

Impact of SARS, H1N1, and COVID-19 on Medical Trainees' Academic and Personal Experience: A Systematic Search and Narrative Review

Megan Cipro¹, Lyne Pitre², Salomon Fotsing¹ and Marjorie Pomerleau²

¹Faculty of Medicine, University of Ottawa, Ottawa, Ontario, Canada. ²Division of Family Medicine, Montfort Hospital, Ottawa, Ontario, Canada.

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ABSTRACT

OBJECTIVES: The SARS-CoV-2 pandemic is a destabilizing experience for medical students and resident doctors and troubles their training in the hospital setting. This narrative review aims to identify the effect of health crises on the academic and personal lives of medical trainees and to develop solutions to support them.

METHODS: EducationSource, MedLine and PsychInfo were consulted on June 30th and December 16th, 2020 to identify the articles explaining the effect of SARS-CoV-1 (2002), A/H1N1 (2009) or SARS-CoV-2 (ongoing) on medical learners. Exclusion criteria included policy papers, letters to the editor or articles detailing the impact on undergraduate medical curricula, on nonmedical trainees, on the residency application process, or the physical impact of the disease. The quality of the selected papers was appraised using CASP for qualitative studies and NHLBI-NIH for cross-sectional studies.

RESULTS: Ninety-four manuscripts were initially generated and 229, secondarily, of which respectively 14 and 16 were included in the final analysis according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines and reviewed qualitatively. It was found that the learners consider their education compromised by exam delays, the suspension of academic activities, and elective surgeries. Anxiety associated with this academic disruption developed. Burnout is exacerbated by the heightened workload. The main difference between the two searches was the long-term effect of COVID-19, including the opportunity for didactic innovation, the worry regarding professional identity formation and the development of mental health issues. The proposed solutions varied from continuous access to mental health resources to the follow-up of learners' well-being.

CONCLUSION: It would be interesting to assess the impact of medical trainees' specialty and country's development on their experience with COVID-19.

KEYWORDS: COVID-19, SARS, H1N1, trainee, learner, academic experience, personal experience

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CORRESPONDING AUTHOR: Marjorie Pomerleau, Montfort Hospital, Family Medicine, 4553 St-Catherine Street, St-Isidore, ON K0C 2B0, Canada.
Email: marjoriepomerleau@montfort.on.ca

Introduction

The unfolding COVID-19 pandemic has sewn fear worldwide and obliged the reconsideration of essentiality. While it overengorges hospitals, the limited and occasionally short-aged medical material has complicated healthcare workers' workload and potentially heightened the disease's mortality rate.¹ It has thus acutely impacted healthcare workers and trainees by the way they deliver their care, but also by threatening their academic development and mental health. Particularly, medical trainees, such as medical students and residents, have seen their training in the hospital setting perturbed.²

Medical students are seeking opportunities for clinical exposure to select a specialty to pursue and become reliable resident doctors while residents themselves are looking to acquire the competencies necessary to become adept clinicians. The destabilization endowed by the current pandemic imposes changes to the normal progression of their training. This inevitably alters their academic trajectory, which in turn impacts their personal life, including their mental health. This carries

weight because it raises the questions of medical education curricula, delivery reformation and trainee well-being amidst a health crisis.

Although the literature on the impact of COVID-19 on medical trainees is expanding, there is no study, to our knowledge, concentrating on the data detailing both the academic and personal repercussions of COVID-19 and previous similar health crises. In this narrative review, we aimed to describe the effect of SARS-CoV-1, A/H1N1, and SARS-CoV-2 on the academic and personal lives of medical students and residents. Both populations were included because the academic changes induced and the personal effects compelled by such health crises may be similar in both groups.^{3,4} Our secondary objective was to gather solutions from the literature to better support them.

Methods

A narrative literature review was conducted to qualitatively determine the academic and personal impact of COVID-19 and similar past health crises on medical students and residents.



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Although this is not a systematic review or a meta-analysis, the search was performed in adherence with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses statement (Figures 1 and 2) for organizational purposes of the articles generated.⁵ Our research is exempt from the Research Ethics Board Review.

Eligibility criteria

The target populations were medical students and doctors in training at the residency level. Language restrictions were set to include English and French articles. Articles detailing the effect of the 2002 SARS-CoV-1 outbreak, the A/H1N1 pandemic and the ongoing SARS-CoV-2 pandemic were included. Articles were included if they addressed the academic or personal impact of a specific crisis on residents and/or medical students. Articles were excluded if they were inaccessible, policy papers, letters to the editor or detailed the impact on undergraduate medical curricula, on the residency application process,

on nonhealthcare workers or students or discussed the physical impact of the disease.

Information sources

The search study was elaborated with the help and expertise of a Health Sciences librarian at the Library of the Faculty of Medicine of the University of Ottawa. An automated search on the databases *EducationSource*, *MedLine*, and *PsychInfo* was conducted to identify the articles explaining the effect of SARS-CoV-1, A/H1N1 or SARS-CoV-2 on medical students and residents. The search was performed twice, once on June 30th, 2020 during the first wave of COVID-19 and once more on December 16th, 2020 during the second wave, to assess the evolution of the data as COVID-19 unfolded in its early phases. Articles reviewed were published until these respective dates. All references were managed by Mendeley Reference Manager v1.19.8. Duplicate articles were removed automatically with a revision from one reviewer (M.C.).

