

Psychosocial Determinants of Total Knee Arthroplasty Outcomes Two Years After Surgery

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Objective. To evaluate the association of preoperative psychosocial and demographic factors with total knee arthroplasty (TKA) outcomes and satisfaction in patients with osteoarthritis (OA) of the knee at 24 months after surgery.

Methods. A prospective cohort study of patients undergoing TKA was conducted. Outcome measures included: Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) and Short Form 36 (SF-36) scores at baseline and 24 months after surgery, and patient satisfaction with TKA at 24 months. Linear regression models were performed to evaluate the association of preoperative psychosocial determinants (ie, Medical Outcome Study Social Support Scale; Depression, Anxiety, and Stress Scale; Brief COPE inventory, The Life Orientation Test-Revised; Multidimensional Health Locus of Control; and Arthritis Self-Efficacy Scale) on outcomes.

Results. We included 178 patients. Increasing WOMAC pain scores at 24 months were associated with increasing age and body mass index (BMI); low tangible social support and low optimism were associated with higher levels of pain ($R^2 = 0.15$). A decrease in WOMAC function scores was also associated with older age and higher BMI; low tangible support, increased stress, and low optimism were also associated with worse function ($R^2 = 0.22$). When evaluating quality of life, lower SF-36 physical functioning scores at 24 months were associated with age, high BMI, and comorbidity ($R^2 = 0.34$). Lower SF-36 mental functioning scores were associated with depression and low optimism ($R^2 = 0.38$). Having a dysfunctional style of coping was associated with lower satisfaction with surgery after 24 months (adjusted $R^2 = 0.12$).

Conclusion. Psychosocial factors, such as tangible support, depression, dysfunctional coping, and optimism, were associated with pain, function, and satisfaction 2 years after TKA. Perioperative programs identifying and addressing psychosocial problems may result in improvements in pain and function after TKA.

INTRODUCTION

Total knee arthroplasty (TKA) provides marked pain relief and functional improvement in patients with osteoarthritis (OA) (1) and has shown to be cost effective (2). Yet, although most patients who undergo TKA report substantial pain reduction and functional improvement, about 15% to 25% of patients experience insufficient improvements in pain, physical functioning, and quality of life and are thus dissatisfied with the results of the procedure (3–5).

Multiple factors have been associated with poor outcomes and dissatisfaction after TKA, including sociodemographic factors (eg, older age, living alone, being African American), preoperative status (eg, lower functional ability, poor patient-reported outcomes, less severe degenerative changes), intraoperative factors (eg, prosthesis used, surgical technique, alignment), and postoperative factors (eg, complications, lower physical activity, lower overall health scores) (6). Several studies have reported that patients with preoperative psychosocial dysfunction may have worse outcomes

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SIGNIFICANCE & INNOVATIONS

- We identified psychosocial and demographic factors that are predictive of patient-reported total knee arthroplasty (TKA) outcomes and satisfaction 2 years after surgery.
- Psychosocial factors, such as dysfunctional coping, stress, depression, and optimism, were associated with TKA outcomes and patient satisfaction at 24 months after surgery.
- Increased age and high body mass index were associated with increased Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) pain scores and decreased WOMAC function scores at 24 months after surgery.
- Our findings can help guide other studies evaluating current TKA or rehabilitation techniques and determine the psychosocial factors measures that, if assessed in patients with knee osteoarthritis before undergoing TKA, can predict outcomes and satisfaction at 24 months after surgery.

after TKA (7–12). However, most of these studies failed to include important psychosocial factors such as coping, social support, stress, and optimism.

We previously showed that tangible support, problem-solving coping, and internal locus of control have been associated with decreased pain and increased function 6 months after TKA, whereas depression and dysfunctional coping were associated with increased pain and decreased function (1). In the current study, we sought to determine whether these associations between psychosocial factors and TKA outcomes persist at 24 months after surgery. It was hypothesized that tangible support, problem-solving coping, and internal locus of control would remain significantly associated with poor functional outcomes and satisfaction.

