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Analysis of Factors associated with Return to Work After Lumbar Surgery up to 2-years follow-up: A Michigan Spine Surgery Improvement Collaborative (MSSIC) Study

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MINI ABSTRACT/ PRÉCIS: Preoperative employment, followed by private insurance, were strongest predictors of return-to-work at all three follow-up time intervals: 90d, 1y, and 2y. In two independent sub-analyses of only preoperatively employed patients and preoperatively unemployed patients, private insurance was the only predictor of return-to-work at all three time intervals in both sub-analyses.

ABSTRACT

Study Design. Michigan Spine Surgery Improvement Collaborative (MSSIC) prospectively collects data on all patients undergoing operations for degenerative and/or deformity indications.

Objective. We aimed to identify which factors are significantly associated with return-to-work after lumbar surgery at long-term follow-up.

Summary of Background Data. Prior publications have created a clinically relevant predictive model for return-to-work, wherein education, gender, race, comorbidities, and preoperative symptoms increased likelihood of return-to-work at 3 months after lumbar surgery. We sought to determine if these trends 1) persisted at 1 year and 2 years postoperatively; or 2) differed among preoperatively employed versus unemployed patients.

Methods. MSSIC was queried for all patients undergoing lumbar operations (2014–2019). All patients intended to return-to-work postoperatively. Patients were followed for up to 2 years postoperatively. Measures of association were calculated with multivariable generalized estimating equations (GEE).

Results. Return-to-work increased from 63% (3542/5591) at 90 days postoperatively to 75% (3143/4147) at 1 year and 74% (2133/2866) at 2 years postoperatively. Following GEE, neither clinical nor surgical variables predicted return-to-work at all three time intervals: 90 days, 1 year, and 2 years postoperatively. Only socioeconomic factors reached statistical significance at all follow-up points. Preoperative employment followed by insurance status had the greatest associations with return-to-work. In a sub-analysis of patients who were preoperatively employed, insurance was the only factor with significant associations with return-to-work at all three follow-up intervals. The return-to-work rates among unemployed patients at baseline increased from 29% (455/1100) at 90 days, 44% (495/608) at 1 year, and 46% (366/426) at 2 years postoperatively. The only two significant factors associated with return-to-work at all three follow-up intervals were Medicaid, as compared to private insurance, and male gender.

Conclusion. In patients inquiring about long-term return-to-work after lumbar surgery, insurance status represents the important determinant of employment status.

KEY WORDS: Employment; insurance; lumbar; MSSIC; return; return to work; work

Level of Evidence: 2

INTRODUCTION

For over a century, return-to-work postoperatively has been reported as an indication of surgical success.[1] In the spine literature, specifically, return-to-work has been validated as a surrogate marker of patient satisfaction after lumbar surgery.[2] Unlike other patient-reported outcomes, this variable represents an objective measure that occurs at a discrete time point, which renders a suitable primary outcome measure for clinical studies in spine surgery.

While society, specifically employers and insurance payors, benefits from increased participation in the workforce, patients who return-to-work exhibit improved mental health and financial stability.[3-5] Research initially focused on the relationship between return-to-work and preoperative comorbidities.[6-9] Surgical complexity and disease severity have also been established in the literature.[10,11] Other studies have focused on the effect of socioeconomic factors, such as ethnicity, education level, employment, and insurance status.[12,13] However, studying these variables in independent analyses likely underestimates the interplay between these factors. Utilizing a large database provides a high level of granularity to collectively examine demographic variables, socioeconomic factors, intraoperative parameters, and postoperative complications as well as patient health questionnaires. As a prominent example, Asher et al queried the Quality Outcomes Database (QOD) to create a clinically relevant predictive model for return-to-work, wherein higher education level, male gender, Caucasian patients, non-diabetic patients, and preoperative symptoms <3 months increased the hazards of return-to-work at 3 months after lumbar surgery.[14] Their study was only limited to preoperatively employed patients. We sought to determine if these trends 1) persisted at 1 year and 2 years postoperatively; or 2) differed among preoperatively employed versus unemployed patients. The primary objective of this study is to identify which factors are significantly associated with return-to-work after lumbar surgery at long-term follow-up.

METHODS

Study Design and Setting

The Michigan Spine Surgery Improvement Collaborative (MSSIC) prospectively collects data on all (or a representative sample of) patients undergoing cervical and lumbar operations for degenerative and/or deformity indications at 26 participating hospitals. Traumatic, neoplastic, and infectious etiologies are not collected. MSSIC includes patients across the state of Michigan, from tertiary academic centers and smaller community hospitals, to private practice settings.

