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The Relationship Between Psychological Aspects and Trajectories of Symptoms in Total Knee Arthroplasty and Total Hip Arthroplasty

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ABSTRACT

Background: This study aimed to examine different trajectories of physical symptoms in hip and knee arthroplasty patients from presurgery to 1 year postsurgery and relate this to preoperative anxiety and depressive symptoms.
Methods: Patients (N = 345) completed the Hip injury and Osteoarthritis Outcome Score or the Knee injury and Osteoarthritis Outcome Score to examine their preoperative and postoperative pain, stiffness, and function, presurgery, and 3, 6, and 12 months postsurgery. Presurgery anxiety and depressive symptoms were assessed using the 7-item Generalized Anxiety Disorder Scale and the 9-item Patient Health Questionnaire. Latent trajectory analysis was used to identify different subgroups in trajectories. The step-3 method was used to assess subgroup characteristics.
Results: The effect of time on pain, function, and stiffness was different between subgroups of patients. Knee patients belonged mainly to classes with least improvement. Least improvement in pain was characterized by a combination of high levels of both anxiety and depressive symptoms. Anxiety and depressive symptoms were independently related to less reduction in stiffness while little improvement in function was characterized by higher depressive symptoms.
Conclusion: The results of this study indicate that anxiety and depressive symptoms were significantly, but differently, related to the distinct physical symptoms examined.

Relief of physical complaints is the foremost goal of treatment for osteoarthritis (OA) [1,2]. In end stage, this disease is commonly treated with joint replacement [3–11]. Accordingly, pain and impaired function resulting from OA are the most common indications for total knee arthroplasty (TKA) and total hip arthroplasty (THA) [12,13]. TKA and THA are considered highly successful treatment options, with less than 2% of patients needing revision within 1 year [5,6,8,11,14–17]. Moreover, more than 94% of all patients have a hip or knee prosthesis that survives more than 9 years [11].

Both hip and knee patients improve in physical function and experience less pain due to THA and TKA, respectively. However, large variations in recovery time and recovery rates are reported

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Ethical approval: The study has been performed in accordance with the ethical standards of the 1964 Declaration of Helsinki and with relevant regulations of the US Health Insurance Portability and Accountability Act (HIPAA).

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[7,18–28]. Up to 50% of patients experience persistent postoperative pain [24,26–28] or impaired postoperative function [29–32]. There are striking differences in postoperative outcomes between hip and knee patients. Hip patients generally seem to obtain more favorable outcomes than knee patients [7,18–23] and show faster recovery [33–36] than knee patients.

Several psychological characteristics may explain why some patients achieve suboptimal outcomes after TKA or THA. High levels of anxiety and depressive symptoms are reported in patients with arthritis [37–41]. Moreover, significant associations were found between the presence of these psychological symptoms and pain or disability in patients with OA [39,42–44]. Likewise, multiple studies indicated that anxiety and depressive symptoms could affect pain and function scores after surgery [45–48]. It is expected that patients with high levels of anxiety or depressive symptoms engage in less exercise and adopt less effective coping strategies, due to lost interest in daily and recreational activities or fear-avoidance beliefs [42,49,50]. This could lead to increased disuse of muscles, corresponding muscle weakness, and subsequently to suboptimal outcomes such as heightened pain levels and lower levels of both self-reported and clinical observed physical function [42,51–53]. In addition, patients might have a heightened perception of pain, due to greater pain sensitivity resulting from anxiety [50].

Thus, anxiety and depressive symptoms seem negatively related to both preoperative symptoms and postoperative outcomes. Nevertheless, conflicting findings are also reported, in which the relationship among depressive symptoms, anxiety, and pain or function after surgery only holds for TKA patients and not for THA patients [41]. Additionally, other studies found that anxiety was not related to these surgical outcomes [46], and that depression was not related to preoperative functioning in OA [42,54], but merely to general health [55]. It was proposed that high levels of anxiety and depressive symptoms, therefore, do not relate to OA-specific preoperative symptoms or postoperative outcomes, but rather to general health status [42]. An interaction between depressive symptoms and anxiety could also explain the inconsistent findings [42], considering that only the presence of *multiple* psychiatric symptoms was associated with impaired function in one study [54].

Pain and impaired function resulting from OA are the most common indications for TKA and THA [12,13]. Anxiety and depressive symptoms are thought to be associated with both preoperative symptoms and postoperative outcomes. Therefore, it could be that patients with high levels of anxiety and depressive symptoms who are scheduled for surgery should not (yet) have received the recommendation for surgery, as this possibly could result in dissatisfying outcomes [45–48]. However, no known study examined different preoperative and postoperative physical variables (ie, pain, stiffness, physical functioning) in relationship with anxiety and depression over time. Therefore, this study aims to examine different trajectories of physical symptoms in both TKA and THA patients from presurgery up to 1 year postsurgery, in relationship with preoperative anxiety and depressive symptoms. Different physical symptoms (pain, stiffness, functioning) were distinguished. Moreover, an interaction effect of anxiety and depression on physical outcome measures was examined.

Methods

The data collected for this paper were part of a larger prospective cohort study, the EXPECT study, which examined the relationship between expectations and satisfaction TKA and THA patients. The study was conducted at the Department of Orthopedics of the Elisabeth-TweeSteden Hospital, the Netherlands. Data for this paper were collected between November 2016 and September 2019. The EXPECT study was carried out according to the principles of the Declaration of Helsinki (version 8, 2013) and the Medical Research Involving Human Subject Act and was approved by the local Medical Ethics Review Board.

