

# Effect of COVID-19 Pandemic on General Surgery Practice and Resident Education

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## Research Article

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# Abstract

## Background

Sudden change in general surgery practice during pandemic caused a detrimental effect on residency training. The main objective of this study is to reveal the effect of Covid-19 pandemic on general surgery practice and surgical residency education.

## Methods

This retrospective cross sectional study included all patients operated at a tertiary university hospital, general surgery department between 11-March 2019/ 11- January-2019 (Pre-Covid 19 Period) and 11-march 2020- 11- January – 2020 (Covid 19 period). Two period compared in terms of case volume, complexity difference and effect of this difference on residents training.

## Results

Overall 2740 cases included to study. Elective case volume significantly decreased during pandemic ( $p = 0.001$ ). This decrease is much more obvious for B-C category operations. Intermediate seniority resident's case volumes and complexity of the cases they performed decreased during pandemic.

## Conclusion

Surgical residency programs must be revised urgently in order to provide adequate training which altered due to Covid-19 pandemic.

## Highlights

- The COVID-19 pandemic has affected surgical residency training in Turkey
- Cancellations of elective operations have deeply affected general surgery practice
- Intermediate senior residents have been worse affected by reduction in case load
- Resident training programs need urgent revision to sustain the healthcare system
- There is a need for future strategies for both healthcare delivery and training

## Introduction

On March 11, 2020, the World Health Organization declared a global pandemic due to the uncontained spread of the coronavirus disease (COVID-19) caused by severe acute respiratory syndrome coronavirus-type 2 (SARS-CoV-2). The very same day, the first such COVID-19 case was identified in Turkey (1).

The pandemic has led to serious burdens on the healthcare system across different countries. The shortage of personal protective equipment, the scarcity of both inpatient and intensive care unit beds and ventilators due to the high numbers of patients seeking hospitalization, the lack of respiratory support, extended periods of stay, and the decline of the healthcare workforce due to the high numbers of infected personnel or relocation were the early problems faced by global healthcare systems (2, 3). Several countries enforced preventive measures such as strict lockdowns and quarantine rules in an attempt to mitigate the effects of the high dissemination potential, long incubation period, high asymptomatic carriage rate, and difficulties/insufficiencies of the testing process of the virus.

To limit the rate of in-hospital transmission, healthcare facilities implemented strict measures such as physical or social distancing, restriction of visitors, isolated hospitalization of all patients in a single room, closure of outpatient clinics, redeployment of work force, setting up of new operation rooms for suspected or infected COVID-19 patients, and the reorganization of operating room protocols(4–8).

After the declaration of the pandemic, the Hacettepe University Hospital set up an institutional infectious disease control committee and enforced rapid response measures to reduce unnecessary patient circulation, save resources, and avoid high mortality and morbidity rates among the operated COVID-19 positive patients. Furthermore, all elective operations were canceled and non-surgical management strategies took prominence based on the available literature (9, 10). There were drastic changes in the healthcare system given the lockdown restrictions and the reluctance of patients to get admitted in hospitals. Among these, substantial case load reduction altered surgical residency training. Some studies used web-based questionnaires to address this problem, and showed a significant decrease in both elective and emergency cases, and significant alterations to resident education (11–13).

Hacettepe University's Department of General Surgery was founded in 1961. It received the European Board of Surgery Quality Certificate on September 27, 2002 and the National Board Certificate in 2007. The department is divided into four groups (A, B, C, and D) and each group works under the supervision of three faculty members. All of the residents have regular rotations among these groups. The General Surgery department accepts four general surgery residents each year and after five years of training, the residents graduate according to the regulations set by the Turkish Ministry of Health (14). During their term, resident logbooks are regularly evaluated by the chair of the department and a faculty member responsible for resident education. As mentioned earlier, the pandemic led to a significant decrease in the caseload, and thus, there have been concerns about the adequacy of resident training since the outbreak of the virus.

This study aims to present how surgical practice has been affected by the pandemic. It further examines whether the decreased case load and change in the distribution of elective/emergency cases have had a detrimental effect on residency training and if so, it identifies the group of residents whose training was significantly affected by the pandemic.

## Materials And Methods

This study was approved by the Turkish Ministry of Health and Institutional Ethics Committee (G0 21/124).