PATIENTS AND METHODS

The manuscript was prepared according to the Strengthening the Reporting of Observational Studies in Epidemiology statement (13).

Study design. We conducted a prospective cohort study of patients undergoing TKA (Patient Expectations After Knee Surgery) and reported their outcomes 6 months after surgery (1). The current manuscript reports the association between baseline psychosocial determinants and TKA outcomes 24 months after surgery of the same cohort.

Setting. Four orthopedic surgeons from two orthopedic outpatient clinics in Houston, Texas, agreed to participate in this study. We invited their patients as they were scheduled for surgery. Participant recruitment started in 2004 and was completed

in 2007. The data collection of the 24-month follow-up occurred between 2007 and 2009. All surgeries were performed at the same location. The study was approved by the institutional review board of the all the institutions participating in the study. All participants provided signed consent forms.

Participants. Inclusion criteria included (a) radiologic diagnosis of knee OA; (b) first TKA (prior hip replacement was allowed, but prior contralateral TKA excluded); (c) adequate cognitive status (as determined by the research staff evaluating participant's orientation to time, place, and person); (d) not living in long-term care facilities; and (e) ability to communicate in English. Exclusion criteria included (a) revision surgery, (b) inflammatory arthropathies, (c) neurologic disorders, (d) Paget syndrome or metabolic bone disorders, (e) litigation process related to surgery, or (f) seeking or receiving workers' compensation benefits.

Variables. Participants were assessed at baseline and then again at 24 months after surgery. Primary outcome measures included the following:

1. Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) scores. Measures pain, function, and stiffness experienced during the past 48 hours. Subscale scores (ie, pain, function, and stiffness) are calculated as the average numeric responses to the items within each subscale. Scores were rescaled from 0 to 100, with higher scores indicating worse outcomes. We established a priori that we would use only the pain and function subscales, which have shown the best reliability and validity in previous studies (14,15).
2. Short Form 36 (SF-36) scores measures health-related quality of life (16,17). It contains eight subscales that measure different domains of health: physical functioning, role limitations due to physical health, bodily pain, general health perceptions, vitality, social functioning, role limitations due to emotional problems, and mental health. Two summary scores are derived from these subscales: physical component summary subscale (PCS) and mental component summary subscale (MCS). Summary scores range from 0 to 100 (PCS and MCS means in the US population are 50.04 [SE: 0.1180] and 51.50 [SE: 0.1163], respectively (18)); higher scores indicate better outcomes. We used only the PCS and MCS scores for our analysis.

A secondary outcome measure in our analysis was Satisfaction with Knee Procedure (SkiP) survey scores (19). Six items assess patients' experiences with knee surgery and their feelings about it. Scores range from 6 to 30; higher scores indicate more satisfaction with the knee procedure (20). Test-retest reliability in patients with osteoarthritis has been reported as 0.96 and validity as 0.58.

Independent variables. For each participant, we also ascertained (at baseline) demographic characteristics, body mass index (BMI), number of comorbid conditions (measured as the total number of comorbidities patient had at baseline), and the following psychosocial determinants (measured at 24 months):