Patients

Patients with symptoms of OA were included in our study, when they were able to understand and complete the questionnaires (eg, not suffering from severe cognitive impairment [eg, dementia], and having sufficient knowledge of the Dutch language). Included patients who received no diagnosis of OA after medical consultation (ie, patients whose symptoms were mistakenly reported as symptoms of OA) were excluded from analysis and the remainder of the study.

Procedure

Patients were referred to the Department of Orthopedics by their general practitioner. Patients were consecutively included at first medical consultation at the Department of Orthopedics. Patients were informed about the nature and objectives of the study at least 48 hours before their medical consultation. All included patients gave written informed consent. Patients received a questionnaire presurgery (T1), 3 months postsurgery (T2), 6 months postsurgery (T3), and 1 year postsurgery (T4).

Measures

Sociodemographic data of patients were collected at T1. Patients completed the Hip injury and Osteoarthritis Outcome Score (HOOS) [56] or the Knee injury and Osteoarthritis Outcome Score (KOOS) [57] to examine their preoperative and postoperative pain, stiffness, and function at T1, T2, T3, and T4. Anxiety and depressive symptoms were assessed at T1.

Physical Symptoms

The HOOS [56] and KOOS [57] were used to assess pain, stiffness, and functional status. The questionnaires consist of 42 and 40 items, respectively, which could be divided into 3 Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) [58] subscales (pain, stiffness, and function). Participants had to indicate on a 5-point Likert scale whether they experienced the problems presented during the last week. Total scores were derived by summing the answers of each scale. Scores on the WOMAC scales could range from respectively 0-20 (pain), 0-8 (stiffness), and 0-68 (function). Scores were transformed on a scale of 0%-100%, in which lower scores indicate more extreme problems. The scales have good psychometric properties in hip and knee patient populations [56,57]. Within our sample, the HOOS and KOOS showed excellent internal consistency presurgery (HOOS: $\alpha = 0.97$, KOOS: $\alpha = 0.95$), 3 months postsurgery (HOOS: $\alpha = 0.97$, KOOS: $\alpha = 0.96$), 6 months postsurgery (HOOS: $\alpha = 0.98$, KOOS: $\alpha = 0.97$), and 1 year postsurgery (HOOS: $\alpha = 0.98$, KOOS: $\alpha = 0.97$).

Anxiety

The validated 7-item Generalized Anxiety Disorder Scale was used to assess anxiety [59,60]. Patients were asked how often they were bothered by symptoms on a 4-point Likert scale ranging from 0 ("not at all") to 3 ("almost every day"). The total score ranges from 0 to 21 with higher scores reflecting more severe anxiety. A score of 5, 10, and 15 was used as cut-off points for mild, moderate, and severe anxiety [61]. The scale has good psychometric properties [59,60]. Within our sample, the questionnaire shows excellent internal consistency ($\alpha = 0.90$).

Depressive Symptoms

The validated 9-item Patient Health Questionnaire (PHQ-9) was used to examine depressive symptoms [62–64]. Patients were asked how often they were bothered by symptoms on a 4-point Likert scale ranging from 0 ("not at all") to 3 ("almost every day"). Total score ranges from 0 to 27 with higher scores reflecting more severe depressive symptoms [62]. A score of 5, 10, and 15 was used as cut-off points for low, medium, and high severity of depressive symptoms [62]. The scale has good psychometric properties [62–64]. Within our sample, the questionnaire shows excellent internal consistency ($\alpha = 0.79$).

Statistical Analysis

Statistical analyses were performed using IBM SPSS Statistics version 24 and LatentGold Choice version 5.1 [65,66]. A .05 level of significance was applied to evaluate statistical significance. Total scores for the WOMAC scales, 7-item Generalized Anxiety Disorder Scale, and PHQ-9 were calculated.

Means and standard deviations (SDs) were calculated for continuous demographic, clinical, and psychological variables, and frequencies for categorical demographic variables. A number of independent *t*-tests and chi-squared tests were conducted to examine differences between hip and knee patients on demographics (eg, age, gender), anxiety, depressive symptoms, function, stiffness, and pain. In addition, missing values were analyzed.

Separate latent class trajectory analyses were conducted using the factors pain, stiffness, and function, to identify a number of distinct subgroups each representing a different trajectory of symptoms and recovery. Because the scores on the factors pain, stiffness, and function were extremely skewed, the scores were merged into 8 roughly equal sized bins. The 4 time points were collapsed into 1 nominal "time" variable. Model fit of models from 0 up to 10 subgroups was examined using the Bayesian information criteria (BIC). As lower BIC values indicate better fit of a model relative to another model (thereby also taking into consideration the complexity of the model [Npar]), the model with the lowest BIC was selected. The Wald(0) test indicates whether there is an effect of time. Moreover, symptoms over time were regarded as different between classes when the Wald(=) test was significant.

The step-3 method [65] was used, which conducts a series of univariate regression analyses to compare the different subgroups on sociodemographic (age, gender, hip or knee patient) and psychological (anxiety and depressive symptoms) characteristics. All predictors were entered as continuous covariate variables with an multilabel adjustment and proportional classification, except for gender and being a hip or knee patient, which were entered as nominal variables. Quadratic effects of anxiety and depressive symptoms were tested, as well as an interaction effect between anxiety and depressive symptoms. Variables were regarded associated with class membership when the Wald(0) test was significant.

