



Contents lists available at ScienceDirect

North American Spine Society Journal (NASSJ)

journal homepage: www.elsevier.com/locate/xnsj

Clinical Studies

Worsening pain and quality of life for spine surgery patients during the COVID-19 pandemic: Roles of psychological distress and patient activation



Rachel S. Bronheim*, Khaled M. Kebaish, Amit Jain, Brian J. Neuman, Richard L. Skolasky

From the Department of Orthopaedic Surgery, The Johns Hopkins University School of Medicine, Baltimore, MD, USA

ARTICLE INFO

Keywords:

Anxiety
 COVID-19
 Depression
 Patient activation
 Patient-reported outcomes
 Spine surgery

ABSTRACT

Background: Public health measures during the COVID-19 pandemic have disrupted access to basic resources (income, food, housing, healthcare). The effects may impact patients differently based on socioeconomic status (SES), pre-existing psychological distress, and patient activation (knowledge, skills, and motivation to manage healthcare). We examined changes in access to basic resources and in pain and health-related quality of life (HRQoL) during the pandemic and determined how pre-existing psychological distress and patient activation are associated with exacerbation or mitigation of effects on pain and HRQoL.

Methods: This cross-sectional study assessed 431 patients in a longitudinal-outcomes registry who underwent or scheduled spine surgery at our institution and were surveyed about COVID-19 effects on accessing basic resources. We assessed pain (numeric rating scale) and HRQoL (PROMIS 29-Item Profile). Information on preoperative SES, psychological distress, patient activation, pain, and HRQoL was collected previously. We compared access to basic resources by SES. We compared changes from pre-COVID-19 to COVID-19 assessments of pain and HRQoL and proportions of patients reporting worsened pain and HRQoL stratified by psychological distress. We analyzed associations between patient activation and negative effects on HRQoL using multivariable linear regression. Alpha=0.05.

Results: Respondents reported minor disruptions in accessing basic resources (no difference by SES) but significant worsening of back ($p=.027$) and leg pain ($p=.013$) and HRQoL (physical function, fatigue, $p<0.001$; satisfaction with participation in social roles, $p=0.048$) during COVID-19. Psychological distress was associated with clinically relevant worsening of back, pain, leg pain, and physical function all, ($p<0.05$). High patient activation was associated with less impairment of physical function ($p=0.03$).

Conclusion: Patients with pre-existing psychological distress experienced greater worsening of pain and HRQoL. High patient activation appeared to mitigate worsening of physical function. Providers should screen for psychological distress and patient activation and enhance supports to manage pain and maintain HRQoL in at-risk patients.

Level of Evidence: III

Background

At the time of this writing, the United States has had more than 46 million confirmed cases of the novel coronavirus disease (COVID-19) and more than 700,000 deaths [1]. The consequences of public health protection measures have included loss of income, lack of access to basic resources (including healthcare), and negative effects on health and well-being [2]. Little is currently known regarding the effects of these public health measures on spine surgery patients and their recovery.

The results of the COVID-19 pandemic may affect individuals differently according to their access to socioeconomic resources and their burden of preexisting psychological distress. In a systematic review, Aalto et al [3] reported that higher income was associated with better health

outcomes after surgery for lumbar spinal stenosis. Evidence suggests that the presence of psychological distress, defined as a high burden of symptoms of anxiety and/or depression, is associated with poorer postoperative outcomes. In those undergoing decompressive surgery for either cervical radiculopathy and lumbar spinal stenosis, patients who had a high burden of depression had worse postoperative pain intensity and pain-related disability [4–7]. Although it is clear that psychological distress is associated with poor postoperative outcomes, it is unclear how psychological distress may interact with an external stressor, such as the COVID-19 pandemic, to impede recovery of surgical spine patients.

Because of the effects of the pandemic, patients may need to rely more on their internal strengths as they recover from spine surgery. One measure of internal strength is patient activation—a hierarchical con-

* Corresponding author.

E-mail address: rskolas1@jhmi.edu (R.S. Bronheim).<https://doi.org/10.1016/j.xnsj.2022.100103>

Received 30 December 2021; Received in revised form 7 February 2022; Accepted 8 February 2022

Available online 13 February 2022

2666-5484/© 2022 The Authors. Published by Elsevier Ltd on behalf of North American Spine Society. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>)

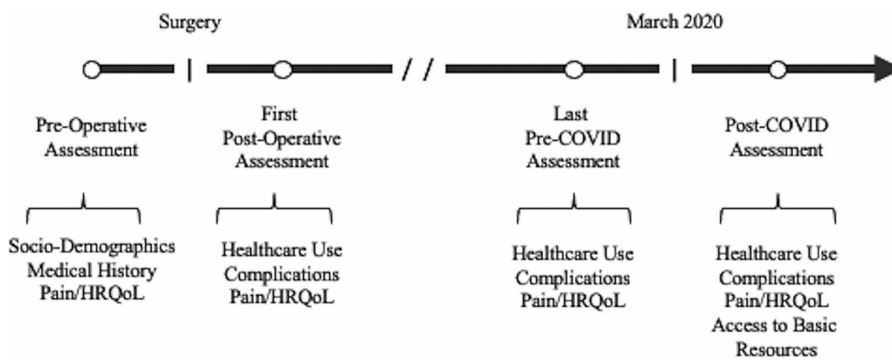


Fig. 1. Study timeline for 296 patients who had undergone spine surgery and contributed data to both a longitudinal cohort study and a survey of the impact of COVID-19 on access to basic resources (including healthcare), pain, and health-related quality of life (HRQoL).

struct that encompasses the knowledge, skills, and confidence to manage one's healthcare [4]. Individuals with high patient activation are more likely to engage in physical therapy and home exercise during postoperative recovery [8,9] and to experience sustained reduction in pain and improvement in physical function after spine surgery [9,10]. Patient activation may mitigate the negative effects of psychological distress in patients undergoing or recovering from spine surgery [11].

To understand these factors in spine surgery patients, we investigated changes during the COVID-19 pandemic in their access to basic resources (defined as socioeconomic standing and access to healthcare) and their pain and health-related quality of life (HRQoL) (physical, mental, and social domains of health). Further, to understand how pre-existing negative and positive factors are related to the risks of external stress, we analyzed associations of patients' psychological distress (symptoms of anxiety/depression) and patient activation as measured before COVID-19 (pre-pandemic) with their pain levels and HRQoL during COVID-19.

