Journal of Clinical Orthopaedics and Trauma 11 (2020) S837–S843

Contents lists available at ScienceDirect

Journal of Clinical Orthopaedics and Trauma

journal homepage: www.elsevier.com/locate/jcot

PROMIS physical function two weeks following orthopaedic surgery

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ARTICLE INFO

Article history:
Received 9 April 2020
Received in revised form
5 June 2020
Accepted 6 June 2020
Available online 11 June 2020

Keywords:
PROMIS
Physical function
Orthopaedic surgery
Patient reported outcomes

ABSTRACT

Many patients opt for elective orthopaedic procedures to regain physical function. However, little data exist about patient-reported early postoperative function.

Purpose: To characterize physical function two weeks postoperative from upper and lower extremity orthopaedic surgery and to determine pre-operative factors that are associated with physical function two weeks following surgery.

Methods: Patients 17 years and older undergoing elective orthopaedic surgery at one institution were enrolled prospectively and completed questionnaires prior to surgery and again two weeks post-operatively. The questionnaires included: six of the PROMIS computer adaptive questionnaires: Physical Function (PF), Pain Interference, Fatigue, Social Satisfaction, Anxiety, and Depression; a joint-specific function questionnaire, a joint numeric pain scale, and a body numeric pain scale. Physical activity levels were measured using Tegner, IPAQ, and Marx. Responses were analyzed using Spearman's correlation coefficient, ANOVA, and multivariate linear stepwise regression with two-week PF as the dependent variable.

Results: 435 patients (47% female) with mean age 41.1 ± 15.7 were included in our final analysis. Mean baseline PF score was 42.1 and mean two-week PF score was 35.5 ($p < .0001$). Patients undergoing upper extremity surgery had higher PF at two weeks than those undergoing lower extremity surgery (39.1 vs 32.2, $p < .0001$). Younger age, Hispanic ethnicity, preoperative narcotic use, injury prior to surgery, and procedure all had a significant relationship with lower 2-week postoperative PF score ($p < 0.05$). Numerous baseline and 2-week measures were correlated with postoperative PF score, with 2-week Social Satisfaction demonstrating the strongest correlation ($r_s = 0.604$, $p < .0001$). Multivariable regression confirmed that the better preoperative PF score and upper extremity surgery were independent preoperative predictors of better 2-week PF scores.

Conclusions: Patients have a significant decline in physical function following orthopaedic surgery, with those undergoing lower extremity surgery having a significantly greater decline. Many factors are associated with activity levels, including mental health, pain, and satisfaction. This information can be used to help manage patients' short-term expectations.

1. Introduction

The incidence of orthopaedic surgeries in the United States has increased rapidly over the past two decades and is projected to continue to increase.[1,2] The number of shoulder arthroplasties performed increased 2.5-fold from 2000 to 2008.[3] With this increase in elective orthopaedic procedures, there has been increased interest in evaluating patient-reported outcomes. Previous research has largely been focused on long-term outcomes of patients following surgery.[4–8] However, there is limited current data evaluating short-term activity levels following upper and lower-extremity surgery. Activity restriction is ubiquitous in the immediate postoperative period, but the degree to which patients are active during this time period is unknown.

Patient-reported activity assessments can be used to help

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https://doi.org/10.1016/j.jcot.2020.06.014
0976-5662/

physicians set their patients' expectations immediately following surgery. Given the association between patient expectations and satisfaction following orthopaedic surgery,[9–14] this study aimed to assess patient-reported physical function two weeks postoperative from both upper and lower extremity orthopaedic surgery. We hypothesized that physical function at two weeks following surgery would be significantly decreased from preoperative levels and that patients undergoing upper extremity surgery will report higher levels of function than those undergoing lower extremity surgery. We additionally hypothesized that certain preoperative demographic variables and patient-reported measures, like age, smoking status, and pain would be associated with postoperative function level.

2. Patients and methods

Patients gave informed consent to be enrolled in the Maryland Orthopaedic Registry (MOR).[15] This study is a retrospective analysis of a cohort of MOR patients who underwent surgery from August 2015 to March 2018 at a single institution. All patients over 17 years old who underwent elective upper or lower extremity orthopaedic surgery were eligible. Four hundred thirty-five patients were available and analyzed.

