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A Year of Pandemic—Comparison of Depression Among Neurosurgeons After the Advent of the COVID-19 Vaccine

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■ **OBJECTIVE:** To determine factors associated with anxiety and depression among neurosurgeons after vaccination during the coronavirus disease 2019 (COVID-19) pandemic.

■ **METHODS:** An online survey was completed by neurosurgeons worldwide over 4 weeks. Depression in neurosurgeons was assessed by the 20-item self-reporting questionnaire.

■ **RESULTS:** A total of 534 responses were received and analyzed. Almost half of the respondents were from Asia (50.9%), followed by Europe (38.8%). The majority of the respondents were <40 years old (88%), and almost two thirds were trainees (62.2%). Half of the respondents worked in departments with <40 beds (50.7%), and the majority were practicing in the private sector (72.5%). Most of the respondents (85.8%) had COVID-19—positive colleagues in their department, and 64% had exposure to a COVID-19—positive colleague, family member, and/or patient. More than half of the respondents were exposed to infected patients and/or colleagues, and almost half (43.1%) underwent COVID-19 testing when exposed. Nearly half of the respondents underwent COVID-19 testing more than twice (52.4%). Of respondents, 83% had received at least the first dose of the vaccine. The odds of depression among vaccinated respondents were found to be significantly less than among unvaccinated respondents in the univariable model.

■ **CONCLUSIONS:** Among health care workers, neurosurgeons are one of the groups indirectly affected by the pandemic. Adaptation to the new normal and advent of vaccines is speculated to control psychological distress among all groups of health care workers, including neurosurgeons. We found that odds of depression among vaccinated people were lower than among people who were not vaccinated.

INTRODUCTION

The coronavirus disease 2019 (COVID-19) pandemic has acutely changed health care, transforming clinical services, modifying procedures, and altering standards of medical management. This changed urgent and emergent patient care dynamics, challenging health care workers (HCWs) professionally and personally.¹ Amidst all the havoc, combating an invisible, unknown disease, facing an unpredictable calamity, and eventually adapting to an emerging situation, health care workers (HCWs) are now getting used to the new normal.

Amidst the reaction and adaptation responses of HCWs were emotional turmoil and psychological distress. Studies conducted in 2020 in HCWs showed higher rates of anxiety, depression, and psychological stress among all, not only frontline, HCWs, including surgeons, nurses, and other HCWs.² We conducted a study in neurosurgeons in 2020 during the initial phase of the

Key words

- Anxiety
- COVID-19
- Depression
- Neurosurgeons
- Postvaccination
- Vaccination

Abbreviations and Acronyms

- CI: Confidence interval
 COVID-19: Coronavirus disease 2019
 HCW: Health care worker
 OR: Odds ratio
 PCR: Polymerase chain reaction
 PPE: Personal protective equipment
 WSCS: World Spinal Column Society

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Citation: World Neurosurg. (2022) 159:e466-e478.
<https://doi.org/10.1016/j.wneu.2021.12.076>

Journal homepage: www.journals.elsevier.com/world-neurosurgery

Available online: www.sciencedirect.com

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pandemic, evaluating the frequency and factors associated with stress, depression, and anxiety. With a 14% prevalence, depression was significantly higher in neurosurgeons who did not feel safe with the provided personal protective equipment (PPE). Participants who had moderate concerns for the health of their families had lesser odds of anxiety and depression than those with more concerns. Being exposed to a COVID-19-positive colleague was also shown to significantly increase the likelihood of anxiety and/or depression.³

The evolution of health care for >18 months of the pandemic led to specialists, including neurosurgeons, initially struggling to cope and eventually adapting to the surfacing situation. Therefore, we hypothesized that the initial distress this pandemic caused among neurosurgeons might have settled to a large extent, especially with vaccination and adaptation to a new normal.⁴ Therefore, the aim of this study was to research how this specific group of HCWs is coping, including their current psychological health and associated factors after the advent of the vaccine.

MATERIALS AND METHODS

Study Design

This cross-sectional study was conducted between May 1, 2021, and May 31, 2021, using an anonymous online questionnaire. Information only about the city location of respondents was collected to address the ethical implications of the survey. The questionnaire was modified based on suggestions from World Spinal Column Society (WSCS) executive board members. Most members of WSCS are neurosurgeons who also perform spinal surgery. The survey was designed on Google Forms (Google LLC, Mountain View, California, USA) and sent to neurosurgeons who were members of scientific societies globally through the WSCS Executive Committee. The survey was circulated to members of WSCS on their social media, WhatsApp (WhatsApp LLC, Menlo Park, California, USA) groups, and e-mails and through a snowballing technique locally and internationally.

Neurosurgeons identified through these media were asked to forward the survey to other neurosurgeons in their professional circle. Of 1000 neurosurgeons who were approached, 534 responded. The methodology of this study was standardized and replicated from a previously published study in 2020, "COVID 19—Depression and Neurosurgeons,"³ to reassess the frequency and factors associated with anxiety and depression among neurosurgeons after a period of adaptation and the advent of vaccine.

Consent was obtained from all individuals who completed the online questionnaire. The participant's identity and institution were not disclosed. All data were kept confidential in a password-protected computer. There was no financial compensation for participation or any penalty for not participating.

