



PROMIS Subgroup Cluster Analysis Predicts Two-Year Outcomes in Knee Surgery Patients

Sean J. Meredith, M.D.

Samir S. Kaveeshwar MD, Justin Kung MD, Michael S. Rocca MD, Daniel Rivkin BS,
Jacob Hartline MD, Evan L. Honig BA, Jonathan D. Packer MD, Sean J. Meredith MD,
Natalie L. Leong MD, R. Frank Henn, III MD

Department of Orthopaedics,
University of Maryland School of Medicine, Baltimore, MD

Disclosures

I (and/or my coauthors) have something to disclose

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INTRODUCTION

- Patient-reported outcome (PRO) assessments are important measures of clinical improvement following orthopaedic surgery.
- The Patient-Reported Outcomes Measurement Information System (PROMIS) is a validated and standardized PROM that uses computer adaptive testing to evaluate various domains, including Physical Function, Pain Interference, Social Satisfaction, Fatigue, Anxiety, and Depression.
- Individual PROMIS domains have been investigated for prognostic value, but they remain limited as they do not provide a holistic representation of patient status prior to surgery.
- George et al. recently performed a unique clustering analysis that aggregated multiple baseline PROMIS domains to create 4 patient profiles based on level of impairment and distress. However, it is unclear if PROMIS clustering has two-year postoperative outcome prognostic value.

OBJECTIVES

- The purpose of this study was to determine if clustering knee surgery patients into four preoperative PROMIS profiles would have prognostic value for two-year postoperative outcomes.

HYPOTHESIS

- We hypothesized that preoperative cluster would be predictive of two-year outcomes.



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METHODS

- 488 of 697 (70%) patients from the Maryland Orthopaedic Registry who received knee surgery between June of 2015 and November of 2017 completed two-year follow-up and were analyzed.
- Demographic data was self-reported and electronic medical review was conducted to obtain medical and operative data.
- All enrolled patients were administered at baseline and two years postoperatively:
 - six PROMIS computer adaptive testing questionnaires (Physical Function, Pain Interference, Fatigue, Social Satisfaction, Anxiety, and Depression)
 - International Knee Documentation Committee (IKDC) Subjective Knee Evaluation Form
 - Marx Knee Activity Rating Scale (MARS)
 - Surgical Satisfaction Questionnaire-8 (SSQ-8)
 - a single “Completely Better” (CB) question

METHODS

- The CB question consists of a prompt, “Is the condition for which you underwent surgery completely better now?” with answer choices “Yes” or “No.”
- Minimal clinically important differences (MCIDs) were set at 10 for PROMIS domains and IKDC scores, and 12.5 for MARS.
- Patient clusters were derived from the six PROMIS baseline domains using k-means cluster analysis.
- Bivariate analyses were conducted between cluster group and socioeconomic factors, operative factors, and outcomes.
- Multivariable analyses were conducted using backward-stepwise linear regression to identify if cluster group was an independent predictor of postoperative outcomes.



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RESULTS

- Cluster analysis revealed 4 distinct groups based off preoperative PROMIS scores as shown in Figure 1 and Table 1. PROMIS Depression was the most important domain for cluster membership due to the highest misclassification rate without its inclusion.
- More impaired clusters were associated with higher rates of arthroplasty, African-American race, preoperative opioid use, lower income, higher comorbidity index, and other sociodemographic and operative factors ($p < 0.05$).

