

# A Literature Review about Impact of COVID-19 on Operative Activity, Educational Process and Mental Health of Surgical Residents

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## Abstract

**Background and aim:** The COVID-19 pandemic has negatively affected all sections of society, including medical staff. Based on a review study, the aim of this study was to look at the impact of the COVID-19 pandemic on surgical residents, educational process, surgical, and mental health components.

**Material and methods:** The results of this study were based on the method of review studies. To conduct this study, a systematic search of international databases including Web of Science, Science Direct, Scopus, PubMed, and Google Scholar between 2000 and 2021 was first performed using related keywords. Finally, 30 articles were chosen based on the scope and the necessary criteria for obtaining data, and the needed results were extracted from them.

**Results:** The results showed that 6776 residents and 220 program managers participated in these studies, with the largest sample sizes coming from the United States (3187 people), India (716 people) and Italy (661 people), respectively. Furthermore, the results showed that the COVID-19 pandemic had a negative effect on surgical residents', educational activities, as well as mental health, and surgical activities.

**Conclusion:** Based on the results, it can be concluded that COVID-19 pandemic has a negative effect on surgical residents' educational process, as well as increased their anxiety and stress, and for that reason, proper planning by managers is needed to reduce these negative effects.

**Keywords:** COVID-19 • Pandemic • Training • Operative • Mental health • Surgical residents

## Introduction

Since December 2019, a global epidemic of the new coronavirus (COVID-19), also known as severe acute respiratory syndrome, has emerged, posing a threat to the health and lives of millions of people around the world [1]. Other acute respiratory disorders, such as Severe Acute Respiratory Syndrome (SARS) and Middle East Respiratory Syndrome (MERS), have been identified by the World Health Organization (WHO) in the last two decades. The mortality rate due to SARS disease is recorded to be 8096 people in 29 countries, and the mortality rate due to MERS disease is reported to be 858 people in 27 countries [2]. However, the mortality rate from the COVID-19 disease is even higher, with more than 3.3 million individuals worldwide having died from this epidemic until May/11/2021. The greatest concern about COVID-19 comes from the fact that the disease's occurrence and mortality are increasing day after day, and the rate of medication differs throughout the world. Since not everyone in the world has access to vaccines, this epidemic will continue to cause anxiety and concern for a long time.

Going to declare a state of emergency, governments and public health systems have taken comprehensive steps to prevent the disease from spreading. Millions of people around the world have changed their lifestyles as a result of the disease [3]. Furthermore, the rate of disease transmission and the resulting mortality has caused considerable anxiety among people all over the world [4].

The physical and mental health of both ordinary citizens and medical staff has been influenced by the disease's stress and its adverse

psychosocial impacts [5-9]. In their study, Al-Rabiaah, et al. found that medical professionals are not excluded from this rule or principle, and that they are often influenced by these psychological stresses. This medical staff group may also be much more vulnerable than other people in the community, and they also have higher rates of depression and anxiety [9-11].

In medicine, dentistry, and veterinary medicine, surgery is one of the possible treatments or operations. Of course, the knowledge and techniques of this method are also called surgery. In this process, an incision is usually made to remove a part of the body (such as the gallbladder, tonsils, or appendix) or infectious or cancerous tissue, or to insert a tube or device (such as a prosthesis or prosthetic valve), or to manipulate, fix, and correct a defect (such as suturing an aneurysm or opening a vein) has been used [12].

Surgery is one of the most important medical professions that many people need, resulting in the development of various areas of surgery for the majority of the human body. The most significant and well-known areas related to surgery are general surgery, plastic surgery, heart surgery, vascular and trauma surgery, pediatric surgery, chest and cardiothoracic surgery, orthopedic surgery, obstetrics and gynecology surgery, kidney and urinary tract surgery, neurological surgery, Otorhinolaryngology and/or otolaryngology (ENT) surgery, rhinoplasty, eye (ocular) surgery, laryngeal surgery, periodontal (gum) surgery, oral and maxillofacial surgery are the most important and famous fields related to surgery. Considering that the most of a patient's organs may require surgery, and therefore this field of

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Received date: December 16, 2021; Accepted date: December 30, 2021; Published date: January 06, 2022

medicine can be considered as the most important, relevant and necessary field for patient treatment.