1. Social support, measured using the Medical Outcome Study Social Support Scale (21). This survey asks patients to indicate how often four types of social support are available to them if they need it. Four subscale scores are derived: tangible support, affectionate support, social interaction support, and emotional/informational support. The overall score is the average numeric response to all items ranging from 0 to 100, with higher scores indicating greater availability of support.
2. Depression, Anxiety, and Stress Scale (DASS21) was used to measure the negative emotional states of depression, anxiety, and stress. Each subscale contains seven items rated on a four-point severity/frequency scale. Subscale scores range from 0 to 21, higher scores indicate greater depression, stress, or anxiety (22).
3. Coping responses, measured using the Brief COPE inventory, examines responses to stressors such as illness and natural disasters. It contains examples of actions categorized into 1 of 14 types of coping behaviors, with 2 examples for each type of behavior: active coping, planning, positive reframing, acceptance, humor, religion, using emotional support, using instrumental support, self-distraction, denial, venting, substance abuse, behavioral disengagement, and self-blame. Three summary subscale scores are derived and were used in the current study: (a) emotional coping, (b) problem-solving coping, and (3) dysfunctional coping (23). Higher scores indicate more coping of different types.
4. The Life Orientation Test-Revised (LOT-R) was used to measure optimism. Overall scores range from 0 to 24, with high values implying optimism (24). To facilitate interpretation, we rescaled the scores to range from 0 to 100.
5. Multidimensional Health Locus of Control (MHLC) scores. MHLC measures beliefs about what determines one's health (25). It consists of 18 items divided into 3 subscales: internal (I am in control of my health); chance (my health is related to chance events), and powerful others (others have control over my health). Individual subscale scores range from 6 to 36; higher scores indicate stronger beliefs about that particular determinant of one's health.
6. Arthritis Self-Efficacy Scale (ASES) (26) is designed to measure perceived self-efficacy in patients with arthritis. For our study, we used a modified version of the ASES that consisted of only 8 items rather than the standard 20. Overall scores range from 1 to 10. Higher scores indicate greater self-efficacy.

Measurements. Detailed description of the recruitment process is provided elsewhere (1). In brief, participants completed face-to-face baseline questionnaires at time of recruitment (within the month before they were scheduled for surgery) and 6 months after surgery. At 24 months, questionnaires were mailed to each participant and returned via mail. For participants who did not mail in the questionnaires, an attempt was made to conduct the assessment over the phone or during a home visit by the research assistant.

Statistical methods. Frequencies and percentages, as well as means and standard deviations, were generated to describe patient characteristics. Internal consistency of the baseline psychosocial scales was determined by Cronbach α . Differences in means of outcome variables and psychosocial determinants between baseline and 24 months were assessed using paired t test. Multiple linear regression was employed for each outcome of interest to determine the independent association between various patient characteristics and psychosocial domain scores at baseline and 24-month outcomes. Variables in the final model were selected using the stepwise method. Patient age and sex were forced into all models, whereas for the rest of the variables, a P value of 0.20 was required to enter the model and a P value of 0.10 was required to remain in the model. Multicollinearity was assessed between predictor variables by looking at variance inflation factors (VIF) 10 or greater. For each outcome, a model that considered the baseline outcome measure as one of the predictors and a model that did not consider this were run. In addition, another set of models with and without income adjustment was created; because many patients did not respond to the income question, it was not included in the primary analysis. Patient age and sex were forced into all models. For the rest of the variables, a value of $P < 0.20$ was required to enter the model and a value of $P < 0.10$ was required to remain in the model. We also examined differences in baseline outcome measures, baseline psychosocial assessment scores, and demographic characteristics between patients who were lost to follow-up at 24 months ($n = 69$) and those who completed both follow-up assessments at 6 and 24 months ($n = 172$). Our results are based on the 178 patients who completed the 24-month assessment (three had incomplete data for some questionnaires and were excluded from some analyses).

RESULTS

Participants. Patient disposition from the original cohort study at 2 years is shown in Figure 1. Of the original 615 patients scheduled for TKA, 253 (41%) were ineligible (not first TKA, revision surgery, inflammatory arthritis such as rheumatoid arthritis); of the 392 eligible, 90 (23%) declined to participate. Of the 272 patients initially included, 178 (65%) completed the 24-month questionnaires.

