



## Assessing the Correlation between Lumbar Spine Surgery and Mental Health Disorders

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### Abstract

**Object:** We sought to analyze the overall prevalence of mental health disorders among patients who undergo initial and revision lumbar spine surgery, and to demonstrate if mental health disorders increase patients' likelihood of undergoing revision surgery. We also sought to establish trends in anti-depressant prescription medications among patients with mental health disorders and to evaluate their effect on rates of revision surgery.

**Methods:** Retrospective review of patients who underwent lumbar spine surgery from 2007-2014 within the Humana Insurance subset of the PearlDiver Inc. database. Rates of revision surgery were compared between longitudinally-followed lumbar spine surgery patients with and without diagnoses of mental health disorders. Chi-squared, odds-ratio, and Wilcoxon rank-sum tests were used for statistical analysis.

**Results:** 117,507 patients underwent lumbar spine surgery between 2007 and 2014. Of those patients, 29,325 (25.0%) were diagnosed with a mental health disorder within 90 days prior to surgery. There were 67,079 (57.1%) patients diagnosed with a mental health disorder at some point from 2007-2015 and 50,428 (42.9%) patients never diagnosed from 2007-2015. Women were more likely to be diagnosed with mental health disorders ( $p < 0.0001$ , OR: 2.68, CI: 2.60-2.76) and more likely to be prescribed anti-depressants ( $p < 0.0001$ , OR: 1.47, CI: 1.40-1.55). Patients diagnosed with a mental health disorder within 90 days of their first surgery had revision surgeries at a rate of 9.6%, significantly higher than the rate of 7.2% for patients who were never diagnosed with a mental health disorder ( $p < 0.0001$ , OR: 1.37, CI: 1.30-1.44). Patients who were prescribed anti-depressants had higher rates of revision surgery than patients not prescribed anti-depressants ( $p < 0.0001$ , OR: 1.19, CI: 1.10-1.29).

**Conclusion:** There is a high prevalence of mental health disorders among patients who undergo lumbar spine surgery, and an increased risk of revision surgery among patients with mental health disorders. Patients prescribed anti-depressants underwent higher rates of revision surgery.

**Keywords:** Lumbar; Mental Health; Anti-Depressants; Fusion; psychological disorders; Spine surgery

### Introduction

There has been a well-documented relationship between chronic low-back pain and mental health disorders. [4,22,23,27]. Further, data indicates that psychosocial factors negatively affect patient-reported outcomes following lumbar spine surgery [1,2,7,8,17-19,23-25,32]. However, there has been limited data to demonstrate the prevalence of mental health disorders among patients who undergo lumbar spine surgery and the effect of such disorders on rates of revision surgery [24].

In 2007, it was estimated that 46% of the general United States population suffers from a psychiatric illness during their lifetime [16]. Studies have found an even higher prevalence of psychiatric disorders among patients with Chronic Low Back Pain (CLBP) [4,22,23,27]. Depression, the leading cause of disability worldwide, has been the primary focus of most studies which analyze the effect of psychosocial factors on clinical outcomes [3,12,14,26,34]. Depression includes several symptoms that overlap with the symptoms of chronic pain. A study by the Group Health Cooperative of Puget Sound indicated that all nine symptoms of depression were statistically elevated among pain patients, especially symptoms of psychological distress (feeling that everything is an effort,

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trouble sleeping, worry, and fatigue) [33].

Indications for spine surgeries are diverse, but the similarity in symptoms between depression, anxiety and chronic back pain indicates that psychological disorders may affect exacerbate patients' pain and affect their response to surgery in terms of recurrent pain and necessity for revision.

Though early studies showed that chronic pain patients with psychiatric disorders were often treated no differently than those without, more recent studies have advocated for the integration of psychosocial treatment with treatment for spinal pathologies [2,7,8,13,24,25,31,32]. As this biopsychosocial model has become more prevalent, studies have attempted to create and analyze the effectiveness of psychosocial assessment tools prior to surgery [5,23]. Ultimately, the goal of these tools would be to determine which patients are better candidates for surgery, and which need more thorough psychosocial intervention and conservative management [7].

The goal of this study was to analyze the overall prevalence of mental health disorders among patients who undergo initial and revision lumbar spine surgery, and to demonstrate if mental health disorders increase patients' likelihood of undergoing a revision surgery. We also sought to establish trends in anti-depressant prescription medications and to evaluate their effect on rates of revision surgery.

