Original Article

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Personal Health of Spine Surgeons Can Impact Perceptions, Decision-Making and Healthcare Delivery During the COVID-19 Pandemic - A Worldwide Study

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Objective: To determine if personal health of spine surgeons worldwide influences perceptions, healthcare delivery, and decision-making during the coronavirus disease 2019 (COVID-19) pandemic.

Methods: A cross-sectional study was performed by distributing a multidimensional survey to spine surgeons worldwide. Questions addressed demographics, impacts and perceptions of COVID-19, and the presence of surgeon comorbidities, which included cancer, cardiac disease, diabetes, obesity, hypertension, respiratory illness, renal disease, and current tobacco use. Multivariate analysis was performed to identify specific comorbidities that influenced various impact measures.

Results: Across 7 global regions, 36.8% out of 902 respondents reported a comorbidity, of which hypertension (21.9%) and obesity (15.6%) were the most common. Multivariate analysis noted tobacco users were more likely to continue performing elective surgery during the pandemic (odds ratio [OR], 2.62; 95% confidence interval [CI], 1.46–4.72; p = 0.001) and were less likely to utilize telecommunication (OR, 0.51; 95% CI, 0.31–0.86; p = 0.011), whereas those with hypertension were less likely to warn their patients should the surgeon become infected with COVID-19 (OR, 0.57; 95% CI, 0.37–0.91; p = 0.017). Clinicians with multiple comorbidities were more likely to cite personal health as a current stressor (OR, 1.32; 95% CI, 1.07–1.63; p = 0.009) and perceived their hospital's management unfavorably (OR, 0.74; 95% CI, 0.60–0.91; p = 0.005).

Conclusion: This is the first study to have mapped global variations of personal health of spine surgeons, key in the development for future wellness and patient management initiatives. This study underscored that spine surgeons worldwide are not immune to comorbidities, and their personal health influences various perceptions, healthcare delivery, and decision-making during the COVID-19 pandemic.

Keywords: COVID-19, Coronavirus, Spine, Surgeon, Health, Burnout

INTRODUCTION

The novel coronavirus disease 2019 (COVID-19) has affected both patients and healthcare providers around the world. The current healthcare landscape has changed, and healthcare delivery has molded to provide care to patients who otherwise would not receive it during these times.[1,2] However, despite our greatest efforts, the effects of COVID-19 have persisted, and the spine surgery community is not exempt. A recent study by Louie et al.[3] revealed the worldwide impact of COVID-19 on clinical practice, income, personal life, research, resident and fellow training, and anxiety levels among spine surgeons.

While many physicians have halted their surgical practices in lieu of restrictions on elective surgeries and face-to-face encounters, thousands of physicians, including spine surgeons, have found themselves at the front-line managing patients in the intensive care unit (ICU) and medical wards.[4,5] Worried that they themselves may become infected with COVID-19, physicians and other healthcare providers have become filled with fear. COVID-19 specifically affects the respiratory system, and can induce a pneumonia and chronic fibrosis with long-term sequelae, and may even lead to death.[6] Contrary to popular belief, physicians are fraught with cardiopulmonary and other comorbidities that increase the risk of complications from COVID-19.[7]

Several studies have noted physician burnout and mental health consequences.[8-10] However, there is limited evidence highlighting the physical health of spine surgeons. As physicians are finding themselves treating patients with COVID-19, the importance of physician health becomes even more relevant. Furthermore, as spine practices slowly return to normalcy, there is little understanding of how the health of spine surgeons will be affected, and how such health status influences spine surgery healthcare delivery in the age of COVID-19. Therefore, the authors aimed to examine the health disparities of spine surgeons around the world, and how their health influences their perspectives, healthcare delivery, and decision-making during the COVID-19 pandemic.

MATERIALS AND METHODS

1. Survey Design and Content

A survey, known as the AO Spine COVID-19 and Spine Surgeon Global Impact Survey, was developed to obtain representation from various global regions. Both multiple-choice and free-text questions were created based on input from multiple authors utilizing a Delphi method as previously reported.[3] Ques-

tions were structured to capture relevant components including: demographics, perceptions related to COVID-19, and the associated financial impacts, as well as future predictions. Comorbidities surveyed included cancer, cardiac disease, diabetes, obesity, hypertension, respiratory illness, renal disease, and current tobacco use.

2. Survey Distribution

Utilizing a secure email distribution method, the 73-item survey was administered to all AO Spine members who agreed to receive surveys, approximately 3,805 individuals. The survey recipients were provided 9 days to complete the survey (March 27, 2020 to April 4, 2020). Participants were notified of their willingness to contribute and that the information gained would be confidentially analyzed and published. Respondents were able to omit responses, and several questions allowed for multiple responses, altering the total number of responses to be less than or more than the total respondents.

3. Statistical Analyses

All statistical analyses were performed with Stata ver. 13.1 (StataCorp LC, College Station, TX, USA) with graphical representation of comorbidity distribution using RStudio v1.2.1335 (RStudio Inc, Boston, MA, USA). Survey findings were collected for each respondent and summarized using count data and percentage calculations. Medical comorbidities were then tabulated for each respondent, allowing stratification of the cohort into groups based upon the number of concomitant diagnoses (1, 2, 3, or more comorbidities, and no comorbidities). All comorbidity findings were then assessed using a combination of chi-square and Fisher exact tests to determine relevance with other collected survey responses.

Multivariate models were then derived to further assess the significance of comorbidities, controlling for age, sex, specialty, and practice type. All model covariates were selected and agreed upon by the senior coauthors due to the potential for confounding with assessed survey responses and comorbidity status. Multivariate logistic regression analysis was performed for binary outcome survey queries while multivariate ordinal logistic regression was performed for questions including ordinal scales. Odds ratios (ORs), 95% confidence intervals (CIs), and p-values were then calculated for each covariate and used to further assess comorbidity significance. ORs greater than 1 suggest that the assessed variable increases the likelihood of a particular response, whereas those less than 1 suggest a lower response. ORs equal to 1 indicate that the variable has no effect on either in-

Table 1. Medical comorbidity demographics

Variable	Overall No.	Overall %	Africa No.	Africa %	Asia No.	Asia %	Australia No.	Australia %	Europe No.	Europe %	Middle East No.	Middle East %	North America No.	North America %	South America/Latin America No.	South America/Latin America %	p-value
Age (yr)																	
25–34	127	14.4	5	11.4	28	13.2	0	0.0	29	12.0	16	20.8	28	18.5	21	14.5	0.017*
35–44	338	38.4	21	47.7	66	31.0	1	12.5	97	40.1	25	32.5	63	41.7	65	44.8	
45–54	241	27.4	11	25.0	73	34.3	3	37.5	66	27.3	22	28.6	32	21.2	34	23.5	
55–64	149	16.9	5	11.4	44	20.7	4	50.0	42	17.4	14	18.2	20	13.3	20	13.8	
65+	25	2.8	2	4.6	2	0.9	0	0.0	8	3.3	0	0.0	8	5.3	5	3.5	
Sex																	
Male	812	93.8	42	100.0	203	95.8	8	100.0	213	91.0	74	96.1	140	94.0	132	91.7	0.144
Female	54	6.2	0.0	0.0	9	4.3	0	0.0	21	9.0	3	3.9	9	6.0	12	8.3	
Specialty																	
Orthopaedics	625	71	35	79.6	178	83.6	5	62.5	151	62.4	54	71.1	115	75.7	87	60.0	<0.001*
Neurosurgery	244	27.7	8	18.2	36	16.9	2	25.0	85	35.1	19	25.0	38	25.0	56	38.6	
Trauma	102	11.6	5	11.4	18	8.5	0	0.0	54	22.3	9	11.8	2	1.3	14	9.7	
Other	52	5.9	2	4.6	13	6.1	2	25.0	18	7.4	8	10.5	4	2.6	5	3.5	
Practice type																	
Academic/private combined	198	22.5	13	29.6	29	13.6	4	50.0	47	19.4	28	36.4	23	15.1	54	37.2	<0.001*
Academic	400	45.4	20	45.5	127	59.6	1	12.5	115	47.5	23	29.9	91	59.9	23	15.9	
Private	142	16.1	7	15.9	26	12.2	1	12.5	20	8.3	15	19.5	30	19.7	43	29.7	
Public/local hospital	137	15.6	4	9.1	30	14.1	2	25.0	59	24.4	11	14.3	7	4.6	24	16.6	
Comorbidity																	
Obesity	102	15.6	7	24.1	23	15.5	0	0.0	26	13.9	16	31.4	8	6.3	22	20.8	<0.001*
Hypertension	155	21.9	10	31.3	36	22.4	0	0.0	34	17.4	18	34.0	20	14.3	37	30.6	0.003*
Current tobacco use	75	11.9	2	8.3	32	20.4	0	0.0	23	12.5	7	16.7	2	1.6	9	9.7	<0.001*
Respiratory illness	35	6.0	3	12.0	5	3.9	1	14.3	9	5.3	2	5.4	6	4.8	9	9.7	0.390
Renal disease	5	0.9	1	4.4	2	1.6	0	0.0	1	0.6	0	0.0	1	0.8	0	0.0	0.541
Cancer	4	0.7	0	0.0	2	1.6	0	0.0	1	0.6	0	0.0	1	0.8	0	0.0	0.878
Cardiac disease	25	4.3	3	12.0	4	3.1	1	14.3	7	4.2	2	5.4	3	2.4	5	5.6	0.300
Diabetes	44	7.4	5	18.5	19	13.2	0	0.0	3	1.8	9	20.5	2	1.6	6	6.7	<0.001*
1 Comorbidity	250	31.1	15	40.5	68	35.2	2	25.0	65	28.8	31	47.0	24	16.7	45	34.9	<0.001*
2 Comorbidities	63	10.2	6	21.4	15	10.7	0	0.0	12	6.9	10	22.2	6	4.8	14	14.3	0.003*
3+ Comorbidities	15	2.6	1	4.4	5	3.9	0	0.0	4	2.4	1	2.8	2	1.6	2	2.3	0.945
No comorbidities	553	62.8	22	50.0	125	58.7	6	75.0	161	66.5	35	45.5	120	79.0	84	57.9	<0.001*

Calculation of p-values was performed using a combination of chi-square and Fisher exact tests.
*p<0.05, statistical significance.

creasing or decreasing the likelihood of a given answer. Statistical significance was set at $p < 0.05$ and p-values were assessed for precision.