Results

Almost all surgery patients (N = 345, 87%) returned their questionnaire presurgery. Three months postsurgery, 98% of these patients (N = 339) returned their questionnaire. Likewise, more than 3-quarter of patients returned their questionnaire 6 months postsurgery (N = 334, 97%) and 1 year postsurgery (N = 304, 88%) (Table 1). Missing values were missing at random ($\chi^2 = 114.2$, $P = .23$). More knee than hip patients had missing values at T2 ($\chi^2 = 8.0$, $P \leq .01$). More women than men had missing values at T1 ($\chi^2 = 4.5$, $P = .03$).

Patient Characteristics

Hip (N = 197) and knee (N = 186) patients did not significantly differ by age, employment status, marital status, physical comorbidity, and education level (Table 2). Mean age was 70 years (SD = 8.1) and 60% of the patients was female. However, there were more women in the group of knee patients (N = 122, 66%) compared to the group of hip patients (N = 109, 55%). Of all patients, 77.5% were married and 18.6% of patients were employed for monetary reimbursement. About half of all patients (51%) indicated secondary education as highest level of education (Table 2).

OA Symptoms

Presurgery, patients scored 46.3 (SD = 19.8) as average score on pain presurgery on a scale ranging from 0 (worst pain) to 100 (no pain at all) (Table 2). Their pain scores diminished to an average score of 87.1 (SD = 16.0) for hip patients and a score of 81.8 (SD = 19.8) for knee patients, 1 year postsurgery. Knee patients reported significantly more residual pain at 1 year postsurgery compared to hip patients ($t = 2.5$, $P \leq .01$) (Table 2).

Presurgery, hip patients scored 43.1 (SD = 20.5) and knee patients scored 45.4 (SD = 19.4, $t = -2.9$, $P \leq .01$) as average score on function on a scale ranging from 0 (worst functional disability) to 100 (no functional disability at all). Their function scores diminished to an average score of 82.8 (SD = 17.0) for hip patients and 79.6 (SD = 19.5) for knee patients, 1 year postsurgery. Knee patients reported significantly more impaired function 1 year postsurgery compared to hip patients ($t = 3.5$, $P \leq .001$) (Table 2).

Presurgery, patients scored 44.2 (SD = 20.0) as average score on stiffness presurgery on a scale ranging from 0 (worst stiffness) to 100 (no stiffness at all). Hip and knee patients' stiffness scores diminished to an average score of 81.3 (SD = 18.3), 1 year postsurgery (Table 2). No significant differences were found between hip and knee patients in terms of stiffness.

Anxiety and Depressive Symptoms

On a scale of 0-21, patients scored an average of 3.1 (SD = 3.9) on level of anxiety (Table 2). Almost 3-quarter of patients experienced no anxiety (N = 214, 73.6%). Nevertheless, 20% of patients (N = 61)

Table 1
Number of Missing Values at T1, T2, T3, and T4.

N	Missing T1[a]			Missing T2[a]			Missing T3[a]			Missing T4[a]		
		t/χ^2	*P* Value		t/χ^2	*P* Value		t/χ^2	*P* Value		t/χ^2	*P* Value
Age	47	0.5	.60	56	.63	.63	58	0.7	.50	84	0.4	.68
Knee patients	30	2.1	.15	**38**	**8.0**	**.01**	32	0.2	.67	41	0.9	.35
Hip patients	22			**20**			31			52		
Women	**35**	**4.5**	**.03**	39	2.4	.12	36	2.4	.12	50	0.0	.87
Men	**12**			17			22			34		
Anxiety	33	1.2	.22	28	0.6	.52	33	0.2	.83	69	1.1	.26
Depressive symptoms	33	0.9	.35	28	0.0	.99	32	0.8	.44	69	0.3	.78

[a]Missing values on the Hip injury and Osteoarthritis Outcome Score or the Knee injury and Osteoarthritis Outcome Score.
Bold indicates the significant on a .05 level of significance.

Table 2
Patient Sociodemographic, Psychological, and Clinical Characteristics.

