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Early Identification of Patient Satisfaction Two Years After Total Knee Arthroplasty

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ABSTRACT

Background: There are numerous reports of poor satisfaction after total knee arthroplasty (TKA), yet there is little known about when to use evidence-based models of care to improve patient outcomes.
Objective: This study aimed to characterize longitudinal changes in patient-reported satisfaction after TKA and to identify factors for early identification of poor satisfaction.
Methods: For a cohort of primary TKA surgeries (n = 86), patient-reported outcomes were captured one week before TKA and 6 weeks, 12 weeks, 6 months, and 1 and 2 years after TKA. "Satisfied" versus "not fully satisfied" patients were defined using a binary response (≥90 vs <90) from a 100-point scale. Wilcoxon signed-rank tests identified changes in satisfaction between follow-up times, and longitudinal analyses examined demographic and questionnaire factors associated with satisfaction.
Results: Improvements in satisfaction occurred within the first 6 months after TKA ($P \leq 0.01$). Preoperative patient-reported outcome measures alone were not predictive of satisfaction. Key factors that improved longitudinal satisfaction included higher Oxford Knee Scores (odds ratio (OR) = 2.1, $P < .001$), general health (EQ-VAS, OR = 1.3, $P = .03$), and less visual analog scale pain (VAS; OR = 1.7, $P < .001$). Differences in these factors between satisfied and not fully satisfied patients were identified as early as 6 weeks after surgery.
Conclusion: Visibly different satisfaction profiles were captured among satisfied and not fully satisfied patient responses, with differences in patient-perceived joint function, general health, and pain severity occurring as early as 6 weeks after surgery. This study provides metrics to support early identification of patients at risk of poor TKA satisfaction, enabling clinicians to apply timely targeted treatment and support interventions, with the aim of improving patient outcomes.

Total knee arthroplasty (TKA) is a high incidence joint arthroplasty surgery with increasing prevalence [1,2]. Procedure rates are rising among younger and more physically demanding individuals with high functional expectations [3,4]. Although TKA is widely recognized as an effective procedure, patient-reported satisfaction rates remain around 80%, low relative to other orthopedic procedures; over 2% of patients are at risk of revisions, and readmissions impact over 6% of patients within 3 months [4–7]. Common reports of poor patient-reported outcome measures (PROMs) in a subset of patients after TKA signal the continued need to improve our understanding of which patients are at risk for adverse outcomes to inform evidence-based models of care and maximize outcomes [8].

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General satisfaction with TKA can be influenced by a variety of factors and has been attributed preoperatively to severity of pain [7,9], self-reported function [9], and mental health scores [9,10]. Postoperatively, satisfaction has been attributed to pain relief [7,9–11], health-related quality of life [9,10], and self-reported function scores [7,9,10], in addition to considerations of expectations [7,10], procedure complications [7], pain in other joints [9,11], and personality traits [12]. Despite broad knowledge of features associated with satisfaction, we still have a poor ability to predict satisfied patients. Specifically, preoperative patient-reported measures lack the predictive ability to identify satisfied patients postoperatively [13,14], and a recent review has suggested that many associations with satisfaction are controversial or equivocal because of methodological differences in study timelines, cohorts, and outcomes [15]. Although the myriad of dimensions that influence satisfaction are complex, patients who do report poor responses in the years after TKA will continue to experience more pain or poor satisfaction at 10-15 years, without a quantifiable radiographic or clinical premise for their response [16,17]. This suggests that some patients are being missed who may have benefitted from early postoperative care strategies, conservative treatment strategies [18], or approaches that deviate from the standard of care [19,20]. Most postoperative assessments of satisfaction lack this longitudinal approach by measuring satisfaction at a single time point, typically between 6 months to 2 years after TKA. Only one investigation has addressing earlier postoperative outcomes at 3 months [21]. If patients at risk of poor satisfaction cannot be identified before arthroplasty [13,14], there is impetus to identify them as early as possible in the care processes, as appropriate supports or interventions could be essential in achieving desirable outcomes longitudinally.

