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ORIGINAL ARTICLE

# Relating preoperative MCS-12 to microdiscectomy outcomes

**Jeremy C. Heard[1] · Yunsoo Lee[1] · Teeto Ezeonu[1] · Mark J. Lambrechts[1] · Rajkishen Narayanan[1] · Caleb Yeung[1] · Justin Wright[1] · John Paulik[1] · Caroline Purtill[1] · John J. Mangan[1] · Mark F. Kurd[1] · Ian D. Kaye[1] · Jose A. Canseco[1] · Alan S. Hilibrand[1] · Alexander R. Vaccaro[1] · Gregory D. Schroeder[1] · Christopher K. Kepler[1]**

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## Abstract

**Purpose** To determine the impact of poor mental health on patient-reported and surgical outcomes after microdiscectomy.

**Methods** Patients ≥ 18 years who underwent a single-level lumbar microdiscectomy from 2014 to 2021 at a single academic institution were retrospectively identified. Patient-reported outcomes (PROMs) were collected at preoperative, three-month, and one-year postoperative time points. PROMs included the Oswestry Disability Index (ODI), Visual Analog Scale Back and Leg (VAS Back and VAS Leg, respectively), and the mental and physical component of the short form-12 survey (MCS and PCS). The minimum clinically important differences (MCID) were employed to compare scores for each PROM. Patients were categorized as having worse mental health or better mental health based on a MCS threshold of 50.

**Results** Of 210 patients identified, 128 (61%) patients had a preoperative MCS score ≤ 50. There was no difference in 90-day surgical readmissions or spine reoperations within one year. At 3- and 12-month time points, both groups demonstrated improvements in all PROMs ($p < 0.05$). At three months postoperatively, patients with worse mental health had significantly lower PCS (42.1 vs. 46.4, $p = 0.004$) and higher ODI (20.5 vs. 13.3, $p = 0.006$) scores. Lower mental health scores were associated with lower 12-month PCS scores (43.3 vs. 48.8, $p < 0.001$), but greater improvements in 12-month ODI (−28.36 vs. −18.55, $p = 0.040$).

**Conclusion** While worse preoperative mental health was associated with lower baseline and postoperative PROMs, patients in both groups experienced similar improvements in PROMs. Rates of surgical readmissions and reoperations were similar among patients with varying preoperative mental health status.

**Keywords** Lumbar spine · Disc herniation · Microdiscectomy · Mental health · Outcomes

## Introduction

Lumbar disc herniations have an incidence of up to 2%, most commonly impacting people in their thirties to fifties. Conservative management includes analgesic or muscle-relaxing medications, physical therapy, and epidural steroid injections. Surgical intervention is often indicated after failure of conservative management, most often microdiscectomy [1]. There has been significant research on factors impacting the success of disc herniation management, including sarcopenia, lumbar disc herniation characteristics, timing of surgery, and surgical approach [2–6]. However, the impact of mental health on outcomes after microdiscectomy has yet to be defined.

Prior studies that have assessed the relationship between preoperative mental health, as measured by the mental health component of the short form-12 survey (MCS-12), and outcomes after various types of spine surgery have yielded conflicting results [7–14]. While there is evidence in the literature supporting the adverse impact of poor mental health on outcomes after lumbar fusion surgery [7, 13, 14], it appears that clinical improvement after less invasive surgeries, such as anterior cervical discectomy and fusion and lumbar laminectomy, has not been associated with baseline differences in mental health status [8, 10]. Microdiscectomies, which are also relatively less invasive spinal surgical procedures, have not been similarly studied in this context, and whether preoperative

✉ Yunsoo Lee
yunsoo.lee@rothmanortho.com

[1] Spine Surgery, Department of Orthopaedic Surgery, Rothman Institute, Thomas Jefferson University, 925 Chestnut Street, 5thFloor, Philadelphia, PA 19107, USA

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MCS-12 is associated with worsened outcomes after microdiscectomy remains unknown. Therefore, our study aimed to assess the impact of poor mental health preoperatively on patient-reported and surgical outcomes after microdiscectomy surgery.