Participants

This study was approved by our institutional review board (IRB#10581). The MSSIC registry was queried for all patients undergoing lumbar operations from February 2014 – December 2019. The analysis only includes patients who intended to return-to-work postoperatively,

which was determined by preoperative survey. Patients were followed for up to 2 years postoperatively. Patients lost to follow-up were removed from the analysis; however, we assume these patients were missing at random.

Variables and Data Sources/ Measurement

The primary outcome measure was return-to-work after surgery. Clinical factors that may explain return-to-work include age, gender, smoking, diabetes, opioid use, and readmission within 90 days after surgery. Surgical parameters include fusion versus decompression only, number of spinal levels, and return to operating room within 90 days. Socioeconomic factors that may explain return-to-work were captured by race (Caucasian, African-American, and other), insurance status (private, Medicare/ Other public, Medicaid), education (<high school diploma/ General Education Equivalent [GED], at least some college, post-college), medium/ heavy physical workload, and workers' compensation as primary payor. These variables, as well as Patient Health Questionnaire-2 (PHQ-2) for depression, were collected via patient surveys upon follow-up visits (except for insurance status, collected by medical records). Patient-reported outcomes derived from those surveys included: Patient-Reported Outcomes Measurement Information System (PROMIS) Physical Function short form, Numeric Rating Scale (NRS – 0-10) – back pain, and NRS – leg pain.

Quantitative Variables

To limit a selection bias at any given follow-up time, three independent analyses were completed in each time interval: 90 days, 1 year, and 2 years. Within each time frame, patients who returned to work were compared with patients who did not return-to-work.

Statistical Methods

Clinical, surgical and socioeconomic factors as well as patient-reported outcomes were compared between patients returning and not returning to work using chi-square tests for categorical variables and t-tests for approximately Gaussian distributed continuous variables, and the Wilcoxon rank-sum test for continuous variables with skewed distributions. Multivariable generalized estimating equation (GEE) models that specified a Poisson error distribution and log link function were used to estimate the association between returning to work and the clinical, surgical and socioeconomic factors and PROMIS baseline scores. This type of model is similar to a generalized linear model such as Poisson or logistic regression but also considers the potential latent effects that vary from hospital to hospital.

RESULTS

Participants, Descriptive Data, and Outcome Data

From February 2014 – December 2019, 9562 patients intended to return-to-work after undergoing lumbar surgery. Follow-up information was available for 5591 patients at 90 days, 4147 patients at 1 year, and 2866 patients at 2 years [**Table 1**]. The remaining patients

were lost to follow-up. Return-to-work increased from 63% (3542 out of 5591 patients) at 90 days postoperatively to 75% (3143 out of 4147 patients) at 1 year and 74% (2133 out of 2866) at 2 years postoperatively. In all the 90-day, 1-year, and 2-year follow-up cohorts, clinical factors that were statistically significantly associated with return-to-work included younger age, non-current smoking, and absence of diabetes, while socioeconomic factors included Caucasian rather than African-American race, private insurance, education with at least some college education, and baseline employment. On the other hand, the percentage covered by workers' compensation was statistically significantly smaller. Baseline PHQ-2 for depression was statistically significantly lower in the return-to-work cohort versus the no return-to-work cohort [**Figure 1**]. Surgical parameters that statistically significantly increased the percentage of return-to-work included decompression only versus fusion, single-level surgery, and lower complication rates postoperatively.

Main Results

Following a GEE controlling for clinical variables [**Table 2**], neither clinical nor surgical variables predicted return-to-work at all three time intervals: 90 days, 1 year, and 2 years postoperatively. Only socioeconomic factors reached statistical significance at all follow-up points. Preoperative employment had the greatest association with return-to-work among all patients followed for 90 days, 1 year, and 2 years. The only other variable that significantly increased the likelihood of return-to-work at all three time intervals was insurance type. As compared to private insurance, Medicaid decreased the probability of return-to-work >20%, and Medicare/ other public insurance decreased the probability of return-to-work >10%. African American race versus Caucasian, daily opioid use >6 months, education ≤ high school diploma/ GED, and fusion versus decompression decreased chances of return-to-work at 90 days and 1 year, but these trends did not persist at 2 years.

On patient-reported outcomes, patients in the return-to-work cohort had a statistically significantly higher probability of achieving a minimally clinically important difference (MCID) on PROMIS Physical Function, NR –Back Pain, and NRS–Leg Pain at 1 year and 2 years postoperatively [**Figures 1, 2**]. To that end, the return-to-work cohort reported lower PHQ-2 for depression at 1 year and 2 years postoperatively.

Other Analysis: Sub-analysis of pre-operative employment status

In **Table 1**, the rates of return-to-work among employed patients were 87% at 90 days, 84% at 1 year, and 83% at 2 years postoperatively. In a sub-analysis of patients who were preoperatively employed, insurance was the only factor with significant associations with return-to-work at all three follow-up time intervals [**Table 3**]. Patients in this public insurance group had a lower likelihood of return-to-work by at least 10%. Education ≥ at least some college increased their chances of return-to-work at 90 days and 1 year, but not 2 years.