Mean (SD)	Combined	*N*	Hip	*N*	Knee	*N*	Hip vs Knee	
							t/χ^2	*P* Value
Women, n (%)	231 (60.3)	383	**109 (55.3)**	**197**	**122 (65.6)**	**186**	**4.2**	**.04**
Age	69.8 (8.0)	383	70.5 (8.3)	197	69.2 (7.7)	186	1.6	.11
Employed for monetary reimbursement: yes (%)	64 (18.6)	345	27 (14.8)	183	37 (22.8)	162	5.3	.15
Married: yes (%)	269 (77.5)	347	141 (77.0)	183	128 (78.0)	164	2.6	.77
Education, n (%)		339		179				
Primary education	48 (14.2)		30 (16.8)		18 (11.3)		3.9	.14
Secondary education	173 (51.0)		83 (46.4)		90 (56.3)			
Tertiary education	118 (34.8)		66 (36.9)		52 (32.5)			
Physical comorbidity: yes (%)	145 (42.5)	341	70 (38.7)	181	75 (46.9)	160	2.3	.13
GAD-7: severity of anxiety, n (%)	3.1 (3.9)	307	3.3 (3.9)	168	3.0 (3.8)	139	0.6	.52
Mild	61 (19.9)		32 (19.0)		29 (21.0)			
Moderate	12 (3.9)		7 (4.2)		5 (3.6)			
Severe	8 (2.6)		5 (3.0)		3 (2.2)			
PHQ-9: severity of depressive symptoms, n (%)	4.4 (4.1)	306	4.7 (4.3)	168	4.2 (3.9)	138	1.1	.28
Low	79 (25.9)		44 (26.2)		35 (25.5)			
Medium	27 (8.9)		16 (9.5)		11 (8.0)			
High	10 (3.3)		6 (3.6)		4 (2.9)			
Pain								
Presurgery	46.3 (19.8)	336	47.2 (20.6)	177	45.3 (18.8)	159	0.9	.37
3 mo postsurgery	78.8 (19.1)	336	**84.0 (15.4)**	**181**	**72.7 (21.1)**	**155**	**5.6**	**≤.001**
6 mo postsurgery	82.6 (18.8)	336	**86.2 (16.2)**	**174**	**78.8 (20.7)**	**162**	**3.6**	**≤.001**
1 y postsurgery	84.5 (18.1)	299	**87.1 (16.0)**	**152**	**81.8 (19.8)**	**147**	**2.5**	**≤.01**
Function								
1 wk presurgery	35.9 (23.1)	345	**43.1 (20.5)**	**167**	**45.4 (19.4)**	**149**	**−2.9**	**≤.01**
3 mo postsurgery	58.1 (24.1)	346	**76.9 (16.1)**	**168**	**72.0 (18.1)**	**143**	**3.6**	**≤.001**
6 mo postsurgery	67.6 (23.5)	338	**81.5 (16.7)**	**161**	**76.1 (19.2)**	**153**	**3.2**	**≤.01**
1 y postsurgery	73.0 (25.3)	307	**82.8 (17.0)**	**145**	**79.6 (19.5)**	**139**	**3.5**	**≤.001**
Stiffness								
1 wk presurgery	44.2 (20.0)	316	32.5 (23.6)	181	39.6 (22.1)	164	−1.0	.30
3 mo postsurgery	74.6 (17.2)	311	**62.3 (23.5)**	**186**	**53.1 (24.0)**	**160**	**2.5**	**≤.01**
6 mo postsurgery	48.9 (18.1)	314	**71.5 (22.7)**	**174**	**63.4 (23.8)**	**164**	**2.7**	**≤.01**
1 y postsurgery	81.3 (18.3)	284	78.0 (23.3)	155	68.1 (26.4)	152	1.5	.14

Note: Physical comorbidity contains heart diseases, stroke, asthma, chronic obstructive pulmonary disease, diabetes, cancer.
GAD-7, 7-item Generalized Anxiety Disorder Scale; PHQ-9, 9-item Patient Health Questionnaire.
Bold indicates the significant on a .05 level of significance.

reported mild anxiety, 4% reported moderate anxiety (N = 12), and 3% reported severe anxiety levels (N = 8). No differences were found between hip and knee patients in severity of anxiety ($t = 0.6$, $P = .52$).

Patients scored, on average, 4.4 (SD = 4.1) on a scale of 0-27, as level of depressive symptoms (Table 2). Almost 62% of patient (N = 189) reported no depressive symptoms. Almost 26% scored with the range of low severity of depressive symptoms. Medium severity of depressive symptoms was experienced by 9% of patients (N = 27) and high severity of depressive symptoms by 3% of patients (N = 10). No differences were found between hip and knee patients in severity of depressive symptoms ($t = 1.1$, $P = .28$).

Table 3
Indicators of Fit for 1-5 Clusters for Pain, Function, and Stiffness.

	LL	BIC (LL)	Npar	R^2	Class.Err.
Pain					
Class 1	−2225.5	4504.9	9	0.40	0.00
Class 2	−2087.5	4288.7	19	0.67	0.07
Class 3	**−2042.2**	**4258.0**	**29**	**0.73**	**0.12**
Class 4	−2020.6	4274.5	39	0.74	0.14
Class 5	−2007.0	4307.2	49	0.76	0.14
Function					
Class 1	−2281.6	4622.9	10	0.39	0.00
Class 2	−2142.2	4409.8	21	0.67	0.07
Class 3	**−2088.7**	**4368.5**	**32**	**0.73**	**0.14**
Class 4	−2063.2	4383.3	43	0.76	0.18
Class 5	−2048.0	4418.6	54	0.77	0.17
Stiffness					
Class 1	−2546.8	5153.4	10	0.26	0.00
Class 2	**−2414.8**	**4955.2**	**21**	**0.59**	**0.07**
Class 3	−2391.3	4974.0	32	0.62	0.16
Class 4	−2371.7	5000.8	43	0.64	0.20
Class 5	−2353.9	5031.0	54	0.70	0.17

BIC, Bayesian information criteria; LL, log-likelihood; Npar, number of parameters; Class. err., classification error.
Bold indicates the significant on a .05 level of significance.

Trajectories of Symptoms

The BIC suggested a 3-subgroup model for pain and function and a 2-subgroup model for stiffness (Table 3). The total variance explained ranged from 59% for stiffness to 73% for pain and function. There was a significant effect of time for pain (Wald(0) = 183.0, $P \leq .001$), function (Wald(0) = 194.5, $P \leq .001$), and stiffness (Wald(0) = 216.0, $P \leq .001$). In addition, the time effect of pain (Wald(=) = 37.7, $P \leq .001$), function (Wald(=) = 34.6, $P \leq .001$), and stiffness (Wald(=) = 36.9, $P \leq .001$) was significantly different between the subgroups (Fig. 1).