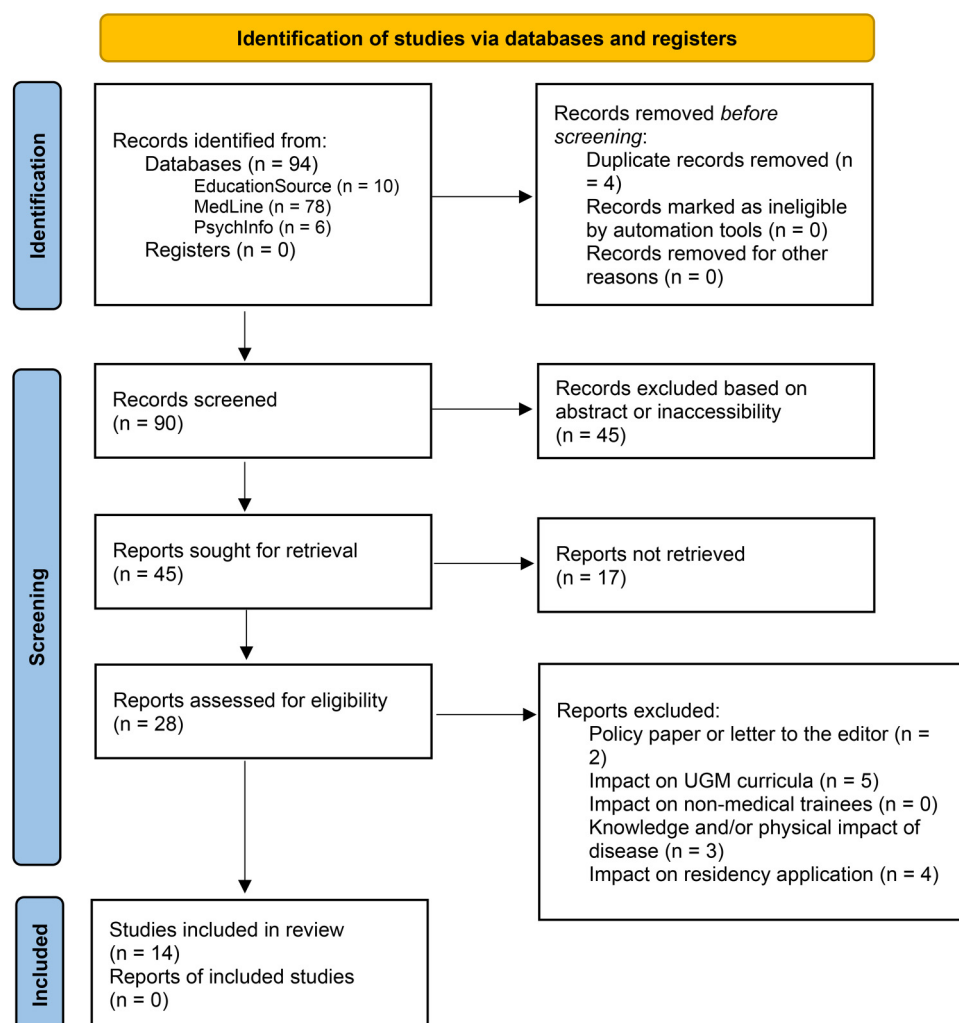


Figure 1. PRISMA diagram of literature search and exclusion criteria from first search on June 30th, 2020. Of notes, articles were excluded by a human, without the use of automation tools. PRISMA, Preferred Reporting Items for Systematic Reviews and Meta-Analyses.