This retrospective cross-sectional clinical study included all operations performed at the clinic of the Department of General Surgery, Hacettepe University, between March 11 and December 11, 2019 (pre-COVID-19 period), and between March 11 and December 11, 2020 (COVID-19 period). Due to normalization efforts and the onset of the vaccination drive from January 2021 in Turkey, we limited the study period to nine months for more accurate results.

All procedures were classified into five different categories based on their level of complexity (from A–E), defined by the Turkish Ministry of Health (15). Category A represents the most complex operations such as esophagectomies, total gastrectomies, hepatectomies, Whipple procedures, laparoscopic hemicolectomies, and low anterior resections, while category E represents simple operations such as suturing lacerations, drainage of superficial abscesses, and superficial lymph node biopsies which can generally be performed on patients in outpatient clinics under local anesthesia.

In this study, we only included operations under categories A–D, examining the procedures performed in the operation theaters (OT). Table 1 presents the categorization of common general surgery procedures.

Table 1  
Categorization of common general surgical procedures.

A	B	C	D	E
Esophagectomy	Thyroidectomy	Laparotomy	Pilonidal sinus excision	Lymph node biopsy (superficial)
Fundoplication	Segmental small bowel resection	Inguinal hernia repair (elective)	Perianal abscess drainage	Suturing superficial lacerations
Total gastrectomy	Primary repair of duodenal perforations	Appendectomy	Hemorrhoidectomy	Simple abscess drainage
Subtotal gastrectomy	Cholecystectomy	Perianal fistulotomy	Lymph node biopsy (deep, cervical, axillary)	
Adrenalectomy	Inguinal hernia repair (emergent)		Sphincterotomy	
Abdominoperineal resection	Bilateral inguinal hernia repair		Debridement	
Subtotal colectomy	Hemicolectomy (open)			
Hemicolectomy (laparoscopic)	Mastectomy (simple, modified radical)			
Pancreatectomy	Colostomy/ileostomy			
Hepatectomy				
Morbid obesity procedures				

According to the institutional regulations, all operations were performed either by a faculty member or by a resident under the supervision of the responsible faculty member. Residents were grouped into three categories according to their seniority as first-year residents, second–fourth year residents, and fifth year residents.

Figure 1 presents the numbers and distribution of residents actively working at the department as of March 2019 and 2020. Due to resignations and rotations, there are minor changes to the number of active residents based on the date.

After the COVID-19 outbreak, all patients going in for surgery were screened using the reverse transcription polymerase chain reaction (RT–PCR) assay before their operation. Computed tomography (CT) of the thorax was performed for those who tested negative in the RT–PCR test but were symptomatic or clinically suspected patients. Only emergency operations were performed on COVID-19 positive patients under infection control regulations.

The demographic data of the patients, their preoperative diagnoses, indications (i.e., for a benign condition or suspected/confirmed malignancy), type of operation (emergency or elective), information about the performing surgeon and operation category, complication rate/grade based on the Clavien-Dindo classification, and the length of the patient’s stay at the hospital were all analyzed retrospectively (16). Preoperative diagnosis, indications, performing surgeon and operation category data collected from general surgery department’s data base which is active from 1996. All other data collected from institutional database which is open for all medical doctors working at Hacettepe University.

## Statistical analysis

IBM Statistics SPSS Version 20 was used for data analysis. The results of age, admission time and length of hospital stay were presented as median and interquartile range, as they were nonparametrically distributed according to Skewness and Kurtosis analysis. The differences between pre-covid and covid period were calculated with the Mann Whitney-u Test. Chi-square test was used to compare categorical variables such as sex, surgery category, emergency status, complication, Clavien Dindo classification, mortality status, ASA score, malignancy status, anesthesia type, operator type, covid status between pre-covid and covid period. A p-value of less than 0,05 was considered to be statistically significant

## Results

Data about the demographics of patients, the type of operation, complication rates, mortality rates, indications, and length of hospital stay are given in Table 2.