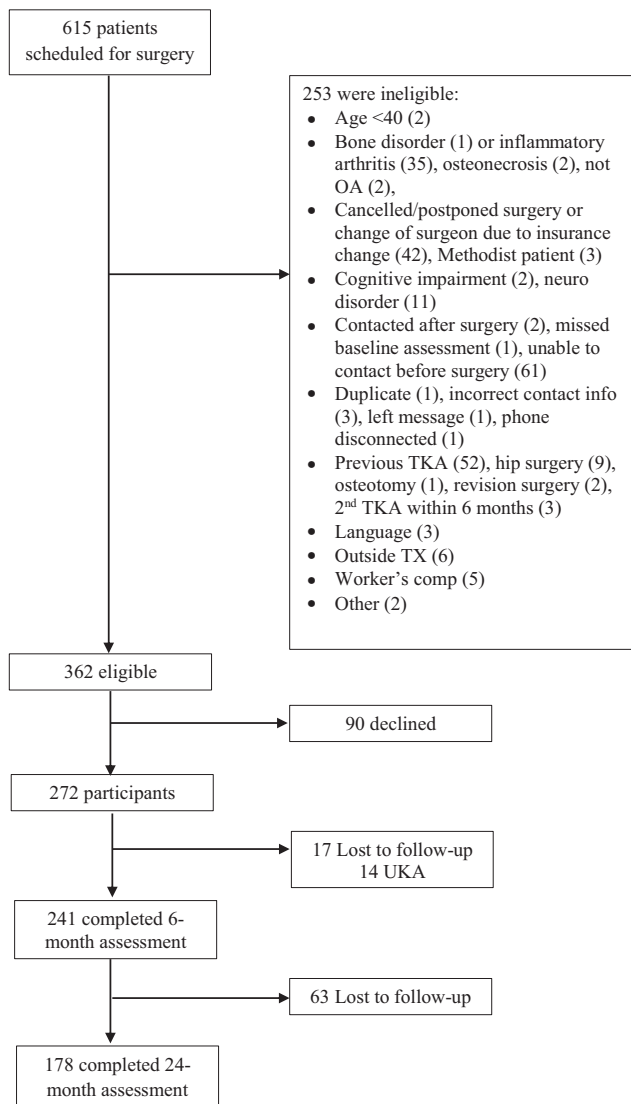


Figure 1. Participants' flow chart.

Descriptive data. Demographic characteristics are presented in Table 1. Table 2 shows scores for the primary and secondary outcome measures (ie, WOMAC, SF-36, and SkiP) and psychosocial assessments at baseline and 24 months after surgery. Scale reliability (Cronbach α) was greater than 0.60 for all of the variables except for the chance subscale of MHLC. Primary outcome measures (WOMAC and the PCS subscale of SF-36) significantly improved at 24 months compared with baseline. Other than anxiety, psychosocial constructs did not significantly change between baseline and 24 months. Interestingly, anxiety as measured by the DASS21 worsened at 24 months ($P < 0.01$).

Associations between psychosocial factors and TKA outcomes 24 months after surgery. Results of the multivariate regression analyses are presented in Tables 3 and 4. No significant levels of multicollinearity were observed among the predictor variables (VIF < 10 ; results not shown).

Pain. Increased age, high BMI, low tangible support, low optimism, and high baseline WOMAC pain scores were associated with high WOMAC pain 24-month scores (high scores = worse outcomes; adjusted $R^2 = 0.15$).

Function. Increased age, high BMI, low tangible support, increased stress, and low optimism were associated with high WOMAC function scores at 24 months (high scores = worse outcomes; adjusted $R^2 = 0.22$).

Health-related quality of life. Increased age, high BMI, a high number of comorbidities, and reduced physical function at baseline were predictive of low PCS scores (adjusted $R^2 = 0.34$). Increased depression, low optimism, and poor MCS scores at baseline were predictive of low MCS scores at 24 months (adjusted $R^2 = 0.38$).

Satisfaction with knee procedure. Those with a highly dysfunctional style of coping were less likely to be satisfied with their surgery (adjusted $R^2 = 0.12$). On the basis of the adjusted R^2 values in these models, patient demographic and psychosocial factors combined are responsible for 15% to 38% of the variability observed in patient-reported 24-month outcomes.

Ancillary analyses. Sensitivity analyses. The observed associations held generally true for regression models with household income adjustment. With this adjustment, low optimism was also associated with reduced satisfaction with the surgery (adjusted $R^2 = 0.03$), and high income (\geq US\$50 000) was associated with greater MCS scores at 24 months (adjusted $R^2 = 0.43$; data not shown).