The rates of return-to-work among unemployed patients at baseline who stated that they intended to return-to-work after surgery increased from 29% (455/1100) at 90 days, 44% (495/608) at 1 year, and 46% (366/426) at 2 years postoperatively. The only two significant factors associated with return-to-work at all three follow-up time intervals were Medicaid, as compared to private insurance, and male gender [**Table 4**]. The likelihood of return-to-work with Medicaid was lowered by over 40%. The same associations with return-to-work were also observed with the Medicare/other public insurance group at 1 year (odds of return-to-work decreased by 46%) and 2 years (decreased by 47%) postoperatively; but not at 90 days. Male gender increased likelihood of return-to-work by at least 30% at all three follow-up time intervals. Daily opioid use >6 months and fusion versus decompression only decreased chances of return-to-work at 90 days and 1 year, but not 2 years.

DISCUSSION

Key Results

Although clinical variables (age, smoking status, and diabetes), surgical variables (number of spinal levels and inclusion of fusion), and socioeconomic variables were associated with return-to-work after surgery in univariate analyses of this study, only socioeconomic variables had significant associations in the multivariable analyses at all three follow-up time intervals. Preoperative employment, followed by private insurance, represented the strongest predictors of return-to-work in the multivariable GEE at all three follow-up time intervals. In two independent sub-analyses of only preoperatively employed patients and preoperatively unemployed patients, private insurance was the only predictor of return-to-work at all three follow-up time intervals in both sub-analyses. Male gender was associated with return-to-work at all three follow-up time intervals among only patients unemployed preoperatively.

Interpretation

According to the QOD study by Asher et al, preoperatively employed patients who intended to return-to-work after lumbar surgery had a postoperative employment rate of 82%.[14] Consistent with their findings, 87% of our patient population with similar characteristics in this study returned to work after lumbar surgery. The rates of return-to-work among preoperatively *unemployed* patients have been poorly defined in the literature. On short-term follow-up, 29% of unemployed patients were back at work at 90 days after surgery in our study. These rates increased to 44% at 1 year and 46% at 2 years, which highlights the importance of long-term follow-up in return-to-work studies. Factors that potentially may negatively affect return-to-work are workers' compensation cases, which have been previously explored by Atlas et al.[15] The authors, however, found no association between workers' compensation with return-to-work on long-term follow-up, similar to the multivariable GEE at 1-year and 2-years in this study.

In the QOD study by Asher et al, demographic, biological, and surgical factors predicted return-to-work at 3 months after lumbar surgery.[14] However when our study

extended follow-up to 1 year and 2 years, socioeconomic factors – preoperative employment and insurance status – were the most important predictors of return-to-work. In another QOD study for factors associated with return-to-work after surgery for degenerative spinal diseases, Khan et al reported that patients with private insurance as compared to no insurance or Medicare, Medicaid, Veterans Affairs, and other government insurance were more likely to return-to-work.[16] Insurance factors illustrate the point that private insurance is largely linked to employer benefits, with the exception of other members of a household or plans purchased through the Affordable Care Act exchanges. Medicare patients, on the other hand, are either patients at or beyond retirement age or patients with permanent disability, which may contribute to lower rates of return-to-work. The inverse relationship of Medicaid insurance and return-to-work may reflect the effects of disadvantaged socioeconomic status.[17] Patients covered by Medicaid often have suboptimal access to health care, which results in patient presentation with more advanced-staged disease processes and subsequent permanent neurological damage.[18,19]

Our study also included subset analyses of preoperatively employed patients and preoperatively unemployed patients. Only among the latter group of patients, male gender increased the likelihood of return-to-work by 30%. Than et al. demonstrated a similar trend: male gender was significantly associated with return-to-work following lumbar discectomy in their overall study population but not in their subset analysis of only those patients who were employed preoperatively.[20] Spine surgery literature has demonstrated that when faced with postoperative activity restrictions, men were significantly more likely to return to light work than to heavy work, while women were more likely to retire after surgery.[21,22]

Limitations and Generalizability

The MSSIC multi-center statewide registry relies on chart abstraction as well as patient-reported surveys with inherent limitations in terms of data quality and completeness of data. Incomplete data, or loss to follow-up, was assumed to be missing at random; therefore, patients with missing covariates in the multivariable regression were dropped from the statistical analysis. Finally, the MSSIC registry does not contain information regarding the duration of preoperative unemployment, a factor that has been found to be significantly correlated with postoperative return-to-work.[21]

As far as generalizability, MSSIC incorporates data from both orthopedic spine surgeons and neurosurgeons across a variety of practice environments in Michigan. Our large and representative sample allows for this study's results to be widely generalizable to all patients undergoing surgery for degenerative lumbar disease. However, MSSIC does not collect data on those patients undergoing spine surgery for trauma, tumor, and infection and thus these results should not be generalized to those patients. Lastly, there may be demographic features inherent to the population of Michigan that are not found in other regions and this should be considered when applying our findings.