As previously stated, medical staff can suffer severe stress and anxiety as a result of the specific situations they encounter while faced with COVID-19 patients, and this may have an impact on their learning during training, working conditions, and mental health, as well as greatly impress surgeons and residents in this field [5-9]. However, up to date, only one review study has been conducted on the effect of COVID-19 pandemic on the educational activity of surgical residents [13], however, since the mentioned study consisted primarily on studies conducted in 2020 and focuses mainly on the effect of this pandemic on the educational process of surgical residents, and since the COVID-19 pandemic is still affecting most countries in 2021, the need for studies conducted in 2021 for the topic in question is also critical. In addition to the educational aspect, it is necessary to pay attention to other aspects of the COVID-19 pandemic effect, including burnout, operative activity, mental health, working conditions and quality, as well as the personal life of surgical residents, which will be addressed in this study as much as possible.

Because of the above reasons, the main purpose of this study is to investigate the impact of COVID-19 pandemic on working conditions, educational status and learning as well as the mental health status of surgeons and surgical residents by reviewing previous and similar studies.

## Material and Methods

Systematically search globally accessible databases such as Web of Science, Science Direct, Scopus, PubMed, and Google Scholar from December 2000 to May 2021 in order to review and collect the required data from published articles and reviews relating to the topic under study. Systematic review using Mesh terms "COVID-19", "surgical", "surgeons", "psychological", "residents", "impact", "training", "pandemic", "work",

"Medical", "Coronavirus 2019", "Coronavirus 2019", "Operative impact", "mental health", "stress", "anxiety", "educational", "hospital", "job Status", "working patterns", "operation", "effect", "Response", "time of COVID-19", "during of COVID-19", "Residents' Perspective", "training program", "general surgery", "Online education", "coping strategies", "learning" was done. The same Mesh terms were used in other databases in a similar way. To ensure that the search was systematic, the references of the studies that were found were checked (Reference Checking) to exclude the possibility of missing studies. Figure 1 was used to study citation tracing, and texts were checked and articles were received through using PRISMA guidelines [14]. Moreover, informal papers, articles published in the letter-to-the-editor format, as well as unpublished articles and content from websites were also removed from the list of files to be accessed. Finally, for this study, the results of 30 published articles were reviewed.

## Results and Discussion

A total of 373 different types of articles and reports were initially listed for the current study based on the search strategy (Figure 1). Since there are several target groups for the topic under study, including various fields of medicine, and also for the subject under consideration, several studies were conducted prior to the COVID-19 pandemic, and as a result, the initial articles collected were many. Finally, 30 articles were chosen based on the inclusion criteria, and the required results were extracted from their full text and listed in Table 1.

After reviewing the studies, it was discovered that the majority of them were linked to the United States (12 studies) and Italy (4 studies), with just 1-2 studies performed in the remaining countries. Based on the current results of the reviewed studies [15-18], 6776 residents and 220 program managers actively participated in these studies, with the highest sample sizes in the United States (3187 people), India (716 people), and Italy (661 people), respectively (Figure 2).

