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Impact of COVID-19 on Saudi Neurosurgery Residency: Trainers' and Trainees' Perspectives

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■ **INTRODUCTION:** After the official announcement of the coronavirus disease-19 pandemic on March 11, 2020, the disease impacted most aspects of health care delivery, especially postgraduate education and training.

■ **METHOD:** A cross-sectional, online questionnaire-based assessment was performed. The study participants involved neurosurgery residents and program directors (PDs) across the country between May 16 and May 27, 2020.

■ **RESULTS:** Approximately 74 of 95 (77.9%) of the residents experienced an impact on their training calendar. Before the pandemic, 51 residents (53.3%) were involved in 2–3 surgeries per week, but during the pandemic, 66 (69.5%) were attending 0–1 case per week. Fifty-three residents (55.8%) agreed that academic sessions were affected despite the helpful effort of online teaching sessions. Thirty-four (35.8%) residents graded their anxiety during coronavirus disease-19 times as high. Ten PDs (58.8%) confirmed spending 3–5 hours per week on educational activities normally, whereas during the pandemic, 15 PDs (88.2%) reduced their educational hours to 0–2 hours per week.

■ **CONCLUSION:** Our study showed that educational activities significantly decreased and shifted toward virtual teaching methods. Operative volume showed a substantial reduction for both junior and senior residents. Academic and

clinical teaching was the main concern for PDs, and they faced challenges interviewing newly matched residents.

INTRODUCTION

In December 2019, a case of pneumonia occurred in Wuhan, China. On January 7, 2020, a novel coronavirus, termed severe acute respiratory syndrome coronavirus-2, was discovered.¹ The first case of coronavirus disease-19 (COVID-19) in the Kingdom of Saudi Arabia (KSA) was diagnosed in the eastern province on March 2, 2020.² A state of global pandemic was established on March 11.³ Since then, the pandemic has had a significant impact on all aspects of society, including health care provision. In addition, postgraduate medical education and training were affected.

The precautionary measures implemented by the Ministry of Health led to the dissolution of many educational activities. Surgical specialty programs suffered the most in their training, as omission of elective surgeries and strict triaging were implemented. Learning objectives were perturbed, and many centers transitioned to virtual teaching sessions. As the pandemic progressed in the KSA, increased demands of intensive care units (ICUs) created an additional workload on ICU staff.⁴

Many neurosurgical residents were instructed to cover ICU shifts. This affected neurosurgical service coverage, and

Key words

- COVID-19
- Impact
- Neurosurgery
- Residency
- Training

Abbreviations and Acronyms

COVID-19: Coronavirus disease-19
ICU: Intensive care unit
KSA: Kingdom of Saudi Arabia
OR: Operating room
PD: Program director

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From the ¹Neurosurgery Department, National Neuroscience Institute, King Fahad Medical City; ²Neurosurgery Division, Neurosciences Department, King Faisal Specialist Hospital and

designation of backup teams was advised. All these changes will have an impact on the well-being of residents and program directors (PDs). To the best of our knowledge, this is the second study assessing the impact of COVID-19 on neurosurgical training from residents' and PDs' perspectives, intended to assess the extent of the impact on training and the residents' physical and mental welfare and compare the concerns of both groups.

METHODS

This study is a questionnaire-based assessment of neurosurgery residents across the KSA with a target sample size of 115 residents. The questionnaire was distributed through online social channels during the pandemic period from May 16 to 27, 2020. The respondents were asked to complete an online 38-item survey, with an implied consent stating that by filling the survey, you are agreeing to participate. Questions ranged from demographic data, training level, and type of training center, surgical exposure per week before and after COVID-19 periods, and time spent on educational activities. A section of the survey was designated to assess residents' anxiety level during the pandemic and a grading of expected contributing factors. A few questions were directed toward the current adapted educational activities and the degree of satisfaction among residents.

Another survey composed of 20 items targeted PDs. PDs across the KSA were identified with a target sample size of 17 PDs. It was distributed through online social channels and formal groups of Saudi neurosurgical PDs during the pandemic period from May 20 to 28, 2020. Questions ranged from demographic data, number of residents in the training center, and hours of educational activities before and during the COVID-19 period. Another section focused on the risk assessment of different factors on residents' well-being from the PDs' perspective.