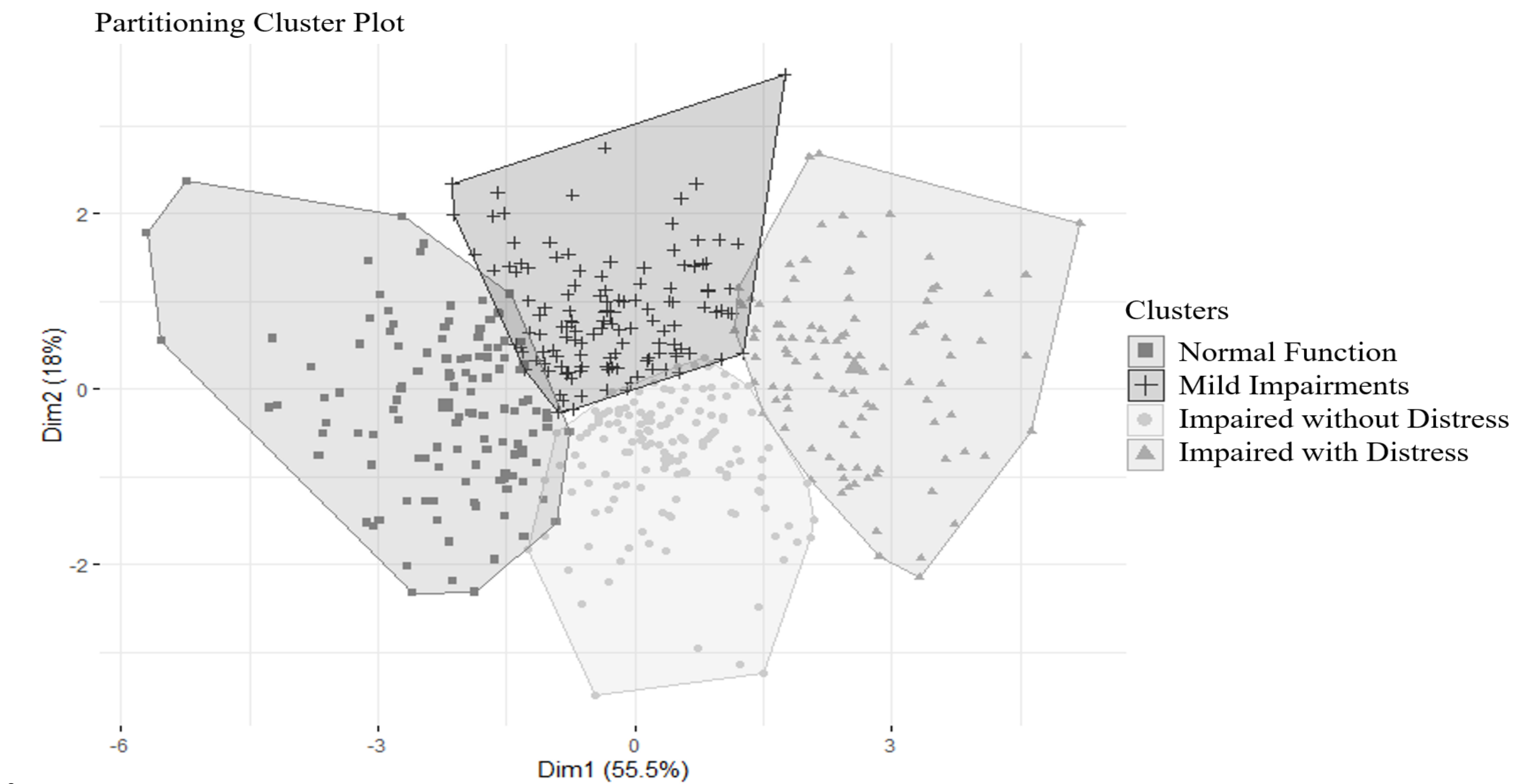


Figure 1. K-means cluster analysis revealed 4 preoperative clusters derived from the six PROMIS domains

Table 1: Average baseline PROMIS scores by Cluster Profile				
PROMIS domain	Preoperative PROMIS Cluster			
	Normal Function (N=123)	Mild Impairments (N=126)	Impaired without Distress (N=139)	Impaired with Distress (N=100)
Physical Function	47.9 (7.1)	45.3 (6.2)	37.3 (5.5)	34.6 (6.7)
Pain Interference	53.1 (5.7)	56.7 (4.9)	62.9 (4.5)	67.9 (5.0)
Fatigue	40.7 (6.5)	49.7 (6.4)	53.2 (6.9)	64.4 (5.8)
Social Satisfaction	50.5 (8.6)	46.6 (6.0)	39.9 (5.8)	34.9 (6.6)
Anxiety	46.7 (7.1)	58.3 (6.1)	53.7 (5.7)	65.0 (6.2)
Depression	41.2 (6.0)	53.5 (5.3)	45.5 (6.2)	59.2 (6.7)

Note: Reported as Mean (SD).



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RESULTS

- Better preoperative clusters were associated with higher two-year postoperative scores in all PROs (Table 2).

Table 2: Two-year PRO scores by Cluster Profile

Two-year PROs	Preoperative PROMIS Cluster Profile				P-value
	Normal Function (N=123)	Mild Impairments (N=126)	Impaired w/o Distress (N=139)	Impaired w/ Distress (N=100)	
PROMIS PF	56.7 (10.3)	53.7 (10.1)	49.4 (9.3)	43.9 (8.9)	<0.001
PROMIS PI	45.6 (8.2)	48.8 (8.8)	52.3 (9.3)	57.2 (9.9)	<0.001
PROMIS Fatigue	41.4 (8.5)	47.0 (9.9)	47.0 (10.7)	53.8 (10.6)	<0.001
PROMIS SS	58.7 (10.0)	53.8 (10.9)	52.2 (11.4)	46.6 (11.2)	<0.001
PROMIS Anxiety	45.2 (10.0)	51.0 (10.0)	48.1 (9.9)	55.1 (9.5)	<0.001
PROMIS Depression	42.5 (7.6)	48.6 (9.0)	45.0 (8.7)	52.5 (10.0)	<0.001
IKDC	78.0 (19.4)	72.5 (20.1)	63.5 (24.2)	54.6 (23.7)	<0.001
Marx Knee Activity	45.2 (32.3)	47.5 (31.2)	30.2 (34.0)	23.9 (31.0)	<0.001
SSQ-8	85.0 (19.1)	79.1 (18.9)	76.2 (21.3)	69.3 (23.2)	<0.001

Note: Reported as Mean (SD). Bold values indicate statistically significant difference (p < 0.05)



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RESULTS

- Worse preoperative cluster was associated with higher chance of achieving MCID on all metrics ($p \leq 0.034$) except PROMIS Pain Interference, IKDC, and MARS postoperatively (Table 3).

