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Residents' Training in COVID-19 Pandemic Times: An Integrated Survey of Educational Process, Institutional Support, Anxiety and Depression by the Saudi Commission for Health Specialties (SCFHS)

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Abstract: In late December of 2019, the outbreak of coronavirus disease (COVID-19) was first reported in the city of Wuhan, the capital of Hubei province in China, and was declared a pandemic by the World Health Organization in March 2020. Globally, as of 8 July 2020, there have been 11,669,259 confirmed cases of COVID-19, including 539,906 deaths. In Saudi Arabia, the confirmed cases have already reached 223,327, with 161,096 patients confirmed to have recovered, and 2100 deaths. This study aims to determine the effect of the COVID-19 pandemic on the training programs of the Saudi Commission for Health Specialties (SCFHS) and assess trainees' mental health status (i.e., anxiety and depression). Trainee evaluations on training programs were also sought in order to obtain insights for strategic planning necessary for curricular modifications or improvements to address the clinical learning needs of trainees during this pandemic. The main contribution of our work is an investigation of the incidence of depression and anxiety regarding COVID-19 within the community of residents and fellows. Furthermore, we elaborate on key responsive actions towards the enhancement of the mental health of trainees. Last but not least, we propose the Saudi Commission for Health Specialties (SCFHS) Model for Residents' Mental Health Enhancement during the COVID-19 Pandemic, which consists of five integrative value layers for medical education and training, namely: the knowledge creation process and innovation; technological capabilities for personalized medicine and patient-centric healthcare with a social impact; innovative applications of technology-enhanced learning and web-based active learning approaches for medical training and education; residents' wellbeing and the impact of COVID-19 in strategic layers. In our future work, we intend to enhance the proposed framework with studies on trainee satisfaction and the efficiency of different technology-enhanced learning platforms for medical education.

Keywords: medical training; residents training; quality; COVID-19; medical education assurance; training; accreditation; satisfaction; governance; Saudi Commission for Health Specialties; framework; best practices; healthcare

1. Introduction

The spread of the COVID-19 pandemic has had a significant impact on diverse aspects of medical training worldwide. Several researchers worldwide claim the need to enhance medical training programs and comprehensive continuing medical education with an emphasis on skills and competencies development [1]. Furthermore, the suspension of medical education and clinical attachments of students [2] due to COVID-19, in several cases [2], poses critical questions about the delivery of medical training at a top-quality level. Additionally, various psychological factors, including stress, anxiety and burnout, are extensively discussed in research studies [3] emphasizing the need for integrated psychological intervention programs for the support of physicians and medical staff. We aim to move towards prevention, alleviation, and treatment of the increased psychological load.

Since the emergence and pandemic spread of highly contagious COVID-19, the pace of medical education and training programs has drastically changed. The Saudi government, with the collaboration of health agencies worldwide, imposed new policies and measures to contain and mitigate the spread of infection to individuals and communities. This has limited medical students' and trainees' roles in the clinical environment, and their opportunities to gain new experiences.

Within this new, demanding context, several complimentary aspects of medical education and training should be reconsidered. On one hand, aspects related to human factors and psychological pressure of residents and fellows as well as healthcare workers and senior medical staff have a direct impact on the training process. On the other hand, the need to support training with technology-enhanced learning methods and active learning strategies becomes a necessity that requires strategic support. Finally, training institutions for medical trainees have often served also as COVID-19 hospitals, and this adds to the complexity of the phenomenon.

In our research, we focus on the phenomenon of the medical training during COVID-19 times and we emphasize the analysis of the psychological factors that have an impact on the quality and efficiency of medical training. For the purpose of our research, we delivered an integrated survey in the Saudi Commission for the Health Specialties with a focus on training programs of fellows and residents.

The Saudi Commission for Health Specialties (SCFHS) is a government agency that regulates health care-related practices and accreditation at all levels in Saudi Arabia. This is home to over 160 residency programs with more than 15,000 residents. There are over 600 institutions accredited by SCFHS as training centers and all trainees, including residents and fellows, are designated in a clinical area corresponding to their chosen specialty. In accordance with the precautionary health measures recommended by the competent authorities to prevent the spread of the emerging COVID-19, SCFHS endorsed a bundle of initiatives which were directed to support the residents and fellows. Firstly, a 24/7 hotline was established to offer psychological support through Da'em to all trainees and practitioners.

The health academy's programs, which are set up in training centers in universities, hospitals, and medical centers, are suspended until further notice. Thus, SCFHS ensured that virtual education is fully activated for this category of trainees through the educational platforms in place to ensure the continuation of the educational process. Moreover, the first part the exam for all trainees at all levels, including the final written exam, was postponed. Accordingly, failure in those exams, whether the first part or the final exam, is not counted as an attempt among the limited number of possible attempts. Additionally, SCFHS extended the period of personal interviews for new candidates and applicants to all training programs.

Other helpful decisions included exempting residents and fellows from administrative fees to register in electronic exams for the current training year, converting the promotion test to become part of the continuous evaluation aimed at giving feedback and not attributing success or failure to the programs that were decided by the Scientific Council to have a promotion test. Furthermore, the possibility was introduced to carry over two weeks of leave to the next year for those trainees who did not have the opportunity to take parts of their annual leave this year in accordance with the regulations governing this, and the re-training of the training year within the maximum duration of the program was not counted.

The previously mentioned actions are timely responses to the COVID-19 pandemic. It is extremely important to investigate (with a scientific approach) the capacity of these actions to support the mental health of trainees and also to investigate which plans it is necessary to support.

Our research paper is organized as follows. In Section 2, we provide a summary of our critical literature review on the domain with an emphasis on studies undertaken during the COVID-19 pandemic related to residents training. In Section 3, we discuss our research methodology. The key results of our analysis are presented in Section 4; in Section 5 we constructively interpret the key findings and we proposed a methodological framework for well-being and training quality in residents training programs. Finally, in Section 6, we provide our conclusions and future research directions.

2. Critical Literature Review

The COVID-19 pandemic, beyond its health determinants, has had a variety of indirect implications on society, sustainable health strategies, and medical training and policy making. It also poses critical challenges for the digital transformation of health and for the adoption of emerging and streamline technologies for new value-adding medical services. In the abundant recent literature on the COVID-19 pandemic, our study is linked to diverse research areas. Our special interest and our research problem are related to the impact of the COVID-19 pandemic on medical training and its subsequent psychological implications for trainees. In this context, the assessment of psychological pressure among health experts is a key priority for the justification of responsive actions and the updating of policies relates to the psychological support of doctors [4,5]. Mental health, well-being, and quality of life of residents and fellows in medical training programs is another significant component of sustainable health.

The analysis of the impact of COVID-19 on residents' health during the COVID-19 pandemic in a recent study [6] provides interesting insights. Twenty-nine residents that participated in the relevant study emphasized that social isolation due to a colleague's inability to engage in outdoor activities and social gatherings provide significant psychological pressure on their personalities. Furthermore, they expressed their concern about the impact of COVID-19 on the quality and mode of their didactic education as well as on their clinical rotations.

In another recent study in Saudi Arabia [7], researchers investigated the issue of mental health among healthcare providers during the COVID-19 pandemic. Some of their key findings are also related to the objectives of this research. The respondents in the survey from a variety of health specialties at a high level had depressive disorders which ranged from mild (24.9%), moderate (14.5%), and moderately severe (10%) to severe (5.8%). Half of the sample had generalized anxiety disorder (51.4%), which ranged from mild (25.1%) and moderate (11%) to severe (15.3%). In our study, we intend to investigate the anxiety and depression rates in residents and fellows of medical training programs in Saudi Arabia and also to understand which are the determinants of the COVID-19 pandemic that have a direct association with psychological factors of trainees.

In a closely related study [8], researchers analyzed the psychological status of healthcare workers during the COVID-19 pandemic. In this interesting research, authors tried to combine and to understand the association of depressive behavior and anxiety of 745 healthcare workers from 15 hospitals. The main finding of the research is that almost half of the respondents faced depression and anxiety symptoms (56.3% had depressive symptoms, while 46.7% had anxiety symptoms). The main factors investigated and confirmed for causal effect with depression are age, residency status, department, stigmatization, and living in a conflict zone. Anxiety symptoms were found to be linked with characteristics of healthcare workers like age, department, years of experience, working hours per week, internal displacement, stigmatization, living in a conflict zone, and verbal abuse. In our study, we focus also on determinant factors of depression and anxiety and we also want to investigate to what extent the training institutions of residents, the educational process, and the mode of education during the COVID-19 pandemic are related to psychological factors. One of the greatest concerns of the respondents ($n = 73$; response rate—73.7%) was the decline in operative exposure. Another significant

finding of this research is that residents are more worried and concerned about the health of their loved ones than about their own risk and exposure of contracting COVID-19 [9].

In another study in Singapore [10] with 122 participants (frontline healthcare workers), the main finding was increased level of anxiety and depression during the COVID-19 pandemic. The key aspects of increased depression rate were associated with factors such as physical exhaustion, loss of appetite, poor sleep quality and the use of a sedative.

Similar findings also appear in a study among 906 healthcare staff from 5 hospitals in India and Singapore [11]. Increased anxiety and severe depression among participants were associated with various factors. Almost 17% of the healthcare workers showed moderate to very severe symptoms. Out of the 906 healthcare workers who participated in the survey, almost 14% showed moderate to very-severe depression and almost 11% moderate to extremely severe anxiety.

Studies in other countries like the USA [12] investigate the mental health toll on healthcare staff. The stark findings also reveal increased levels of anxiety and depression among the participants in a large sample ($n = 657$).

Numerous other studies [13–18] provide interesting insights for the multidimensional psychological pressure of COVID-19 to healthcare workers, residents, fellows and medical staff. In the complimentary scientific approaches that are deployed and beyond the various research tools that are deployed, there is a systematic argument for the association between COVID-19 and depression, anxiety, and stress of participants in the surveys. Cross-sectional studies and focused group studies in China [13,14] investigated and monitored the evolution of the COVID-19 pandemic and its association with psychological factors of health specialists. Other studies [15] focused on symptoms of posttraumatic stress, anxiety, depression, levels of resilience and burnout in Spain with significant findings that are closely related to the overall trend of the impact of the COVID-19 pandemic on the mental health of healthcare staff. Other interesting studies focus on issues like job satisfaction and the health conditions of medical staff [16–18] during the pandemic.

Medical education has faced many interruptions throughout history. As a result, the quality of training has been negatively affected. For example, some medical schools shortened their medical programs by several years to cover the acute need of doctors during the World War [19].

A heavy burden is placed on society and health care systems to provide treatment to a continuously increasing number of COVID-19 patients and to afford extensive measures to contain or limit the individual and community transmission of infection. It is almost 10 months since the cluster of patients confirmed with COVID-19 disease was reported in Wuhan, China [20]. Several countries have effectively managed the COVID-19 health crisis situation; however, others are still battling due to the increasing number of cases and limitations caused by lack of treatment resources and facilities. Currently, there are ongoing clinical trials for the treatment and prevention of COVID-19 that serve as the hope for people to overcome this pandemic crisis.

Health care workers are at greater risk of acquiring the infection because they are directly engaged in the diagnosis, treatment, and care for patients with COVID-19. In the United States, it was reported that redeployment of residents increased by 11% and almost 50% in states with higher incidences of COVID-19 and 70% exposure to patients who tested positive for COVID-19, which is similar to this study (i.e., 72.77%) [21]. In a single tertiary center study in Wuhan, China, the infection rates of first-line and non-first-line health care workers were shown to be 0.5% and 1.45%, respectively [22].

The current COVID-19 pandemic is similar to other historical events that posed major challenges to the global health system. Postgraduate medical trainees (residents and fellows) had to reduce their routine clinical and surgical practice due to the increasing number of COVID-19 patients [23]. Non-urgent surgeries are postponed, and outpatients' appointments have been cancelled or transformed into telehealth clinics. To limit the exposure to the COVID-19 virus, some trainees have been placed on standby. All these changes will affect their skills and reduce their learning opportunities to achieve competency in their fields of specialties [24].