Collected data were coded and analyzed using the Statistical Package for Social Sciences SPSS version 25.0 (IBM, Armonk, New York, USA). We analyzed the descriptive statistics and distribution of the study's sample population. Categorical variables were compared using the χ^2 test and Fisher's exact test for variables with <5 counts in a cell. The dependent categorical variable, the anxiety grade, was compared with different independent categorical variables, such as the resident's postgraduate year or gender and years of experience for PDs. Continuous variables were contrasted in 2 groups using the independent t-test for parametric data and the Mann-Whitney U-test for nonparametric data. A P value of <0.05 was considered statistically significant.

RESULTS

Residents' Feedback

Demographic Data. Of 95 residents (Table 1), 60 were male (63.2%). Regarding the residents' age, 79 were under 30 years (83.2%), and 16 were over 30 (16.8%). Fifty-nine residents were single (62.1%), 36 were married (37.9%), and 15 of them had children (15.8%). Regarding the residents' health status, 85 of 95 were healthy (89.5%). Concerning the postgraduate year (PGY), 27 junior residents (28.4%) were at PGY1–2, 48 (50.5%) PGY3–4, and 20 (21.1%) PGY5–6. Regarding the location of the neurosurgery program, the percentage of residents in each city was as

follows: 1) Riyadh, 67 residents (70.5%); 2) western province, 17 residents (17.9%); and 3) eastern province, 10 residents (10.6%). Sixty-seven residents (70.5%) were trained in tertiary care hospitals, 12 in university hospitals (12.6%), 8 in military hospitals (8.4%), and 7 in secondary care hospitals (7.4%).

Academic Teaching Data. The rotation schedule of 74 residents (77.9%) was affected during the pandemic. Sixty-five residents were not called back to their primary training centers (68.4%). Fifty-five residents reported that their average on-call duties were affected (57.9%); 34 had an increase in their on-call duties (35.8%). Regarding operating room (OR) exposure before the COVID-19 pandemic, 51 residents (53.3%) were performing 2–3 cases per week, and 34 (35.8%) were assisting in 4–5 cases per week. During the COVID-19 pandemic, the number of cases per week for 66 residents (69.5%) significantly decreased to 0–1 per week, whereas 29 (30.6%) residents still had 2 or more cases per week (Figure 1). Fifty-seven percent of junior residents were performing 2–3 cases per week before the pandemic (P value = 0.04), whereas 72% of juniors were performing 0–1 case per week during the pandemic (P value = 0.43). Forty percent of senior residents performed 4–5 cases per week before COVID-19 (P value = 0.04), whereas currently, 60% performed 0–1 case per week (P value = 0.43). In terms of virtual educational activities, 53 residents (55.8%) agreed that teaching is affected despite the helpful effort of online teaching.

Working Environment Data. Pertaining to the safety of the working environment, 91 (95.8%) residents confirmed that their respective training centers admitted patients with COVID-19. Subsequently, 69 (72.6%) of the participants did not feel safe while on duty. Nearly 83 (87%) of residents answered "yes" when asked whether their hospital has designated COVID-19 health care teams, and 78 (94%) of those residents who answered "yes" confirmed that they had no involvement in a COVID-19 team.

In addition, 51 (53.7%) confirmed that their department's workflow was affected by a colleague being infected or quarantined.

Approximately 80 (84.2%) residents worried about transmitting the virus to their family, 12 (12.6%) are living away from family, and 3 (3.2%) deny having this fear. Few trainees changed their residence (4, 4.2%), 27 (28.4%) are isolating themselves in a room inside their house, and 39 (41.1%) are only practicing social distancing. The majority of hospitals are recruiting residents from different departments to help in the ICU and quarantines, and 50 (52.7%) neurosurgery residents were prepared to help in critical areas by lectures or crash courses. Only 9 residents (9.5%) confirmed being called to help in the ICU and quarantine areas.