Methods

Institutional review board approval was obtained, and participants provided informed consent for this study.

Data source and study population

We selected adults who were previously enrolled in a longitudinal cohort study to understand the impact of spine surgery on HRQoL, which was assessed using patient-reported outcomes. These patients had either undergone or were scheduled to undergo spine surgery for cervical or lumbar spine degeneration or deformity correction at our academic center.

Study timeline

We defined 2 distinct time periods to understand the impact of the public health consequences of the COVID-19 pandemic: pre-COVID (before March 1, 2020) and post-COVID (March 1, 2020 and after). Pre-COVID assessments of sociodemographic characteristics, medical history, healthcare use, complications, and HRQoL were obtained from a longitudinal cohort study (Fig. 1). The last pre-COVID assessment was the last available postoperative assessment before March 1, 2020. Between May 1 and July 31, 2020, patients were asked to complete a survey regarding the effects of COVID-19 on their health, wellbeing, and personal life. Surveys were sent to 1,506 patients, 431 of whom (29%) completed and returned them.

Respondents were asked to report their age, gender, ethnicity and race, annual household income, highest educational attainment, marital status, employment status, and current smoking status (Table 1). Comorbid conditions were assessed using the Charlson Comorbidity Index [12,13].

The mean (\pm standard deviation [SD]) age of respondents was 61 ± 15 years. Fifty-five percent of respondents identified as female, and most respondents were non-Hispanic (92%) and white (81%) (Table 1). Most reported living with a partner (71%) and were not currently employed (68%). Approximately one-fifth of respondents reported an annual household income of $\leq \$50,000$, and 120 (28%) reported having less than a college education. Two hundred twenty-nine patients (53%) were being treated for a degenerative lumbar condition, 118 (27%) for a degenerative cervical condition, and 84 (19%) for spinal deformity. We found no significant differences between groups in terms of demographic characteristics.

Outcomes of interest

Respondents reported their health and wellness, as well as their access to basic resources and healthcare.

Access to basic resources

To assess patients' access to basic resources, the survey asked about loss of employment/income, difficulty affording rent, mortgage, food, or healthcare, and difficulty obtaining food. To assess access to healthcare, the survey asked about cancellation of appointments and the ability to obtain prescription medications. These questions have been used previously to understand the impact of the COVID-19 pandemic on patients managing chronic low back pain. [14]

Assessments of pain and HRQoL

Patients scored their worst back, leg, neck, and arm pain during the previous week on a numeric rating scale, with 0 representing no pain and 10 representing the worst imaginable pain [15,16]. Patients completed the Patient-Reported Outcome Measurement Information System 29-Item Profile, version 2 (PROMIS-29), which assesses HRQoL using the following domains: Pain Interference, Physical Function, Fatigue, Anxiety, Depression, Sleep Disturbance, and Satisfaction with Participation in Social Roles [17–19]. PROMIS-29 domains are scored using a T-score normalized method, in which a score of 50 approximates the general population mean with a SD of 10 points.

Covariates of interest

At their preoperative visit, patients provided information on their annual income and highest level of education attained and completed assessments of psychological distress (anxiety and depression) and patient activation. For patients who had already undergone surgery, this information was collected before the pandemic.

We categorized respondents according to self-reported annual income ($\leq \$50,000$ or $> \$50,000$ (cutoff near the median household income of \$50,379 in the Baltimore metropolitan region was chosen) and highest level of education attained (less than 4-year college degree, 4-year college degree, or postgraduate degree). Patients were categorized

Table 1

Sociodemographic and clinical characteristics of 431 patients having undergone or scheduled for spine surgery responding to a COVID-19 Impact Survey between May 1, 2020 and July 31, 2020

Characteristics	N (%)			p-value*		
	Overall (N = 431)	Preoperative (N = 135)	Postoperative (N = 296)	1–12 months (N = 178)	12–24 months (N = 35)	>24 months (N = 83)
Age, years	61 ± 15 [†]	58 ± 17 [†]	61 ± 14 [†]	63 ± 12 [†]	62 ± 13 [†]	0.168
Gender						0.560
Male	194 (45)	68 (50)	75 (42)	13 (37)	38 (46)	
Female	234 (54)	67 (50)	101 (57)	22 (63)	44 (53)	
Unknown/refused	3 (<1)	0 (0)	2 (1)	0 (0)	1 (1)	
Race [‡]						0.486
American Indian	2 (<1)	2 (1)	0 (0)	0 (0)	0 (0)	
Asian	15 (3)	3 (2)	7 (4)	1 (3)	4 (5)	
Black	44 (10)	13 (10)	14 (8)	6 (17)	11 (13)	
White	348 (81)	114 (84)	145 (81)	26 (74)	63 (76)	
Multiracial	6 (1)	0 (0)	3 (2)	1 (3)	2 (2)	
Unknown/refused	16 (4)	3 (2)	9 (5)	1 (3)	3 (4)	
Ethnicity						0.078
Hispanic	13 (3)	3 (2)	9 (5)	1 (3)	0 (0)	
Non-Hispanic	397 (92)	130 (96)	156 (88)	32 (91)	79 (95)	
Unknown/refused	21 (5)	2 (1)	13 (7)	2 (6)	4 (5)	
Educational level						0.613
<4-year college degree	120 (28)	40 (30)	50 (28)	12 (34)	18 (22)	
4-year college degree	97 (23)	28 (21)	50 (28)	5 (14)	14 (17)	
Postgraduate degree	117 (27)	37 (27)	57 (32)	11 (31)	12 (14)	
Unknown/refused	97 (23)	30 (22)	21 (12)	7 (20)	39 (47)	
Household Income						0.408
≤\$50,000	68 (16)	20 (15)	34 (19)	3 (9)	11 (13)	
>\$50,000	207 (48)	64 (47)	95 (53)	22 (63)	26 (31)	
Unknown/refused	156 (36)	51 (38)	49 (28)	10 (29)	46 (55)	
Living alone						0.721
Yes	125 (29)	40 (30)	54 (30)	10 (29)	21 (25)	
No	304 (71)	95 (70)	122 (69)	25 (71)	62 (75)	
Unknown/refused	2 (<1)	0 (0)	2 (1)	0 (0)	0 (0)	
Currently working						0.101
Yes	137 (32)	55 (41)	52 (29)	8 (23)	22 (27)	
No	292 (68)	80 (59)	124 (70)	27 (77)	61 (73)	
Unknown/refused	2 (<1)	0 (0)	2 (1)	0 (0)	0 (0)	
If not working, reason						0.323
Retired (not because of illness)	145 (50)	35 (44)	63 (51)	16 (59)	31 (50)	
Disabled/retired because of illness	87 (30)	33 (41)	25 (21)	8 (30)	21 (34)	
Looking for work	5 (2)	3 (4)	2 (2)	0 (0)	0 (0)	
Choose not to work	9 (3)	2 (2)	4 (3)	1 (4)	1 (2)	
Attending school	5 (2)	3 (4)	2 (2)	0 (0)	0 (0)	
Unknown/refused	41 (14)	4 (5)	28 (23)	2 (7)	8 (13)	
Current smoker						0.560
Yes	27 (6)	11 (8)	8 (4)	3 (9)	5 (6)	
No	402 (93)	124 (92)	168 (94)	32 (91)	78 (94)	
Unknown/refused	2 (<1)	0 (0)	2 (1)	2 (1)	0 (0)	
Charlson Comorbidity Index [§]	0.59 ± 0.35 [†]	0.66 ± 0.35 [†]	0.59 ± 0.34 [†]	0.54 ± 0.36 [†]	0.52 ± 0.36 [†]	0.131
Spine condition						0.469
Lumbar degeneration	229 (53)	69 (51)	89 (50)	23 (66)	48 (58)	
Cervical degeneration	118 (27)	39 (29)	55 (31)	7 (20)	17 (20)	
Deformity	84 (19)	27 (20)	34 (19)	5 (14)	18 (22)	