Characteristics of Pain

Class 1 (labeled “early, most improvement”) included 45.7% of patients. Class 2 (labeled “gradually, moderate improvement”) included 33.9% of patients. Class 3 (labeled “least improvement”) included 20.4% of patients (Fig. 1). The scores on preoperative pain and postoperative pain increased per class from class 1 to class 3. Patients in class 3 (μ= 68.3, SD = 8.6) were significantly younger than patients in class 1 (μ = 70.4, SD = 7.5) and 2 (μ = 69.4, SD =

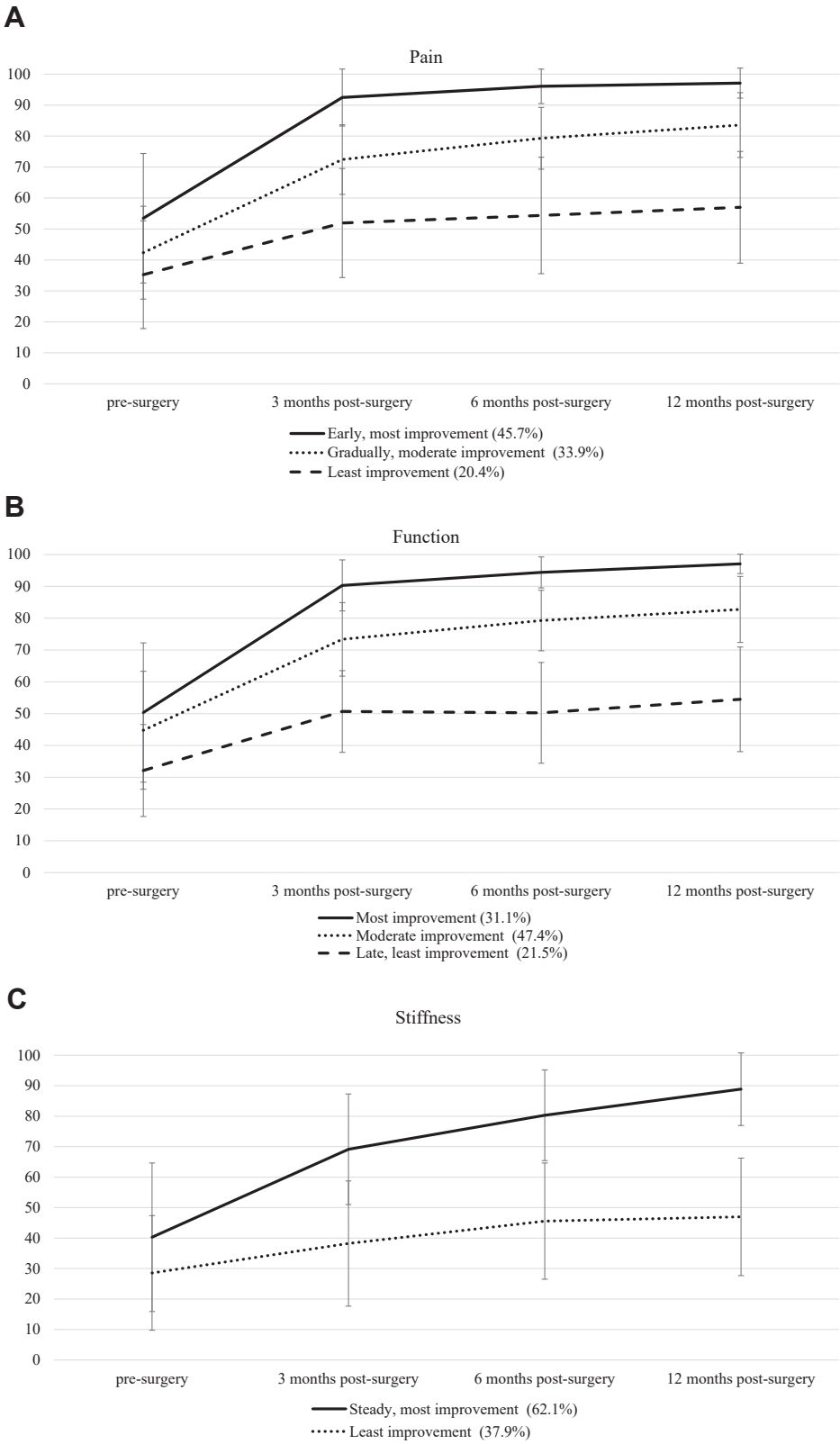

Fig. 1. Trajectories of pain (A), function (B), and stiffness (C) from presurgery to 1-year postsurgery. Class sizes are shown. Lines represent class means. Higher scores indicate less symptoms. Standard errors of class means are presented on the vertical lines.

8.0) ($P = .04$). The difference between hip and knee patients was significantly associated with class membership ($P \leq .001$) (Table 4, Fig. 2). The group with least improvement had the most knee patients (68.7%) and the group with steady, most improvement had the least knee patients (34.1%). Moreover, the chance of being within the least improvement group was higher for knee patients (ie, 26%) compared to hip patients (ie, 10%). A significant interaction effect was found for the relationship between anxiety and depressive symptoms and class membership (Table 4, Fig. 3). The correlation between anxiety and depressive symptoms was highest in the least improvement group ($r = .79$). That is, in the least improvement group (class 3), in comparison with class 1 ($P \leq .01$) and class 2 ($P \leq .001$), patients had the highest chance of experiencing both high levels of anxiety and depressive symptoms. Moreover, the correlation was also higher in class 2, as compared to class 1 ($P = .03$).

