New Patient PROMIS Scores of Patients Presenting with Low Back Pain Predict Time to Elective Spine Surgery

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Abstract:

Introduction: This study aims to determine whether Patient-Reported Outcomes Measurement Information System (PROMIS) domain scores can predict elective spine surgery within 1 year of initial clinic evaluation.

Methods: A retrospective query for all new patient spine clinic visits with diagnosis codes related to lower back pain was carried out at a single academic institution. A chart review was conducted to collect sociodemographic variables, clinic visit details, and PROMIS domain scores (PF [Physical Function], PI [Pain Interference], Depression, and Global Health—Physical and Global Health—Mental). Patients were divided into Surgery and No Surgery, and for time to surgery, a subanalysis was also carried out.

Results: Overall, 116 (8.4%) of 1,387 new patients underwent surgery within 1 year. Race, Surgeon vs. Advanced Practice Provider (APP), and whether advanced imaging (MRI or CT myelogram) was available for interpretation were statistically associated with undergoing surgery. Patients in the Surgery group had statistically significant worse PROMIS scores in all domains when compared with the No Surgery group, and PROMIS PI was additionally associated with Time to Surgery. Multivariate analysis identified PROMIS PI, race, presence of advanced imaging interpretation, and Surgeon vs. APP as independent predictors of Surgery vs. No Surgery; however, only race and PROMIS PI were independent predictors of Time to Surgery.

Conclusions: Worse new patient PROMIS PI scores were associated with undergoing surgery within one year of initial evaluation. To determine if PROMIS scores may help in a triage capacity to identify which patients are most appropriate for a surgeon visit versus a nonsurgical provider, further research is needed, thereby improving the efficiency of surgical care delivery.

Keywords:

PROMIS, patient-reported outcomes, value-based healthcare, lumbar, back pain

Spine Surg Relat Res 2025; 9(2): 237-243

dx.doi.org/10.22603/ssrr.2024-0177

Introduction

With the development of value-based healthcare in orthopedics, patient-reported outcome measures (PROMs) have become routinely collected in various orthopedic subspecialties[1]. Patient-Reported Outcomes Measurement Information System (PROMIS) surveys are validated and standardized PROMs that utilize computerized adaptive testing to evaluate multiple domains, such as physical function (PF), pain interference (PI), and mental health quickly and reliably. In the literature, PROMIS scores are commonly employed to compare preoperative and postoperative measurements, which provides insights into the efficacy of surgical interventions. Nonetheless, their clinical utility beyond this comparative analysis is still limited.

Many studies have explored the potential prognostic value of preoperative PROMIS scores. Notably, a growing body of literature has consistently shown that patients with worse preoperative scores tend to experience greater improvements after spine surgery[2-4]. Furthermore, these studies have often observed a correlation between lower preoperative PROMIS scores and more unfavorable 2-year postoperative outcomes[5,6]. These findings suggest that preoperative PROMIS scores can serve as reliable indicators of patient potential for

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Received: June 20, 2024, Accepted: August 21, 2024, Advance Publication: October 5, 2024

Table 1. Top 6 Visit Diagnosis Codes for Patients Who Present Low Back Pain.

Visit Diagnosis Code	Count (Frequency)
Low back pain, unspecified [M54.50]	572 (41.3%)
Spinal stenosis, lumbar region with neurogenic claudication [M48.062]	270 (19.5%)
Spondylosis without myelopathy or radiculopathy, lumbar region [M47.816]	136 (9.8%)
Radiculopathy, lumbar region [M54.16]	85 (6.1%)
Dorsalgia, unspecified [M54.9]	82 (5.9%)
Spondylolisthesis, lumbar region [M43.16]	50 (3.6%)

improvement and postoperative recovery. However, to our knowledge, new patient PROMIS scores concerning the prediction of elective spine surgery have yet to be explored.