COVID-19, coronavirus disease 2019.

* Comparison among time since surgery groups using analysis of variance

† Reported as mean ± standard deviation.

‡ No patients self-identified as Hawaiian/Pacific Islander.

§ The Charlson Comorbidity Index ranges from 0 to 1 and predicts 10-year mortality in patients with multiple comorbid conditions.

as screening positive for generalized anxiety disorder or major depressive disorder if they scored 60 points or higher on their preoperative PROMIS-29 anxiety or depression health domains, which have been shown to be valid instruments to screen for these 2 disorders [20].

Patient activation was assessed using the Patient Activation Measure (PAM), a 13-item scale that asks respondents to rate their agreement with test items, ranging from strongly disagree to strongly agree. Scores on the PAM are continuous measures ranging from 0 (no activation) to 100 (high activation). Previous reports of the use of the PAM have shown observed scores between 40 and 80 points (mean 55 points) [4,21]. The PAM is a multistage scale, in which each successive stage re-

quires greater activation. The stages are as follows: believing active role important (items 1 and 2); having confidence and knowledge to take action (items 3–8); taking action (items 9–11); and “staying the course” under stress (items 12 and 13) [4,22]. Patients were categorized as having high patient activation (stage 3 or 4) or low patient activation (stage 1 or 2) according to their preoperative PAM scores.

Statistical analysis

To address our first aim, we used data from all 431 patients who had either undergone or were scheduled to undergo spine surgery for cer-

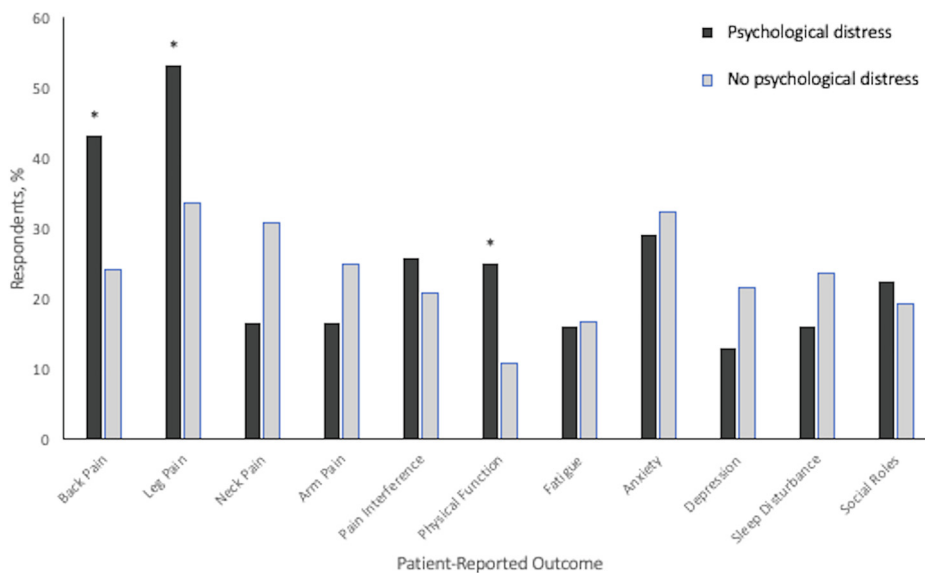


Fig. 2. Proportion of 296 patients who had undergone spine surgery and who reported worsening pain and quality of life outcomes, as measured by the Patient-Reported Outcome Measurement Information System 29-Item Profile, between their final postoperative visit pre pandemic and the time of their COVID-19 Impact Survey, stratified by presence of psychological distress (symptoms of depression/anxiety). Worsening outcomes were those that met or exceeded established minimum clinically important difference thresholds. *Indicates significant difference between groups ($p < .05$). “Social roles” indicates satisfaction with participation in social roles.

vical or lumbar spine degeneration or deformity correction at our academic center. We compared the patient-reported impact of COVID-19 on access to basic resources among this cohort stratified by annual household income and highest educational attainment. Descriptive statistics were used to describe the impact of the pandemic on access to basic resources. Means (and SDs) were used to describe continuous variables, and counts (and percentages) were used to describe categorical variables. Analysis of variance and chi-squared tests were used to compare predefined groups.