Table 1. Demographic characteristics of the patients included in the analysis (n = 178)

Characteristic	No. (%)
Mean age (\pm SD)	65 \pm 9 years
Female	116 (65%)
Race/ethnicity	
African American	42 (23)
Spanish/Hispanic	10 (6)
White ^a	126 (71)
Education	
Did not finish high school	9 (5)
At least a high school diploma	169 (95)
Living with spouse	
No	64 (36)
Yes	114 (64)
Employment status	
Employed	77 (43)
Disabled	6 (3)
Retired	85 (48)
Other	10 (6)
Household income ^b	
<US\$50 000	69 (45)
\geq US\$50 000	85 (55)
Mean body mass index (\pm SD)	32.6 \pm 6.4
Mean no. of comorbidities at baseline (\pm SD)	2 \pm 1

^a Two patients with a self-reported ethnicity of American Indian were included in this group.

^b Only 154 participants provided this information.

Table 2. Primary and secondary outcome measures and psychosocial assessment scores at baseline and 24 months after surgery

Assessment	Internal Consistency (Cronbach α)	Mean Baseline Score (SD)	Mean 24-Month Score (SD)	<i>P</i>
WOMAC				
Pain	0.84	53.3 (18.6)	18.3 (19.1)	<0.0001
Function	0.94	51.8 (18.3)	20.1 (17.9)	<0.0001
SF-36				
PCS		29.5 (7.8)	42.2 (10.1)	<0.0001
MCS		52.5 (12.0)	53.2 (10.8)	0.39
SkiP	0.78		4.6 (0.7)	
MOS-SSS				
Emotional/informational support	0.94	4.1 (0.8)	4.2 (0.9)	0.18
Tangible support	0.90	4.2 (1.0)	4.2 (1.0)	0.76
Affectionate support	0.86	4.4 (0.9)	4.4 (0.9)	0.96
Social interaction support	0.85	4.3 (0.8)	4.3 (0.9)	0.89
Overall	0.96	80.1 (19.3)	81.3 (21.4)	0.46
DASS21				
Stress	0.79	6.9 (6.7)	6.0 (6.5)	0.10
Anxiety	0.67	2.6 (4.0)	3.6 (5.1)	0.006
Depression	0.84	3.4 (5.6)	4.2 (6.6)	0.08
Brief COPE inventory				
Dysfunctional coping	0.66	1.7 (0.4)		
Problem-solving coping	0.71	3.2 (0.7)		
Emotional coping	0.72	2.8 (0.6)		
MHLC				
Internal	0.70	25.9 (4.9)		
Chance	0.56	15.9 (5.1)		
Powerful others	0.69	20.0 (5.9)		
ASES	0.93	5.3 (2.5)		
LOT-R	0.68	76.8 (15.6)		

Note. *P* values were obtained from a paired sample *t* test.

Abbreviations: ASES, Arthritis Self-Efficacy Scale; DASS21, Depression, Anxiety, and Stress Scale; LOT-R, Life Orientation Test-Revised; MCS, mental component summary subscale; MHLC, Multidimensional Health Locus of Control; MOS-SSS, Medical Outcome Study Social Support Scale; PCS, physical component summary subscale; SF-36, Short Form 36; SkiP, Satisfaction with Knee Procedure; WOMAC, Western Ontario McMaster Universities Osteoarthritis Index.

Losses to follow-up. Twenty-nine percent of our patients were lost to follow-up at 24 months. Those who completed both assessments were slightly older than those who were lost to follow-up (66 vs 63 years, $P < 0.01$) and more educated (95% with at least a high school diploma vs 87%, $P < 0.05$). No significant differences in sex, race, and baseline psychosocial scores were observed between the two groups except for DASS21, COPE dysfunctional, and self-efficacy scores, where patients who completed both assessments had better baseline scores than those who did not. There were differences between completers and noncompleters in mean baseline outcomes (WOMAC and SF-36 scores) in that completers had better outcomes at baseline than noncompleters (data not shown).