## Methods

After institutional review board approval, all adults who underwent a single-level lumbar microdiscectomy from 2014 to 2021 at a single academic institution were retrospectively identified. The following CPT codes were utilized for an inclusive list of patients undergoing microdiscectomy and hemilaminectomy: 63,030 and 63,047. Operative notes were reviewed to confirm that the procedure was a single-level microdiscectomy of the lumbar spine. Patients were excluded if there were no PROM data at one-year follow-up [14].

### Data extraction

Patient demographics and surgical characteristics were collected through a Structured Query Language search confirmed by a manual chart review of the electronic medical records. Variables collected included patient age, sex, body mass index (BMI), race, diabetes status, smoking status (nonsmoker, current smoker, former smoker), Elixhauser comorbidity index (ECI), weakness duration, preoperative injections, and surgical levels.

### Outcomes

Surgical characteristics collected included surgical level, 90-day surgical readmissions, the reason for 90-day surgical readmissions (including cerebrospinal fluid leak, infection, same-level (SL) herniation), one-year spine reoperation, and the reason for spine reoperation. PROMs were collected at preoperative, three-month, and one-year postoperative time points. Those included the Oswestry Disability Index (ODI), Visual Analog Scale Back and Leg (VAS Back and VAS Leg, respectively), and the mental and physical component of the short form-12 survey (MCS and PCS). The difference found by subtracting the preoperative PROM from the one-year or three-month postoperative PROM was defined as delta (Δ). The minimum clinically important differences (MCID), as described by Parker et al., were employed to compare groups for each respective PROM (2.1 for VAS Back, 2.8 for VAS Leg, 14.9 for ODI, 8.1 for PCS-12, and 4.7 for MCS-12) [15, 16].

### Statistical analysis

Patients were dichotomized based on if the MCS was $> 50$ or $\leq 50$, as described in the literature [13, 17–19]. Patients with MCS scores $\leq 50$ were referred to as having worse preoperative mental health than those with scores $> 50$. Descriptive statistics, including means with standard deviation, were reported for patient demographics, surgical characteristics, and PROMs at the preoperative and postoperative time points. A Shapiro–Wilk test was used to analyze the normality of each continuous variable, and parametric data were compared with independent *t* tests. Nonparametric data were compared with Mann–Whitney *U* tests. Dichotomous variables were compared with Pearson's chi-squared tests. A multivariable logistic regression model accounting for age, sex, BMI, and ECI was developed to determine whether preoperative MCS score was a significant independent predictor of ΔPROMs. These variables were included in the analysis to remove their potential confounding effect on outcomes, as they have been demonstrated to influence mental health status [20, 21]. Statistical significance was set at $p < 0.05$. All statistical analyses were performed using RStudio Version 4.0.2 (Boston, MA).

## Results

### Patient demographic and surgical characteristics

Of 210 patients total, 128 patients had a preoperative MCS score $\leq 50$ (average MCS: $38.5 \pm 8.50$), while 82 patients had an MCS score $> 50$ (average MCS: $56.5 \pm 4.99$). Patients with a lower MCS score had a significantly higher BMI ($29.4 \pm 6.32$ vs. $27.2 \pm 5.64$, $p = 0.014$). There were no other significant differences in demographic or surgical characteristics (Table 1).

### Surgical outcomes

Bivariate analysis of surgical outcomes yielded no significant differences between groups with regard to 90-day surgical readmissions for cerebrospinal fluid leak, infection, or same-level herniation, nor with regard to spine reoperation within one year (Table 2).

### Patient-reported outcomes

Preoperatively, patients with lower preoperative MCS scores demonstrated significantly higher preoperative ODI scores ($49.1 \pm 16.8$ vs. $42.3 \pm 17.9$, $p = 0.009$). There were no other differences in preoperative PROMs ($p > 0.05$). All