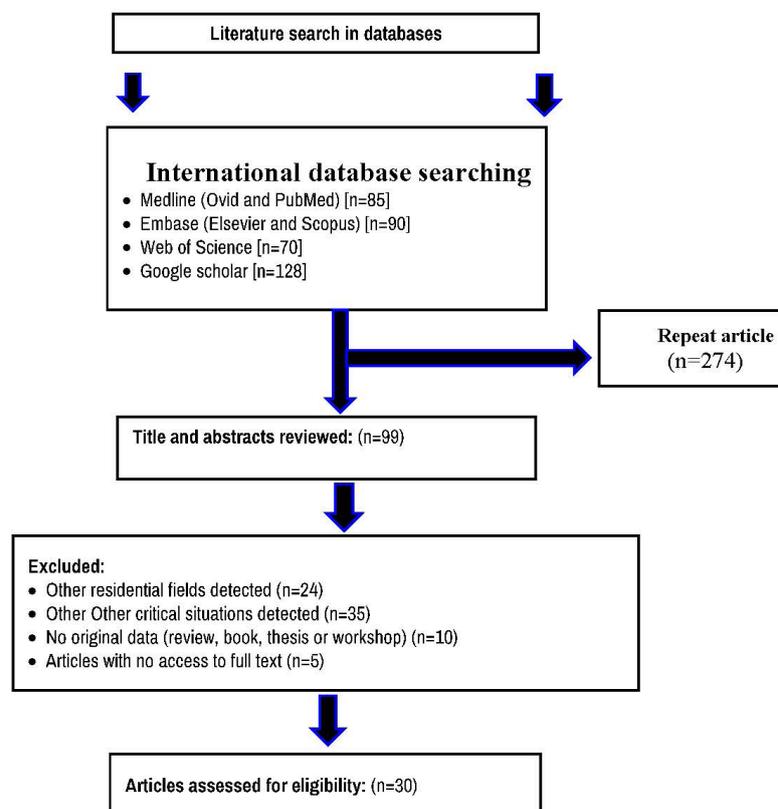


Figure 1. Flow diagram of study identification according to PRISMA.

**Table 1.** The summary of reviewed studies.

Study	Study location	Number of participants/ programme directors	Subject under study	Specialized field	The most important outputs of the study
Wise et al. [19]	USA	146	Impact on education	Cardiothoracic, General Surgery, Neurosurgery, Orthopedics, Otolaryngology/Head and Neck Surgery, Plastics, Urology, and Vascular Surgery	<ul style="list-style-type: none"> <li>• 99.7% of the participants predicted that they would be able to finish their academic year on time.</li> <li>• 75.2% of the virtual learning received is as effective as face-to-face training sessions, and perhaps even better.</li> <li>• Most participants were aware of their ability to have sufficient knowledge and skills in caring for patients with COVID-19.</li> <li>• Most participants were concerned about their potential exposure to COVID-19.</li> </ul>
Aljehani et al. [20]	Saudi Arabia and Bahrain	234	Impact on stress and psychological	General surgery	<ul style="list-style-type: none"> <li>• There was a significant association between experiencing anxiety and male gender (<math>p=0.055</math>), level of training (<math>p=0.002</math>), deployment to cover ICUs (<math>p=0.050</math>), testing positive for COVID-19 (<math>p=0.054</math>) and having an infected family member (<math>p=0.004</math>).</li> </ul>
Inzunza et al. [21]	Chile	Not applicable	Impact on operative volume	General surgery	<ul style="list-style-type: none"> <li>• The results of the study showed that 61.7% of surgeries at the time of the COVID-19 pandemic (2020 year) had decreased compared to the time before (2019 year)</li> </ul>
Abdelsattar et al. [22]	USA and Canada	111	Impact on residents' clinical, educational, and personal	General surgery	<ul style="list-style-type: none"> <li>• Advantages: the use of telehealth and virtual didactics, an increased sense of camaraderie amongst residents, and flexibility in scheduling</li> <li>• Disadvantages: Uncertainty at work regarding personal protective equipment and scheduling, decreased case volume and educational opportunities, and emotional trauma and burnout associated with the pandemic</li> </ul>
Purdy et al. [23]	USA	1358	Impact on operative volume	General surgery	<ul style="list-style-type: none"> <li>• There was a 33.5% reduction in total operative volume in March to June 2020 compared with 2018 and 2019.</li> <li>• There was a 10.2% reduction in operative volume during the 2019-2020 academic year compared with the 2 previous years.</li> </ul>
Givi et al. [24]	USA	31 trainees and 37 programme directors	Impact on operative volume	Otolaryngology surgery	<ul style="list-style-type: none"> <li>• 86% of operations were canceled compared to the time before the pandemic.</li> <li>• 82% of individuals were performed the number of operations required to obtain certification.</li> <li>• 97% of cases reported weekly participation in virtual tumor program</li> </ul>