The objective of this study was to characterize changes in patient-reported general satisfaction from 6 weeks to 2 years after TKA and to identify patient-reported outcomes and demographics that are associated with dissatisfaction. Longitudinal data analysis was used to identify when particular factors become meaningful in high-risk patient profiling, while confirming the relevance of factors up to 2 years after TKA.

Materials and Methods

This was a secondary study on a subset of patients recruited for a radiostereometric analysis implant migration study [22]. Surgeries were performed by 5 high-volume surgeons at a single site for primary TKA between 2011 and 2014. Patients were asked to voluntarily participate in this study. Patients were included in this study if they were scheduled for TKA, if they were able and willing to provide study participation consent, and if they attended follow-up visits (no explicit exclusion criteria were applied). Pre-TKA patient factors and PROMs were collected during preadmission surgical visits, which included demographics (age, gender), body mass index (BMI), and the following questionnaires: 1) the Hospital for Special Surgery Knee Replacement Expectations Survey (19 [highest]-95 [lowest]) [23], 2) the Pain Catastrophizing Score (PCS, 0 [least]-52 [most]) [24] reflecting anxious preoccupation and a sense of helplessness regarding pain, shown to be an independent predictor of post-TKA chronic pain [25], 3) the joint-specific functional Oxford-12 Knee Score (OKS) (0 [worst]-48 [best]) [26], 4) the visual analog scale (VAS) Pain Score (0 [worst pain imaginable]-100 [no pain]) [27], 5) the UCLA Physical Activity Score (0 [lowest]-10 [highest]) [28], 6) the EuroQoL EQ-VAS general health score (0 [worst]-100 [best]), and 7) the EQ-5D questionnaire based on 5 questions regarding difficulties with i) walking, ii) self-care, ii) performing usual activities, iv) experiencing pain or discomfort, and v) anxiety/depression (5 [best]-15 [worst]) [29]. Post-TKA outcomes were collected longitudinally through follow-up mail-outs at 6 weeks, 3 months, 6 months, and 1 and 2 years after TKA. Follow-up questionnaires included numbers 3-7 from those listed previously. A Satisfaction VAS questionnaire was also asked before TKA and at each follow-up. Patients were asked "How satisfied are you with your knee today, in your opinion" and indicated on a scale from 0 (unsatisfied) to 100 (completely satisfied). The satisfaction score was used to define a binary outcome: "satisfied" for scores $\geq$ 90 and "not fully satisfied" for scores $\leq$ 89. A binary cutoff score of 90 was selected as it approximated mean satisfaction scores at one year. Furthermore, a study by Noble et al [30] reported satisfaction on a similar population using both a VAS and the five-factor satisfaction scale of the New Knee Society Scoring System more commonly reported [7,9–11,31,32]. Those categorized as "satisfied" using the five-factor New Knee Society Scoring System had mean satisfaction scores postoperatively that approximated 90 on the VAS. This supported the satisfaction threshold assumption applied for the purposes of examining clinically not fully satisfied patients who underwent TKA. The score of 90 also agreed with an expected ~80% satisfaction rate for candidates who underwent TKA at 1 year.

Patients missing pre-TKA satisfaction scores and 3 or more satisfaction responses after TKA (ie, missing $\geq$3/5 post-TKA responses) were removed from analysis. Statistical analysis was performed using R (2015, R Foundation for Statistical Computing, Vienna, Austria). Data analysis was performed on a deidentified database, under Research Ethics Board approval.

Satisfaction at One Year

Satisfaction scores at one year after TKA were used to create stratified groups of "satisfied" and "not fully satisfied" at a common and stable time point [7,9,21]. Mann-Whitney U tests, unpaired t-tests, and chi-squared tests were used to identify differences between one-year satisfaction stratified groups in PROMs and demographics at each collection time.