The study population comprised of patients operated on by 12 surgeons, and all study data was collected using electronic data capture tools.[16] All enrolled patients filled out preoperative questionnaires within a week of surgery that included PROMIS computer adaptive tests for Physical Function (PF), Pain Interference (PI), Fatigue, Social Satisfaction (SS), Anxiety, and Depression. The PROMIS questionnaires generate a score in which 50 is the mean score, and 10 is the standard deviation of the relevant reference population. Higher scores represent better PF and SS, and worse PI, Fatigue, Anxiety, and Depression.[15]

In addition to the PROMIS questionnaires, an appropriate joint-specific questionnaire was administered, such as the International Knee Documentation Committee (IKDC) questionnaire for the knee, American Shoulder and Elbow Surgeons (ASES) Score for the shoulder, and the Brief Michigan Hand Outcomes Questionnaire (BMHQ) for the hand. Two numeric pain scales (NPS) were used to assess pain in the operative joint (Joint Pain) and in the rest of the body (Body Pain). Preoperative expectations of treatment were assessed by administering the Musculoskeletal Outcomes Data Evaluation and Management System (MODEMS) expectations questionnaire.[9] Physical activity levels were measured using the Tegner Activity Scale (Tegner), the International Physical Activity Questionnaire (IPAQ), and Marx Activity Rating Scales (Marx) for upper and lower extremity. Two weeks postoperatively, patients completed a follow-up questionnaire utilizing the same questionnaires as well as a Surgical Satisfaction Score.[15,17]

2.1. Statistical analyses

The PROMIS Physical Function score at the two-week follow up visit was the primary outcome. We compared means of continuous variables among groups by Analysis of Variance (ANOVA). Relationships between continuous variables and two-week PROMIS PF were assessed using Spearman's correlation coefficients (ρ). We applied backwards stepwise elimination regression for maximum validation R^2 to identify independent preoperative predictors of two-week PROMIS PF. Preoperative parameters that were significant in the bivariate analyses were included as possible predictors. Since joint-specific legacy PROMs (IKDC, ASES, BMHQ) were not all done for all patients, they were not included in multivariable analysis. All statistical tests used were two-sided, and $p < 0.05$ was used to indicate statistical significance.

3. Results

A cohort of 435 patients undergoing extremity orthopaedic surgery who were enrolled in MOR from 8/30/2016 to 3/19/2018 and completed both baseline and two-week postoperative assessments were analyzed in this study. An overview of the patient demographics included is shown in Table 1, and overall mean PRO scores can be found in Table 2. Table 3 shows that, overall, patients had a significant decline in physical function at two weeks postoperatively, from a mean score of 42.1 ± 8.8 to 35.5 ± 8.9. Compared with the national mean PROMIS PF score of 50, orthopaedic patients two weeks following surgery, on average, have 28.9% less function than the average person. Patients undergoing orthopaedic surgery on the lower extremity had significantly lower PROMIS PF scores than patients undergoing upper extremity surgery (Table 4). Additionally, there was significant greater decline in lower extremity patients compared to upper extremity patients.

Tables 5 and 6 display the ten most common surgeries included in the study performed on the lower and upper extremity, respectively. There were significant differences between surgeries performed on the lower extremity for both baseline PF and two-week PF. Arthroscopic removal of foreign bodies in the knee and synovectomy of the knee were associated with the highest levels of baseline and two-week PF, while the lowest PF levels were associated with ACLR and meniscus repair. We found significant differences between upper extremity surgeries for two-week PF only. Higher function levels were seen with tendon sheath incision and neuroplasty and/or transposition of the median nerve, while lower function levels were associated with total shoulder replacement and distal claviculectomy. Associations between two-week PROMIS PF score and categorical variables are shown in Table 1. Patients who listed their ethnicity as "Non-Hispanic or Latino" had a significantly greater level of activity at two weeks postoperatively than those who were listed as "Hispanic or Latino". Patients taking preoperative narcotics had significantly less function postoperatively than those who did not. Patients who did not suffer an injury leading to their surgery had significantly higher function two weeks postoperatively than those who did sustain an injury. Patients' physical function following orthopaedic surgery were significantly different between baseline and postoperative IPAQ classifications. Of note, patients classified as highly active under IPAQ prior to surgery had significantly higher function levels two weeks postoperatively according to PROMIS PF when compared to those categorized as Inactive or Minimally Active at baseline.

Correlations between continuous demographic variables and two-week PROMIS PF score are shown in Table 7. Older age was shown to be significantly weakly correlated to higher postoperative function. There was no observed correlation between postoperative physical function and BMI. Baseline PROMIS PF and SS scores were shown to be positively correlated with two-week function levels, while worse baseline mental health scores were significantly negatively correlated, with the strongest relationship seen with Anxiety. Baseline ASES and normalized BMHQ were significantly positively correlated; however, baseline IKDC, Joint Pain, and Body Pain scales were not significantly correlated. There was a positive correlation with pre-operative Tegner activity level and a negative correlation with baseline Marx upper extremity scale.