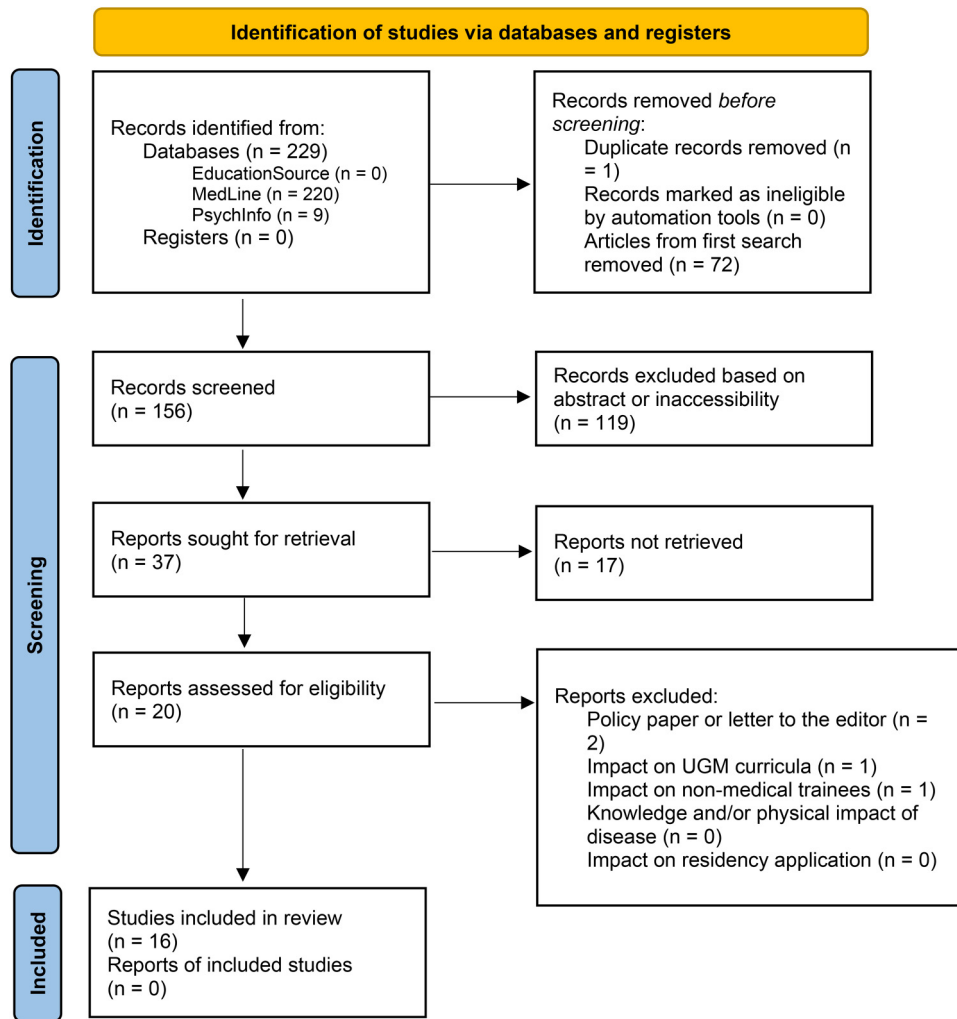


Figure 2. PRISMA diagram of literature search and exclusion criteria from the first search on December 16th, 2020. Of notes, articles were excluded by a human, without the use of automation tools.

Search strategy

The search strategy was built on the PICO principle (population, intervention, comparison, outcome).⁶ The population was medical students and/or residents. Interventions were SARS-CoV-1, SARS-CoV-2, or H1N1. Comparison was not required. The outcome was an impact on academic and personal life. There were no restrictions on study design. The final input is described in Table 1.

Selection process

All imported references were first screened by their title and abstract by a sole reviewer (M.C.). Those meeting inclusion criteria were preserved. Inclusion criteria were further applied to the preserved articles, which were secondarily assessed in their entirety by the same reviewer. Those failing to meet the criteria are listed in Tables 1 and 2 of the Supplemental data with the exclusion criteria they fulfill. All articles retained from then were reviewed and validated with the field expert (M.P.).

Table 1. Search algorithm.

| Population | Medical students or residents |
|---|--------------------------------------|
| Intervention | SARS-CoV-1, SARS-CoV-2, or H1N1 |
| Outcome | Effect on personal and academic life |
| Input: ((coronavirus or covid or covid19 or covid-19 or SARS-CoV-2) OR (sars or "severe acute respiratory syndrome" or SARS-CoV or SARS-CoV-1) OR (H1N1 or "swine flu" or "influenza pandemic")).ti, ab. AND (medical adj3 (student* or resident* or learner* or trainee*)).ti,ab. AND (impact* or effect* or repercussion* or consequence*).ti,ab. | |

The entirety of this process was organized with and on Google Spreadsheets. The references of these articles were assessed in the same manner to find pertinent references that may not have been generated in the database searches.

Data collection process

Upon analysis of the articles included in qualitative synthesis, data was organized on a spreadsheet to include the following

variables from each article: year of publication, journal, country, type of study, health crises discussed, target group investigated, sample size, main objective, article summary, limitations, academic impact, personal impact, and proposed solutions. This process was undertaken by the first author (M.C.) and reviewed and validated with the field experts (M.P. and L.P.).

Risk of bias inherent in each study

Articles meeting inclusion criteria were reviewed by a sole reviewer (M.P.). The data collected from them was reviewed by and validated by field experts (M.P. and L.P.). Only the articles that were cross-sectional studies, systematic reviews or qualitative studies were evaluated for risk of bias. These were evaluated by a sole reviewer (M.C.). These were assessed according to *NHLBI-NIH Quality Assessment Tool for Cross-Sectional Studies*,⁷ *NHLBI-NIH Quality Assessment Tool for Systematic Reviews*,⁷ *CASP Quality Assessment Tool for Qualitative Studies*.⁸ The quality of the selected papers was appraised using the following tools.

Synthesis of results

A qualitative description of results for academic impact, personal impact and proposed solution was summarized.

Results

Study selection

A total of 94 articles were identified during the first search. Ninety were screened, of which 45 were ultimately assessed for eligibility. Reasons for exclusion are listed in Figure 1. Fourteen articles were included for qualitative synthesis. Two out of the 14 articles pertained to the SARS-CoV-1 epidemic while the remaining 12 discussed the SARS-CoV-2 pandemic. None pertained to A/H1N1. Two hundred and twenty-nine articles were identified in the second search. One hundred forty-four were screened, of which 65 were assessed for eligibility. Reasons for exclusion are listed in Figure 2. Sixteen articles were included for qualitative synthesis. These all pertained to the current SARS-CoV-2 pandemic.

Study characteristics

In the first search, 221 medical learners were surveyed in the context of SARS-CoV-1 within the specified timeframe. At least 9848 learners were questioned in the context of SARS-CoV-2. The exact number of participants cannot be valued precisely as some articles did not specify this information or were not designed to do so (ie commentaries, systematic reviews). In the second search, at least 3614 medical learners were queried. Table 2 detail the target group, sample size, main goal, and issues addressed yielding from the first and second search, respectively. Table 3 details the results of individual studies.