To address our second and third aims, we restricted our analysis to the 296 patients who had undergone surgery prior to COVID-19 and had at least 1 pre-COVID-19 postoperative assessment. We used data from our existing prospectively maintained registry of patient-reported outcomes to match survey responses with assessments at initial preoperative and last pre-COVID-19 postoperative assessments. To answer our second aim, we calculated means and SDs for all patient-reported outcomes at preoperative, last pre-COVID-19, and COVID-19 assessments. Paired T-tests were used to compare differences in pain and HRQoL between most recent pre-pandemic and COVID-19 assessments.

To address the associations of psychological distress and patient activation with the impact of COVID-19 (our third aim), we determined which patients reported significant worsening of their pain or HRQoL between last pre-COVID-19 and COVID-19 assessments. We defined worsening of pain or HRQoL according to the difference between the last pre-COVID-19 postoperative assessment and the COVID-19 assessment that exceeded the minimum clinically important difference (MCID) threshold for pain [15,16] or HRQoL [17,18], depending on the measure.

We compared the proportion of patients experiencing worsening of each health outcome stratified by the presence of preoperative psychological distress. Chi-squared tests of association were used to compare patients with psychological distress versus those without psychological distress. Using a generalized estimating equation to account for the correlation between repeated measures of the patient-reported outcomes, we modeled changes from baseline PROMIS-29 health domain scores as a function of time (categorical as last pre-COVID-19 postoperative and COVID-19 assessments) and high patient activation (stage 3 or 4 vs. stage 1 or 2). Our model included interaction terms between time and preoperative factors to determine whether these factors were associated with change over time.

Significance was set at $p < .05$. All statistical analyses were conducted using SAS, version 9.4 (SAS Institute, Cary, NC).

Results

Access to basic resources

Most respondents (81%) did not report experiencing a loss of income due to COVID-19. Respondents reported little difficulty in affording basic resources or accessing food and prescription medication (Table 2). Healthcare access was interrupted, with 117 respondents (43%) reporting a canceled healthcare appointment. We found no significant differences in access to basic resources according to income category or educational level.

Assessments of pain and health-related quality of life

Respondents who had undergone spine surgery before the pandemic ($N = 296$) reported significantly worse outcomes between the last pre-COVID-19 and COVID-19 assessments (Table 3). Mean \pm SD time between last pre-COVID-19 postoperative and COVID-19 assessments was 7.3 ± 10.4 months. During COVID-19, respondents reported worsening of the following: back pain (mean increase, 0.57 ± 3.0 points; $p = .027$), leg pain (mean increase, 0.74 ± 3.4 points; $p = .013$), physical function (mean decrease, 2.4 ± 7.5 points; $p < .001$), fatigue (mean increase, 3.8 ± 9.6 points; $p < .001$), and satisfaction with participation in social roles (mean decrease, 1.9 ± 11 points; $p = .048$).

Role of psychological distress

When analyzing the proportion of respondents who reported worsening patient-reported outcomes that exceeded the MCID threshold, those experiencing preoperative psychological distress were more likely to have clinically relevant worsening of back pain during COVID-19 (43% vs. 24%), leg pain (53% vs. 34%), and physical function (25% vs. 11%) compared with those not experiencing preoperative psychological distress (Fig. 2).

Role of patient activation

Respondents who had high preoperative patient activation experienced significantly greater reduction in pain interference ($p = .038$) and more improvement in physical function ($p = .003$) compared with those who had low patient activation. Respondents who had high patient activation experienced less impairment of physical function dur-

Table 2

Responses of 431 patients having undergone or scheduled for spine surgery regarding access to basic resources and healthcare during the COVID-19 pandemic, by income and educational level

COVID-19 Effects	Annual Household Income ¹		p-value*	Educational Level ²			p-value†
	≤\$50,000	>\$50,000		<College	College	Postgraduate	
Loss of income			0.404				0.741
Yes	15 (22)	30 (15)		17 (14)	19 (20)	21 (18)	
No	51 (75)	168 (81)		96 (80)	76 (78)	91 (78)	
Unknown/refused	2 (3)	9 (4)		7 (6)	2 (2)	5 (4)	
Difficulty affording			0.258				0.180
Rent	3 (4)	1 (<1)		1 (2)	1(1)	1 (1)	
Mortgage	2 (3)	6 (3)		2 (2)	4 (4)	2 (2)	
Food	2 (3)	2 (1)		3 (3)	2 (2)	1 (1)	
Healthcare	0 (0)	2 (1)		2 (2)	2 (2)	0 (0)	
Other	3 (4)	8 (4)		3 (1)	2 (2)	7 (6)	
Difficulty getting food			0.693				0.995
Yes	11 (16)	29 (14)		16 (13)	13 (13)	15 (13)	
No	57 (84)	175 (85)		103 (86)	84 (87)	100 (85)	
Unknown/refused	0 (0)	3 (1)		1 (1)	0 (0)	2 (2)	
Canceled appointment			0.636				0.910
Yes	31 (46)	86 (42)		50 (42)	44 (45)	49 (42)	
No	36 (53)	115 (55)		67 (56)	53 (55)	63 (54)	
Unknown/refused	1 (1)	6 (3)		3 (2)	0 (0)	5 (4)	
Unable to obtain prescription medication			0.354				0.334
Yes	5 (7)	10 (5)		6 (5)	6 (6)	5 (4)	
No	61 (90)	187 (90)		110 (92)	85 (88)	109 (93)	
No prescriptions	0 (0)	6 (3)		3 (2)	3 (3)	1 (1)	
Unknown/refused	2 (3)	4 (2)		1 (1)	3 (3)	2 (2)	

COVID-19, coronavirus disease 2019.

* Comparison between income groups using Student t-tests.

† Comparison among educational groups using analysis of variance.