Better scores on all assessments at 2 weeks were significantly correlated with greater 2-week PROMIS PF (Table 8). The strongest correlations were with PROMIS Social Satisfaction, Pain Interference, and Fatigue scores. Better surgical satisfaction sores were significantly associated with higher 2-week PF.

Multivariable regression confirmed that the better preoperative PF scores and upper extremity surgery were independent preoperative predictors of better 2-week PF scores (Table 9).

Table 1
Patient Demographics vs. Mean 2-week PROMIS PF Score.

	Mean (±SD)		
Mean Age in years	41.1 (15.7)		
Mean BMI in kg/m^2	29.4 (6.7)		
Charlson Comorbidity Index	2.08 (1.39)		
MODEMS – Expectations Overall	4.4 (0.8)		
1) Relief from symptoms	4.4 (0.9)		
2) Activities	4.5 (0.9)		
3) Sleep	4.4 (1.0)		
4) Usual work	4.4 (1.1)		
5) Exercise	4.3 (1.0)		
6) Disability	4.3 (0.9		
Number of Surgeries (ANY)	4.2 (4.4)		
Number of Orthopaedic Surgeries	1.4 (2.3)		
Number of Surgeries on Operative Joint	0.35 (0.87)		
	Number of Patients (Percent):	**PROMIS PF Score Mean (± SD)**	**P Value:**
Sex: (n = 435)			
Male	232 (53%)	35.69 (8.71)	0.69
Female	203 (47%)	35.35 (9.14)	
Race: (n = 431)			
Black	95 (22%)	35.28 (9.47)	0.93
White	298 (69%)	35.61 (8.70)	
Other	38 (9%)	35.26 (9.44)	
Ethnicity: (n = 428)			
Non-Hispanic or Latino	400 (93%)	35.79 (9.02)	**0.012**
Hispanic or Latino	28 (7%)	31.43 (6.32)	
Education: (n = 430)			
Not a College Graduate	226 (52%)	35.49 (9.22)	0.85
College Graduate or Above	206 (48%)	35.65 (8.67)	
Employment status: (n = 435)			
Currently Employed	277 (64%)	35.80 (8.79)	0.54
Student	67 (15%)	34.45 (9.43)	
Not Currently Employed	91 (21%)	35.50 (8.90)	
Marital Status: (n = 429)			
Married or domestic partnership	197 (46%)	36.09 (8.78)	0.18
Not Married	232 (54%)	34.94 (8.87)	
Caregiver Status: (n = 431)			
Available	423 (98%)	35.47 (8.88)	0.74
Not Available	9 (2)	36.48 (9.63)	
Family/Friend Caregiver Status: (n = 425)			
Family/Friend Available	413 (97%)	35.35 (8.87)	0.85
Family/Friend Not Available	12 (3%)	35.84 (8.67)	
Income: (n = 435)			
Less than $70,000	174 (40%)	35.87 (8.94)	0.75
More than $70,000	241 (55%)	35.24 (8.80)	
Income Not Reported	20 (5%)	36.04 (10.07)	
Insurance Status: (n = 435)			
Uninsured or Not Reported	68 (16%)	35.31 (8.71)	0.88
Private or Employer Sponsored	303 (69%)	35.48 (8.97)	
Government Sponsored	64 (15%)	36.03 (8.89)	
Smoking Status: (n = 428)			
Current smoker	43 (10%)	37.50 (8.50)	0.20
Never smoked	307 (72%)	35.04 (8.95)	
Quit Smoking	78 (18%)	35.89 (8.47)	
Recreational Drug Use: (n = 435)			
No	404 (93%)	35.52 (8.96)	0.95
Yes	31 (7%)	35.64 (8.22)	
Recreational Marijuana Use: (n = 435)			
No	410 (94%)	35.54 (8.94)	0.97
Yes	25 (6%)	35.46 (8.47)	
Alcohol Consumption: (n = 430)			
Never	123 (29%)	35.35 (8.99)	0.06
4 times monthly or fewer	198 (46%)	34.64 (8.43)	
More than 4 times monthly	109 (25%)	37.13 (9.10)	
Preoperative Narcotic Use: (n = 431)			
No	320 (74%)	36.03 (8.94)	**0.020**
Yes	111 (26%)	33.76 (8.44)	
ASA Score: (n = 425)			
1	166 (39%)	35.51 (9.35)	0.19
2	230 (54%)	34.70 (8.07)	
3	29 (7%)	37.66 (8.86)	
Depression Symptoms: (n = 434)			
No	382 (88%)	35.80 (9.02)	0.05