Study Variables

The outcome and depression were assessed using the same scale as used previously with a World Health Organization validated questionnaire, the 20-item self-reporting questionnaire.⁵ A cutoff score of ≥ 7 was considered as positive for depression. Independent variables were age (years), country, continent,

consultant/resident self-rating of COVID-19 knowledge, level of practice, experience, size of department, number of consultants/staff, number of trainees, level of awareness regarding self-protection provided by current workplace, provision of adequate PPE at the workplace, training courses conducted for PPE use, safe practice with provided PPE by institution, presence of COVID-19-positive colleagues, redeployment to COVID-19-affected area, perception about redeployment, concerns regarding the health of family members, perception of the family regarding workplace safety, exposure to the disease and severity, exposure to any positive colleague or family member, death of family member, polymerase chain reaction (PCR) testing, and vaccination.

Data Analysis

Categorical variables including age, designation, departmental size, number of trainees, self-rating of knowledge, feeling safe with provided PPE, family concerns, deployment in different areas, perception of the family about workplace safety, enough knowledge to deal if deployed, presence of COVID-19-positive colleagues, exposure to the disease and severity, exposure and death of a family member, PCR testing, vaccination, and 20-item self-reporting questionnaire were expressed as frequencies and percentages. The χ^2 test was applied to compare study variables among depressed and nondepressed individuals. The McNemar test was used to see the difference in proportions of neurosurgeons performing elective surgeries in the previous and current studies. Univariate binary logistic regression was applied to determine the association of each independent variable with the outcome (anxiety/depression). Multivariate logistic regression was used to measure the association of multiple independent variables with the outcome (anxiety/depression) by computing adjusted odds ratios (ORs) and 95% confidence intervals (CIs). Variables with a *P* value <0.05 were considered significant in the multivariate model.

RESULTS

Respondents' Characteristics

A total of 534 responses were received and analyzed. Respondents' characteristics are presented in **Table 1**. Almost half of the respondents were from Asia (50.9%), followed by Europe (38.8%), Africa (4.9%), South America (2.8%), and North America (2.6%). The majority of the respondents were <40 years old (88%), and almost two thirds were trainees (62.2%). Half of the respondents worked in departments with <40 beds (50.7%), and the majority were practicing in the private sector (72.5%).

Almost two thirds of respondents reported a moderate level of self-rated COVID-19 knowledge (59.2%). The majority were provided with PPE by their hospital (85%), and 58% had received PPE use training courses from their institution. Regarding practice, 68.5% of respondents felt safe to practice with provided PPE, while 59.2% had major concerns regarding family health. More than half (56.9%) reported that their families do not feel safe about them working.

Most respondents (85.8%) have had COVID-19-positive colleagues in their department, while 64% had exposure to a COVID-19-positive colleague, family member, and/or patient.

Table 1. Characteristics of Survey Respondents in the Current and Previous Studies

Study Variables	Current Study (N = 534)	Previous Study (N = 375)	P Value
Continent			
Europe	207 (38.8)	108 (29)	<0.001*
Africa	26 (5)	13 (3.5)	
Asia	272 (51)	181 (48.7)	
South America	15 (2.8)	23 (6.2)	
North America	14 (2.6)	47 (12.6)	
Designation			
Consultant	202 (37.8)	295 (79.3)	<0.001*
Trainee	332 (62.2)	77 (20.7)	
Practice area			
Private	387 (72.5)	87 (24.3)	<0.001*
Government	24 (4.5)	68 (19)	
Combined	43 (8.1)	0 (0)	
University	72 (13.5)	143 (40)	
Both	8 (1.5)	87 (24.3)	
How would you rate your self-knowledge about COVID-19?			
Basic	163 (30.5)	115 (30.8)	0.26
Moderate	316 (59.2)	207 (55.5)	
Extensive	55 (10.3)	51 (13.7)	
Is your hospital providing adequate information for your protection?			
Yes	392 (73.4)	254 (68.1)	0.08
No	142 (26.6)	119 (32)	
Are you provided with PPE by your hospital?			
Yes	454 (85)	258 (68.8)	<0.001*
No	80 (15)	117 (31.2)	
Did you get training courses in use of PPE?			
Yes	311 (58.2)	204 (54.4)	0.22
No	223 (41.8)	171 (45.6)	
Do you feel safe to practice with the PPE provided by your hospital?			
Yes	366 (68.5)	204 (54.4)	<0.001*
No	168 (31.5)	171 (45.6)	
Do you have concerns regarding the health of your family?			
Minor	97 (18.2)	40 (10.7)	<0.001*
Moderate	121 (22.7)	64 (17.1)	
Major	316 (59.2)	271 (72.3)	
Are/were there any COVID-19—positive colleagues in your department?			
Yes	458 (85.8)	80 (21.3)	<0.001*
No	76 (14.2)	295 (78.7)	
Does your family feel safe for you to go to work?			
			Continues