## Methods

Using PearlDiver, a large national private insurance database, patients were identified based on International Classification of Diseases, Ninth Edition (ICD-9) and Current Procedural Terminology (CPT) insurance billing codes. Mental health disorders were inclusive of depression, anxiety, bipolar, schizophrenia, psychosis, neurosis, hypochondriacism, or some combination thereof. Patients were considered to have a mental health disorder if any of these diagnoses were present on a patient record within the specified timeframe.

Patients who underwent lumbar fusion, vertebroplasty, laminectomy, discectomy, or exploration/decompression between 2007 and 2014 were selected as the "Initial Lumbar Surgery" cohort. The surgery had to be the patient's first such surgery within the database. The overall prevalence of patients from the initial lumbar surgery cohort who were ever diagnosed with a mental health disorder (from 2007 through 2015) was recorded. This group was meant to compare to, however imperfectly, the "lifetime prevalence" statistics of previous studies which analyzed the prevalence of psychiatric illness among patients with chronic pain.

The initial lumbar surgery cohort was then split into two groups that were analyzed longitudinally: Patients who were diagnosed with a mental health disorder on the same day or within 90 days prior to surgery, and patients who were never diagnosed with a mental health disorder (either before or after surgery) throughout the span of the database (Figure 1). The timeframe of 90 days prior to surgery was chosen to capture those patients with a psychological disorder that was prominent near the time of surgery, but who may not have been billed for the diagnosis on the actual day of surgery. The Charlson Comorbidity Index (CCI) is a validated tool to predict mortality based on comorbidities noted within administrative databases, and was compared between the longitudinally analyzed groups [6,9]. Means were compared with the student's t-test, and medians were

compared with the Wilcoxon rank-sum test for non-normally distributed samples.

Single-level and multi-level fusion patients were analyzed as subsets of the initial lumbar surgery cohort, and depression was analyzed as a subset of the psychological disorder cohort since it had been the primary focus of previous studies discussing chronic pain.

Patients who had a second surgery between one week and one year after their initial surgery were considered to have had a revision surgery. Insurance codes for this group included all the same codes as for the initial lumbar surgery group, but with additional codes added that specified "revision." Patients prescribed anti-depressants within 30 days before or after their initial surgery were compared against patients not prescribed anti-depressants for rates of revision surgery.

Chi-squared analysis and odds-ratio were used for statistical analysis. Gender and age were compared within each group.

Similar to the initial surgery cohort, the overall prevalence of mental health disorders among revision surgery patients was analyzed and compared to initial surgery patients using Chi-squared and odds-ratio.

This study was exempt from Institutional Review Board approval, as a commercial database was used to obtain non-identifiable information.

## Results

### Initial lumbar surgery

From the beginning of 2007 through the third quarter of 2014, 117,507 patients within the database underwent lumbar spinal surgery. Over half of those patients (61,169; 52.1%) underwent spinal fusion surgery, with slightly more patients undergoing single-level procedures (18,951; 16.1%) than multi-level procedures (17,372; 14.8%). There were more females than males who underwent surgery, and patients aged 65-69 were the most populous age group (Table 1).

### Mental health disorders at time of initial surgery

Of the patients who underwent lumbar spine surgery, 67,079 (57.1%) were diagnosed with a mental health disorder at some point from 2007 through 2015 and 50,428 (42.9%) were never diagnosed. Within 90 days prior to their initial surgery, 29,325 (25.0%) patients were diagnosed with a mental health disorder (Figure 1). Patients diagnosed with a mental health disorder within 90 days prior to surgery had higher mean and median CCI scores than patients never diagnosed with a psychological disorder (means: 2.64 vs. 2.05, t-test:  $p < 0.0001$ ; medians: 2 vs. 1, Wilcoxon rank-sum test:  $p < 0.0001$ ).

There was some variability in the prevalence of mental health disorders between the specific surgery types. Generally, fusion patients were more likely than laminectomy or discectomy patients to have a psychological disorder, though the categories were not exclusive to each other. Discectomy patients were the least likely to be diagnosed with a mental health disorder within 90 days prior to surgery, with a prevalence of 19.7%. Laminectomy patients had a prevalence of 23.7% and ALIF, PLIF, and PLF patients all had a prevalence of psychological disorders above 27%. Single- and multi-level fusion patients had nearly equivalent rates of psychological disorders ( $p = 0.81$ , OR: 1.01, CI: 0.96-1.05).