RESULTS

Of all spine surgeons surveyed, 902 participated, providing distinct data across 91 countries and 7 global regions affected by COVID-19. Detailed demographic results of the surveyed cohort have been previously published and reported by Louie et al.[3] Specifically, Table 1 presents the significant differences in age, specialty, and hospital practice type between regions. Roughly 36.8% of surgeons have at least 1 medical comorbidity, with hypertension (21.9%) and obesity (15.6%) being the most commonly reported. Further, some surgeons suffer from additional medical burden, with 10.2% and 2.6% reporting 2 and 3 or more comorbidities, respectively. Overall, despite these findings, most survey respondents are currently healthy (62.8%). There was also a significant difference in the prevalence of obesity, hypertension, tobacco use, diabetes, and the number of comorbidities between regions ($p < 0.05$) (Fig. 1).

When compared to healthy individuals, surgeons with specific comorbidities demonstrated significant variations in reported perceptions and stressors during the COVID-19 pandemic (Table 2). Surgeons suffering from obesity, hypertension, cardiac disease, and 1 or 2 comorbidities had significant concern about their personal health, whereas those diagnosed with cancer and respiratory illnesses were more concerned with return to nonessential activities and economic issues, respectively. Respondents with no comorbidities, hypertension, or 1 comorbidity were also more concerned with the timeline to resume clinical practice. A diagnosis of renal disease did not influence COVID-19 perceptions. Those with 3 or more comorbidities had the greatest influence on being personally diagnosed with COVID-19. Lastly, a diagnosis of cancer was associated with being quarantined ($p = 0.007$), though comorbidities otherwise had no association with institutional or governmental perceptions (Table 2).

There was also significant variation in those performing elective cases during the COVID-19 pandemic when comparing practitioners with and without comorbidities (any comorbidity: $p = 0.006$; 1 comorbidity: $p = 0.003$) (Table 3). There was also significant variation in respondents with diabetes and how they would warn their patients if they tested positive for COVID-19 ($p = 0.026$). Further, when compared to healthy clinicians, those with comorbidities ($p = 0.031$) or hypertension reported signifi-

cant differences on impacted research productivity. Finally, regarding the implementation of specific surgical precaution, those with one or more comorbidities (any comorbidity: $p = 0.014$; 1 comorbidity: $p = 0.033$), hypertension ($p = 0.020$), tobacco use ($p = 0.030$), or cardiac disease ($p = 0.049$) had significant variation in whether they would be absent during patient intubation/extubation, while those with 1 comorbidity varied in their opinions to proceed with standard precautions ($p = 0.036$). There was no significant association between medical comorbidities
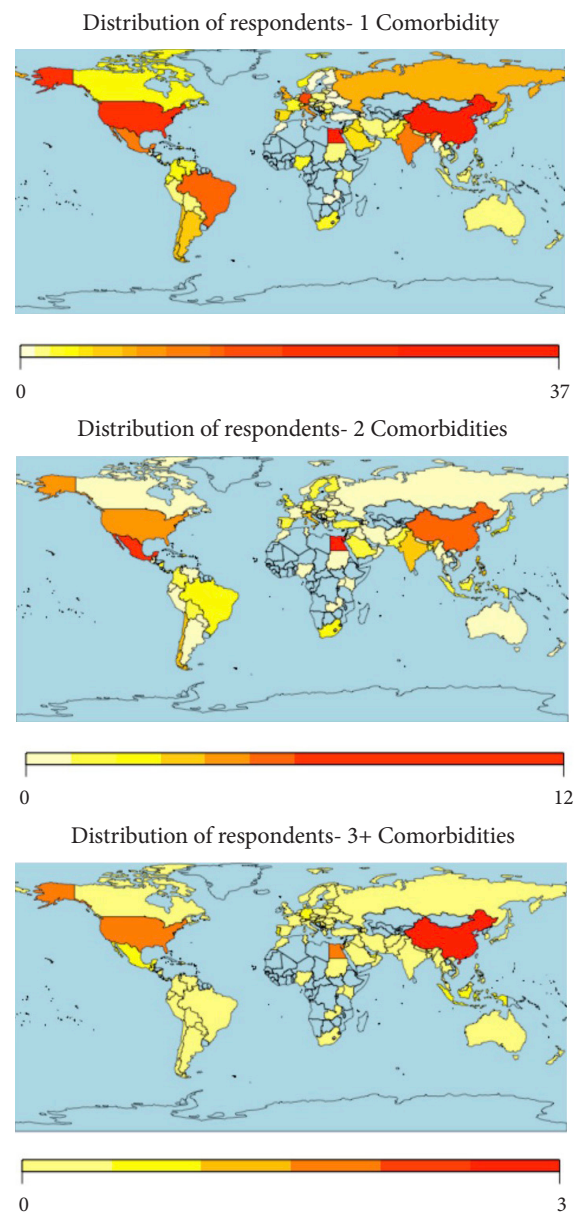

Fig. 1. Geographical distribution of spine surgeons reporting medical comorbidities. Coloring of maps based on number of respondents with specified comorbidities.

Table 2. Medical comorbidities and association with COVID-19 perceptions

Variable	Obesity			Hypertension			Current tobacco use			Respiratory illness			Renal disease		
	No.	%	p-value	No.	%	p-value	No.	%	p-value	No.	%	p-value	No.	%	p-value
COVID-19 diagnosis															
Know someone diagnosed	41	14.2	0.519	72	22.5	0.469	35	12.4	0.356	16	6.1	0.562	1	0.4	0.916
Personally diagnosed	3	37.5	0.079	1	16.7	0.781	1	16.7	0.665	0	0.0	0.592	0	0.0	0.892
COVID-19 testing															
Know how to get tested	74	14.2	0.067	122	21.4	0.943	55	11.0	0.626	26	5.5	0.927	1	0.2	0.210
Personally tested	6	13.0	0.641	7	14.9	0.254	1	2.4	0.065	3	7.0	0.648	0	0.0	0.688
Reason for testing															
Direct contact with COVID-19 positive patient	4	30.8	0.448	6	27.3	0.210	1	10.0	0.050	1	25.0	0.503	-	-	-
Prophylactic	2	15.4	0.300	1	4.6	0.679	2	20.0	0.158	0	0.0	0.585	-	-	-
Demonstrated symptoms	6	46.2	0.918	11	50.0	0.846	6	60.0	0.461	3	75.0	0.285	-	-	-
Ask to be tested	1	7.7	0.473	4	18.2	0.012*	1	10.0	0.329	0	0.0	0.704	-	-	-
Current stressors															
Personal health	49	50.0	0.035*	78	53.1	0.002*	27	39.7	0.866	15	48.4	0.280	1	50.0	0.742
Family health	76	77.6	0.597	115	78.2	0.425	50	73.5	0.786	25	80.7	0.482	2	100.0	0.415
Community health	36	36.7	0.120	61	41.5	0.422	34	50.0	0.456	9	29.0	0.078	1	50.0	0.892
Hospital capacity	44	44.9	0.573	65	44.2	0.605	26	38.2	0.570	11	35.5	0.485	0	0.0	0.231
Timeline to resume clinical practice	41	41.8	0.218	55	37.4	0.016*	29	42.7	0.355	11	35.5	0.156	0	0.0	0.170
Government/leadership	19	19.4	0.988	22	15.0	0.227	13	19.1	0.968	7	22.6	0.656	0	0.0	0.489
Return to nonessential activities	11	11.2	0.450	22	15.0	0.784	10	14.7	0.888	4	12.9	0.855	0	0.0	0.567
Economic issues	43	43.9	0.513	62	42.2	0.255	29	42.7	0.453	21	67.7	0.028*	0	0.0	0.180
Other	0	0.0	0.222	0	0.0	0.135	0	0.0	0.309	1	3.2	0.456	0	0.0	0.861
Media perceptions															
Accurate coverage	35	35.7	0.041*	73	50.0	0.394	35	51.5	0.881	13	41.9	0.416	1	50.0	0.775
Excessive coverage	53	54.1		54	37.0		21	30.9		14	45.2		1	50.0	
Not enough coverage	18	18.4		19	13.0		12	17.7		4	12.9		0	0.0	
Current media sources															
International news - internet	22	25.0	0.663	30	21.0	0.023*	20	31.3	0.693	6	20.0	0.971	0	0.0	0.856
International news - television	8	9.1		17	11.9		5	7.8		3	10.0		0	0.0	
National/local news - internet	25	28.4		29	20.3		20	31.3		11	36.7		1	50.0	
National/local news - television	21	23.9		43	30.1		9	14.1		6	20.0		1	50.0	
Newspaper	1	1.1		6	4.2		2	3.1		1	3.3		0	0.0	
Social media	11	12.5		18	12.6		8	12.5		3	10.0		0	0.0	
Quarantined	21	15.7	0.945	41.0	26.6	0.068	21	15.7	0.945	10.0	8.1	0.144	1	0.9	0.319
Perception of hospital effectiveness															
Acceptable/appropriate	46	52.3	0.216	86	60.1	0.570	31	48.4	0.188	18	60.0	0.283	0	0.0	0.141
Excessive/unnecessary	3	3.4		2	1.4		2	3.1		1	3.3		0	0.0	
Disarray/disorganized	13	14.8		10	7.0		9	14.1		0	0.0		0	0.0	
Not enough action	26	29.6		45	31.5		22	34.4		11	36.7		2	100.0	
Perception of government effectiveness															
Acceptable/appropriate	53	60.2	0.711	79	55.2	0.627	37	57.8	0.849	21	70.0	0.445	1	50.0	0.899
Excessive/unnecessary	1	1.1		4	2.8		3	4.7		0	0.0		0	0.0	
Disarray/disorganized	11	12.5		22	15.4		7	10.9		3	10.0		0	0.0	
Not enough action	23	26.1		38	26.6		17	26.6		6	20.0		1	50.0	