Zoia et al. [25]	Italy	192	Impact on operative volume and production of scientific articles or research projects	Neurosurgery	<ul style="list-style-type: none"> <li>• 72.4% of the cases reported that their presence in the neurosurgery department has decreased.</li> <li>• 78.6% of cases reported that they performed less operations during this pandemic period</li> <li>• 16.1% of cases reported that they performed no operations during this pandemic period.</li> <li>• 55.7% of cases reported that production of scientific articles or research projects has increased during this pandemic.</li> </ul>
An et al. [26]	USA	121	Impact on outpatient activity, mental health and educational activities	Orthopedics surgery	<ul style="list-style-type: none"> <li>• 20% of the centers (1/5) had redeployed trainees to support patients with COVID-19.</li> <li>• 60% (3/5) residency programs canceled all outpatient activity for trainees</li> <li>• 20% of cases used mental health resources to maintain their health.</li> <li>• During this pandemic, video conferencing was used to conduct educational activities.</li> </ul>
White et al. [27]	USA	84 programme directors	Impact on resident's presence and educational activities	General surgery	<ul style="list-style-type: none"> <li>• 44% reported that during this pandemic, they operated without resident's presence.</li> <li>• 86.9% of the cases reported that the way of educating residents is being done online.</li> </ul>
Alhaj et al. [28]	Canada, USA, Kuwait, Saudi Arabia, Serbia and Italy	52	Impact on training, mental health and social life of residents	Neurosurgery	<ul style="list-style-type: none"> <li>• 98, 90 and 100% of cases reported that the pandemic affects education, mental health and social life, respectively.</li> </ul>
Zingaretti et al. [29]	Italy	115	Impact on training	Plastic surgery	<ul style="list-style-type: none"> <li>• Most participants reported that lack of training reduced professional progress.</li> <li>• Most of the participants stated that the use of training tools by the webinar preserves the updated knowledge.</li> </ul>
Bernardi et al. [30]	Italy	3	Impact on training and outpatient activity	General surgery	<ul style="list-style-type: none"> <li>• The number of interventions was greatly reduced.</li> <li>• The number of surgeries as the first operator was greatly reduced.</li> <li>• Participation in surgery training (via webinars and other virtual methods) was greatly reduced.</li> </ul>
Megaloiconomos et al. [31]	23 European countries	327	Impact on training, anxiety and outpatient activity	Orthopedics surgery	<ul style="list-style-type: none"> <li>• 58.8% of the participants stated that this pandemic time disrupted the educational process of the residents.</li> <li>• 58.2% of participants are concerned about achieving their annual training goals.</li> </ul>

Osama et al. [32]	Pakistan	112	Impact on training, anxiety and burnout	All specialized surgical fields	<ul style="list-style-type: none"> <li>• 86.6% of the participants stated that their practical experience was negatively affected.</li> <li>• 82.1% of participants reported that their experience with clinical exposure was negatively affected.</li> <li>• 61% of the participants stated that they were anxious and worried about the possible transmission of the virus to their relatives.</li> <li>• The number of working hours per week has been significantly reduced, and this, in the view of the study participants, reduces burnout.</li> </ul>
Figueroa et al. [33]	Chile	100	Impact on training	Orthopedics	<ul style="list-style-type: none"> <li>• 13% of the participants stated that practical training through online methods is a big problem for them to learn.</li> <li>• 86% of the participants stated that they use online training tools for practical and non-practical training.</li> <li>• 30% of the participants feel that all impractical training courses should be done using virtual methods</li> </ul>
Abdessater et al. [34]	France	275	Impact on work quality and mental health	Urology	<ul style="list-style-type: none"> <li>• 85.5% of the participants stated that this pandemic had a negative effect on the quality of their work quality.</li> <li>• 91.6% of the participants stated that they were stressed due to facing this pandemic.</li> </ul>
Amparore et al. [35]	Italy	351	Impact on work status	Urology	<ul style="list-style-type: none"> <li>• 7.7% of the participants stated that they are working in the ward of patients with COVID-19.</li> <li>• The amount of decrease related to different fields of work of trainees including diagnostic methods, endoscopic surgery, open surgery and minimally invasive surgery had 74.1%, 62.1%, 57.8% and 44.2%, respectively.</li> <li>• 85.2% of participants reported spending at least 2 hours a day pursuing smart learning goals.</li> </ul>
Bar et al. [36]	USA	33 programme directors	Impact on work status and mental health	Oral and maxillofacial surgery Survey	<ul style="list-style-type: none"> <li>• The negative effects of this pandemic have caused most selective and non-urgent programs to be suspended.</li> <li>• About 40% of participants reported using telemedicine during the pandemic COVID-19.</li> <li>• 73% of cases stated that used the various resources for resident goodness and stress reduction</li> <li>• Necessary trainings are done using virtual methods.</li> </ul>
Burks et al. [37]	USA	1 programme	Impact on operative volume	Neurosurgery	<ul style="list-style-type: none"> <li>• The number of operation at all levels of education had decreased. In addition, the number of cases decreased significantly compared to the previous year.</li> </ul>