The objectives of this study are as follows: (1) to evaluate whether new patient PROMIS scores can differentiate whether a patient undergoes elective spine surgery within 1 year, (2) to determine if PROMIS scores can differentiate between undergoing surgery sooner rather than later, and (3) to determine meaningful PROMIS thresholds that can help contextualize whether a patient is more or less likely to undergo surgery. We hypothesize that patients with worse PROMIS scores, indicative of poorer health-related quality of life, will be more likely to undergo elective spine surgery within a year.

Materials and Methods

The study was deemed to be exempted from Institutional Review Board approval. Informed consent was not required. A retrospective query for all new adult patient clinic visits with a diagnosis code related to low back pain at a single institution from February 2022 to June 2022 was conducted. Patients were excluded if there were no PROMIS scores collected at the initial visit or if symptom duration was less than 30 days. Demographic data including age, gender, body mass index (BMI), and Charles comorbidity index (CCI) were collected from chart review of electronic medical records. Initial office visit notes were reviewed for provider, provider degree, visit diagnosis, and whether advanced imaging (MRI or CT myelogram) was available for interpretation. A total of five surgeons and four advanced practice providers (APPs) contributed to the study cohort.

At this institution, patients are asked to fill out PROMIS domain (PF, PI, Depression, and Global Health—Physical and Global Health—Mental) questionnaires either before their appointment or after they check into the clinic but prior to being seen by a provider. The PROMIS PF domain assesses the ability to perform activities of daily living, PROMIS PI assesses the degree to which pain hinders social, cognitive, emotional, physical, and recreational activities, PROMIS Depression assesses cognitive manifestations of depression, and PROMIS Global Health generally monitors physical, mental, and social health. Notably, PROMIS PF, PI, and Depression are correlated with legacy spine PROs, such as the Oswestry Disability Index (ODI) and Neck Disability Index (NDI)[7]. PROMIS scores are standardized from 0 to 100 with a mean of 50 and a standard deviation (SD) of 10. A higher PROMIS domain score indicates an increase in what is being measured (e.g., more function, pain, or depression). To collect PROMIS scores for each new patient visit and whether the patient underwent elective spine surgery at this institution within 1 year of being seen, a chart review was conducted. Patients were divided into those who underwent surgery within 1 year and those who did not (Surgery vs. No Surgery). Of those who did, Time to Surgery subgroups were created for each 3-month period (0-3 months, 3-6 months, 6-9 months, and 9-12 months). For all PROMIS scores, a minimal clinically important difference (MCID) of 8 was employed[3].

Continuous data were reported as means and SDs, whereas categorical data were reported as count (N) and percentage. Between Surgery vs. No Surgery and demographic variables, bivariate analysis was carried out using Student's T-test or Chi-squared. Finally, using backward stepwise logistic regression to control for confounders and identify independent predictors of Surgery as well as Time to Surgery, multivariable analyses were performed. For example, the backward stepwise regression approach begins with all variables associated with Surgery with subsequent elimination of redundant variables to find a reduced model that best explains the data. All statistical tests employed were two-sided, and to determine statistical significance, a P-value of <0.05 was used.

Results

Overall, in this study, 1,387 patients were included. Of the included patients, 116 (8.4%) patients underwent elective spinal surgery within 1 year of initial clinic visit. The most common Visit Diagnosis Code was "Low back pain, unspecified [M54.50]" followed by "Spinal stenosis, lumbar region with neurogenic claudication [M48.062]" (Table 1). White or Caucasian race, being seen by an MD and having advanced imaging available for interpretation, was statistically associated with elective spinal surgery within 1 year (Table 2). A total of 72.4% of the patients in the Surgery group were initially seen by an MD and were compared with 45.7% of the patients in the No Surgery group; 57.8% of the patients in the Surgery group and 30.2% of the patients in the No Surgery group had an advanced imaging in-

Table 2. Sociodemographic Variables and Appointment-specific Variables of Surgery vs. No Surgery Patients.