(*continued on next page*)

Table 1 (*continued*)

	Mean (±SD)		
Yes	52 (12%)	33.28 (7.62)	
Operative Joint (n = 435)			
Upper Extremity	209 (48%)	39.09 (8.61)	< **0.0001**
Lower Extremity	226 (52%)	32.24 (7.85)	
Prior Operation on Operative Joint (n = 433)			
No	339 (78%)	35.89 (9.09)	0.11
Yes	94 (22%)	34.24 (8.22)	
Injury Prior to Surgery: (n = 435)			
No	153 (35%)	36.96 (9.44)	**0.014**
Yes	282 (65%)	34.76 (8.51)	
Legal Claim: (n = 435)			
	405 (93%)	35.61 (8.98)	0.48
Yes	30 (7%)	34.43 (7.89)	
Workers' Compensation: (n = 435)			
No	420 (97%)	35.55 (8.95)	0.78
Yes	15 (3%)	34.90 (7.68)	
Legal Claim (MVC): (n = 435)			
No	426 (98%)	35.58 (8.93)	0.43
Yes	9 (2%)	33.23 (7.73)	
Legal Claim (Personal Injury): (n = 435)			
No	421 (97%)	35.58 (8.95)	0.52
Yes	14 (3%)	34.01 (7.39)	
Baseline IPAQ Category (PI): (n = 435)			
Inactive	173 (40%)	34.15 (8.84)	**0.017**
Minimally Active	39 (9%)	34.99 (8.14)	
HEPA	223 (51%)	36.70 (8.96)	
2 week IPAQ Category (PI): (n = 435)			
Inactive	295 (68%)	33.72 (8.75)	< **0.0001**
Minimally Active	57 (13%)	37.23 (7.61)	
HEPA	83 (19%)	40.80 (7.97)	

Table 2
Mean PRO scores.

	Baseline Mean (±SD)	Two Week Mean (±SD)	Change from Baseline Mean (±SD)
PROMIS Physical Function	42.1 (8.8)	35.5 (8.9)	−6.5 (10.0)
PROMIS Social Satisfaction	42.4 (9.3)	39.0 (8.1)	−3.4 (10.1)
PROMIS Pain Interference	60.1 (7.0)	61.7 (7.6)	1.6 (8.5)
PROMIS Fatigue	51.5 (10.4)	54.4 (10.0)	2.9 (10.5)
PROMIS Anxiety	54.9 (8.7)	53.6 (9.6)	−1.3 (8.4)
PROMIS Depression	48.7 (9.4)	49.4 (10.5)	0.73 (8.0)
IKDC	51.0 (16.2)	–	–
ASES	41.9 (21.3)	–	–
BMHQ	47.8 (19.4)	–	–
Numeric Pain Scale – Joint	4.9 (2.8)	4.1 (2.4)	−0.75 (2.9)
Numeric Pain Scale – Body	1.3 (2.0)	1.7 (2.1)	0.34 (2.1)
Treatment Expectations	87.0 (16.6)	55.0 (27.6)	−31.9 (30.5)
Total METs/week	7269 (6025)	3854 (3707)	−3641 (6336)
Tegner activity (Pre-injury)	5.9 (2.7)	–	–
Tegner activity (Current)	2.2 (1.9)	1.1 (1.4)	−1.1 (1.9)
Activity Rating Scale – Lower	38.8 (37.0)	–	–
Activity Rating Scale – Upper	57.6 (29.4)	–	–
Braden Score	22.7 (1.0)	–	–
Charlson Score	2.1 (1.4)	–	–
Surgical Satisfaction	–	69.1 (16.0)	–
Improvement Average	–	56.0 (24.7)	–

Table 3
Baseline vs Two Week Post-operative PROMIS Physical Function Scores.

	Baseline PROMIS PF	Two Week PROMIS PF	P Value
Mean Score	42.06	35.53	< **0.0001**
Standard Deviation	8.83	8.90	

Table 4
Upper and lower extremity PROMIS physical function scores.

Extremity (n)	Baseline (Mean ± SD)	Two Weeks (Mean ± SD)	P Value
Upper (209)	43.93 ± 9.60	39.09 ± 8.61	< **0.0001**
Lower (226)	40.33 ± 7.68	32.24 ± 7.85	< **0.0001**
P Value	< **0.0001**	< **0.0001**	

4. Discussion

With the increased emphasis on patient-reported outcomes and postoperative satisfaction to determine operative success, it is essential to properly set patients' expectations both before and after surgery. Postoperative satisfaction is well predicted by how well postoperative expectations are met; therefore, it is vital that

Table 5
Ten most common lower extremity CPT codes.