Longitudinal Satisfaction

Wilcoxon signed-rank tests were used to identify changes in mean satisfaction scores between each follow-up time point. A generalized linear mixed effects model with a binomial logit link function was applied to examine pre- and post-TKA PROMs and demographics associated with longitudinal satisfaction. This model accounted for dependencies caused by repeated measures and within-subject variability. Patient-specific random effects were included, as were fixed effects to test for the effect of demographic and questionnaire factors. Influence of factors was presented as odds ratios (ORs). For clinical interpretability, Pain VAS, EQ-VAS, and OKS were standardized such that ORs represented 10% changes. Models were assessed using randomized quantile residual and Q-Q plots, Shapiro-Wilk normality tests, and the Akaike information criterion. Significant effects were those with a P-value $\leq$ .05.

Results

Demographic and pre-TKA satisfaction scores were available for 110 patients who underwent primary TKA. After correcting for missing data points (dropouts), 86 TKA surgeries with pre-TKA satisfaction responses were included (Fig. 1). Questionnaire responses ($n_{\text{unique knees}} = 86$, $j_{\text{observations}} = 483$) and missing data elements at each time point are summarized in Table 1. Comparing demographic and PROM responses between dropouts and the study group captured higher VAS pain scores in the dropout group relative to the study group ($P = .03$).

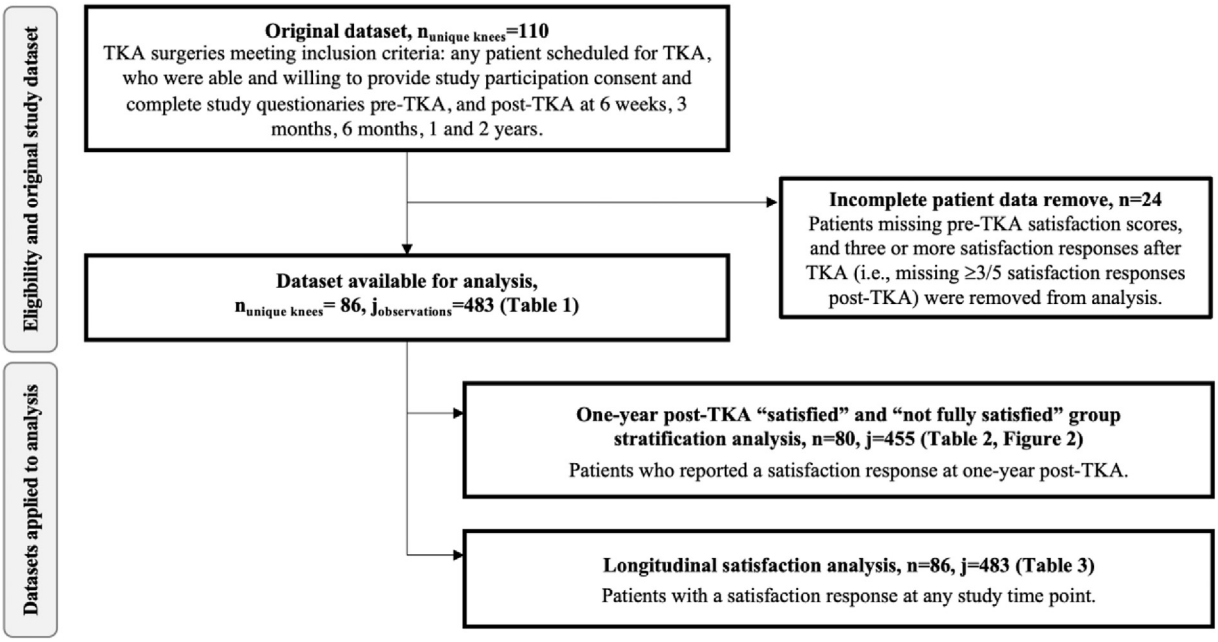

Fig. 1. CONSORT (Consolidated Standards of Reporting Trials) diagram of patient eligibility and selection processes for data analysis.

Satisfaction at One Year

Eighty satisfaction follow-up scores were completed at one year after TKA and were included in the one-year stratified analysis (n = 80, j = 455). Mean satisfaction scores at one year were 91.8 ± 14.4 (Table 1). Using a satisfaction threshold of ≥90, 82.5% (n = 66/80) were categorized as satisfied (Table 1), with mean satisfaction scores of 96.6 ± 3.9 among the satisfied group, relative to 69.1 ± 22.6 among those not fully satisfied (Table 2). Time series satisfaction scores between these groups are shown in Figure 2.