This pandemic is also affecting the accreditation system. As the impact of COVID-19 differs from one region to another, the Accreditation Council for Graduate Medical Education (ACGME) allocated three stages and each training program will function in one of them during the period of the COVID-19 pandemic:

- Stage 1—the workflow will continue as usual with no changes in requirements.
- Stage 2 will be implemented according to the increase in clinical demands, and some residents may be shifted to COVID-19 patient care duties. In this stage, the impact on education will be acknowledged by suspending accreditation and self-study activities. Residents will be supervised by via telemedicine. Virtual lectures and journal clubs are allowed. Fellows will function by attending the same working hours as previously. The decision of graduation requirements will be left to the program director.
- Stage 3 is considered high Pandemic Emergency Status. All educational activities are suspended, and care for COVID-19 patients is prioritized [25].

On 9 March 2020, the ACGME also postponed all scheduled accreditation visits [26]. The American Board of Radiology has delayed the board certification exam to September. Such interruption in graduation and credentialing might delay the onboarding time for new residents [27]. Radiology and otolaryngology training programs in the USA suggested additional didactic sessions to fulfill the minimum requirement for graduation [28,29].

Many residency training programs have designed innovative online platforms to bridge the educational gap during the COVID-19 era [25,30–33]. Chick R.C. proposed innovative solutions for continuing the academic education for surgical residents that do not require large group meetings [25]. Solutions are summarized in Table 1.

Table 1. Innovative solutions for continuing the academic education (summary from other research contributions).

Solution	Aim
Flipped online classroom model	Provide learners with educational material in the form of a prerecorded videos that they can watch anytime remotely before the conference
Novel social-media-based platform	Discussion of surgical topics, daily exposure to practice questions
Weekly academic conferences/webinars via teleconference	Live online lectures
Tele-clinics	Keep trainees involved with outpatients' clinical activities
Surgical videos	Self-review of surgeries

Similarly, Schwartz et al. strongly [30] recommended the use of videoconferencing and tele-clinics to maintain residents' education. Stambough et al. [31] reported on orthopedic surgical education by using online meetings, journal clubs, and a surgical videos database such as cadaver, bone-substitute simulations, and the Orthopedic Video Theater. Similarly, in Singapore, cadaver is reported as an intelligent sourcing for self-directed learning in orthopedics. Another study reported that a virtual reality (VR) procedure improves the residents' surgical skills when transferred to the real world [32]. Vargo et al. reported on the experience of urology residents in virtual conference teaching of high-priority robotic cases [33].

Research activity has been disrupted too. To ensure the continuation of residency research programs, research mentors encourage residents to work from home and develop research projects during their off days by meeting remotely [28,34]. Crosby et al. reported on the Southern Otolaryngology Department at the Illinois University School of Medicine holding a weekly virtual research meeting for

all residents to review the projects' updates in depth [28]. In-parallel, radiology programs in North America encourage research mentors and their residents to have continuing meetings to discuss their projects during the pandemic, including methodology, statistical analysis, funding, and reshaping the project into publishable material [34].

The COVID-19 pandemic caused an increased burden on the mental wellness of trainees [34]. Previous studies on Ebola and SARS show a severe emotional distress during the outbreaks [35]. Changes related to the COVID-19 pandemic have led to an unprecedented impact on residents' education and may contribute to resident burnout. One of the greatest challenges for programs at this time is to maintain the well-being of residents in the face of uncertainty, stress, and anxiety. Recently, ACGME emphasized the role of program directors to maintain a high-quality educational environment which directly affect residents' well-being [36]. The American College of Radiology recently conducted webinars, podcasts and released fitness apps as recourses for residents' self-care and well-being [36]. Khallafallah reported on a neurosurgical resident who had concerns about not achieving the surgical milestones and the future of their training [37]. In the USA, about 54.4% of residents and fellows have shown at least one symptom of burnout in the form of depersonalization, emotional exhaustion, or reduced senses of accomplishment [38].

The literature summarized in this section highlights a multifaceted research problem. In this context, several diverse variables are interconnected, including the mental health, the quality of educational programs, as well as the variety of technology-enhanced learning tools capable of enhancing the educational process. In the next section, we provide an overview of our research methodology.

3. Research Methodology

The key methodological approach for our research is based on an integrated strategy. The focus is on the detailed analysis of the impact of COVID-19 on psychological factors of residents and the impact of COVID-19 on the educational process and performance. In Figure 1, we summarize the key aspects of our methodology.

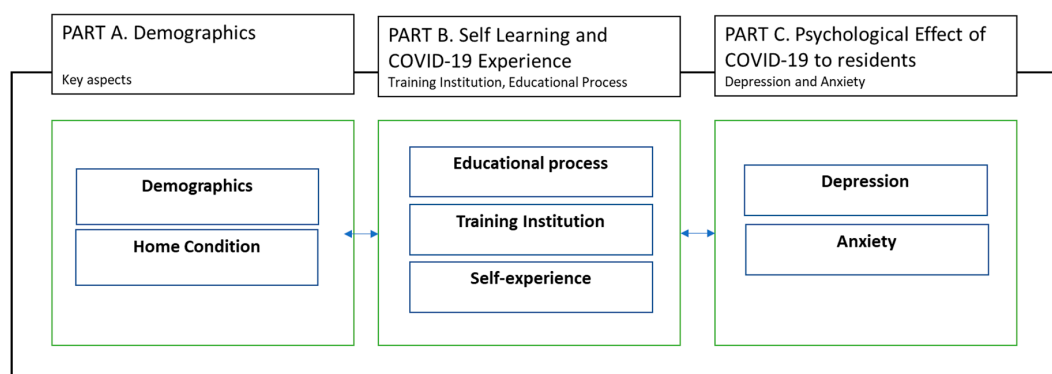


Figure 1. The research approaches.

This research study is part of a greater systematic research in the Saudi Health Commission for Health Specialties. Our main aim is to understand the self-experience of residents in training programs during the pandemic. For this reason, the training institution and the educational process are set as targets in our analysis and provide meaningful pillars in our research tool. The understanding of how COVID-19 was perceived from residents during their training and their service to hospitals is a key development for enhanced decision making. As explained later, we constructed a survey emphasizing complementary aspects of daily professional practice and training activities of residents. In the third component of our research approach, we intend to analyze the psychological effect of COVID-19 on residents with a key emphasis to be placed on two critical factors, namely depression and anxiety.

Our research utilizes a population-based cross-sectional study conducted among trainees from various training centers affiliated with the Saudi Health Commission for Health Specialties (SCFHS). The survey questionnaire was distributed online to 14,000 trainees (i.e., residents and fellows). Consequently, participants who completely filled out the questionnaire will be included in the analysis.

This study used a self-designed questionnaire composed of four parts:

1. Socio-demographic characteristics of the participants.
2. Participants' evaluation on the training program during the COVID-19 pandemic. The result of training program evaluation was used as supplementary data to support the discussion of study findings.
3. Assessment of participants' mental health status (i.e., anxiety and depression) utilizing the Generalized Anxiety Scale (GAD-7) [39] and Patient Health Questionnaire depression module (PHQ-9) [40].
4. Determining factors of anxiety and depression of participants.

GAD-7 is a seven-item anxiety scale use for screening and assessing severity of general anxiety disorder. This had good reliability with sensitivity of 89% and specificity of 82% [27]. Severity score is calculated by assigning scores of 0, 1, 2, and 3 to the response categories “not at all”, “several days”, “more than half the days”, and “nearly every day”, respectively. The total score for the seven items ranges from 0 to 21. The obtained score of 0–4 correspond to minimal anxiety, 5–9 mild anxiety, 10–14 moderate anxiety and 15–21 severe anxiety.

PHQ-9 on the other hand is a nine-item depression scale with good reliability (i.e., sensitivity of 88% and a specificity of 88%) and considered as a valid measure of depression severity [28]. PHQ-9 scoring is calculated by assigning scores of 0, 1, 2, 3 to the response categories “not at all,” “several days,” “more than half the days,” and “nearly every day”, respectively. The total score for the nine items ranges from 0 to 27. The obtained score of 0–4 corresponds to minimal depression, 5–9 to mild depression, 10–14 to moderate depression; 15–29 relates to moderately severe depression and 20–27 to severe depression.

In Figure 2, we provide a more detailed overview of the research design of our study. In Appendix A, we also provide the full questionnaire designed for the purpose of our research. The components of our research tool are summarized as follows:

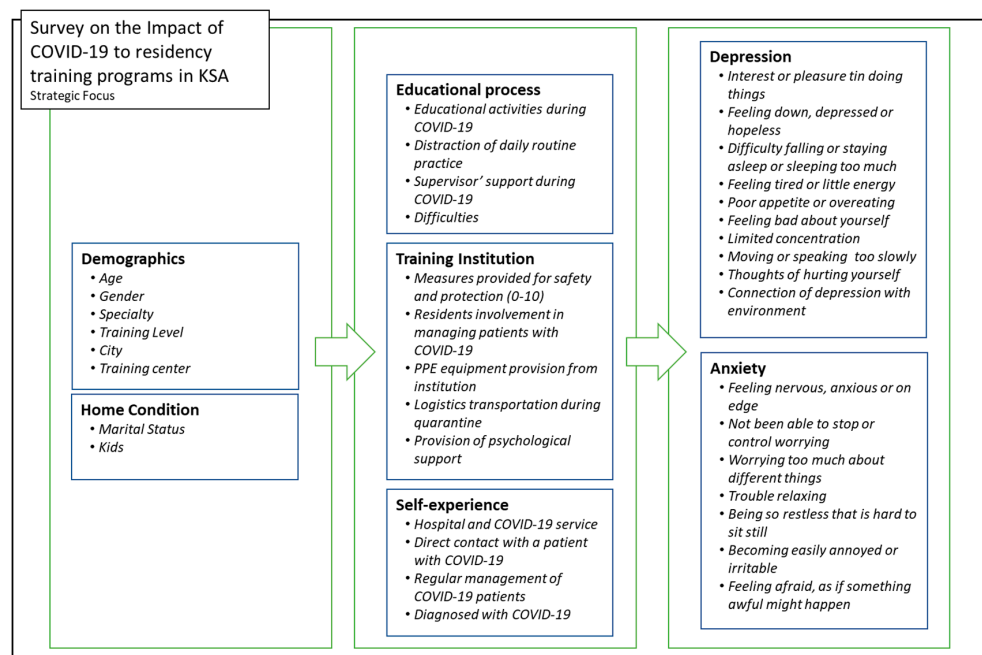


Figure 2. The research model of COVID-19 impact on training.

Educational process: The analysis of the COVID-19 impact on the medical educational process of residents is a key priority in our research. We are interested in understanding how the pandemic posed changes to the educational activities during the COVID-19 pandemic and to interpret them in the discussion and conclusions of our research. In addition, we aim to understand how the distraction of the daily educational routine practice posed psychological pressure to residents and fellows. Another key aspect of our research analysis is related to supervisors' contribution to residents' perceptions of the quality of education in the context of COVID-19. Finally, we are interested in understanding the difficulties of residents to deal with their training and professional activity during the COVID-19 pandemic. The analysis of the key findings in the discussion section informs the scientific dialogue for the required actions towards the enhancement of the educational process during the COVID-19 outbreak. Below we summarize the key focus of the educational process analysis of our research:

- *Educational activities during the COVID-19 pandemic.*
- *Distraction of daily routine practice.*
- *Supervisor' support during the COVID-19 pandemic.*
- *Difficulties.*

Training Institution: In this variable we emphasize on the significant value components of the training institution capability to support residents during the COVID-19 pandemic. One of the most important concerns and research targets is to analyze the perception of residents regarding the measures provided to them for personal safety and protection. We are very much interested in this aspect as we do believe there is also an association with the psychological pressure of residents in training institutions that also serve as hospitals for COVID-19. Another dimension is related to the realization of residents' involvement in managing patients with COVID-19 as well as practical aspects of the support provided to them by the institution. This includes PPE equipment and logistics transportation during quarantine. In addition, the provision of psychological support from the training institution to residents is the focus of our research, since we want to understand the ways it is implemented, and its efficiency as valued by the residents themselves.