Among patients who were diagnosed with a psychological disorder within 90 days prior to their initial surgery, depression was

**Table 1:** Prevalence and demographics of patients with mental health disorders within 90 days prior to their initial lumbar surgery. Odds-Ratio data represents a comparison of the specific type of surgery to the combination of all other surgeries. Bold denotes statistical significance.

Category	Diagnosed within 90 days prior to surgery	Never diagnosed			
<b>Distribution of Surgery Type (% of surgery-matched patients)</b>			<b>p-value</b>	<b>Odds-Ratio</b>	<b>Confidence Interval</b>
<b>All Surgeries (n=117,507)</b>	<b>29,325 (25.0)</b>	<b>50,428 (42.9)</b>			
Fusion Surgery* (n=61,169)	17,218 (28.1)	23, 873 (39.0)	<0.0001	<b>1.58</b>	1.54-1.63
Single-level Fusion (n=18,951)	5,263 (27.7)	7,447 (39.3)	<0.0001	<b>1.26</b>	1.21-1.31
Multi-level Fusion (n=17,372)	4,804 (27.7)	6,497 (37.4)	<0.0001	<b>1.32</b>	1.27-1.38
ALIF (n=13,570)	3,845 (28.3)	5,087 (37.5)	<0.0001	<b>1.35</b>	1.29-1.41
PLIF (n=24,266)	6,730 (27.7)	9,230 (38.0)	<0.0001	<b>1.33</b>	1.28-1.38
PLF (n=34,495)	9,449 (27.4)	13,223 (38.3)	<0.0001	<b>1.34</b>	1.30-1.38
Discectomy (n=22,945)	4,517 (19.7)	11,865 (51.7)	<0.0001	<b>0.59</b>	0.57-0.61
Laminectomy (n=55,478)	13,133 (23.7)	24,299 (43.8)	<0.0001	<b>0.87</b>	0.85-0.90
Other (n=64,073)	17,518 (27.3)	25,348 (39.5)	<0.0001	<b>1.47</b>	1.43-1.51
<b>Distribution of Psychological Disorders (as a percent of all surgery patients diagnosed with a psychological disorder)</b>					
Depression	18,315 (62.5)				
Anxiety	12,659 (43.2)				
Depression/Anxiety	3,744 (12.8)				
Bipolar	2,126 (7.2)				
<b>Distribution by Gender (% of gender-matched lumbar surgery patients)</b>			<b>p-value</b>	<b>Odds-Ratio</b>	<b>Confidence Interval</b>
Female (n=63,370)	19,502 (30.8)	21,476 (33.9)	<0.0001	<b>2.68</b>	2.60-2.76
Male (n=54,137)	9,823 (18.1)	28,952 (53.5)			
<b>Distribution by Age (% of age-matched lumbar surgery patients)</b>					
Age 10-14 (n=238)	<11 (NA)	202 (84.9)			
Age 15-19 (n=435)	48 (11.0)	289 (66.4)			
Age 20-24 (n=442)	59 (13.3)	287 (64.9)			
Age 25-29 (n=767)	143 (18.6)	460 (60.0)			
Age 30-34 (n=1,614)	359 (22.2)	906 (56.1)			
Age 35-39 (n=2,565)	605 (23.6)	1,331 (51.9)			
Age 40-44 (n=3,801)	1,022 (26.9)	1,757 (46.2)			
Age 45-49 (n=5,767)	1,846 (32.0)	2,286 (39.6)			
Age 50-54 (n=7,827)	2,710 (34.6)	2,796 (35.7)			
Age 55-59 (n=9,452)	3,277 (34.7)	3,278 (34.7)			
Age 60-64 (n=10,962)	3,456 (31.5)	3,826 (34.9)			
Age 65-69 (n=22,843)	5,472 (24.0)	10,060 (44.0)			
Age 70-74 (n=20,744)	4,368 (21.1)	9,609 (46.3)			
Age 75-79 (n=14,433)	2,756 (19.1)	6,591 (45.7)			
Age 80-84 (n=8,675)	1,801 (20.8)	3,749 (43.2)			
Age 85-89 (n=2,402)	523 (21.8)	1,031 (42.9)			
Age 90+ (n=4,457)	871 (19.5)	1892 (42.5)			

most common at 62.5%, followed by anxiety at 43.2%, depression and anxiety together at 12.8%, and bipolar disorder at 7.2%.