Sociodemographic and appointment-specific variables	All (N=1,387)	No Surgery (N=1,271)	Surgery (N=116)	P-value
Continuous variables				
Age	56.9±16.0	56.7±16.2	59.1±13.7	0.13
BMI	32.3±7.9	32.3±8.0	31.5±6.3	0.30
CCI	1.9±1.9	1.9±1.9	2.3±2.1	0.07
Categorical variables				
Gender				0.29
Female	899 (64.8%)	829 (65.2%)	70 (60.3%)	
Male	488 (35.2%)	442 (34.8%)	46 (39.7%)	
Race				**0.009**
White or Caucasian	746 (53.9%)	668 (52.6%)	78 (67.2%)	
Black or African American	546 (39.4%)	518 (40.8%)	28 (24.1%)	
Hispanic	40 (2.9%)	37 (2.9%)	3 (2.6%)	
Asian or Pacific Islander	14 (1.0%)	13 (1.0%)	1 (0.9%)	
Multiracial	2 (0.1%)	2 (0.2%)	0	
Other	37 (2.7%)	31 (2.4%)	6 (5.2%)	
Ethnicity				0.86
Hispanic or Latino	48 (3.5%)	45 (3.5%)	3 (2.6%)	
Nonhispanic/Latino	1,327 (95.7%)	1,216 (95.7%)	111 (96.5%)	
Declined	11 (0.8%)	10 (0.8%)	1 (0.9%)	
Marital Status				
Married/Life partner	690 (50.5%)	621 (49.6%)	69 (61.1%)	0.07
Divorced/Legally separated	121 (8.9%)	110 (8.8%)	11 (9.7%)	
Single	319 (23.4%)	298 (23.8%)	21 (18.6%)	
Widowed	121 (8.9%)	113 (9.0%)	8 (7.1%)	
Other	114 (8.3%)	110 (8.8%)	4 (3.5%)	
Insurance				0.51
Commercial	560 (40.4%)	509 (40.1%)	51 (44.0%)	
Government	768 (55.4%)	708 (55.7%)	60 (51.7%)	
None	46 (3.3%)	41 (3.2%)	5 (4.3%)	
Other	9 (0.6%)	9 (0.7%)	0	
Workers Compensation	4 (0.3%)	4 (0.3%)	0	
Appointment-Specific				
MD vs. APP				**<0.0001**
MD	666 (48.0%)	582 (45.7%)	84 (72.4%)	
APP	722 (52.0%)	690 (54.3%)	32 (27.6%)	
Advanced Imaging Interpretation				**<0.0001**
Yes	451 (32.5%)	384 (30.2%)	67 (57.8%)	
No	937 (67.5%)	888 (69.8%)	49 (42.2%)	

Abbreviations: *APP*, Advanced Practice Provider; *BMI*, body mass index; *CCI*, Charles comorbidity index; *MD*, Doctor of Medicine

Advanced imaging includes MRI or CT myelogram.

Bold font indicates a statistically significant (P<0.05) difference.

terpretation. Age, BMI, CCI, gender, ethnicity, marital status, and insurance were not statistically significant. All PROMIS domain scores were statistically worse in the Surgery group than in the No Surgery group; however, for all domains, average differences were less than MCID (Table 3).

Of those who underwent surgery, 62 had surgery within 0-3 months, 31 had surgery within 3-6 months, and 22 had surgery within 6-9 months. Only one patient had surgery within 9-12 months, so this patient was excluded from further analysis. PROMIS PI revealed a statistically significant difference between patients who underwent surgery in 0-3 months and those who underwent surgery in 6-9 months (70.0±5.9 vs. 66.6±5.6, P-value=0.03, Table 4). PROMIS PF, Depression, GHP, and GHM did not depict statistically significant differences with Time to Surgery.