- *Measures provided for safety and protection (0–10).*
- *Residents involvement in managing patients with COVID-19.*
- *PPE equipment provision from institution.*
- *Logistics transportation during quarantine.*
- *Provision of psychological support.*

Self-experience: We are very much interested in understanding residents' self-experience with COVID-19 in their training institutions. Several complementary aspects of the phenomenon include but are not limited to the following: the analysis of residents' involvement and service in hospitals that serve patients with COVID-19, and the measurement of the population of residents' that had direct contact with COVID-19 patients and their service in regular COVID-19 units. In addition, we investigate the number of residents that diagnosed with COVID-19. The self-experience component in our research tool also provides significant insights regarding the psychological impact of COVID-19 upon residents. In the discussion and conclusions of our research, we elaborate on the key findings and we make significant recommendations.

- *Hospital and COVID-19 service.*
- *Direct contact with a patient with COVID-19.*
- *Regular management of COVID-19 patients.*
- *Diagnosed with COVID-19.*

The third pillar of our research approach focuses on the depression and anxiety of residents as it is imposed by the various aspects of the pandemic and the special interconnections with the

educational process and the training institution. These two aspects are set as key priorities and key research objectives of our research. We intend to analyze the impact of the pandemic on the anxiety and depression of residents and to recommend actions for an integrative support of residents in their training and professional conduct. We understand from the beginning that this is an ambitious objective given the limitations of our study that are discussed in the relevant sections.

Depression: For the analysis of Depression, as we already discussed, we used PHQ-9 which is based on a nine-item depression scale with good reliability. We believe that during the COVID-19 pandemic, such a scale provides a good measurement for the estimation of depression provided by the COVID-19 pandemic. It would be also significant through research to integrate into such scales specific items related to the interaction of residents or medical staff with COVID-19. In the discussion of the key findings of our research we provide our insights relating to this direction. The key components of this scale include the following factors.

- *Interest or pleasure in doing things.*
- *Feeling down, depressed, or hopeless.*
- *Difficulty falling or staying asleep or sleeping too much.*
- *Feeling tired or little energy.*
- *Poor appetite or overeating.*
- *Feeling bad about yourself.*
- *Limited concentration.*
- *Moving or speaking too slowly.*
- *Thoughts of hurting yourself.*
- *Connection of depression with environment.*

Anxiety: For the analysis of anxiety, we adopted the Generalized Anxiety Scale (GAD-7) which includes five measures. It is extremely important in our research to measure anxiety and to categorize our sample into the mild, moderate, and severe clusters. We also need to interpret, to the best possible degree, how these aspects are interconnected to COVID-19 or they are also related to the training and professional conduct of residents. We understand that this is an ambitious effort given the limitations, but we will try to provide our key interpretation in the discussion and conclusions section. The following are some of the key components of the GAD-7 scale for anxiety measurement:

- *Feeling nervous, anxious or on edge.*
- *Not being able to stop or control worrying.*
- *Worrying too much about different things.*
- *Trouble relaxing.*
- *Being so restless that is hard to sit still.*
- *Becoming easily annoyed or irritable.*
- *Feeling afraid, as if something awful might happen.*

The research objectives of our study are summarized as follows:

- **Research Objective 1:** What are the key implications of the COVID-19 pandemic on the training and educational process of residents in KSA?
- **Research Objective 2:** What are the key perceptions of residents regarding the support from training institutions during the COVID-19 pandemic?
- **Research Objective 3:** What are the key aspects of psychological pressure including depression and anxiety of residents in KSA during the COVID-19 pandemic?
- **Research Objective 4:** What are the key implications of this study for future recommendations towards best practices of training, psychological support, and technology-enhanced learning of residents' medical training?

Data analysis was conducted using a statistical analysis Statistical Package for the Social Sciences, version 21.0 (SPSS, version 21.0; Chicago, IL, USA). Descriptive statistics (frequencies and percentages) were used to describe the participants' socio-demographics, determining factors of anxiety and depression and trainees' evaluation on training programs. Forward stepwise multinomial regression analysis was then configured to use selection criterion obtained from demographic variables and determining factors to identify the odds of anxiety and depression among participants. The level of statistical significance was set to $p < 0.05$.

In the next section we summarize the key facts from our analysis.

4. Analysis and Main Findings

In the previous section, we presented the key aspects of our research methodology. In this section, we provide the basic aspects of our analysis. We organize our presentation according to the relevance of the three methodological pillars, namely, Demographics, Educational Process, and Training Institution and Psychological Factors, and we focused on the anxiety and depression of residents.

The survey questionnaire was distributed online to 14,000 trainees (i.e., residents and fellows). Of the 160 medical specialty training programs in 600 local and international training centers affiliated by Saudi Commission for Health Specialties, 1985 trainees participated in the survey and 1528 completed the GAD-7 anxiety and PHQ-9 depression questionnaires and were included in final data analysis. In Tables 2 and 3 below, we present the key demographic data for our participants.

Table 2. Trainee evaluation of services provided during the COVID-19 pandemic.

	Items	Mean	Standard Deviation
1.	How happy are you with the measures provided by your institution for your own safety and protection during the COVID-19 pandemic?	4.39	3226
2.	How supportive is your supervisor during the COVID-19 pandemic?	4.26	3484
3.	How would you rate the institution's provided psychological support?	3.16	2756
4.	How would you rate the Da'em program provided by SCFHS?	1.46	2369
5.	How would you rate the curriculum educational experience during the COVID-19 pandemic?	3.59	3184

4.1. Demographics

The trainees' mean age was 29.4, they were mostly male (see Figure 3, below), married (see Figure 4, below), and had no children (see Figure 5, below).

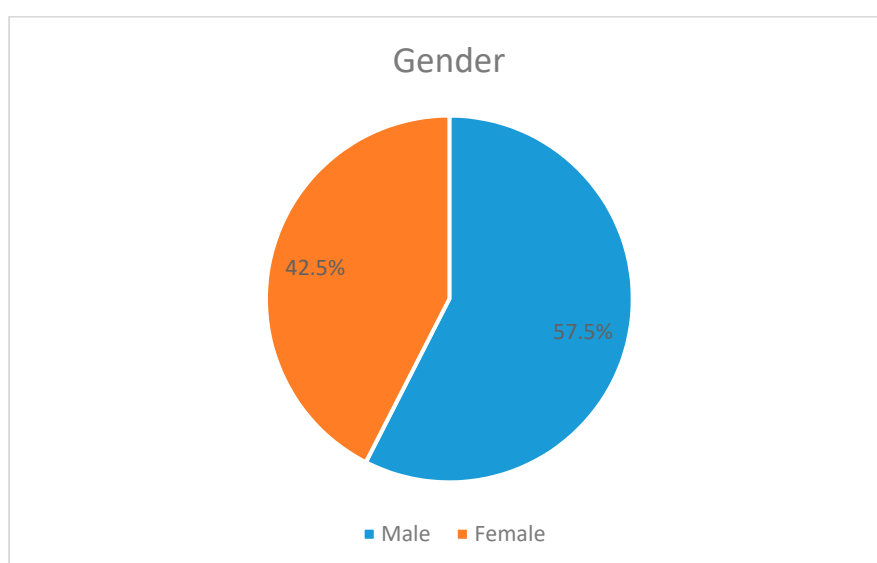
Concerning the number of children, most of the respondents had no children (58.2%) while 33.8% had 1 to 2 children, 7.3% three to four children and 0.7% had more than four children.

Some more facts about the marital status of participants in our survey are summarized as follows:

- Single (living with your parents): 32.9%.
- Single (living alone): 12.2%.
- Married (living with your family): 40.6%.
- Married (living alone): 12.3%.
- Unspecified: 2.0%.

Table 3. A summary of key findings of the statistical analysis

Items	Anxiety	Depression
Residents Level 1	less likely to have mild and moderate anxiety	
Residents Level 2	less likely to have mild anxiety	less likely to have mild (and moderate) depression
Residents Level 3	less likely to have moderate anxiety	
Residents Level 4	more likely to have moderate and severe anxiety	
Residents Level 5	-	are more likely to have severe depression
Residents Level 6	-	
Fellows Level 1	-	
Fellows Level 2	-	less likely to have moderate depression
Fellows Level 3	-	
Trainees provided with enough PPE	less likely to have mild, moderate, and severe anxiety	
Those who regularly managing COVID-19 patients	more likely to have moderate and severe anxiety	more likely to have severe depression
Those who had direct contact with COVID-19 patients		more likely to have moderately severe depression
Those who were provided with transportations logistics to training center		less likely to have moderate depression and severe depression
Males		less likely to have mild depression, moderate severe and severe depression

**Figure 3.** Demographics: Gender.

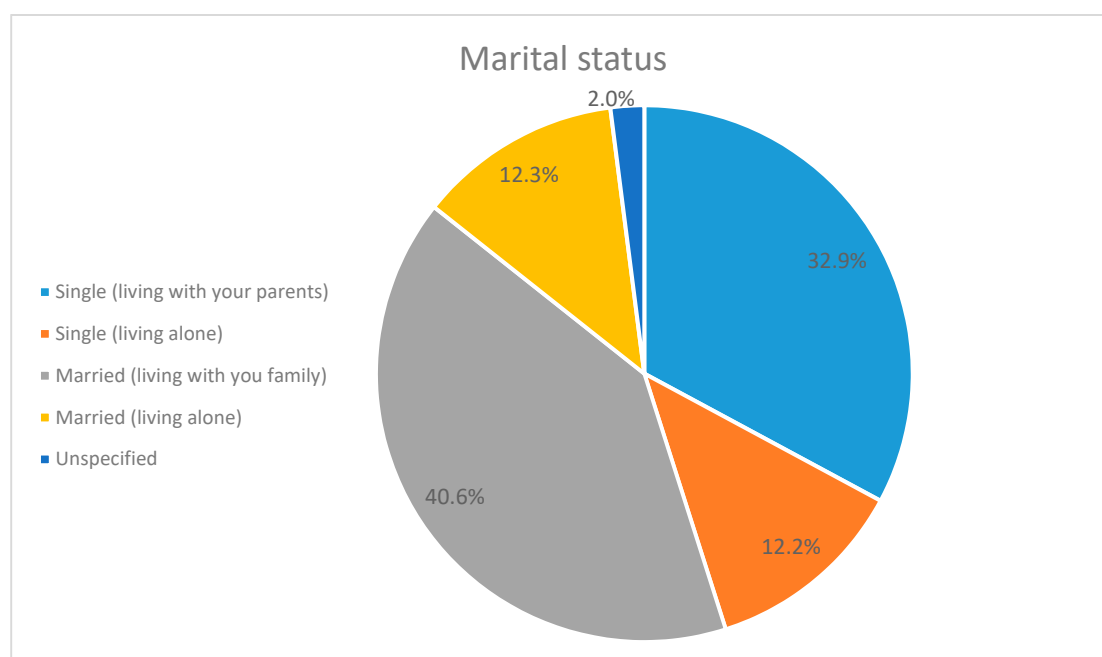


Figure 4. Demographics: Marital status.