Anxiety Level Data. Residents graded their anxiety as high (34, 5.8%), moderate (35, 36.8%), and low (26, 27.4%) during the COVID-19 pandemic. There was a difference in the anxiety self-graded levels between males and females, with females feeling the mental influence of this pandemic more than males (P value = 0.05). Different factors were thought to contribute to residents' anxiety levels. Transmitting the virus to family members was the most highly contributing factor, chosen by 64 residents (67.4%), followed equally by the ambiguity of upcoming examinations and evaluation measures and the uncertainty of the pandemic situation, each chosen by 53 residents (55.8%). Residents' anticipation

Table 1. Demographic Section of Residents' Survey

Categories	Subcategories	Count	Percentage
1. Sex	Female	35	36.8
	Male	60	63.2
2. Age	20–25	5	5.3
	26–30	74	77.9
	31–35	16	16.8
3. Marital status	Married	36	37.9
	Single	59	62.1
4. Children	No	80	84.2
	Yes	15	15.8
5. Do you have any medical condition?	No	85	89.5
	Yes	10	10.5
6. If you answered YES, kindly list your medical conditions	Crohn's disease	1	10.0
	Asthma	5	50.0
	Psoriasis	2	20.0
	SLE	2	20.0
7. Residency year	PGY1	15	15.8
	PGY2	12	12.6
	PGY3	30	31.6
	PGY4	18	18.9
	PGY5	11	11.6
	PGY6	9	9.5
8. Program	Abha	1	1.1
	Al-Khobar	3	3.2
	Al-Madinah	4	4.2
	Dammam	7	7.4
	Jeddah	11	11.6
	Makkah	2	2.1
	Riyadh	67	70.5
9. Type of hospital	Military hospital	8	8.4
	MOH	1	1.1
	Secondary care hospital	7	7.4
	Tertiary care hospital/ medical city	67	70.5
	University hospital	12	12.6

SLE, systemic lumbous erythematosis; PGY, postgraduate year; MOH, ministry of health hospital.

of being called to help in the ICU and quarantine areas came third in the highly contributing factors, chosen by 50 residents (52.6%). The inability to complete learning objectives came fourth, selected

by 40 residents (42.1%). The lowest ranked factors contributing to a resident's anxiety were working in an unsafe environment and becoming infected by the virus, selected only by 37 residents (38.9%) and 33 residents (34.7%), respectively.

Almost 61 residents (64.2%) focused on enhancing their curricular reading. In addition, 59 (62.1%) residents depended on the online teaching webinars to fill their time. Working on research projects was chosen by 43 residents (45.3%). Approximately 29 (30.5%) were focusing on extracurricular activity and interest. Twenty-one residents (22.1%) stated that they were too anxious to read or work on research projects.