CPT	Count	Procedure	Baseline PF	Two-Week PF
29888	65	Arthroscopically aided anterior cruciate ligament repair/augmentation or reconstruction	40.9 ± 6.4	29.3 ± 6.2
29881	60	Arthroscopy, knee, surgical; with meniscectomy (medial OR lateral, including any meniscal shaving) including debridement/shaving of articular cartilage (chondroplasty), same or separate compartment(s), when performed	41.9 ± 6.1	35.4 ± 8.2
29876	49	Arthroscopy, knee, surgical; synovectomy, major, 2 or more compartments (e.g., medial or lateral)	44.6 ± 7.8	35.8 ± 8.0
29882	30	Arthroscopy, knee, surgical; with meniscus repair (medial OR lateral)	41.8 ± 9.2	29.0 ± 6.4
29879	28	Arthroscopy, knee, surgical; abrasion arthroplasty (includes chondroplasty where necessary) or multiple drilling or microfracture	42.5 ± 9.9	30.7 ± 7.6
29877	22	Arthroscopy, knee, surgical; debridement/shaving of articular cartilage (chondroplasty)	40.8 ± 7.5	36.3 ± 9.1
29914	16	Arthroscopy, hip, surgical; with femoroplasty (i.e., treatment of cam lesion)	42.4 ± 6.6	32.0 ± 6.1
29916	15	Arthroscopy, hip, surgical; with labral repair	41.6 ± 6.6	32.6 ± 5.8
29874	13	Arthroscopy, knee, surgical; for removal of loose body or foreign body (e.g., osteochondritis dissecans fragmentation, chondral fragmentation)	46.7 ± 10.2	39.2 ± 8.8
27130	12	Arthroplasty, acetabular and proximal femoral prosthetic replacement (total hip arthroplasty), with or without autograft or allograft	34.1 ± 8.3	32.9 ± 10.6

PROMIS Physical Function was analyzed against CPT code using ANOVA. There were significant differences in Preop PF between CPT codes ($p = 0.002$), and 2 wk PF ($p < .001$).

Table 6
Ten most common upper extremity CPT codes.

CPT	Count	Procedure	Baseline PF	Two-Week PF
29826	38	Arthroscopy, shoulder, surgical; decompression of subacromial space with partial acromioplasty, with coracoacromial ligament (i.e., arch) release, when performed	43.2 ± 9.8	35.2 ± 8.4
23430	23	Arthroscopy, shoulder, surgical; decompression of subacromial space with partial acromioplasty, with coracoacromial ligament (i.e., arch) release, when performed	43.5 ± 9.6	33.7 ± 8.6
29806	22	Arthroscopy, shoulder, surgical; capsulorrhaphy	46.6 ± 7.1	40.6 ± 8.0
29825	21	Arthroscopy, shoulder, surgical; with lysis and resection of adhesions, with or without manipulation	45.7 ± 9.7	38.7 ± 9.1
29823	20	Arthroscopy, shoulder, surgical; debridement, extensive	42.8 ± 7.8	35.9 ± 7.0
23472	17	Arthroplasty, glenohumeral joint; total shoulder (glenoid and proximal humeral replacement (e.g., total shoulder))	42.1 ± 8.3	33.6 ± 9.1
29827	16	Arthroscopy, shoulder, surgical; with rotator cuff repair	42.2 ± 11.4	35.9 ± 9.4
64721	14	Neuroplasty and/or transposition; median nerve at carpal tunnel	49.3 ± 8.5	45.5 ± 9.2
26055	11	Tendon sheath incision (e.g., for trigger finger)	48.1 ± 6.8	46.9 ± 8.5
29824	10	Arthroscopy, shoulder, surgical; distal claviculectomy including distal articular surface (Mumford procedure)	44.0 ± 12.1	34.6 ± 9.2

PROMIS Physical Function was analyzed against CPT code using ANOVA. There were no significant differences in Preop PF between CPT codes ($p = 0.29$), but there was a significant difference in 2 wk PF ($p < .001$).

patient education programs manage expectations for the postoperative recovery period.[11] With proper postoperative expectations set via patient education, patients will likely have increased satisfaction, which leads to greater compliance with postoperative rehabilitation and better surgical outcomes, as reported by Majid et al.[18] Several studies have examined long-term activity level following surgery.[4–8] However, to our knowledge, there is no evidence examining patients' activity levels immediately following orthopaedic surgery.