¹ Annual household income was available for 275 respondents

² Educational level was available for 334 respondents

Table 3

Pain and quality-of-life outcomes reported by 296 patients who had undergone spine surgery, as measured by a numeric pain scale and the PROMIS 29-Item Profile at preoperative, pre-pandemic postoperative, and during COVID-19

Outcome Measure	Mean ± Standard Deviation				P value ¹
	Preoperative	Last pre-COVID-19 Postoperative	COVID-19	Change from Last pre-COVID-19 postoperative to COVID-19	
Worst pain rating					
Back	7.6 ± 2.5	4.4 ± 3.1	5.4 ± 3.2	0.57 ± 3.0	.027
Leg	6.5 ± 3.3	3.3 ± 3.2	4.4 ± 3.4	0.74 ± 3.4	.013
Neck	5.8 ± 3.1	4.0 ± 2.8	3.2 ± 3.1	-0.02 ± 2.8	.962
Arm	4.6 ± 3.4	2.9 ± 3.0	3.4 ± 3.1	0.10 ± 2.6	.756
PROMIS health domain					
Pain interference	65 ± 7.9	59 ± 9.2	60 ± 10	0.84 ± 10	.303
Physical function	36 ± 7.2	39 ± 8.7	40 ± 9.3	-2.4 ± 7.5	<.001
Fatigue	55 ± 10.0	52 ± 10	48 ± 12	3.7 ± 9.6	<.001
Anxiety	53 ± 9.6	49 ± 9.9	50 ± 9.4	0.64 ± 12	.510
Depression	51 ± 8.9	49 ± 9.1	48 ± 8.8	0.29 ± 8.0	.662
Sleep disturbance	55 ± 8.7	52 ± 9.5	53 ± 9.7	0.62 ± 8.4	.365
Satisfaction with participation in social roles	42 ± 8.7	44 ± 10	46 ± 11	-1.9 ± 11	.048

COVID-19, coronavirus disease 2019; PROMIS, Patient-Reported Outcome Measurement Information System.

¹ P-value reflects change from last postoperative to COVID-19 assessment

ing COVID-19 compared with those who had low patient activation (p=.031; Table 4).

Discussion

Access to basic resources

Virus mitigation and containment policies have had a profound effect on the US economy, resulting in widespread unemployment and financial hardship [23]. Furthermore, there appears to be a direct relationship between financial hardship and chronic back pain [24]. Approximately 16% of our cohort attributed loss of income to the COVID-19 crisis, and 16% reported having difficulty affording basic resources. Drawing from data from the Urban Institute’s Health Reform Monitoring Survey, Karpman et al. [23] showed that more than 40% of non-elderly US adults

reported job loss, decreased work hours, or decrease in work-related income, with one-third of adults reporting that their families experienced serious financial hardships because of the COVID-19 pandemic. Furthermore, they found higher rates of financial hardship in low-income and racial/ethnic minority populations.

A previous study reported patients deferring or forgoing routine medical care because of fear of COVID-19 [25]. This parallels behavior seen during the 2002–2004 severe acute respiratory syndrome (SARS) pandemic, which caused high burdens of disease of chronic conditions in its aftermath [26]. Approximately half of our cohort reported canceling medical appointments because of COVID-19: 14% canceled musculoskeletal follow-up appointments, 8% canceled pain management appointments, and 17% canceled rehabilitation or physical therapy appointments. A small fraction of respondents reported difficulty obtaining their medications, most commonly opioid pain medications.

Table 4

Quality-of-life outcomes, as measured by Patient-Reported Outcomes Measurement Information System 29 Health Profile, stratified by psychological distress and patient activation levels for 296 patients who had undergone spine surgery

Parameter	Pain Interference		Physical Function		Fatigue		Sleep Disturbance		Satisfaction with Social Roles	
	Mean (SE)	p-value	Mean (SE)	p-value	Mean (SE)	p-value	Mean (SE)	p-value	Mean (SE)	p-value
Gender										
Male	Referent		Referent		Referent		Referent		Referent	
Female	2.8 (0.97)	0.004	-3.2 (0.96)	<0.001	2.4 (1.1)	0.039	2.0 (0.95)	0.036	-3.2 (1.1)	0.002
Psychological distress										
None	Referent		Referent		Referent		Referent		Referent	
Anxiety	2.6 (1.3)	0.050	-3.2 (1.2)	0.008	2.4 (1.6)	0.136	2.4 (1.6)	0.126	-2.5 (1.2)	0.034
Depression	5.8 (1.3)	<0.001	-3.1 (1.5)	0.037	7.1 (1.8)	<0.001	4.1 (1.8)	0.019	-7.5 (1.4)	<0.001
Patient activation										
Low	Referent		Referent		Referent		Referent		Referent	
High	0.79 (1.2)	0.502	0.04 (0.95)	0.997	3.0 (1.3)	0.025	1.6 (1.2)	0.199	1.6 (1.3)	0.209
Assessment timepoint										
Preoperative	Referent		Referent		Referent		Referent		Referent	
Pre-pandemic ¹	-6.5 (0.83)	<0.001	5.0 (0.71)	<0.001	-4.0 (0.78)	<0.001	-4.0 (0.83)	<0.001	4.6 (0.95)	<0.001
COVID-19	-8.0 (0.84)	<0.001	5.5 (0.67)	<0.001	-4.4 (0.79)	<0.001	-3.9 (0.76)	<0.001	6.1 (0.85)	<0.001
Assessment interaction										
High patient activation × pre-pandemic*	-3.0 (1.4)	0.038	3.6 (1.2)	0.003	-1.8 (1.4)	0.201	-1.9 (1.6)	0.248	2.2 (1.6)	0.169
High patient activation × COVID-19	-2.2 (1.7)	0.188	2.7 (1.2)	0.031	0.22 (1.5)	0.889	-0.98 (1.6)	0.544	2.3 (1.8)	0.210

COVID-19, coronavirus disease 2019; SE, standard error.

* Pre-pandemic refers to the last pre-COVID-19 postoperative assessment completed.

Pain and HRQoL

Reduction of pain and improvement in functional status are two of the most important reasons patients undergo spine surgery, and most patients report postoperative improvements in pain and physical function [27]. It is well known that psychological, social, and environmental factors can affect a patient's perception of pain [24,28]. However, it is unclear how rapid changes in these factors, as have occurred during the COVID-19 pandemic, affect the durability of postoperative pain relief and functional improvements. In the current study, average pain scores for the back and legs worsened significantly, whereas neck and arm pain scores did not change significantly between respondents' latest clinic visit and the onset of the COVID-19 pandemic.