Characteristics of Function

Class 1 in function (labeled "moderate improvement") included 47.4% of patients. Class 2 (labeled "most improvement") included 31.1% of patients. Class 3 (labeled "late, least improvement") included 21.5% of patients (Fig. 1). The scores on preoperative functional disability and postoperative functional disability increased per class from class 2 to class 1, and class 3. The difference between hip and knee patients was significantly associated with class membership ($P \leq .001$) (Table 4, Fig. 2). The group with late, least improvement had the most knee patients (59.9%) and the group with most improvement had the least knee patients (35.4%). In addition, the chance of being in the least improvement group is higher for knee patients (ie, 24%) compared to hip patients (ie, 13%). Depressive symptoms were significantly associated with class membership ($P \leq .001$). Patients in the group with late, least improvement (class 3) had significantly higher scores on the PHQ-9 ($\mu = 7.1$, SD = 5.4), than patients in the moderate (class 1) ($\mu = 4.2$, SD = 3.4) or most improvement groups (class 2) ($\mu = 3.5$, SD = 3.5). No significant differences in depressive symptoms were found between the moderate and high improvement group ($P = .09$).

Characteristics of Stiffness

Class 1 in stiffness (labeled "steady, most improvement") included 62.1% of patients. Class 2 (labeled "least improvement") included 37.9% of patients (Fig. 1). The scores on preoperative stiffness and postoperative stiffness increased per class from class 1 to class 2. The difference between hip and knee patients was significantly associated with class membership ($P \leq .001$) (Table 4, Fig. 2). The group with least improvement had the most knee patients (61.3%) and the group with steady, most improvement had the least knee patients (36.1%). Furthermore, the chance of being within the least improvement group was higher for knee patients (ie, 24%) compared to hip patients (ie, 13%). Class membership was significantly associated with anxiety ($P = .03$) and depressive symptoms ($P = .03$). Patients with least improvement had significantly more severe anxiety ($\mu = 4.0$) and depressive symptoms ($\mu = 5.3$) than patients with most improvement (respectively $\mu = 2.6$ and $\mu = 4.0$). The interaction effect between anxiety and depressive symptoms was not significant ($P = .12$).

Discussion

It was expected that patients with high levels of anxiety and depressive symptoms would experience dissatisfying outcomes in terms of physical symptoms [45–48]. Therefore, this study aimed to examine different trajectories of physical symptoms in both TKA and

Table 4
Characteristics of Pain, Function, and Stiffness.

Mean	Pain				Function				Stiffness		
	Class 1	Class 2	Class 3	*P* Value	Class 2	Class 1	Class 3	*P* Value	Class 1	Class 2	*P* Value
	Fast, Most Improvement N = 160, 45.7%	Steady, Moderate Improvement N = 113, 33.9%	Slow, Least Improvement N = 63, 20.4%		Fast, Most Improvement N = 102, 31.1%	Steady, Moderate Improvement N = 155, 47.4%	Slow, Least Improvement N = 59, 21.5%		Steady, Most Improvement N = 215, 62.1%	Least Improvement N = 130, 37.9%	
Age	70.4 (7.5)	69.4 (8.0)	68.3 (8.6)	**.04**	68.9 (7.8)	70.0 (7.9)	68.3 (7.6)	.11	70.0 (8.0)	69.5 (8.0)	.24
Women, n (%)	88 (55)	65 (58)	45 (72)	.62	54 (53)	93 (60)	36 (62)	.27	118 (55)	87 (67)	.11
Knee patient n (%)	54 (34)	55 (49)	43 (69)	**≤.001**	36 (35)	71 (46)	35 (60)	**≤.001**	77 (36)	79 (61)	**≤.001**
GAD-7	2.4 (3.2)	3.0 (3.4)	5.0 (5.2)	**≤.001**	2.4 (3.6)	2.8 (3.2)	5.0 (4.7)	≤.19	2.6 (3.3)	4.0 (4.4)	**.03**
PHQ-9	3.7 (3.4)	4.4 (3.8)	6.6 (5.3)	**≤.001**	3.5 (3.5)	4.2 (3.4)	7.1 (5.4)	**≤.001**	4.0 (3.6)	5.3 (4.6)	**.03**

GAD-7, 7-item Generalized Anxiety Disorder Scale; PHQ-9, 9-item Patient Health Questionnaire.
Bold indicates the significant on a .05 level of significance.