**Table 2. Demographic data of patients and results.**

Variables	Total (n = 2740)	Pre-COVID-19 period (n = 1802)	COVID-19 period(n = 938)	P
<b>Age</b>	52 (39–63)	53 (40–63)	52 (38–62)	
<b>Gender</b>	M: 45.2% (1239)  F: 54.8% (n = 1501)	M: 43.4%(n = 782)  F: 56.6% (n = 1020)	M: 48.7%(n = 457)  F: 51.3% (n = 481)	
<b>ASA *status</b>				
ASA 1	46.2% (n = 1267)	45.3% (n = 817)	48% (n = 450)	0.445
ASA 2	38.7% (n = 1060)	39.1% (n = 705)	37.8% (n = 355)	
ASA 3	14.6% (n = 399)	15.1% (n = 272)	13.5% (n = 127)	
ASA 4	0.5% (n = 14)	0.4% (n = 8)	0.6% (n = 6)	
<b>Emergency surgery</b>	16.2% (n = 444)	12.7% (n = 229)	22.9% (n = 215)	<b>0.001</b>
<b>Complication rate</b>	16.8% (n = 459)	16.9% (n = 304)	16.5% (n = 155)	0.830
Clavien-Dindo 1	22% (n = 101)	24% (n = 73)	18.1% (n = 28)	
Clavien-Dindo 2	39.4% (n = 181)	38.5% (n = 117)	41.3% (n = 64)	
Clavien-Dindo 3	25.4% (n = 116)	26% (n = 79)	23.9% (n = 37)	
Clavien-Dindo 4	3.3% (n = 15)	2.6% (n = 8)	4.5% (n = 7)	
Clavien-Dindo 5	10% (n = 46)	8.9% (n = 27)	12.1% (n = 19)	
<b>Mortality</b>	2% (n = 54)	1.8% (n = 32)	2.3% (n = 22)	0.313
<b>30-day mortality</b>		0.7% (n = 14)	0.1% (n = 12)	
<b>Malignancy status</b>	38.5% (n = 1056)	39.1% (n = 705)	37.4% (n = 351)	0.385
<b>Length of hospital stay</b>	3(2–7)	2(2–7)	3(2–8)	<b>0.001</b>

\*American Society of Anesthesiologists Score

During the pre-COVID-19 period, 1802 patients underwent operations at our clinic. This number decreased to 938 during the COVID-19 period. During the pre-pandemic period, 87.3% (n = 1573) of the operations were performed under the elective setting, and this rate decreased to 77% (n = 723) during the pandemic. The difference was statistically significant (p = 0.001). The overall complication rate for both periods was 16.9% and 16.5%, respectively. Clavien-Dindo grade 2 complications were observed in both groups, and

there was no statistically significant difference observed between the two groups ( $p = 0.830$ ). We see that 39.1% ( $n = 705$ ) of cases were performed due to confirmed or suspected malignancy before COVID-19, although this rate did not differ between the two periods (37.1% during the pandemic). Furthermore, the volume of overall malignant cases decreased to 351 during the pandemic.

Hospital mortality rates were 1.8% ( $n = 32$ ) and 2.3% ( $n = 22$ ), respectively, and there was no statistically significant difference between the pre-COVID-19 period and during the COVID-19 period ( $p = 0.313$ ). Post-operative mortality rates were 0.7% versus 0.1% ( $p = 0.308$ ). The median length of stay was two (IQR 2–7) days for the pre-COVID-19 period and three (IQR 2–8) days during the COVID-19 period, and this difference was statistically significant ( $p = 0.001$ ).

While this is not the objective of our study, we recorded that during the COVID-19 period, six RT-PCR confirmed cases were operated on due to the prevalence of emergency conditions such as appendicitis, perianal abscess, incarcerated hernia, and colon perforation. One patient who had a small bowel resection performed due to incarcerated femoral hernia died on the eighth post-operative day. Additionally two patients, one who required a total gastrectomy, transverse colectomy, splenectomy, and a non-anatomic liver resection due to gastric cancer, and other one who tested positive for COVID-19 in the early postoperative period and was operated on for incarcerated incisional hernia died two months after their operations due to COVID-19 related complications.

In the pre-COVID-19 period, 734 of 1802 (40.7%) operations were performed by residents under supervision, while during the COVID-19 period, this number decreased to 457. However, the percentage of operations performed by residents rose to 48.7%.

When the operations are grouped according to their complexity, we see that both patients underwent a majority of category B and C operations across both groups (76.8% and 74.4%, respectively). Although the number of cases decreased for all categories, there was no difference between the two periods in terms of operational complexity ( $p = 0.362$ ). Table 3 presents the distribution of all cases according to surgical category.

Table 3  
Case distribution according to complexity.