Table 1. Continued

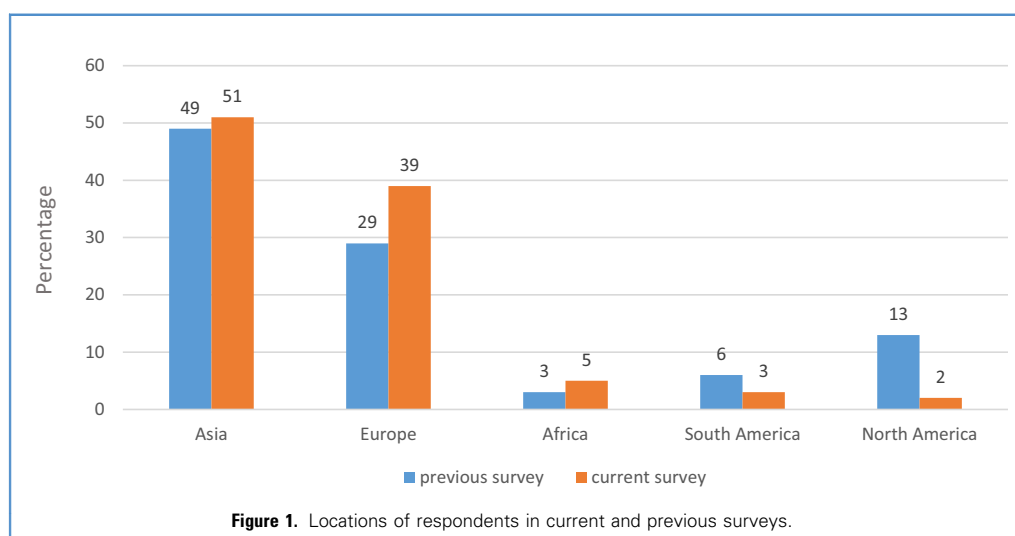
Study Variables	Current Study (N = 534)	Previous Study (N = 375)	P Value
Yes	304 (57)	124 (33.1)	<0.001*
No	230 (43.1)	251 (67)	
Have you been asked to take a redeployment to a COVID-19-affected area?			
Yes	160 (30)	105 (28)	0.52
No	374 (70)	270 (72)	

All values are expressed as number (%).
 COVID-19, coronavirus disease 2019; PPE, personal protective equipment.
 *Significant at $P < 0.01$.

Regarding COVID-19 infection, 67.2% were not infected with COVID-19, 12.5% were unsure about their COVID-19 status, and 20.2% had acquired the infection. The majority of infected respondents had mild disease (87.9%), while a few had moderate (9.3%) or severe (2.8%) disease. Of 20.2% of infected respondents, 7.4% required hospital admission, and 25% needed ventilator support. Half of respondents who needed admission reported that their hospital partially covered their treatment cost, one third (37.5%) reported complete compensation, and 12.5% did not receive any financial help from their organization. Almost one third of the respondents reported their family members had acquired the infection (34.5%), and 6.7% of family members died of COVID-19 infection. More than half of the respondents were exposed to infected patients and/or colleagues, and almost half (43.1%) underwent COVID-19 testing when exposed. Nearly half of the respondents underwent COVID-19 testing more than twice (52.4%).

The biggest concern regarding COVID-19 was lack of adequate organization at the workplace (41%), followed by lack of adequate PPE (17.8%) and lack of adequate training for PPE usage (11.2%). Of respondents, 82% reported that elective surgeries were reduced in their departments during the pandemic, whereas nearly half reported a reduction in emergency cases (47.9%). The mean (SD) number of elective surgeries per week before and after the beginning of the pandemic was 22 (27) and 14 (28), while for emergency surgeries, the mean (SD) was 12 (17) and 12 (49), respectively. Redeployment to a COVID-19-affected area was requested of 30% of respondents, and only 30.3% considered their knowledge and expertise to be meaningful in case of redeployment into a COVID-19-affected area.

Regarding vaccination, 83% of respondents received at least one dose of the vaccine, while 17% did not receive the vaccine. The most frequently administered vaccine was the Pfizer vaccine (42.9%), followed by the Chinese vaccine (38.4%), AstraZeneca



vaccine (13.1%), other vaccines (3.4%), and Russian vaccine (2.2%).

Comparison of the Current Survey with the Previous Survey

Most of the respondents were from Asia and Europe, similar to the previous study,³ but there were fewer respondents from North and South America in the current study (Figure 1). More trainees than consultants participated, and the majority were working in private organizations ($P < 0.001$). Compared with previous studies, more neurosurgeons reported adequate provision of PPE by their organization ($P < 0.001$). More respondents felt safe to practice and did not have major concerns for their families ($P < 0.001$). Moreover, more respondents in the current study reported that their families felt safer about them going to work ($P < 0.001$). Responses regarding self-rated knowledge, adequate organization training, and redeployment to the COVID-19 area were not different between the previous and the current study.

Figure 2 depicts the sources of knowledge for COVID-19 in the previous and current surveys. There was no significant difference in the pattern. The most frequent source of knowledge is a scientific publication, followed by a global network, local organization, social media, and local society.

Figure 3 displays the respondents' opinions regarding the end of the pandemic in the current and the previous survey. In the previous survey, most respondents expected the pandemic to end within 4–8 weeks and 2–6 months. In the current survey, 54.5% thought it would take >6 months, while almost a quarter of the respondents had no idea when it would end. There were significant differences among responses recorded in the previous and the current survey ($P < 0.001$).