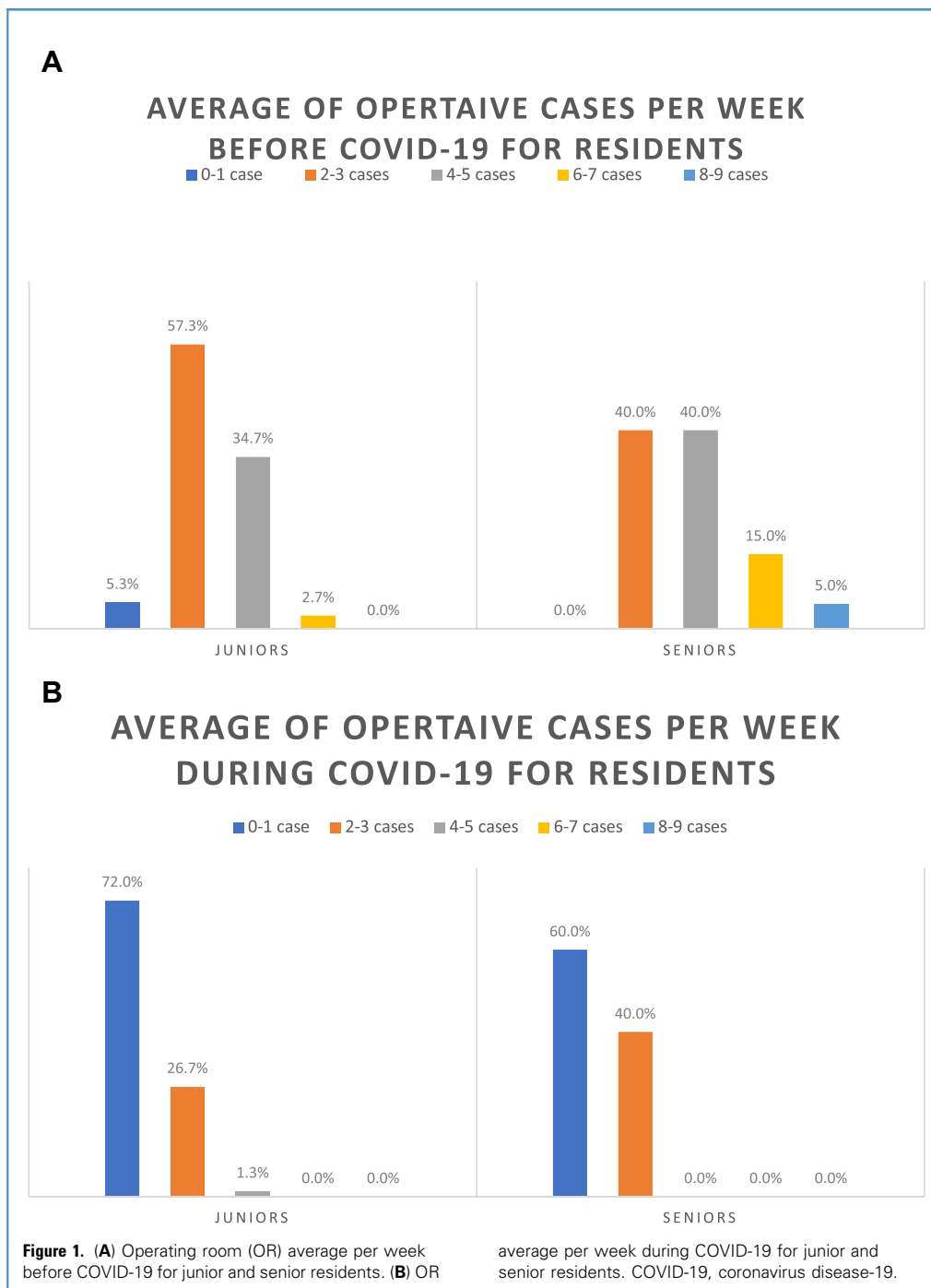
PDs' Feedback

The directors of all neurosurgery programs across Saudi Arabia were invited to complete the survey, with a response rate of 100%. The distributions of directors based on region were as follows: 6 directors (35.3%) were in Riyadh, 7 (41.1%) were in the western province, 3 (17.7%) were in the eastern province, and 1 (5.9%) was in the southern province (Table 2). Twelve PDs worked in tertiary care hospitals (70.6%), 3 in secondary care hospitals (17.6%), and 2 in university hospitals (11.8%). Approximately 10 PDs (58.8%) were assigned as directors for less than 2 years, whereas 7 (41.2%) had been directing their programs for more than 3 years. In the group with less than 3 years of experience, only 1 PD (10%) reported a high grade of anxiety, and 3 (42.9%) of the group with 3 or more years of experience reported a high grade of anxiety (P value = 0.46). Overall, a high anxiety level was reported by 4 PDs (23.5%), moderate by 7 (41.2%), and low by 6 (35.3%). The PDs had a varied number of residents in each center; 9 centers (52.9%) had 5 or fewer residents, 5 centers had 6–10 residents (29.4%), and 3 centers (17.7%) had more than 10 residents.

Concerning educational activities before the COVID-19 pandemic, 10 (58.8%) centers had 3–5 educational hours per week and 6 hours or more in 6 (35.3%) centers. During the COVID-19 pandemic, 15 (88.2%) PDs confirmed the decline in educational activity time to 0–2 hours per week, whereas 2 (11.8%) maintained their educational activities in the range of 3–5 hours per week (Figure 2). The interaction of residents with PDs decreased, as confirmed by 12 (70.6%) PDs. The most common activities in the centers were daily morning meetings, journal clubs, resident teaching activities, and grand rounds.