<b>Surgery category</b>	<b>Total</b>	<b>Pre-COVID-19 period</b>	<b>COVID-19 period</b>
<b>Category A</b>	13.1% ( $n = 358$ )	12.9% ( $n = 232$ )	13.4 ( $n = 126$ )
<b>Category B</b>	48.7% ( $n = 1335$ )	49.6% ( $n = 893$ )	47.1 ( $n = 442$ )
<b>Category C</b>	27.2% ( $n = 746$ )	27.2% ( $n = 490$ )	27.3 ( $n = 256$ )
<b>Category D</b>	11% ( $n = 301$ )	10.4% ( $n = 187$ )	12.2 ( $n = 114$ )

During the COVID-19 period, 202 (21.6%) cases were performed by final year residents. This number was 170 (9.4%) in the pre-COVID-19 period. Although there is a slight decrease in number, the percentage of

cases performed by first-year residents increased from 4.3–7.5% during the COVID-19 period. The most obvious effect was seen in cases performed by intermediate senior (2–4 fourth year) residents. The number of cases decreased from 485 to 183, their rates decreased from 26.9–19.6%, and the difference was statistically significant ( $p = 0.001$ ). The case volume and operation category distribution according to the performing surgeon and rates of the performing surgeon are given in Figs. 2 and 3, respectively.

## Discussion

The COVID-19 pandemic influenced general surgery practice both in terms of healthcare delivery and training. Our study showed that cancellations of non-urgent or elective operations deeply affected general surgery practice. These delayed operations mainly belong to categories B and C (e.g., hernia repairs, cholecystectomies, thyroidectomies, mastectomies, etc.) that are the most common operations in general surgery practice. In our opinion, it is crucial to develop future strategies for an early response and development system to respond to the needs of the potential patients who will overload the healthcare system after the pandemic. Moreover, our study showed a significant decrease in the number of all cases during the pandemic, independent of category. These included cases performed for malignancy or suspected malignancy. Cancellations of screening programs, closure of the outpatient clinics, and delayed or prolonged appointment scheduling due to various prevention measures and the reluctance of patients with respect to hospital admission for operations may have led to a decrease or delay in diagnosing and treating their problems (17–19). Thus, patients who are at advanced stages of diseases and disorders in the future need special attention, and strategies for their treatment must be developed.

We further note that the mean length of hospital stays extended by one day during the COVID-19 pandemic. The main reason for this is the necessity for COVID-19 screening before surgery. While these tests can be performed at the outpatient clinic, the institutional regulations in Turkey require that all patients are hospitalized at least one day before an elective surgical procedure and swap test and/or before the CT (thorax) to protect the patients as well as the healthcare workers. This testing process prolongs the length of hospital stay.

The complication and mortality rates did not change during the pandemic. We see that these rates are consistent with the findings of other studies in the extant literature (20, 21). It is possible that the strict adherence to testing rules for all patients and the identifying of asymptomatic COVID-19 positive patients (prone to especially pulmonary complications and with higher mortality rates) before their operation, and their subsequent isolation has contributed to these results (22, 23) .

In our opinion, the most important result of this study is the detailed and objective examination of the effect of the pandemic on surgical residency training. The pandemic did not disrupt the education programs, but led to the rapid dissemination of knowledge through online programs, webinars, and congresses. This may have contributed to a better theoretical understanding among residents. However, in the OT, skill acquisition still requires training and perfection (24). While only the case load and primary surgeon rate parameters may not reflect the technical and professional capability of the resident, these



are the most common tools used to determine the progress and competence of residents.<sup>25</sup> Some countries including Turkey set the minimum number of operations and indicate the minimum required for a trainee to graduate (14, 26, 27). However, this regulation could pose challenges in the near future due to the pandemic. According to the core education program of general surgery in Turkey, a resident must perform at least 400 cases as a primary surgeon under supervision, and 150 of these cases must belong to categories A, B, or C.

Our study revealed that first-year residents were not affected by this decrease as category D operations were the least affected during the COVID-19 period. Furthermore, the performance of senior residents improved during the COVID-19 period. This may be attributed to a decrease in the burden on faculty members in the OT due to cancelations and efforts to compensate the deficit caused by the pandemic for pre-graduate residents. Intermediate senior residents faced significant changes in their training due to multiple reasons. First, there was a redeployment of surgical staff to COVID-19 dedicated services to provide additional work force. The intermediate senior resident groups were assigned these tasks to avoid disruption of patient care at inpatient services. Second, there was a vast decline of category B and C cases, usually reserved for intermediate senior residents. The case volumes of this group of residents decreased by approximately 70%, as apparent in category B and C operations. Since these are the most common operations in the general surgery practice, intermediate senior residents lost their chance to perform these operations during pandemic. Despite all efforts to contain the pandemic, it continues to affect the global population. There is a need for the urgent revision of residency programs, especially for intermediate senior residents. The case volumes must be monitored frequently and rotation schedules must be rearranged on an individual basis. Furthermore, resident specific operation planning and prolongation of residency duration for this group may help close this gap due to the pandemic.