Patients aged 55-59 were the most likely to be diagnosed with a psychological disorder. Females were 2.68 times as likely to be diagnosed with a mental health disorder 90 days prior to surgery (p<0.0001, OR: 2.68, CI: 2.60-2.76). The same gender trend was true specifically among single- and multi-level fusion patients (p<0.0001, OR=2.58 and 2.51, respectively).

**Anti-depressant medication**

Of patients diagnosed with a mental health disorder within 90 days prior to surgery, 17,401 (59.3%) were prescribed anti-depressant medication, while the remaining 11,924 (40.7%) were not. Similar trends were true among patients who specifically underwent single- and multi-level fusions.

Patients diagnosed with depression within 90 days prior to surgery were prescribed anti-depressants at a rate of 63.4%, a statistically

**Table 2:** The number and demographics of patients prescribed (and not prescribed) anti-depressant medications within 30 days of their initial lumbar surgery, among patients who were diagnosed with a psychological disorder within 90 days prior to their initial lumbar surgery. Bold denotes statistical significance.

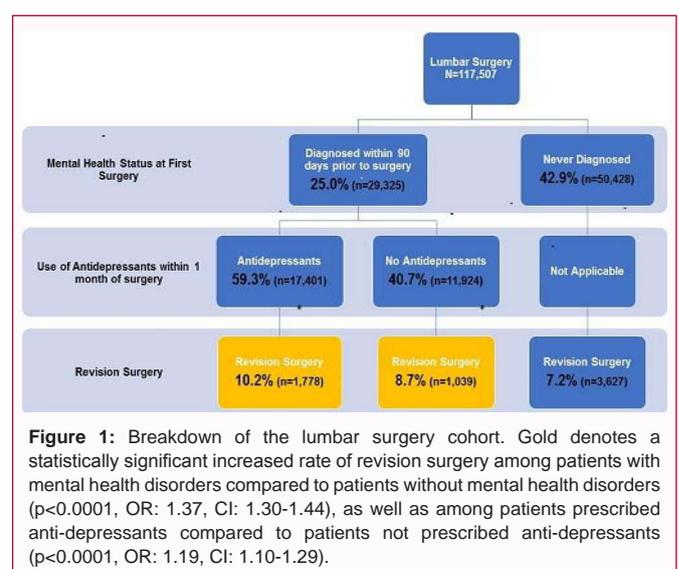
Surgery Type	Diagnosed with a psychological disorder within 90 days prior to surgery				p-value	Odds-Ratio	Confidence Interval
	Prescribed Anti-depressants		Not Prescribed Anti-depressants				
All Surgeries (n=29,325)	17,401	(59.3)	11,924	(40.7)	--	--	--
Fusion Surgery (n=17,218)	10,510	(61.0)	6,708	(40.0)	0.0003	<b>1.07</b>	1.03-1.12
Single-level fusion (n=5,263)	3,248	(61.7)	2,015	(38.3)	0.01	<b>1.11</b>	1.03-1.20
Multi-level fusion (n=4,804)	2,843	(59.2)	1,961	(40.8)			
<b>For Patients who underwent any lumbar surgery</b>							
<b>Gender distribution (% of gender-matched patients diagnosed with a psychological disorder within 90 days prior to surgery)</b>					<b>p-value</b>	<b>Odds-Ratio</b>	<b>Confidence Interval</b>
Female (n=19,502)	12,186	(62.5)	7,316	(37.5)	<0.0001	<b>1.47</b>	1.40-1.55
Male (n=9,823)	5,215	(53.1)	4,608	(46.9)			
<b>Age distribution (% of age-matched patients diagnosed with a psychological disorder within 90 days prior to surgery)</b>							
Age 10-14	<11	NA	<11	NA			
Age 15-19 (n=48)	23	(47.9)	25	(52.1)			
Age 20-24 (n=59)	30	(50.8)	29	(49.2)			
Age 25-29 (n=143)	86	(60.1)	57	(39.9)			
Age 30-34 (n=359)	202	(56.3)	157	(43.7)			
Age 35-39 (n=605)	395	(65.3)	210	(34.7)			
Age 40-44 (n=1,022)	697	(68.2)	325	(31.8)			
Age 45-49 (n=1,846)	1,246	(67.5)	600	(32.5)			
Age 50-54 (n=2,710)	1,904	(70.3)	806	(29.7)			
Age 55-59 (n=3,277)	2,222	(67.8)	1,055	(32.2)			
Age 60-64 (n=3,456)	2,220	(64.2)	1,236	(35.8)			
Age 65-69 (n=5,472)	3,071	(56.1)	2,401	(43.9)			
Age 70-74 (n=4,368)	2,379	(54.5)	1,989	(45.5)			
Age 75-79 (n=2,756)	1,403	(50.9)	1,353	(49.1)			
Age 80-84 (n=1,801)	873	(48.5)	928	(51.5)			
Age 85-89 (n=523)	222	(42.4)	301	(57.6)			
Age 90+ (n=871)	426	(48.9)	445	(51.1)			