CONCLUSION

Among patients who intended to return-to-work after surgery, preoperative employment status, followed by private insurance, were the strongest predictors of employment at 90 days, 1 year, and 2 years postoperatively. In two independent sub-analyses of patients who were preoperatively employed and unemployed, insurance status persisted as the significant predictor at all three time intervals.

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Figure Legends

Figure 1. Patient-reported outcomes: 1) Patient Health Questionnaire-2 (PHQ-2) for Depression; 2) Minimally Clinically Important Difference (MCID) on PROMIS Physical Function; 3) MCID on Numeric Rating Scale (NRS) – Back Pain; and 4) MCID on Numeric Rating Scale (NRS) – Leg Pain. Comparison of the return-to-work cohort versus no return-to-work cohort within each bar reached a statistically significant difference ($p<0.05$).

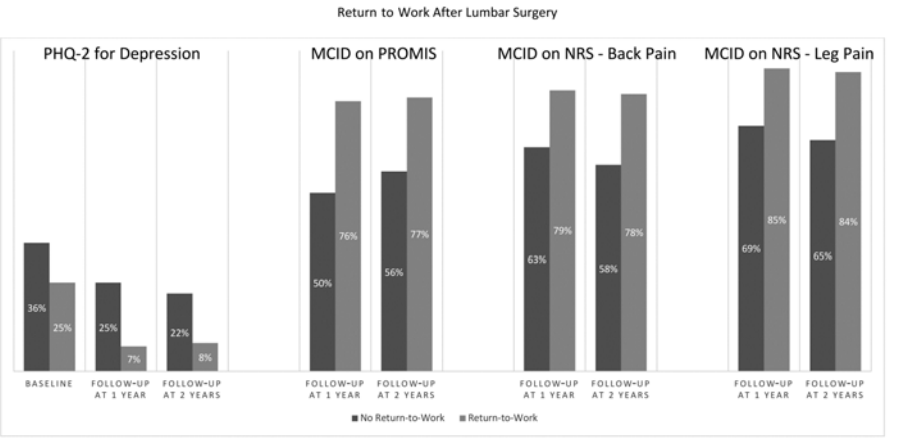

Figure 2. Change in Patient-Reported Outcomes Measurement Information System (PROMIS) from baseline in return-to-work status.

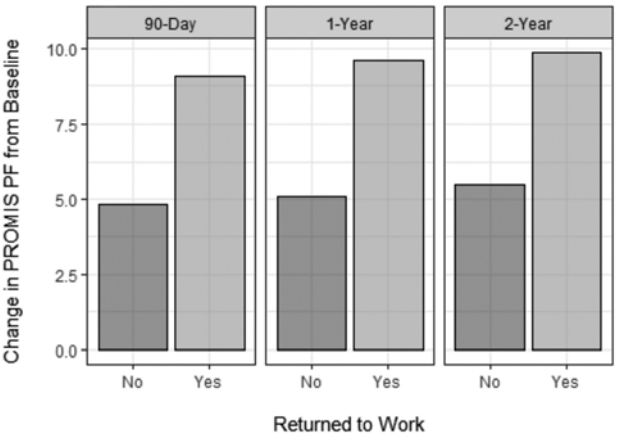

Table 1. Comparison of the return-to-work versus no return-to-work cohorts. Statistically significant values for comparisons between the return-to-work and no return-to-work cohorts within each time interval are in bold.