Risk of relative and cross-study bias

Of the 17 cross-sectional studies included, three have a low risk of bias.^{17,21,33} One has a high risk of bias because the participation rate of eligible persons was not at least 50%, there was no sample size justification, power description, or variance and effect estimate, the exposure of interest was not measured prior to the outcome being measured, the time-frame was not sufficient to reasonably expect to see an association between exposure and outcome, the exposure was not assessed more than once over time and there were no confounding key variables measured and adjusted statistically for their impact on the relationship between the exposure and outcome.²⁵ The remainder have an intermediate risk of bias.^{4,9,11-13,15,23,24,27,29,30,34,35} Table 4 shows a summary of the analysis of these 17 studies.

Of the two systematic reviews included in this study, one has a low risk of bias² while the other, an intermediate risk of bias.¹⁸ Table 5 shows a summary of the analysis of these two studies.

Of the four qualitative studies included, two have a low risk of bias.^{10,22} Two have a high risk of bias.^{16,20} Hilburg et al have a risk because ethical issues were not taken into consideration and the date was not sufficiently rigorous. Dhillon et al have a high risk because the recruitment strategy was not appropriate to the aims of the research, the relationship between researcher and participant was not adequately considered, ethical issues were not taken into consideration, the data analysis was not sufficiently rigorous and there was no clear statement of findings. Table 6 shows a summary of the analysis of these 4 studies.

Syntheses of results

In the first search, the most common academic impact was the suspension of in-person activity, depicted in 6 articles.^{2,9,10,13,22,35} There was an online shift of didactic material.^{9,10,13,22} Deployment and rotation incompleteness was also reported in 4 articles of the 16.^{2,13,30,35} Other, less frequently detailed repercussions included decreased clinical exposure due to lack of personal protective equipment (PPE), cancellation of elective surgeries, and telework.^{2,9,13,27}

The most common personal impact was anxiety related to working in a high-risk environment depicted in 4 articles.^{15,20,22,35} This was closely followed by anxiety secondary to the above academic changes in 3 papers.^{21,22,35} Depression secondary to isolation and burnout due to changes at work also came up.^{11,20-22,25} Another, less frequently mentioned consequence was anxiety due to the financial burden of the health crises.³⁰

Common solutions proposed were the promotion and adoption of healthy lifestyle and didactic innovation.^{11,18,20,21,25} Other initiatives went from check-in emails to instilling accessible mental health resources and PPE.^{13,22}

In the second search, the most common academic impact was limited clinical exposure, depicted in 4 articles.^{3,18,23,29}

Table 2. Data presentation of articles included from both searches.

| Author and year, country | Health crisis | Target group | Sample size (n) | Main goal | Issues addressed |
|---|---------------|---------------------------------|-----------------|--|--|
| Loh et al, 2006 Malaysia ⁹ | SARS-CoV-1 | Medical students | 204 | Assess the knowledge level, the anxiety, and the perception of SARS in medical students. | Personal impact. |
| Rambaldini et al, 2005 Canada ¹⁰ | SARS-CoV-1 | Residents | 17 | Explore the impact of SARS on medical education and develop solutions to perpetuate training in a similar situation. | Academic and personal impact, solutions. |
| Abdulghani et al, 2020 Saudi Arabia ¹¹ | SARS-CoV-2 | Medical students | 243 | Evaluate the impact of COVID-19 on medical students' learning. | Academic and personal impact. |
| Arima et al, 2020 Japan ¹² | SARS-CoV-2 | Medical students | 571 | Evaluate psychological distress in medical students during COVID-19-forced quarantine and the factors associated. | Academic and personal impact, solutions. |
| Cao et al, 2020 China ¹³ | SARS-CoV-2 | Medical students | 7143 | Assess the psychological state of medical students during COVID-19 and identify factors influencing their anxiety. | Academic and personal impact. |
| Chandratre, 2020 USA ¹⁴ | SARS-CoV-2 | Medical students | - | Explain the psychological effect of COVID-19 on medical students. | Academic and personal impact, solutions. |
| Dedeilia et al, 2020 UK ² | SARS-CoV-2 | Medical students and residents | 61 articles | Explore the challenges of COVID-19 on medical and surgical education and offer solutions. | Academic and personal impact, solutions. |
| Dimitriu et al, 2020 Romania ¹⁵ | SARS-CoV-2 | Residents | 100 | Identify the prevalence of burnout in residents during COVID-19 and ways to prevent it. | Personal impact, solutions. |
| Dhillon et al, 2020 Canada ¹⁶ | SARS-CoV-2 | Medical students | - | Offer medical students' perspectives on evolving medical education during COVID-19. | Academic impact, solutions. |
| Essangri et al, 2020 Morocco ¹⁷ | SARS-CoV-2 | Medical students | 549 | Assess medical students' psychological state and factors influencing it during COVID-19. | Personal impact, solutions. |
| Giordano et al, 2020 Italy ¹⁸ | SARS-CoV-2 | Medical students and residents | 14 articles | Explore how various institutions have addressed COVID-19 to continue medical student and resident training. | Academic impact. |
| Hall et al, 2020 Canada ¹⁹ | SARS-CoV-2 | Medical students. and residents | - | Identify ways to promote competency-based education during COVID-19. | Solutions. |
| Hau et al, 2020 Germany ³ | SARS-CoV-2 | Medical students and residents | - | Propose solutions to perpetuate medical and surgical training of medical students and residents. | Academic and personal impact, solutions. |
| Hilburg et al, 2020 USA ²⁰ | SARS-CoV-2 | Medical student and resident | - | Describe the impact of COVID-19 on medical education and explore the equilibrium between wellness and learning during that time. | Academic impact, solutions. |
| Hilmi et al, 2020 France ²¹ | SARS-CoV-2 | Residents | 222 | Evaluate the impact of COVID-19 on oncology residents. | Academic and personal impact. |
| Hoopes et al, 2020 USA ²² | SARS-CoV-2 | Residents | - | Explore available resources for remote surgical training in obstetrics and gynecology. | Academic impact and solutions. |
| Huffman et al, 2021 USA ²³ | SARS-CoV-2 | Residents | 785 | Evaluate the psychological impact of COVID-19 on medical learners and identify stressors to guide intervention. | Academic and personal impact. |
| Loda et al, 2020 Germany ²⁴ | SARS-CoV-2 | Medical students | 372 | Assess the learning stressors in medical students during COVID-19 and their expectations. | Personal impact and solutions. |
| Lyons et al, 2020 Australia ²⁵ | SARS-CoV-2 | Medical students | 297 | Assess the impact of COVID-19 on medical students' mental health and determine their coping mechanisms. | Personal impact and solutions. |
| McMaster et al, 2020 UK ²⁶ | SARS-CoV-2 | Medical students | - | Underline the positive impact of COVID-19 on English medical students. | Academic and personal impact. |