In this study, we determined that patients' physical function levels were significantly decreased at two weeks following orthopaedic surgery compared to their preoperative baseline. Furthermore, patients' undergoing surgery on the upper extremity had significantly higher levels of function than those undergoing surgery on the lower extremity at two weeks after surgery. Patients with greater pre-operative function are associated with higher levels of postoperative physical function. This would be expected as those who are used to having more function are likely to continue that trend postoperatively. We did find significant differences between the type of surgery performed and PF levels for both upper and lower extremity. This is to be expected, as less invasive and minor surgeries would be expected to allow for greater PF. Our results allow for greater clarification when educating patients preoperatively as to what level of PF may be expected based on their baseline PF and surgery being performed. Upper extremity surgery and higher preoperative PROMIS PF were confirmed as the only independent preoperative predictors of greater 2-week PROMIS PF.

Those with higher levels of fatigue, anxiety and depression pre- and postoperatively are associated with lower postoperative function, which is expected as those with depressive symptoms have been shown to have an inverse relationship with physical activity.[19,20] Higher two-week pain scores are significantly inversely correlated with two-week function levels, which also is to be expected with pain hindering patients' activity. Of note, patients with greater social satisfaction at two-weeks postoperatively are associated with higher physical function levels, implying that the patients' postoperative status is not hindering their social activities if they have good function. Finally, greater surgical satisfaction score was also correlated with higher function, likely because patients able to partake in more activity postoperatively are more likely to have satisfied their surgical expectations.

Preoperative opioid use was associated with worse PROMIS PF at two weeks. This is consistent with a recent study examining preoperative opioid use in arthroscopic rotator cuff repair, which found patients taking preoperative opioids did not reach the same level of functionality after surgery as those who did not take opioids.[21] However, opioid use was not an independent predictor in the multivariable analysis. Interestingly, smoking status was not found to be associated with two-week PROMIS PF scores. This is inconsistent with a previous study, which found lower activity levels two years after anterior cruciate ligament reconstruction were associated with smoking within 6 months prior to surgery.[20] History of an injury prior to surgery was associated with lower physical function, which is likely indicative of greater pathology that would limit physical function.

Table 7
Continuous preoperative variable correlations with two week PROMIS PF.

	Spearman Correlation Coefficient	P Value
Age (N = 435)	0.125	**0.009**
BMI (N = 416)	−0.001	0.99
Baseline PROMIS PF Score (N = 435)	0.362	< **0.0001**
Baseline PROMIS Social Satisfaction Score (N = 435)	0.184	**0.0001**
Baseline PROMIS Pain Interference Score (N = 435)	−0.145	**0.002**
Baseline PROMIS Fatigue Score (N = 435)	−0.170	**0.0004**
Baseline PROMIS Anxiety Score (N = 435)	−0.206	< **0.0001**
Baseline PROMIS Depression Score (N = 435)	−0.173	**0.0003**
Baseline IKDDC Score (N = 175)	0.122	0.11
Baseline ASES Score (N = 137)	0.212	**0.013**
Baseline Normalized BMHQ (N = 69)	0.351	**0.003**
Baseline Joint Numeric Pain Scale (N = 429)	−0.011	0.83
Baseline Body Numeric Pain Scale (N = 431)	−0.029	0.55
Baseline Pre-Treatment Expectations (N = 433)	−0.014	0.78
Baseline Total METs/week (N = 344)	0.094	0.08
Tegner Activity Levels Pre-Injury (N = 433)	−0.097	**0.043**
Tegner Activity Level Pre-Operative Baseline (N = 431)	0.179	**0.0002**
Baseline Lower Extremity Activity Rating Scale (N = 432)	−0.050	0.30
Baseline Upper Extremity Activity Rating Scale (N = 433)	−0.105	**0.029**
Baseline Charlson Comorbidity Score (N = 238)	0.037	0.57

Table 8
Continuous post-operative variable correlations with two week PROMIS PF.

	Spearman Correlation Coefficient	P Value
Two Week PROMIS Social Satisfaction Score	0.604	< **0.0001**
Two Week PROMIS Pain Interference Score	−0.508	< **0.0001**
Two Week PROMIS Fatigue Score	−0.509	< **0.0001**
Two Week PROMIS Anxiety Score	−0.281	< **0.0001**
Two Week PROMIS Depression Score	−0.235	< **0.0001**
Two Week Joint Numeric Pain Scale	−0.248	< **0.0001**
Two Week Body Numeric Pain Scale	−0.131	**0.007**
Two Week Post-Treatment Expectations	0.264	< **0.0001**
Two Week IPAQ Total METs	0.275	< **0.0001**
Two Week Tegner Activity Level	0.542	< **0.0001**
Two Week Surgical Satisfaction Score	0.265	< **0.0001**

Table 9
Multivariate analysis of two week PROMIS physical function.

