this is the first study categorizing reasons for revision surgery following primary TKA into clear and less clear reasons for revision. Consensus was reached in a two-round Delphi survey, where some studies need a multi-round survey to reach a consensus. Our study shows that, despite the fact that revision arthroplasties are complex surgical procedures with worse clinical outcomes compared to primary TKA, a total of 45.5% of TKA revisions registered in the LROI were performed for less clear reasons, which has not yet been determined before. Although symptoms of anxiety and/or depression before TKA have been related to worse postoperative pain and function [13–16,18] and revision surgery [38,39], we did not find a difference in revision rate and reason for revision between patients with or without symptoms of anxiety or depression. However, the hazard ratio of NRS pain at rest and EQ5D-3 L pain score in our regression models demonstrated that preoperative pain seems to be associated with higher risk of TKA revision without clear indication. The determined association of preoperative symptoms of anxiety/depression and worse clinical outcome after TKA in previous studies, and knowing that symptoms of anxiety and depression are correlated with pain intensity [18–22], could mean that anxiety and/or depression would have been associated with higher risk of TKA revision without clear indication as well if more specific mental health measures could have been used.

4.2. Limitations

Our data were derived from the LROI and may therefore not be generalized to the international population. Second, survey studies may be subject to selection or non-response bias. Of the 144,682 primary case patients in the registry, 56,233 filled out the preoperative EQ5D-3 L anxiety/depression score (39% response rate). We carried out a comparative analysis for the baseline characteristics for patients who filled out the EQ5D-3 L anxiety/depression question with patients who did not, and we found no differences between the two cohorts (Supplement II). Third, in the Dutch arthroplasty register mental health is assessed using the EQ5D anxiety/depression score. Therefore, psychological distress could only be estimated using this one item of the EQ5D-3 L questionnaire in our study. However, the EQ5D-3 L anxiety/depression score has been shown to be an adequate measure to evaluate preoperative psychological distress compared to other questionnaires, for example in spine surgery [40]. We therefore decided to use the EQ5D-3 L anxiety/depression score as a measure for psychological distress in our study to potentially encourage further research (including more specific outcome measures for psychological distress) on this topic in the future. Only a small number of patients (1688 (3.0%)) reported severe symptoms on the EQ5D-3 L anxiety/depression question. Besides, we assume that it is less subjective for patients to distinguish between the presence or absence of any symptoms of anxiety and/or depression than to distinguish between moderate or severe symptoms of anxiety and/or depression. We therefore compared patients with an EQ5D-3 L anxiety/depression score of 1 to patients with an EQ5D-3 L anxiety/depression score of ≥ 2, which is also described in previous studies [41,42] and in the EQ5D-3 L user guide for studies in which dichotomizing is more convenient [26]. Fourth, severity of osteoarthritis seen on preoperative radiographs seems to play an important role in pain and function after TKA [17]. Therefore, our study could have been more reliable if we adjusted for radiographic osteoarthritis severity in our analyses. However, the LROI does not measure severity of osteoarthritis on preoperative radiographs. It might be preferable to adjust for severity of osteoarthritis on radiographics in future studies to improve the reliability of associations found in the analyses. Another potential limitation of our study could be the determination of the confounders (age, BMI, sex, smoking, ASA score, EQ5D-3 L thermometer and OKS score). We have not found previous studies that for example demonstrated a relation between history of prior knee surgery or details of the surgical procedure (such as use of cement or type of prosthesis) and anxiety/depression and we therefor did not adjust for these variables. However, there may still be residual confounding due to confounders of which we are not aware yet. Sixth, the lower data completeness of the LROI for patients undergoing revision TKA might have impacted the integrity and data quality of the revision surgery data points. Finally, in addition to the retrospective design, we can only speak of associations in our findings, but we are not able to speak of causal relationships [43].

We also acknowledge a few limitations of the Delphi consensus survey. We used a consensus threshold of 70% to define a reason for revision as clear based on previous Delphi studies [44,45]. However, the definition of consensus in terms of percentages in Delphi studies varies widely (range 50–95%) [46]. A lower or higher threshold for the definition of consensus would have led to a different outcome of our Delhi consensus. Second, reasons for revision filled out by orthopaedic surgeons on the LROI registration form might be subject to different interpretations. Third, all participants in the Delphi consensus were members from the Dutch Knee Society, and do not necessarily represent the opinion from other (international) experts.

5. Conclusions

We identified that pain intensity, but not anxiety/depression, before primary TKA may play an important role in revision surgery for remaining symptoms after TKA if there is no clear pathology or technical issue. The fact that pain intensity was associated with reason for revision in our study may suggest that mental health may relate to reasons for revision as well, as pain intensity and mental health seem to be highly associated. One possibility that we did not find this may be related to our limited measurement of anxiety and depression. This underscores the importance for future studies investigating symptoms of anxiety and depression with more specific mental health outcome measures, which may help to inform orthopaedic surgeons and patients considering primary or revision TKA about the patient-specific risk factors of revision surgery.