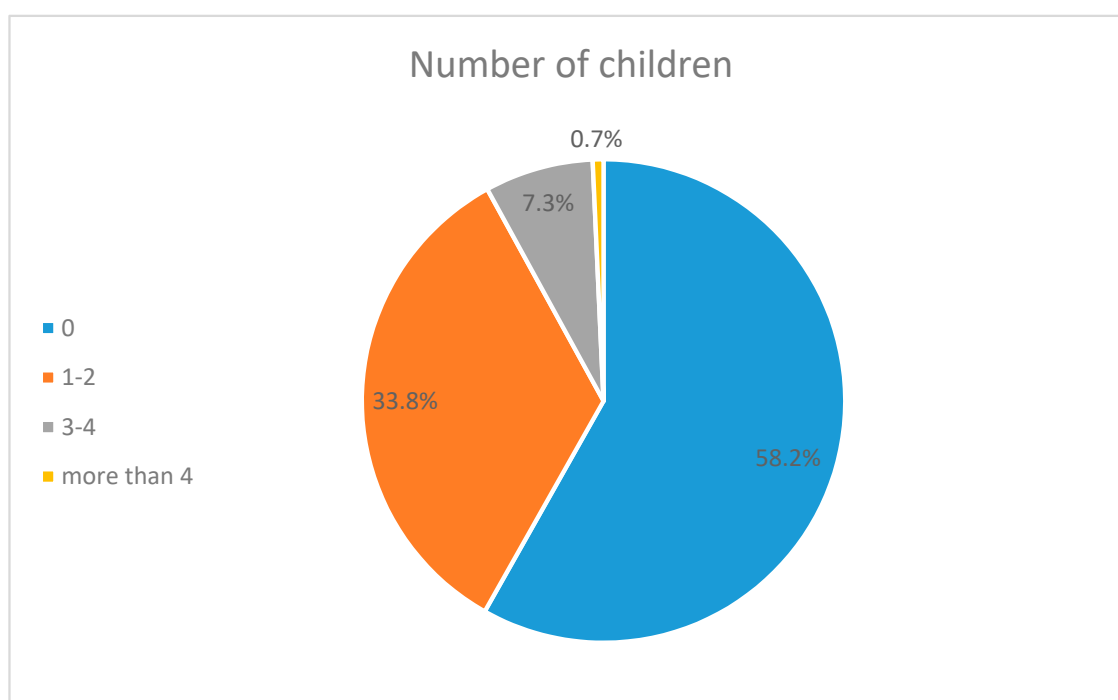


Figure 5. Demographics: Number of children.

The number of trainees in the residency training program is higher than those in the fellowship training program (see Figure 6 below).

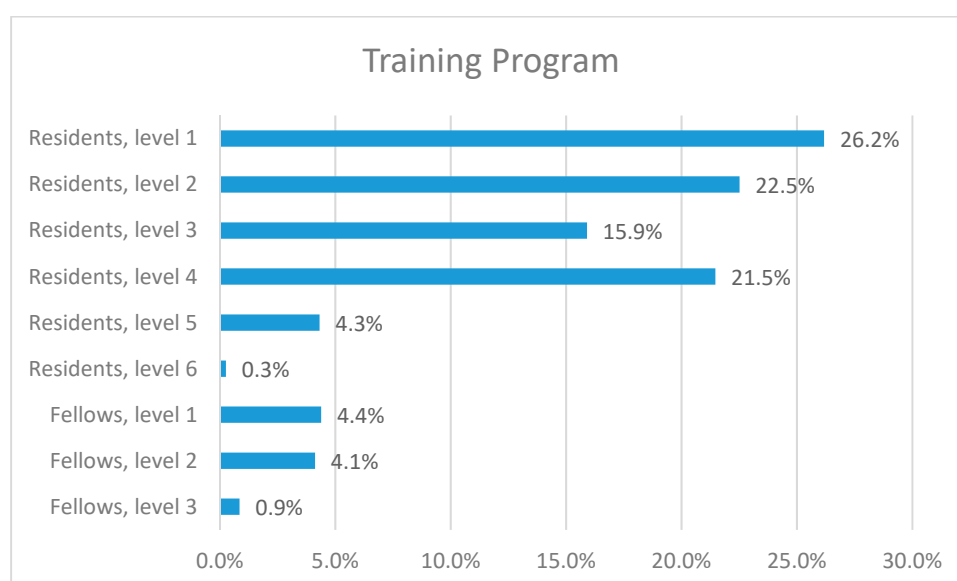


Figure 6. Demographics: Training program type (Resident/Fellow).

The number of trainees in the residency training program is higher (1385, 90.6%) than that in the fellowship training program (143, 9.4%). In Figure 6, more data on the allocation of respondents to different residency or fellow programs are provided. In the next section, we focus on the second pillar of our methodological approach, which is related to the educational process and training institution components.

4.2. Educational Process and Training Institution

Two of the most significant research objectives of the research, as presented in Section 3 above, are related to the understanding of the key implications of the COVID-19 pandemic on the training and educational process of residents and fellows in KSA as well as an analysis of the residents' key perceptions of the training institution's support during the COVID-19 pandemic.

In Figure 7, we provide a basic analysis related to the trainee's evaluation of the services provided to them during the COVID-19 outbreak from the training institution. The overall attitude is not satisfactory. In the scale of 0 to 10 (0 = not supportive at all 10 = completely supportive), the average score and the standard deviation points to several possible enhancements, as we will discuss in the conclusion. As it is summarized in Table 2, there is a limited satisfaction in terms of the measures provided by training institutions' regard for safety and protection during the COVID-19 pandemic. The low mean of 4.39 out of 10 is indicative of residents and fellows feeling somehow unprotected, or at least, expecting higher protection. In the same overview, the psychological support service during the COVID-19 outbreak launched for this purpose (Da'em in Saudi) was poorly rated (mean 1.46) by trainees. This is a very significant finding that poses many questions for its future development and its redesign. We will comment on this key finding in the discussion section. Furthermore, the support provided by supervisors was also rated neutrally (mean 4.26). Another critical aspect for the mode of training during the COVID-19 pandemic is the perception of trainees of the rating of the curriculum educational experience, which received a mean of 3.59.

The synthesis of the various findings of our analysis is that residents and fellows felt a multidimensional pressure in their educational process during the COVID-19 outbreak. Given the fact that many of them also served hospitals with COVID-19 patients, this adds to the complexity of the phenomenon, especially in the context of psychological pressure. It is extremely important for our study to further investigate the psychological pressure of trainees in the form of anxiety and depression.

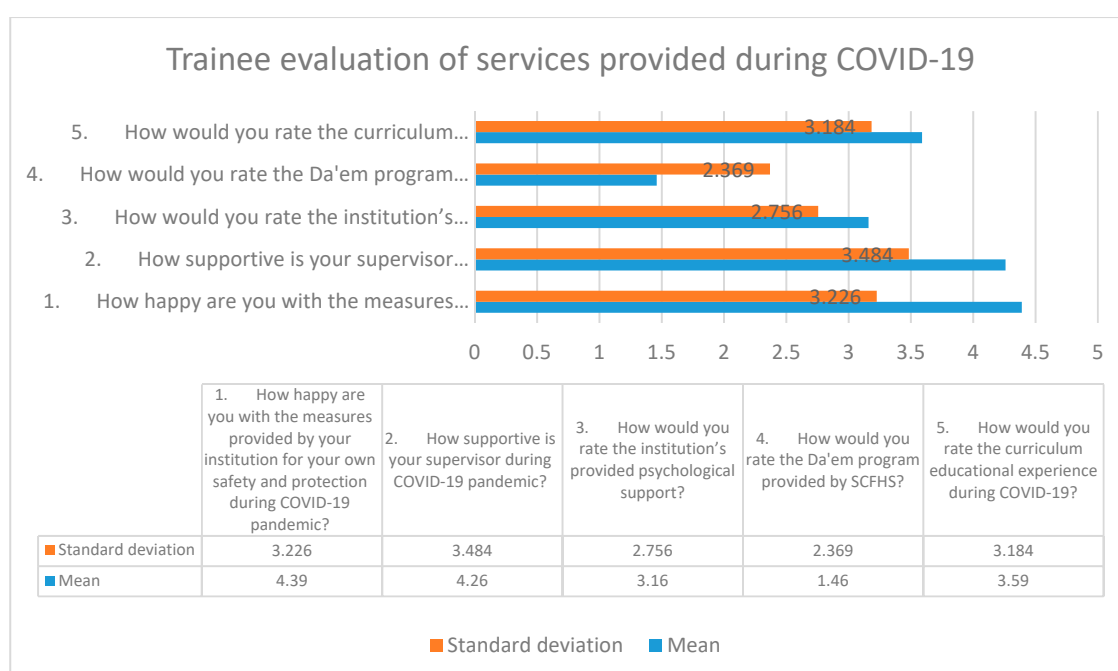


Figure 7. Trainee evaluation of services provided during the COVID-19 pandemic.

In the next section, we emphasize the study of the psychological pressure on trainees during the COVID-19 pandemic.

4.3. Psychological Factors: Depression and Anxiety

Some of the data presented in the previous section highlight the psychological pressure on residents and fellows during the COVID-19 pandemic. It is important before we present the key findings related to the assessment of participants' mental health status (i.e., anxiety and depression) utilizing the Generalized Anxiety Scale (GAD-7) and Patient Health Questionnaire depression module (PHQ-9) to investigate more facts about the psychological pressure on trainees.

In Figure 8 below, we provide a summary of the opinions of trainees with key aspects of their interaction and self-experience during the COVID-19 pandemic. A first interpretation of the key findings is provided below.

Most trainees have been in direct contact with a patient with COVID-19 at their training hospital (73%). This is a significant finding which also highlights the key contribution of residents and fellows to the management of the pandemic crisis. It is extremely important to investigate, through our methodological tools (GAD-7 and PHQ-9 scales), the impact of this fact on the anxiety and depression of trainees. Additionally, almost half of the trainees (53%) regularly managed patients with COVID-19. This exposure can also contribute to the psychological pressure of trainees. Given the fact that the educational process and the educational activities still take place with variations it is interesting to investigate the situation further. Six percent (6%) of the trainees have been diagnosed with COVID-19 due to their service to the training institution.

On the other hand, respondents provided useful insights into the institution's support during the COVID-19 pandemic. Special training for a pandemic crisis was offered to 36% of the respondents. It is quite surprising that the remaining sixty four percent (64%) received no special training in such a demanding situation. Almost half of the respondents (49%) stated that they received enough Personal Protective Equipment (PPE). Unfortunately, the other half of the respondents claim that they did not receive enough protective equipment, and this is one more key finding. We will comment on these findings in our discussion section.

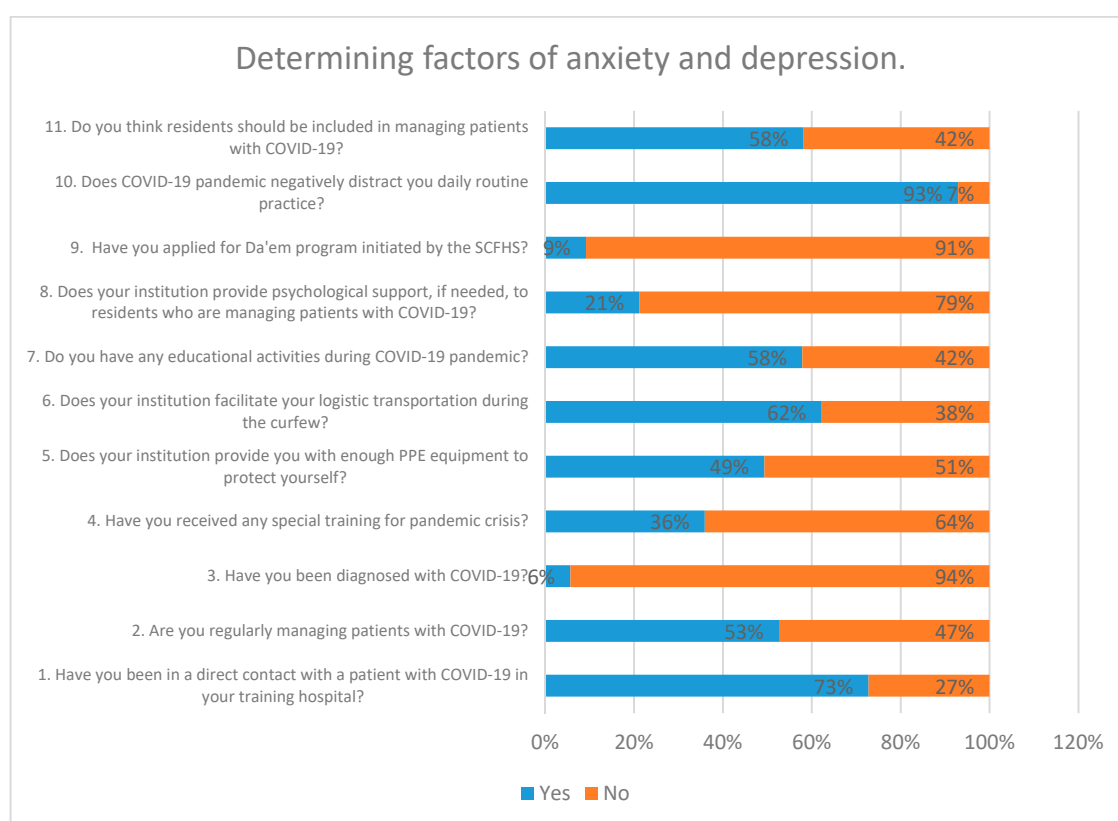


Figure 8. Determining factors for trainee's anxiety and depression during the COVID-19 pandemic.