DISCUSSION

The aim of this study was to identify potential psychosocial factors that are predictive of patient-reported TKA outcomes and satisfaction 2 years after surgery. We observed that at 24 months after TKA, increased age, high BMI, decreased tangible support, and low optimism were associated with increased WOMAC pain

scores, whereas increased age, high BMI, decreased tangible support, increased stress, and low optimism were associated with decreased WOMAC function scores.

Perception of tangible support was associated with decreased pain and improved function at 24 months, a finding also observed in our prior analysis at 6 months (1). Tangible support, a form of social support, is described as the provision of material aid or behavioral assistance (21). Greater tangible support was associated with decreased WOMAC pain and WOMAC function scores at 24 months. In our previous study, we found that increased tangible support was associated with decreased WOMAC function scores at 6 months as well. Social support, in general, is considered to be an important factor in functional recovery after surgery (27). Although social support has not been extensively studied in relation to functional recovery after TKA, it has been reported to be a significant positive predictor of recovery after hip and cardiac surgery (28,29). In a study examining the role of social support in achieving rehabilitation tasks after TKA, Kendall et al found that high perceived social support tended to predict faster achievement of rehabilitation tasks, although the findings were not statistically significant (27). To the best of our

Table 3. Stepwise multiple linear regression models for WOMAC

	WOMAC (n = 175)					
	Pain			Function		
	β	Standardized β (95% CI)	<i>P</i>	β	Standardized β (95% CI)	<i>P</i>
Age	0.4	0.17 (0.03, 0.32)	0.02	0.6	0.29 (0.16, 0.43)	<0.001
Female sex	-0.4	-0.01 (-0.16, 0.13)	0.89	1.6	0.04 (-0.1, 0.18)	0.55
Living with spouse						
Disabled						
Retired						
Other employment status						
Body mass index	0.6	0.20 (0.06, 0.35)	0.006	0.6	0.22 (0.08, 0.36)	0.002
No. of comorbidities						
MOS-SSS tangible support	-4.6	-0.23 (-0.37, -0.09)	0.001	-6.2	-0.33 (-0.52, -0.14)	<0.001
MOS-SSS affectionate support				3.4	0.17 (-0.02, 0.36)	0.08
DASS21 stress				0.6	0.23 (0.08, 0.37)	0.002
DASS21 depression						
Brief COPE inventory dysfunctional coping						
Brief COPE inventory problem-solving coping						
ASES						
LOT-R	-0.2	-0.19 (-0.33, -0.05)	0.007	-0.2	-0.15 (-0.29, -0.01)	0.03
Baseline WOMAC pain score	0.2	0.17 (0.02, 0.31)	0.03			
Baseline SF-36 PCS score						
Baseline SF-36 MCS score						
Adjusted <i>R</i> ² (total)		0.15			0.22	

Abbreviations: ASES, Arthritis Self-Efficacy Scale; CI, confidence interval; DASS21, Depression, Anxiety, and Stress Scale; LOT-R, Life Orientation Test-Revised; MOS-SSS, Medical Outcome Study Social Support Scale; SF-36, Short Form 36; WOMAC, Western Ontario McMaster Universities Osteoarthritis Index.

knowledge, no study has assessed the different types of social support available to patients undergoing TKA and the influence of each type of support on outcomes after surgery.

High baseline depression scores were associated with reduced MCS scores at 24 months after surgery. Previous studies have investigated depression and mental health as independent predictors of pain and mental function outcomes after TKA, but most have shown conflicting results for the influence of depression and mental health on short-term outcomes (≤ 6 months) compared with long-term outcomes (≥ 1 year). In a 2012 review, Vissers et al concluded that preoperative depression and poor mental health had no influence on short-term postoperative mental function, but these were strong predictors of long-term pain and reduced mental function (11). Ayers et al found results similar to ours, wherein mild preoperative depression was associated with low postoperative MCS scores in patients who underwent TKA at 6 months (30). Similarly, a recent systematic review reported that anxiety and/or depression scores were the most common preoperative determinants of satisfaction with TKA in studies with follow-up time ranging from 0.33 to 199 months (31).