		Returned to Work at 90 Days		Returned to Work at 1 Year		Returned to Work at 2 Years	
Variable		**No (N = 2049)**	**Yes (N = 3542)**	**No (N = 1004)**	**Yes (N = 3143)**	**No (N = 733)**	**Yes (N = 2133)**
Increasing age (5-year increments)		**55.0 ± 13.1**	**53.0 ± 12.7**	**57.7 ± 13.3**	**52.6 ± 12.5**	**58.8 ± 12.9**	**52.2 ± 12.4**
Male gender		1106/2049 (54%)	1972/3540 (56%)	546/1004 (54%)	1772/3142 (56%)	403/733 (55%)	1186/2132 (56%)
Race	White	**1695/1989 (85%)**	**3184/3431 (93%)**	**852/976 (87%)**	**2827/3066 (92%)**	**638/720 (89%)**	**1933/2096 (92%)**
	African-American	**197/1989 (10%)**	**119/3431 (3%)**	**78/976 (8%)**	**105/3066 (3%)**	**46/720 (6%)**	**73/2096 (3%)**
	Other	**97/1989 (5%)**	**128/3431 (4%)**	**46/976 (5%)**	**134/3066 (4%)**	**36/720 (5%)**	**90/2096 (4%)**
Current Smoker		**412/2010 (20%)**	**476/3491 (14%)**	**201/988 (20%)**	**414/3093 (13%)**	**116/725 (16%)**	**266/2105 (13%)**
Daily Opioid Use > 6 Months		**523/1891 (28%)**	**524/3320 (16%)**	**272/924 (29%)**	**488/2947 (17%)**	**187/689 (27%)**	**362/2029 (18%)**
Diabetes		**346/2041 (17%)**	**489/3531 (14%)**	**182/996 (18%)**	**417/3133 (13%)**	**145/728 (20%)**	**286/2121 (13%)**
Independently Ambulatory		**1767/2045 (86%)**	**3249/3531 (92%)**	**837/1003 (83%)**	**2910/3139 (93%)**	**617/733 (84%)**	**1972/2132 (92%)**
Symptom Duration > 1 year		**1291/1980 (65%)**	**1919/3410 (56%)**	**633/962 (66%)**	**1687/3009 (56%)**	**454/693 (66%)**	**1176/2053 (57%)**
Previous Spine Surgery		**774/1782 (43%)**	**1047/3039 (34%)**	**392/875 (45%)**	**929/2682 (35%)**	**292/651 (45%)**	**612/1795 (34%)**

Insurance at time of surgery	Private	**1289/2049 (63%)**	**2877/3541 (81%)**	**527/1004 (52%)**	**2557/3143 (81%)**	**392/733 (53%)**	**1755/2133 (82%)**
	Medicare/Other Public	**526/2049 (26%)**	**531/3541 (15%)**	**343/1004 (34%)**	**443/3143 (14%)**	**258/733 (35%)**	**288/2133 (14%)**
	Medicaid	**234/2049 (11%)**	**133/3541 (4%)**	**134/1004 (13%)**	**143/3143 (5%)**	**83/733 (11%)**	**90/2133 (4%)**
Education	Less Than High School	**91/1971 (5%)**	**59/3439 (2%)**	**48/961 (5%)**	**46/3049 (2%)**	**28/700 (4%)**	**44/2082 (2%)**
	High School Diploma/GED	**994/1971 (50%)**	**1292/3439 (38%)**	**476/961 (50%)**	**1172/3049 (38%)**	**329/700 (47%)**	**792/2082 (38%)**
	At Least Some College	**689/1971 (35%)**	**1477/3439 (43%)**	**323/961 (34%)**	**1294/3049 (42%)**	**240/700 (34%)**	**861/2082 (41%)**
	Post-College	**197/1971 (10%)**	**611/3439 (18%)**	**114/961 (12%)**	**537/3049 (18%)**	**103/700 (15%)**	**385/2082 (18%)**
Employed at Baseline		**933/2033 (46%)**	**3070/3525 (87%)**	**390/998 (39%)**	**2632/3127 (84%)**	**303/729 (42%)**	**1759/2125 (83%)**
Medium/Heavy Physical Workload		**276/463 (60%)**	**674/1579 (43%)**	113/240 (47%)	718/1582 (45%)	112/239 (47%)	606/1342 (45%)
Workers' Compensation		**120/1958 (6%)**	**71/3443 (2%)**	**53/958 (6%)**	**99/3056 (3%)**	**45/705 (6%)**	**58/2079 (3%)**
Fusion versus Decompression		**1218/2049 (59%)**	**1302/3541 (37%)**	**546/1004 (54%)**	**1253/3142 (40%)**	**379/733 (52%)**	**852/2132 (40%)**
Spinal Levels	1	**1064/2003 (53%)**	**2054/3426 (60%)**	**489/974 (50%)**	**1835/3041 (60%)**	**340/708 (48%)**	**1221/2052 (60%)**
	2	**559/2003 (28%)**	**914/3426 (27%)**	**305/974 (31%)**	**829/3041 (27%)**	**237/708 (33%)**	**569/2052 (28%)**