Multivariate analysis identified race, MD vs. APP, PROMIS PI, and advanced imaging interpretation as independent predictors of Surgery vs. No Surgery. Of these, only race and PROMIS PI were independent predictors of Time

Table 3. PROMIS Scores of Patients Who Received Surgery vs. Those Who Did Not.

PROMIS	All (N=1,387)	No Surgery (N=1,271)	Surgery (N=116)	P-value
PI	66.3±7.2	66.1±7.3	69.0±6.2	**<0.0001**
PF	36.5±7.9	36.8±7.9	33.6±6.8	**<0.0001**
Depression	51.1±10.9	50.9±10.8	53.3±11.3	**0.03**
Global Health—Physical	36.1±7.7	36.3±7.7	33.8±7.7	**0.0008**
Global Health—Mental	44.1±9.2	44.3±9.1	42.3±9.6	**0.04**

Abbreviations: *PROMIS*, Patient-Reported Outcome Measurement Information System; *PI*, Pain Interference; *PF*, Physical Function

Bold font indicates a statistically significant (P<0.05) difference.

Table 4. PROMIS Scores of Patients Who Received Surgery Between 0–3, 3–6, or 6–9 Months.

PROMIS	3 mo (N=62)	6 mo (N=31)	9 mo (N=22)
PI	**70.0±5.9**	69.0±7.0	**66.6±5.6**
PF	33.4±6.6	33.7±7.6	34.4±6.2
Depression	53.3±10.7	54.8±13.4	51.1±9.7
Global Health (Physical)	33.0±7.9	34.0±7.9	35.7±6.8
Global Health (Mental)	41.9±10.4	41.7±8.3	44.7±9.1

Abbreviations: *PROMIS*, Patient-Reported Outcome Measurement Information System; *PI*, Pain Interference; *PF*, Physical Function; *mo*, month

Bold font indicates a statistically significant (P<0.05) difference.

to Surgery (Table 5).

Predictive thresholds for PROMIS PI were subsequently established. PROMIS PI had an area under the receiver operating characteristic curve (AUC) of 0.61, which indicates that PROMIS PI alone is overall a weak discriminator of Surgery vs. No Surgery[8]. However, some notable thresholds can be observed. No patients with PROMIS PI <55 underwent surgery; thus, PROMIS PI ≥55 had a negative predictive value of 100% (Fig. 1).

A PROMIS PI threshold of ≥68 had a positive predictive value of 11.8%, sensitivity of 53.5%, and specificity of 63.1%.

Discussion

Orthopedic PROMs in the clinical setting are still difficult to meaningfully interpret. PROMIS scores have become more prominent in recent years of orthopedic literature; however, their clinical utilization is still limited. This study mainly aimed to determine if new patient PROMIS scores in patients who presented with low back pain could predict the likelihood and timing of elective spinal surgery within a year of initial clinical evaluation. Our findings suggest that patients with worse PROMIS scores, particularly those with worse PROMIS PI domain, are more likely to undergo surgery within 1 year. PROMIS PI and race, MD vs. APP, and availability of advanced imaging for interpretation were identified as independent predictors of Surgery vs. No Surgery; and PROMIS PI and race were additionally identified as independent predictors of Time to Surgery.

PROMIS PI, PF, Depression, Global Health Physical, and Global Health Mental were all worse in the Surgery group than in the No Surgery group. The finding that PROMIS scores are associated with undergoing surgery within a year is novel but rather expected. Patients with worse clinical presentation may be more likely to have organic pathology, be offered operative treatment, and have great enough disability to opt for operative intervention. Nevertheless, the differences in average PROMIS domain scores between the two groups were small and all less than 4, considerably below the preselected MCID of 8, which suggests that PROMIS scores may not be a strong differentiator of Surgery vs. No Surgery. As for Time to Surgery, only PROMIS PI showed a statistically significant difference at separate time points. Patients who underwent surgery at 0-3 months had an average PROMIS PI of 70.0 when compared with 66.6 for those who underwent surgery at 6-9 months. As similarly suggested above, those with worse PROMIS PI may be more likely to have organic pathology and be offered or be more willing to undergo surgical intervention. However, although trends were present, no statistically significant differences for the other PROMIS domain scores were observed at any of the time points. This similarly suggests, as above, that PROMIS domain scores may not be strong differentiators of Time to Surgery.