The retrospective nature and limited duration of the study period pose limitations. As we collected data over only a nine-month period, the study may not reflect the one-year performance properly. This is a potential weakness due to the sensitive nature of the period for Turkey. Moreover, the more in-depth research is required into the prospective monitoring of the resident performance for more accurate conclusions.

## **Conclusion**

The COVID-19 pandemic has deeply affected surgical practice. Safe surgical practice continues through the course of the pandemic with strict infection control measures and proper preoperative evaluation procedures in place. Through this study, we see that the pandemic has had a negative effect on surgical residency training, especially affecting the intermediate senior residents in terms of the case volumes and the complexity of the performed cases. Thus, it is crucial that surgical residency programs be revised urgently to provide adequate training for the unhindered continuation of the established healthcare system that has presently been altered due to the ongoing pandemic.

## **Abbreviations**

American Society of Anesthesiologists Score : ASA Score

Coronavirus Disease : COVID-19

Computurised Tomography : CT

Reverse Transcription Polymerase Chain Reaction : RT-PCR

Severe Acute Respiratory Syndrome Coronavirus-Type 2 : SARS-CoV-2

## **Declarations**

### **Ethics approval and consent to participate**

This study was approved by the Turkish Ministry of Health and Institutional Ethics Committee (G0 21/124).

### **Consent to Publication :**

We have read and understood your journal's policies, and we believe that neither the manuscript nor the study violates any of these. All Authors have consent for publication at BMC Medical Education Journal.

### **Availability of data and material**

All data of the study can be shared on demand by corresponding author.

### **Competing interests**

None

### **Funding**

None

### **Authors' contributions**

TE conceived and planned the research. KM ,DD, BK and MO carried out the data acquisition . TE , MO, KY contributed to the interpretation of the results. TE took the lead in writing the manuscript. All authors provided critical feedback and helped shape the research, analysis and writing the manuscript.