The training institution facilitates the logistic transportation of 62% of the trainees during the COVID-19 pandemic and also, at a much lower rate (21%), provides psychological support, if needed, to residents who are managing patients with COVID-19. Surprisingly, only 9% of trainees applied for psychological support through the Da'em program for psychological support initiated by the SCFHS. This is also unsatisfactory and in the discussion page we elaborate further with some propositions. Most of the residents (58%) still have educational activities during the COVID-19 pandemic and almost all of them (93%) agree that the COVID-19 pandemic negatively distracts their daily routine practice. While all the previous aspects of increased psychological pressure are evident, the majority of trainees (58%) believe that residents should be included in managing patients with COVID-19.

The median scores of trainees' anxiety and depression were 3.00 (1.00, 4.00) and 3.00 (1, 5.00). Of the 1528 trainees, 201 (13.2%) have minimal anxiety, and 408 (26.7%), 375 (24.5%), and 544 (35.6%) have mild, moderate, and severe anxiety, respectively (see Figure 9, below). This is a stark finding of our research. It appears that the COVID-19 pandemic has increased the levels of anxiety over time.

From a decision-making point of view, it is extremely important to investigate ways to support the residents and fellows in this context, since anxiety has an impact on their efficiency and decision-making capability. In our discussion section, we elaborate further on this issue.

The findings related to the depression level of trainees are summarized in Figure 10. Given the fact that we do not have comparative studies about the depression rates that were recorded before COVID-19, the findings show a rather increased depression rate among trainees. The fact that almost one tenth of the full sample have minimal depression is an indication that the COVID-19 pandemic has put more pressure on trainees.

Some more data on the analysis of depression with the use of PHQ-9 scale are provided below. In our sample, 152 respondents (9.9%) have minimal depression and 358 (23.4%), 373 (24.4%), 341 (22.3%) and 304 (19.9%) have mild, moderate, moderate severe and severe depression, respectively.

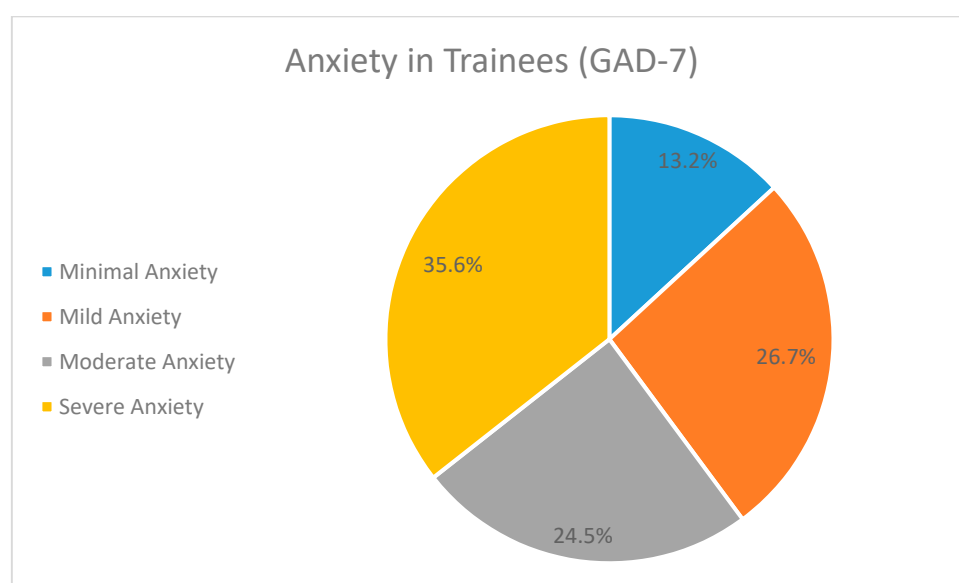


Figure 9. Anxiety in trainees based on Generalized Anxiety Scale (GAD-7) scale during the COVID-19 pandemic.

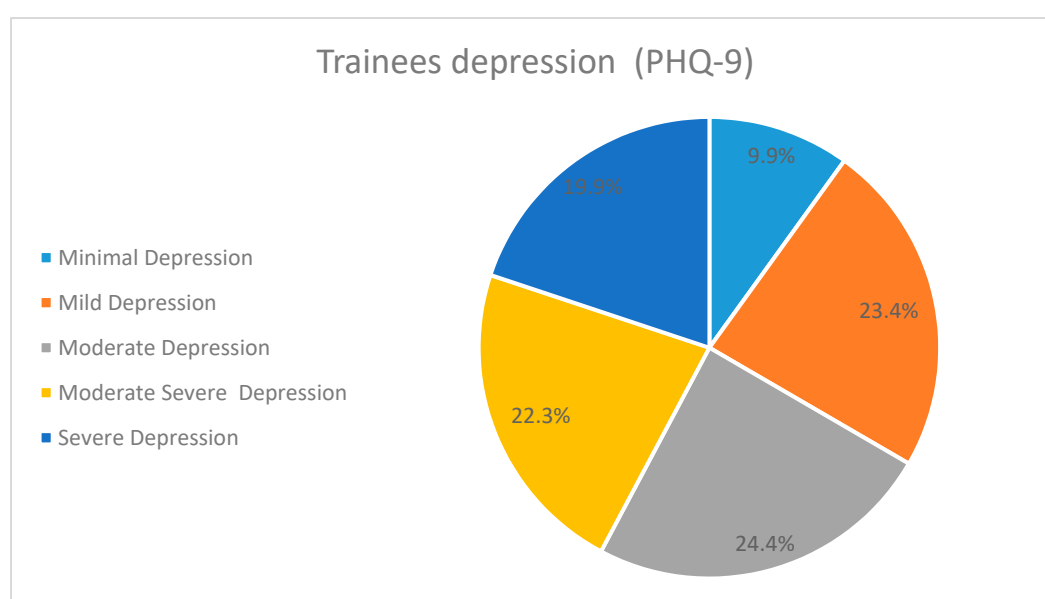


Figure 10. Depression in trainees based on Patient Health Questionnaire depression module (PHQ-9) scale during the COVID-19 pandemic.

To further investigate the correlation between trainee's anxiety and trainee's depression, we deployed relevant statistics tests. This is directly related to the intention of our research objective to understand how the COVID-19 pandemic had an impact on trainee's mental health, as stated in our research methodology section.

Using Pearson correlation analysis, the correlation coefficient between trainees' anxiety score and depression score was 0.791 ($p < 0.00$), which indicates that *trainees' anxiety and depression are highly positively correlated with the COVID-19 pandemic*.

This is a significant finding of our research. While someone can associate COVID-19 with psychological pressure on trainees and medical staff, it is a bold finding in such a big sample (1528 respondents) to approximate the depression and anxiety rates.

We intend soon to measure the same variables again with an enhanced research instrument in order also to understand the causal effect of COVID-19 depression and anxiety of residents and fellows.

In order to further investigate the connections of anxiety and depression, we deployed further statistics, including the Odds Ratio (OR) that quantifies the strength of the association between two events. Additionally, we deployed multinomial regression analysis utilizing a forward stepwise approach to automatically select criterion or variables of trainees' anxiety and depression. Two models were established (anxiety and depression, Tables 3, A1 and A2 in Appendix A). Below are some of the key findings.

Using minimal anxiety as a baseline data:

- Level 2 trainees of a residency training program are less likely to have mild anxiety (OR 0.547; CI 95% 0.338–0.887, $p = 0.014$).
- Level 1 trainees of a fellowship training program are less likely to have mild (OR 0.451; CI 95% 0.212–0.957, $p = 0.038$) and moderate anxiety (OR 0.323; CI 95% 0.137–0.764, $p = 0.010$).
- Level 3 trainees of a fellowship training program are less likely to have moderate anxiety (OR 0.094; CI 95% 0.010–0.853, $p = 0.036$).
- Males are less likely to have mild (OR 0.520; CI 95% 0.352–0.770, $p = 0.001$), moderate (OR 0.445; CI 95% 0.299–0.662, $p = 0.000$) and severe anxiety (OR 0.325; CI 95% 0.222–0.477, $p = 0.000$).
- Trainees provided with enough PPE are less likely to have mild (OR 0.511; CI 95% 0.353–0.742, $p = 0.000$), moderate (OR 0.481; CI 95% 0.329–0.702, $p = 0.000$) and severe anxiety (OR 0.353; CI 95% 0.245–0.509, $p = 0.000$).
- Level 4 trainees of a residency training program are more likely to have moderate (OR 2.101; CI 95% 1.142–3.865, $p = 0.017$) and severe anxiety (OR 2.484; CI 95% 1.365–4.519, $p = 0.003$).
- Those who regularly managing COVID-19 patients are more likely to have moderate (OR 1.771; CI 95% 1.218–2.576, $p = 0.003$) and severe anxiety (OR 2.626; CI 95% 1.829–3.772, $p = 0.000$). Complete results are shown in Appendix A.

Using minimal depression as a baseline data:

- Males are less likely to have mild depression (OR 0.631; CI 95% 0.402–0.990, $p = 0.045$), moderate severe (OR 0.398; CI 95% 0.252–0.629, $p = 0.000$) and severe depression (OR 0.379; CI 95% 0.237–0.607, $p = 0.000$).
- Level 2 trainees of a residency training program are less likely to have mild (OR 0.465; CI 95% 0.264–0.819, $p = 0.008$) and moderate depression (OR 0.460; CI 95% 0.261–0.809, $p = 0.007$).
- Level 2 trainees of a fellowship training program are less likely to have moderate depression (OR 0.314; CI 95% 0.118–0.833, $p = 0.020$).
- Level 5 trainees of a residency training program are more likely to have severe depression (OR 10.746; CI 95% 1.313–87.968, $p = 0.027$).
- Trainees that have been in direct contact with COVID-19 patient are more likely to have moderately severe depression (OR 2.441; CI 95% 1.418–4.201, $p = 0.001$).
- Those who are regularly managing COVID-19 patients are more likely to have severe depression (OR 2.253; CI 95% 1.346–3.771, $p = 0.002$).
- However, those trainees that are provided with transportation are less like to have moderate (OR 0.575; CI 95% 0.361–0.914, $p = 0.019$) depression and severe depression (OR 0.464; CI 95% 0.287–0.749, $p = 0.002$). Complete results are shown in Tables A1 and A2 in Appendix A with reference also to statistically significant results.

In Figures 11–13 below, for reference purposes we summarize some observations related to the anxiety in various groups without all of them to be statistically significantly. These findings require further investigation, and further discussion is provided in the section below.

