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The Impact of COVID-19 Pandemic on Spine Surgeons Worldwide

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Abstract

Study Design: Cross-sectional, international survey.

Objectives: The current study addressed the multi-dimensional impact of COVID-19 upon healthcare professionals, particularly spine surgeons, worldwide. Secondly, it aimed to identify geographical variations and similarities.

Methods: A multi-dimensional survey was distributed to surgeons worldwide. Questions were categorized into domains: demographics, COVID-19 observations, preparedness, personal impact, patient care, and future perceptions.

Results: 902 spine surgeons representing 7 global regions completed the survey. 36.8% reported co-morbidities. Of those that underwent viral testing, 15.8% tested positive for COVID-19, and testing likelihood was region-dependent; however, 7.2% would not disclose their infection to their patients. Family health concerns were greatest stressor globally (76.0%), with anxiety levels moderately high. Loss of income, clinical practice and current surgical management were region-dependent, whereby 50.4% indicated personal-protective-equipment were not adequate. 82.3% envisioned a change in their clinical practice as a result of COVID-19. More than 33% of clinical practice was via telemedicine. Research output and teaching/training impact was similar globally. 96.9% were interested in online medical education. 94.7% expressed a need for formal, international guidelines to manage COVID-19 patients.

Conclusions: In this first, international study to assess the impact of COVID-19 on surgeons worldwide, we identified overall/regional variations and infection rate. The study raises awareness of the needs and challenges of surgeons that will serve as the foundation to establish interventions and guidelines to face future public health crises.

Keywords
COVID-19, coronavirus, spine surgeons, global, worldwide, impact

Introduction

As of April 10, 2020, the novel coronavirus, COVID-19, has spread to more than 210 countries, infecting more than 1 700 000 individuals and causing more than 100 000 deaths.[1-5] Although there is enormous attention surrounding COVID-19, there is a pressing need to accelerate protocols and guidelines for testing, patient management, antiviral therapies, and effective vaccines. The medical community has provided treatment algorithms, protocols for the use of personal protective equipment (PPE), resource allocation, and collaborative

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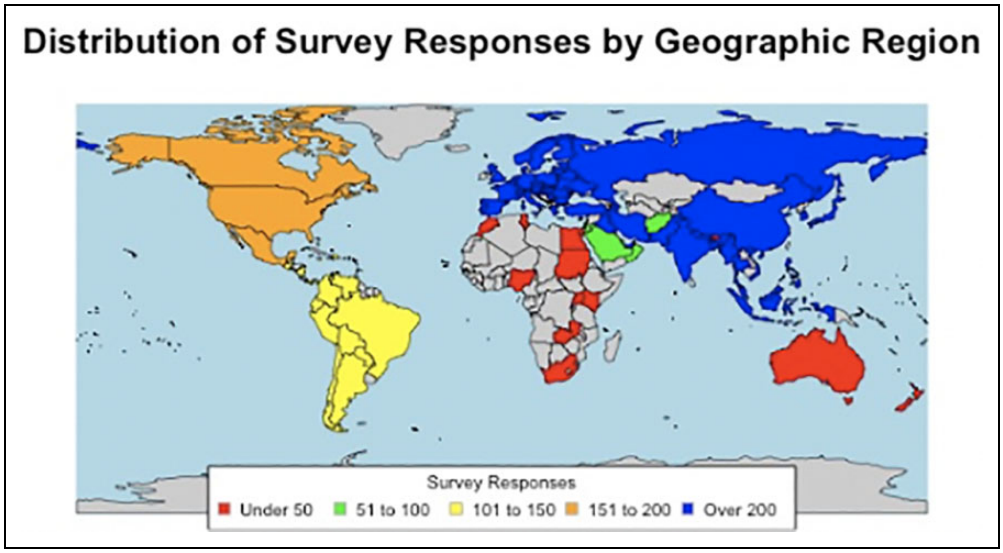

Figure 1. Distribution of survey responses by geographic region; world map depicting number of survey responses received internationally. Color-filled countries indicate that at least 1 survey was received from that geographic region. Red, <50 surveys received; green, 51 to 100; yellow, 101 to 150; orange, 151 to 200; blue, >200; gray, no surveys received.

efforts to mitigate the effects of the COVID-19[6]; however, the standardization and global acceptance of such protocols remain under question, and not all centers have such resources in abundance. In addition, COVID-19 has proven to not only be a medical crisis, but a financial and social one as well.

The impact on individual subspecialists in the age of COVID-19 remains unclear, especially in epicenters where physicians' roles are transforming to meet needs during this pandemic. Furthermore, a great deal of attention has focused on emergency and critical care specialists; however, the surgeon is often lost in the conversation. Baseline burnout rates are incredibly high in this population, and a global pandemic may negatively compound associated consequences.[7,8] Because of the suspension of most elective surgeries worldwide and in-person clinics, many surgeons have had to rapidly adjust their practice and assist on frontline duties. Additionally, surgeons work in multidisciplinary teams; thus, elective surgery cancellations have downstream effects on various health care workers.

The current study addressed the multidimensional impact of COVID-19 on health care professionals, particularly spine surgeons, worldwide. Second, it aimed to identify geographical variations and similarities.

Methods

Survey Design and Content

A survey, known as the AO Spine COVID-19 and Spine Surgeon Global Impact Survey, was developed with representation of various regions. Question selection was based on a Delphi style for consensus, following several rounds of review before finalization. Questions included several domains: demographics, COVID-19 observations, preparedness, personal impact, patient care, and future perceptions.

Survey Distribution

The 73-item survey was presented in English and distributed via email to the AO Spine membership who agreed to receive surveys (n = 3805 of approximately 6000 members). AO Spine is the world's largest society of international spine surgeons (www.aospine.org). The survey recipients were provided 9 days to complete the survey (March 27, 2020, to April 4, 2020). Respondents were informed that their participation was voluntary and confidential; thus, information gained would be disseminated in peer-review journals, websites, and social media.

Statistical Analyses

All statistical analyses were performed with Stata version 13.1 (StataCorp LC, College Station, TX). Graphical representation of survey responses was performed using RStudio v1.2.1335 (RStudio Inc, Boston, MA). Percentages and means were made for count data and rank-order questions, respectively. Statistical analyses were performed to assess significant differences in count data using a combination of Fisher exact and χ^2 tests, where applicable. Differences in continuous variables between groups were assessed using analysis of variance (ANOVA). The threshold for statistical significance for all tests was $P < .05$.

Results

In total, 902 spine surgeons responded to the survey, representing 91 distinct countries and 7 regions. The greatest number of responses were from Europe (242/881; 27.5%), followed by Asia (213/881; 24.2%) and North America (152/881; 17.3%). Most survey responses (Figure 1) were from the United States (128/902; 14.2%), China (73/902; 8.1%), and Egypt (66/902; 7.3%). More respondents were male (826/881; 93.8%) orthopaedic surgeons (637/902; 70.6%), aged 35 to 44 years old

Table 1. Survey Respondent Demographics.

Personal Demographics			Practice Demographics		
	n[a]	Percentage		n[a]	Percentage
Age (years)			Specialty		
25-34	130	14.5	Orthopaedics	637	70.6
35-44	344	38.4	Neurosurgery	246	27.3
45-54	245	27.4	Trauma	104	11.5
55-64	150	16.8	Pediatric Surgery	17	1.9
65+	26	2.9	Other	35	3.9
Sex			Fellowship trained		
Female	55	6.2	Yes	645	71.5
Male	826	93.8	No	257	28.5
Home demographics			Years since training completion		
Spouse at home	773	86.5	Less than 5 years	161	25.3
Children at home			5 to 10 years	141	22.2
0	250	28.2	10 to 15 years	104	16.4
1	221	24.9	15 to 20 years	117	18.4
2	266	30.0	Over 20 years	113	17.8
3	109	12.3	Practice type		
4+	41	4.6	Academic/Private combined	204	22.9
Elderly at home	191	21.4	Academic	405	45.4
Living alone	63	7.1	Private	144	16.1
Estimated home city population			Public/Local hospital	139	15.6
<100 000	46	5.2	Practice breakdown (%)		
100 000-500 000	185	20.7	Percentage research		
500 000-1 000 000	136	15.2	0-25	731	81.9
1 000 000-2 000 000	144	16.1	26-50	129	14.5
>2 000 000	382	42.8	51-75	21	2.4
Geographic region			76-100	12	1.3
Africa	44	5.0	Percentage clinical		
Asia	213	24.2	0-25	22	2.5
Australia	8	0.9	26-50	87	9.7
Europe	242	27.5	51-75	194	21.7
Middle East	77	8.7	76-100	590	66.1
North America	152	17.3	Percentage teaching		
South America/Latin America	145	16.5	0-25	668	74.9
Medical comorbidities			26-50	152	17.0
Cancer	4	0.4	51-75	50	5.6
Cardiac disease	25	2.8	76-100	22	2.5
Diabetes	45	5.0			
Hypertension	156	17.3			
No comorbidities	570	63.2			
Obesity	103	11.4			
Renal failure	5	0.6			
Respiratory illness	35	3.9			
Tobacco use	77	8.5			
Total respondents	902	100			

[a] Number of respondents/votes.