Prior research has demonstrated the link between increased walking during post-operative recovery and higher odds of meaningful improvement in back and leg pain [29]. It is probable that, given pandemic restrictions on non-essential activities, walking and similar activities were curtailed among these patients. PROMIS pain, physical function, fatigue, anxiety, depression, sleep, satisfaction with participation in social roles and activities, and cognitive function scores were not significantly different before versus after the onset of the pandemic. The lack of impact on measures of HRQoL is in contrast with literature from other medical fields that show increased symptoms of anxiety among patients with thyroid cancer [30] and lower mental health scores among patients who had experienced COVID-19 infection [31]. Our population reported low rates of COVID-19 exposure or infection (3.9% and 1%, respectively). In addition, aside from age, they had few risk factors associated at the time with worse prognosis. These may have alleviated the mental health impact of the COVID-19 pandemic.

A notable consequence of public health protection measures is the effect on public mental health. Röhr et al [32] noted that quarantine measures were associated with negative psychosocial outcomes, including depression, anxiety, anger, stress, social isolation, and loneliness [32,33]. Although most respondents in the current study reported feeling socially isolated, they still reported a "somewhat" or "very" good quality of life, demonstrating resilience.

Psychological distress

A systematic review demonstrated that one-third of spine surgery patients experience symptoms of preoperative anxiety and depression, and that the presence of these symptoms is an important predictor of greater pain, physical impairment, and lower HRQoL in patients undergoing spine surgery [34]. The high number of respondents reporting symptoms of anxiety and depression before surgery observed in the current study is consistent with other published reports [8, 9, 21, 33] of psychological distress in spine patients.

Prior studies have documented increased psychological distress during previous epidemics or pandemics, including Ebola virus disease in 2014 [35,36] and severe acute respiratory syndrome (SARS) in 2003 [37]. Psychological distress during the COVID-19 pandemic has been shown to negatively affect health, leading to greater pain severity in patients with chronic pain [38,39] and reduction in patients with musculoskeletal conditions [40]. Our study suggests that individuals with psychological distress, especially depression, experience more detrimental impact on their pain and their satisfaction with participation in social roles compared with those without psychological distress as a response to the external stress of COVID-19.

Patient activation

High patient activation has been associated with an individual's propensity to engage in adaptive health behavior that leads to improved outcomes and has been implicated as a positive prognostic factor in patient recovery [8,27,33]. High patient activation not only helps patients take responsibility for their health, but may also predict their social involvement and connection during the pandemic. Our findings suggest that high patient activation may alleviate the disruptive effects of external stress caused by the COVID-19 pandemic on patients' ability to perform usual activities. Patients who endorsed high patient activation before surgery experienced less disruption in physical function during the pandemic compared to those with low patient activation.

This difference may be related to the ability of those with high patient activation being able to "ride out" the negative impact of the pandemic on their ability to manage their spine condition. The relation-

ship between patient activation and the disruptive effects of external stress may provide an opportunity for healthcare providers and systems to support patients during stressful times. In a study of patients managing various chronic conditions, those experiencing greater COVID-19 related worry or fear about self-management had lower patient activation [41]. Our prior work demonstrated the ability of a telephone-based Health Behavior Change Counseling (HBCC) to improve patient activation and lead to greater health outcomes at one year following spine surgery [10,42,43]. Employing interventions such as HBCC may provide beneficial support for patients in symptom management, especially for those whom in-person healthcare access may be limited either by geography, access, or concern over pandemic exposure.

Limitations

Our study has several limitations. First, it is a single-center study conducted at a large academic tertiary care hospital; thus, results may not be generalizable to other care settings. Compared with other care settings, patients who present to a tertiary care hospital may have more advanced spine disease or comorbid conditions and may require more invasive surgical intervention. However, the demographic and clinical characteristics of our patient population are similar to published data from the Spine Patient Outcomes Research Trial, which encompassed 13 medical centers across 11 states [44–46]. Second, our survey of COVID-19 impact and assessments of pain and quality of life were collected using an internet platform, and our findings may be biased by selection. Certain individual characteristics may lead a patient to answer our survey. For example, those whose access to basic resources and healthcare has been severely disrupted may be less willing or able to access an internet-based survey. By not including their information, we may not provide the true scope of disruption from the public health measures meant to mitigate the spread of COVID-19. However, we did demonstrate associations of psychological distress and patient activation with recovery after spine surgery. Despite these limitations, this study provides a descriptive overview of the impact of the COVID-19 pandemic on spine surgery patients that can guide healthcare providers and health systems in building support for patients who may be vulnerable to these consequences because of their psychological distress or low patient activation.

Conclusions

Although many patients experienced worsening of pain and HRQoL, those patients with pre-existing psychological distress were more likely to experience worsening that met or exceeded the MCID for a worsened health state. Conversely, those who had high patient activation experienced significantly less negative effect on physical function as a result of the COVID-19 pandemic compared with those who had low patient activation. These findings are important because they can enable the identification of patients who may be more or less susceptible to the negative effects that external stressors can have on health. Through identification of these at-risk patients, healthcare providers and systems can better support these patients through times of difficulty.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Funding statement

This research was supported by NIH National Institute on Aging under Award number P01AG066603.

Summary sentence

Spine patients with psychological distress have worse pain & HRQoL during the COVID19 pandemic, but patient activation mitigates this impact

Acknowledgments

For her editorial assistance, we thank Rachel Box, MS, in the Editorial Services group of The Johns Hopkins Department of Orthopaedic Surgery.