Ten of 17 PDs (58.8%) canceled all educational activities, whereas 7 (41.2%) canceled some and switched the rest to virtual versions. In terms of research activity during the pandemic, it decreased in 7 (41.2%) centers and increased in 6 (35.3%). Twelve (70.6%) PDs agreed that virtual teaching sessions compensated for the lack of direct teaching, whereas 5 (29.4%) said that teaching was still lacking. Regarding surgical cases performed in the week before COVID-19, 8 (47%) PDs had 4–7 cases, 5 (29.4%) had 8 or more cases, and 4 (23.5%) had 0–1 case. During the COVID-19 pandemic, 6 (35.3%) PDs had 2–3 cases, 5 (29.4%) had 4–5 cases, 4 (23.5%) had 0–1 case, and only 2 (11.8%) had 6–7 cases per week.

When PDs were asked about residents' surgical skills training, 10 (58.8%) agreed that it would be affected if the pandemic lasted 6 months or more, 6 (35.3%) if it lasted 1 year or more, and 1 (5.9%) if it lasted 3 months or more. Different factors were thought to harbor a risk to residents' physical and mental well-



being. Based on the highest to lowest contributing factor, first, the negative impact on clinical and academic teaching was chosen by 8 (47.1%), followed by the possibility of staff shortages and a subsequent increase in workload selected by 7 PDs (41.2%), with the same percentage selecting the risk of the working environment related to safety during COVID-19. In addition, the risk of the

possibility of sending residents to help in the ICU and quarantine areas on mental and physical well-being was agreed on by 6 PDs (35.3%), followed by the ambiguity of promotion criteria and evaluation measures selected by 6 PDs (35.3%). Last, the lowest ranked factor in the high contribution category was the preparedness of residents to help in the ICU and quarantine areas.

Table 2. General Information of Saudi Program Directors Enrolled in the Study

Categories	Subcategories	Count	Percentage
1. You are directing a program in	Abha	1	5.9
	Al-Hofuf	1	5.9
	Al-Khobar	2	11.8
	Al-Madinah	1	5.9
	Jeddah	3	17.6
	Makkah	3	17.6
	Riyadh	6	35.3
2. Type of hospital	Secondary care hospital	3	17.6
	Tertiary care hospital/ medical city	12	70.6
	University hospital	2	11.8
3. You have been a program director for	1–2 years	4	23.5
	3–4 years	3	17.6
	5–6 years	2	11.8
	9 or more years	2	11.8
	Less than 1 year	6	35.3
4. How many residents are in your center currently?	1–5 residents	9	52.9
	11–15 residents	2	11.8
	16–20 residents	1	5.9
	6–10 residents	5	29.4

COVID-19 and New Residency Applicants

The factor with the strongest impact on PDs in the acceptance of new residents was in-person interviews selected by 10 PDs (58.8%); 6 directors selected applicants' curriculum vitae (35.3%), and college grade point average was chosen by only 1 director (5.9%). All 17 PDs (100%) changed their interviews this year to an online version due to pandemic restrictions. Of the PDs who completed the questionnaire, 14 (82.4%) confirmed that they accepted the new residents of 2020 with as much confidence (of being a successful resident) as last year regardless of the changes in the interview method.

DISCUSSION

Residents' Concerns

Educational Activities. Educational activities have shown a significant decrease and major shift toward online teaching methods; despite all efforts, 46 (48.8%) residents in our study confirmed that there is a defect in teaching. In a cross-sectional analysis of 52 neurosurgery residents during the COVID-19 pandemic, the results demonstrated that daily studying hours were affected by 80%.⁵ In our study, 10 (58.8%) programs stopped all teaching

activities, and 7 (41.2%) switched some activities to online versions. In a John Hopkins study, all meetings during the pandemic were held by videoconferencing services without altering or stopping scheduled activities.⁶