(344/895; 38.4%), and primarily practiced in academic and/or private institutions. Notably, 92.9% of all respondents currently live with a spouse, children, and/or the elderly, and 36.8% report a medical comorbidity (Table 1).

Of the 57 who underwent viral testing, 9 (15.8%) reported testing positive for COVID-19. However, surgeons from some geographic locations were more likely to have been previously tested for COVID-19 ($P < .001$) and had differing opinions on whether local and/or international news outlets were providing accurate ($P < .001$) or excessive coverage ($P = .001$) on the pandemic. Variations arose regarding personal concern for region-specific entities, such as hospital capacity ($P = .011$), roles taken by government/leadership ($P = .016$), and economic consequence ($P = .007$; Table 2, Figure 2). Respondents reported significantly different institutional and government approaches as they related to management of COVID-19. Specifically, distinct variations were observed in quarantining ($P < .001$), hospital/government interventions ($P < .001$ to

Table 2. COVID-19 Perceptions.

	Overall		Africa		Asia		Australia		Europe		Middle East		North America		South America/ Latin America		
	n[b]/ Mean	Percentage/ ±SD	n[b]/ Mean	Percentage/ ±SD	n[b]/ Mean	Percentage/ ±SD	n[b]/ Mean	Percentage/ ±SD	n[b]/ Mean	Percentage/ ±SD	n[b]/ Mean	Percentage/ ±SD	n[b]/ Mean	Percentage/ ±SD	n[b]/ Mean	Percentage/ ±SD	*P* Value[a]
COVID-19 diagnosis																	
Know someone diagnosed	392	46.6	12	27.9	64	33.0	2	25.0	146	63.5	29	41.4	71	48.0	65	48.2	**<.001**
Personally diagnosed	9	1.1	0	0.0	2	1.0	0	0.0	2	0.9	0	0.0	2	1.3	3	2.2	.791
COVID-19 testing																	
Know how to get tested	701	82.9	32	74.4	170	87.6	7	87.5	192	82.8	54	77.1	126	84.6	110	80.9	.259
Personally tested	57	6.7	0	0.0	6	3.1	0	0.0	32	13.8	1	1.4	9	6.0	8	5.9	**<.001**
Reason for testing																	
Direct contact with COVID-19 positive patient	49	35.5	4	57.1	9	25.0	21	44.7	3	37.5	5	41.7	6	22.2	6	4.1	.205
Prophylactic	12	8.7	1	14.3	6	16.7	3	6.4	0	0.0	0	0.0	2	7.4	2	1.4	.369
Demonstrated symptoms	68	49.3	2	28.6	16	44.4	20	42.6	4	50.0	7	58.3	19	70.4	19	13.1	.181
Asked to be tested	9	6.5	0	0.0	5	13.9	3	6.4	1	12.5	0	0.0	0	0.0	8	5.5	.233
Mean worry about COVID-19 (1, not worried, to 5, very worried)	3.7	±1.2	3.6	±1.2	3.7	±1.2	3.1	±2.1	3.7	±1.1	3.4	±1.2	3.8	±1.1	3.9	±1.2	.167
Current stressors																	
Personal health	358	42.5	19	44.2	97	50.5	6	75.0	84	36.4	32	45.7	55	36.9	59	43.4	**.026**
Family health	640	76.0	29	67.4	146	76.0	5	62.5	183	79.2	56	80.0	110	73.8	102	75.0	.553
Community health	370	43.9	22	51.2	95	49.5	4	50.0	97	42.0	38	54.3	50	33.6	56	41.2	**.032**
Hospital capacity	352	41.8	17	39.5	71	37.0	6	75.0	117	50.6	22	31.4	61	40.9	53	39.0	**.011**
Timeline to resume clinical practice	378	44.9	18	41.9	86	44.8	5	62.5	108	46.8	21	30.0	93	62.4	41	30.1	**<.001**
Government/Leadership	154	18.3	6	14.0	50	26.0	2	25.0	33	14.3	6	8.6	29	19.5	27	19.9	**.016**
Return to nonessential activities	116	13.8	6	14.0	19	9.9	3	37.5	35	15.2	7	10.0	33	22.1	12	8.8	**.004**
Economic issues	385	45.7	17	39.5	68	35.4	4	50.0	105	45.5	34	48.6	77	51.7	77	56.6	**.007**
Other	11	1.3	0	0.0	2	1.0	0	0.0	1	0.4	2	2.9	5	3.4	1	0.7	.203
Media perceptions																	
Accurate coverage	407	48.5	17	39.5	98	51.0	5	62.5	115	49.8	23	32.9	90	60.8	53	39.3	**<.001**
Excessive coverage	298	35.5	22	51.2	65	33.9	2	25.0	77	33.3	34	48.6	36	24.3	58	43.0	**.001**
Not enough coverage	135	16.1	4	9.3	29	15.1	1	12.5	39	16.9	13	18.6	22	14.9	24	17.8	.861
Current media sources																	
International news: internet	202	26.0	14	35.0	39	21.8	2	25.0	70	32.3	20	31.8	23	16.1	32	27.4	**.013**
International news: television	72	9.3	7	17.5	12	6.7	0	0.0	14	6.5	17	27.0	7	4.9	12	10.3	**<.001**
National/Local news: internet	224	28.8	7	17.5	53	29.6	4	50.0	62	28.6	9	14.3	61	42.7	26	22.2	**<.001**
National/Local news: television	177	22.8	6	15.0	42	23.5	2	25.0	50	23.0	7	11.1	39	27.3	28	23.9	.232
Newspaper	28	3.6	0	0.0	5	2.8	0	0.0	8	3.7	3	4.8	7	4.9	5	4.3	.787
Social media	75	9.6	6	15.0	28	15.6	0	0.0	13	6.0	7	11.1	6	4.2	14	12.0	**.004**

[a] Calculation of *P* values was performed using χ^2, Fisher, and ANOVA tests. Bolded values indicate statistical significance at $P < .05$.
[b] Number of respondents/votes.

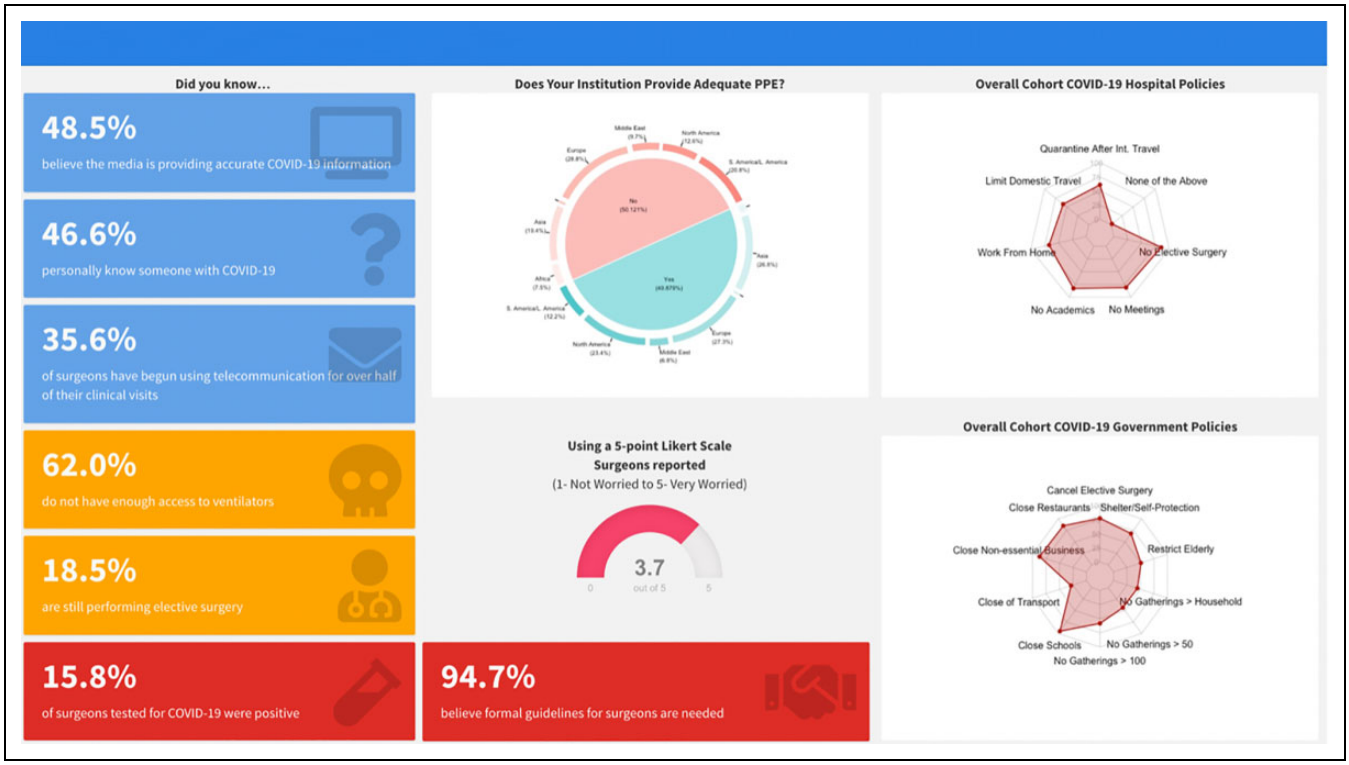

Figure 2. COVID-19 Worldwide Impact Surgeon Infographic highlighting key finding surrounding surgeon perspectives of the media, institutional and governmental policy enactment, and occupational hazard risks from the AO Spine COVID-19 and Spine Surgeon Global Impact Survey.