References

- [1] Times TNY. Coronavirus in the U.S. Latest map and case count. *The New York Times*; 2020.
- [2] Stress in America™ 2020: A National Mental Health Crisis 2020.
- [3] Aalto TJ, Malmivaara A, Kovacs F, Herno A, Alen M, Salmi L, et al. Preoperative predictors for postoperative clinical outcome in lumbar spinal stenosis: systematic review. *Spine (Phila Pa 1976)* 2006;31:E648–63. doi:10.1097/01.brs.0000231727.88477.da.
- [4] Hibbard JH, Stockard J, Mahoney ER, Tusler M. Development of the Patient Activation Measure (PAM): conceptualizing and measuring activation in patients and consumers. *Health Serv Res* 2004;39:1005–26. doi:10.1111/j.1475-6773.2004.00269.x.
- [5] Pakarinen M, Tuomainen I, Koivumaa-Honkanen H, Sinikallio S, Lehto SM, Airaksinen O, et al. Life dissatisfaction is associated with depression and poorer surgical outcomes among lumbar spinal stenosis patients: a 10-year follow-up study. *Int J Rehabil Res* 2016;39:291–5. doi:10.1097/MRR.0000000000000182.
- [6] Skeppholm M, Fransson R, Hammar M, Olerud C. The association between preoperative mental distress and patient-reported outcome measures in patients treated surgically for cervical radiculopathy. *Spine J* 2017;17:790–8. doi:10.1016/j.spinee.2016.02.037.
- [7] Tuomainen I, Pakarinen M, Aalto T, Sinikallio S, Kröger H, Viinamäki H, et al. Depression is associated with the long-term outcome of lumbar spinal stenosis surgery: a 10-year follow-up study. *Spine J* 2018;18:458–63. doi:10.1016/j.spinee.2017.08.228.
- [8] Skolasky RL, Mackenzie EJ, Wegener ST, Riley LH III. Patient activation and adherence to physical therapy in persons undergoing spine surgery. *Spine (Phila Pa 1976)* 2008;33:E784–91.
- [9] Skolasky RL, Maggard AM, Li D, Riley LH III, Wegener ST. Health behavior change counseling in surgery for degenerative lumbar spinal stenosis. Part I: Improvement in rehabilitation engagement and functional outcomes. *Arch Phys Med Rehabil* 2015;96:1200–7. doi:10.1016/j.apmr.2015.03.009.
- [10] Skolasky RL, Maggard AM, Wegener ST, Riley LH III. Telephone-based intervention to improve rehabilitation engagement after spinal stenosis surgery. A prospective lagged controlled trial. *J Bone and Joint Surg Am* 2018;100:21–30.
- [11] Block AR, Marek RJ, Ben-Porath YS. Patient activation mediates the association between psychosocial risk factors and spine surgery results. *J Clin Psychol Med Settings* 2019;26:123–30. doi:10.1007/s10880-018-9571-x.
- [12] Charlson M, Szatrowski TP, Peterson J, Gold J. Validation of a combined comorbidity index. *J Clin Epidemiol* 1994;47:1245–51. doi:10.1016/0895-4356(94)90129-5.
- [13] Charlson ME, Pompei P, Ales KL, MacKenzie CR. A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. *J Chronic Dis* 1987;40:373–83. doi:10.1016/0021-9681(87)90171-8.
- [14] Rassa FS, McFadden M, Aaron RV, Wegener ST, Ephraim PL, Lane E, et al. The relationship between neighborhood deprivation and perceived changes for pain-related experiences among U.S. patients with chronic low back pain during the COVID-19 pandemic. *Pain Med* 2021;pnab179. doi:10.1093/pm/pnab179.
- [15] Farrar JT, Berlin JA, Strom BL. Clinically important changes in acute pain outcome measures: a validation study. *J Pain Symptom Manage* 2003;25:406–11. doi:10.1016/s0885-3924(03)00162-3.
- [16] MacDowall A, Skeppholm M, Robinson Y, Olerud C. Validation of the visual analog scale in the cervical spine. *J Neurosurg Spine* 2018;28:227–35. doi:10.3171/2017.5.SPINE1732.
- [17] Purvis TE, Andreou E, Neuman BJ, Riley LH III, Skolasky RL. Concurrent validity and responsiveness of PROMIS health domains among patients presenting for anterior cervical spine surgery. *Spine (Phila Pa 1976)* 2017;42:e1357–65.
- [18] Purvis TE, Neuman BJ, Riley LH III, Skolasky RL. Discriminant ability, concurrent validity, and responsiveness of PROMIS health domains among patients with lumbar degenerative disease undergoing decompression with or without arthrodesis. *Spine (Phila Pa 1976)* 2018;43:1512–20.
- [19] Raad M, Jain A, Huang M, Skolasky RL, Sciubba DM, Kebaish KM, et al. Validity and responsiveness of PROMIS in adult spinal deformity: the need for a self-image domain. *Spine J* 2019;19:50–5. doi:10.1016/j.spinee.2018.07.014.
- [20] Purvis TE, Neuman BJ, Riley LH III, Skolasky RL. Comparison of PROMIS anxiety and depression, PHQ-8, and GAD-7 to screen for anxiety and depression among patients presenting for spine surgery. *J Neurosurg Spine* 2019;30:524–31.
- [21] Hibbard JH, Mahoney ER, Stockard J, Tusler M. Development and testing of a short form of the patient activation measure. *Health Serv Res* 2005;40:1918–30. doi:10.1111/j.1475-6773.2005.00438.x.
- [22] Hibbard JH, Tusler M. Assessing activation stage and employing a “next steps” approach to supporting patient self-management. *J Ambul Care Manage* 2007;30:2–8. doi:10.1097/00004479-200701000-00002.