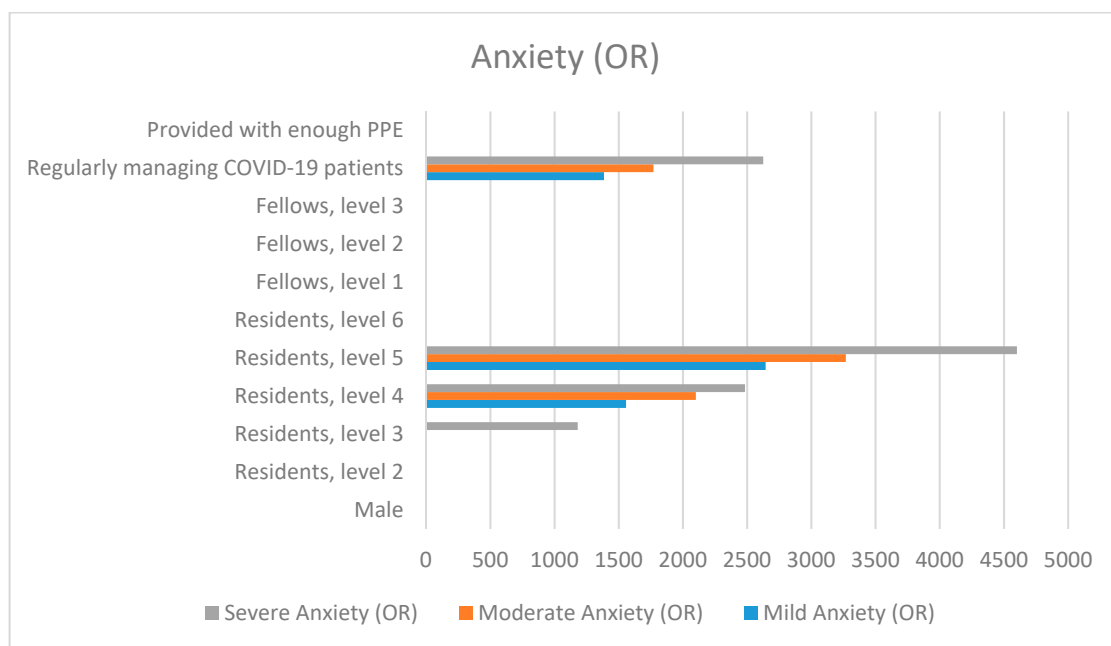


Figure 11. Anxiety of trainees based on GAD-7 scale during the COVID-19 pandemic.

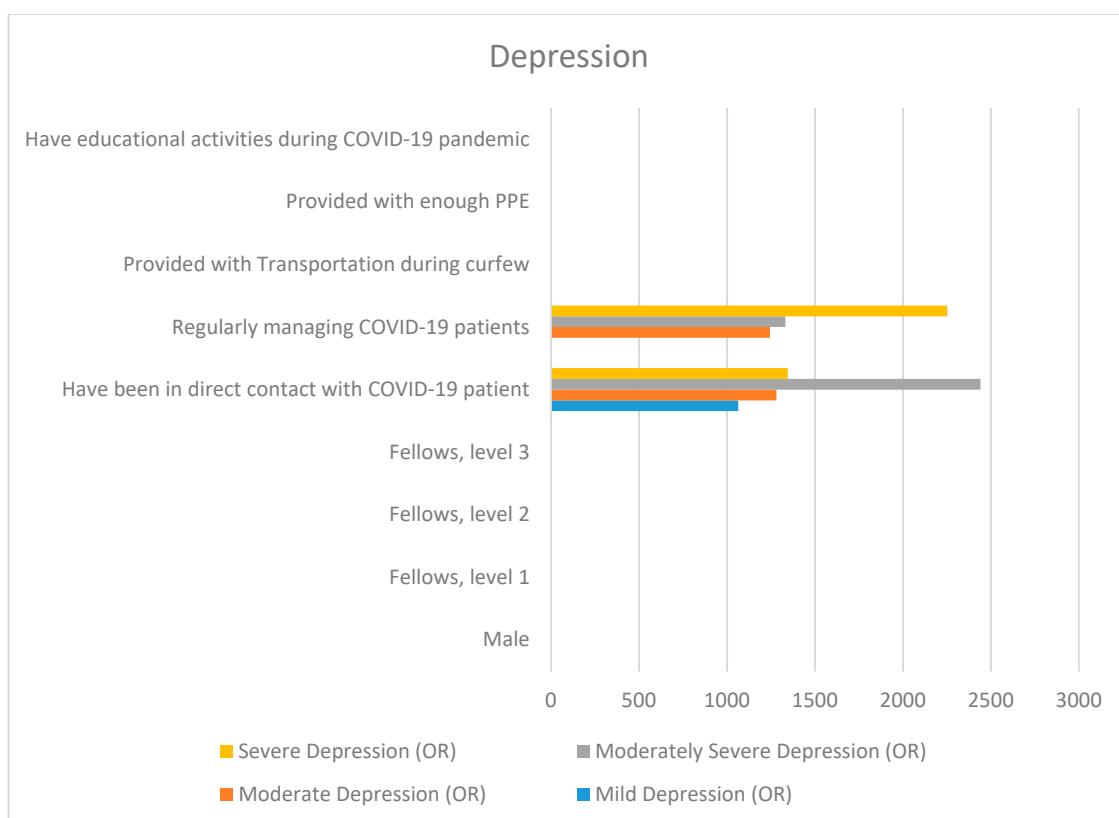


Figure 12. Depression in trainees based on PHQ-9 scale during the COVID-19 pandemic.

The analysis in this section is not exhaustive. It refers mostly to the three research objectives of our study. Various limitations of our study that will be explained in the relevant section pose some methodological questions. For example, no previous study has measured the degrees of anxiety and depression. However, the scientific approach followed in this study permits us to discuss in the next section the significant findings and also the key interpretations of our research for decision making.

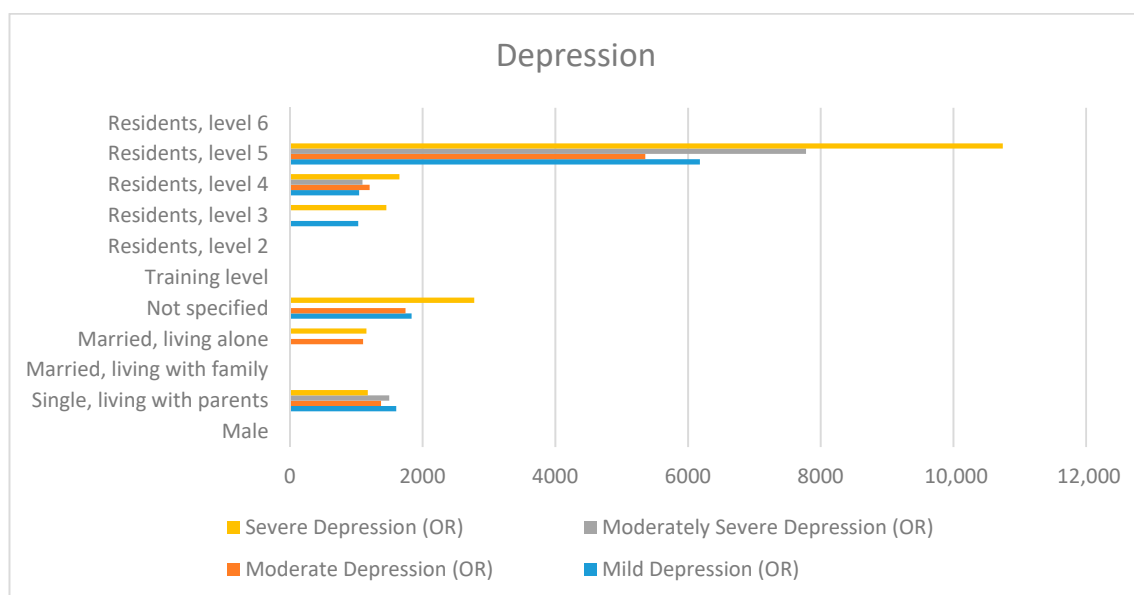


Figure 13. Depression in Trainees based on PHQ-9 scale during the COVID-19 pandemic.

5. Discussion, Limitations, and Interpretation of Our Research

The analysis of the previous section provided useful insights into the impact of the COVID-19 pandemic in the training programs and in the professional service of residents and fellows. In this section, we will elaborate upon the key findings and their implications. We will also try to go beyond the numbers and the statistics to interpret the key findings.

It is important before providing the key discussion to refer to some significant limitations of our research.

5.1. Limitations

In this research study, we investigate diverse and complicated research variables that also provide a challenging research context for COVID-19. Our focus on the training programs and the institutional support to residents and fellows of medical training programs in times of COVID-19 is by itself a very demanding context. Furthermore, we face an inability to compare our findings with the times before COVID-19. There is no relevant or existing research for residents and fellows in Saudi Arabia. Thus, we have a limited capability to compare the anxiety or depression rates with the situation before COVID-19. However, our research collected significant, trusted, and accurate data from a large sample of residents and fellows in KSA.

One more limitation of our research study is that we decided in this study not to include facts or detailed data on learning interventions during the COVID-19 pandemic in residents' training programs. We did this on purpose since we plan another integrated study on the matter of how technology-enhanced learning supports revised educational strategies during the COVID-19 pandemic.

One more significant limitation of our study is also that, since we wanted to secure a great participation from respondents, we did not include many cause and effect questions. Thus, for some facts revealed by our study, we cannot provide concrete interpretations without making significant assumptions. However, we prefer to communicate facts, and our interpretations will be based solely on these facts. For example, the various levels of depression and anxiety are presented as facts, without an effort to explain why the X or the Y subgroup of residents or fellows in medical training programs communicates this attitude or feeling. This will be our objective in future research focusing on the causal effect of psychological pressure. We do believe though that the accurate, trusted data that respondents provided allowed us to make significant propositions and interpretations. For example, it is significant to reveal that the non-provision of PPE equipment is associated with increased anxiety

and depression and, thus, the institutions should take care of this in a transparent way as a responsive action to the impact of COVID-19.

The last limitation of our study is the comparability of findings with other similar studies abroad. We do believe though that the findings and their interpretations that are discussed in the next sections are a contribution that can be valued by researchers and institutions worldwide.

5.2. Discussion, Key Findings and Interpretation

We will organize the discussion in this section regarding our four research objectives

- Combined Discussion on *Research Objective 1*: What are the key implications of the COVID-19 pandemic on the training and educational process of residents in KSA and *Research Objective 2*: What are the key perceptions of residents regarding the training institution support during the COVID-19 pandemic?

In Figure 7, we provided a basic analysis related to the trainee's evaluation of the services provided to them during the COVID-19 pandemic from the training institution. The overall attitude is not satisfactory. On a scale of 0 to 10 (0 = not supportive at all 10 = completely supportive), the average score and the standard deviation show a rather unsatisfactory attitude of trainees regarding support by their training institution.

These are the key findings:

- Residents claim limited satisfaction for the measures provided by their training institution for their own safety and protection during the COVID-19 pandemic. The low mean of 4.39 out of 10 is indicative that residents and fellows felt somehow unprotected or at least they were expecting higher protection.
- The psychological support service during the COVID-19 pandemic launched for this purpose (Da'em in Saudi) was poorly rated (mean 1.46) by trainees. This is a very significant finding that poses many questions for its future development and its redesign. We will comment on this key finding in the discussion section.
- The support provided by supervisors was also rated neutrally (mean 4.26).
- The perception of trainees for the rating of the curriculum educational experience received a mean of 3.59.
- Special training for a pandemic crisis was offered to 36% of the respondents. It is quite surprising that the remaining 64% received no special training in such a demanding situation.
- Almost half of the respondents (49%) stated that they received enough Personal Protective Equipment (PPE). Unfortunately, the other half of the respondents claim that they did not receive enough protective equipment.
- The training institution facilitated the logistic transportation of 62% of the trainees during the COVID-19 pandemic.
- At a much lower rate (21%), the institution provided psychological support, if needed, to residents who were managing patients with COVID-19.
- Surprisingly, only 9% of trainees applied for psychological support through the Da'em program for psychological support initiated by the SCFHS.
- Most of the residents (58%) still have educational activities during the COVID-19 pandemic.
- Almost all of them (93%) agreed that the COVID-19 pandemic negatively distracted them from their daily routine practice.