Table 2. Continued

No.	Cancer No.	%	p-value	Cardiac disease No.	%	p-value	Diabetes No.	%	p-value	1 Comorbidity No.	%	p-value	2 Comorbidities No.	%	p-value	3+ Comorbidities No.	%	p-value	No comorbidities No.	%	p-value
1	1	0.4	0.916	9	3.5	0.621	15	5.7	0.345	112	31.1	0.573	26	9.5	0.517	6	2.4	0.798	248	63.3	0.792
0	0	0.0	0.892	1	16.7	0.116	0	0.0	0.547	3	37.5	0.647	0	0.0	0.448	1	16.7	0.020*	5	55.6	0.608
2	2	0.5	0.526	17	3.7	0.245	33	6.9	0.824	199	30.8	0.532	45	9.2	0.038*	10	2.2	0.548	447	63.8	0.699
0	0	0.0	0.688	2	4.8	0.824	2	4.8	0.590	13	24.5	0.339	4	9.1	0.776	0	0.0	0.307	40	70.2	0.277
1	3	2.7	0.242	3	7.7	0.696	2	5.3	0.492	8	18.2	0.013*	5	12.2	0.820	-	-	-	36	73.5	0.045
0	1	0.0	0.784	1	14.3	0.387	1	14.3	0.481	5	45.5	0.328	1	14.3	0.799	-	-	-	6	50.0	0.357
0	0	0.0	0.342	2	4.7	0.496	2	4.7	0.330	24	36.9	0.252	3	6.8	0.201	-	-	-	41	60.3	0.629
0	0	0.0	0.849	0	0.0	0.642	2	40.0	0.005	4	57.1	0.148	2	40.0	0.038*	-	-	-	3	33.3	0.063
2	2	100.0	0.076	16	69.6	0.003*	17	7.6	0.541	110	47.0	0.030*	37	59.7	0.001*	5	38.5	0.989	206	57.5	0.003*
1	1	50.0	0.415	20	87.0	0.193	28	7.2	0.908	184	78.6	0.283	46	74.2	0.883	10	76.9	0.877	362	62.6	0.868
1	1	50.0	0.892	13	56.5	0.287	22	8.4	0.176	92	39.3	0.129	30	48.4	0.635	7	53.9	0.537	241	65.1	0.328
1	1	50.0	0.815	8	34.8	0.501	11	4.7	0.095	99	42.3	0.904	27	43.6	0.796	3	23.1	0.175	223	63.4	0.979
2	2	100.0	0.147	10	43.5	0.631	14	5.1	0.125	88	37.6	0.005*	23	37.1	0.086	8	61.5	0.356	259	68.5	0.005*
0	0	0.0	0.489	6	26.1	0.424	6	5.5	0.545	36	15.4	0.192	12	19.4	0.995	3	23.1	0.735	103	66.9	0.308
2	2	100.0	0.001*	3	13.0	0.889	4	5.1	0.505	31	13.3	0.761	7	11.3	0.548	3	23.1	0.359	75	64.7	0.745
1	1	50.0	0.943	13	56.5	0.395	13	4.9	0.088	95	40.6	0.079	32	51.6	0.536	5	38.5	0.520	253	65.7	0.182
1	1	50.0	<0.001*	0	0.0	0.554	1	11.1	0.607	3	1.3	0.814	0	0.0	0.331	0	0.0	0.656	8	72.7	0.514
1	1	100.0	0.590	9	39.1	0.601	18	6.5	0.691	119	51.3	0.052	26	41.9	0.595	3	23.1	0.180	259	63.6	0.181
0	0	0.0		10	43.5		12	6.3		88	37.9		23	37.1		7	53.9		180	60.4	
0	0	0.0		4	17.4		9	8.7		25	10.8		13	21.0		3	23.1		94	69.6	
1	1	50.0	0.018*	1	4.6	0.082	9	6.4	0.110	58	27.1	0.496	10	16.4	0.005*	3	23.1	0.277	131	64.9	0.238
0	0	0.0		3	13.6		3	6.4		17	7.9		11	18.0		0	0.0		44	61.1	
0	0	0.0		6	27.3		6	3.8		55	25.7		11	18.0		5	38.5		153	68.3	
0	0	0.0		9	40.9		9	8.0		49	22.9		23	37.7		1	7.7		104	58.8	
1	1	50.0		0	0.0		3	15.0		9	4.2		1	1.6		1	7.7		17	60.7	
0	0	0.0		3	13.6		21	15.3		26	12.2		5	8.2		3	23.1		41	54.7	
2	2	1.7	0.007*	3	2.6	0.350	12	9.6	0.159	60	34.7	0.149	16	12.4	0.396	4	3.4	0.402	113	58.6	0.101
2	2	100.0	0.750	12	54.6	0.430	24	7.3	0.406	136	63.6	0.758	31	50.8	0.322	6	46.2	0.464	304	63.7	0.772
0	0	0.0		0	0.0		0	0.0		3	1.4		1	1.6		1	7.7		12	70.6	
0	0	0.0		4	18.2		1	2.3		16	7.5		7	11.5		2	15.4		43	63.2	
0	0	0.0		6	27.3		12	8.5		59	27.6		22	36.1		4	30.8		130	60.5	
2	2	100.0	0.673	14	63.6	0.179	23	7.7	0.476	143	66.8	0.064	29	47.5	0.438	7	53.9	0.156	277	60.8	0.409
0	0	0.0		0	0.0		0	0.0		4	1.9		2	3.3		0	0.0		14	70.0	
0	0	0.0		5	22.7		2	3.5		22	10.3		6	9.8		4	30.8		56	63.6	
0	0	0.0		3	13.6		12	7.7		45	21.0		24	39.3		2	15.4		144	67.0	

Calculation of p-values was performed using a combination of chi-square and Fisher exact tests.

Comparisons are made between respondents with comorbidities and healthy individuals. Clinicians with no comorbidities were compared to those with one or more comorbidity. All percentages are calculated based upon the total number of responses received for each question and comorbidity combination.

COVID-19, coronavirus disease 2019.

*p<0.05, statistical significance.

Table 3. Medical comorbidities and association with clinical practice

Variable	Obesity			Hypertension			Current tobacco use			Respiratory illness			Renal disease			Cancer		
	No.	%	p-value	No.	%	p-value	No.	%	p-value	No.	%	p-value	No.	%	p-value	No.	%	p-value
Still performing elective surgery	18	18.6	0.348	33	24.5	0.500	21	21.0	0.001*	1	1.3	0.060	0	0.0	0.543	0	0.0	0.543
Essential/emergency spine surgery	74	14.2	0.055	123	21.5	0.308	59	11.6	0.841	25	5.3	0.387	2	0.4	0.611	2	0.4	0.611
Impact on clinical time spent																		
Increased	3	3.3	0.283	10	6.9	0.889	5	7.6	0.865	2	6.5	0.829	0	0.0	0.832	0	0.0	0.832
Decreased	76	82.6		122	84.1		55	83.3		25	80.7		2	100.0		2	100.0	
Stayed the same	13	14.1		13	9.0		6	9.1		4	12.9		0	0.0		0	0.0	
Perceived impact on resident/fellow training																		
Not currently training residents/fellows	31	34.1	0.813	45	31.0	0.838	28	42.4	0.267	11	35.5	0.839	0	0.0	0.680	1	50.0	0.951
Hurts training experience	49	53.9		84	57.9		30	45.5		16	51.6		2	100.0		1	50.0	
Improves training experience	4	4.4		6	4.1		2	3.0		2	6.5		0	0.0		0	0.0	
No overall impact	7	7.7		10	6.9		6	9.1		2	6.5		0	0.0		0	0.0	
Warning patients if the surgeon is COVID-19 positive																		
Absolutely	66	74.2	0.298	102	70.3	0.343	49	74.2	0.200	28	90.3	0.209	2	100.0	0.886	1	50.0	0.084
Likely	8	9.0		21	14.5		6	9.1		3	9.7		0	0.0		0	0.0	
Less likely	6	6.7		7	4.8		7	10.6		0	0.0		0	0.0		0	0.0	
Not at all	9	10.1		15	10.3		4	6.1		0	0.0		0	0.0		1	50.0	
Research activities impacted																		
No research engagement	31	36.5	0.091	42	29.4	0.006*	20	31.3	0.731	12	41.4	0.394	0	0.0	0.316	1	50.0	0.443
Complete stop	13	15.3		19	13.3		12	18.8		4	13.8		1	50.0		0	0.0	
Decrease in productivity	20	23.5		57	39.9		19	29.7		6	20.7		0	0.0		0	0.0	
No change	15	17.7		21	14.7		7	10.9		3	10.3		1	50.0		0	0.0	
Increase in productivity	6	7.1		4	2.8		6	9.4		4	13.8		0	0.0		1	50.0	
Surgery Impact																		
Advise against	67	16.0	0.533	102	22.5	0.990	43	10.9	0.383	26.0	6.9	0.108	2	0.6	0.360	2	0.6	0.360
Proceed with standard precautions	15	20.3	0.971	25	22.3	0.668	16	32.7	0.051	4	14.8	0.479	0	0.0	0.474	0	0.0	0.474
Absent during intubation/extubation	37	43.5	0.465	46	36.2	0.020*	19	32.8	0.030*	13	44.8	0.753	0	0.0	0.177	0	0.0	0.177
Additional PPE during surgery	47	51.7	0.508	71	49.0	0.171	33	50.0	0.407	16	51.6	0.681	1	50.0	0.878	0	0.0	0.116

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Table 3. Continued

	Cardiac disease			Diabetes			1 Comorbidity			2 Comorbidities			3+ Comorbidities			No comorbidities		
	No.	%	p-value	No.	%	p-value	No.	%	p-value	No.	%	p-value	No.	%	p-value	No.	%	p-value
	4	4.8	0.749	10	11.2	0.087	56	41.5	0.003*	11	12.2	0.670	3	3.7	0.468	79	53.0	0.006*
	18	3.9	0.336	35	7.2	0.504	187	29.4	0.141	52	10.4	0.448	12	2.6	0.674	449	64.1	0.154
	1	4.6	0.809	0	0.0	0.181	12	5.4	0.587	3	4.8	0.878	1	7.7	0.492	30	65.2	0.703
	18	81.8		36	7.8		183	82.4		52	83.9		12	92.3		428	63.4	
	3	13.6		2	3.9		27	12.2		7	11.3		0	0.0		49	59.0	
	7	33.3	0.588	15	8.1	0.677	70	31.4	0.476	22	35.5	0.089	6	50.0	0.167	170	63.4	0.791
	11	52.4		18	6.0		129	57.9		33	53.2		4	33.3		284	63.1	
	2	9.5		2	10.0		6	2.7		6	9.7		0	0.0		18	60.0	
	1	4.8		3	10.0		18	8.1		1	1.6		2	16.7		27	56.3	
	17	77.3	0.717	23	5.7	0.026*	160	72.4	0.380	41	67.2	0.369	11	84.6	0.134	383	64.4	0.273
	3	13.6		6	8.0		27	12.2		10	16.4		0	0.0		69	65.1	
	0	0.0		6	20.0		14	6.3		3	4.9		2	15.4		24	55.8	
	2	9.1		3	8.8		20	9.1		7	11.5		0	0.0		31	53.5	
	9	40.9	0.427	7	5.5	0.134	59	27.8	0.211	20	33.3	0.084	6	46.2	0.549	121	58.7	0.031*
	2	9.1		10	11.5		35	16.5		8	13.3		2	15.4		77	63.1	
	7	31.8		15	9.0		69	32.6		23	38.3		3	23.1		152	61.5	
	3	13.6		4	5.8		34	16.0		8	13.3		1	7.7		65	60.2	
	1	4.6		1	1.6		15	7.1		1	1.7		1	7.7		63	78.8	
	14	3.8	0.498	28	7.4	0.668	153	30.3	0.628	46	11.6	0.416	10	2.8	0.610	352	62.8	0.993
	1	6.7	0.190	4	4.7	0.347	49	28.5	0.036*	8	16.0	0.458	0	0.0	0.110	81	58.7	0.229
	4	23.5	0.049*	13	5.6	0.348	76	38.8	0.033*	22	39.3	0.226	3	27.3	0.177	221	68.6	0.014*
	13	59.1	0.733	24	8.0	0.353	113	50.7	0.239	31	50.8	0.497	7	53.9	0.911	277	64.7	0.212