significant increase over patients diagnosed with any mental health disorder ( $p < 0.0001$ , OR: 1.19, CI: 1.15-1.24).

Among those diagnosed with a psychological disorder within 90 days before surgery, patients aged 50-54 and females were the most likely to be prescribed anti-depressants (statistically significant, (Table 2)). The same trends were true among depressed patients, specifically.

**Mental health diagnoses at revision surgery**

Of the 117,507 who underwent initial surgery, 10,639 underwent a second surgery within one year of their index procedure, making the overall rate of revision surgery 8.8% (Figure 2). While 57.1% of the 117,507 patients who underwent initial surgery had a mental health disorder at some point throughout the database, 65.2% (n=6,799) of the 10,426 patients who underwent revision surgery were diagnosed with a mental health disorder. This demonstrates that patients who have multiple surgeries have a higher prevalence of mental health disorders than the general lumbar surgery population ( $p < 0.0001$ , OR: 1.41, CI: 1.35-1.47, (Figure 3)). Of those 6,799 revision surgery patients who were diagnosed with a mental health disorder throughout the database, 5,071 (74.5%) were diagnosed before their revision surgery, and 2,713 (39.9%) were diagnosed specifically within the year between their first and second surgery (Table 3).

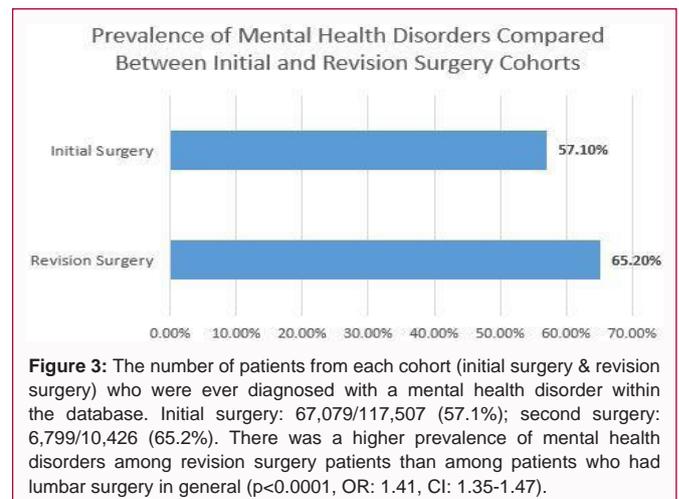
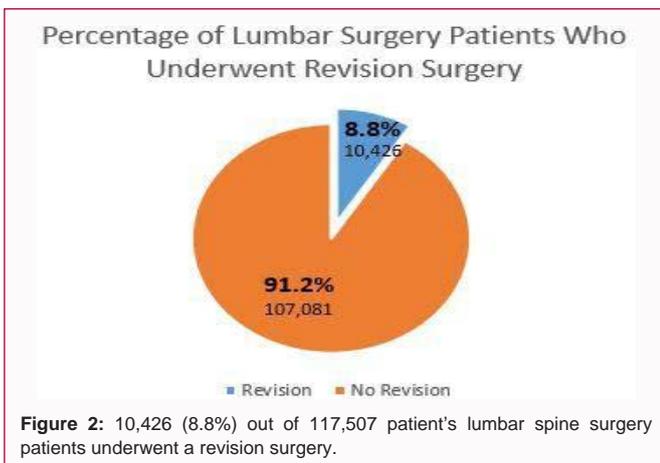


**Figure 1:** Breakdown of the lumbar surgery cohort. Gold denotes a statistically significant increased rate of revision surgery among patients with mental health disorders compared to patients without mental health disorders ( $p < 0.0001$ , OR: 1.37, CI: 1.30-1.44), as well as among patients prescribed anti-depressants compared to patients not prescribed anti-depressants ( $p < 0.0001$ , OR: 1.19, CI: 1.10-1.29).