Differences between those categorized as satisfied and not fully satisfied at one year were found in the pre-TKA data, with the not fully satisfied group having higher PCS (24.3 vs 13.0, $P = .02$) and lower EQ-5D scores (0.46 vs 0.63, $P < .001$) (Table 2). There were no differences in gender or BMI between the one-year satisfied and not fully satisfied groups preoperatively. Additional differences were found at 6 weeks after TKA, with the one-year not fully satisfied group reporting lower OKS (25.2 vs 30.3, $P = .01$), worse Pain VAS (57.6 vs 71.7, $P = .03$), and lower EQ-VAS scores (62.3 vs 77.3, $P < .01$).

Longitudinal Satisfaction

Mean satisfaction scores increased over time, with significant differences between pre-TKA and 6 weeks ($P = .001$), 6 weeks and 3 months ($P = .001$), and 3 months and 6 months ($P = .01$). No statistical differences in satisfaction scores were captured between 6-month up to the 2-year follow-up point ($P > .4$).

Table 1
Patient Factors, Mean PROM Responses, Standard Deviations, and Missing Data Pre-TKA and at Each Follow-Up Time (n = 86 Unique Knees; j = 483 Observations).

	Baseline (Pre-TKA)	6 Wk	3 Mo	6 Mo	1 Y	2 Y
Responses	86	85	83	81	80	68
Age (y)[a]	63.1 (8.7)					
Gender (F:M)[a]	55:31					
BMI (kg/m^2) [a]	34.6 (7.7)					
Knee replacement expectations survey[a]	41.2 (13.6)					
Missing	39					
Pain Catastrophizing Scale[a]	15.4 (13.0)					
Missing	18					
Mean satisfaction VAS	26.3 (25.7)	78.3 (18.3)	86.9 (14.6)	90.9 (14.2)	91.8 (14.4)	92.6 (10.5)
% Satisfied	3.5%	37.6%	62.7%	81.5%	82.5%	85.3%
Missing	0	1	3	5	6	18
Oxford Knee Score	21.3 (6.5)	29.3 (7.3)	36.4 (7.3)	38.8 (6.5)	39.6 (6.9)	39.9 (6.6)
Missing	0	0	0	0	0	0
Pain VAS	47.6 (22.5)	67.6 (22.9)	84.1 (17.4)	86.6 (21.3)	88.2 (19.6)	90.2 (16.0)
Missing	0	1	2	0	0	0
EQ-5D	0.60 (0.16)	0.73 (0.12)	0.79 (0.14)	0.82 (0.15)	0.84 (0.15)	0.83 (0.15)
Missing	0	0	0	0	1	1
EQ-VAS	67.2 (17.5)	74.4 (16.5)	79.9 (15.9)	83.4 (14.6)	83.7 (15.2)	82.4 (15.3)
Missing	0	1	0	0	0	1
UCLA Activity Score	4.7 (2.0)	4.6 (1.3)	5.2 (1.4)	5.7 (1.5)	5.5 (1.8)	5.5 (1.5)
Missing	0	3	0	0	0	1

PROM, patient-reported outcome measure; TKA, total knee arthroplasty; BMI, body mass index; VAS, visual analog scale.
[a] Denotes time-independent features captured preoperatively.

Table 2
Mean Patient Scores and Standard Deviations Based on One-Year "Satisfied" and "Not Fully Satisfied" Group Stratification (n = 80 Unique Knees; j = 455 Observations).