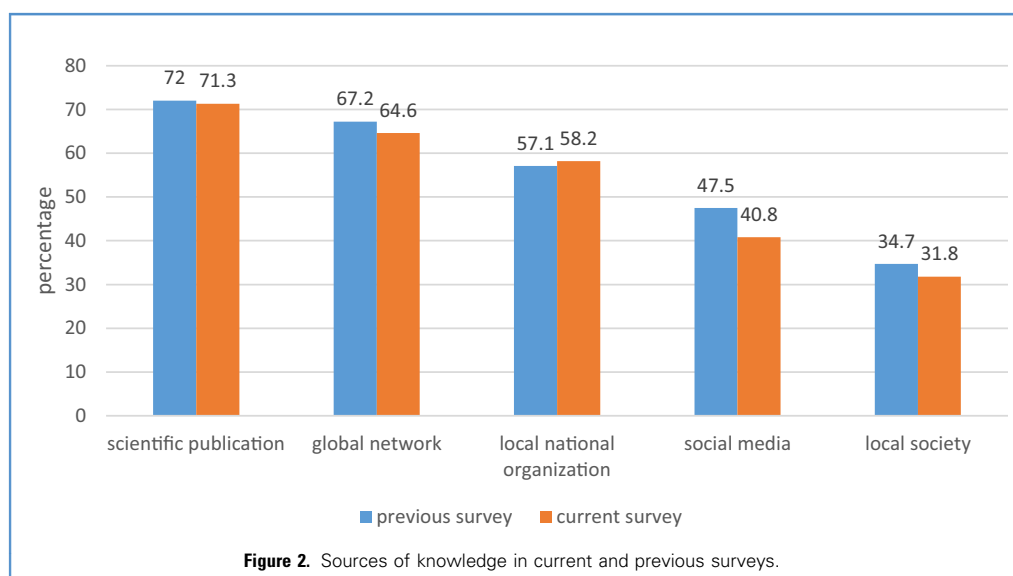
Table 2 shows the comparison of symptoms of depression among respondents in the previous and the current survey. The overall prevalence of depression (score of ≥ 7) among survey respondents was 16.3% (87 of 534) compared with 14.1% (52 of 370) in the previous study ($P = 0.359$). In the current survey,

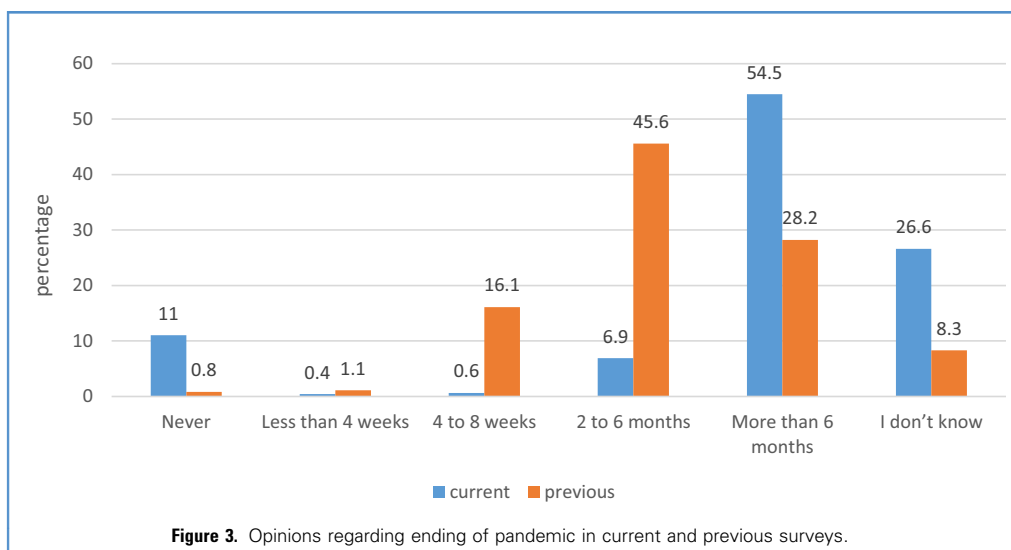
there was a significant rise in the frequency of headache ($P < 0.001$), feeling of fatigue ($P = 0.009$), and tiredness ($P = 0.002$). Fewer respondents reported poor appetite ($P = 0.005$), feeling of unhappiness ($P = 0.014$), difficulty in enjoying daily activities ($P = 0.020$), and daily work suffering ($P = 0.002$) in the current study compared with the previous study.

Univariable and Multivariable Association of Respondents' Characteristics with Depression

Table 3 presents univariable analysis of study variables among depressed and nondepressed survey respondents. There was no significant difference between depressed and nondepressed respondents in terms of age ($P = 0.009$), continents ($P = 0.691$), department size ($P = 0.972$), number of consultants ($P = 0.992$), number of residents ($P = 0.522$), type of practice ($P = 0.993$), self-rating of COVID-19 knowledge ($P = 0.246$), attending training courses in use of PPE ($P = 0.178$), positive COVID-19 colleagues in department ($P = 0.071$), family members infected with COVID-19 ($P = 0.138$), death in family owing to COVID-19 ($P = 0.053$), exposure to positive COVID-19 cases ($P = 0.139$), and impact of COVID-19 on elective ($P = 0.174$) and emergency surgeries ($P = 0.181$).

Table 4 presents the multivariable ORs of depression according to patients' characteristics. The risk of depression was significantly lower in trainees (OR 0.51, 95% CI 0.32–0.80) than consultants. Depression was less likely among respondents who received enough information for their protection (OR 0.47, 95% CI 0.29–0.76), who were provided adequate PPE by their hospital (OR 0.35, 95% CI 0.20–0.60), and who felt safe to practice with provided PPE (OR 0.5, 95% CI 0.31–0.80). Odds of depression were lower among respondents with minor concerns regarding their family's health (OR 0.42, 95% CI 0.2–0.89) and whose families felt safe for them to go to work (OR 0.37, 95% CI 0.233–0.602). Odds of depression were also lower among vaccinated respondents (OR 0.46, 95% CI 0.27–0.79).