Patients who were diagnosed with a mental health disorder within 90 days before their first surgery had revision surgeries at a rate of 9.6%, significantly higher than the rate of 7.2% for patients

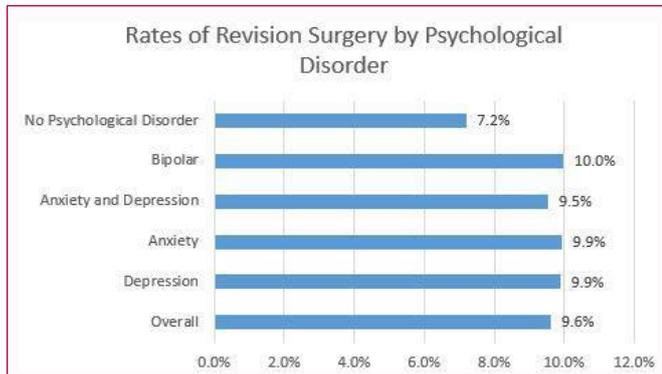
**Table 3:** The first column of Odds-Ratios represents the odds of patients prescribed anti-depressants undergoing revision surgery, compared to patients not prescribed anti-depressants. The second column of Odds-Ratios represents the odds of patients with mental health disorders (within 90 days prior to initial surgery) undergoing revision surgery, compared to patients never diagnosed with a mental health disorder. Bold denotes statistical significance.

	Diagnosed within 90 days prior to surgery				Never Diagnosed				
	Prescribed Anti-depressants (%)		Not Prescribed Anti-depressants (%)		Odds Ratio	Total (%)	No Mental Diagnosis		Odds Ratio
<b>Number of patients who underwent revision surgery, distributed by initial surgery type</b>									
All Surgeries	1,778	(10.2)	1,039	(8.7)	<b>1.19</b>	2,817 (9.6)	3,627	(7.2)	<b>1.37</b>
Fusion Surgery	1,043	(9.9)	528	(7.9)	<b>1.28</b>	1,571 (9.1)	1,574	(6.6)	<b>1.42</b>
Single-Level Fusion	310	(9.5)	159	(7.9)	<b>1.23</b>	469 (8.9)	484	(6.5)	<b>1.41</b>
Multi-Level Fusion	291	(10.2)	148	(7.5)	<b>1.40</b>	439 (9.1)	399	(6.1)	<b>1.54</b>
<b>For patients who underwent any lumbar surgery</b>									
<b>Gender</b>									
Female	1,236	(10.1)	630	(8.6)	<b>1.20</b>	1,866 (9.6)	1,537	(7.2)	<b>1.37</b>
Male	542	(10.4)	409	(8.9)	<b>1.19</b>	951 (9.7)	2,090	(7.2)	<b>1.38</b>
<b>Age</b>									
Age 10-14	0	(0.0)	0	(0.0)	NA	0 0	<11	NA	NA
Age 15-19	<11	NA	<11	NA	NA	NA NA	14	(4.8)	NA
Age 20-24	<11	NA	0	(0.0)	NA	NA NA	12	(4.2)	NA
Age 25-29	<11	NA	<11	NA	NA	NA NA	27	(5.9)	NA
Age 30-34	16	(7.9)	12	(7.6)	1.04	28 7.8	56	(6.2)	1.28
Age 35-39	32	(8.1)	11	(5.5)	1.59	43 7.1	62	(4.7)	<b>1.57</b>
Age 40-44	68	(9.8)	31	(9.5)	1.03	99 9.7	110	(6.3)	<b>1.61</b>
Age 45-49	116	(9.3)	55	(9.2)	1.02	171 9.3	162	(7.1)	<b>1.34</b>
Age 50-54	189	(9.9)	78	(9.7)	1.03	267 9.9	175	(6.3)	<b>1.64</b>
Age 55-59	249	(11.2)	86	(8.2)	<b>1.42</b>	335 10.2	266	(8.1)	<b>1.29</b>
Age 60-64	253	(11.4)	125	(10.1)	1.14	378 10.9	309	(8.1)	<b>1.4</b>
Age 65-69	329	(10.7)	211	(8.8)	<b>1.25</b>	540 9.9	703	(7.0)	<b>1.46</b>
Age 70-74	253	(10.6)	177	(8.9)	1.22	430 9.8	755	(7.9)	<b>1.28</b>
Age 75-79	134	(9.6)	102	(7.5)	1.3	236 8.6	482	(7.3)	<b>1.19</b>
Age 80-84	86	(9.9)	90	(9.7)	1.02	176 9.8	287	(7.7)	<b>1.31</b>
Age 85-89	20	(9.0)	31	(10.3)	0.86	51 9.8	75	(7.3)	1.38
Age 90+	35	(8.2)	33	(7.4)	1.12	68 7.8	140	(7.4)	1.06