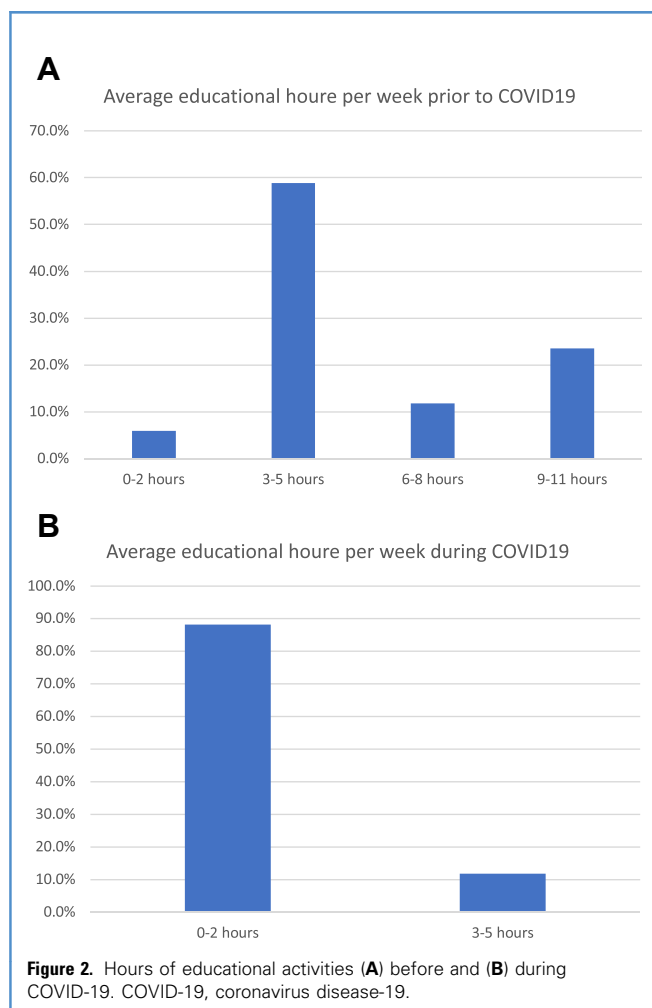
OR Exposure. The operative cases for residents showed a prominent decline for junior and senior levels, as illustrated in [Figure 1](#). In addition, the registry of our institution clearly shows a drop in both elective and emergency surgeries ([Figure 3](#)). Similarly, at Geneva University Hospital, elective ORs were all locked.⁷ Khalafallah et al⁶ reported cases in April 2019 in comparison to April 2020, which showed a significant reduction of 68.89%. Redeployment of residents is another contributing factor for a low operative volume; 1 center reported that half of the residents were taken to cover COVID-19 patient units.⁷

Most PDs in our study believe that the surgical skills of residents will be affected if the pandemic effect lasts 6 months or more. This statement brings attention to the importance of using all efforts to enrich not only theoretical teaching but also operative skills. Geneva University Hospital introduced daily microsurgery courses while applying all the precautionary measures of social distancing. They tested the residents during this period with multiple-choice questions to guide their learning and reading.⁷ From a British perspective, the authors clearly expressed the strong concern of the training shortcomings, especially for surgical programs, and suggested a training period extension to overcome the defect in training.⁸ Huotari et al⁹ described using smartphone cameras and suture sets to help improve residents' microsurgical skills.

Mental Well-Being. In the survey, we asked the residents to self-grade their anxiety levels during this pandemic, and the results were as follows: 34 (35.8%) high, 35 (36.8%) moderate, and 26 (27.4%) low. Alhaj et al⁵ were the first to study the impact of COVID-19 through neurosurgery residents' perspective, and 90% of their sample confirmed that the pandemic affected their mental health. A study of the impact of COVID-19 on the anxiety of French urologists in training showed that more than 90% of the trainees felt stressed by the pandemic. In addition, seniors were more likely to feel that the pandemic impacted their careers.¹⁰

Pelargos et al¹¹ studied the impact of this pandemic on US residents at different levels, despite the limitation of a low response rate, and showed important results. Over 64% of residents confirmed that this pandemic affected their interpersonal relationships with family and friends;¹¹ comparably, 64 (67.4%) residents in our study ranked the fear of spreading the virus as the highest factor contributing to their anxiety. Subsequently, 70 (73%) residents were isolating themselves in a room within their personal residence, practicing social distancing at home, or changed their residence entirely to keep their families safe.