	Baseline (Pre-TKA)			6 Wk			3 Mo			6 Mo			1 Y			2 Y		
	1-Year Satisfied	1-Year Not Fully Satisfied	P	1-Year Satisfied	1-Year Not Fully Satisfied	P	1-Year Satisfied	1-Year Not Fully Satisfied	P	1-Year Satisfied	1-Year Not Fully Satisfied	P	1-Year Satisfied	1-Year Not Fully Satisfied	P	1-Year Satisfied	1-Year Not Fully Satisfied	P
Age (y) [a]	62.6 (8.6)	65.4 (9.6)	.34															
Gender (F:M)[a]	41:25	10:4	.51															
BMI (kg/m^2)[a]	34.0 (7.3)	36.0 (8.9)	.44															
Knee arthroplasty expectations[a]	41.0 (13.3)	43.1 (16.7)	.86															
Pain Catastrophizing Scale[a]	13.0 (11.3)	24.3 (15.8)	**.02**[b]															
Mean Satisfaction VAS	26.4 (26.4)	27.9 (24.7)	.62	81.2 (16.4)	68.6 (25.5)	.05	90.0 (9.9)	70.9 (22.2)	**.001**[b]	93.9 (7.6)	75.6 (25.6)	**.01**	96.6 (3.9)	69.1 (22.6)	**<.001**[b]	95.0 (7.8)	80.1 (14.8)	**<.001**[b]
Oxford Knee Score	21.8 (6.3)	18.6 (7.5)	.15	30.3 (7.4)	25.2 (6.3)	**.01**[b]	37.8 (6.0)	30.1 (10.2)	**<.01**[b]	40.6 (4.5)	30.9 (8.2)	**<.001**[b]	41.3 (5.3)	31.1 (7.6)	**<.001**[b]	41.8 (4.8)	31.4 (8.4)	**<.001**[b]
Pain VAS	49.2 (23.6)	38.1 (19.1)	.12	71.7 (22.0)	57.6 (22.3)	**.03**[b]	88.4 (11.8)	63.1 (23.5)	**<.001**[b]	90.1 (18.7)	67.6 (25.4)	**<.001**[b]	94.9 (9.2)	56.9 (24.8)	**<.001**[b]	92.2 (14.9)	78.6 (19.3)	**.001**[b]
EQ-5D	0.63 (0.1)	0.46 (0.2)	**<.001**[b]	0.74 (0.1)	0.67 (0.1)	**<.01**[b]	0.82 (0.1)	0.67 (0.2)	**<.01**[b]	0.85 (0.1)	0.71 (0.2)	**<.01**[b]	0.88 (0.1)	0.69 (0.1)	**<.001**[b]	0.87 (0.1)	0.70 (0.1)	**<.001**[b]
EQ-VAS	68.9 (16.5)	64.1 (19.8)	.43	77.3 (15.3)	62.3 (16.8)	**<.01**[b]	83.7 (12.2)	64.7 (18.2)	**<.001**[b]	85.4 (13.4)	74.6 (17.1)	**.01**[b]	87.7 (11.7)	65.0 (15.9)	**<.001**[b]	84.0 (15.2)	74.6 (13.9)	**.02**[b]
UCLA Activity Score	4.9 (1.9)	4.5 (2.2)	.43	4.7 (1.2)	4.3 (1.4)	.37	5.2 (1.3)	5.1 (1.8)	.52	5.9 (1.4)	4.9 (1.5)	**.03**[b]	5.6 (1.7)	4.6 (2.1)	**.04**[b]	5.7 (1.4)	4.8 (1.4)	.07

Six participants used in the longitudinal analysis did not have a satisfaction result at 1 year and were therefore not included in the stratified group analysis.
BMI, body mass index; VAS, visual analog scale. Bold indicates *P*-value ≤ .05.
[a] Denotes time-independent features captured preoperatively.
[b] Denotes *P* < .05.

Longitudinal analysis conducted on the entire data set (n = 86, j = 483) found the strongest contributors for improved odds of satisfaction in an individual to be higher OKS (OR = 2.08, *P* < .001), less pain (OR = 1.69, *P* < .001), and higher EQ-VAS scores (OR = 1.34, *P* = .03), where a 1 point change in the OR of the β coefficient represented a 10% increase in each score, Table 3. Although EQ-5D total scores were not significant in the model (*P* = .07), breaking down EQ-5D responses by each of the 5 questions, question one was significant, described greater odds of a satisfaction response in patients with less difficulty walking (*P* < .05). Question two neared significance (*P* = .07), which captured dimensions of self-care, included to optimize model Akaike Information Criterion. All features remained significant after EQ-5D question two's removal. When testing this model using a continuous VAS satisfaction outcome variable, only OKS and VAS Pain factors contributed to an improved satisfaction response (*P* < .001). Patient age, gender, and BMI were not significant in the longitudinal analysis.