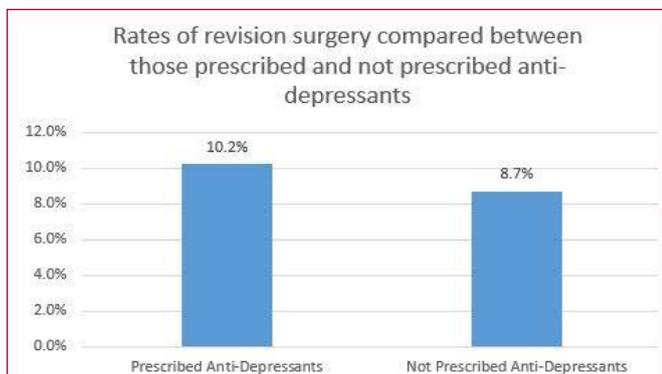


who were never diagnosed with a mental health disorder (p<0.0001, OR: 1.37, CI: 1.30-1.44). The same results were true among single-level (p<0.0001, OR: 1.41, CI: 1.23-1.61) fusion, multi-level fusion (p<0.0001, OR: 1.54, CI: 1.33-1.77), and depressed patients (Figure 4).

Generally, surgery patients with psychological disorders who were prescribed anti-depressants had higher rates of revision surgery than patients with psychological disorders who were not prescribed



**Figure 4:** More patients with mental health disorders underwent revision surgery than patients never diagnosed with a mental health disorder ( $p < 0.0001$ , OR: 1.37, CI: 1.30-1.44).



**Figure 5:** Patients prescribed anti-depressants had higher rates of revision surgery ( $p < 0.0001$ , OR: 1.19, CI: 1.10-1.29).

anti-depressants (10.2% vs. 8.7%,  $p < 0.0001$ , OR: 1.19, CI: 1.10-1.29, (Figure 5)). The difference was most pronounced among multi-level fusion patients, where patients on anti-depressants had revision surgery at a rate of 10.2%, while those not on anti-depressants had revision surgery at a rate of 7.5% ( $p = 0.02$ , OR: 1.40, CI: 1.14-1.72). The mean CCI score was 2.6 for patients who were prescribed anti-depressants and 2.7 for patients not prescribed anti-depressants (t-test:  $p = 0.004$ ), while the median score was 2 for each group (Wilcoxon rank-sum test:  $p = 0.01$ ).

Of patients who were diagnosed with a mental disorder within 90 days of their initial surgery males and females underwent revision surgery at a nearly equivalent rate (9.6% vs. 9.7%,  $p = 0.77$ ). Similarly, males and females never diagnosed with a mental health disorder underwent equivalent rates of revision surgery (7.2% each,  $p = 0.81$ ). Patients aged 60-64 were the most likely to undergo revision surgery.

## Discussion

### Prevalence of mental health disorders and rates of revision spine surgery

The current study showed that patients who undergo lumbar spine surgery have a higher prevalence of mental health disorders than the general population [26]. The results were more significant among patients who underwent revision lumbar surgery, as patients with mental health disorders accounted for nearly two-thirds of the revision surgery population.

From a clinical perspective, patients with psychological disorders demonstrated an increased likelihood of revision surgery over

patients without psychological disorders. While previous studies had shown that depression and other psychological disorders increase perioperative complications, increase 30-day readmission rates, and worsen patient-reported outcomes, there was limited data suggesting what this meant specifically for rates of revision surgery [1,2,7,8,17-19,23-25,32]. The increased likelihood of revision surgery indicated in our study, though modest, was consistent among different ages, genders, and type of surgery (including single- versus multi-level fusion) and thus a tangible indication of the increased morbidity experienced by patients with psychological disorders.

### Possible effects of mental health disorders on rates of surgery

Depression was the most prevalent diagnosis among surgery patients with psychological disorders, in concordance with previous studies [10,31,33]. According to the WHO, mental health disorders, specifically depression and anxiety, are known to affect more women than men, and that was reflected in our study as well [34]. Females who underwent an initial lumbar surgery were twice as likely to be diagnosed with mental health disorders compared to men. However, after adjusting for the higher number of women with psychological disorders, both women and men with mental health disorders underwent revision surgeries at similar frequencies. Similarly, patients who underwent single- or multi-level fusion surgery had similar rates of revision surgery. This suggests that mental health was a greater risk factor than gender or number of levels with regard to revision spine surgery.