The next anxiety-contributing factor was the ambiguity of the upcoming residency examinations and promotion measures, chosen by 53 (55.8%) residents. At the time of this survey, it had not been decided what changes will apply to promotion criteria, taking into consideration the precautionary measures applied. However, the promotion examination was canceled, and a surgical logbook with rotation evaluation was considered to have minimal requirements. Likewise, an article from the British perspective on the impact of COVID-19 on neurosurgical training has stated



concerns around the drop in surgical volume and the difficulty in achieving the required number of surgical logbook cases.⁸

The third factor selected by 50 (52.6%) residents is the possibility of being deployed to help in the ICU or quarantine areas. During the distribution of this survey questionnaire, we were at the peak of preparing neurosurgical residents to help in ICU areas by crash courses and lectures. Only 9 respondents were called to help in the ICU (9.5%). In the Pelargos et al¹¹ study, 35.1% of residents were involved in the care of non-neurosurgical COVID-19 patients. According to the Johns Hopkins Department of Neurosurgery's experience, approximately 20 residents were scheduled to cover ICU-COVID 19 shifts.⁶ To help alleviate the impact on mental health, the concept of virtual gathering during social distancing was discussed by Pennington et al¹² as a measure to help boost residents' psychological resilience.

PDs' Concerns

Academic and clinical teaching was the main concern among PDs. Correspondingly, a survey-based study conducted in the United States targeting a group of PDs demonstrated that the greatest concern was maintaining residents' education.¹² In the KSA,

similar to many countries, the transition was directed toward online teaching activities held by national or international neurosurgical societies.^{6,8,13} In our survey, 10 (58%) PDs confirmed canceling all their departmental activities, whereas 7 (41%) switched some of their activities to a virtual version.

The second factor concerning PDs was the possibility of staff shortages due to either redeployments of residents or exposure to the virus. Hence, many departments established dedicated COVID-19 teams. Over 80 (85%) residents confirmed having a COVID team; of those, approximately 78 (94%) confirmed not being a member of these teams. In Huang et al's study,¹² over 90% of PDs helped reduce the exposure of residents by decreasing the number of residents in the hospital at one time by decreasing the shift length or number of working days per week, whereas others reduced the number of scrubbing residents per procedure. In our study, only 9 (9.5%) of participants confirmed being redeployed to the ICU or quarantine areas.

Many reports and editorials since the start of this pandemic have reported neurosurgery staff being redeployed to ICU areas starting from residents, PDs, and other attendings. Bydon et al¹⁴ reported that 24% of PDs confirmed that their residents were redeployed to cover the ICU COVID area. The British experience reported that some neurosurgical residents have been redeployed to the ICU, emergency room, and internal medicine departments to assist staff shortages in COVID-19 wards. Furthermore, the authors listed the positive outcome of these measures in refreshing the medical knowledge of residents.⁸

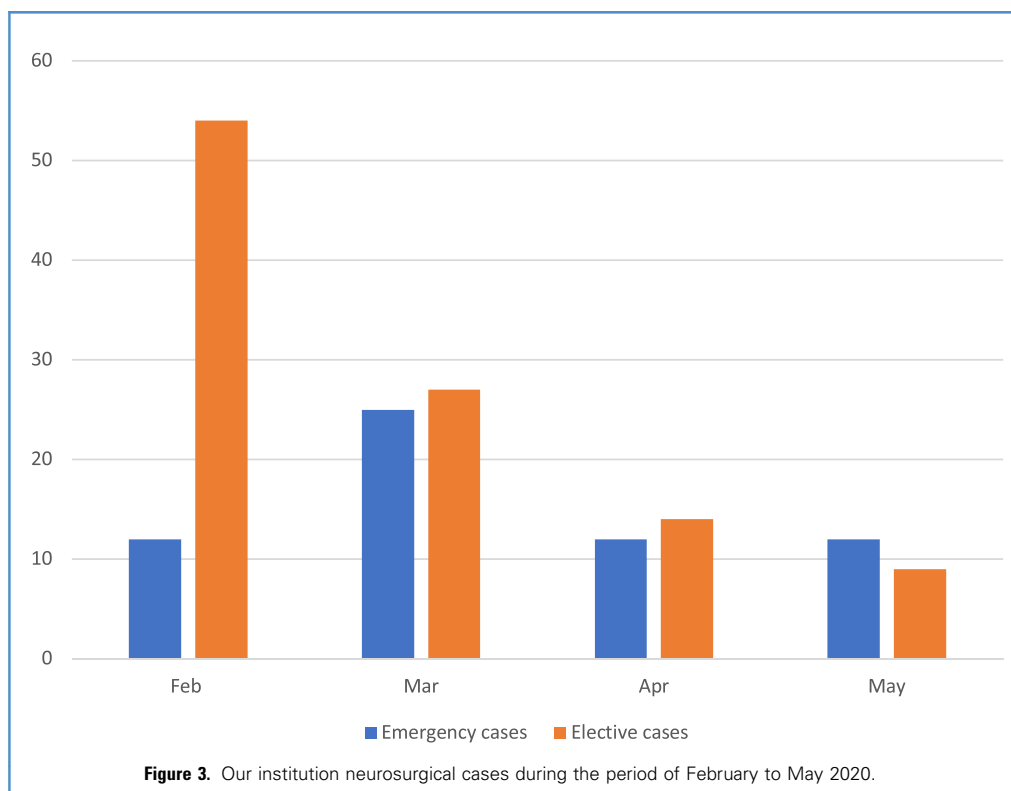
PDs were concerned about the safety of their residents and their preparedness to help in critical care units. We found that 50 (52.7%) residents confirmed being prepared by crash courses and lectures. Alhaj et al⁵ aimed to assess the readiness of residents to cover COVID patient areas; over 70% of residents received formal hand hygiene training, and 57% finished personal protective equipment training.