$P = .024$), PPE availability and type ($P < .001$ to $P = .045$), and medical staff employment ($P < .001$). Most surgeons had roughly similar perceptions about institutional responsiveness ($P = .169$ to $P = .881$; Tables 3 and 4; Figure 3).

COVID-19 had varying impact on clinical practice. Although most report cancellation of >75% of their surgical cases per week (539/803; 67.1%), differences in reported cancellation rate were seen across geographic regions ($P < .001$ to $P = .021$). Similar discrepancies are present with ongoing elective ($P < .001$) and emergency surgical cases ($P < .001$), with variation in precaution recommendations for procedures. Although there was no difference in the recommendation of additional PPE ($P = .583$) and/or cancellation of procedures ($P = .253$) between regions (Figure 4), opinions varied regarding the use of standard precautions and/or modifications during the intubation/extubation procedures (Table 4; Figure 5).

Respondents had similar breakdowns for their allocation of time and stress-coping mechanisms. No significant differences were seen across geographic regions for spending time with family, personal wellness, resting, future planning, hobbies, or academic/clinical work. Greatest current stressors were family health (76%), followed by economic issues (45.7%), timeline to resume normal practice (44.9%), and community health (43.9%). Similarly, stress relief through reading, television, meditation, research, family, and telecommunication with friends was comparable between regions. Significant differences largely arose surrounding the cancellation of business and leisure activities ($P < .001$ to $P = .026$; Table 5).

Although most practitioners envision changes to their clinical practice as a result of COVID-19 (618/751; 82.3%), they similarly recognized the need for future standardized guidelines (710/750; 94.7%) across geographic regions ($P = .068$ and $P = .418$, respectively). Respondents expressed further dissimilarities regarding the current use of telecommunication clinical visits ($P < .001$).

Discussion

To our knowledge, our study is the first to assess the multidimensional impact of COVID-19 on surgeons worldwide. With >900 respondents worldwide, we noted variations between regions for COVID-19 testing, government/leadership perceptions, impact of media/news outlets, hospital capacity for COVID-19, and economic consequences. We identified that 16% of all spine surgeons who underwent viral testing globally tested positive for COVID-19, and up to 13% would be less likely and not at all compelled to disclose their positive testing to their patients. The study also noted an overwhelming need for guidelines to manage patients under a pandemic. It noted that key PPEs, such as masks, face shields, gowns, and so on, were not readily available to clinicians.

COVID-19 Surveys

Few surveys have also examined specific COVID-19 domains in health care providers. Khan et al[9] evaluated 302 health care

Table 3. Institutional/Government Impact.

	Overall		Africa		Asia		Australia		Europe		Middle East		North America		South America/ Latin America		*P*
	n[b]	Percentage	n[b]	Percentage	n[b]	Percentage	n[b]	Percentage	n[b]	Percentage	n[b]	Percentage	n[b]	Percentage	n[b]	Percentage	Value[a]
Quarantined	193	22.9	4	9.3	28	14.7	1	12.5	42	18.1	8	11.4	27	18.1	77	57.0	**<.001**
Institution																	
Formal guidelines in place	452	60.4	25	56.8	122	57.3	7	87.5	118	48.8	36	46.8	90	59.2	50	34.5	**<.001**
Adequate PPE provided	415	49.6	12	27.3	110	51.6	3	37.5	112	46.3	28	36.4	96	63.2	50	34.5	**<.001**
N95	451	54.0	10	23.3	106	55.2	6	75.0	115	50.4	23	33.3	123	83.7	62	45.9	**<.001**
Surgical mask	738	88.4	38	88.4	174	90.6	8	100.0	213	93.4	63	91.3	130	88.4	100	74.1	**<.001**
Face shield	415	49.7	15	34.9	99	51.6	7	87.5	123	54.0	18	26.1	107	72.8	42	31.1	**<.001**
Gown	491	58.8	25	58.1	102	53.1	8	100.0	142	62.3	44	63.8	113	76.9	53	39.3	**<.001**
Full face respirator	95	11.4	2	4.7	24	12.5	1	12.5	27	11.8	3	4.4	28	19.1	10	7.4	**.013**
Ventilators	343	41.0	3	6.8	84	39.4	3	37.5	114	47.1	14	18.2	80	52.6	41	28.3	**<.001**
Other	55	6.6	2	4.7	12	6.3	1	12.5	14	6.1	8	11.6	8	5.4	8	5.9	.663
None	33	4.0	3	7.0	6	3.1	0	0.0	5	2.2	1	1.5	4	2.7	14	10.4	**.003**
Hospital interventions																	
Quarantine after international travel	507	60.9	21	48.8	131	68.2	8	100.0	125	54.6	30	43.5	104	72.2	82	60.7	**<.001**
Limitations on domestic travel	483	58.0	23	53.5	120	62.5	8	100.0	126	55.0	28	40.6	104	72.2	68	50.4	**<.001**
Nonessential employees work from home	558	67.0	21	48.8	98	51.0	6	75.0	175	76.4	42	60.9	124	86.1	84	62.2	**<.001**
Cancellation of all educational/ academic activities	689	82.7	30	69.8	153	79.7	8	100.0	208	90.8	55	79.7	121	84.0	101	74.8	**<.001**
Cancellation of hospital meetings	674	80.9	29	67.4	138	71.9	8	100.0	200	87.3	53	76.8	130	90.3	105	77.8	**<.001**
Cancellation of elective surgeries	714	85.7	33	76.7	131	68.2	8	100.0	217	94.8	62	89.9	140	97.2	113	83.7	**<.001**
None of the above	17	2.0	1	2.3	5	2.6	0	0.0	0	0.0	4	5.8	1	0.7	6	4.4	**.020**
Medical staff furlough																	
Yes	307	40.5	17	44.7	70	40.0	1	12.5	81	38.8	25	41.0	40	28.2	67	58.8	**.020**
Potentially	165	21.8	10	26.3	22	12.6	4	50.0	51	24.4	10	16.4	44	31.0	23	20.2	**.001**
No	286	37.8	11	29.0	83	47.4	3	37.5	77	36.8	26	42.6	58	40.9	24	21.1	**<.001**
Medical staff unemployment																	
Yes	67	8.8	4	10.0	11	6.3	1	12.5	9	4.3	2	3.3	23	16.4	17	14.7	**<.001**
Potentially	108	14.2	5	12.5	14	8.0	2	25.0	27	12.9	6	9.8	23	16.4	28	24.1	**<.001**
No	586	77.0	31	77.5	151	85.8	5	62.5	173	82.8	53	86.9	94	67.1	71	61.2	**<.001**
Perception of hospital effectiveness																	
Acceptable/Appropriate	477	61.4	14	35.0	125	69.8	5	62.5	129	59.5	30	48.4	105	73.4	63	53.9	**<.001**
Excessive/Unnecessary	17	2.2	1	2.5	4	2.2	0	0.0	5	2.3	1	1.6	5	3.5	1	0.9	.881
Disarray/Disorganized	68	8.8	1	2.5	11	6.2	0	0.0	26	12.0	6	9.7	10	7.0	14	12.0	.169
Not enough action	215	27.7	24	60.0	39	21.8	3	37.5	57	26.3	25	40.3	23	16.1	39	33.3	**<.001**
Frequency of updates from hospital																	
Multiple times per day	160	20.7	7	17.5	33	18.5	1	12.5	41	19.0	8	12.9	52	36.6	15	12.8	**<.001**
Once a day	366	47.3	17	42.5	85	47.8	5	62.5	108	50.0	22	35.5	74	52.1	52	44.4	.330

(continued)

Table 3. (continued)