- [23] Karpman M, Zuckerman S, Gonzalez D, Kenney GM. The COVID-19 Pandemic Is Straining Families' Abilities to Afford Basic Needs. Urban Institute 2020. <https://www.urban.org/research/publication/covid-19-pandemic-straining-families-abilities-afford-basic-needs> (accessed December 30, 2020).
- [24] Yang H, Haldeman S. Chronic spinal pain and financial worries in the US adult population. *Spine (Phila Pa 1976)* 2020;45:528–33. doi:10.1097/BRS.0000000000003319.
- [25] Kittleson MM. The invisible hand - medical care during the pandemic. *N Engl J Med* 2020;382:1586–7. doi:10.1056/NEJMp2006607.
- [26] Huang Y-T, Lee Y-C, Hsiao C-J. Hospitalization for ambulatory-care-sensitive conditions in Taiwan following the SARS outbreak: a population-based interrupted time series study. *J Formos Med Assoc* 2009;108:386–94. doi:10.1016/S0929-6646(09)60082-6.
- [27] Skolasky RL, Mackenzie EJ, Wegener ST, Riley LH III. Patient activation and functional recovery in persons undergoing spine surgery. *J Bone Joint Surg Am* 2011;93:1665–71.
- [28] Piraccini E, Byrne H, Taddei S. Chronic pain management in COVID-19 era. *J Clin Anesth* 2020;65:109852. doi:10.1016/j.jclinane.2020.109852.
- [29] Master H, Pennings JS, Coronado RA, Bley J, Robinette PE, Haug CM, et al. How many steps per day during the early postoperative period are associated with patient-reported outcomes of disability, pain, and opioid use after lumbar spine surgery? *Arch Phys Med Rehabil* 2021;102:1873–9. doi:10.1016/j.apmr.2021.06.002.
- [30] Graves CE, Goyal N, Levin A, Nuño MA, Kim J, Campbell MJ, et al. Anxiety during the COVID-19 pandemic: a web-based survey of thyroid cancer survivors. *Endocr Pract* 2022 S1530-891X(22)00002-7. doi:10.1016/j.eprac.2022.01.002.
- [31] Lapin B, Katzan IL. Health-related quality of life mildly affected following COVID-19: a retrospective pre-post cohort study with a propensity score-matched control group. *J Gen Intern Med* 2022. doi:10.1007/s11606-021-07340-0.
- [32] Röhr S, Müller F, Jung F, Apfelbacher C, Seidler A, Riedel-Heller SG. [Psychosocial Impact of Quarantine Measures During Serious Coronavirus Outbreaks: A Rapid Review]. *Psychiatr Prax* 2020;47:179–89. doi:10.1055/a-1159-5562.
- [33] Skolasky RL, Riley LH III, Maggard AM, Bedi S, Wegener ST. Functional recovery in lumbar spine surgery: a controlled trial of health behavior change counseling to improve outcomes. *Contemp Clin Trials* 2013;36:207–17. doi:10.1016/j.cct.2013.06.018.
- [34] Strøm J, Bjerrum MB, Nielsen CV, Thisted CN, Nielsen TL, Laursen M, et al. Anxiety and depression in spine surgery—a systematic integrative review. *Spine J* 2018;18:1272–85. doi:10.1016/j.spinee.2018.03.017.
- [35] Greenberg N, Wessely S, Wykes T. Potential mental health consequences for workers in the Ebola regions of West Africa—a lesson for all challenging environments. *J Ment Health* 2015;24:1–3. doi:10.3109/09638237.2014.1000676.
- [36] Mohammed A, Sheikh TL, Gidado S, Poggensee G, Nguku P, Olayinka A, et al. An evaluation of psychological distress and social support of survivors and contacts of Ebola virus disease infection and their relatives in Lagos, Nigeria: a cross sectional study—2014. *BMC Public Health* 2015;15:824. doi:10.1186/s12889-015-2167-6.
- [37] Maunder RG, Lancee WJ, Balderson KE, Bennett JP, Borgundvaag B, Evans S, et al. Long-term Psychological and Occupational Effects of Providing Hospital Healthcare during SARS Outbreak. *Emerg Infect Dis* 2006;12:1924–32. doi:10.3201/eid1212.060584.
- [38] Serrano-Ibáñez ER, Esteve R, Ramírez-Maestre C, Ruiz-Párraga GT, López-Martínez AE. Chronic pain in the time of COVID-19: Stress aftermath and central sensitization. *Br J Health Psychol* 2021;26:544–52. doi:10.1111/bjhp.12483.
- [39] Fujiwara A, Watanabe K, Ida M, Kawanishi H, Kimoto K, Yoshimura K, et al. The short-term effect of COVID-19 pandemic on disability, pain intensity, psychological status, and exercise habits in patients with chronic pain. *J Anesth* 2021. doi:10.1007/s00540-021-02992-y.
- [40] Macfarlane GJ, Hollick RJ, Morton L, Heddl M, Bachmair E-M, Anderson RS, et al. The effect of COVID-19 public health restrictions on the health of people with musculoskeletal conditions and symptoms: the CONTAIN study. *Rheumatology (Oxford)* 2021;60:S113–24. doi:10.1093/rheumatology/keab374.
- [41] Imeri H, Holmes E, Desselle S, Rosenthal M, Barnard M. The impact of the COVID-19 pandemic on self-reported management of chronic conditions. *J Patient Exper* 2021;8 23743735211007692. doi:10.1177/23743735211007693.
- [42] Skolasky RL, Maggard AM, Li D, Riley LH, Wegener ST. Health behavior change counseling in surgery for degenerative lumbar spinal stenosis. Part I: improvement in rehabilitation engagement and functional outcomes. *Arch Phys Med Rehabil* 2015;96:1200–7. doi:10.1016/j.apmr.2015.03.009.
- [43] Skolasky RL, Maggard AM, Li D, Riley LH, Wegener ST. Health behavior change counseling in surgery for degenerative lumbar spinal stenosis. Part II: patient activation mediates the effects of health behavior change counseling on rehabilitation engagement. *Arch Phys Med Rehabil* 2015;96:1208–14. doi:10.1016/j.apmr.2015.02.031.
- [44] Weinstein JN, Lurie JD, Tosteson TD, Tosteson ANA, Blood EA, Abdu WA, et al. Surgical versus nonoperative treatment for lumbar disc herniation: four-year results for the Spine Patient Outcomes Research Trial (SPORT). *Spine (Phila Pa 1976)* 2008;33:2789–800. doi:10.1097/BRS.0b013e31818ed8f4.
- [45] Pearson A, Blood E, Lurie J, Tosteson T, Abdu WA, Hillibrand A, et al. Degenerative spondylolisthesis versus spinal stenosis: does a slip matter? Comparison of baseline characteristics and outcomes (SPORT). *Spine (Phila Pa 1976)* 2010;35:298–305. doi:10.1097/BRS.0b013e3181bdafd1.
- [46] Weinstein JN, Lurie JD, Tosteson TD, Zhao W, Blood EA, Tosteson ANA, et al. Surgical compared with nonoperative treatment for lumbar degenerative spondylolisthesis. four-year results in the Spine Patient Outcomes Research Trial (SPORT) randomized and observational cohorts. *J Bone Joint Surg Am* 2009;91:1295–304. doi:10.2106/JBJS.H.00913.