Discussion

Satisfied and not fully satisfied patients demonstrated visibly different satisfaction recovery patterns that have not previously been captured, with trajectories differing early postoperatively (Fig. 2). Patient satisfaction scores significantly improved within the first 6 months after TKA (*P* ≤ 0.01) and stabilized thereafter (*P* > .4). Therefore, final satisfaction perceptions do not stabilize and should not be measured as a definitive patient response until 6 months postoperatively. This likely coincides with the period of postoperative healing and improved physical function, with muscle recovery plateauing at approximately 6 months after TKA [38]. Interestingly, significant differences in satisfaction scores between "satisfied" and "not fully satisfied" groups were not apparent until 3 months, lagging other PROMs (Table 2). This delayed response could reflect patient realization that the procedure may not meet expectations, or a surgical team's ability to manage expectations closely after surgery, but be less effective with long-term management. It may also reflect an acclimatization after the expiry of support sessions, such as physiotherapy, and return to everyday activities (eg, work), as previous studies have identified associations between less social supports and low self-reported quality of life, and between living alone and dissatisfaction after TKA [7,39]. As early as 6 weeks after TKA, differences between satisfaction groups were identified in pain severity (VAS), general health (EQ-5D), and joint-specific health (OKS) (Table 2). These features were also the key predictors of satisfaction using longitudinal models (Table 3). These findings agree with prior studies at 3 [21] and 6 months [9], but a longitudinal approach provided novel insights into divergence in these factors earlier than previously reported. Therefore, this study supports the potential to identify individuals on a poor satisfaction trajectory as early as 6 weeks postoperatively using auxiliary domains of pain intensity, general health, and joint-specific health. Collection of these scores should be prioritized during clinical practice, with Table 2 representing early postoperative responses of patients in an at-risk range, providing metrics for clinical at-risk patient identification and an ability to address domains of concern at an individual level. Early identification of poor outcomes, paired with timely and targeted extended treatment, expectation management, or shared decision-making programs [8,33,34] may have the ability to alter patient outcome trajectories early in the postoperative period and improve satisfaction outcomes up to 2 years after TKA.

Preoperatively, satisfied patients self-reported less pain catastrophizing (PCS, *P* = .02) and better general health scores (EQ-5D total, *P* < .001) by one-year post-TKA stratification. However, neither pain catastrophizing nor EQ-5D general health scores