We found that increased baseline levels of stress were associated with reduced WOMAC function 24-month scores after surgery. To the best of our knowledge, no prior studies have evaluated the role of preoperative stress on functional outcomes after TKA. One study reported that stress was not a significant predictor of postoperative pain in patients who underwent TKA (32).

Optimism was the most common psychosocial factor associated with TKA outcomes in our study. Low baseline optimism was a significant predictor of WOMAC pain scores, WOMAC function scores, and MCS scores at 24 months. Previous studies, including our own 6-month findings in this patient cohort, reported no significant association of optimism with pain or function after TKA. However, these studies examined the effects of optimism only up to 6 months after surgery (1,33,34). The greatest gains in pain and function after TKA occur mostly within the first 3 to 6 months after surgery. Thus, it can be hypothesized that patients' preoperative optimism levels are predictive of longer-term TKA outcomes, possibly after patients achieve greater pain control and function.

Increased dysfunctional coping was associated with decreased satisfaction with the procedure after 24 months. Previous studies examining both short-term and long-term determinants of satisfaction in patients undergoing TKA have reported that patients' age, expectations about surgery, pain and functional outcomes after surgery, social functioning, mental health, and general physical well-being (35–40) are predictive of satisfaction with the procedure. It has been shown that reduced coping efficacy and pain catastrophizing negatively affect pain and physical functioning after TKA in the short term (1,34,41,42). In our analysis of 6-month outcomes, increased dysfunctional coping was associated with increased WOMAC pain scores, whereas reduced problem-solving coping was associated with decreased WOMAC function scores. Thus, it can be hypothesized that dysfunctional coping acts as a mediator in the relationship between pain and

Table 4. Stepwise multivariate regression for SF-36 and SKiP

	SF-36								
	PCS (n = 175)			MCS (n = 178)			SKiP (n = 178)		
	β	Standardized β (95% CI)	<i>P</i>	β	Standardized β (95% CI)	<i>P</i>	β	Standardized β (95% CI)	<i>P</i>
Age	-0.3	-0.28 (-0.41, -0.15)	<0.001	-0.02	-0.02 (-0.14, 0.1)	0.78	-0.004	-0.05 (-0.21, 0.11)	0.54
Female sex	0.02	0.001 (-0.12, 0.13)	0.99	-1.6	-0.07 (-0.19, 0.05)	0.26	0.1	0.08 (-0.08, 0.24)	0.32
Living with spouse							0.2	0.16 (0, 0.32)	0.05
Disabled							0.3	0.09 (-0.06, 0.23)	0.24
Retired							-0.1	-0.08 (-0.25, 0.08)	0.32
Other employment status							-0.8	-0.29 (-0.44, -0.13)	<0.001
Body mass index	-0.3	-0.19 (-0.32, -0.06)	0.006						
No. of comorbidities	-1.8	-0.17 (-0.3, -0.04)	0.01						
MOS-SSS tangible support				1.2	0.11 (-0.02, 0.23)	0.09			
MOS-SSS affectionate support									
DASS21 stress				-0.2	-0.12 (-0.26, 0.03)	0.11			
DASS21 depression				-0.4	-0.19 (-0.34, -0.05)	0.01			
Brief COPE inventory dysfunctional coping							-0.3	-0.20 (-0.35, -0.05)	0.009
Brief COPE inventory problem-solving coping							0.1	0.14 (0, 0.29)	0.06
ASES	0.5	0.11 (-0.02, 0.24)	0.08						
LOT-R				0.2	0.27 (0.15, 0.4)	<0.001			
Baseline WOMAC pain score									
Baseline SF-36 PCS score	0.4	0.35 (0.21, 0.48)	<0.001						
Baseline SF-36 MCS score				0.2	0.24 (0.1, 0.38)	0.001			
Adjusted <i>R</i> ² (total)	0.34			0.38			0.12		