	Overall		Africa		Asia		Australia		Europe		Middle East		North America		South America/ Latin America		*P*
	n[b]	Percentage	n[b]	Percentage	n[b]	Percentage	n[b]	Percentage	n[b]	Percentage	n[b]	Percentage	n[b]	Percentage	n[b]	Percentage	Value[a]
2-3 Times per week	106	13.7	5	12.5	30	16.9	1	12.5	33	15.3	4	6.5	18	12.7	14	12.0	0.523
Once per week	44	5.7	1	2.5	15	8.4	1	12.5	11	5.1	3	4.8	3	2.1	9	7.7	.204
Less than once per week	10	1.3	1	2.5	3	1.7	0	0.0	2	0.9	0	0.0	0	0.0	3	2.6	.474
Not at all	142	18.4	12	30.0	29	16.3	0	0.0	37	17.1	27	43.6	4	2.8	30	25.6	**<.001**
Government																	
Cancel elective surgery	646	77.2	27	62.8	122	63.9	8	100.0	201	87.4	58	84.1	124	83.8	95	70.4	**<.001**
Shelter/Self-protection	570	68.1	21	48.8	123	64.4	7	87.5	169	73.5	42	60.9	119	80.4	80	59.3	**<.001**
No gatherings > 50 people	365	43.6	25	58.1	88	46.1	6	75.0	74	32.2	34	49.3	76	51.4	58	43.0	**.001**
No gatherings > 100 people	458	58.3	16	37.2	118	61.8	4	50.0	150	65.2	27	39.1	117	79.1	49	36.3	**<.001**
No gatherings > household	371	44.3	13	30.2	70	36.7	6	75.0	151	65.7	22	31.9	61	41.2	46	34.1	**<.001**
Closure of nonessential business	727	86.9	34	79.1	152	79.6	7	87.5	206	89.6	59	85.5	139	93.9	119	88.2	**.003**
Closure of schools/universities	795	95.0	40	93.0	175	91.6	7	87.5	225	97.8	66	95.7	144	97.3	125	92.6	**.045**
Closure of dine-in restaurants	711	85.0	33	76.7	129	67.5	8	100.0	215	93.5	58	84.1	142	96.0	113	83.7	**<.001**
Closure of public transportation	239	28.6	12	27.9	96	50.3	2	25.0	36	15.7	24	34.8	34	23.0	29	21.5	**<.001**
Restrict elderly to home	426	50.9	15	34.9	94	49.2	4	50.0	143	62.2	22	31.9	54	36.5	91	67.4	**<.001**
Perception of government effectiveness																	
Acceptable/Appropriate	456	58.5	17	42.5	114	63.7	5	62.5	130	59.9	41	65.1	68	47.6	74	62.7	**.017**
Excessive/Unnecessary	20	2.6	0	0.0	4	2.2	0	0.0	7	3.2	0	0.0	7	4.9	2	1.7	.346
Disarray/Disorganized	88	11.3	2	5.0	13	7.3	1	12.5	24	11.1	5	7.9	28	19.6	13	11.0	**.019**
Not enough action	215	27.6	21	52.5	48	26.8	2	25.0	56	25.8	17	27.0	40	28.0	29	24.6	**.038**

[a] Calculation of *P* values was performed using χ^2 and Fisher exact tests. Bolded values indicate statistical significance at $P < .05$.
[b] Number of respondents/votes.

Table 4. Practice Impact.

	Overall		Africa		Asia		Australia		Europe		Middle East		North America		South America/Latin America		*P* Value[a]
	n[b]	Percentage	n[b]	Percentage	n[b]	Percentage	n[b]	Percentage	n[b]	Percentage	n[b]	Percentage	n[b]	Percentage	n[b]	Percentage	
Still performing elective surgery	149	18.5	12	27	84	39.4	0	0.0	24	9.9	9	11.7	6	4.0	14	9.7	**<.001**
Essential/Emergency spine surgery	700	87.3	35	80	159	74.7	7	87.5	199	82.2	56	72.7	137	90.1	98	67.6	**<.001**
Percentage cancelled surgical cases per week																	
0-25	69	8.6	8	20	41	22.0	1	12.5	12	5.4	1	1.5	3	2.1	6	4.8	**<.001**
26-50	123	15.3	6	15	20	10.8	0	0.0	15	6.7	12	18.2	2	1.4	12	9.7	**<.001**
51-75	72	9.0	7	17	34	18.3	0	0.0	28	12.6	21	31.8	16	11.1	15	12.1	**.002**
76-100	539	67.1	20	49	91	48.9	7	87.5	168	75.3	32	48.5	123	85.4	91	73.4	**<.001**
Impact on clinical time spent																	
Increased	46	5.7	1	2	10	5.4	1	12.5	13	5.8	2	3.0	2	1.4	15	12.1	**.008**
Decreased	675	84.0	38	93	152	82.2	6	75.0	180	80.7	61	91.0	138	95.2	92	74.2	**<.001**
Stayed the same	83	10.3	2	5	23	12.4	1	12.5	30	13.5	4	6.0	5	3.5	17	13.7	**.021**
Perceived impact on resident/fellow training																	
Not currently training residents/fellows	268	33.7	14	35	68	36.8	0	0.0	67	30.5	30	44.8	42	29.6	43	35.0	.096
Hurts training experience	450	56.5	25	63	96	51.9	6	75.0	127	57.7	35	52.2	88	62.0	67	54.5	.439
Improves training experience	30	3.8	1	3	8	4.3	0	0.0	9	4.1	1	1.5	2	1.4	8	6.5	.370
No overall impact	48	6.0	0	0	13	7.0	2	25.0	17	7.7	1	1.5	10	7.0	5	4.1	.053
Medical duties outside specialty	183	22.8	9	21	34	16.0	1	12.5	70	28.9	3	3.9	34	22.4	34	22.4	**<.001**
Warning patients if the surgeon is COVID-19 positive																	
Absolutely	595	74.2	27	68	140	75.7	8	100.0	160	72.4	43	63.2	114	78.6	94	75.8	.117
Likely	106	13.2	4	10	23	12.4	0	0.0	35	15.8	11	16.2	16	11.0	16	12.9	.661
Less likely	43	5.4	4	10	12	6.5	0	0.0	11	5.0	6	8.8	5	3.5	4	3.2	.370
Not at all	58	7.2	5	13	10	5.4	0	0.0	15	6.8	8	11.8	10	6.9	10	8.1	.492
Research activities affected																	
No research engagement	206	27.0	9	23	42	24.1	2	25.0	60	28.4	22	36.1	28	19.6	37	32.2	.147
Complete stop	122	16.0	7	18	31	17.8	1	12.5	35	16.6	10	16.4	16	11.2	19	16.5	.793
Decrease in productivity	247	32.4	15	38	64	36.8	3	37.5	61	28.9	16	26.2	56	39.2	31	27.0	.186
No change	108	14.2	6	15	24	13.8	2	25.0	30	14.2	10	16.4	23	16.1	12	10.4	.833
Increase in productivity	80	10.5	3	8	13	7.5	0	0.0	25	11.9	3	4.9	20	14.0	16	13.9	.197
Surgery impact																	
Advise against	561	70.4	26	63	119	64.3	6	75.0	157	71.7	53	80.3	104	72.2	87	70.7	.253
Proceed with standard precautions	138	17.3	8	20	46	24.9	1	12.5	26	11.9	15	22.7	13	9.0	28	22.8	**<.001**
Absent during intubation/extubation	322	40.4	10	24	52	28.1	5	62.5	92	42.0	23	34.9	82	56.9	56	45.5	**<.001**
Additional PPE during surgery	428	43.7	16	39	105	56.8	4	50.0	117	53.4	38	57.6	78	54.2	67	54.5	.583

(continued)

Table 4. (continued)

	Overall		Africa		Asia		Australia		Europe		Middle East		North America		South America/Latin America		*P*
	n[b]	Percentage	n[b]	Percentage	n[b]	Percentage	n[b]	Percentage	n[b]	Percentage	n[b]	Percentage	n[b]	Percentage	n[b]	Percentage	Value[a]
Income impact																	
Losing income	308	40.5	22	55	46	26.3	7	87.5	80	38.3	30	49.2	50	35.5	68	58.6	**<.001**
No impact, salary	244	32.1	12	30	70	40.0	1	12.5	83	39.7	15	24.6	51	36.2	9	7.8	**<.001**
No impact, compensation-based	7	0.9	0	0	0	0.0	0	0.0	3	1.4	2	3.3	1	0.7	1	0.9	.382
Planned reduction, salary	138	18.1	6	15	48	27.4	0	0.0	32	15.3	9	14.8	12	8.5	28	24.1	**<.001**
Planned reduction, compensation-based	64	8.4	0	0	11	6.3	0	0.0	11	5.3	5	8.2	27	19.2	10	8.6	**<.001**
Percentage personal income affected																	
0-25	219	28.9	6	15	62	35.4	1	12.5	77	37.4	6	9.8	53	37.9	10	8.6	**<0.001**
26-50	226	29.9	16	40	49	28.0	1	12.5	61	29.6	29	47.5	26	18.6	44	37.9	**<.001**
51-75	142	18.8	10	25	34	19.4	3	37.5	36	17.5	12	19.7	25	17.9	20	17.2	.754
76-100	170	22.5	8	20	30	17.1	3	37.5	32	15.5	14	23.0	36	25.7	42	36.2	**<.001**
Percentage hospital income affected																	
0-25	169	22.3	8	20	42	24.1	2	25.0	64	30.6	7	11.7	26	18.7	15	12.9	**.003**
26-50	199	26.3	13	33	47	27.0	2	25.0	62	29.7	19	31.7	24	17.3	31	26.7	.188
51-75	207	27.3	11	28	53	30.5	2	25.0	48	23.0	19	31.7	41	29.5	33	28.5	.710
76-100	182	24.0	8	20	32	18.4	2	25.0	35	16.8	15	25.0	48	34.5	37	31.9	**.001**

[a] Calculation of *P* values was performed using χ^2 and Fisher exact tests. Bolded values indicate statistical significance at $P < .05$.
[b] Number of respondents/votes.