Although PROMIS PI was identified as an independent predictor of Surgery vs. No surgery and time to surgery, PROMIS PI in isolation is not a strong predictor of either outcome. With an AUC of 0.61 for differentiating Surgery vs. No Surgery, PROMIS PI has a weak differentiating ability in isolation. However, some notable thresholds hold clinical significance. In this study, no patients with PROMIS PI less than 55 underwent surgery; thus, the threshold of PROMIS PI ≥55 had a negative predictive value of 100%. PROMIS PI ≥68 was another notable threshold identified via ROC analysis that optimized sensitivity and specificity; 11.8% of patients with PROMIS PI ≥68 underwent surgery, and 93.6% of patients with PI <68 did not undergo surgery within a year (Fig. 1). Overall, PROMIS scores provide insight into possible surgical candidates but are only a small

Table 5. Multivariable Analysis of Patients Receiving Surgery and Time to Surgery.

Model	Estimate	Standard error	P-value	Adjusted r^2
Surgery vs. No Surgery				0.11
Race	0.41	0.11	0.0002	
MD vs. APP	–0.48	0.11	<0.0001	
PROMIS PI	0.07	0.015	<0.0001	
Advanced imaging interpretation	–0.48	0.10	<0.0001	
Time to Surgery				0.08
Race	–	–	0.001	
PROMIS PI	–	–	0.02	

Abbreviations: *APP*, Advanced Practice Provider; *MD*, Doctor of Medicine; *PROMIS*, Patient-Reported Outcome Measurement Information System; *PI*, Pain Interference

Advanced imaging includes MRI or CT myelogram.

Bold font indicates statistical significance (P<0.05).

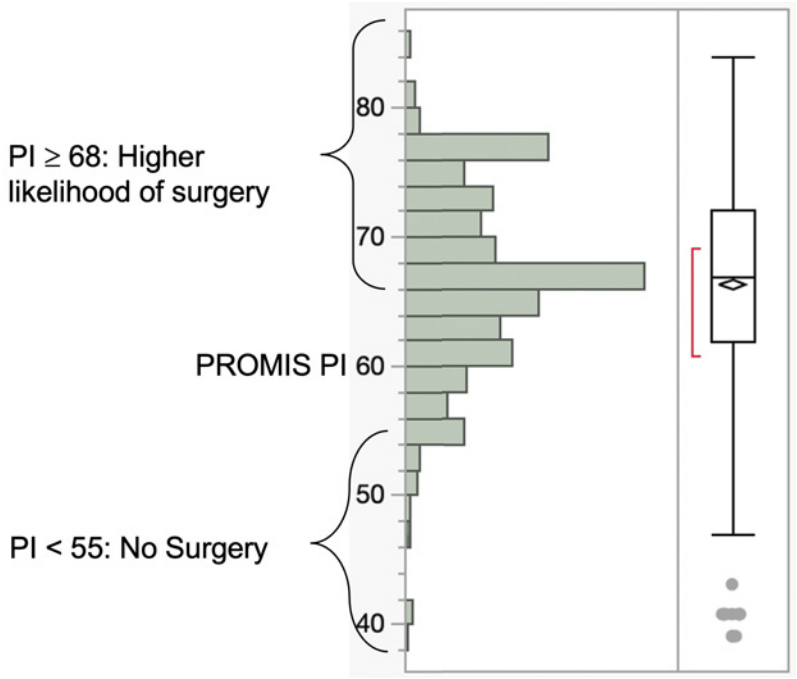

Figure 1. Distribution of PROMIS PI annotated with the likelihood of elective spine surgery within a year.

part of the overall decision to identify optimal surgical candidates.