Calculation of p-values was performed using a combination of chi-square and Fisher exact tests.
Comparisons are made between respondents with comorbidities and healthy individuals. Clinicians with no comorbidities were compared to those with one or more comorbidity. All percentages are calculated based upon the total number of responses received for each question and comorbidity combination.
COVID-19, coronavirus disease 2019; PPE, personal protective equipment.
*p < 0.05, statistical significance.

Table 4. Medical comorbidities and future perceptions

Variable	Obesity			Hypertension			Current tobacco use			Respiratory illness			Renal disease		
	No.	%	p-value	No.	%	p-value	No.	%	p-value	No.	%	p-value	No.	%	p-value
Belief that future guidelines are needed															
Yes	81	97.6	0.525	130	94.9	0.595	57	90.5	0.336	25	89.3	0.187	2	100.0	0.948
No	0	0.0		2	1.5		1	1.6		1	3.6		0	0.0	
Unsure	2	2.4		5	3.7		5	7.9		2	7.1		0	0.0	
Perceived impact in 1 year															
No change	13	13.4	0.643	24	22.2	0.948	11	11.6	0.953	6	6.7	0.623	0	0.0	0.511
Heighted awareness of hygiene	50	79.4	0.828	73	78.5	0.941	31	75.6	0.711	14	70.0	0.394	2	100.0	0.455
Increase use of PPE	47	61.0	0.060	67	55.8	0.214	30	58.8	0.204	12	48.0	0.892	2	100.0	0.153
Ask patients to reschedule if sick	40	50.6	0.064	53	41.4	0.698	28	49.1	0.164	11	42.3	0.776	2	100.0	0.081
Increase nonoperative measures prior to surgery	19	24.1	0.163	38	28.8	0.004*	20	33.9	0.003*	5	19.2	0.816	1	50.0	0.228
Increase digital options for communication	39	47.0	0.404	46	33.6	0.074	24	38.1	0.547	13	46.4	0.650	2	100.0	0.098
How likely to attend a conference in 1 year															
Likely	54	65.1	0.232	90	66.2	0.626	39	61.9	0.490	19	67.9	0.997	2	100.0	0.627
Not likely	3	3.6		8	5.9		7	11.1		2	7.1		0	0.0	
Unsure	26	31.3		38	27.9		17	27.0		7	25.0		0	0.0	
Timeframe to resume elective surgery															
<2 Weeks	5	5.5	0.720	5	3.5	0.279	4	6.1	0.399	0	0.0	0.396	0	0.0	0.850
2–4 Weeks	16	17.6		29	20.1		9	13.6		6	19.4		0	0.0	
1–2 Months	15	16.5		24	16.7		8	12.1		4	12.9		0	0.0	
>2 Months	3	3.3		4	2.8		2	3.0		0	0.0		0	0.0	
No current stoppage	11	12.1		21	14.6		10	15.2		1	3.2		0	0.0	
Unknown	41	45.1		61	42.4		33	50.0		20	64.5		2	100.0	
Anticipated # weeks to resume baseline activity															
<2 Weeks	10	11.8	0.450	13	9.3	0.041*	10	15.6	0.805	1	3.5	0.403	0	0.0	0.307
2–4 Weeks	24	28.2		43	30.7		15	23.4		9	31.0		0	0.0	
4–6 Weeks	19	22.4		34	24.3		15	23.4		6	20.7		0	0.0	
6–8 Weeks	13	15.3		21	15.0		10	15.6		5	17.2		0	0.0	
>8 Weeks	19	22.4		29	20.7		14	21.9		8	27.6		2	100.0	
% Telecommunication clinical visits/wk															
0–25	51	55.4	0.355	77	53.1	0.147	42	63.6	0.025*	18	58.1	0.326	1	50.0	0.845
26–50	11	12.0		26	17.9		11	16.7		2	6.5		0	0.0	
51–75	5	5.4		12	8.3		4	6.1		1	3.2		0	0.0	
76–100	25	27.2		30	20.7		9	13.6		10	32.3		1	50.0	

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Table 4. Continued

	Cancer			Cardiac disease			Diabetes			1 Comorbidity			2 Comorbidities			3+ Comorbidities			No comorbidity		
	No.	%	p-value	No.	%	p-value	No.	%	p-value	No.	%	p-value	No.	%	p-value	No.	%	p-value	No.	%	p-value
	2	100.0	0.948	21	95.5	0.932	35	7.3	0.008*	195	93.8	0.309	55	96.5	0.418	12	92.3	0.825	448	63.1	0.313
	0	0.0		0	0.0		2	40.0		4	1.9		1	1.8		0	0.0		3	37.5	
	0	0.0		1	4.6		0	0.0		9	4.3		1	1.8		1	7.7		21	65.6	
	0	0.0	0.511	5	5.6	0.553	7	7.7	0.859	40	32.3	0.647	4	4.6	0.040*	5	5.6	0.057	84	63.2	0.963
	2	100.0	0.455	12	70.6	0.464	23	7.4	0.883	105	73.9	0.313	37	90.2	0.069	7	63.6	0.255	286	65.8	0.717
	2	100.0	0.153	12	60.0	0.354	18	8.0	0.455	98	56.0	0.143	35	66.0	0.022*	5	41.7	0.597	206	59.9	0.045*
	1	50.0	0.762	10	47.6	0.458	13	7.0	0.784	81	42.6	0.462	24	44.4	0.484	7	53.9	0.298	173	60.7	0.291
	1	50.0	0.228	6	27.3	0.241	10	11.4	0.101	52	26.9	0.006*	17	30.4	0.020*	3	23.1	0.600	78	52.0	0.002*
	1	50.0	0.821	5	22.7	0.072	18	8.3	0.436	91	43.8	0.683	19	33.3	0.205	5	38.5	0.795	199	63.4	0.850
	1	50.0	0.678	13	59.1	0.004*	21	6.1	0.325	132	63.8	0.384	34	59.7	0.341	9	69.2	0.478	321	64.7	0.295
	0	0.0		6	27.3		3	7.9		14	6.8		4	7.0		2	15.4		35	63.6	
	1	50.0		3	13.6		13	10.2		61	29.5		19	33.3		2	15.4		115	58.4	
	0	0.0	0.843	3	13.6	0.058	1	6.3	0.902	14	6.3	0.175	2	3.3	0.359	0	0.0	0.923	15	48.4	0.178
	1	50.0		3	13.6		8	8.8		41	18.5		9	14.8		3	23.1		83	61.0	
	0	0.0		1	4.6		5	5.5		29	13.1		10	16.4		2	15.4		86	67.7	
	0	0.0		0	0.0		2	8.0		9	4.1		1	1.6		0	0.0		23	69.7	
	0	0.0		3	13.6		5	9.6		26	11.7		11	18.0		1	7.7		47	55.3	
	1	50.0		12	54.6		17	6.3		103	46.4		28	45.9		7	53.9		254	64.8	
	0	0.0	0.160	3	13.6	0.216	3	4.4	0.082	24	11.5	0.126	6	10.0	0.267	1	7.7	0.876	65	67.7	0.039*
	0	0.0		8	36.4		12	11.1		58	27.8		19	31.7		4	30.8		96	54.2	
	2	100.0		5	22.7		13	10.6		49	23.4		15	25.0		3	23.1		110	62.2	
	0	0.0		0	0.0		3	4.3		32	15.3		7	11.7		2	15.4		67	62.0	
	0	0.0		6	27.3		6	4.1		46	22.0		13	21.7		3	23.1		139	69.2	
	0	0.0	0.168	9	40.9	0.599	20	7.7	0.009*	112	50.2	0.323	36	59.0	0.047*	9	69.2	0.389	241	60.6	0.068
	0	0.0		4	18.2		11	14.1		38	17.0		12	19.7		1	7.7		67	56.8	
	0	0.0		4	18.2		2	3.6		18	8.1		5	8.2		0	0.0		54	70.1	
	2	100.0		5	22.7		4	2.7		55	24.7		8	13.1		3	23.1		142	68.3	

Calculation of p-values was performed using a combination of chi-square and Fisher exact tests.

Comparisons are made between respondents with comorbidities and healthy individuals. Clinicians with no comorbidities were compared to those with one or more comorbidity. All percentages are calculated based upon the total number of responses received for each question and comorbidity combination.

PPE, personal protective equipment.

*p<0.05, statistical significance.