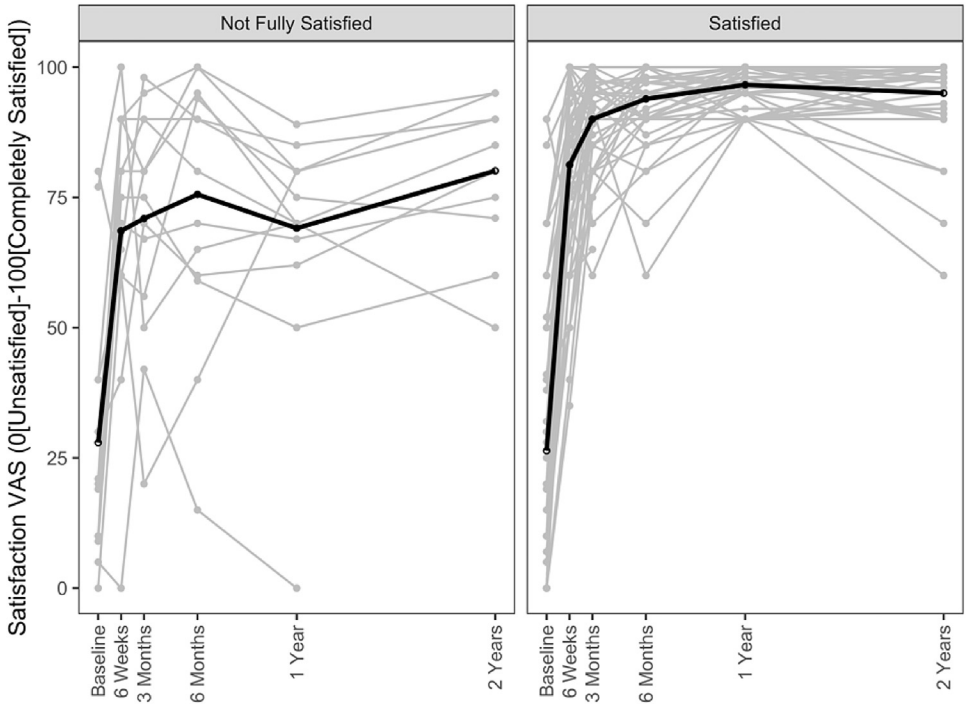

Fig. 2. Mean patient-reported satisfaction at each follow-up. Satisfied (right) is defined by VAS satisfaction scores ≥90 at one year after TKA (n = 80 unique knees). VAS, visual analog scale; TKA, total knee arthroplasty.

which differed among satisfaction groups preoperatively were stable in separating satisfied patients using longitudinal models. It has been suggested that preoperative self-reported metrics alone do not have the predictive capacity to identify satisfied patients postoperatively [13,14], and these findings support the notion that pre-TKA PROMs do not have utility for prioritizing patients for care. However, it was surprising that pain catastrophizing was not meaningful in satisfaction prediction. Preoperative pain catastrophizing has previously been associated with poor TKA outcomes in terms of pain [25,35] and quality of life [36]. Similarly, patient expectations which have been characterized as a leading predictor of poor satisfaction (when assessed postoperatively [4,6,7,9], but a poor predictor when captured preoperatively [10,11,37]) were also not significant in longitudinal satisfaction modeling. Both pain catastrophizing and expectation metrics were only available preoperatively, a time-independent feature, and both of these features included notable (18/86 and 39/86) missing responses. A sensitivity analysis confirmed that preoperative pain catastrophizing and expectations remained insignificant when modeling longitudinal TKA satisfaction when using data subsets with complete cases. However, further work should investigate the importance of pain catastrophizing and expectations captured postoperatively on longitudinal satisfaction, as these features might be expected to meaningfully contribute to early satisfaction identification [4,6,7,9,25,35]. Still, findings demonstrate that preoperative scores should not be used to prioritize access to care and clinical support, and if we wish to attempt to do so, examination of patients at a 6-week postoperative time point would be more effective.

Monitoring diverse patient domains in addition to general satisfaction shares insights into the basis behind poor satisfaction responses. For example, although pain relief is a main expectation of patients undergoing TKA and pain-related domains are generally reported to be a leading contributor to satisfaction followed by physical domains [7,9,32,40,41], the influence of pain (Pain VAS OR 1.69 ± 0.10) on long-term satisfaction in this study was less than the influence of the function-based OKS (OKS OR 2.08 ± 0.18). Functional measures have consistently been shown to contribute to satisfaction, captured using diverse tools including the OKS [9], Western Ontario and McMaster Universities Arthritis Index [7,10], other functional scores [6,9], and from gait measures [31]. Furthermore, the longitudinal satisfaction model specifically

Table 3
Factors Associated With Patient Satisfaction (Score ≥ 90) as Determined Using a Generalized Linear Mixed Effects Model (n = 86 Unique Knees; j = 483 Observations).