**Table 1** Demographic and surgical characteristics

| | Worse MCS score (MCS ≤ 50) $N=128$ | Better MCS score (MCS > 50) $N=82$ | *P* value |
|---|---|---|---|
| Age | 44.2 (13.1) | 45.1 (12.8) | 0.644 |
| Sex | | | 0.942 |
| F | 55 (43.0%) | 34 (41.5%) | |
| M | 73 (57.0%) | 48 (58.5%) | |
| BMI | 29.4 (6.32) | 27.2 (5.64) | **0.014*** |
| Diabetes | | | 0.265 |
| No | 117 (91.4%) | 79 (96.3%) | |
| Yes | 11 (8.59%) | 3 (3.66%) | |
| Smoking | | | 0.444 |
| Never | 97 (75.8%) | 68 (82.9%) | |
| Current | 15 (11.7%) | 6 (7.32%) | |
| Former | 16 (12.5%) | 8 (9.76%) | |
| ECI | 0.55 (0.79) | 0.41 (0.77) | 0.129 |
| Weakness duration | 12.5 (8.89) | 11.3 (8.31) | 0.516 |
| Preoperative injections | 0.34 (0.63) | 0.43 (0.70) | 0.387 |
| Surgical levels | | | |
| L2-L3 | 2 (1.56%) | 1 (1.22%) | 1.000 |
| L3-L4 | 8 (6.25%) | 2 (2.44%) | 0.322 |
| L4-L5 | 48 (37.5%) | 26 (31.7%) | 0.478 |
| L5-S1 | 70 (54.7%) | 53 (64.6%) | 0.199 |

*BMI* body mass index; *ECI* Elixhauser comorbidity index

*indicates statistical significance

**Table 2** Surgical outcomes

| | Worse MCS score (MCS ≤ 50) $N=128$ | Better MCS score (MCS > 50) $N=82$ | *P* value |
|---|---|---|---|
| 90-day surgical readmissions | 2 (2.38%) | 5 (3.36%) | 1.000 |
| CSF leak | 0 (0.00%) | 2 (2.44%) | 0.151 |
| Infection | 2 (1.56%) | 0 (0.00%) | 0.522 |
| Same-level herniation | 2 (1.56%) | 1 (1.22%) | 1.000 |
| 1-year spine reoperation | 10 (7.81%) | 3 (3.66%) | 0.355 |
| Same-level herniation | 7 (5.47%) | 3 (3.66%) | 0.743 |
| Adjacent-level herniation | 1 (0.78%) | 0 (0.00%) | 1.000 |
| Other | 2 (1.56%) | 0 (0.00%) | 0.522 |

*CSF* cerebrospinal fluid

*indicates statistical significance

patients in both groups improved from the preoperative to the three-month postoperative time point ($p<0.05$). At three months postoperatively, patients with lower preoperative MCS demonstrated significantly lower PCS (42.1 ± 8.64 vs. 46.4 ± 9.19, $p=0.004$) and higher ODI (20.5 ± 17.3 vs. 13.3 ± 12.8, $p=0.006$). No other significant differences in PROM analysis were found (Table 3).

At 12 months postoperatively, both groups demonstrated significant improvements in PROMs compared to preoperative scores in both groups ($p<0.05$). Worse preoperative mental health scores were associated with lower 12-month PCS scores (43.3 ± 9.33 vs. 48.8 ± 9.49, $p<0.001$). Greater improvement in ODI at 12 months postoperatively (−28.36 ± 27.1 vs. −18.55 ± 26.8, $p=0.040$) was noted in patients with lower preoperative MCS scores. There were no other significant differences observed (Table 4).

### Multivariable linear regression

Multivariable analysis did not show any associations between worse mental health (MCS < 50) and change in PROMs ($p<0.001$) (Table 5).

## Discussion

Prior studies have used various methods to assess mental health prior to spinal surgery, including MCS cutoffs, which has allowed for evaluation of the impact of worsened preoperative mental health on the outcomes after spine surgery [7–14]. However, no prior study has assessed microdiscectomy alone in this context. Our study is the first to investigate this gap in the literature. We noted that all patients experienced significant improvements in PROMs after microdiscectomy, regardless of preoperative mental health status. Encouragingly, we also demonstrated that the surgical outcomes were not associated with preoperative mental health status.