(continued)

Table 2. Continued.

| Author and year, country | Health crisis | Target group | Sample size (n) | Main goal | Issues addressed |
|--|---------------|--------------------------------|-----------------|--|--|
| Meo et al, 2020 Saudi Arabia ²⁷ | SARS-CoV-2 | Medical students | 530 | Evaluate the impact of quarantine during COVID-19 on medical student wellness and learning. | Academic and personal impact, solutions. |
| Ong, 2020 Singapore ²⁸ | SARS-CoV-2 | Residents | - | Explore the changes in graduate medical education and their impact on resident burnout during COVID-19. | Academic and personal impact, solutions. |
| Paesano et al, 2020 Spain ²⁹ | SARS-CoV-2 | Residents | 148 | Assess the impact of COVID-19 on residency training in urology. | Academic impact and solutions. |
| Pandey et al, 2020 India ⁴ | SARS-CoV-2 | Medical students and residents | 83 | Evaluate the psychological impact of COVID-19 on obstetrics and gynecology trainees. | Personal impact. |
| Que et al, 2020 China ³⁰ | SARS-CoV-2 | Residents | 994 | Assess the psychological impact of COVID-19 on residents and explore factors associated with mental illness. | Personal impact and solutions. |
| Rainbow et al, 2020 UK ³¹ | SARS-CoV-2 | Medical students | - | Evaluate COVID-19's impact on medical training and medical schools' response. | Academic impact. |
| Rolak et al, 2020 USA ³² | SARS-CoV-2 | Medical students | - | Discuss the challenges in medical education during COVID-19 and the response to remedy them. | Academic impact and solutions. |
| Saraswathi et al, 2020 India ³³ | SARS-CoV-2 | Medical students | 217 | Assess the mental health of medical students before and after the onset of COVID-19. | Personal impact. |
| Torun et al, 2020 Turkey ³⁴ | SARS-CoV-2 | Medical students | 275 | Explore the knowledge of medical students and the impact of COVID-19 on their mental well-being. | Personal impact. |
| Xiao et al, 2020 China ³⁵ | SARS-CoV-2 | Medical students | 933 | Assess the psychological impact of social distancing in medical students. | Personal impact and solutions. |

Legend: USA = United States of America; UK = United Kingdom.

Suspension of in-person activities and online shift of didactic material were mentioned in 3, as well as the cancelation of elective surgeries.^{3,17,18,33} Less supervision was detailed in three papers.^{3,18,23} Other, less frequently detailed repercussions included were delayed rotations and graduation, lack of professional identity formation, and increase in work hours and telework.^{3,18,23,29,33,34}

The most common personal impact was anxiety depicted in 8 articles.^{3,4,23,24,26,28,34} This was followed closely by insomnia or changes in sleep patterns and depression.^{4,23,24,26,28,34} Other, less frequently mentioned consequences were fear related to virus exposure and infection of loved ones and worry about career development.^{4,12,28,29,34}

Common solutions proposed were having accessible mental health resources and training in telehealth precepting.^{3,18,19,26,29} Other initiatives went from professional development programs to ensuring technological support and training.^{18,26}

Reporting biases

The screening process of articles generated initially in each search was undertaken by a sole reviewer (M.C.) to exclude those failing to fulfill inclusion criteria. Those meeting them were assessed by the same reviewer to eliminate those suiting

the exclusion criteria. Provided this undertaking was performed by a sole person, subjectivity in the initial selection process remains an important bias in our methodology. Furthermore, the qualitative report of this study dilutes objectivity as the reviewers' opinions are involved.