Table 3: Percent (%) That Achieve MCID by Cluster Profile

Two-year PROs	Preoperative PROMIS Cluster Profile				P-value
	Normal Function (N=123)	Mild Impairments (N=126)	Impaired w/o Distress (N=139)	Impaired w/ Distress (N=100)	
PROMIS PF	43.9%	38.9%	<u>56.1%</u>	44.0%	0.034
PROMIS PI	45.0%	46.0%	50.4%	51.0%	0.73
PROMIS Fatigue	10.1%	16.1%	41.7%	<u>47.4%</u>	<0.001
PROMIS SS	44.4%	38.2%	<u>55.4%</u>	53.7%	0.025
PROMIS Anxiety	24.8%	35.8%	32.0%	<u>44.7%</u>	0.022
PROMIS Depression	5.1%	27.1%	16.4%	<u>33.7%</u>	<0.001
IKDC	82.4%	75.2%	72.7%	73.8%	0.26
MARS	14.6%	12.7%	11.3%	16.3%	0.73
% Achieved Completely Better Status	<u>68.6%</u>	58.9%	49.6%	48.3%	0.011

Note: Underlined values indicate highest % MCID achievement among statistically significant cluster groups in given PRO metric.



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RESULTS

- Multivariable analysis demonstrated that better preoperative cluster was predictive of better PROMIS Physical Function and Pain Interference, IKDC scores, and satisfaction ($p < 0.05$), and worse preoperative cluster was predictive of greater improvement on PROMIS Physical Function and Pain Interference ($p < 0.05$) but not IKDC (Table 4a and 4b).
- Cluster status was not a significant predictor of achieving completely better status in the multivariable analysis (Table 4a).

Table 4a: Multivariable Regression for Relevant Two-Year Outcome Metrics

Two-Year PRO Metric Model	Preoperative PROMIS Cluster				R ² , Adj
	Normal Function	Mild Impairments	Impaired w/o Distress	Impaired w/ Distress	
PROMIS PF	4.33 (<0.001)	0.89 (0.30)	-1.92 (0.017)	-3.31 (0.001)	0.39
PROMIS PI	-4.72 (<0.001)	-0.94 (0.23)	1.20 (0.10)	4.46 (<0.001)	0.32
IKDC	7.22 (<0.001)	1.01 (0.59)	-4.05 (0.023)	-4.17 (0.06)	0.36
SSQ-8	7.41 (<0.001)	-0.59 (0.76)	-1.67 (0.38)	-5.15 (0.022)	0.11
CB Status	-	-	-	-	-

Note: Bolded font indicates statistically significant ($p < 0.05$) estimates. Scaled estimates (p-value) given and in reference to 0. For example: members of the “Normal” cluster score 4.33 points higher on two-year PROMIS PF relative to a reference of 0.

Table 4b: Multivariable Regression for Relevant Change Outcome Metrics

Change PRO Metric Model	Preoperative PROMIS Cluster				R ² , Adj
	Normal Function	Mild Impairments	Impaired w/o Distress	Impaired w/ Distress	
PROMIS PF	-1.82 (0.042)	-2.57 (0.003)	2.30 (0.006)	2.09 (0.037)	0.15
PROMIS PI	1.78 (0.049)	1.84 (0.040)	-0.88 (0.29)	-2.73 (0.010)	0.06
IKDC	-	-	-	-	-

Note: Bolded font indicates statistically significant ($p < 0.05$) estimates. Scaled estimates (p-value) given and in reference to 0. For example: members of the “Normal” cluster worsened 1.82 points on two-year PROMIS PF relative to a reference of 0.



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DISCUSSION

- Empirically-derived preoperative PROMIS clusters have prognostic value in predicting outcomes for knee surgery patients even when associated sociodemographic factors are controlled for.
- Worse clusters were associated with multiple demographic, socioeconomic, and operative factors.
- Better preoperative cluster predicts superior two-year outcomes.
- While worse preoperative cluster was associated with worse two-year scores, they still experienced substantial improvement and reached MCID in various domains despite having lower satisfaction rates and CB rates.

DISCUSSION

- The impaired without distress group had markedly better improvement in PROMIS Physical Function than our impaired with distress group, which contributes to the body of evidence that implies a relationship between psychological resilience and functional outcomes.

CONCLUSION

- **This study shows that preoperative PROMIS-based clusters have prognostic value in predicting knee surgery outcomes.**
- **Cluster are a novel, convenient, and potentially more clinically relevant application of patient-reported outcome metrics in the knee surgery population.**



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