Aziz et al. [38]	USA	1102	Impact on operative activity, training activity and burnout	General surgery	<ul style="list-style-type: none"> <li>• 40.6% of participants reported that they were not allowed to enter the operating room to avoid exposure to patients with COVID-19 (which carries a high risk of transmission of the Corona virus).</li> <li>• The number of surgeries per week reduced significantly.</li> <li>• 80.7% of the participants stated that they had not performed any outpatient clinical activities.</li> <li>• 80.6% of the participants reported that they performed all their educational activities through online operating systems.</li> <li>• 33.1% of participants reported having more burnout than before the pandemic period.</li> </ul>
Collins et al. [39]	USA	73	Impact on operative activity and mental health	General and plastic surgery	<ul style="list-style-type: none"> <li>• 90% of study participants were concerned that they were not exposure to practical training for operative activity.</li> <li>• According to the results of this study, the volume of operations decreased to 63.3%.</li> <li>• Most participants in this study were concerned about the health of their loved ones, mainly because residents were at risk for COVID-19 and could transmit the virus to their families.</li> </ul>
Ferrara et al. [40]	32 countries	504	Impact on training activity and work status	Ophthalmology	<ul style="list-style-type: none"> <li>• 55.2% of the participants felt that the COVID-19 pandemic had a great impact on the educational process of the residents.</li> <li>• 76.4% of participants reported that more than 50% of their clinical activity had decreased.</li> <li>• 67.7% of the participants stated that they tend to perform their educational activities through web agents.</li> </ul>
Paesano et al. [41]	Latin America and Spain	148	Impact on operative activity and surgical training.	Urology	<ul style="list-style-type: none"> <li>• 82% of participants reported that the activity of the urology department was significantly reduced due to concerns related to the COVID-19 pandemic.</li> <li>• 75% of the participants felt that the COVID-19 pandemic had a strong impact on surgical training.</li> </ul>
Kapila et al. [42]	10 countries	86	Impact on operative activity, mental health and surgical training	Plastic surgery	<ul style="list-style-type: none"> <li>• 85% of participants felt that the COVID-19 pandemic had a negative effect on surgical education.</li> <li>• According to 86% of Belgian surgical trainees and 73% of international trainees, the rate of operative activity has decreased significantly.</li> <li>• 54% of Belgian surgical trainees, as well as 69% of international trainees, were anxious about developing COVID-19.</li> </ul>