This detailed picture of the perception of residents towards support by their training institution should initiate a dialogue and reflective actions. One of the key measurements should be the enhancement of PPE provision to residents and fellows. Furthermore, the low evaluation of the curriculum educational experience should set new directions for technology-enhanced learning

and development of active learning engagements of residents. In this direction, new forms of virtual and augmented reality and simulation labs can also be exploited. In a future research study, we intend to discuss the experimentation with various technology-enhanced learning tools. The limited psychological support to trainees as well as the limited use of the Da'em service, a platform for psychological support initiated by the SCFHS, proves that (in this context) a lot more work and effort is needed. The platform for Da'em provided integrated services for support, but it seems that residents do not use it. Thus, a new awareness and communication campaign is needed to promote to trainees the value and the capacity of the new digital channel for psychological support. Moreover, the rather limited registration of trainees to Da'em proves that a new campaign for this is required. This is a key finding of our study. In order for the sophisticated digital platform to be efficient, the development of a learning curve is required from users, and, sometimes, psychological barriers do not allow targeted users to deploy the services. Thus, it is necessary to investigate the main reasons for the limited use of the Da'em platform soon.

Supervisors also must put more effort into supporting residents and trainees, especially in the context of COVID-19. We assume that supervisors also have increased workload and psychological pressure, so a new future survey must also target the population of supervisors in residents' programs. Technology can also support the supervisors with sophisticated services. Technology-enhanced supervision must be the focus of recommendations.

Finally, the distraction of the educational process must be seen as a key challenge for SCFCS.

- **Research Objective 3:** What are the key aspects of psychological pressure including depression and anxiety of residents in KSA during the COVID-19 pandemic?

The key aspects of the psychological pressure on residents and fellows are summarized as follows. There is a continuous distraction from the educational process and limited support by supervisors, or, at least, support is not provided at a preferable level. Trainees offer their services to hospitals with COVID-19 patients and have direct contact with them while the provision of PPE equipment is, according to them, not satisfactory. Our research also revealed a direct association between COVID-19 times and significant rates of anxiety and depression. The relevant rates of anxiety and depression are significant and can initiate an integrated discussion for the relief of trainees. Towards this direction, several actions can be implemented, including:

- Hiring of more medical staff during the pandemic.
- Release of working time for research and rehabilitation.
- Access to technology-enhanced services for psychological support and recreation.
- Enhancement of social community engagement of trainees and building of optimistic faith for the future and their role in the pandemic.
- Increase in rewards and appreciation for their services during the pandemic.
- Access to sophisticated active learning engagement resources.
- Provision of virtual and augmented reality labs and simulation platforms.

The previous list is not exhaustive but contributes to a strategic plan for the enhancement of the psychology of trainees. One of the most important findings of our research is that *trainees' anxiety and depression are highly positively correlated with the COVID-19 pandemic*.

Some additional key findings of our research based on significant statistics are summarized in Table 3 below.

Some key implications from this sophisticated analysis of depression and anxiety rates, though quite simplistic, are as follows.

- Women should be provided with additional support.
- The provision of transportation logistics to trainees seems to be a catalyst for depression. This may have a psychological connection with the feeling of caring. Maybe residents feel that the institution is caring for them and this has a good impact on their psychology.

- The provision of PPE equipment to trainees seems to be a key catalyst for the elimination of anxiety. This is a bold recommendation of our research that all the medical staff should be provided with sufficient and efficient PPE equipment during COVID-19 times and there must be a transparent procedure for the management of this equipment.
- Special and continuous psychological support must be provided to all the residents and fellows that regularly manage COVID-19 patients or have direct contact with COVID-19 patients. From our analysis, it is evident that these two categories show moderate severe and severe rates of depression and anxiety. Special programs for their support and recreation and reward must be designed and this is a high-level recommendation for policy making that has emerged from our research.

In this study, however, for almost one-quarter of residents and fellows that had a direct contact with patients who tested positive for COVID-19, 7% of those acquired the disease, which is approximately 4 to 14-fold higher as compared to a latter study [41]. This infection rate among the trainees must be investigated to provide insights for strategic planning on improving COVID-19 transmission management practices among trainees. In addition, 41.8% of resident physicians and fellows in this study argued that they should not be included in managing patients with COVID-19. This indicates the fear and anxiety of trainees associated with managing patients with COVID-19.

Nonetheless, frontline healthcare workers were indeed at a higher risk of symptoms of depression and anxiety. As this study shows, 98% and 90% of the trainees have anxiety and depression, ranging from mild to severe cases, respectively. Level 4 and 5 residents, those with direct contact and continuous management of patients with COVID-19, and females were found in this study as the groups that have a greater risk for severe anxiety and depression. One of the variables identified in this study is similar to the study done in Italy that found that being exposed to patients with COVID-19 was associated with symptoms of depression. These identified vulnerable groups need prompt attention, psychological guidance, and management necessary to help them overcome difficulties during this COVID-19 crisis and to prevent significant functionality problems that might affect their training path. The Saudi Commission for Health Specialties are very keen to provide support for trainees, and launched the Da'em program. This program particularly aims to improve the productivity and reduce the risk of psychological and professional burnout among trainees. Despite the high percentages of trainees with anxiety and depression in this study, only 141 or 9.22% applied for the program and rated the program at 3.60/10 (i.e., 0 = very poor to 10 = excellent). Although training centers also provided psychological support to trainees, trainees rated the service at 6.15/10 (i.e., 0 = very poor to 10 = excellent). Supervisor support to trainees during the COVID-19 pandemic was also evaluated and rated at 4.26/10 (i.e., 0 = very poor to 10 = excellent). Finally, trainees evaluated the curriculum educational experience during the COVID-19 pandemic at 3.59/10 (i.e., 0 = very poor to 10 = excellent). This indicates that the training program, curriculum delivery, psychological support, and guidance among trainees are unsatisfactory, need to be addressed, and require further improvement.

Providing trainees with necessary support such as transportation during curfews and lockdowns, continuous educational activities, and most importantly an adequate supply of protective personal equipment (PPE) were found in this study to be the significant factors that reduce risk of anxiety and depression among trainees. However, in the evaluation questionnaires about safety and protection measures provided to trainees by the training centers, trainees' evaluations were based on their happiness level, which was rated at 4.39/10 (0 = not happy at all to 10 = very happy). This indicates that the measures provided by the training centers are still unsatisfactory.

5.3. Implications of Our Research Recommendations

In this section, we are elaborating upon the last research objective of our research which is summarized as follows: *Research Objective 4: What are the key implications of this study for future recommendations towards best practices of training, psychological support, and technology-enhanced learning for medical training residents?*

The highly demanding COVID-19 pandemic challenges not only the way of delivering education, but also the integrated strategies for the management of the human capital in times of emergency and crisis. In the recent literature, various aspects of the phenomenon have been addressed, including psychological factors, social dynamics, and technological capability. The overload in the health systems worldwide is also flagging the capacity of modern management theories and applied systems for monitoring and control of resources to deliver the promised social value. The analysis of our survey provided interesting insights into the impact of COVID-19 on the training of residents. In this section, we communicate our interpretation of this survey in terms of an integrated approach for residents' training during the pandemic crisis.

In Figure 14, we communicate a high-level abstraction of our strategic approach at SCFHS and the intended integrative residents' training approach for the near future while COVID-19 is still spreading. In fact, five distinct pillars are collaborating towards the efficiency of the health services, medical training, and quality of life and wellbeing for residents and supervisors during the COVID-19 pandemic.

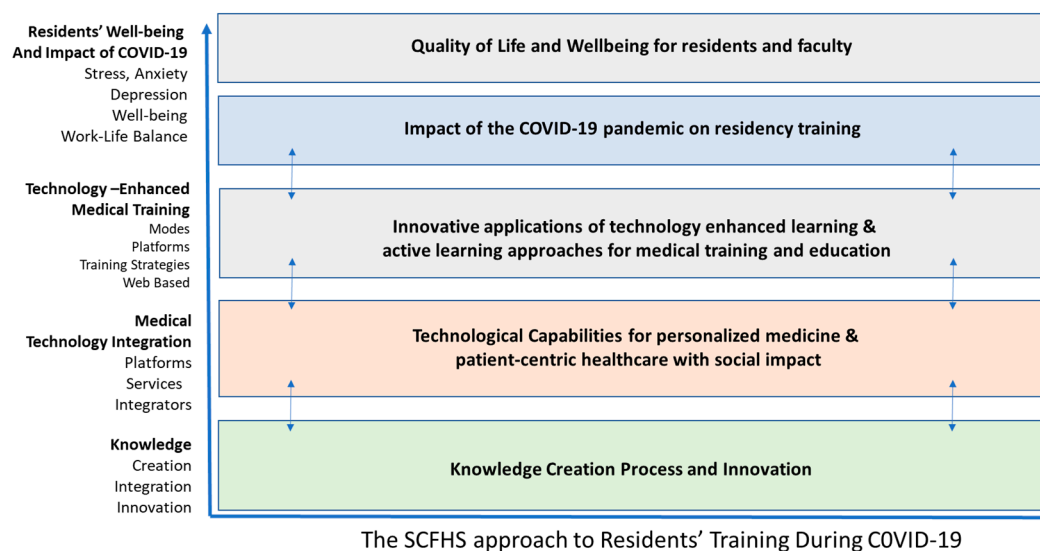


Figure 14. The SCFHS Model for Residents' Mental Health Enhancement during the COVID-19 Pandemic.

At the lower level, knowledge creation process and innovation serves as the scientific and applied medicine domain enabler for knowledge dissemination and applications. Key issues like knowledge creation, integration, and innovation can be integrated into training programs and educational curricula.

Technological capabilities for personalized medicine and patient-centric healthcare with social impact, in layer 2, refer to medical technology integration, including platforms, services and value integrators in the health domain. Various consideration and strategic decisions at this level have an impact on the readiness of the health system to manage the current time of crisis with COVID-19.

In the context of the quality of medical training and innovation, the third layer is related to innovative applications of technology-enhanced learning and web-based active learning approaches for medical training and education. In the strategic agenda of this layer, we are dealing with strategies and services for Technology-Enhanced Medical Training (TEME), modes and platforms for TEME, with training strategies for online learning and integrators for learning capabilities within daily medical practices.

Finally, residents' well-being and the impact of COVID-19 is the upper strategic layer with various health and psychological issues involved including stress, anxiety, and depression management, strategies and actions for well-being and work-life balance. We intend to present in a future research

paper some more detailed findings on factors integrated into this model with an emphasis placed on satisfaction of trainees and effectiveness of distance and online learning for clinical and surgical training.

Within such a demanding context, there are various complementary facets of the research phenomenon which need further investigation.

- **Impact of the COVID-19 pandemic on residency training.** For example, Amparore et al. [42] focus on urology residency training in Italy. Their key findings are quite interesting. For example, almost 97% of the participants reported that their surgical exposure was reduced due to the pandemic. They also recommend that continuing to revise steadily using webinars, podcasts, prerecorded sessions, and social media is a key way to maintain high-quality medical education. This key proposition leads directly to the new significant aspect of the literature. Finally, they also propose that routine activities such as journal clubs and departmental teaching should be facilitated through webinars if possible. In a similar study, Vargo et al. [33] studied the impact of COVID-19 in resident urology training in Cleveland. The findings are quite similar since the COVID-19 pandemic has resulted in reduced surgical volume and has disrupted established urology residency program curriculums nationwide. The authors propose a new framework based on a revised curriculum with emphasis on daily virtual learning as a key means of collaboration between faculty and residents. They also conclude that tele-medicine will be a key area for the near future.
- **Innovative applications of technology-enhanced learning and active learning approaches** for the support of medical education during COVID-19 times. For example, Tomlinson et al. [43] discuss in a recent research study the innovations in neurosurgical education during the COVID-19 pandemic and they question if it is time to reexamine the current neurosurgical training models. One of the bold findings of their research is the rapid increase in web traffic in relation to medical training resources and the adoption of emerging technologies, including virtual reality. The adoption of medical educational content on the internet by residency programs has supported a fair continuation of the curriculum despite the variety and complexity of barriers. Their key message is that the medical education community is currently eagerly awaiting significant enhancement in medical simulation software and virtual and augmented reality industry in order to have access to sophisticated tools that provide readiness to face similar crises in the future.
- **Quality of Life and Wellbeing for residents and faculty.** The aspect of well-being for residents and medical staff is a very delicate matter. The increased anxiety, technostress and human factors require significant research and support. Chong et al. [44] in their recent research study, focus on this dimension. In our research, we have a special interest in understanding the degrees of anxiety and depression of residents. We also intend to interpret the findings and to present an integrated framework for supporting residents.
- **Knowledge Creation Processes and Learning Excellence.** The knowledge creation in COVID-19 times as a responsive action to the pandemic requires enhancement and integration of the training and learning initiatives. Naeve et al. [45] describe efficient knowledge creation modes based on Nonaka's model of knowledge creation, and set a basis for parametrizing the technology-enhanced learning support of residents' education.
- **Capabilities of Emerging Technologies.** In recent years, the evolution of streamline and emerging technologies including artificial intelligence, virtual and augmented reality, medical big data and analytics, data warehouses, image processing, and cloud computing, has resulted in a brand-new era of capabilities of exploitation in the health specialties. Spruit and Lytras [46] integrated various aspects of data science for the healthcare domain towards patient-centric healthcare and personalized medicine. These also challenge the domain of medical education and there is an extremely significant need to study and understand how any of these technologies offer added value for residents during COVID-19 times. This is another aspect of our ongoing research in the Saudi Commission for the Health Specialties (SCFHS). The Quality Initiative, as described by Housawi et al. [47] in a recent study, targets the understanding of key performance indicators in residents' programs in Saudi Arabia and proposes an integrated framework for sustainable medical

education and trainees satisfaction [48]. Also, issues related to the use of ICTs, mobile learning and social media to enhance learning for special needs should be considered in the future [49].