Discussion

The current COVID-19 pandemic continues to strain the healthcare system and its workers as well as test their adaptability. Notably, physicians-in-training have seen their academic development bothered and their personal life, challenged. In this narrative review, we intended to describe the effect of COVID-19 and past epidemics and pandemics on the academic and personal lives of medical students and residents. To this effect, an automated search was performed on two occasions: one during the first wave of COVID-19, and the other, during its second wave, each of which 14 and 16 articles, respectively, were included for qualitative synthesis. This review confirmed and recognized the academic and personal impact of the sanitary crisis on junior healthcare workers and identified solutions to alleviate the burden they bestow.

Academic repercussions common to articles yielded from both searches were the suspension of in-person academic activities, online teaching, examination postponement, cancelation

Table 3. Results of individual studies.

| Author (year) | Results |
|---------------------------------|---|
| Loh (2006) ⁹ | <ul style="list-style-type: none"> Assesses the anxiety level of Malaysian medical students during the SARS-CoV-1 outbreak. Preclerkship students were overall more anxious than clerkship students, a finding the authors explain by the difference in maturity and clinical exposure between the two groups. 12.5% of preclerks ($n = 91$) were frightened to go into hospitals, compared to 1.8% of clerks ($n = 204$). |
| Rambaldini (2005) ¹⁰ | <ul style="list-style-type: none"> Describes the impact of SARS-CoV-1 on residency programs in Toronto, Canada. Most participants (58.8%) thought the crisis compromised their education due to the cancelation of educational activities and changes in core rotations. Anxiety arose among participants due to a lack of communication and differences in information distributed by the various departments and hospitals they serve about the virus and the protocols instilled regarding the care of SARS patients. An increase in feelings of isolation and loneliness due to social distancing and restrictions was noted. Strong leadership and effective communication from staff were solutions offered. |
| Abdulghani (2020) ¹¹ | <ul style="list-style-type: none"> Correlates the shift to online learning and examination to increased stress in Saudi medical students ($n = 243$), with 20.3% describing online learning as burdensome and a severe stress level. Stress was positively correlated to urban living. Coping strategies put forth by the participants included regular exercise, online activities with loved ones, participating in religious activities and acceptance of the sanitary situation. |
| Arima (2020) ¹² | <ul style="list-style-type: none"> Identifies that 28.5% of included Japanese medical students ($n = 571$) experienced significant psychological distress. They found that self-esteem and self-efficacy were protective against this. |
| Cao (2020) ¹³ | <ul style="list-style-type: none"> 24.9% of the Chinese medical students surveyed ($n = 7143$) experience anxiety varying from mild to severe with the onset of COVID-19. This anxiety was exacerbated by decreased social support, living in an urban area, living with parents, knowing a loved one suffering from the virus and academic delays. |
| Chandratne (2020) ¹⁴ | <ul style="list-style-type: none"> Describes the impact of COVID-19 on American medical students, including the reduction of clinical experience or absence thereof, the remaining of which are limited by the lack of personal protective equipment (PPE). Shift toward virtual learning, delays in licensing examination and the alteration in the residency application process (ie cancelation of visiting electives) further impact the academic experience. Suggests that the anxiety created by the crisis and ensuing social distancing may further exacerbate medical students' physical and mental illbeing, especially that they compose a population at risk of depression and suicidal ideation. As a remedy, availability of PPE, mental health check-ins alongside the meeting of basic needs (ie food and water) are some of the proposed solutions. |
| Dedeilia (2020) ² | <ul style="list-style-type: none"> Pinpoints the suspension of activities, PPE shortages, cancelation of conferences and elective surgeries. Highlights the fear surrounding the pandemic as a worker in a high-risk environment lacking appropriate PPE and the worry of infecting people at home. For residents, there was worry regarding the lack of time to complete residency requirements in time secondary to deployment, lessened supervision, and shift of work toward emergency medicine and acute care. Proposed innovations ranged from promoting telemedicine, teleconference and virtual reality simulations to ensuring mental health care access to learners, virtual social gatherings, and free meals. |
| Dimitriu (2020) ¹⁵ | <ul style="list-style-type: none"> Compares burnout in Romanian residents working on the front line of the COVID-19 pandemic and those working on hospital wards. Burnout frequency in the former group rose to 86% ($n = 43$) compared to 66% ($n = 33$) in the latter. They proposed physical activity to help counter burnout. |
| Dhillon (2020) ¹⁶ | <ul style="list-style-type: none"> Uses the perspective of medical students from McGill University to evaluate how medical education has changed during COVID-19. They report telemedicine and the cancelation of in-person clinical sessions mainly for preclerkship students. Clerks are confronted with decreased hands-on learning opportunities and are thus worried about becoming competent residents. Proposes e-learning modules to develop their nonclinical skills and mock clinical encounters to sharpen the clinical ones as well as peer-led workshops for practical techniques. |
| Essangri (2020) ¹⁷ | <ul style="list-style-type: none"> Aims to evaluate the psychological well-being of Moroccan medical students and factors influencing it. Finds that depression, anxiety, and insomnia were positively correlated to living in areas of viral concentration, quarantine for more than 2.5 weeks, and a psychiatric history. |

(continued)

Table 3. Continued.