Studies have previously assessed the impact of mental health on outcomes after surgery. In both orthopedic and non-orthopedic literature, poor mental health has been identified as a significant predictor of worsened surgical outcomes after operative intervention [22–24]. In a retrospective database study, Huang et al. demonstrated that worsened mental health hindered outcomes after spine surgery for degenerative disease. In this study of 10,109 patients, ventilator use (odds ratio (OR) = 1.62, $p<0.05$), hospital length of stay (OR = 1.77, $p<0.05$), and rehabilitation utilization (OR = 1.25, $p<0.01$) were all significantly higher in patients with worsened preoperative mental health status. This study was limited by heterogeneity as it included patients who underwent discectomy, laminectomy, and spinal fusion, which vary greatly with multiple preoperative and postoperative factors including invasiveness, potential complications, length of stay, and postoperative pain. In addition, this study did not assess for patient-reported outcome measures postoperatively [9].

**Table 3** Three-month postoperative PROMs

| | Worse MCS score (MCS ≤ 50) N = 92 | Better MCS score (MCS > 50) N = 55 | P value |
|---|---|---|---|
| Pre-op VAS Back | 5.70 (2.65) | 5.34 (2.90) | 0.528 |
| Post-op 3-month VAS Back | 2.22 (2.09) | 2.35 (2.37) | 0.686 |
| Δ3-month VAS Back | −3.49 (3.55) | −2.99 (4.05) | 0.391 |
| Intragroup *P* value | < 0.001* | < 0.001* | |
| 3-month VAS Back MCID | 65 (70.7%) | 32 (58.2%) | 0.172 |
| | N = 92 | N = 55 | |
| Pre-op VAS Leg | 6.66 (2.38) | 6.67 (2.49) | 0.908 |
| Post-op 3-month VAS Leg | 2.51 (2.60) | 2.65 (2.86) | 0.956 |
| Δ3-month VAS Leg | −4.15 (3.87) | −4.02 (3.74) | 0.748 |
| Intragroup *P* value | 0.002* | < 0.001* | |
| 3-month VAS Leg MCID | 64 (69.6%) | 37 (67.3%) | 0.915 |
| | N = 90 | N = 54 | |
| Pre-op PCS | 30.4 (6.78) | 32.7 (8.56) | 0.137 |
| Post-op 3-month PCS | 42.1 (8.64) | 46.4 (9.19) | 0.004* |
| Δ3-month PCS | 11.3 (8.96) | 13.3 (12.8) | 0.328 |
| Intragroup *P* value | < 0.001* | < 0.001* | |
| 3-month PCS MCID | 56 (62.2%) | 34 (63.0%) | 1.000 |
| | N = 84 | N = 52 | |
| Pre-op ODI | 49.1 (16.8) | 42.3 (17.9) | 0.009* |
| Post-op 3-month ODI | 20.5 (17.3) | 13.3 (14.6) | 0.006* |
| Δ3-month ODI | −29.30 (19.7) | −27.74 (25.3) | 0.914 |
| Intragroup *P* value | < 0.001* | < 0.001* | |
| 3-month ODI MCID | 66 (78.6%) | 40 (76.9%) | 0.990 |

*MCID* minimal clinically important difference; *PT* physical therapy; *MCS* mental component score (of SF-12); *PCS* physical component score (of SF-12); *ODI* Oswestry Disability Index; *VAS* Visual Analog Scale; Δ postoperative minus preoperative results

*indicates statistical significance ($p < 0.05$)

In contrast to Huang et al., we demonstrated that mental health did not impact surgical outcomes after microdiscectomy surgery. This contrasting finding may be due to the minimally invasive nature and quicker recovery of a microdiscectomy surgery. Specifically in our study, we demonstrated that preoperative ODI, three-month postoperative ODI and PCS, and 12-month postoperative PCS scores were significantly worse in patients with MCS < 50. On Bivariate analysis, ODI improvement was hindered in the group with worsened preoperative mental health scores, but the multivariable analysis did not redemonstrate these findings. Importantly, however, clinical improvement was not found to be associated with preoperative MCS. Our results are supported by findings noted previously in other less invasive spinal surgical procedures, demonstrating that preoperative mental health status does not appear to affect the magnitude clinical improvement following surgical intervention, even if they may be associated with absolute differences in PROMs at various time points postoperatively [8, 10]. The lack of significance of preoperative MCS in the multivariate regression analyses indicates that when other patient factors such as age, sex, BMI, and ECI are accounted for, the overall significance of mental health status is reduced.