Table 5. Multivariate assessment of medical comorbidities & COVID-19 survey responses

Assessed survey responses	Age			Female sex			Orthopaedics			Neurosurgery			Trauma			Academic Practice		
	OR	95% CI	p-value	OR	95% CI	p-value	OR	95% CI	p-value	OR	95% CI	p-value	OR	95% CI	p-value	OR	95% CI	p-value
Reasons for COVID-19 testing																		
Personally tested for COVID-19	0.99	0.74–1.33	0.962	2.56	1.04–6.29	0.041*	2.71	0.55–13.27	0.219	3.47	0.72–16.71	0.121	1.98	0.91–4.28	0.083	1.35	0.69–2.65	0.386
Direct contact with COVID-19 positive patient	1.03	0.70–1.51	0.873	0.82	0.20–3.34	0.782	0.21	0.02–2.43	0.210	0.30	0.03–3.51	0.340	1.76	0.51–6.14	0.374	1.11	0.41–3.03	0.835
Prophylactic	3.05	1.22–7.63	0.017*	1.00	1.00–1.00	-	108.44	0.85–13,777.31	0.058	126.17	0.92–17289.75	0.054	18.97	2.39–150.68	0.005*	0.92	0.17–4.99	0.919
Demonstrated symptoms	0.82	0.56–1.18	0.280	1.46	0.40–5.28	0.564	2.00	0.23–17.69	0.532	1.38	0.16–12.01	0.770	0.32	0.08–1.17	0.085	0.82	0.32–2.08	0.670
Ask to be tested	0.70	0.29–1.69	0.430	3.53	0.28–44.17	0.328	-	-	-	-	-	-	1.00	1.00–1.00	-	1.49	0.14–15.86	0.741
Current stressors																		
Personal health	1.10	0.95–1.28	0.199	0.72	0.39–1.35	0.307	0.59	0.26–1.32	0.196	0.69	0.30–1.57	0.379	1.11	0.70–1.77	0.657	0.97	0.68–1.38	0.855
Family health	1.16	0.94–1.43	0.168	0.29	0.15–0.56	<0.001*	1.23	0.43–3.50	0.699	1.45	0.50–4.25	0.494	1.24	0.65–2.35	0.513	1.12	0.69–1.81	0.644
Community health	0.96	0.83–1.12	0.627	1.14	0.63–2.06	0.675	2.31	1.00–5.34	0.050	2.12	0.91–4.97	0.082	1.77	1.11–2.81	0.017*	0.71	0.50–1.01	0.058
Hospital capacity	0.97	0.83–1.12	0.662	1.15	0.63–2.11	0.644	1.08	0.48–2.44	0.852	1.18	0.52–2.69	0.700	1.63	1.02–2.59	0.041*	1.42	1.00–2.03	0.053
Timeline to resume clinical practice	0.94	0.81–1.08	0.371	1.45	0.80–2.62	0.217	1.06	0.48–2.32	0.887	0.96	0.43–2.14	0.928	0.95	0.60–1.51	0.837	0.94	0.66–1.33	0.716
Government/leadership	0.94	0.78–1.13	0.507	2.05	1.08–3.91	0.028*	2.19	0.76–6.29	0.145	1.79	0.62–5.15	0.278	0.98	0.55–1.74	0.945	1.57	0.97–2.54	0.068
Return to nonessential activities	1.01	0.82–1.25	0.923	1.33	0.61–2.89	0.470	1.35	0.46–3.99	0.586	1.13	0.38–3.39	0.829	1.77	0.99–3.17	0.052	1.66	0.96–2.86	0.067
Economic issues	0.85	0.73–0.99	0.032*	0.70	0.38–1.30	0.262	1.78	0.77 ,4.07	0.175	1.70	0.73–3.93	0.216	0.95	0.59–1.51	0.823	0.55	0.38–0.78	0.001*
Clinical practice																		
Quarantine	1.03	0.86–1.23	0.735	2.07	1.08–3.95	0.028*	1.35	0.52–3.52	0.542	2.28	0.87–5.98	0.094	0.80	0.44–1.47	0.472	0.66	0.44–1.00	0.049*
Still performing elective surgery	1.13	0.93–1.37	0.218	0.44	0.15–1.27	0.128	1.23	0.40 ,3.83	0.718	0.78	0.25–2.45	0.665	0.32	0.14–0.72	0.006*	2.18	1.33–3.55	0.002*
Essential/emergency spine surgery	0.91	0.73–1.14	0.407	0.52	0.24–1.14	0.103	1.44	0.45–4.63	0.536	2.22	0.66–7.44	0.196	0.77	0.40–1.49	0.446	2.35	1.33–4.15	0.003*
Advise against	1.01	0.85–1.19	0.940	0.79	0.42–1.51	0.475	0.74	0.29–1.87	0.524	0.52	0.21–1.33	0.174	1.57	0.90–2.74	0.113	0.82	0.55–1.21	0.323
Proceed with standard precautions	1.11	0.91–1.35	0.265	0.26	0.08–0.87	0.067	1.15	0.41 ,3.26	0.583	1.46	0.51–4.18	0.287	1.66	0.94–2.93	0.244	0.95	0.60–1.51	0.936
Absent during intubation/extubation	0.84	0.72–0.98	0.076	0.73	0.39–1.36	0.805	0.80	0.33–1.89	0.966	0.84	0.35–2.04	0.974	1.03	0.64–1.66	0.618	1.27	0.88–1.84	0.135
Additional PPE during surgery	0.91	0.78–1.06	0.214	1.51	0.81–2.84	0.198	1.55	0.67–3.63	0.307	2.00	0.84–4.72	0.115	0.86	0.54–1.37	0.525	1.20	0.84–1.71	0.319
% Telecommunication clinical visits/wk	0.94	0.81–1.08	0.380	1.69	0.95–3.01	0.077	0.68	0.32–1.46	0.328	0.85	0.40–1.84	0.689	0.99	0.64–1.54	0.972	1.78	1.27–2.49	0.001*
Perceived impact in 1 year																		
No change	1.08	0.88–1.33	0.449	0.69	0.29–1.64	0.403	0.98	0.33–2.89	0.974	1.15	0.38–3.42	0.806	0.98	0.51–1.86	0.943	1.53	0.90–2.60	0.117
Heighted awareness of hygiene	0.89	0.76–1.04	0.292	1.23	0.65–2.33	0.427	1.58	0.68–3.69	0.790	1.59	0.67–3.76	0.984	1.05	0.64–1.72	0.964	0.77	0.52–1.12	0.149
Increase use of PPE	0.92	0.79–1.08	0.318	0.98	0.53–1.83	0.950	0.84	0.36–1.93	0.678	1.23	0.53–2.87	0.625	1.06	0.65–1.72	0.828	0.68	0.47–0.99	0.042*
Ask patients to reschedule if sick	1.17	0.99–1.37	0.026*	1.00	0.53–1.89	0.938	0.85	0.37–1.97	0.883	0.97	0.42–2.28	0.938	1.28	0.78–2.09	0.240	0.99	0.68–1.45	0.932
Increase nonoperative measures prior to surgery	0.98	0.80–1.20	0.994	1.45	0.70–3.02	0.291	0.74	0.28–1.94	0.709	1.01	0.38–2.70	0.822	1.27	0.71–2.30	0.381	0.83	0.53–1.31	0.490
Increase digital options for communication	1.14	0.97–1.34	0.112	1.34	0.72–2.49	0.352	1.07	0.46–2.52	0.871	1.36	0.57–3.22	0.491	1.14	0.70–1.87	0.591	1.08	0.74–1.57	0.685
Other perceptions																		
Media perceptions	1.02	0.89–1.17	0.810	0.59	0.33–1.05	0.071	0.57	0.28–1.19	0.133	0.75	0.36–1.58	0.455	1.30	0.84–2.01	0.244	1.17	0.84–1.63	0.353
Perception of hospital effectiveness	1.51	1.29–1.77	<0.001*	0.61	0.34–1.10	0.103	1.47	0.62–3.46	0.381	1.17	0.49–2.80	0.724	1.28	0.78–2.09	0.335	1.98	1.38–2.85	<0.001*
Perception of government effectiveness	1.19	1.02–1.38	0.024*	0.61	0.34–1.08	0.088	0.87	0.41 ,1.88	0.728	0.80	0.37–1.74	0.570	1.17	0.73–1.87	0.511	1.13	0.79–1.61	0.496
Warning patients if the surgeon is COVID-19 positive	1.46	1.22–1.74	<0.001*	0.82	0.43–1.59	0.564	1.34	0.52–3.44	0.548	1.76	0.67–4.65	0.255	1.10	0.65–1.87	0.709	0.57	0.37–0.88	0.010*

(Continued to the next page)