**Table 2.** Comparison of Response Distribution of Self-Reporting Questionnaire Items Between the Current and Previous Survey

Self-Reporting Questionnaire Items	Current Survey (N = 534)	Previous Survey (N = 372)	P Value
Do you often have headaches?	58 (15.7)	147 (27.5)	<0.001†
Is your appetite poor?	26 (7)	16 (3)	0.005†
Do you sleep badly?	93 (25.1)	147 (27.5)	0.42
Do your hands shake?	23 (6.2)	36 (6.7)	0.75
Are you easily fatigued?	72 (19.5)	144 (27)	0.009†
Do you feel nervous, tense, or worried?	126 (34.1)	169 (31.6)	0.45
Is your digestion poor?	35 (9.5)	52 (9.7)	0.89
Do you have trouble thinking clearly?	40 (10.8)	79 (14.8)	0.08
Do you feel unhappy?	122 (33)	136 (25.5)	0.01*
Do you cry more than usual?	19 (5.1)	42 (8)	0.11
It is difficult to enjoy daily activities?	116 (31.4)	130 (24.3)	0.02*
Do you have difficulty in decision making?	34 (9.2)	62 (11.6)	0.24
Is your daily work suffering?	120 (32.4)	123 (23)	0.002†
Are you unable to play a useful part in life?	78 (21.1)	87 (16.3)	0.07
Have you lost interest in things?	59 (16)	107 (20)	0.12
Do you feel you are a worthless person?	22 (6)	33 (6.2)	0.88
Has the thought of ending your life been on your mind?	19 (5.1)	26 (5)	0.86
Do you have an uncomfortable feeling in the stomach?	52 (14.1)	62 (11.6)	0.28
Do you feel tired all the time?	53 (14.3)	103 (19.3)	0.05
Are you easily tired?	77 (20.8)	161 (30.1)	0.002†
Identified as depressed	52 (14.1)	87 (16.3)	0.36

All values are expressed as number (%).
 *Significant at $P < 0.05$.
 †Significant at $P < 0.01$.

Table 3. Univariable Analysis of Study Variables Among Depressed and Nondepressed Survey Respondents (*N* = 534)

Study Variables	Depressed (<i>n</i> = 87)	Nondepressed (<i>n</i> = 447)	<i>P</i> Value
Age			
≤40 years	72 (15.3)	398 (84.7)	0.1
>40 years	15 (23.4)	49 (76.6)	
Continent			
Europe	34 (16.4)	173 (83.6)	0.7
Africa	2 (7.7)	24 (92.3)	
Asia	47 (17.3)	225 (82.7)	
South America	3 (20)	12 (80)	
North America	1 (7)	13 (93)	
Designation			
Trainee	42 (12.7)	290 (87.3)	0.003†
Consultant	45 (22.3)	157 (77.7)	
Size of department			
≤40 beds	44 (16.2)	227 (83.8)	0.97
>40 beds	43 (16.3)	220 (83.7)	
Number of consultants			
<4	16 (16.3)	82 (83.7)	0.1
≥4	71 (16.3)	365 (83.7)	
Number of residents			
<10	46 (15.4)	253 (84.6)	0.52
≥10	41 (17.4)	194 (82.6)	
Type of practice			
Private	65 (16.8)	322 (83.2)	0.1
Government	3 (12.5)	21 (87.5)	
Combined	7 (16.3)	36 (83.7)	
University	11 (15.3)	61 (84.7)	
Both	1 (12.5)	7 (87.5)	
Rating of self-knowledge			
Basic	22 (13.5)	141 (86.5)	0.25
Moderate to extensive	65 (17.5)	306 (82.5)	
Is your hospital providing adequate information for your protection?			
Yes	52 (13.3)	340 (86.7)	<0.001†
No	23 (32.4)	48 (67.6)	
Not sure	12 (17)	59 (83)	
Are you provided with PPE by your hospital?			
Yes	62 (13.7)	392 (86.3)	<0.001†
No	25 (31.3)	55 (68.8)	
Did you get training courses in use of PPE?			
Yes	45 (14.5)	266 (85.5)	0.18
No	42 (18.8)	181 (81.2)	
			Continues