| Author (year) | Results |
|-------------------------------|--|
| | <ul style="list-style-type: none"> Solutions proposed revolved around supporting students when obliged into confinement such as access to mental health resources and training in coping skills. |
| Giordano (2020) ¹⁸ | <ul style="list-style-type: none"> Evaluates how various institutions perpetuated undergraduate and graduate medical education. Virtual transition for rounds, mortality and morbidity conferences and teaching sessions, telemedicine, and at-home surgical simulations were common outcomes. |
| Hall (2020) ¹⁹ | <ul style="list-style-type: none"> Focuses on elaborated ways to promote competency-based education during COVID-19. Solutions included prioritizing the safety and well-being of learners (ie workplace safety, attentiveness to burnout), conserving clinical opportunities when possible, emphasize nonclinical skills like the CanMEDS roles, promote innovation for teaching and learning and preparing to catch up postpandemic. |
| Hau (2020) ³ | <ul style="list-style-type: none"> Notes disruption of clinical clerkship and residency rotations, in-person lectures, and elective surgeries as well as the impossibility of observing mandatory ones. The lack of collegial exchange, self-isolation and risk of virus contraction promoted the development of mental health problems in German medical students and residents as well as difficulties with time management. They propose virtual didactics, teleconferences, development of surgical simulation platforms, exploitation of social media, and creation of at-home surgical models. |
| Hilburg (2020) ²⁰ | <ul style="list-style-type: none"> Describes the academic impact on American medical students and residents, stating reservation of direct patient contact to senior workers, decreased supervision of skills, cancelation of elective rotations and redeployment, delays in graduation, virtual interviews, and telemedicine. Promotes virtual educational activities with utilization of video conference features (ie whiteboard, breakout rooms, file share) and appropriate technological support. |
| Hilmi (2020) ²¹ | <ul style="list-style-type: none"> Explores the impact of COVID-19 on French oncology residents. 70% of respondents ($n = 222$) experienced more ethical dilemmas as they felt they were providing less support to patient's family and thus suboptimal care. 32% were redeployed and 31% of residents with access to PPE judged it inadequate. 89% had less training activities, and working hours increased by 31%. They felt their short-term training was compromised. 36% reported exhaustion and feeling overwhelmed. 32% were deemed anxious, and 17% depressed. Substance consumption increased: 31% increased their tobacco use, 24%, their alcohol intake, and 29%, their psychostimulant use. |
| Hoopes (2020) ²² | <ul style="list-style-type: none"> Proposes resources to pursue surgical training at a distance during COVID-19 for gynecological residents, given the cancelation of elective procedures and diminished time in the operating room. Includes laparoscopy boxes, virtual reality simulators, video games, webinars and surgical videos. |
| Huffman (2020) ²³ | <ul style="list-style-type: none"> Reports concerns about loss of professional identity in American residents ($n = 720$) and found increased stress levels (76.7%), with fear of infection of loved ones as an important stressor. Participants also reported more anxiety, exhaustion, and sleep disturbances. |
| Loda (2020) ²⁴ | <ul style="list-style-type: none"> Reveals high levels of distress in German medical students, which exhibited mild anxiety and depression. Their greatest academic stressors included uncertainty about their training during COVID-19 and changes in exams, clinical exposure and online curricula. |
| Lyons (2020) ²⁵ | <ul style="list-style-type: none"> Assesses medical student well-being in Australia. 68% ($n = 297$) reported worsening in their well-being due to lack of social connection, stress related to studies, self-isolation and worry about family members becoming sick. Solutions mainly lied in supporting mental health including mindfulness and meditation practices, proper medical and psychological follow-up, mentorship, and virtual social activities. |
| McMaster (2020) ²⁶ | <ul style="list-style-type: none"> Emphasizes the opportunity for English medical students to consolidate academic material, promote career development and innovation in learning tools during the interruption of in-clinical and class duties during COVID-19. |
| Meo (2020) ²⁷ | <ul style="list-style-type: none"> Intends to evaluate the impact of social distancing and quarantining on Saudi medical students' well-being and learning during COVID-19. Roughly half (50.6%) of the participants ($n = 530$) agreed that their academic performance and studying had deteriorated, which involved studying for less time and having trouble concentrating. 44.2% agree they feel detached from loved ones, 23.6% have felt depressed and 38.9% report feeling anxious and experiencing insomnia. Solutions proposed went from promoting a healthy diet to at-home exercise and good sleep hygiene. |
| Ong (2020) ²⁸ | <ul style="list-style-type: none"> Comments on the curricular changes brought to residency programs in Singapore during COVID-19, the biggest of which is a shift of academic activities online. |

(continued)

Table 3. Continued.