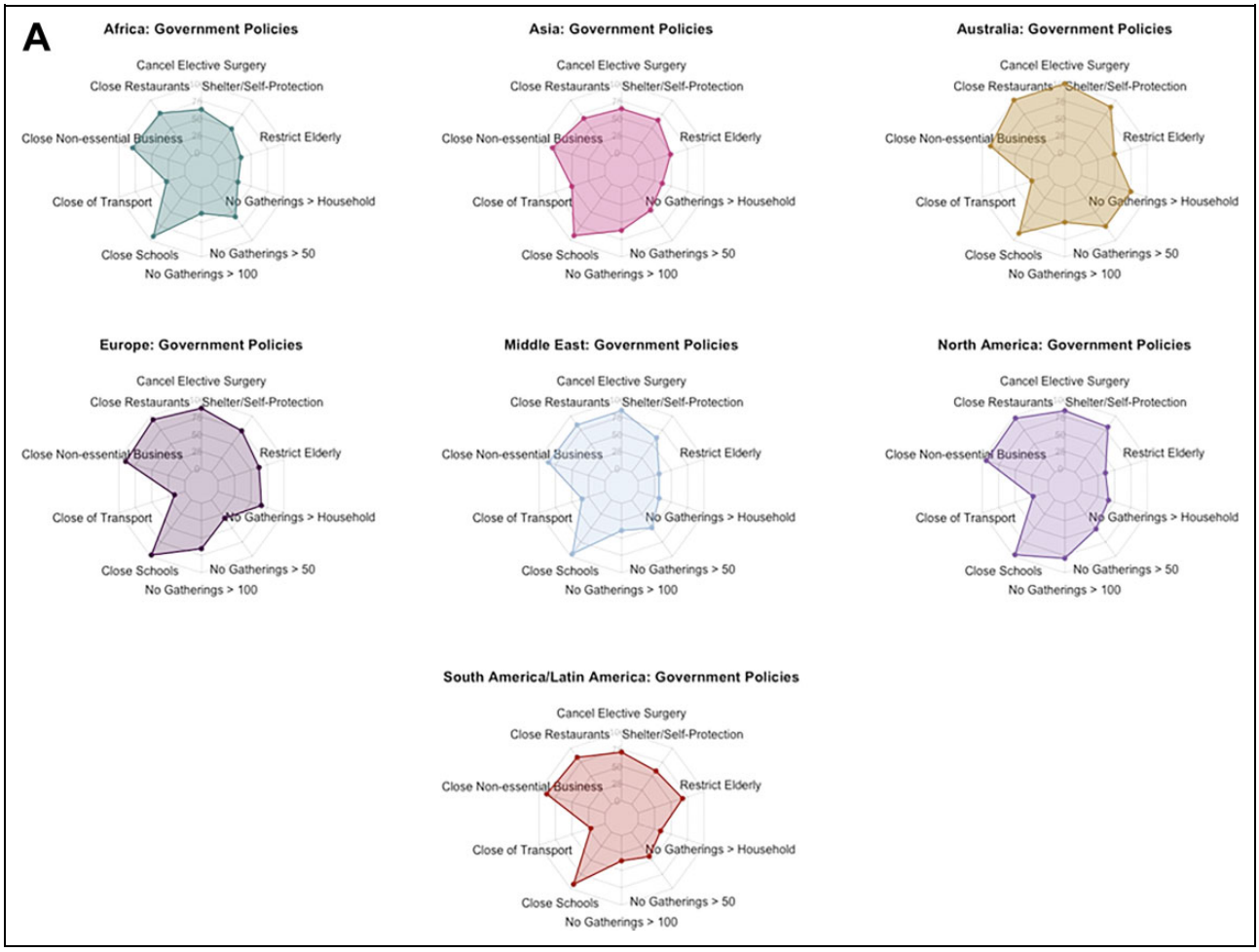

Figure 3. A. Radar chart depictions of current COVID-19 government policies by geographic region: 10-sided (decagon) radar charts visually depicting cumulative percentage of responses verifying the enactment of a given COVID-19 government policy at the time of survey distribution. Queried policies are listed at the vertex of a given figure, whereby points falling on a vertex of the innermost decagon correspond to a cumulative total of 0% of survey responses received. Moving outward from one decagon to the next corresponds to a 25% increase in responses for a given category. B. Radar chart depictions of current COVID-19 hospital policies by geographic region: 7-sided (heptagon) radar charts visually depicting cumulative percentage of responses verifying the enactment of a given COVID-19 hospital policy at the time of survey distribution. Queried policies are listed at the vertex of a given figure, whereby points falling on a vertex of the innermost heptagon correspond to a cumulative total of 0% of survey responses received. Moving outward from one heptagon to the next corresponds to a 25% increase in responses for a given category.

workers in Pakistan on their basic knowledge of COVID-19 and found that front-line workers were not prepared for the pandemic. Lai et al[10] identified high levels of psychological burden in 1257 health care workers in 34 hospitals throughout China caring for COVID-19 patients. Huang et al[11] surveyed 230 medical staff in a tertiary infectious disease hospital for COVID-19 in China and discovered a high incidence of anxiety and stress among staff. Because these surveys target individuals in specific regions and domains of COVID-19 knowledge and opinions, our survey gathered responses from a "global" audience of health care providers across various domains. We also outlined regional breakdowns and demographic variables. Our goal was not to investigate the specific factors involved with the regional differences, but rather shed light on how the different regions perceived and reacted to this global crisis.

Resources and Testing

The COVID-19 outbreak demands increasing focus on resource allocation and the roles in which physicians function. In our study, 23% of the surgeons reported working outside their normal scope of practice, illustrating the unique challenges facing physicians not often at the forefront of the COVID-19 conversation, with varying levels of concern in the mounting pressure. Limitations in testing have been cited as a major shortcoming.[12,13] However, 83% of our respondents stated that they have access to testing. Contact with

Figure 3. (continued)

symptomatic patients was described as the most common reason to seek testing, yet we found that only 7% of our physicians have undergone formal COVID-19 testing; 47% stated that they know someone who has been diagnosed, and only 16% of respondents tested positive. This infection rate was based on respondents who had actually undergone formal viral testing. Substantiated data on the infection rate in health care workers has not been well established because this population describes inconsistent access to testing, if not being actively discouraged to do so. Additionally, infections are being inconsistently tracked and, in some cases, uncounted at the hospital/medical center level. Based on various global news outlets, health care workers have accounted for anywhere between 14% and 30% of total positive COVID-19 tests in various regions.[14,15] More widespread active COVID-19 viral (and eventual antibody) testing is a crucial focus of multiple global entities at this time because these results will help plan for return to work protocols. Overall, spine surgeons exhibited elevated anxiety and uncertainty for the future. The lower rates of testing and diagnosis among our cohort, compared with the general population, suggest surgeons' knowledge of disease transmission and/or possible greater adherence to public health measures aimed at limiting exposure.

Surgeon Well-being

Our survey captures surgeons' health status and age highlighting potential personal factors affecting this cohort's susceptibility to COVID-19. We found that more than 80% of our respondents are <55 years old, with hypertension and obesity as the 2 most common comorbidities, and anxiety levels were moderately high. Although these respondents are younger and with less severe comorbidities than higher-risk populations, concerns for well-being are clearly evident. Concerns for personal well-being and family health as well as professional concerns raise awareness of the unknown psychological stressors faced by surgeons and front-line workers.