Table 5. Continued

Private practice			Public/local practice			Obese			Hypertension			Current tobacco use			Respiratory illness			Cardiac disease			Diabetes		
OR	95% CI	P-value	OR	95% CI	P-value	OR	95% CI	P-value	OR	95% CI	P-value	OR	95% CI	P-value	OR	95% CI	P-value	OR	95% CI	P-value	OR	95% CI	P-value
0.42	0.13–1.34	0.143	0.55	0.19–1.55	0.259	1.06	0.43–2.59	0.902	0.79	0.33–1.89	0.603	0.18	0.02–1.33	0.093	1.05	0.23–4.76	0.949	1.93	0.41–9.09	0.404	0.85	0.19–3.79	0.834
1.64	0.41–6.59	0.488	1.89	0.53–6.74	0.324	0.50	0.13–1.98	0.325	0.59	0.18–1.88	0.370	0.14	0.02–1.20	0.073	0.75	0.06–10.04	0.825	2.04	0.33–12.61	0.441	1.03	0.17–6.23	0.971
0.07	0.00–6.09	0.247	0.07	0.00–1.51	0.090	3.79	0.49–29.12	0.200	0.18	0.01–2.27	0.183	9.90	1.10–89.14	0.041*	1.00	1.00–1.00	-	0.54	.01–42.62	0.780	1.26	0.09–18.54	0.866
0.93	0.24–3.59	0.918	0.72	0.21–2.45	0.604	1.21	0.33–4.37	0.772	1.42	0.48–4.22	0.526	1.73	0.44–6.86	0.433	3.46	0.25–46.99	0.352	0.47	0.07–3.03	0.428	0.35	0.06–2.14	0.258
1.00	1.00–1.00	-	6.48	0.41–102.85	0.185	2.36	0.17–32.46	0.522	7.55	0.99–57.45	0.051	1.75	0.13–22.97	0.672	1.00	1.00–1.00	-	1.00	1.00–1.00	-	3.58	0.38–34.15	0.267
0.73	0.47–1.16	0.185	1.26	0.79–2.03	0.335	1.33	0.86–2.07	0.199	1.50	1.01–2.23	0.046*	0.81	0.48–1.37	0.428	1.55	0.72–3.34	0.264	2.49	0.98–6.30	0.055	0.81	0.41–1.59	0.531
1.23	0.65–2.33	0.521	1.00	0.53–1.86	0.988	1.24	0.65–2.38	0.515	0.95	0.55–1.67	0.869	0.52	0.28–0.97	0.039*	1.69	0.48–5.96	0.412	1.15	0.32–4.12	0.834	0.79	0.33–1.93	0.609
0.91	0.58–1.42	0.665	0.67	0.42–1.08	0.102	0.65	0.42–1.03	0.066	0.89	0.60–1.33	0.578	1.41	0.84–2.37	0.189	0.48	0.20–1.11	0.087	1.94	0.81–4.67	0.139	1.89	0.97–3.71	0.063
0.61	0.38–0.99	0.044*	2.28	1.42–3.68	0.001*	1.28	0.82–2.00	0.284	1.39	0.92–2.08	0.114	0.75	0.44–1.29	0.298	0.97	0.43–2.15	0.932	0.71	0.28–1.79	0.470	0.51	0.24–1.06	0.071
1.12	0.72–1.74	0.622	0.70	0.43–1.12	0.133	0.89	0.57–1.38	0.591	0.77	0.52–1.15	0.209	0.95	0.56–1.59	0.838	0.56	0.25–1.26	0.158	1.20	0.50–2.85	0.685	0.77	0.38–1.52	0.447
1.48	0.82–2.68	0.198	1.47	0.79–2.72	0.226	1.14	0.66–1.97	0.647	0.85	0.50–1.46	0.565	0.85	0.50–1.46	0.565	1.16	0.45–2.96	0.758	1.81	0.67–4.88	0.241	0.84	0.34–2.12	0.716
1.70	0.88–3.29	0.117	1.29	0.63–2.64	0.493	0.75	0.38–1.48	0.407	1.32	0.76–2.30	0.324	1.32	0.76–2.30	0.324	1.04	0.35–3.09	0.945	0.89	0.25–3.18	0.858	0.66	0.22–1.94	0.448
1.26	0.80–1.98	0.314	0.51	0.31–0.82	0.006*	0.81	0.52–1.27	0.359	0.87	0.58–1.312	0.514	0.87	0.58–1.31	0.514	2.97	1.27–6.96	0.012*	1.86	0.77–4.50	0.170	0.61	0.30–1.26	0.184
0.91	0.55–1.52	0.731	0.54	0.30–0.97	0.038*	0.83	0.48–1.41	0.483	1.29	0.82–2.04	0.277	1.29	0.82–2.04	0.277	1.88	0.84–4.24	0.127	0.42	0.11–1.56	0.196	1.56	0.74–3.27	0.240
0.82	0.40–1.66	0.575	1.56	0.80–3.04	0.191	1.17	0.65–2.09	0.604	1.24	0.76–2.02	0.396	1.24	0.76–2.02	0.396	0.16	0.02–1.22	0.077	0.92	0.29–2.91	0.887	1.26	0.57–2.77	0.569
0.79	0.43–1.45	0.446	0.82	0.43–1.57	0.556	0.61	0.33–1.12	0.113	0.88	0.48–1.59	0.663	0.88	0.48–1.59	0.663	0.69	0.25–1.93	0.477	0.97	0.30–3.18	0.962	1.90	0.55–6.58	0.310
1.73	0.99–3.03	0.054	0.64	0.39–1.08	0.094	1.15	0.69–1.92	0.598	0.89	0.58–1.38	0.605	0.89	0.58–1.38	0.605	1.90	0.70–5.12	0.205	0.60	0.24–1.53	0.288	1.20	0.56–2.58	0.642
0.65	0.34–1.27	0.114	1.40	0.77–2.53	0.234	0.92	0.50–1.69	0.795	1.07	0.64–1.81	0.604	1.07	0.64–1.81	0.604	0.85	0.29–2.55	0.543	0.19	0.03–1.49	0.133	0.53	0.18–1.56	0.176
1.04	0.65–1.68	0.825	1.22	0.74–2.00	0.191	1.11	0.70–1.77	0.751	0.76	0.50–1.16	0.307	0.76	0.50–1.16	0.307	1.00	0.45–2.22	0.980	0.42	0.14–1.29	0.268	0.96	0.47–1.97	0.974
0.72	0.45–1.13	0.155	1.27	0.78–2.06	0.336	0.94	0.60–1.48	0.786	0.85	0.57–1.27	0.420	0.85	0.57–1.27	0.420	0.87	0.40–1.87	0.720	1.66	0.67–4.13	0.273	1.76	0.87–3.55	0.114
1.08	0.70–1.67	0.732	0.71	0.44–1.14	0.153	0.97	0.63–1.49	0.874	0.88	0.61–1.27	0.489	0.88	0.61–1.27	0.489	0.89	0.42–1.91	0.768	1.67	0.76–3.66	0.200	0.67	0.36–1.26	0.218
1.41	0.73–2.73	0.309	2.67	1.42–5.03	0.002*	0.84	0.44–1.60	0.591	0.93	0.54–1.61	0.808	0.93	0.54–1.61	0.808	1.57	0.60–4.07	0.358	1.24	0.43–3.58	0.695	1.13	0.47–2.71	0.789
0.65	0.40–1.06	0.207	0.43	0.26–0.72	0.001*	1.20	0.74–1.96	0.604	0.81	0.53–1.23	0.676	0.81	0.53–1.23	0.676	0.76	0.34–1.71	0.273	1.14	0.47–2.78	0.713	1.30	0.64–2.64	0.946
0.49	0.30–0.79	0.004*	0.61	0.37–1.00	0.051	1.51	0.94–2.44	0.089	1.14	0.75–1.74	0.527	1.14	0.75–1.74	0.835	0.86	0.38–1.97	0.727	1.58	0.65–3.85	0.315	1.05	0.52–2.10	0.893
0.99	0.61–1.61	0.912	1.07	0.65–1.77	0.816	1.53	0.95–2.46	0.111	0.87	0.57–1.34	0.442	0.87	0.57–1.34	0.442	1.01	0.44–2.30	0.931	1.14	0.47–2.77	0.909	0.81	0.40–1.67	0.491
0.55	0.29–1.04	0.071	0.88	0.48–1.60	0.622	1.00	0.56–1.80	0.976	1.59	0.97–2.61	0.085	1.59	0.97–2.61	0.085	0.71	0.23–2.18	0.516	1.48	0.54–4.08	0.529	1.35	0.61–2.97	0.467
0.67	0.41–1.09	0.107	0.80	0.49–1.33	0.393	1.39	0.86–2.25	0.180	0.58	0.38–0.90	0.015*	0.58	0.38–0.90	0.015*	0.97	0.42–2.25	0.949	0.42	0.15–1.20	0.105	1.57	0.78–3.16	0.210
1.23	0.81–1.87	0.340	1.17	0.75–1.83	0.492	1.28	0.84–1.96	0.248	1.20	0.83–1.73	0.345	1.20	0.83–1.73	0.345	1.44	0.69–2.98	0.329	1.10	0.48–2.54	0.815	0.66	0.35–1.25	0.204
2.01	1.25–3.23	0.004*	1.00	0.62–1.60	0.994	0.72	0.46–1.14	0.162	0.72	0.48–1.08	0.108	0.72	0.48–1.08	0.108	1.23	0.57–2.67	0.601	0.46	0.19–1.10	0.083	1.05	0.53–2.09	0.883
1.12	0.71–1.78	0.626	0.85	0.53–1.36	0.498	0.99	0.63–1.55	0.961	0.67	0.45–0.99	0.047*	0.67	0.45–0.99	0.047*	1.59	0.71–3.57	0.259	0.76	0.31–1.85	0.550	1.08	0.56–2.07	0.828
0.87	0.49–1.54	0.633	0.55	0.32–0.96	0.037*	0.88	0.52–1.49	0.629	0.58	0.37–0.91	0.017*	0.58	0.37–0.91	0.017*	5.23	1.20–22.83	0.028*	0.96	0.33–2.79	0.940	0.50	0.25–0.99	0.048*

COVID-19, coronavirus disease 2019; OR, odds ratio; CI, confidence interval; PPE, personal protective equipment.

All multivariate models were assessed using the same set of independent factors and included baseline demographics, practice-specific variables, and medical comorbidities. Renal disease and cancer were excluded from assessment due to low study prevalence.

Multivariate logistic regression was used to assess survey responses with simple binary outcomes where ordinal logistic regression was implemented for questions with ordinal scales.

*p<0.05, statistical significance.

Table 6. Multivariate assessment of number of medical comorbidities and COVID-19 survey responses