As a summary of strategic implications of our research, here are some key suggestions (see also Figure 15 below):

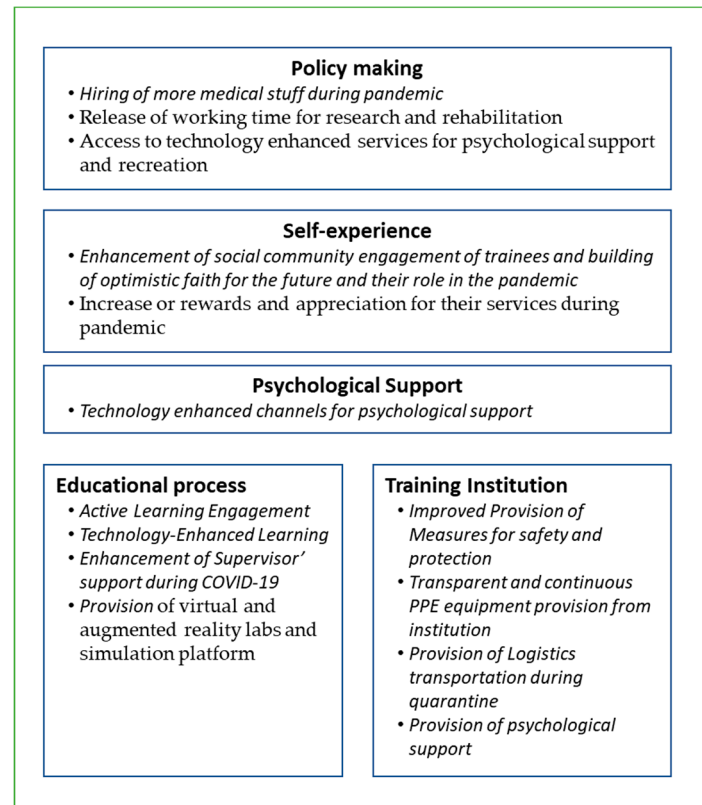


Figure 15. Strategic implications and recommendations.

Polycymaking

- Hiring of more medical staff during the pandemic;
- Release of working time for research and rehabilitation;
- Access to technology-enhanced services for psychological support and recreation.

Self-experience

- Enhancement of social community engagement of trainees and building of optimistic faith for the future and their role in the pandemic;
- Increase in rewards and appreciation for their services during pandemic.

Psychological Support

- Technology-enhanced channels for psychological support.

Educational process

- Active learning engagement;
- Technology-enhanced learning;
- Enhancement of supervisor' support during the COVID-19 pandemic;

- Provision of virtual and augmented reality labs and simulation platform.

Training Institution

- Improved provision of measures for safety and protection;
- Transparent and continuous PPE equipment provision from institution;
- Provision of logistics transportation during quarantine;
- Provision of psychological support.

6. Conclusions

In conclusion, residents and fellows are a group that is vulnerable to COVID-19 infection, with a high proportion also experiencing significant moderate to severe anxiety and depression, merely due to dissatisfaction with training programs and curriculum delivery that was undeniably affected by the COVID-19 pandemic. Dissatisfaction regarding the provided safety and protection measures has a great impact on their mental status. The individual trainees experiencing moderate to severe anxiety must be identified and provided with prompt attention, support and psychological management. This study also suggests a need for improvement in the psychological support provided by training centers to trainees, promote trainees' awareness of the available psychological services, such as the Da'em program and its benefits, and provide additional service initiatives to improve trainee's safety and protection regarding COVID-19. Most importantly, training centers should identify and manage the factors associated with the high infection rate of COVID-19 among trainees.

The key findings of our research can be a starting point for the strategic consultation and crafting of new strategies. In the future, we will communicate the key findings of two complimentary research studies. One is related to the job satisfaction of trainees and the other one explores the efficiency of various technology-enhanced learning methods during the COVID-19 pandemic.

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Appendix A

Table A1. Multinomial-logistic regression analysis of the factors of anxiety among trainees.

Variables	Mild Anxiety				Moderate Anxiety				Severe Anxiety			
	OR	(CI 95%)		<i>p</i>	OR	(CI 95%)		<i>p</i>	OR	(CI 95%)		<i>p</i>
Male	0.520	0.352	0.770	0.001	0.445	0.299	0.662	0.000	0.325	0.222	0.477	0.000
Training Level												
Residents, level 1 **												
Residents, level 2	0.547	0.338	0.887	0.014	0.653	0.400	1.065	0.088	0.779	0.484	1.253	0.302
Residents, level 3	0.994	0.558	1.768	0.982	0.990	0.549	1.788	0.974	1.181	0.666	2.094	0.568
Residents, level 4	1.558	0.847	2.866	0.154	2.101	1.142	3.865	0.017	2.484	1.365	4.519	0.003
Residents, level 5	2.645	0.736	9.507	0.136	3.269	0.904	11.819	0.071	4.602	1.303	16.253	0.018
Residents, level 6	0.387	0.022	6.783	0.516	1.862×10^{-9}	1.862×10^{-9}	1.862×10^{-9}	.	0.706	0.052	9.590	0.794
Fellows, level 1	0.451	0.212	0.957	0.038	0.323	0.137	0.764	0.010	0.566	0.265	1.207	0.141
Fellows, level 2	0.878	0.397	1.943	0.748	0.564	0.229	1.388	0.212	0.670	0.281	1.597	0.366
Fellows, level 3	0.247	0.055	1.104	0.067	0.094	0.010	0.853	0.036	0.295	0.069	1.262	0.100
Regularly managing COVID-19 patients	1.385	0.958	2.001	0.083	1.771	1.218	2.576	0.003	2.626	1.829	3.772	0.000
Provided with enough PPE	0.511	0.353	0.742	0.000	0.481	0.329	0.702	0.000	0.353	0.245	0.509	0.000

Odds ratio (OR) > 1.0; High-risk for anxiety, Significant at $p < 0.05$ level. ** Baseline data. Note for the info in the tables: The blue colored boxes represent key findings. Values for OR > 1 are associated with significant findings. The red number for p test represents significant statistical findings.

Table A2. Multinomial-logistic regression analysis of the factors of depression among trainees.

Variables	Mild Depression				Moderate Depression				Moderately Severe Depression			Severe Depression				
	OR	(CI 95%)		<i>p</i>	OR	(CI 95%)		<i>p</i>	OR	(CI 95%)	<i>p</i>	OR	(CI 95%)		<i>p</i>	
Male	0.631	0.402	0.990	0.045	0.644	0.409	1.012	0.057	0.398	0.252	0.629	0.000	0.379	0.237	0.607	0.000
Marital Status																
Single, living alone **																
Single, living with parents	1.602	0.798	3.217	0.185	1.374	0.691	2.732	0.365	1.497	0.743	3.016	0.259	1.174	0.570	2.418	0.663
Married, living with family	0.975	0.509	1.868	0.940	0.696	0.366	1.324	0.270	0.774	0.401	1.491	0.443	0.580	0.294	1.144	0.116
Married, living alone	0.988	0.433	2.258	0.978	1.104	0.496	2.456	0.808	0.858	0.373	1.975	0.719	1.155	0.502	2.656	0.734
Not specified	1.835	0.330	10.200	0.488	1.744	0.318	9.570	0.522	0.442	0.054	3.599	0.445	2.778	0.508	15.202	0.239
Training level																
Residents, level 1 **																
Residents, level 2	0.465	0.264	0.819	0.008	0.460	0.261	0.809	0.007	0.577	0.327	1.021	0.059	0.661	0.361	1.210	0.180
Residents, level 3	1.030	0.519	2.045	0.933	0.954	0.480	1.896	0.893	0.673	0.328	1.380	0.280	1.455	0.710	2.985	0.306
Residents, level 4	1.044	0.536	2.034	0.899	1.203	0.622	2.325	0.583	1.094	0.559	2.142	0.793	1.652	0.826	3.307	0.156
Residents, level 5	6.179	0.779	49.010	0.085	5.358	0.666	43.126	0.115	7.779	0.971	62.344	0.053	10.746	1.313	87.968	0.027
Residents, level 6	2.312 × 10 ^{−9}	2.312 × 10 ^{−9}	2.312 × 10 ^{−9}		0.241	0.011	5.086	0.360	0.392	0.019	8.005	0.543	0.309	0.013	7.483	0.470
Variables	Mild Depression				Moderate Depression				Moderately Severe Depression			Severe Depression				
	OR	(CI 95%)		<i>p</i>	OR	(CI 95%)		<i>p</i>	OR	(CI 95%)	<i>p</i>	OR	(CI 95%)		<i>p</i>	
Male	0.631	0.402	0.990	0.045	0.644	0.409	1.012	0.057	0.398	0.252	0.629	0.000	0.379	0.237	0.607	0.000
Fellows, level 1	0.807	0.332	1.963	0.637	0.638	0.252	1.617	0.344	0.689	0.261	1.819	0.452	0.542	0.177	1.656	0.282
Fellows, level 2	0.572	0.243	1.348	0.202	0.314	0.118	0.833	0.020	0.405	0.154	1.067	0.067	0.582	0.206	1.642	0.306
Fellows, level 3	0.181	0.030	1.091	0.062	0.277	0.055	1.383	0.118	0.214	0.035	1.299	0.094	0.306	0.047	1.985	0.214
Have been in direct contact with COVID-19 patients	1.064	0.643	1.763	0.809	1.281	0.765	2.142	0.346	2.441	1.418	4.201	0.001	1.346	0.765	2.368	0.303
Regularly managing COVID-19 patients	0.938	0.576	1.526	0.796	1.245	0.767	2.021	0.375	1.332	0.817	2.171	0.250	2.253	1.346	3.771	0.002
Provided with Transportation during curfew	0.672	0.422	1.070	0.094	0.575	0.361	0.914	0.019	0.731	0.455	1.176	0.196	0.464	0.287	0.749	0.002
Provided with enough PPE	0.460	0.295	0.717	0.001	0.435	0.280	0.678	0.000	0.423	0.270	0.662	0.000	0.297	0.187	0.471	0.000
Have educational activities during COVID-19 pandemic	0.827	0.536	1.276	0.391	0.706	0.459	1.087	0.114	0.544	0.352	0.841	0.006	0.598	0.381	0.937	0.025

Odds ratio (OR) > 1.0; High-risk for anxiety, Significant at $p < 0.05$ level. ** Baseline data. Note for the info in the tables: The blue colored boxes represent key findings. Values for OR > 1 are associated with significant findings. The red number for p test represents significant statistical findings.

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