Recently, Lai et al[10] assessed the mental health outcomes among Chinese health care workers exposed to COVID-19, revealing that 50% experienced depression, 34% insomnia, and

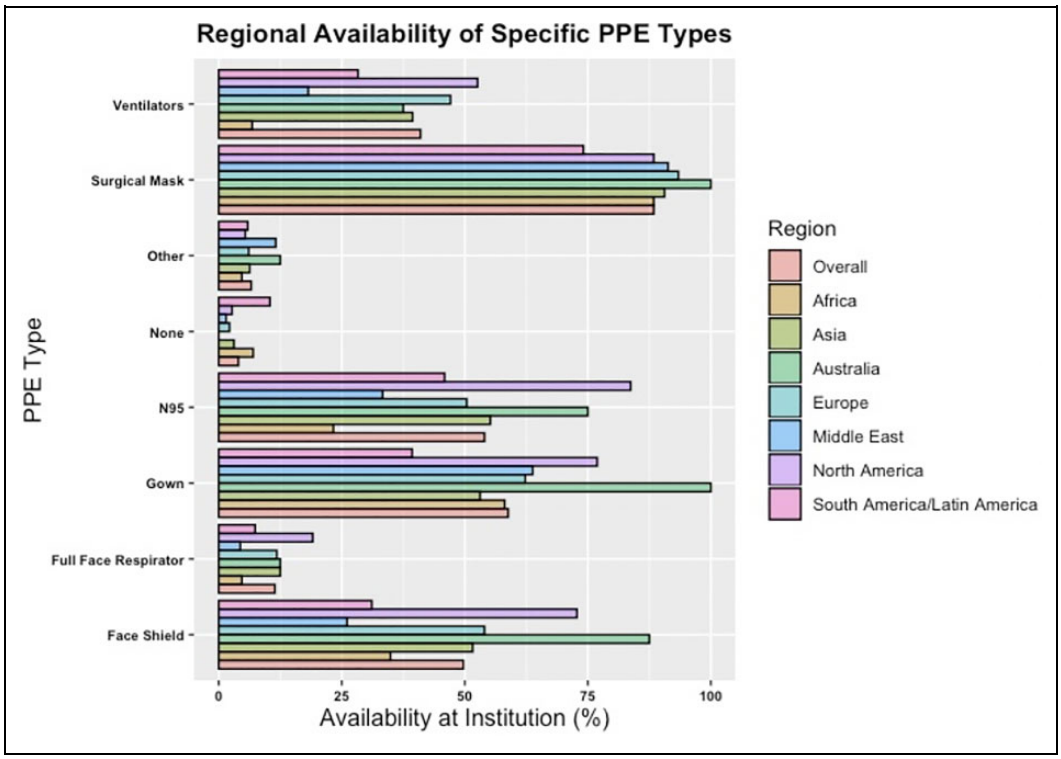

Figure 4. Regional availability of personal protective equipment (PPE) bar chart detailing overall and regional availability of various types of PPE. *X*-axis: percentage of survey responses received; *Y*-axis: type of PPE equipment queried.

72% psychological distress. The perception of personal and community danger, present among frontline workers, is evident among surgeons worldwide. Additionally, 60% of surgeons cancelled or postponed leisure travel because of the outbreak, leading to an inability to obtain much needed respite during this stressful time. Respondents also cited predominantly spending time with family, exercise, and reading as the most common coping mechanisms, with meditation and spiritual/religious activities. The expanding impact of the outbreak will continue to challenge the importance of healthy coping mechanisms during critical times. Finally, surgeons' evolving role in combating this outbreak adds an additional layer of strain, emphasizing the importance of mental health in reducing physician burnout.

Patient Care

International and governmental recommendations have curbed nonemergent surgery in order to optimize delivering care to COVID-19 patients.[16,17] This has a significant impact on surgeons' ability to meet their patients' needs. We found that 81% of surgeons are no longer performing elective surgery, yet the majority (87%) are performing emergency/essential surgery. Thus, surgeons, although greatly affected, are adhering to national and international recommendations to limit nonessential surgery while addressing critical surgical issues. The current pause on elective surgery has brought much consideration of time frames upon which surgeons can safely resume elective surgeries. Our findings indicate that the majority of respondents (49%) have yet to receive a time frame for resuming elective cases. Returning to normal is a crucial issue because economic concerns were the second greatest stressor, and more than 67% of respondents reported decreased income during the pandemic.

One significant challenge facing surgeons is COVID-19 patients requiring surgery and how to manage this population. Such challenging issues complicate the care of these patients. When asked about performing surgery on COVID-19 patients, 70% of respondents recommended against surgery at this time. However, in the setting of urgent and emergency surgery, the decision to perform surgery has life or death implications even without the COVID-19 threat. Additionally, surgeons must consider resource allocation in light of ventilator shortages when deciding to proceed with surgery. Although operating room ventilators are not equivalent to intensive care unit ventilators, in the setting of severe shortages, physician leaders must account for all possible resources and implement uses of best practice to serve the greater good. Interestingly, 59% of surgeons felt that their hospitals did not have enough ventilators, which illustrates the difficult decision of ventilator allocation and best practice. Surgeons are in a unique position as the demands of COVID-19 patients require thoughtful consideration of the risks and benefits of these complexities.

Beyond recommendations against surgery, 44% of surgeons stated donning additional PPE during the surgery of COVID-19

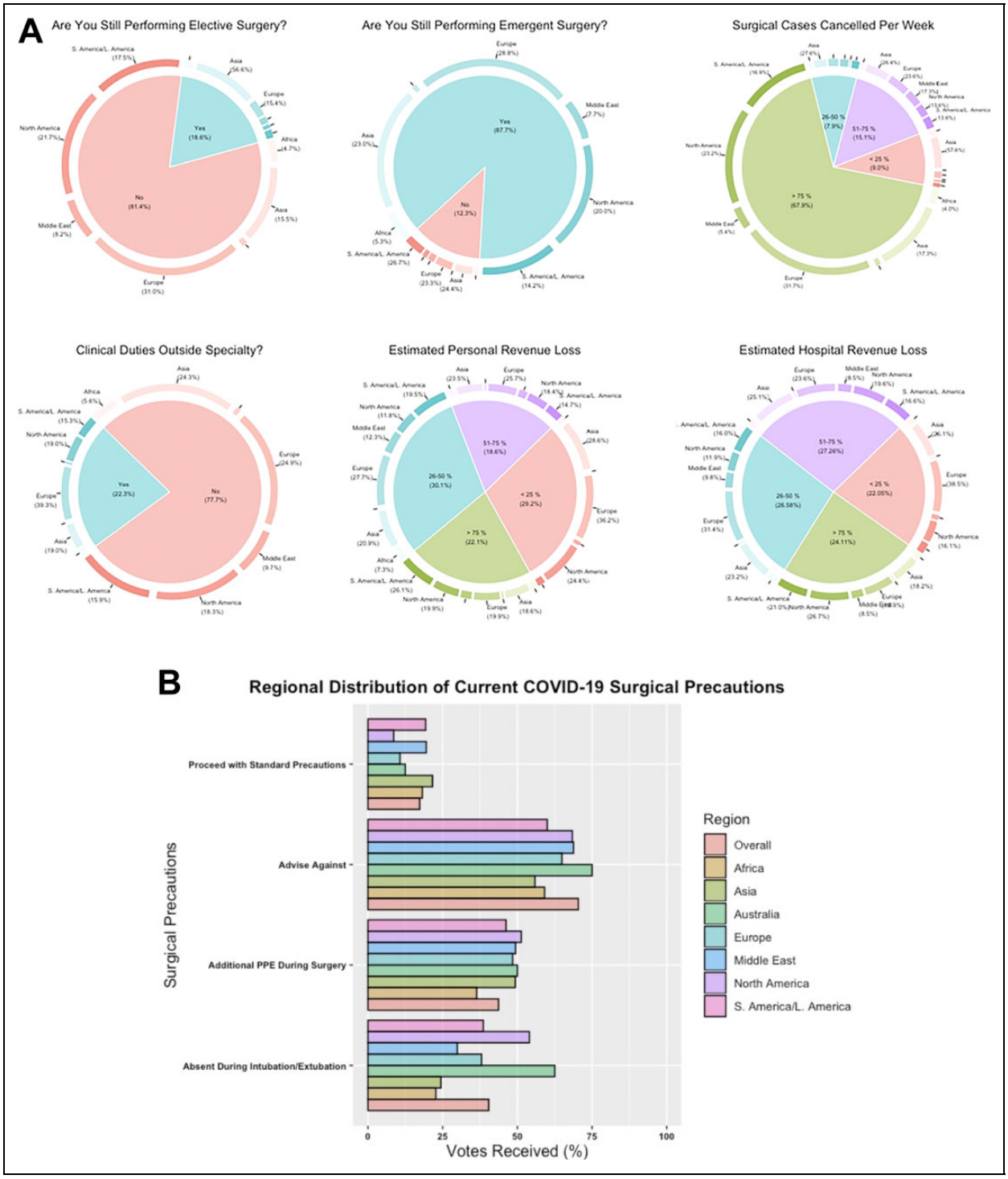

Figure 5. A. Pie donut depictions of questions highlighting COVID-19's impact on clinical practice graphical depictions of specific questions and distribution of responses by geographic region highlighting the impact of COVID-19 on a respondent's surgical practice. Inner pie chart highlights the percentage of responses received for a given answer choice, whereas the outer "donut" reveals the respective geographic distribution. Regions constituting <2% of the overall pie chart area are omitted for clarity. B. Regional distribution of current COVID-19 surgical precautions bar chart detailing overall and regional practices of surgical precautions for COVID-19 positive surgical candidates. *X*-axis, percentage of survey responses received; *Y*-axis, type of surgical precaution queried.