Two Week PROMIS Physical Function	Estimate	SE	t Ratio	P Value	Adjusted R^2
Upper Extremity Surgery	2.9	0.5	5.9	<.0001	0.28
Baseline PROMIS Physical Function	0.4	0.1	6.8	<.0001	

Following preoperative variables were included in multivariable analysis: Baseline PROMIS PF Score, Baseline PROMIS SS, Baseline PROMIS PI, Baseline PROMIS Fatigue, Baseline PROMIS Anxiety, Baseline PROMIS Depression, Tegner Activity Levels Pre-injury, Tegner Activity Level Pre-Operative, Baseline UE Activity Rating Scale, Ethnicity, Preoperative Narcotic, Operative Joint, and Injury Prior to Surgery.
PROMIS: Patient Reported Outcome Measurement Instrument Systems; **Estimate**: regression coefficient.

Hispanic ethnicity was associated with lower 2-week physical function but was not an independent predictor in the multivariable analysis, suggesting possible confounding with other factors. One of the strengths of this registry is the inclusion of a diverse patient population characteristic on an urban population, which has historically been very underrepresented in the orthopaedic literature.[15] Older age was also weakly associated with better 2-week physical function, which was likley confounded by older patients undergoing upper extremity surgery, and therefore was not an independent predictor of 2-week physical function after controlling for confounding variables with multivariable analysis.

Although this study was prospective and had a robust sample size with a diverse patient population, there were several limitations. First, all of the surgeries included in the study were conducted at an academic orthopaedic surgery center, which can have key differences in patient population compared to non-academic centers. A multivariate analysis, which should account for variations in patient populations by determining the independent predictors of patient expectations, was used to attempt to control for this discrepancy. Second, our cohort consisted of many more patients with shoulder (n = 115) and knee (n = 174) operations compared to the other joints. This difference could cause the study to not be equally representative of operations on all joints. Third, there were significant differences between patients who completed both their preoperative & early postoperative questionnaires and patients who completed the preoperative questionnaire but not early postoperative questionnaire. Specifically, patients with more fatigue and pain have been shown to be less likely to fill out their postoperative questionnaires.[17] This could limit our ability to generalize our findings to the general population of patients undergoing extremity orthopaedic surgery.

Prior studies examining activity levels of orthopaedic patients have not measured postoperative activity levels at two weeks. The shortest follow-up period was by Issa et al. who noted that activity

levels were significantly decreased at six weeks postoperatively after total knee arthroplasty. This is consistent with our findings, but our study may be more generalizable as we included all orthopaedic surgeries done on both upper and lower extremities.

5. Conclusions

Patients' activity was 28.9% less than the national average two weeks postoperatively, with patients undergoing upper extremity surgery having higher physical function levels than lower extremity patients. Many factors are associated with activity levels, including mental health, pain, and satisfaction. We encourage physicians to use this information to properly educate their patients about appropriate expectations in the early postoperative period.

Funding

This work was supported by a grant from The James Lawrence Kernan Hospital Endowment Fund, Incorporated.

Declaration of competing interest

None.

CRediT authorship contribution statement

Gregory Perraut: Writing - original draft, Data curation, Visualization, Investigation. **Ali Aneizi:** Formal analysis, Writing - review & editing, Data curation, Visualization. **Vidushan Nadarajah:** Writing - review & editing. **Patrick MJ. Sajak:** Visualization, Writing - review & editing. **Michael P. Smuda:** Writing - review & editing. **Julio J. Jauregui:** Writing - review & editing. **Min Zhan:** Formal analysis, Data curation. **Jonathan D. Packer:** Supervision. **R. Frank Henn:** Supervision, Funding acquisition, Project administration, Writing - review & editing.

Acknowledgements

The authors thank J. Kathleen Tracy, Ph.D.; Andrew Dubina, M.D.; Julio Jauregui, M.D.; Farshad Adib, M.D.; Craig Bennett, M.D.; Mohit Gilotra, M.D.; S. Ashfaq Hasan, M.D.; Jonathan Packer, M.D.; Ebrahim Paryavi, M.D.; Raymond Pensy, M.D.; Michael Smuda; and Shaun Medina for their assistance with data collection.