Caucasian race, being seen by an MD instead of an APP, and having advanced imaging available for interpretation were also noted to be significantly associated with undergoing elective spine surgery within 1 year. Disparities in spine surgical intervention among racial minorities have been previously evaluated[9]. Possible causes include differences in clinical decision-making among providers regarding offering surgical care to minorities; differences in access to care due to financial, educational, or geographical barriers; or differences in attitude toward surgical care among various racial groups. The institutionalization of Accountable Care Organizations for the implementation of value-based healthcare has not yet been shown to improve surgical access for minorities; thus, specific programs that incentivize this may be necessary[10]. The effect of race on the time to surgery was not fully understood. This is probably because of variables not collected in this study that could affect the finding, such as other medical comorbidities or other socioeconomic variables. Moreover, there may be cultural or other differences in pain, PI, doctor-patient relationship, or the collection tool itself, which may have affected this finding. Currently, we are exploring the effect of this variable further. APPs have been shown to improve access to healthcare for patients and reduce the burden on orthopedic surgeons[11]. Our study revealed that being initially seen by an APP was an independent predictor of No Surgery but was not an independent predictor of Time to Surgery. These appropriately suggest that APPs at this institution are more likely to see patients who do not need surgery within a year while also not delaying intervention for those who do. Finally, having advanced im-

aging available for interpretation at the initial visit was associated with undergoing surgery within a year. MRIs or CT myelograms at the initial visit may help identify whether patients have organic pathology that can be addressed with surgical intervention.

Studies that evaluate PROMIS scores in relation to Time to Surgery are scarce. Horn et al. evaluated whether PROMIS scores could differentiate between patients undergoing hip and knee total joint arthroplasty (TJA) from non-surgical controls[12]. They similarly found that PROMIS PF and PI were worse in patients who undergo TJA than in controls; however, they noted that PROMIS PF is the only PROMIS domain to differentiate undergoing surgery in both hip and knee cohorts. In the orthopedic spine literature, PROMIS PI has been shown to have a stronger correlation with traditional PROMs, including the ODI and NDI when compared with PROMIS PF[7].

Limitations and future directions

Even though this study presents a unique utilization of PROMIS scores in the orthopedic spine literature, notable limitations still exist. First, this study is a retrospective analysis; thus, limitations related to this study design are applicable, and our associations cannot be considered causal. Second, this study was carried out at a single academic institution and may not be generalizable to other clinical settings. Third, although 1,387 patients were included in this study, the number of surgical patients was only 116; a larger sample size may have strengthened the study. Fourth, we did not evaluate other potential indicators for surgery, including MRI findings, duration of nonoperative treatment, and neurological symptoms. Fifth, this study is subject to selection bias because each surgeon has their own criteria when selecting surgical candidates as well as their own protocols for preoperative optimization, which may have an impact on Time to Surgery. Despite these limitations, this study identified that PROMIS PI can help differentiate patients who undergo surgery in 1 year.

Conclusion

Many health systems have been able to implement the collection of PROMIS measures within orthopedic settings[13]. Nonetheless, clinical interpretation of scores remains limited, and incorporation of PROMIS scores into clinical decision-making processes is still in its preliminary phase[14]. In this study, we found that PROMIS PI is the PROMIS domain that can best differentiate whether a patient undergoes surgery within 1 year as well as how urgently. Nonetheless, to validate these findings in a prospective study design, further research is warranted.

Conflicts of Interest: The authors declare that there are no relevant conflicts of interest.

Sources of Funding: No sources of funding were acquired for this study.

Acknowledgement: The authors would like to acknowledge William Kelly and Brice Smoker for assistance with data collection.

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Ethical Approval: This project was exempted from PRISMA Health IRB approval.

Informed Consent: This study involved no more than minimal risk to the subjects; thus, informed consent was not required.

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