	3	**228/2003 (11%)**	**320/3426 (9%)**	**106/974 (11%)**	**264/3041 (9%)**	**84/708 (12%)**	**182/2052 (9%)**
	4+	**152/2003 (8%)**	**138/3426 (4%)**	**74/974 (8%)**	**113/3041 (4%)**	**47/708 (7%)**	**80/2052 (4%)**
Length of Stay		**2 (1, 3)**	**1 (0, 2)**	**2 (1, 3)**	**1 (0, 3)**	**2 (1, 3)**	**1 (0, 3)**
Discharge Home		**1901/2047 (93%)**	**3445/3535 (97%)**	**918/1004 (91%)**	**3056/3133 (98%)**	**664/732 (91%)**	**2067/2128 (97%)**
Readmitted within 90 Days		**116/1998 (6%)**	**91/3452 (3%)**	**58/977 (6%)**	**79/3035 (3%)**	**47/711 (7%)**	**58/2071 (3%)**
Returned to Operating Room within 90 Days		**81/1998 (4%)**	**47/3452 (1%)**	**35/977 (4%)**	**43/3035 (1%)**	**25/711 (4%)**	**32/2071 (2%)**
Surgical Site Infection		**42/1998 (2%)**	**31/3452 (1%)**	17/977 (2%)	41/3035 (1%)	**16/711 (2%)**	**24/2071 (1%)**
Minimal Clinically Important Difference (MCID) on Patient-Reported Outcomes Measurement Information System (PROMIS)	90 Days	**949/1949 (49%)**	**2503/3350 (75%)**	**373/736 (51%)**	**1606/2225 (72%)**	**283/567 (50%)**	**1104/1514 (73%)**
	1 Year	**554/974 (57%)**	**1449/1904 (76%)**	**472/943 (50%)**	**2234/2927 (76%)**	**275/508 (54%)**	**1168/1482 (79%)**
	2 Years	**416/685 (61%)**	**1009/1327 (76%)**	**276/478 (58%)**	**1141/1480 (77%)**	**385/691 (56%)**	**1517/1968 (77%)**

Table 2. Generalized Estimating Equation (GEE) for return-to-work among all patients. Statistically significant values in bold.

	90-Day (N = 3768)		**1-Year (N = 2758)**		**2-Year (N = 1932)**	
Variable	**Risk Ratio (95% Confidence Interval)**	***P***	**Risk Ratio (95% Confidence Interval)**	***P***	**Risk Ratio (95% Confidence Interval)**	***P***
Increasing Age (5-year increments)	1.00 (0.99, 1.00)	0.296	0.98 (0.97, 0.99)	**<0.001**	0.97 (0.95, 0.98)	**<0.001**
Male Gender	1.02 (0.98, 1.07)	0.306	1.07 (1.03, 1.11)	**0.001**	1.05 (1.00, 1.11)	0.061
Race						
White	REFERENCE		REFERENCE		REFERENCE	
African-American	0.70 (0.59, 0.83)	**<0.001**	0.83 (0.73, 0.96)	**0.011**	0.84 (0.70, 1.01)	0.067
Other	0.83 (0.73, 0.95)	**0.006**	0.94 (0.86, 1.03)	0.163	0.97 (0.87, 1.07)	0.505
Diabetes	1.00 (0.94, 1.06)	0.911	1.01 (0.96, 1.07)	0.612	1.04 (0.97, 1.12)	0.313
Independently Ambulatory	1.05 (0.97, 1.14)	0.222	1.12 (1.03, 1.21)	**0.007**	1.13 (1.01, 1.26)	**0.029**
Symptom Duration > 1 year	0.97 (0.93, 1.01)	0.200	0.96 (0.93, 1.00)	0.069	0.95 (0.91, 0.99)	**0.016**
Patient Health Questionnaire-2 (PHQ-2) for Depression	0.93 (0.88, 0.99)	**0.014**	0.99 (0.95, 1.03)	0.560	1.00 (0.93, 1.07)	0.937
Previous Spine Surgery	0.99 (0.95, 1.04)	0.747	0.98 (0.94, 1.03)	0.429	0.93 (0.88, 0.97)	**0.002**
Current Smoker	0.90 (0.83, 0.97)	**0.004**	0.95 (0.90, 1.00)	0.056	0.99 (0.93, 1.06)	0.819
Daily Opioid Use > 6 Months	0.94 (0.88, 1.00)	**0.035**	0.92 (0.87, 0.98)	**0.010**	0.97 (0.91, 1.03)	0.340