Table 5. Personal Impact and Future Perceptions.

	Personal Impact																
	Overall		Africa		Asia		Australia		Europe		Middle East		North America		South America/ Latin America		
	n[b]/ Mean	Percentage /±SD	n[b]/ Mean	Percentage /±SD	n[b]/ Mean	Percentage /±SD	n[b]/ Mean	Percentage /±SD	n[b]/ Mean	Percentage /±SD	n[b]/ Mean	Percentage /±SD	n[b]/ Mean	Percentage /±SD	n[b]/ Mean	Percentage /±SD	*P* Value[a]
Percentage leisure activities cancelled																	
0-25	177	21.1	14	32.6	49	25.5	1	12.5	53	22.9	16	22.9	12	8.2	30	22.2	**<.001**
26-50	98	11.7	5	11.6	25	13.0	0	0.0	26	11.3	13	18.6	3	2.0	24	17.8	**<.001**
51-75	64	7.6	5	11.6	18	9.4	0	0.0	9	3.9	6	8.6	10	6.8	16	11.9	.105
76-100	500	59.6	19	44.2	100	52.1	7	87.5	143	61.9	35	50.0	122	83.0	65	48.2	**<.001**
Percentage business/academic activities cancelled																	
0-25	98	11.6	8	18.6	21	10.9	0	0.0	34	14.7	10	14.3	6	4.0	17	12.5	**.026**
26-50	116	13.8	9	20.9	31	16.1	1	12.5	34	14.7	13	18.6	7	4.7	19	14.0	**.023**
51-75	76	9.0	4	9.3	21	10.9	0	0.0	17	7.4	7	10.0	4	2.7	22	16.2	**.006**
76-100	553	65.6	22	51.2	120	62.2	7	87.5	146	63.2	40	57.1	132	88.6	78	57.4	**<.001**
Sick leave for COVID-19	4	50.0	0	0.0	0	0.0	0	0.0	2	66.7	0	0.0	0	0.0	2	100.0	.149
Hospitalization for COVID-19	1	12.5	0	0.0	0	0.0	0	0.0	1	33.3	0	0.0	0	0.0	0	0.0	.592
Intensive care unit treatment	1	12.5	0	0.0	0	0.0	0	0.0	1	33.3	0	0.0	0	0.0	0	0.0	.852
Mean personal allocation of time (1, most time; 8, least time)																	
Spending time with family	2.7	±2.2	2.4	±2.0	2.7	±2.1	3.0	±1.7	3.0	±2.4	2.8	±2.5	2.4	±2.0	2.4	±2.1	.161
Personal wellness	3.8	±1.9	3.1	±1.6	3.6	±1.9	4.0	±1.4	4.3	±1.9	3.0	±1.8	3.9	±1.9	3.5	±1.8	.846
Resting	4.3	±2.0	3.4	±1.8	4.3	±2.0	4.5	±1.9	4.4	±2	3.7	±2.0	4.6	±1.9	4.1	±2.0	.986
Future planning	4.6	±1.8	4.4	±1.8	4.8	±1.8	4.8	±2.8	4.5	±1.8	5.1	±1.8	4.3	±1.7	4.6	±1.9	.726
Hobbies	5.2	±1.9	6.1	±1.7	5.5	±1.9	5.3	±1.9	5.1	±1.9	5.0	±2.1	5.5	±1.7	4.7	±2.0	.628
Academic projects/research	4.6	±2.1	5.2	±2.1	4.6	±2.1	3.9	±1.8	4.5	±2.1	4.6	±1.9	4.6	±2.3	4.5	±2.1	.860
Community outreach	6.3	±2.0	6.1	±1.8	6.1	±2.0	6.0	±3.1	6.1	±2.3	6.3	±1.5	7.0	±1.4	6.3	±1.9	**<.001**
Spine practice/Medical center work	4.1	±2.5	5.1	±2.5	4.1	±2.6	3.9	±2.9	3.5	±2.5	5.3	±2.3	3.4	±2.2	5.0	±2.4	.616
Current stress coping mechanisms																	
Exercise	463	62.9	15	38.5	110	65.9	6	75.0	119	58.3	23	39.0	115	82.1	72	66.1	**<.001**
Music	330	44.8	5	12.8	81	48.5	4	50.0	96	47.1	21	35.6	53	37.9	68	62.4	**<.001**
Meditation/Mindfulness	118	16.0	4	10.3	33	19.8	0	0.0	23	11.3	14	23.7	23	16.4	20	18.4	.100
Tobacco	29	3.9	2	5.1	7	4.2	0	0.0	15	7.4	4	6.8	0	0.0	0	0.0	**.005**
Alcohol	89	12.1	0	0.0	16	9.6	2	25.0	25	12.3	3	5.1	23	16.4	19	17.4	**.015**
Research projects	244	33.2	13	33.3	61	36.5	1	12.5	65	31.9	15	25.4	46	32.9	42	38.5	.480
Family	578	78.5	33	84.6	127	76.1	6	75.0	151	74.0	49	83.1	114	81.4	90	82.6	.375
Spiritual/Religious activities	116	15.8	11	28.2	27	16.2	0	0.0	15	7.4	20	33.9	20	14.3	19	17.4	**<.001**
Reading	458	62.2	25	64.1	112	67.1	5	62.5	125	61.3	32	54.2	83	59.3	69	63.3	.681
Television	394	53.5	21	53.9	84	50.3	2	25.0	93	45.6	41	69.5	75	53.6	70	64.2	.003
Telecommunication with friends	322	43.8	14	35.9	71	42.5	5	62.5	80	39.2	25	42.4	67	47.86	57	52.3	.227

(continued)

Table 5. (continued)

	Future Perceptions																
	Overall		Africa		Asia		Australia		Europe		Middle East		North America		South America/ Latin America		
	n[b]/ Mean	Percentage /±SD	n[b]/ Mean	Percentage /±SD	n[b]/ Mean	Percentage /±SD	n[b]/ Mean	Percentage /±SD	n[b]/ Mean	Percentage /±SD	n[b]/ Mean	Percentage /±SD	n[b]/ Mean	Percentage /±SD	n[b]/ Mean	Percentage /±SD	*P* Value[a]
	n[b]	Percentage	n[b]	Percentage	n[b]	Percentage	n[b]	Percentage	n[b]	Percentage	n[b]	Percentage	n[b]	Percentage	n[b]	Percentage	
Belief that future guidelines are needed																	
Yes	710	94.7	38	97.4	160	93.6	8	100.0	190	92.7	58	95.1	139	97.9	107	94.7	.418
No	8	1.1	0	0.0	4	2.3	0	0.0	2	1.0	0	0.0	0	0.0	2	1.8	.448
Unsure	32	4.3	1	2.6	7	4.1	0	0.0	13	6.3	3	4.9	3	2.1	4	3.5	.583
Most effective method for hospital updates																	
Internet webinar	379	48.8	18	40.9	96	45.1	4	50.0	95	39.3	29	37.7	55	36.2	77	53.1	.068
Email	486	62.6	20	45.5	69	32.4	8	100.0	166	68.6	30	39.0	125	82.2	60	41.4	**<.001**
Text message	223	28.7	19	43.2	81	38.0	5	62.5	37	15.3	21	27.3	20	13.2	37	25.5	**<.001**
Flyers	49	6.3	7	15.9	17	8.0	1	12.5	8	3.3	7	9.1	1	0.7	8	5.5	**<.001**
Automated phone calls	43	5.5	11	25.0	19	8.9	0	0.0	3	1.2	7	9.1	0	0.0	3	2.1	**<.001**
Social media outlets	218	28.1	19	43.2	78	36.6	2	25.0	33	13.6	37	48.1	11	7.2	36	24.8	**<.001**
Perceived impact in 1 year																	
No change	133	17.7	5	12.8	24	14.0	3	37.5	47	22.8	7	11.5	30	21.1	16	14.2	.068
Heighted awareness of hygiene	435	57.9	26	66.7	114	66.7	5	62.5	93	45.2	43	70.5	85	59.9	60	53.1	**<.001**
Increase use of PPE	344	45.8	25	64.1	90	52.6	3	37.5	94	45.6	31	50.8	41	28.9	56	49.6	**<.001**
Ask patients to reschedule if sick	285	38.0	15	38.5	75	43.9	3	37.5	85	41.3	17	27.9	46	32.4	38	33.6	.180
Increase nonoperative measures prior to surgery	150	20.0	7	18.0	49	28.7	1	12.5	41	19.9	15	24.6	13	9.2	22	19.5	**.003**
Increase digital options for communication	314	41.8	14	35.9	55	32.2	4	50.0	93	45.2	22	36.1	87	61.3	38	33.6	**<.001**
How likely to attend a conference in 1 year																	
Likely	496	66.3	26	66.7	91	53.5	5	62.5	151	73.3	41	67.2	101	71.6	74	66.1	**.004**
Not likely	55	7.4	1	2.6	16	9.4	0	0.0	13	6.3	3	4.9	9	6.4	11	9.8	.526
Unsure	197	26.3	12	30.8	63	37.1	3	37.5	42	20.4	17	27.9	31	22.0	27	24.1	**.012**
Timeframe to resume elective surgery																	
<2 Weeks	31	3.9	0	0.0	14	7.5	1	12.5	6	2.7	2	3.0	0	0.0	8	6.5	**.005**
2-4 Weeks	136	16.9	4	10.0	39	21.0	0	0.0	23	10.3	15	22.4	20	13.8	32	25.8	**.001**
1-2 Months	127	15.8	3	7.5	22	11.8	1	12.5	29	13.0	3	4.5	51	35.2	15	12.1	**<.001**
>2 Months	33	4.1	0	0.0	7	3.8	1	12.5	9	4.0	0	0.0	11	7.6	5	4.0	.109
No current stoppage	85	10.6	7	17.5	45	24.2	0	0.0	9	4.0	3	4.5	3	2.1	17	13.7	**<.001**
Unknown	392	48.8	26	65.0	59	31.7	5	62.5	147	65.9	44	65.7	60	41.4	47	37.9	**<.001**