References

1. Losina E, Thornhill TS, Rome BN, Wright J, Katz JN. The dramatic increase in total knee replacement utilization rates in the United States cannot be fully explained by growth in population size and the obesity epidemic. *J Bone Joint Surg Am*. 2012;94:201–207.
2. Kim S, Bosque J, Meehan JP, Jamali A, Marder R. Increase in outpatient knee arthroscopy in the United States: a comparison of national surveys of ambulatory surgery, 1996 and 2006. *J Bone Joint Surg Am*. 2011;93:994–1000.
3. Kim SH, Wise BL, Zhang Y, Szabo RM. Increasing incidence of shoulder arthroplasty in the United States. *The Journal of bone and joint surgery American*. 2011;93:2249–2254.
4. Garcia GH, Taylor SA, DePalma BJ, et al. Patient Activity levels after reverse total shoulder arthroplasty: what are patients doing? *Am J Sports Med*. 2015;43:2816–2821.
5. Bulhoff M, Sattler P, Bruckner T, Loew M, Zeifang F, Raiss P. Do patients return to sports and work after total shoulder replacement surgery? *Am J Sports Med*. 2015;43:423–427.
6. Issa K, Jauregui JJ, Given K, Harwin SF, Mont MA. A prospective, longitudinal study of patient Activity levels following total knee arthroplasty stratified by demographic and comorbid factors. *J Knee Surg*. 2015;28:343–347.
7. Chang MJ, Kim SH, Kang YG, Chang CB, Kim TK. Activity levels and participation in physical activities by Korean patients following total knee arthroplasty. *BMC Muscoskel Disord*. 2014;15:240.
8. Huch K, Muller KA, Sturmer T, Brenner H, Puhl W, Gunther KP. Sports activities 5 years after total knee or hip arthroplasty: the Ulm Osteoarthritis Study. *Ann Rheum Dis*. 2005;64:1715–1720.
9. Zywiel MG, Mahomed A, Gandhi R, Perruccio AV, Mahomed NN. Measuring expectations in orthopaedic surgery: a systematic review. *Clin Orthop Relat Res*. 2013;471:3446–3456.
10. Scott CE, Bugler KE, Clement ND, MacDonald D, Howie CR, Biant LC. Patient expectations of arthroplasty of the hip and knee. *J Bone Joint Surg Br*. 2012;94:974–981.
11. Culliton SE, Bryant DM, Overend TJ, MacDonald SJ, Chesworth BM. The relationship between expectations and satisfaction in patients undergoing primary total knee arthroplasty. *J Arthroplasty*. 2012;27:490–492.
12. Soroceanu A, Ching A, Abdu W, McGuire K. Relationship between preoperative expectations, satisfaction, and functional outcomes in patients undergoing lumbar and cervical spine surgery: a multicenter study. *Spine (Phila Pa 1976*. 2012;37:E103–E108.
13. Bourne RB, Chesworth BM, Davis AM, Mahomed NN, Charron KD. Patient satisfaction after total knee arthroplasty: who is satisfied and who is not? *Clin Orthop Relat Res*. 2010;468:57–63.
14. Noble PC, Conditt MA, Cook KF, Mathis KB. The John Insall Award: patient expectations affect satisfaction with total knee arthroplasty. *Clin Orthop Relat Res*. 2006;452:35–43.
15. Henn 3rd RF, Dubina AG, Jauregui JJ, Smuda MP, Tracy JK. The Maryland Orthopaedic Registry (MOR): design and baseline characteristics of a prospective registry. *J Clin Orthop Trauma*. 2017;8:301–307.
16. Harris PA, Taylor R, Thielke R, Payne J, Gonzalez N, Conde JG. Research electronic data capture (REDCap)–a metadata-driven methodology and workflow process for providing translational research informatics support. *J Biomed Inf*. 2009;42:377–381.
17. Sajak PM, Aneizi A, Gopinath R, et al. Factors associated with early postoperative survey completion in orthopaedic surgery patients. *J Clin Orthop Trauma*. 2020;11:S158–S163.
18. Majid N, Lee S, Plummer V. The effectiveness of orthopedic patient education in improving patient outcomes: a systematic review protocol. *JBI Database System Rev Implement Rep*. 2015;13:122–133.
19. Stavrakakis N, de Jonge P, Ormel J, Oldehinkel AJ. Bidirectional prospective associations between physical activity and depressive symptoms. The TRAILS Study. *J Adolesc Health*. 2012;50:503–508.
20. Dunn WR, Spindler KP, Consortium M. Predictors of activity level 2 years after anterior cruciate ligament reconstruction (ACLR): a Multicenter Orthopaedic Outcomes Network (MOON) ACLR cohort study. *Am J Sports Med*. 2010;38:2040–2050.
21. Williams BT, Redlich NJ, Mickschl DJ, Grindel SI. Influence of preoperative opioid use on postoperative outcomes and opioid use after arthroscopic rotator cuff repair. *J Shoulder Elbow Surg*. 2019;28:453–460.