Insurance Type at time of surgery						
Private	REFERENCE		REFERENCE		REFERENCE	
Medicare/Other Public	0.89 (0.83, 0.95)	**0.001**	0.82 (0.77, 0.88)	**<0.001**	0.81 (0.74, 0.88)	**<0.001**
Medicaid	0.76 (0.64, 0.91)	**0.002**	0.74 (0.64, 0.86)	**<0.001**	0.70 (0.59, 0.83)	**<0.001**
At Least Some College	1.10 (1.06, 1.15)	**<0.001**	1.05 (1.01, 1.09)	**0.014**	1.03 (0.99, 1.08)	0.156
Employed at Baseline	2.35 (2.14, 2.59)	**<0.001**	1.88 (1.73, 2.05)	**<0.001**	1.78 (1.62, 1.96)	**<0.001**
Workers' Compensation	0.73 (0.59, 0.91)	**0.005**	0.99 (0.88, 1.12)	0.917	0.93 (0.79, 1.10)	0.419
Patient-Reported Outcomes Measurement Information System (PROMIS) Baseline (5-point increments)	1.01 (0.99, 1.02)	0.553	0.99 (0.98, 1.01)	0.337	1.00 (0.98, 1.02)	0.723
Fusion versus Decompression Only	0.75 (0.71, 0.80)	**<0.001**	0.93 (0.89, 0.98)	**0.004**	0.98 (0.93, 1.03)	0.398
Number of Levels						
1	REFERENCE		REFERENCE		REFERENCE	
2	0.97 (0.92, 1.01)	0.172	0.95 (0.91, 0.99)	**0.028**	0.96 (0.90, 1.02)	0.192
3	0.89 (0.83, 0.95)	**0.001**	0.96 (0.89, 1.03)	0.260	0.97 (0.89, 1.05)	0.462
4+	0.79 (0.70, 0.90)	**<0.001**	0.89 (0.79, 1.02)	0.084	0.87 (0.76, 1.01)	0.059

Table 3. Generalized Estimating Equation (GEE) for return-to-work among patients employed preoperatively. Statistically significant values in bold.

	90-Day (N = 1336)		**1-Year (N = 1183)**		**2-Year (N = 1064)**	
Variable	**Risk Ratio (95% Confidence Interval)**	***P***	**Risk Ratio (95% Confidence Interval)**	***P***	**Risk Ratio (95% Confidence Interval)**	***P***
Increasing Age (5-year increments)	1.00 (0.99, 1.01)	0.895	0.99 (0.98, 1.00)	**0.006**	0.97 (0.96, 0.98)	**<0.001**
Male Gender	1.00 (0.95, 1.06)	0.938	1.01 (0.97, 1.05)	0.723	0.99 (0.95, 1.04)	0.748
Race						
White	REFERENCE		REFERENCE		REFERENCE	
African-American	0.74 (0.58, 0.94)	**0.015**	0.92 (0.78, 1.07)	0.278	0.88 (0.70, 1.10)	0.255
Other	0.92 (0.78, 1.07)	0.284	0.98 (0.89, 1.09)	0.715	1.03 (0.93, 1.14)	0.550
Diabetes	1.01 (0.92, 1.10)	0.887	0.99 (0.93, 1.06)	0.754	1.05 (0.97, 1.13)	0.252
Independently Ambulatory	1.07 (0.96, 1.20)	0.197	1.08 (0.98, 1.20)	0.113	1.07 (0.96, 1.21)	0.234
Symptom Duration > 1 year	1.01 (0.96, 1.07)	0.683	1.00 (0.95, 1.04)	0.899	0.97 (0.93, 1.02)	0.205
Patient Health Questionnaire-2 (PHQ-2) for Depression	0.95 (0.88, 1.03)	0.192	0.99 (0.94, 1.04)	0.719	0.99 (0.93, 1.04)	0.640
Current Smoker	0.97 (0.89, 1.05)	0.424	0.98 (0.92, 1.04)	0.547	1.00 (0.93, 1.08)	0.909
Daily Opioid Use > 6 Months	0.99 (0.91, 1.06)	0.702	0.99 (0.92, 1.07)	0.781	1.02 (0.95, 1.09)	0.555
Previous Spine Surgery	0.98 (0.92, 1.03)	0.443	0.96 (0.91, 1.00)	0.057	0.93 (0.88, 0.98)	**0.009**

Insurance Type at time of surgery						
Private	REFERENCE		REFERENCE		REFERENCE	
Medicare/Other Public	0.87 (0.79, 0.95)	**0.002**	0.89 (0.82, 0.96)	**0.004**	0.88 (0.80, 0.97)	**0.008**
Medicaid	0.85 (0.68, 1.06)	0.141	0.79 (0.65, 0.96)	**0.020**	0.74 (0.58, 0.93)	**0.011**
At Least Some College	1.08 (1.01, 1.16)	**0.029**	1.07 (1.03, 1.12)	**0.002**	1.04 (0.99, 1.09)	0.083
Medium/Heavy Physical Workload	0.86 (0.80, 0.92)	**<0.001**	1.02 (0.99, 1.06)	0.156	1.00 (0.95, 1.05)	0.885
Workers' Compensation	0.83 (0.63, 1.10)	0.188	1.01 (0.90, 1.15)	0.832	0.90 (0.70, 1.16)	0.410
Patient-Reported Outcomes Measurement Information System (PROMIS) Baseline (5-point increments)	1.04 (1.01, 1.07)	**0.021**	1.02 (0.99, 1.04)	0.123	1.01 (0.98, 1.04)	0.527
Fusion versus Decompression Only	0.79 (0.73, 0.85)	**<0.001**	0.97 (0.92, 1.02)	0.175	0.99 (0.94, 1.05)	0.756
Number of Levels						
1	REFERENCE		REFERENCE		REFERENCE	
2	0.95 (0.89, 1.01)	0.079	0.94 (0.90, 0.98)	**0.003**	0.96 (0.90, 1.03)	0.269
3	0.90 (0.81, 1.00)	0.052	0.96 (0.89, 1.04)	0.336	1.00 (0.90, 1.10)	0.936
4+	0.82 (0.70, 0.97)	**0.017**	0.96 (0.84, 1.09)	0.556	0.97 (0.85, 1.11)	0.671