	β	95% CI β	Odds Ratio (β)	Std. Error (β)	Z Value	*P*
(Intercept)	−8.68	(−12.44, −4.92)	0.00	1.92	−4.52	<.001[a]
Follow-up time	0.02	(0.00,0.03)	1.02	0.01	2.45	.01[a]
Pain VAS	0.52	(0.32,0.72)	1.69	0.10	5.08	<.001[a]
EQ-5D Q1 (mobility)	−0.84	(−1.68, 0.00)	0.43	0.43	−1.97	<.05[a]
EQ-5D Q2 (self-care)	−1.48	(−3.10, 0.15)	0.23	0.83	−1.78	.07
EQ-VAS	0.29	(0.03, 0.55)	1.34	0.13	2.21	.03[a]
Oxford Knee Score	0.73	(0.38, 1.08)	2.08	0.18	4.10	<.001[a]

Pain VAS, EQ-VAS, and OKS were standardized such that ORs represent 10% changes.
CI, confidence interval; VAS, visual analog scale.
[a] Denotes $P < .05$.

included the EQ-5D question 1 (perceived difficulty walking) over other dimensions of general health, which is a unique finding. This may suggest that less satisfied patients are perceptive to a lack of improvement in mobility early in the recovery process, having utility for early patient profiling. The patients who underwent TKA in this study had a mean age of 63 and were therefore younger than the typically reported age of 70 in previous studies [7,9,32], potentially resulting in heightened functional awareness relative to populations previously studied. Recent work has also demonstrated a link between objective joint-level gait mechanics and self-reported outcomes after TKA [20,31,42] and identified surgical corrections after TKA that may be perceived through PROMs as unfavorably among some surgical candidates [19,20,43]. As TKA demographics become younger, with greater functional expectations [3,4], findings collectively demonstrate the importance of functional considerations to the patient experience longitudinally [44], a domain that may need to be better explored in relation to TKA to provide expected improvements for all patients.

Limitations of this study included anchoring our analysis on satisfaction and self-reported tools, which can be heavily biased by external contradictory or nonmodifiable factors [15]. As with most satisfaction studies, the applied "satisfaction" threshold of 90 also overlooked any distribution characteristics of the outcome variable. However, the incidence of a satisfied response at one year after TKA in this study (82.5%) aligned with an expected ~80% satisfaction rates commonly reported [7,9–11,21,31,32], making stratified groups representative of prior literature. Other limitations include missing data. The study sample was restricted to include patients with 3 or more satisfaction responses after TKA, yet also had high missing data specifically in the mentioned domains of pain catastrophizing (missing 18/86) and expectations (missing 39/86) which were only measured preoperatively. However, accounting for missing data, the power, given the sample size and repeated measures, was acceptable at >80% [45,46]. Another limitation included greater baseline pain in the excluded populations relative to the study population ($P = .03$). Dropout populations have been shown to be less satisfied [32], and results may be biased in terms of overoptimistic outcome scores. Ten knees (5 participants) in this study received bilateral TKA (1 simultaneous; 4 operated on 1.8 ± 0.6 years apart), not controlled for in this study. Postoperative conservative treatments such as physiotherapy regimes and compliance were also not captured or controlled for, which may have influenced satisfaction responses. Large response variance in self-reported scores was also observed, particularly among not fully satisfied individuals (Table 2) and visible in Figure 2. For example, an observation with a satisfaction score of 0 could be observed at 1 year after TKA. This patient went on to undergo revision surgery. Sensitivity analysis removing this surgery from the model did not alter results. Longitudinal analysis is robust in the handling of missing data [47], and a sample of 86 unique knees with 483 observations lends to the stability of these findings with valuable temporal insights into individual patient outcome trajectories.

This study provided novel insights into long-term satisfaction recovery patterns after TKA. Although findings suggest it is not feasible to identify patients at high-risk of poor satisfaction preoperatively [13,14], trajectory for satisfaction recovery is set in the early postoperative period. This study provides metrics to identify high risk of poor satisfaction patients as early as 6 weeks after TKA using pain intensity, general health, and joint-specific function postoperative responses (Table 2), enabling clinicians to address domains of concern at an individual patient-level. Monitoring of poor outcomes as early as 6 weeks after TKA, paired with timely and targeted extended treatment, expectation management, or support interventions for at-risk patients [8,33,34] may have the ability to alter patient outcome trajectories and improve satisfaction outcomes up to 2 years after TKA.

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