PDs have faced challenges in interviewing newly matched residents. In-person interviews have the greatest influence on PD decisions. Nevertheless, the majority are as confident in their choices this year as last year. Similarly, Bergsneider et al¹⁵ expressed the strong impact of interviews on the rank-list position. In addition, they highlighted the anxiety of many future applicants due to the impact of current matching and training situations on obtaining letters of recommendation and away rotations for students and interns. This may suggest that programs might consider increasing the number of applicants accepted for interviews.¹⁵

Suggested Solutions

Online Teaching. The main player during the shift of traditional neurosurgical residency educational tools was the online platform,¹⁶ which contributed greatly to the continuity of the educational process. Yet, one cannot deny the decline in hands-on neurosurgical practice suffered by junior and senior residents.¹⁷ Although a part of the online activities was focused on surgical teaching, the gap persisted. The well-known Neurosurgical Atlas introduced the virtual OR experience, providing weekly virtual exposure to many neurosurgical techniques.¹⁸

Residency/Fellowship Requirements. Minority of concerned residents suggested the extension of residency years as a measure to



compensate for the negative impact of the pandemic, whereas other stated that their compensation will be adequately achieved by their planned fellowships.¹⁹ In our opinion, a more reasonable way will be providing hands-on courses (cadaveric or practice models) to the residents and include them as a requirement to pass their residency. Microscopic surgical courses will be more appropriate to target the deficiencies in senior residents training.

CONCLUSION

This study shows the negative impact of the COVID-19 pandemic on resident training, operative exposures, and mental well-being. The volume of operative cases showed a substantial decline in both junior and senior residents. Academic and clinical teaching was the main concern for PDs. The residents mainly feared the spread of the virus to their family; this factor exceeded the fear of declined teaching and training quality of the program.

Our study covers only 1 neurosurgical society with a good response among residents (82%) and an excellent response rate among PDs (100%). We recommend a large-scale cross-sectional study to address future long-term effects on training.

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Razan Almufarriji: Conceptualization, Methodology, Writing – original draft, Formal analysis. **Turki Elarjani:** Investigation, Writing – original draft, Formal analysis. **Jamal Abdullah:** Resources, Writing – original draft, Formal analysis. **Abdullah Alobaid:** Data curation, Investigation, Writing – review & editing, Project administration, Supervision. **Abdulrahman Y. Alturki:** Writing – review & editing. **Abdulrahman Aldakkan:** Writing – review & editing. **Abdulrazag Ajlan:** Writing – review & editing. **Ahmed Lary:** Writing – review & editing. **Hosam Al Jehani:** Writing – review & editing. **Mubarak Algahtany:** Writing – review & editing. **Saad Alqahatani:** Writing – review & editing. **Fahd Alsubaie:** Writing – review & editing, Supervision.

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