Table 3. Continued

Study Variables	Depressed (n = 87)	Nondepressed (n = 447)	P Value
Do you feel safe to practice with the PPE provided by your hospital?			
Yes	48 (13)	318 (87)	<0.001†
No	24 (33.3)	48 (66.7)	
Not sure	15 (15.6)	81 (84.4)	
Do you have concerns regarding the health of your family?			
Minor	9 (9.3)	88 (90.7)	0.03*
Moderate	16 (13.2)	105 (86.8)	
Major	62 (19.6)	254 (80.4)	
Are/were there any COVID-19—positive colleagues in your department?			
Yes	80 (17.5)	378 (82.5)	0.07
No	7 (9.2)	69 (90.8)	
Have you been infected with COVID-19?			
Yes	23 (21.3)	85 (78.7)	0.03*
Maybe	16 (23.9)	51 (76.1)	
No	48 (13.4)	311 (86.6)	
Did any of your family members become infected with COVID-19?			
Yes	36 (19.6)	148 (80.4)	0.14
No	51 (14.6)	299 (85.4)	
Did any of your family members die of COVID-19 infection?			
Yes	10 (27.8)	26 (72.2)	0.05
No	77 (15.5)	421 (84.5)	
Were you exposed to a COVID-19—positive colleague, patient, and/or family member?			
Yes	64 (18.7)	279 (81.3)	0.14
No	12 (12)	87 (88)	
Not sure	11 (12)	81 (88)	
How many times during the pandemic did you get a COVID-19 PCR test?			
Never	9 (10.5)	77 (89.5)	0.007†
Once	12 (17.4)	57 (82.6)	
Twice	27 (27.3)	72 (72.7)	
More than twice	39 (14)	241 (86.1)	
Impact of COVID-19 on average number of elective surgeries			
Reduced	67 (15.3)	371 (84.7)	0.17
Increased/no change	19 (21)	71 (79)	
Impact of COVID-19 on average number of emergency surgeries			
Reduced	36 (14)	220 (86)	0.18
Increased/no change	51 (18.3)	227 (81.7)	

All values are expressed as number (%).
PPE, personal protective equipment; COVID-19, coronavirus disease 2019; PCR, polymerase chain reaction.
*Significant at $P < 0.05$.
†Significant at $P < 0.01$.

Continues

Table 3. Continued

Study Variables	Depressed (n = 87)	Nondepressed (n = 447)	P Value
Does your family feel safe for you to go to work?			
Yes	32 (10.5)	272 (89.5)	<0.001†
No	55 (23)	175 (77)	
Have you been asked to take a redeployment to a COVID-19-affected area?			
Yes	41 (25.6)	119 (74.4)	<0.001†
No	46 (12.3)	328 (87.7)	
Did you get a COVID-19 vaccine?			
Yes	63 (14.2)	380 (85.8)	0.004†
No	24 (26.4)	67 (73.6)	

All values are expressed as number (%).

PPE, personal protective equipment; COVID-19, coronavirus disease 2019; PCR, polymerase chain reaction.

*Significant at $P < 0.05$.

†Significant at $P < 0.01$.

The odds of depression were higher among respondents who reported that their organization was not providing enough information on protection and infection (OR 2.36, 95% CI 1.06–5.22). Participants who did not feel safe to practice with provided PPE were significantly more likely to be depressed (OR 2.7, 95% CI 1.29–5.64). Higher odds of depression were also observed for respondents who were infected with COVID-19 (OR 1.75, 95% CI 1.01–3.04) or were not sure if they had acquired the infection (OR 2.03, 95% CI 1.07–3.85) than for respondents who had not acquired the infection. The likelihood of depression was significantly higher in respondents who underwent the COVID-19 PCR test ≥ 2 times (OR 3.21, 95% CI 1.41–7.28) than those who were never tested for COVID-19. Redeployment to a COVID-19-affected area significantly increased the odds of depression (OR 2.46, 95% CI 1.53–3.93).

When the multivariable logistic regression model was adjusted for other covariates, higher odds of depression were observed in respondents who underwent COVID-19 PCR testing ≥ 2 times than those who were never tested for COVID-19 (adjusted OR 3.08, 95% CI 1.20–7.90). The risk of depression was lower for respondents who reported that their family considered it safe for them to go to work (adjusted OR 0.48, 95% CI 0.27–0.87). The likelihood of depression was higher in respondents who were re-deployed to a COVID-19 area (adjusted OR 2.81, 95% CI 1.62–4.87) than in those who were not displaced.

DISCUSSION

Globally, as of June 2, 2021, 172,630,637 confirmed cases of COVID-19, including 3,718,683 deaths, were reported to the World Health Organization.⁶ One third of COVID-19 survivors develop neurological or mental disorders, as stated in one study.⁷ A rapid review of 44 studies regarding the psychological impact of pandemic outbreaks on HCWs reported posttraumatic stress symptoms during outbreaks, with symptoms lasting beyond 1–3 years in 10%–40% of the individuals.⁸

The medical profession and institutions worldwide responded and continue to modify their response as the COVID-19 pandemic

unfolds. Various guidelines have been published, and several measures are being taken to safeguard the physical and psychological well-being of HCWs and medical specialists. This is a follow-up study after 1 year of the pandemic, which included the participation of neurosurgeons around the globe to assess the frequency and modification of factors associated with depression.

As policies and procedures were modified and concerns of infection among HCWs were addressed by hospital administrations,⁹ more neurosurgeons in this study reported adequate provision of PPE by their organization than in the previous study. Another study published at the beginning of the pandemic reported only 12% of the physicians were fully satisfied with the provision of PPE, while almost 94% felt unprotected.¹⁰ Suboptimal standard operating procedures and lack of provision of PPE were significantly associated with depression in the previous study and univariate analysis of the current study data. Therefore, with the majority of neurosurgeons provided with adequate PPE within a year, they feel safer to practice and have fewer concerns for their families. Although the majority of the neurosurgeons have had exposure to an infected patient, one third had an infected family member, almost 7% reported death in the family owing to COVID-19, and 20% were infected themselves; yet, families significantly felt safer for them to continue to practice in the current study. Moreover, in the multivariable model, the risk of depression was lower for respondents who reported that their family considered it safe for them to go to work. This indicates that institutional support, provision of PPE, training in use of PPE, redesigning organizational models, and modified guidelines to safeguard the health of neurosurgeons alleviated their fear and consoled their families to a large extent.