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None

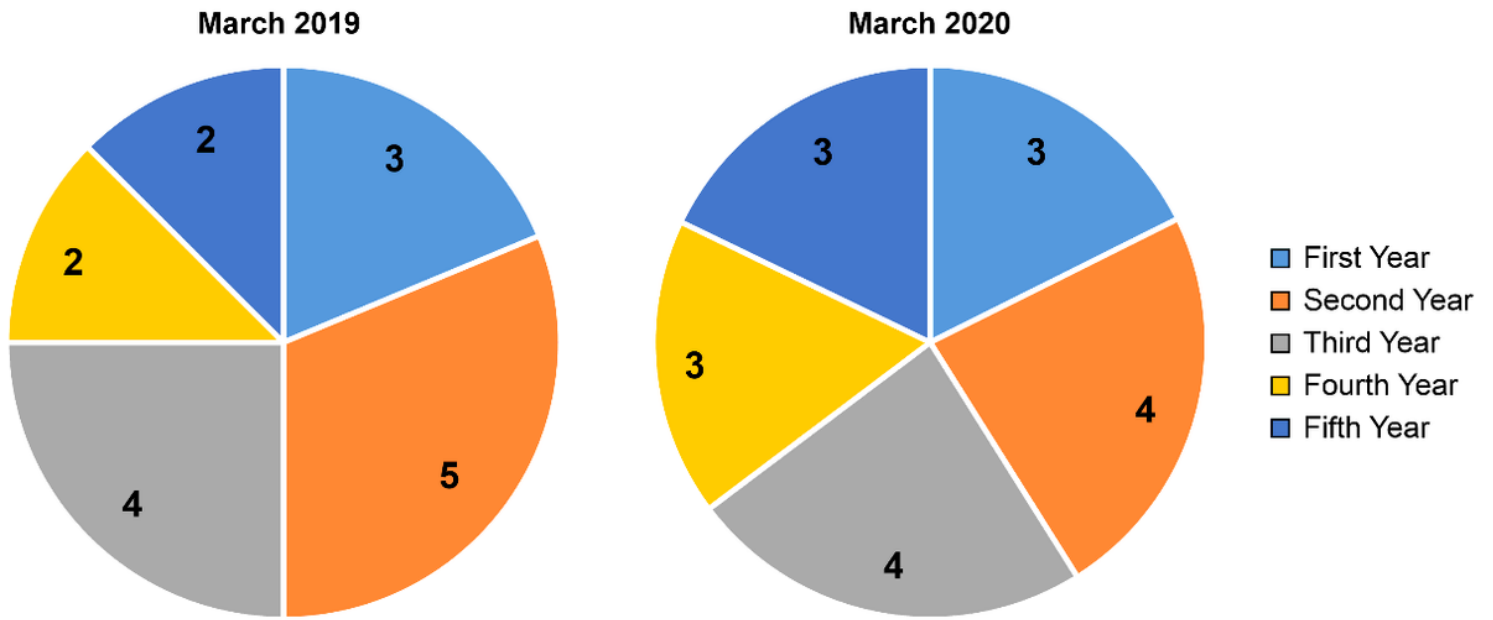
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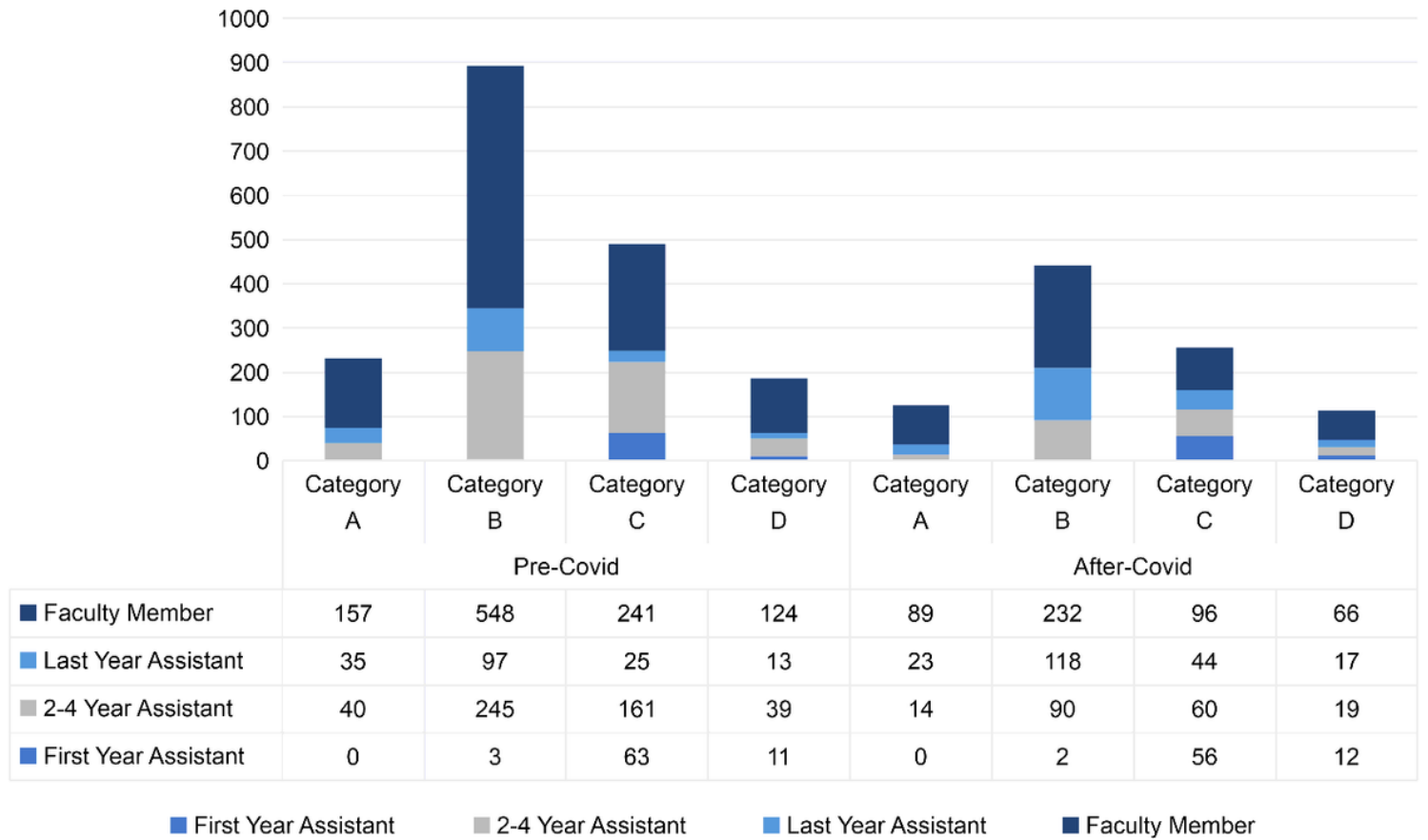
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## Figures