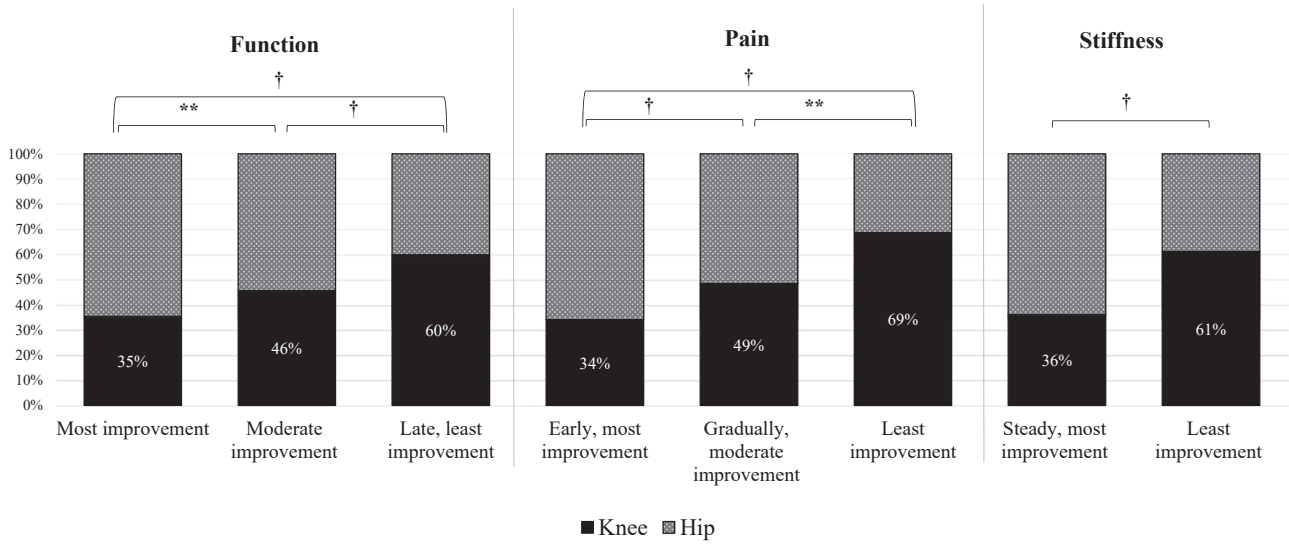

Fig. 2. Percentages of hip and knee patients in each class, stratified for function, pain, and stiffness. $^{**}P \leq .01$, $^{\dagger}P \leq .001$.

THA patients from presurgery up to 1 year postsurgery, in relationship with preoperative anxiety and depressive symptoms. Patients experienced high levels of pain, function, and stiffness before surgery. These scores declined for both hip and knee patients after surgery. However, the effect of time was different between subgroups of patients. Knee patients belonged mainly to classes with least improvement in pain, function, and stiffness. Moreover, least improvement in pain was characterized by young age and a combination of high levels of both anxiety and depressive symptoms. Meanwhile, anxiety and depressive symptoms were independently related to lower reduction in stiffness, while low improvement in function was characterized by higher depressive symptoms.

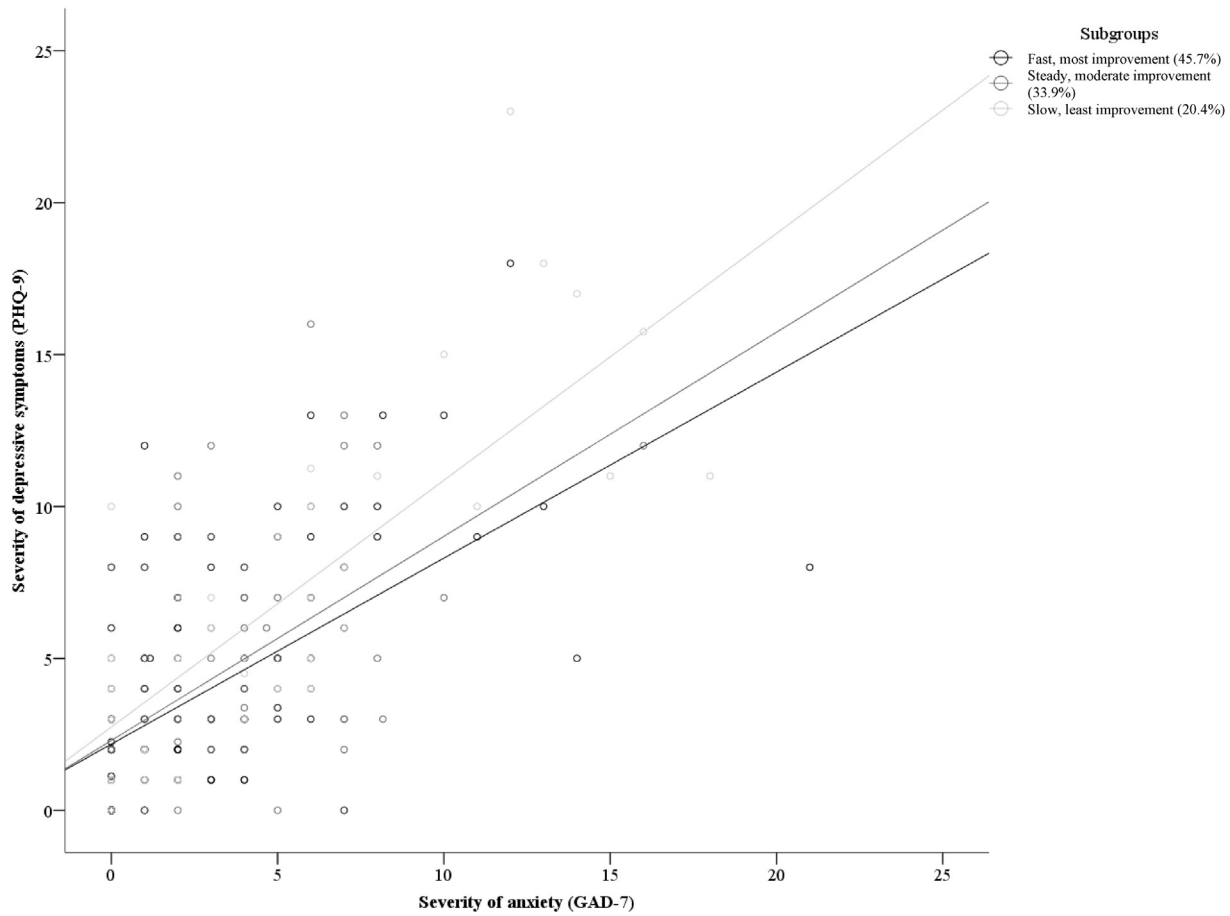

Fig. 3. Interaction effect of anxiety and depressive symptoms on class membership. PHQ-9, 9-item Patient Health Questionnaire; GAD-7, 7-item Generalized Anxiety Disorder Scale.