The dynamics of the pandemic evolved, yet the frequency of depression did not decrease significantly, as the medical profession continued to face different dilemmas and new challenges.^{1,11} We found higher odds of depression among neurosurgeons who underwent COVID-19 PCR testing ≥ 2 times than neurosurgeons who were never tested. Repeated COVID-19 testing may be associated with higher exposure, frequency of flulike symptoms, and

Table 4. Multivariable Association of Study Variables with Depression (*N* = 534)

Variables	OR (95% CI)	P Value	aOR (95% CI)	P Value
Age				
≤40 years	0.591 (0.32–1.11)	0.102	0.76 (0.34–1.74)	0.52
>40 years	Reference		Reference	
Designation				
Trainee	0.51 (0.32–0.80)	0.004†	0.74 (0.41–1.35)	0.33
Consultant	Reference		Reference	
Is your hospital providing enough information for your protection?				
Yes	0.47 (0.29–0.76)	0.002†	0.80 (0.41–1.50)	0.47
No	Reference		Reference	
Are you provided with PPE by your hospital?				
Yes	0.35 (0.20–0.60)	<0.001†	0.52 (0.24–1.13)	0.1
No	Reference		Reference	
Did you get training courses in use of PPE?				
Yes	0.73 (0.46–1.16)	0.179	1 (0.51–1.76)	0.92
No	Reference		Reference	
Do you feel safe to practice with the PPE provided by your hospital?				
Yes	0.5 (0.31–0.80)	0.004*	1.06 (0.50–2.27)	0.88
No	Reference		Reference	
Do you have concerns regarding the health of your family?				
Minor	0.42 (0.2–0.90)	0.021*	0.67 (0.30–1.60)	0.37
Moderate	0.62 (0.34–1.13)	0.121	0.76 (0.38–1.51)	0.43
Major	Reference		Reference	
Are/were there any COVID-19–positive colleagues in your department?				
Yes	2.09 (0.90–4.71)	0.077	1.53 (0.62–3.76)	0.36
No	Reference		Reference	
Have you been infected with COVID-19?				
Yes	1.75 (1.01–3.04)	0.046*	0.96 (0.48–2)	0.1
May be	2.03 (1.07–3.85)	0.029*	1.34 (0.61–2.95)	0.47
No	Reference		Reference	
Did any of your family members become infected with COVID-19?				
Yes	1.43 (0.90–2.28)	0.139	1.00 (0.55–1.83)	0.1
No	Reference		Reference	
Did any of your family members die of COVID-19 infection?				
Yes	2.10 (1–4.54)	0.058	1.39 (0.55–3.54)	0.48
No	Reference		Reference	
Were you exposed to a COVID-19–positive colleague, patient, and/or family member?				
Yes	1.7 (0.85–3.35)	0.134	1.81 (0.85–3.88)	0.13
No	1.02 (0.43–2.43)	0.972	1.64 (0.62–4.32)	0.32
Not sure	Reference		Reference	

OR, odds ratio; CI, confidence interval; aOR, adjusted odds ratio; PPE, personal protective equipment; COVID-19, coronavirus disease 2019; PCR, polymerase chain reaction.

*Significant at *P* < 0.05.†Significant at *P* < 0.01.

Continues

Table 4. Continued

Variables	OR (95% CI)	P Value	aOR (95% CI)	P Value
How many times during the pandemic did you get a COVID-19 PCR test?				
Never	Reference		Reference	
Once	1.80 (0.71–4.56)	0.215	1.41 (0.50–4.00)	0.52
Twice	3.21 (1.41–7.28)	0.005†	3.08 (1.20–8)	0.02*
More than twice	1.38 (0.64–3)	0.407	1.56 (0.65–3.71)	0.32
Impact of COVID-19 on average number of elective surgeries				
Reduced	0.68 (0.38–1.19)	0.176	0.97 (0.49–1.93)	0.94
Increased/no change	Reference		Reference	
Impact of COVID-19 on average number of emergency surgeries				
Reduced	0.73 (0.46–1.16)	0.182	0.66 (0.38–1.15)	0.14
Increased/no change	Reference		Reference	
Does your family feel safe for you to go to work?				
Yes	0.37 (0.233–0.602)	<0.001†	0.48 (0.27–0.87)	0.01*
No	Reference		Reference	
Have you been asked to take a redeployment to a COVID-19–affected area?				
Yes	2.46 (1.53–4)	<0.001†	2.81 (1.62–4.87)	<0.001†
No	Reference		Reference	
Did you get a COVID-19 vaccine?				
Yes	0.46 (0.27–0.80)	0.005†	0.54 (0.28–1.05)	0.07
No	Reference		Reference	

OR, odds ratio; CI, confidence interval; aOR, adjusted odds ratio; PPE, personal protective equipment; COVID-19, coronavirus disease 2019; PCR, polymerase chain reaction.
 *Significant at $P < 0.05$.
 †Significant at $P < 0.01$.