Indeed, in a retrospective study of 264 anterior cervical discectomies and fusion (ACDF) patients, Divi et al. [8] demonstrated that while baseline PROMs (VAS-Neck $p < 0.001$, VAS-Arm $p < 0.001$, and NDI $p < 0.001$) and postoperative PROMs (VAS-Arm $p = 0.001$, NDI $p = 0.010$, and PCS $p = 0.02$) scores were significantly lower for patients with MCS < 35, there were no significant differences between groups when comparing clinical improvement. Similarly, in a smaller study of 52 ACDF patients, Mayo et al. [11] found that lower MCS scores (< 47.5) were associated with worse preoperative PROMs (NDI $p < 0.001$ and VAS-Arm $p = 0.026$). However, improvement in PROMs was uniform between groups ($p > 0.05$). Kobayashi et al. retrospectively studied PROMs in 122 patients undergoing laminectomy surgery based on MCS ≤ 36.2 versus > 36.2.

**Table 4** Twelve-month postoperative PROMs

| | Worse MCS score (MCS ≤ 50) $N$ = 92 | Better MCS score (MCS > 50) $N$ = 55 | $P$ value |
|---|---|---|---|
| Pre-op VAS Back | 5.70 (2.65) | 5.34 (2.90) | 0.528 |
| Post-op 12-month VAS Back | 2.55 (2.46) | 3.08 (2.57) | 0.248 |
| Δ12-month VAS Back | −3.16 (3.97) | −2.26 (3.77) | 0.118 |
| Intragroup $P$ value | **< 0.001*** | < 0.001* | |
| 12-month VAS Back MCID | 57 (62.0%) | 32 (58.2%) | 0.780 |
| | $N$ = 92 | $N$ = 55 | |
| Pre-op VAS Leg | 6.66 (2.38) | 6.67 (2.49) | 0.908 |
| Post-op 12-month VAS Leg | 2.39 (2.65) | 2.13 (2.31) | 0.697 |
| Δ12-month VAS Leg | −4.27 (3.92) | −4.55 (3.13) | 0.952 |
| Intragroup $P$ value | 0.002* | < 0.001* | |
| 12-month VAS Leg MCID | 64 (69.6%) | 40 (72.7%) | 0.826 |
| | $N$ = 81 | $N$ = 55 | |
| Pre-op PCS | 30.4 (6.78) | 32.7 (8.56) | 0.137 |
| Post-op 12-month PCS | 43.3 (9.33) | 48.8 (9.49) | < 0.001* |
| Δ12-month PCS | 13.2 (11.5) | 16.3 (11.8) | 0.138 |
| Intragroup $P$ value | < 0.001* | < 0.001* | |
| 12-month PCS MCID | 51 (63.0%) | 41 (74.5%) | 0.219 |
| | $N$ = 84 | $N$ = 52 | |
| Pre-op ODI | 49.1 (16.8) | 42.3 (17.9) | **0.009*** |
| Post-op 12-month ODI | 20.7 (20.3) | 22.6 (19.7) | 0.460 |
| Δ12-month ODI | −28.36 (27.1) | −18.55 (26.8) | 0.040* |
| Intragroup $P$ value | < 0.001* | < 0.001* | |
| 12-month ODI MCID | 61 (72.6%) | 31 (59.6%) | 0.166 |

*MCID* minimal clinically important difference; *MCS* mental component score (of SF-12); *PCS* physical component score (of SF-12); *ODI* Oswestry Disability Index; *VAS* Visual Analog Scale; Δ postoperative minus preoperative results

*indicates statistical significance ($p < 0.05$)

Similar to the studies on ACDF mentioned above, patients demonstrated worse preoperative PROMs but no significant differences in clinical improvement after surgery [10].