Within this study, 3 distinct trajectories were found for pain and function and 2 for stiffness. In all trajectories, patients with less preoperative pain and stiffness and better functional status reported the most improvement over time. This is in accordance with multiple previous findings [67–69]. The group of patients whose scores almost improved until perfect recovery comprises a large part of all patients (ie, 31%-62%). Yet, a substantial number of patients show a trajectory of late, and least improvement in pain, function, and stiffness (ie, 20%-38%). Considering that worse preoperative status is associated with suboptimal outcomes, delaying surgery until end stage OA may not be recommended [70–72]. Notwithstanding, patients with high levels of preoperative function might experience less meaningful improvement [73,74]. Recommendations for optimal timing should therefore be developed.

The relationship between less preoperative symptoms and worse postoperative outcomes was found mostly in knee patients, compared to hip patients [67]. Likewise, in our sample, at least 60% of patients within the least improvement groups were knee patients, and the probability of belonging to the least improvement group or the moderate improvement group was higher for knee patients than for hip patients. Moreover, as was expected, levels of pain, function, and stiffness over time significantly differed between hip and knee patients [7,18–23].

There were no significant differences in level of anxiety or depressive symptoms between hip and knee patients. Yet, more than a quarter of patients (ie, 26.4%) reported anxiety presurgery and more than 38% of patients reported depressive symptoms. These high levels of presurgical psychological symptoms are in accordance with the existing literature [37–41] and often seem to follow high levels of physical disability and high levels of pain that often accompany OA [40,45]. Therefore, it was previously proposed that they are merely a consequence of a chronic disease and not a precursor of symptoms [37,40,45]. If this were true, it would be expected that levels of anxiety and depressive symptoms were highest in trajectories with high preoperative symptoms. Indeed, in our study, both anxiety and depressive symptoms were related to higher baseline levels of stiffness. Moreover, they not only seem a consequence of a chronic disease, as they were, in our sample, both related to the corresponding least improvement in stiffness symptoms over time. As was found before [75,76], both presurgery and postsurgery, fear (of movement) seems associated with stiffness (ie, a decreased range of motion), in our sample. Likewise, a lack of movement, and thus stiffness, could also be associated with depressive symptoms, considering that patients often lose the interest for daily activities [42,49,50]. No interaction effect between anxiety and depressive symptoms on stiffness was found, that is, both anxiety and depressive symptoms were independently, and when controlled for, related to higher levels of stiffness.

Nevertheless, this interaction effect was found for levels of pain. Patients in the least improvement group had the highest probability of experiencing a combination of anxiety and depressive symptoms. This could explain the inconsistent findings in the literature, as anxiety and depressive symptoms often coexist [77,78], and in some studies only the compound effect of anxiety and depressive symptoms was found to relate to worse symptoms [42,54,79,80]. Depressive symptoms were found to relate to heightened pain sensitivity and less adaptive coping styles [50]. In addition, anxiety tends to be associated with pain catastrophizing [81]. The heightened awareness and catastrophizing effects of anxiety and depressive symptoms, then, might amplify the experience of pain in patients [79]. Moreover, several, shared, biological mechanism could also explain the concurrence among depression, anxiety, and pain [79,82,83]. Furthermore, a significant association was found between class membership and age. Younger patients were often classified as the group of patients with least improvement in pain, which is in accordance with previous findings [37].

Only depressive symptoms and not anxiety was related to function. Even though depressive symptoms were related to function in previous studies [39,41,48,84], the effect on function in OA was mostly diminished when anxiety was added to the analyses [42]. Previously, it was suggested that depressive symptoms mainly affected physical function in case of low levels of anxiety [42]. However, we did not find this interaction effect. One explanation for the presence of a relationship between depressive symptoms and functional disability may be coping behavior. Patients with depressive symptoms might find it harder to find effective ways of coping and adapting to their disease [85], which might lead to limitations in daily living. Additionally, it was found that a lack of social and recreational activities could contribute to depression [86,87]. Depressive symptoms, then, might be a result of high functional disability. Nevertheless, it might also be the other way around; depressive symptoms could lead to less productivity and engagement in activities [88–90].

This study has a number of limitations. First, we did not control for the overlap in symptoms between depressive symptoms and OA symptoms on the one hand, and anxiety and OA symptoms on the other hand. Future research should therefore examine which factors could uniquely contribute to the association between these variables. Second, this study is a prospective study, which limits the interpretation of causality of the relationships. As a result, we are not able to predict whether depressive symptoms and anxiety precede or follow OA symptoms. Finally, we only examined depressive symptoms and anxiety presurgery. Future studies should investigate how symptoms relate to postoperative depressive symptoms and anxiety.

Nonetheless, our findings provide valuable insights in the relationship between preoperative levels of anxiety and depressive symptoms and pain, function, and stiffness over time.

Previous studies suggested that anxiety and depressive symptoms merely related to general health and not to symptoms in OA patients [42,54,55]. Yet, the results of this study indicate that depression and anxiety were significantly, but differently, related to the distinct symptom measures examined (ie, pain, stiffness, and function). Moreover, the relationships were significant when controlling for the effect of being a hip or knee patient. This indicates that the relationship, in contrast to previous findings [41], holds for both TKA and THA patients. Nonetheless, the expression of this relationship might be more pronounced in knee patients, considering that they are more often in the group with the most symptoms. In clinical practice, emphasis should particularly be placed on patients with high levels of anxiety and depressive symptoms, which are often patients with high levels of preoperative symptoms, as this could relate to suboptimal surgical outcomes.

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