Table 4. Generalized Estimating Equation (GEE) for return-to-work among patients unemployed preoperatively. Statistically significant values in bold.

	90-Day (N = 1015)		**1-Year (N = 724)**		**2-Year (N = 522)**	
Variable	**Risk Ratio (95% Confidence Interval)**	***P***	**Risk Ratio (95% Confidence Interval)**	***P***	**Risk Ratio (95% Confidence Interval)**	***P***
Increasing Age (5-year increments)	0.96 (0.92, 1.00)	0.068	0.94 (0.90, 0.97)	**0.001**	0.92 (0.89, 0.97)	**<0.001**
Male Gender	1.30 (1.04, 1.63)	**0.020**	1.33 (1.11, 1.60)	**0.002**	1.32 (1.06, 1.64)	**0.014**
Race						
White	REFERENCE		REFERENCE		REFERENCE	
African-American	0.72 (0.45, 1.15)	0.170	0.68 (0.47, 0.98)	**0.038**	0.73 (0.40, 1.34)	0.306
Other	0.64 (0.32, 1.26)	0.196	0.59 (0.29, 1.18)	0.134	0.66 (0.37, 1.17)	0.154
Diabetes	1.11 (0.90, 1.37)	0.323	1.10 (0.90, 1.34)	0.339	1.09 (0.83, 1.43)	0.529
Independently Ambulatory	1.08 (0.85, 1.38)	0.524	1.19 (0.94, 1.49)	0.145	1.24 (0.96, 1.61)	0.094
Symptom Duration > 1 year	0.84 (0.70, 1.02)	0.072	0.86 (0.72, 1.04)	0.112	0.81 (0.66, 0.99)	**0.042**
Patient Health Questionnaire-2 (PHQ-2) for Depression	0.90 (0.74, 1.09)	0.276	0.98 (0.84, 1.14)	0.765	1.03 (0.82, 1.30)	0.780
Current Smoker	0.82 (0.64, 1.05)	0.110	0.87 (0.70, 1.08)	0.203	1.02 (0.81, 1.28)	0.856
Daily Opioid Use > 6 Months	0.67 (0.52, 0.87)	**0.002**	0.71 (0.55, 0.91)	**0.008**	0.82 (0.63, 1.06)	0.135
Previous Spine Surgery	1.00 (0.83, 1.20)	0.977	1.06 (0.91, 1.24)	0.451	0.89 (0.74, 1.07)	0.228

Insurance Type at time of surgery						
Private	REFERENCE		REFERENCE		REFERENCE	
Medicare/Other Public	0.76 (0.56, 1.02)	0.071	0.54 (0.42, 0.71)	**<0.001**	0.53 (0.41, 0.70)	**<0.001**
Medicaid	0.58 (0.40, 0.86)	**0.006**	0.56 (0.38, 0.82)	**0.003**	0.52 (0.34, 0.78)	**0.002**
At Least Some College	1.06 (0.89, 1.27)	0.497	1.14 (0.99, 1.32)	0.067	1.15 (0.97, 1.36)	0.111
Workers' Compensation	0.69 (0.48, 0.99)	**0.041**	0.88 (0.68, 1.13)	0.298	0.87 (0.63, 1.21)	0.400
Patient-Reported Outcomes Measurement Information System (PROMIS) Baseline (5-point increments)	0.91 (0.83, 0.99)	**0.031**	0.94 (0.86, 1.02)	0.131	0.99 (0.91, 1.09)	0.881
Fusion versus Decompression Only	0.56 (0.45, 0.68)	**<0.001**	0.77 (0.65, 0.91)	**0.003**	1.05 (0.89, 1.24)	0.576
Number of Levels						
1	REFERENCE		REFERENCE		REFERENCE	
2	0.92 (0.75, 1.14)	0.466	0.92 (0.77, 1.09)	0.334	1.01 (0.83, 1.24)	0.898
3	0.70 (0.46, 1.07)	0.102	0.85 (0.63, 1.14)	0.273	0.82 (0.58, 1.15)	0.251
4+	0.49 (0.28, 0.88)	**0.017**	0.70 (0.44, 1.11)	0.127	0.67 (0.34, 1.32)	0.251