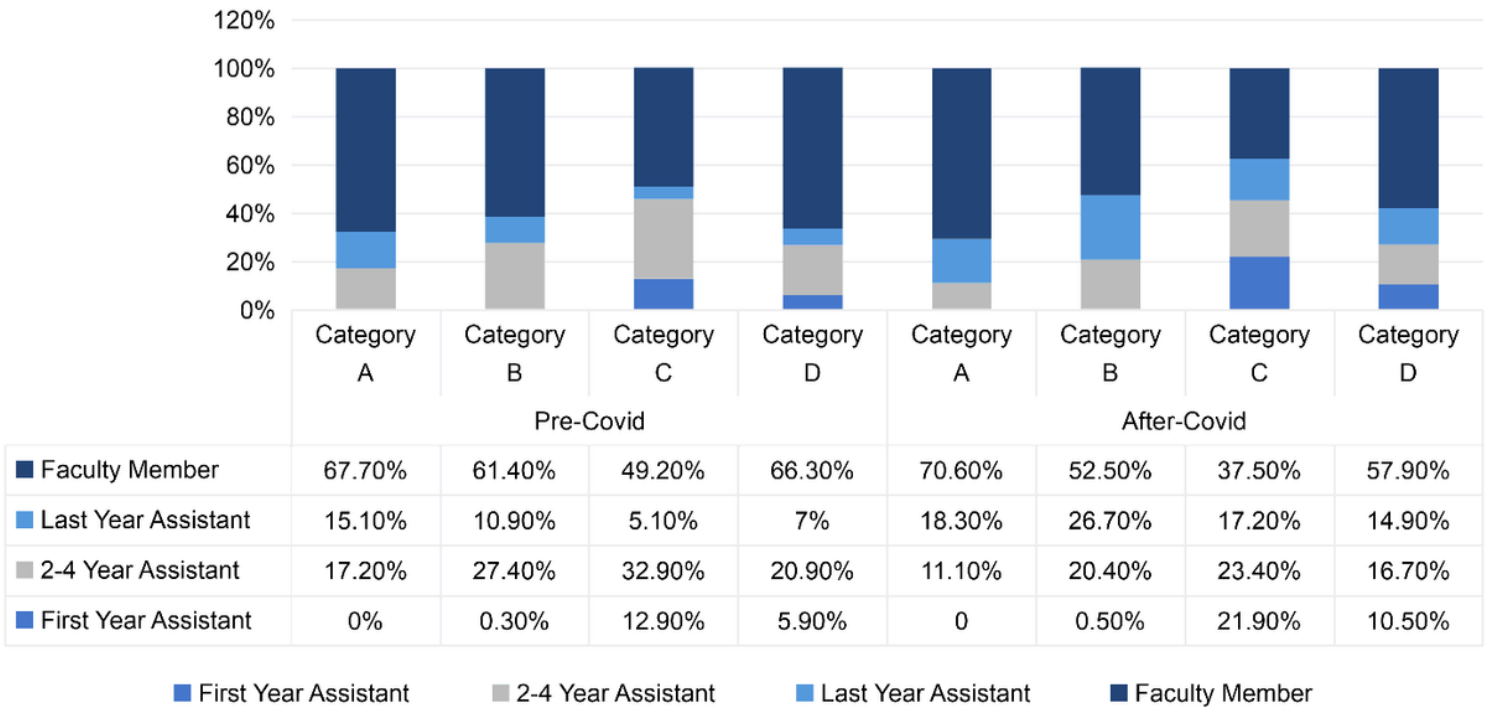
**Figure 1**

Distribution of active residents according to seniority.



**Figure 2**

Case volume and operation category distribution according to the performing surgeon.



**Figure 3**

Rates of performing surgeon according to category.