Mishra et al. [43]	India	716	Impact on mental health and surgical training	Ophthalmology	<ul style="list-style-type: none"> <li>• 80.7% of participants felt that the COVID-19 pandemic had a negative effect on surgical training.</li> <li>• 75.7% of the participants stated that virtual methods can be useful for surgical training in the COVID-19 pandemic course.</li> <li>• COVID-19 pandemic caused stress and unhappiness in 54.9% and 46.5% of the participants in this study, respectively.</li> </ul>
Khusid et al. [44]	USA	332	Impact on mental health	Urology	<ul style="list-style-type: none"> <li>• According to the participants in the study, risk factors for the virus included local severity of COVID-19, a personal history of infection, and concerns about operative autonomy</li> </ul>
Munjal et al. [45]	22 countries	66 residents + 30 faculties	Impact on training activity, operative activity and work status	Otolaryngology and pediatric otolaryngology	<ul style="list-style-type: none"> <li>• 91.7% of the participants reported that due to this pandemic, all the elective cases were canceled</li> <li>• 86.4% of the participants stated that the COVID-19 pandemic affected all levels of training and employment of surgeons.</li> <li>• 87.5% of the participants stated that no additional surgical training is being provided.</li> <li>• 41.7% of the participants reported that all teaching seminars are conducted using the virtual method.</li> </ul>
Pelargos et al. [46]	USA and Canada	197	Impact on training activity, anxiety and work status	Neurosurgery	<ul style="list-style-type: none"> <li>• 35.1% of residents provide non-specialist care to patients with COVID-19.</li> <li>• Based on the results, COVID-19 pandemic has reduced 82% of inpatient and outpatient cases.</li> <li>• 91% of participants reported that responsibility decreased due to reduced daily working hours.</li> <li>• 33.7% of trainees are concerned about the negative impact of this pandemic on the surgical training process, and senior trainees are significantly more concerned about this.</li> <li>• 26.5% of residents are worried about getting the desired employment or the scholarship.</li> </ul>
Rosen et al. [47]	USA	65 programme directors	Impact on training activity and work status	Urology	<ul style="list-style-type: none"> <li>• 92% of the program reported that the presence of resident interns was reduced and, in addition, the duration of contact with the patient was significantly reduced.</li> <li>• 48% of the programs reported that pandemic COVID-19 had a negative effect on the surgical training process.</li> </ul>
General surgery	Impact on training activity	24	USA	Zheng et al. [48]	<ul style="list-style-type: none"> <li>• 92% of the program reported that the presence of resident interns was reduced and, in addition, the duration of contact with the patient was significantly reduced.</li> <li>• 48% of the programs reported that pandemic COVID-19 had a negative effect on the surgical training process.</li> </ul>

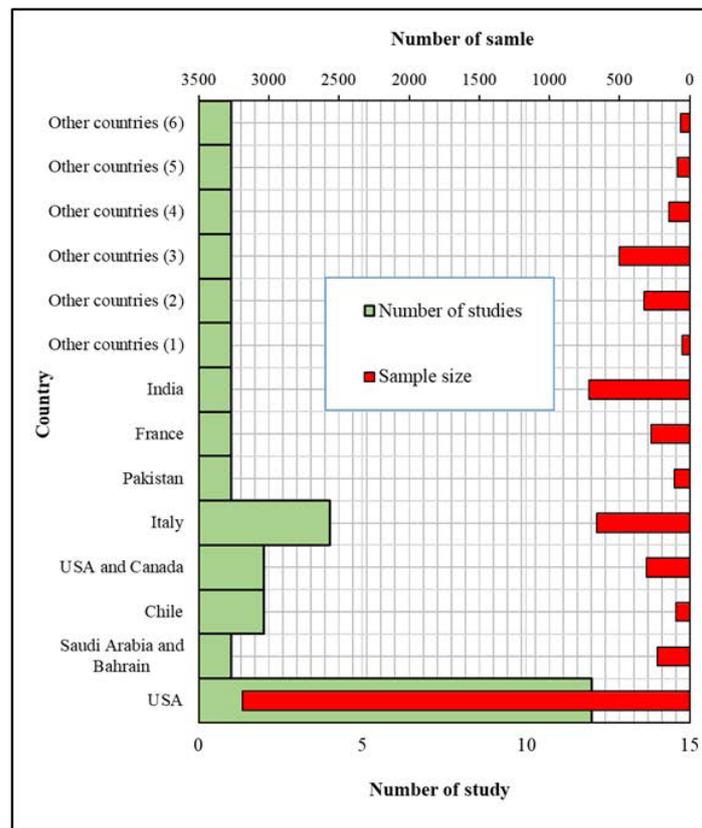


Figure 2. The comparison of number of study diagram of study identification according to PRISMA.

The results of the present study showed that the amount of Operative Activity (OA) has decreased in the majority of studies performed in various countries. For example, in the study of Inzunza et al. in Chile, the rate of OA reduction was reported to be 61.7%, while this reduction rate in the United States in the studies of Purdy et al. and Collins et al. were reported to be 33.5% and 63.3%, respectively. Other studies, including Givi et al., Zoia et al., Burks et al., Aziz et al., Paesano et al., Kapila et al., and Munjal et al., have identified other methods of reducing OA, however the precise sum of OA has not been reported, whereas, the higher incidence of surgical case cancellations[19-20], as well as the decline in the participation of surgical trainees in surgical centers and hospitals, have been specifically highlighted in these studies Surgical trainees have expressed concern about the reduction in the number of surgical cases and the lack of in-person teaching of the surgical process. This confusion comes mostly from a lack of practical surgical knowledge as well as experience doing prospective job duties [21-27].