In contrast to the literature on ACDFs and laminectomy, prior studies assessing more invasive procedures such as spinal fusions have demonstrated significant associations between preoperative mental health scores and clinical improvement after surgery. In a retrospective analysis of 172 patients undergoing minimally invasive transforaminal lumbar interbody fusion, Yoo et al. reported that patients with preoperative MCS < 50 had significantly worse preoperative physical function scores, as measured by the patient-reported outcome measurement information system physical function (PROMIS PF). In addition, these patients demonstrated significantly less clinical improvement in PROMIS PF from baseline at one year ($p = 0.002$) postoperative [13]. Similarly, Carreon et al. studied the impact of preoperative MCS < 50 on improvement in PROMs achieved by lumbar fusion surgery in a retrospective analysis of 546 patients. The authors showed that patients with preoperative MCS > 50 had significantly greater improvement in ODI ($p < 0.001$) and PCS ($p = 0.0155$) [7]. Similarly, Stull et al. retrospectively studied 391 lumbar fusion patients and determined that, with an MCS cutoff of 45.6, lower preoperative mental health scores were significantly associated with worsened postoperative VAS Leg, VAS Back, ODI, and PCS-12 ($p < 0.033$). However, these authors found that even the cohort of lower preoperative MCS scores had significant improvement in all PROMs after surgery [14]. Ultimately, there is substantial variation in the literature regarding which MCS cutoff score is most appropriate. The MCS-12 uses norm-based scoring such that the mental summary measure has a mean of 50 and a standard deviation of 10 in the US general population. Thus, scores less than 50 indicate worse mental health status compared to the US general population. We felt it was most appropriate to use a cutoff score of 50 given this study's geographic location.

**Table 5** Multivariable linear regressions for predictors of delta PROMs

| | ΔVAS Leg | | | | ΔVAS Back | | | | ΔPCS | | | | ΔODI | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Est. | L 95% | U 95% | *p* | Est. | L 95% | U 95% | *p* | Est. | L 95% | U 95% | *p* | Est. | L 95% | U 95% | *p* |
| *3 months* | | | | | | | | | | | | | | | | |
| Pre-op mental health score ≤ 50[1] | −0.182 | 1.121 | −1.484 | 0.785 | −0.506 | 0.768 | −1.780 | 0.438 | −2.210 | 1.356 | −5.776 | 0.227 | −1.044 | 6.678 | −8.766 | 0.791 |
| Age | 0.009 | −0.039 | 0.058 | 0.703 | 0.001 | −0.046 | 0.048 | 0.968 | −0.116 | −0.248 | 0.016 | 0.087 | 0.155 | −0.134 | 0.444 | 0.295 |
| Male sex (ref: female) | 0.954 | −0.325 | 2.233 | 0.146 | 1.145 | −0.107 | 2.396 | 0.075 | −3.591 | −7.097 | −0.086 | 0.047* | 4.656 | −2.979 | 12.292 | 0.234 |
| BMI | 0.000 | −0.115 | 0.114 | 0.996 | −0.027 | −0.139 | 0.085 | 0.638 | 0.136 | −0.177 | 0.448 | 0.396 | −0.146 | −0.819 | 0.527 | 0.671 |
| ECI | −0.120 | −1.016 | 0.775 | 0.793 | 0.272 | −0.604 | 1.149 | 0.543 | 1.013 | −1.435 | 3.462 | 0.419 | −2.568 | −8.003 | 2.867 | 0.356 |
| *12 months* | | | | | | | | | | | | | | | | |
| Pre-op mental health score ≤ 50[1] | 0.302 | 1.526 | −0.922 | 0.630 | −0.847 | 0.468 | −2.162 | 0.209 | −2.483 | 1.634 | −6.601 | 0.239 | −8.529 | −0.910 | -17.969 | 0.079 |
| Age | 0.018 | −0.027 | 0.063 | 0.436 | 0.023 | −0.025 | 0.072 | 0.348 | 0.007 | −0.156 | 0.171 | 0.931 | 0.307 | −0.047 | 0.661 | 0.091 |
| Sex | 0.920 | -0.282 | 2.122 | 0.136 | 1.066 | −0.226 | 2.357 | 0.108 | −1.479 | −5.478 | 2.521 | 0.470 | 3.825 | −5.509 | 13.159 | 0.423 |
| BMI | −0.045 | −0.153 | 0.062 | 0.411 | −0.053 | −0.168 | 0.063 | 0.373 | −0.210 | −0.572 | 0.153 | 0.259 | −0.358 | −1.181 | 0.465 | 0.395 |
| ECI | −0.683 | −1.525 | 0.159 | 0.114 | −0.396 | −1.301 | 0.509 | 0.392 | −1.245 | −3.979 | 1.488 | 0.373 | −2.231 | −8.875 | 4.413 | 0.512 |

*MCS* mental component score (of SF-12); *PCS* physical component score (of SF-12); *ODI* Oswestry Disability Index; *VAS* Visual Analog Scale; Δ postoperative minus preoperative results

*indicates statistical significance ($p < 0.05$)

[1]Independent linear regression was performed accounting for age, sex, body mass index, and Elixhauser comorbidity index. Reference was MCS-12 ≤ 50

Furthermore, an MCS score < 50 has been shown to be an accurate indicator of psychological distress [12, 25].