Abbreviations: ASES, Arthritis Self-Efficacy Scale; CI: confidence interval; DASS21, Depression, Anxiety, and Stress Scale; LOT-R, Life Orientation Test-Revised; MCS, mental component summary subscale; MHL, Multidimensional Health Locus of Control; MOS-SSS, Medical Outcome Study Social Support Scale; PCS, physical component summary subscale; SF-36, Short Form 36; SKiP, Satisfaction with Knee Procedure.

function and satisfaction with TKA. In the first few months after surgery, high levels of pain and low function are associated with increased dysfunctional coping, whereas in the long term, when patients have achieved some level of pain reduction and increased function, dysfunctional coping no longer influences pain and function and is associated only with reduced satisfaction.

In our analysis of 6-month outcomes, anxiety scores significantly decreased compared with baseline (1), a finding corroborated in another study (43). However, at 24-months we observed a small increase in anxiety levels at 24 months, although the mean value remained within the normal range. Anxiety, not as a disorder but as an expression of worry, can increase in older adults (44,45). The mean age of our cohort was 63 at the time of surgery, and aging after 2 years could possibly have mildly increased anxiety levels, as the effect size although statistically significant was quite small. One could speculate that improvement in outcomes in the

short term could decrease anxiety, but after this initial impact, worrying and the associated anxiety could have increased after 2 years in these older adults. Another possible explanation of increased anxiety may be due in part to the patients' awareness of the prosthesis. A prior qualitative study reported that some participants worry because their prosthesis feels foreign to their bodies and they fear that it could initiate an inflammatory response, induce a malignancy, or lead to more surgery (46).

Across our models, 15% to 38% of the variability in the outcomes was explained by baseline demographic and psychosocial variables. We did not include factors such as length of hospital stay, postsurgical complications, and surgery wait times, which are known to influence TKA outcomes (47). Therefore, other important but unmeasured or unknown variables are likely to be predictive of long-term pain and functional outcomes after TKA, and these may vary at 6 and 24 months.

Our study was conducted in a private hospital, and all patients had medical insurance and were predominantly white, so our results may not be generalizable to other, more disadvantaged populations. Several participants who were included in the 6-month follow-up analysis did not complete the 24-month follow-up assessment for the current analysis. Although no significant differences in most psychosocial variables were observed at baseline between these two groups (data not shown), we do not know if nonresponders had different long-term outcomes than responders. Some differential results were observed in baseline psychosocial characteristics predictive of pain and function outcomes at 24 months compared with those observed at 6 months, attributable to the smaller sample size in the current study, which caused certain variables that were significant predictors of outcomes at 6 months to drop out of models at 24 months. Also, because we did not measure SF-36 and SkiP scores at 6 months, or Knee Society Rating System scores at 24 months, we are unable to compare these findings between the two follow-up time periods (1). Finally, although TKA or rehabilitation techniques have evolved and/or may differ across surgeons, our findings indicate that regardless of the chosen technique used, baseline psychosocial measures, such as dysfunctional coping, stress, depression, and optimism, should be assessed in patients considering TKA.

In summary, we found that important psychosocial factors, such as dysfunctional coping, stress, depression, and optimism, were associated with TKA outcomes and patient satisfaction at 24 months after surgery and therefore remain important predictors of long-term outcomes. Across our models, only 15% to 38% of the variability in the outcomes can be explained by baseline demographic and psychosocial variables. This suggests that other important but unknown variables are predictive of long-term pain and functional outcomes after TKA. Rehabilitation of patients undergoing TKA is challenging, requiring patients' full participation while they are in pain (21). It is conceivable, then, that specific strengths in psychosocial domains may assist patients in their recovery. Intervention strategies targeting relevant psychosocial domains should be developed and tested, especially in high-risk patients with maladaptive behaviors and thoughts who may require more extensive rehabilitation during their recovery.

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AUTHOR CONTRIBUTIONS

All authors were involved in drafting the article or revising it critically for important intellectual contact, and all authors approved the final version

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