Assessed survey responses	Age			Female sex			Orthopaedics			Neurosurgery		
	OR	95% CI	p-value	OR	95% CI	p-value	OR	95% CI	p-value	OR	95% CI	p-value
Reasons for COVID-19 testing												
Personally tested for COVID-19	1.02	0.76–1.35	0.917	2.47	1.01–6.00	0.047*	2.51	0.56–11.29	0.230	3.06	0.69–13.50	0.140
Direct contact with COVID-19 positive patient	1.05	0.72–1.51	0.804	0.78	0.20–3.02	0.723	0.31	0.03–3.37	0.339	0.39	0.04–4.13	0.432
Prophylactic	2.04	1.01–4.13	0.048*	1.00	1.00–1.00	-	44.29	0.80–2446.18	0.064	57.56	1.10–3012.99	0.045*
Demonstrated symptoms	0.81	0.57–1.15	0.246	1.59	0.45–5.61	0.472	1.56	0.19–12.63	0.677	1.24	0.15–9.89	0.842
Ask to Be Tested	0.98	0.47–2.05	0.954	2.82	0.25–32.26	0.405	-	-	-	-	-	-
Current Stressors												
Personal health	1.12	0.97–1.29	0.123	0.73	0.39–1.35	0.313	0.60	0.27–1.34	0.211	0.70	0.31–1.57	0.387
Family health	1.18	0.96–1.44	0.114	0.29	0.15–0.57	<0.001*	1.35	0.47–3.90	0.579	1.56	0.52–4.64	0.425
Community health	0.98	0.85–1.13	0.821	1.12	0.62–2.02	0.714	2.25	0.98–5.14	0.056	2.02	0.87–4.68	0.102
Hospital capacity	0.98	0.84–1.13	0.747	1.15	0.63–2.09	0.650	1.07	0.48–2.40	0.868	1.18	0.52–2.67	0.693
Timeline to resume clinical practice	0.94	0.81–1.08	0.358	1.44	0.80–2.60	0.227	1.04	0.47–2.29	0.917	0.95	0.43–2.11	0.898
Government/leadership	0.93	0.78–1.12	0.456	2.04	1.07–3.89	0.029*	2.22	0.76–6.46	0.144	1.83	0.63–5.33	0.268
Return to nonessential activities	1.03	0.84–1.25	0.809	1.34	0.62–2.90	0.461	1.32	0.44–3.89	0.620	1.12	0.37–3.36	0.846
Economic issues	0.85	0.74–0.98	0.029*	0.72	0.39–1.33	0.296	1.77	0.78–4.03	0.170	1.71	0.75–3.92	0.206
Clinical Practice												
Quarantine	1.02	0.86–1.21	0.786	2.10	1.10–4.01	0.025*	1.34	0.52–3.44	0.541	2.29	0.89–5.91	0.086
Still performing elective surgery	1.10	0.91–1.32	0.324	0.44	0.15–1.28	0.131	1.13	0.35–3.64	0.836	0.74	0.23–2.42	0.620
Essential/emergency spine surgery	0.92	0.74–1.14	0.453	0.51	0.24–1.12	0.096	1.41	0.45–4.35	0.555	2.15	0.66–7.00	0.202
Advise against	0.99	0.84–1.16	0.856	0.80	0.42–1.52	0.498	0.77	0.30–1.97	0.584	0.54	0.21–1.40	0.208
Proceed with standard precautions	1.07	0.89–1.30	0.393	0.26	0.08–0.88	0.065	1.10	0.39–3.10	0.691	1.47	0.52–4.21	0.308
Absent during intubation/extubation	0.83	0.72–0.97	0.059	0.72	0.39–1.34	0.767	0.84	0.36–1.96	0.961	0.89	0.38–2.10	0.927
Additional PPE during surgery	0.93	0.80–1.07	0.298	1.49	0.79–2.79	0.217	1.61	0.69–3.75	0.269	2.00	0.85–4.72	0.114
% Telecommunication clinical visits/wk	0.96	0.84–1.10	0.556	1.66	0.93–2.96	0.085	0.68	0.32–1.46	0.325	0.83	0.39–1.79	0.639
Perceived impact in 1 year												
No change	1.09	0.90–1.33	0.375	0.70	0.30–1.65	0.417	1.00	0.35–2.92	0.994	1.16	0.39–3.42	0.792
Heighted awareness of hygiene	0.88	0.76–1.03	0.264	1.22	0.64–2.30	0.467	1.66	0.71–3.86	0.831	1.63	0.69–3.85	0.938
Increase use of PPE	0.92	0.79–1.07	0.486	0.97	0.52–1.81	0.880	0.85	0.37–1.95	0.697	1.24	0.53–2.88	0.670
Ask patients to reschedule if sick	1.13	0.97–1.32	0.066	0.99	0.52–1.87	0.950	0.84	0.37–1.94	0.816	0.99	0.42–2.30	0.950
Increase nonoperative measures prior to surgery	1.00	0.83–1.21	0.879	1.43	0.69–2.98	0.306	0.68	0.26–1.80	0.562	0.94	0.35–2.52	0.964
Increase digital options for communication	1.08	0.93–1.26	0.329	1.34	0.72–2.48	0.359	1.15	0.49–2.65	0.751	1.45	0.62–3.39	0.397
Other Perceptions												
Media perceptions	1.01	0.88–1.16	0.868	0.60	0.34–1.06	0.078	0.58	0.28–1.20	0.142	0.76	0.36–1.60	0.470
Perception of hospital effectiveness	1.49	1.28–1.74	<0.001*	0.62	0.34–1.12	0.115	1.60	0.68–3.77	0.283	1.27	0.53–3.04	0.592
Perception of government effectiveness	1.14	0.99–1.32	0.073	0.62	0.35–1.10	0.105	0.89	0.42–1.92	0.770	0.84	0.39–1.82	0.653
Warning patients if the surgeon is COVID-19 positive	1.40	1.18–1.67	<0.001*	0.87	0.45–1.67	0.676	1.33	0.52–3.40	0.549	1.83	0.70–4.79	0.220

(Continued to the next page)

Table 6. Continued

	Trauma			Academic practice			Private practice			Public/local practice			Number of comorbidities		
	OR	95% CI	p-value	OR	95% CI	p-value	OR	95% CI	p-value	OR	95% CI	p-value	OR	95% CI	p-value
	1.95	0.91–4.18	0.087	1.32	0.68–2.59	0.413	0.45	0.14–1.40	0.168	0.58	0.21–1.62	0.298	0.80	0.51–1.28	0.357
	1.64	0.50–5.31	0.412	1.11	0.42–2.94	0.830	1.86	0.48–7.22	0.368	1.85	0.54–6.29	0.328	0.70	0.38–1.28	0.244
	11.98	1.78–80.77	0.011*	0.65	0.13–3.16	0.592	0.08	0.00–3.43	0.187	0.12	0.01–1.82	0.125	1.26	0.45–3.54	0.662
	0.41	0.12–1.39	0.154	0.84	0.34–2.09	0.710	0.88	0.24–3.26	0.849	0.69	0.21–2.30	0.549	0.99	0.57–1.73	0.971
	1.00	1.00–1.00	-	2.11	0.22–20.13	0.516	1.00	1.00–1.00	-	3.79	0.27–53.95	0.326	2.70	0.98–7.41	0.054
	1.11	0.70–1.77	0.647	0.95	0.67–1.36	0.795	0.77	0.49–1.21	0.259	1.27	0.79–2.03	0.320	1.32	1.07–1.63	0.009*
	1.29	0.68–2.44	0.440	1.09	0.68–1.77	0.711	1.28	0.68–2.41	0.444	0.99	0.53–1.84	0.970	0.89	0.68–1.18	0.421
	1.74	1.10–2.76	0.018*	0.73	0.51–1.03	0.074	0.88	0.57–1.37	0.576	0.70	0.44–1.12	0.135	1.01	0.82–1.24	0.941
	1.60	1.01–2.54	0.045*	1.39	0.97–1.98	0.071	0.62	0.38–1.00	0.049*	2.19	1.37–3.51	0.001*	1.02	0.82–1.26	0.880
	0.96	0.61–1.52	0.876	0.94	0.66–1.33	0.721	1.11	0.72–1.72	0.640	0.71	0.44–1.14	0.160	0.83	0.68–1.03	0.087
	1.00	0.56–1.78	0.990	1.57	0.97–2.54	0.066	1.52	0.84–2.75	0.165	1.53	0.82–2.82	0.178	1.02	0.78–1.33	0.894
	1.75	0.98–3.12	0.057	1.65	0.96–2.84	0.069	1.67	0.87–3.23	0.125	1.26	0.61–2.57	0.532	1.02	0.76–1.38	0.884
	0.97	0.61–1.54	0.890	0.55	0.39–0.78	0.001*	1.31	0.84–2.05	0.229	0.53	0.33–0.84	0.008*	0.92	0.75–1.14	0.457
	0.78	0.43–1.43	0.429	0.67	0.45–1.01	0.056	0.89	0.54–1.47	0.645	0.52	0.29–0.93	0.028*	1.19	0.94–1.51	0.143
	0.33	0.14–0.74	0.007*	2.21	1.36–3.59	0.001*	0.77	0.38–1.55	0.466	1.61	0.83–3.12	0.156	1.32	1.02–1.71	0.032*
	0.75	0.39–1.44	0.392	2.37	1.35–4.18	0.003*	0.76	0.42–1.38	0.364	0.82	0.44–1.54	0.539	0.91	0.68–1.24	0.558
	1.57	0.90–2.73	0.113	0.82	0.56–1.22	0.329	1.74	1.00–3.03	0.051	0.64	0.38–1.06	0.082	0.99	0.79–1.25	0.966
	1.63	0.93–2.87	0.247	0.95	0.60–1.51-	0.946	0.63	0.32–1.21	0.090	1.37	0.76–2.47	0.242	0.96	0.73–1.27	0.879
	1.03	0.64–1.65	0.611	1.27	0.88–1.83	0.139	1.06	0.66–1.70	0.850	1.20	0.73–1.95	0.222	0.78	0.62–0.97	0.060
	0.86	0.54–1.38	0.533	1.20	0.84,1.71	0.315	0.72	0.46–1.14	0.164	1.29	0.79–2.08	0.307	0.95	0.77–1.17	0.637
	0.99	0.64–1.54	0.961	1.74	1.25–2.43	0.001*	1.11	0.72–1.71	0.651	0.72	0.45–1.15	0.168	0.82	0.67–1.00	0.050*
	0.97	0.51–1.84	0.936	1.53	0.90–2.59	0.118	1.44	0.75–2.78	0.278	2.67	1.43–5.00	0.002*	0.96	0.72–1.27	0.771
	1.06	0.65–1.75	0.924	0.76	0.52–1.12	0.149	0.65	0.40–1.05	0.174	0.44	0.27–0.72	0.001*	0.96	0.77–1.19	0.712
	1.07	0.66–1.75	0.694	0.68	0.47–0.98	0.099	0.50	0.31–0.80	0.011*	0.62	0.38–1.01	0.110	1.22	0.98–1.52	0.083
	1.32	0.81–2.15	0.198	0.99	0.67–1.44	0.929	1.00	0.62–1.62	0.923	1.10	0.67–1.81	0.724	1.08	0.87–1.34	0.624
	1.24	0.69–2.23	0.451	0.85	0.54–1.33	0.533	0.55	0.30–1.04	0.072	0.88	0.48–1.59	0.643	1.38	1.07–1.78	0.017
	1.16	0.71–1.89	0.547	1.08	0.75–1.56	0.687	0.65	0.40–1.06	0.082	0.81	0.49–1.33	0.398	0.88	0.71–1.10	0.275
	1.30	0.84–2.01	0.242	1.16	0.84–1.62	0.369	1.27	0.83–1.93	0.273	1.17	0.75–1.82	0.497	1.12	0.92–1.37	0.247
	1.26	0.77–2.06	0.362	1.99	1.39–2.85	<0.001*	1.95	1.22–3.11	0.005*	0.98	0.61–1.57	0.939	0.74	0.60–0.91	0.005*
	1.19	0.75–1.90	0.467	1.15	0.81–1.63	0.449	1.13	0.71–1.78	0.608	0.87	0.55–1.39	0.572	0.93	0.76–1.14	0.483
	1.20	0.71–2.01	0.503	0.57	0.38–0.88	0.010*	0.93	0.52–1.64	0.792	0.57	0.33–0.99	0.047*	0.74	0.58–0.93	0.010*

All multivariate models were assessed using the same set of independent factors and included baseline demographics, practice, specific variables, and number of medical comorbidities.