anxiety regarding a positive result, which may predispose to distress and hence depression. Yet, it is interesting to note that although respondents who were tested twice were more likely to be depressed, a similar association was not seen with multiple testing. There is a possibility that neurosurgeons who had a PCR test more than twice in a year did it as a routine institutional policy and not because of symptoms, contact, or a higher possibility of infection, whereas a PCR test that was done twice was more likely due to direct exposure or symptoms and hence the anxiety. The frequency of deployment to a COVID-19 area was similar in both the previous and the current study, yet this was a significant factor associated with depression in the current study. This means that neurosurgeons were able to adjust and adapt to their working environment within a year despite a significant reduction in elective and emergency procedures reported by the majority of respondents. Yet, it can be assumed that a change in a niche can lead to distress and hence depression among neurosurgeons, possibly owing to maladaptation.¹²

We hypothesized that there would be a decline in the frequency of depression after a year owing to better organizational support and coping skills. Yet, the prevalence was higher, though not statistically significant, than in the previous study. Similarly, our study revealed a significant increase in the frequency of

headaches, fatigue, and tiredness. Relatively younger respondents in this study than in the previous study may explain this. This assumption is supported by another study in Turkish neurosurgeons, which showed that older experienced neurosurgeons were better able to combat depression symptoms than younger ones.¹³

Although significantly more respondents thought that the pandemic would end sooner in the previous study, this study revealed that a quarter of neurosurgeons were clueless regarding when the pandemic would end. Interestingly, after a year of hopelessness and despair, significantly fewer respondents reported poor appetite, feeling of unhappiness, difficulty enjoying daily activities, and daily work suffering in this study. Overall, the frequency of depression among neurosurgeons was relatively less in both surveys than the rate reported among frontline HCWs directly involved with COVID-19 patients.^{14–17} For example, a previous study showed an alarming 43% prevalence of anxiety and depression among frontline physicians in Pakistan.⁴

Finally, the advent of the COVID-19 vaccine is speculated to halt the pandemic and alleviate the associated psychological distress among the general population and HCWs. As of June 2, 2021, a total of 1,638,006,899 vaccine doses have been administered.⁶ However, even though researchers discovered the morphology, pathophysiology, and treatment of the virus, new strains and different variants of the

novel coronavirus were also identified.¹⁸ Hence, we are still combating wave after wave of mutant strains.¹⁹ Despite the ongoing pandemic, with the advent of vaccines, we hypothesized that vaccination would reduce the psychological distress, creating a sense of being protected. In our survey, 83% of respondents had received at least the first dose of the vaccine. We found that the odds of depression among vaccinated respondents were significantly less than among unvaccinated respondents in the univariable model. This variable was not significant in the multivariable model, although there was a trend. This could be explained by the findings of initial studies indicating a low uptake, acceptance, and apprehension among HCWs regarding different vaccines and their adverse effects.^{16,17} As our survey was done during the first 3 months of vaccination administration, we did not find a significant change in the sense of protection, reduction in distress, and hence depression among neurosurgeons. A recent qualitative analysis of 13 studies regarding the efficacy of 11 COVID-19 vaccines concluded that most COVID-19 vaccines appear to be effective and safe.²⁰ Therefore, with proven effectiveness and reduction in morbidity with infection, the apprehension among HCWs may be put to rest.

Limitations

Participation bias is unavoidable in online surveys, yet this was the best possible data collection method from neurosurgeons worldwide during the pandemic. More trainees than consultants from private institutions of Asia and Europe responded to the current online survey. There is a possibility that workloads of consultants were returning to near normal, especially in the United States. The vaccination rate in developed countries was also much higher than in other regions. A bombardment of online surveys and educational activities may also have led to a low response rate among consultants. Therefore, the discrepancy in respondents' characteristics is evident, although the identical mechanism was deployed for data collection.

The previous and current studies did not compare the baseline rate of mental health problems in neurosurgeons with the rate during the pandemic because no data were reported before the pandemic to evaluate the psychological health of physicians in a competitive specialty such as neurosurgery. However, it can be reasonably assumed that even though the prevalence at baseline may not be different, the associated factors are considerably diverse at each phase of the pandemic. Hence, the steps taken to control damage to psychological health should be guided by the underlying factors, as indicated by this study.

CONCLUSIONS

Among HCWs, neurosurgeons are one of the indirectly affected groups by the COVID-19 pandemic. Although vaccination status was significant in univariate analysis, it was insignificant in the multivariable model, which may be because of an inadequate vaccination uptake by respondents at the time of the survey. Yet, adaptation to the new normal and advent of vaccines are speculated to control psychological distress among HCWs, including neurosurgeons. We recommend ongoing intervention to prevent psychological distress among neurosurgeons, which may be due to multiple dynamic factors.

CRedit AUTHORSHIP CONTRIBUTION STATEMENT

Salman Sharif: Writing – original draft, Writing – review & editing. **Faridah Amin:** Writing – original draft, Writing – review & editing. **Mehak Hafiz:** Writing – original draft, Writing – review & editing. **Francesco Costa:** Investigation, Writing – review & editing. **Rully Hanafi Dahlan:** Investigation, Writing – review & editing. **Sandeep Vaishya:** Investigation, Writing – review & editing. **Nikolay Peev:** Investigation, Writing – review & editing. **Edward Benzel:** Investigation, Writing – review & editing. **WSCS Executive Board:** Investigation, Writing – review & editing.

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commercial or financial relationships that could be construed as a potential conflict of interest.

Received 25 October 2021; accepted 20 December 2021

Citation: *World Neurosurg.* (2022) 159:e466-e478.

<https://doi.org/10.1016/j.wneu.2021.12.076>

Journal homepage: www.journals.elsevier.com/world-neurosurgery

Available online: www.sciencedirect.com

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