Some studies have shown that during the COVID-19 pandemic, some surgical trainees engaged in non-surgical medical treatment rather than doing surgery, which is a negative influencing factor in terms of gaining experience and learning the fundamentals of surgery.

The results of the present study showed that most surgical residents in various studies felt that due to the COVID-19 pandemic, their educational activities were negatively affected. For example, in the studies of Alhaj et al., Zingaretti et al., Bernardi et al., Figueroa et al., Ferrara et al., Paesano et al. and Munjal et al. have clearly reported the negative impact of the COVID-19 pandemic on the surgical education process [28-36].

Due to the decrease in clinical and surgical operations conducted by trainees since the COVID-19 pandemic, so the duration of their theoretical training activities outside of surgical centers and hospitals has increased. Most studies have reported that the way of conducting training sessions has changed from face-to-face to virtual due to the reduction of face-to-face meetings to prevent the transmission of the coronavirus. However, some limited studies have shown that the virtual model of teaching surgery is

less efficient and effective than the face-to-face method. This viewpoint indicates that keeping a virtual training process may have a negative impact on surgical trainees' ability to achieve experiences and create anxiety about their future careers [13]. In some articles, it has been reported that due to the decrease in the clinical activity of surgical trainees, they have more opportunities to conduct research activities as well as the use of updated and new scientific articles and reports, which is clearly stated in the study of Zoia et al. [25].

One of the other effects of the COVID-19 pandemic, in addition to impacting educational, clinical, and surgical activities, was the psychological impact of the crisis on surgical trainees, which has been clearly reported in several previous studies. Numerous surgical trainees suffer anxiety and stress as a result of exposure to the COVID-19 pandemic, according to studies by An et al., Alhaj et al., Abdessater et al., Bar et al., Collins et al., Kapila et al., Mishra et al. and Khusid et al. Furthermore, it has been stated in these studies that some surgical trainees are concerned about transmitting the coronavirus to their families and loved ones when they are exposed to patients with COVID-19 [37-48].

Given that the COVID-19 pandemic has decreased surgical residents' operative volume, this has reduced burnout in them, as noted and confirmed in the study by Abdelsattar et al. [22], while Aziz et al. reported that 33.1% of general surgery residents' burnout during the COVID-19 pandemic was higher than during the pre-pandemic period [38].

## Conclusion

Based on the results of the present study, it can be concluded that the COVID-19 pandemic has had significant effects on educational process, surgical activities, mental health and burnout of surgical trainees around the world. In most parts of the world, due to the fear of COVID-19, the operative volume has decreased and unfortunately this has had a negative impact on the training and learning process of trainees because trainees share a large part of their experiences in person while watching and participating

in a surgical operation and they will then get actual surgery, which was canceled during the COVID-19 pandemic. In terms of educational dimension, most trainees feel that the pandemic has had a negative impact on their educational experiences, and in terms of mental health, most surgical trainees have encountered stress and anxiety as a result of the pandemic. Reduced burnout and further opportunities for research activities are among the positives of this pandemic for surgical trainees. Most various studies around the world have reported that most of the educational activities of surgical residents are performed by virtual methods. Finally, based on the results of the present review study, it can be concluded that the COVID-19 pandemic has a great negative impact on educational activities, surgical activities as well as mental health of surgical residents and that the necessary conditions, facilities and strategies to prevent the negative effects of this pandemic to all clinical personnel, including surgical residents, should be provided by the relevant officials and managers of the treatment department.

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**How to cite this article:** Alireza Negahi, Nahid Nafissi, Foolad Eghbali, and Behnaz Nouri, et al. "A Literature Review about Impact of COVID-19 on Operative Activity, Educational Process and Mental Health of Surgical Residents" *Clin Schizophr Relat Psychoses* 15S (2021).Doi: 10.3371/CSRP.NANN.010622.