Multivariate logistic regression was used to assess survey responses with simple binary outcomes where ordinal logistic regression was implemented for questions with ordinal scales.

COVID-19, coronavirus disease 2019; OR, odds ratio; CI, confidence interval; PPE, personal protective equipment.

*p < 0.05, statistical significance.

and additional personal protective equipment (PPE) use during surgery.

When prompted, obesity was not associated with variations in personal impact and future perceptions (p > 0.05), but a perceived impact at 1 year varied significantly based on diagnosis (Table 4). Spine surgeons with hypertension (p = 0.004), tobacco use (p = 0.003), any comorbidity (p = 0.002), 1 comorbidity (p = 0.006), or 2 comorbidities (p = 0.020) had a significant association with increasing nonoperative care prior to surgery at 1 year. Telecommunication was also significantly associated with tobacco use (p = 0.025), diabetes (p = 0.009), and 2 comorbidities (p = 0.047).

Multivariate regression analysis controlling for baseline demographics, such as age, and practice-specific factors revealed that tobacco users were more likely to get prophylactically tested for COVID-19 (OR, 9.90; 95% CI, 1.10–89.14; p = 0.041). Those with hypertension were more likely to cite personal health as a current stressor (OR, 1.50; 95% CI, 1.00–2.22; p = 0.046), whereas spine surgeons with tobacco use were less likely to cite family health as a stressor (OR, 0.52; 95% CI, 0.28–0.97; p = 0.039. Similarly, respondents with current tobacco use were more likely to still be performing elective spine surgery during the pandemic (OR, 2.62; 95% CI, 1.46–4.72; p = 0.001), more likely to pursue nonoperative care at 1 year (OR, 1.81; 95% CI, 1.0–3.28; p = 0.39), and less likely to be absent during intubation/extubation (OR, 0.51; 95% CI, 0.28–0.97; p = 0.038). In addition, those with hypertension were less likely to perceive their government's pandemic management favorably (OR, 0.67; 95% CI, 0.45–0.99; p = 0.047) and were less likely to warn their patients should they become infected with COVID-19 (OR, 0.57; 95% CI, 0.37–0.91; p = 0.017). In comparison, under similar circumstances, those with respiratory illnesses were far more likely to warn their patients of a COVID-19 infection (OR, 5.23; 95% CI, 1.20–22.83; p = 0.028). Clinicians reporting a current tobacco use history were less likely to report utilization of telecommunication for recent clinical visits (OR, 0.51; 95% CI, 0.31–0.86; p = 0.011) (Table 5).

When grouped by number of comorbidities in the multivariate regression model, spine surgeons with more comorbidities were more likely to cite personal health as a current stressor (OR, 1.32; 95% CI, 1.07–1.63; p = 0.09) and more likely to be performing elective surgery (OR, 1.32; 95% CI, 1.02–1.71; p = 0.030), though also perceived their hospital's management unfavorably (OR, 0.74; 95% CI, 0.60–0.91; p = 0.005), were less likely to currently use telecommunication clinical visits (OR, 0.82; 95% CI, 0.67–1.00; p = 0.05), and would less likely warn

their patients of a personnel COVID-19 infection (OR, 0.74; 95% CI, 0.58–0.93; p = 0.010) (Table 6).

DISCUSSION

COVID-19 and its implications have raised concerns of patient health and safety. However, spine surgeons find themselves not only on the front-line during the height of such a pandemic but also facing the aftermath. Spine surgeons carry an increased work burden and are faced with stressors that compound health-related complications of comorbidities they may have. However, very little research has been published regarding spine surgeon well-being. Therefore, the authors utilized unique data from a COVID-19 global outreach survey to better understand health disparities in spine surgeons, which demonstrated that nearly 37% of participants had a major comorbidity, and those with more comorbidities were more likely to be concerned about their personal health, though they would also still be performing elective surgery. This is the first study to highlight the health of spine surgeons and how it relates to the perception of COVID-19 and how such a pandemic affects spine practices across the globe.

In a national health survey between 1986 and 1994, physicians were among the occupations with the lowest morbidity rate.[11] Similarly, fewer resources are allocated towards promoting preventative health measures for physicians when compared to other occupations. The current study identified a cohort of spine surgeons, most of whom were male and 44 years-of-age or younger, and yet nearly 37% reported a major comorbidity. While the United States has a nearly 10% incidence of diabetes, rates of obesity vary geographically,[12,13] findings which were also highlighted in our present study as comorbidities varied across regions.

Hypertension and obesity were identified as the most commonly reported comorbidities, which is similar to recent studies analyzing COVID-19.[3] Guan et al.[7] evaluated 1,590 patients diagnosed with COVID-19, noting an increased risk of ICU admission, invasive ventilation, or death in patients with chronic obstructive pulmonary disease (COPD) (hazard ratio [HR], 2.681), hypertension (HR, 1.58), diabetes (HR, 1.59), or malignancy (HR, 3.50). Similarly, a meta-analysis of 6 studies evaluating patients with COVID-19 identified hypertension (OR, 2.29), respiratory disease (OR, 5.97), cardiac disease (OR, 2.93), diabetes (OR, 2.47) as significant risk factors associated with COVID-19.[14] Tobacco use which has historically been linked to respiratory disease such as COPD also increases the risk of com-

plications associated with COVID-19.[15] In a meta-analysis of 15 studies, Alqahtani et al.[16] evaluated the mortality rates in COPD and tobacco use associated with COVID-19. Their analysis revealed that tobacco users were nearly 1.5 times more likely to have severe complications from COVID-19 when compared to nonsmokers, and tobacco users had a significantly higher mortality rate approaching 40%. Furthermore, tobacco users were more likely to perform surgery during the pandemic, exposing themselves to a deadly virus, and yet were also more likely to cite personal health as a stressor, highlighting the importance of smoking cessation. Given these findings, However, those with a respiratory illness were far more likely to inform their patients if they were diagnosed with COVID-19, suggesting a sense of sympathy.

In the present study, irrespective of the COVID-19 outbreak, spine surgeons with more comorbidities were more likely to cite personal health as a current stressor. A study by Gross et al.[17] demonstrated that of 915 physicians, only 65% had a regular source of medical care, and not having such care was associated with having a diagnosis of malignancy and not having the influenza vaccine at 6-year follow-up. Taub et al.[18] performed a study regarding guidelines for physician health and wellness. Though seemingly rhetorical, the value of healthy living habits and having a personal physician is undervalued, as the current study highlighted how spine surgeons also have modifiable comorbidities such as tobacco use and obesity. Furthermore, orthopedic surgical training can induce hypertension, though transient in nature.[19] Similarly, neurosurgery has been demonstrated to increase intraoperative blood pressure to levels higher than vigorous exercise.[20] Regardless, respondents with 1 comorbidity varied in their opinions regarding standard precautions and a lack of association between number of comorbidities and use of additional PPE during surgery infers riskier behavior by surgeons who would otherwise benefit from heightened awareness of their health.

Future perceptions and financial impacts from COVID-19 were also linked to spine surgeon health. While there was an association between comorbidity diagnosis and being present during intubation/extubation, multivariate analysis suggested that tobacco users were less likely to be absent during patient intubation/extubation. As restrictions are lifted allowing elective spine surgery to be performed, spine surgeons should continue to remain wary of their health. At baseline, surgeons practice meticulous sterile technique, but these techniques may expand into the clinical setting. Furthermore, use of masks and gloves for routine visits may become commonplace. This may even become expected, as spine surgeons with increasing comorbidities are at increased risk for complications from communicable diseases such as COVID-19. Telecommunication as a means of delivering healthcare is becoming more commonplace,[21] though was less likely to be utilized in the present study by spine surgeons with current tobacco use.

Similarly, univariate analysis of comorbidities suggested that unhealthier spine surgeons with comorbidities such as hypertension and tobacco use perceived that they would increase nonoperative measures over the next year. Fortunately, duration of symptoms is an inconsistent marker of postoperative outcomes.[22] On the contrary, spine surgeons with more comorbidities were more likely to be performing elective surgery during the pandemic, though they also perceived their hospital administration negatively.

Like the current study, substance abuse (tobacco in the current study) contributes significantly to overall health status, especially as physicians have been noted to neglect their own health.[23] Interestingly, the unhealthier population using tobacco were more concerned with their personal health, though they were also more likely to still be performing elective surgery during the pandemic. This highlights the lack of introspection of surgeons who may be facing economic pressures and may forget about their health. Furthermore, work-hour restrictions and avoidance of sleep deprivation in medical professionals, from the standpoint of spine surgeon health as well as patient safety, has increased awareness of overall physician health.[24,25] Aside from the noted comorbidities, stress management, family support, and recreation have been cited as tools to battle fatigue or burnout.[26,27] Not only does such burn out affect individual surgeon health but may affect productivity, outcomes, and patient care.

However, the present study is not without limitations. For one, if a respondent did not note any comorbidities, this could also imply that they did not feel comfortable to disclose such information, raising issues of transparency and willingness to share personal information via such a survey. However, the distribution of comorbidities, noting hypertension and obesity as the most common, would imply that the trend of capturing such information may be representative given the fact that such conditions are well known to be more common. Also, the present study did not compare perceptions between outbreak and nonoutbreak nations facing COVID-19 despite the vast prevalence of the virus. Furthermore, there were several instances where having "1 comorbidity" would significantly influence perceptions and impacts from COVID-19, though each individual di-

agnosis was insignificant, highlighting the likely low statistical power of individual diagnoses. It is expected that statistical significance would emerge with a higher number of respondents with each diagnosis in such scenarios.

CONCLUSION

The present study is the first to map out comorbidities of spine surgeons across the globe, highlighting comorbidities that had a significant impact on healthcare delivery and clinical decision-making related to the COVID-19 pandemic. Without question, COVID-19 has impacted patients and healthcare providers worldwide. This study has emphasized the importance of spine surgeon health. Spine surgeons are not immune to common comorbidities, and as the surgical landscape slowly returns to normalcy, it becomes even more relevant for this community to remain introspective about their health to prevent any individual health-related complications and maximize optimal patient care and outcomes.

CONFLICT OF INTEREST

The authors have nothing to disclose.

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