6. Addendum: Delphi consensus process

6.1. Methods

6.1.1. Reasons for revision

The LROI has categorized reasons for revision into fourteen subgroups (infection, patellar dislocation, patellar pain, insert wear, periprosthetic fracture, malalignment, instability, loosening [femoral/tibial/patellar component], progression of osteoarthritis, second stage revision after removal of knee arthroplasty, arthrofibrosis and other). After revision surgery, orthopaedic surgeons indicate one or more reasons for revision on the LROI knee revision form.

Table 4
Delphi consensus process.

Delphi Consensus Panel Members, n = 59				
A	Characteristics	n (%)		
	Working in the field of orthopaedics	59 (100)		
	Length of experience as a specialist			
	Resident	5 (8.5)		
	<5 years	15 (25.4)		
	5-10 years	15 (25.4)		
	10-20 years	15 (25.4)		
	>20 years	9 (15.3)		
	Performing Revision Surgery	49 (83.1)		
B	**Reason for Revisions**	**Responses, n**	**Clear n (%)**	**Less clear* n (%)**
	Infection	**59**	**57 (96.6)**	**2 (3.4)**
	Patellar dislocation	**59**	**46 (78.0)**	**13 (22.0)**
	Patellar pain	59	0 (0.0)	59 (100.0)
	Insert wear	**57**	**44 (77.2)**	**13 (22.8)**
	Periprosthetic fracture	**59**	**42 (71.2)**	**17 (28.8)**
	Malalignment	59	27 (45.8)	32 (54.2)
	Instability	59	31 (52.5)	28 (47.5)
	Loosening femur component	**58**	**54 (93.1)**	**4 (6.9)**
	Loosening tibia component	**59**	**56 (94.9)**	**3 (5.1)**
	Loosening patellar component	**59**	**48 (81.4)**	**11 (18.6)**
	Progression of osteoarthritis	59	38 (64.4)	21 (35.6)
	Second stage revision after removal PKA	**59**	**57 (96.6)**	**2 (3.4)**
	Arthrofibrosis	58	5 (8.6)	53 (91.4)

n = number; % = percentage; PKA = primary knee arthroplasty.
Bold = clear reason for revision.
* Less clear / Unexplained reasons.

6.1.2. Delphi consensus - expert panel

59 experienced knee and arthroplasty surgeons who are expert members of the Dutch Knee Society (77% has > 5 years of experience as specialist, 82% performs revision surgery) participated in the Delphi survey (Table 4A).

6.1.3. Delphi consensus - questionnaire

We carried out a web-administered Delphi survey, consisting a pilot (among the investigators from this study group) and two rounds (among the expert panel) (Supplement IX). After the first round, a copy of the results was sent out to each participant in round two with the opportunity to agree or comment further.

6.1.4. Delphi consensus – outcome agreement

We asked participants to categorize reasons for revision into the following categories: clear reason for revision and less clear reason for revision (Supplement IX). Based on the degree of agreement in previous reported Delphi studies [44,45], we defined a reason for revision as clear if >70% of the experts categorized a reason for revision as clear. Otherwise, the reason was categorized as less clear.

7. Results

The Delphi method resulted in the following categorization for less clear reasons for revision: patellar pain, malalignment, instability, progression of osteoarthritis and arthrofibrosis (Table 4B). After returning a copy of the results of the first round to the 59 participants of the expert panel, who had the opportunity to comment on these results, no changes had to be made regarding the classification of the reasons for revision.

Data availability

The data that has been used is confidential.

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Author contributions statement

Juliette C. Sorel: Conceptualization, Data curation, Formal analysis, Investigation, Methology, Software, Validation, Visualization, Writing - original draft. Jacobien H. F. Oosterhoff: Conceptualization, investigation, Methology, Conceptualization, Writing - original draft. Birit F. P. Broekman: Conceptualization, Supervision, Writing - review. Ruurd L. Jaarsma: Supervision, Writing - review. Job N. Doornberg: Conceptualization, Supervision, Writing - review. Frank F. A. IJpma: Supervision, Writing - review. Paul C. Jutte: Supervision, Writing - review. Anneke Spekenbrink-Spooren: Data curation, Writing - review. Maaike G.J. Gademan: Conceptualization, Formal analysis, Investigation, Methology, Supervision, Writing - review. Rudolf W. Poolman: Conceptualization, Investigation, Methology, Supervision, Writing - review.

Declaration of Competing Interest

None. Each author certifies that he or she has no commercial associations (e.g., consultancies, stock ownership, equity interest, patent/licensing arrangements, etc) that might pose a conflict of interest in connection with the submitted article.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.genhosppsych.2022.07.001.

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