(continued)

Table 5. (continued)

	Future Perceptions																
	Overall		Africa		Asia		Australia		Europe		Middle East		North America		South America/ Latin America		
	n[b]/ Mean	Percentage /±SD	n[b]/ Mean	Percentage /±SD	n[b]/ Mean	Percentage /±SD	n[b]/ Mean	Percentage /±SD	n[b]/ Mean	Percentage /±SD	n[b]/ Mean	Percentage /±SD	n[b]/ Mean	Percentage /±SD	n[b]/ Mean	Percentage /±SD	*P* Value[a]
Anticipated number of weeks to resume baseline activity																	
<2 Weeks	96	12.7	5	12.8	35	20.2	0	0.0	18	8.6	5	8.3	20	14.0	11	9.5	**.016**
2-4 Weeks	177	23.3	12	30.8	53	30.6	2	25.0	37	17.7	17	28.3	35	24.5	19	16.4	**.028**
4-6 Weeks	177	23.3	9	23.1	38	22.0	2	25.0	48	23.0	19	31.7	26	18.2	33	28.5	.386
6-8 Weeks	108	14.2	6	15.4	19	11.0	1	12.5	34	16.3	7	11.7	18	12.6	21	18.1	.630
>8 Weeks	201	26.5	7	18.0	28	16.2	3	37.5	72	34.5	12	20.0	44	30.8	32	27.6	**.002**
Percentage telecommunication clinical visits per week																	
0-25	398	50.0	24	58.5	112	60.5	3	37.5	113	50.7	35	53.0	31	21.7	75	60.5	**<.001**
26-50	118	14.7	8	19.5	35	18.9	3	37.5	19	8.5	18	27.3	18	12.6	15	12.1	**<.001**
51-75	77	9.6	4	9.8	14	7.6	0	0.0	22	9.9	5	7.6	19	13.3	13	10.5	.632
76-100	208	26.0	5	12.2	24	13.0	2	25.0	69	30.9	8	12.1	75	52.5	21	16.9	**<.001**
Interest in online spine education																	
Very interested	318	42.5	16	41.0	66	38.8	3	37.5	83	40.3	28	45.9	52	36.6	65	58.0	**.022**
Interested	300	40.1	15	38.5	76	44.7	4	50.0	81	39.3	26	42.6	59	41.6	35	31.3	.439
Somewhat interested	131	17.5	8	20.5	35	20.6	1	12.5	45	21.8	6	9.8	27	19.0	7	6.3	**.010**
Not interested	23	3.1	1	2.6	3	1.8	0	0.0	6	2.9	1	1.6	7	4.9	5	4.5	.675

[a] Calculation of *P* values was performed using ANOVA, χ^2, and Fisher exact tests. Bolded values indicate statistical significance at $P < .05$.
[b] Number of respondents/votes.

patients. The allocation and utilization of PPE has become a controversial issue among leadership because shortages take on a seemingly linear relationship to rates of disease.[18,19] Half of the surgeons felt that their hospitals provide adequate PPE for frontline workers, whereas the remainder stated inadequate PPE resources. Regional analysis revealed that only 27% of surgeons in Africa felt that they have adequate PPE, followed by Latin America (35%), the Middle East (36%), and Australia (38%). Of the forms of PPE provided, the following were the most common: surgical masks (88%), gowns (59%), N-95 masks (54%), and face shields (50%). Regional analysis demonstrated that North America (84%) and Australia (75%) have the greatest access to N95 masks, whereas the Middle East (33%) and Africa (23%) have the least access. Guidelines have standardized infectious disease prevention, and surgeons appear to be adherent.[20] Although hospitals and governments look to optimize use and manufacturing of PPE, there clearly remain concerns across the world.[6,21]

Government, Media, and Future Guidelines

We found that 68% of our respondents have mandates from regional governments for citizens to self-isolate at home. Opinions of individual government responses to COVID-19 have varied. Our cohort's perception of how their governments have been handling the pandemic was mixed, although 59% stated that the response has been acceptable and appropriate; 28% felt that their government had taken some action (but not enough), 11% found their government's reaction to be disorganized, and the remaining 3% thought the actions were excessive and unnecessary. Perceptions of governments' responses reveal that only 18% of respondents attributed government/leadership as a major stressor during this time point of the outbreak. The effectiveness of governmental policies may require eventual post hoc commissions. One component that continues to influence current perception of policies is media coverage, which only 48% felt has been accurate; 36% felt that coverage has been excessive and overblown. Although subjective, this information offers insight into how citizens and news outlets are responding and portraying current policies. Our data imply that the majority feel that their governments are taking appropriate action.

Minimizing mortality remains the highest priority, even at the cost of societal dynamics and economic consequences. Based on our survey, only 60% of respondents noted that guidelines exist to manage such outbreaks in their hospitals/medical centers; however, 95% declared that formal guidelines are needed to address crises for their profession. This desire for widespread guidelines for outbreaks is widely shared across the globe and has been a focus for organizations in all regions.[2,22-24] Finally, the use of online technology will be paramount from an academic and patient care standpoint. International collaboration with research and development of these platforms will be critical to adapt to widespread public health changes.

Limitations

As with many survey-based studies, there are limitations to this study. The survey distribution was limited to the current AO Spine surgeon members' network. The survey was sent out to 3805 spine surgeons worldwide; however, only 902 surgeons responded (23.7%). Perhaps a higher response rate would have been achieved with longer survey duration. Although the response rate may appear low, perhaps we have captured respondents who take special interest in this topic. As such, there may be questionable generalizability in regions in which there were few or no respondents. Potential selection bias may represent a unique makeup of those opting to receive the survey as opposed to those who did not. Previous studies have described that a low response rate does not necessarily mean that the study results have low validity, but rather a greater risk of this.[25,26] So response rates can be informative but independently should not be considered a good proxy for study validity. Another limitation was response completion. The 73-item survey may have created some fatigue; thus, not all parameters were addressed by all respondents. Given the length limit of surveys in general, we were not able to capture all the possible domains related to COVID-19. However, given the variety of regional responses and COVID-19 outbreak severity, we sought to capture the majority of global regions. Despite these limitations, this remains the largest international survey to assess multiple domains of impact the COVID-19 pandemic has had among health care professions, in this case surgeons. This global sample size forms a snapshot of the current situation and provides us with foundational information that can be revisited with future studies to assess longitudinal effects.

Conclusion

This is the first international survey to assess COVID-19 impact among surgeons. Up to 16% of all surgeons who tested for COVID-19 were found to be positive. Specific geographical variations as well as similarities between surgeons were also noted. We plan to further explore these preliminary findings through more analytical approaches to understand some of the subdomains represented in this survey. Additionally, we plan to distribute a follow-up survey at 6 and 12 months to assess the longer-term impact and perform predictive modeling. In closing, findings from our study have noted that COVID-19 has had a substantial impact on surgeons. Therefore, specific attention to the needs and challenges of such a population is needed in the age of the current crisis and in any future public health crises.

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