The issue of causality may make the prevalence of mental health issues in the lumbar spine surgery population especially relevant. While many studies have indicated a chronology of events which suggests that back pain either causes or makes worse psychological conditions, Polatin et al. showed that 54% of depressed patients, 97% of substance-abusing patients, and 95% of anxious patients exhibited their psychological symptoms before the onset of their chronic pain [14,27,29]. In our study, we found that 25% of patients were diagnosed with a psychological disorder within 90 days prior to their first surgery. Though we cannot say definitively if the patients who underwent surgery had concurrent low back pain, these data leave open the possibility that depression and other psychological disorders may play a role in the development or perception of symptoms among patients indicated for surgery. Given the significantly higher prevalence of mental health disorders among spine surgery patients reported in our study, the increased rates of revision surgery among patients with mental health disorders, and the data which has already demonstrated the effect of psychosocial factors on clinical outcomes, other studies should seek to clarify the extent to which effectively managing psychosocial factors may reduce the need for initial or revision surgery.

The slightly elevated CCI scores among patients with psychological disorders offers a possible explanation of why those patients' rates of revision surgery were higher. However, psychological disorders like depression are known to increase rates of several conditions included within the CCI score, some of which (like diabetes) are also associated with revision spine surgery [20,21,30,38]. It is not the capability or goal of the present study to declare mental health disorders as independent predictors of revision spine surgery. Rather, in light of the high prevalence of mental health disorders in the spine surgery population, the increased prevalence of such disorders among the revision surgery population, and comparatively higher rates of

revision surgery among patients with mental health disorders, the goal is to establish mental health as an important component among many that should be considered when devising a treatment plan for patients.

### Anti-depressant medications and rates of revision surgery

The data unfortunately does not suggest any “simple” remedy to psychological illness in the context of spine surgery. Patients with psychological disorders (and specifically depression) who were prescribed antidepressants had higher rates of revision surgery than patients not treated with anti-depressants. Though the median CCI score was 2 for each population, the average CCI score was slightly (though statistically significantly) less among patients who were prescribed anti-depressants. In light of this data, the conclusion should not be made that anti-depressants are a risk factor for failed primary surgery. Patients who are taking anti-depressant medications may have a more severe psychological disorder or may be unable to cope with their psychological disorder without medications. Instead, this data should be used to indicate 1) that the higher rate of revision surgery among patients on anti-depressants is not necessarily due to a difference in their comorbidities at the time of surgery, 2) that patients with more severe psychological conditions may be predisposed to higher rates of revision surgery, and 3) that anti-depressants alone are not enough to improve clinical outcomes following surgery—more comprehensive therapies are needed for this population.

It was interesting to note that females were prescribed antidepressants at a rate greater than males, even after adjusting for the greater number of females who had mental health disorders. Though it is possible that females were simply more likely to take anti-depressant medications compared to males, this data may be an indication that females were affected by more severe cases of psychological disorders. But given the data suggesting that gender was not a risk factor for revision (or single- vs. multi-level fusion), the higher rates of revision surgery among patients prescribed anti-depressants may truly be due to the increased severity of their psychological condition. Future studies should explore the relationship between gender, antidepressants, and spine surgery further.

### Limitations

It is a limitation of the database that other factors such as physical therapy compliance, occupation, lifestyle, and social support cannot be tracked, as all may be strong predictors of mental or physical health. Additionally, though we specified diagnosis codes and timeframes in which those codes had to be recorded, we were unable to determine the true cause of initial or revision surgery, the severity of the mental conditions, and the dosage of anti-depressants prescribed. However, we believe the large volume of this study, the prevalence it measured, and its unique assessment of mental health’s correlation to revision spine surgery provide an important next step in understanding and caring for the conditions which presuppose patients for lumbar spine surgery. While mental health disorders should be considered as a risk factor for lumbar surgery, it is clear that the relationship is more complex than simply treating the underlying psychological disorder with prescription medications. We hope that future studies will investigate issues like compliance with rehabilitation programs and access to psychosocial support in order to better understand how best to care for the large number of patients with mental health disorders who seek lumbar spine surgery.

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