Certainly, although all physicians are obligated to improve patient well-being, which entails recognition and appropriate referral of patients with mental health problems, it appears that impaired mental health status should not preclude or delay patients from receiving medical care in the form of microdiscectomy surgery in patients indicated for operative management of lumbar disc herniations. Additionally, our findings suggest that patients undergoing microdiscectomy are likely less susceptible to blunted postoperative improvement as compared to lumbar fusion surgeries. Nevertheless, surgeons must still exercise judgment with regard to patient selection and postoperative assessment with regard to other patient safety and outcome metrics [26]. Given this is the first study of its kind, we also acknowledge the need for additional prospective studies to assess the relationship between mental health and surgical outcomes after microdiscectomy. Additionally, future research should more deeply investigate the directionality of the proposed association between mental health status and clinical improvement after spine surgery. While this analysis demonstrated an association between the two variables on bivariate analysis, we cannot soundly define a causal relationship, especially given the results of our multivariate regression analysis.

Our study is advantaged by inclusion of patients from a large practice with multiple locations and surgeons at multiple hospitals, increasing the generalizability of the results to most clinical practices. Limitations of this study are those inherent to retrospective review. Self-reported demographic characteristics such as duration of symptoms, diabetes status, and smoking status introduce reporting bias. In addition, because only patients with completed PROMs were included in this study, a selection bias is introduced. Unfortunately, a complete psychiatric history, including any previous diagnosis of depression or other mental health disorders, could not be gleaned for patients through chart review. Additionally, although MCS has been validated by prior research and used in other studies similar to the present study [8, 9, 12, 14, 17, 27], the original intent of the survey was not for stratification based on mental health status. Additionally, this measure condenses all mental health disorders into a single score. A better analysis would provide individualized assessment unique to common mental health disorders like major depressive disorder, generalized anxiety disorder, and bipolar disorder. In addition, assessing patients based on the severity of these specific mental health conditions would also be appropriate given the wide range of symptoms that pertain to each psychiatric condition. Nonetheless, one potentially beneficial factor to the use of MCS that has been noted previously is that this methodology may capture undiagnosed mental health illnesses [8]. Another limitation that we acknowledge is that we do not account for patient socioeconomics and race in our analyses. Race and socioeconomic factors have been associated with poor mental health and poor clinical improvement after surgery [21, 28]. Our analysis does not account for the effect that these variables may have on MCS and other PROMs. Finally, we note that preoperative mental health was assessed concerning a single preoperative time point and did not account for potential changes throughout the preoperative time the patient was followed; this study was also limited to one-year follow-up. PROM assessment beyond a single year would be appropriate for future investigations, though patients who receive microdiscectomy and demonstrate clinical improvement are less likely to be followed after one year postoperatively in general. We also acknowledge the possibility that there may not be enough poor surgical outcomes to adequately detect if there was a significant difference between groups. This might explain why MCS had little effect on microdiscectomy outcomes, whereas the prior literature suggests lower MCS had a significant impact in lumbar fusion procedures.

## Conclusion

The impact of preoperative mental health on outcomes after microdiscectomy surgery has yet to be defined. While worse baseline and postoperative PROMs may be associated with lower preoperative MCS scores, the amount of PROM improvement was not found to depend on MCS score. Similarly, rates of surgical readmissions and reoperations were not found to be significantly different based on MCS. Additional investigation on the topic is required to strengthen the findings of the present study that patients undergoing microdiscectomy for lumbar disc herniations are likely to similarly improve clinically regardless of preoperative mental health status.

### Declaration

**Conflict of interest** No relevant conflict of interest.

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