| Author (year) | Results |
|---------------------------------|--|
| | <ul style="list-style-type: none"> Proposes revamping examination protocols like pushing back final evaluations to appropriately assess clinical competencies. While they did not conduct a study per se, they notice an increase in burnout in residents given the decrease in social contact, deployment, and the increase in workload. Encourages constant psychological hotline access, mindfulness workshops, and a “no questions asked policy” regarding sick days/leaves. |
| Paesano (2020) ²⁹ | <ul style="list-style-type: none"> Explores the impact of COVID-19 on Urology residents in South America and Spain, with the main impact being performance of emergency surgeries only, decrease in clinical activity and alternation among residents between working from home and being at the hospital. Participants wished to prolong their residency because of this disruption. |
| Pandey (2020) ⁴ | <ul style="list-style-type: none"> Assesses the psychological impact on Indian Obstetrics and Gynecology trainees. 45% of respondents ($n = 83$) expressed concerns about their health. 10% had moderate anxiety and 7% severe depression. |
| Que (2020) ³⁰ | <ul style="list-style-type: none"> Assesses the psychological burden of COVID-19 on Chinese health workers, particularly medical residents. 46% disclosed anxiety ($n = 2285$), 44% depression and 29%, insomnia at the moment of survey. Weights in on solutions pertaining to psychosocial support including professional help but also relaxation techniques and regular exercise. |
| Rainbow (2020) ³¹ | <ul style="list-style-type: none"> Reports cancelation of in-person classes, electives and research opportunities that would otherwise prepare students for a career in academic medicine. Discusses the limitations of virtual teaching such as developing interpersonal and practical skills as well as financial limitations to procuring resources for remote learning. Encourages student engagement through volunteering in nonclinical duties. |
| Rolak (2020) ³² | <ul style="list-style-type: none"> Identifies shift to online lectures, cancelation of in-person clinical skills sessions and exams, shortened clerkship rotations and decreased opportunity to explore specialties as educational changes. Solutions proposed include resumption of clinical rotations with proper PPE, PPE donation coordination, and involvement in clinical work where risk of infection is weaker. |
| Saraswathi (2020) ³³ | <ul style="list-style-type: none"> Shows that Indian medical students worried about their skills acquisition and career development. Overall levels of anxiety and depression were elevated, and the latter were positively correlated to male sex and living in an urban area. |
| Torun (2020) ³⁴ | <ul style="list-style-type: none"> Shows that overall anxiety in Turkish medical students was worsened and factors related to this increase were existence of underlying chronic disease, low familial income, and poverty of knowledge relating to the virus, its transmission and prevention. Sleep disturbances and changes in appetite were also noted. |
| Xiao (2020) ³⁵ | <ul style="list-style-type: none"> Evaluates the impact of social distancing during COVID-19 on Chinese medical students. 17.1% of participants ($n = 933$) reported anxiety and 23.4%, depression. Anxiety and depression were increased in areas where COVID-19 cases were concentrated. Healthy lifestyle was encouraged to counteract these. |

of elective procedures, disruption of rotation and telemedicine. This suggests the perpetuation of guidelines minimizing in-person interactions to curtail infection propagation. The need for appropriate distancing measures as well as the shortage of PPE has forced hospitals to minimize nonessential staff in the workplace, which means medical learners now lack bedside teaching and direct observation of their clinical ability in both assessing a patient and elaborating their management.^{2,13} Dedeilia et al further emphasize the greater impact on surgical education as urgent and emergency procedures solely are performed, most of which are not usually performed by trainees, further precluding their training.²

The personal impact raised in both searches was anxiety, depression, and worry related to academic changes, social distancing guidelines, and work in a high-risk environment. Anxiety in the time of COVID-19 sees itself exacerbated by life and work in an urban area, gaps in social support or lack thereof due to social distancing guidelines alongside living with parents who may have comorbidities and thus, may be at higher risk of either contracting the virus or displaying a more serious presentation of it.¹⁷ Those relocated to busier centers are further isolated, and potentially further burdened financially.^{17,22} Once more, this underlines the persisting, and perhaps worsening, psychological state of residents as

Table 4. Bias assessment of cross-sectional studies.

| NHLBI-NIH quality assessment tool for cross-sectional studies | | | | | | | | | | | | | | | |
|---|------------|-------------|--------------|-------------|------------|-------------|--------------|---------------|-------------|------------|-------------|--------------|---------------|--------------|---------------------|
| Study (year) | Criteria I | Criteria II | Criteria III | Criteria IV | Criteria V | Criteria VI | Criteria VII | Criteria VIII | Criteria IX | Criteria X | Criteria XI | Criteria XII | Criteria XIII | Criteria XIV | Global risk of bias |
| Loh (2006) ⁹ | Yes | Yes | Yes | Yes | No | No | No | N/A | Yes | No | Yes | No | N/A | No | Intermediate |
| Abdulghani (2020) ¹¹ | Yes | Yes | Yes | Yes | No | No | No | N/A | Yes | No | Yes | No | N/A | No | Intermediate |
| Arima (2020) ¹² | Yes | Yes | Yes | Yes | No | No | No | N/A | Yes | No | Yes | No | N/A | No | Intermediate |
| Cao (2020) ¹³ | Yes | Yes | Yes | Yes | No | No | No | N/A | Yes | No | Yes | No | N/A | No | Intermediate |
| Dimitriu (2020) ¹⁵ | Yes | Yes | Yes | Yes | No | No | No | N/A | Yes | No | Yes | No | N/A | No | Intermediate |
| Essangri (2020) ¹⁷ | Yes | Yes | No | Yes | Yes | No | No | N/A | Yes | No | Yes | No | N/A | Yes | Low |
| Hilimi (2020) ²¹ | Yes | Yes | Yes | Yes | No | No | No | N/A | Yes | No | Yes | No | N/A | Yes | Low |
| Huffman (2020) ²³ | Yes | No | Yes | Yes | No | No | No | N/A | Yes | No | Yes | No | N/A | Yes | Intermediate |
| Loda (2020) ²⁴ | Yes | Yes | Yes | Yes | No | No | No | N/A | Yes | No | Yes | No | N/A | No | Intermediate |
| Lyons (2020) ²⁵ | Yes | Yes | No | Yes | No | No | No | N/A | Yes | No | Yes | No | N/A | No | High |
| Meo (2020) ²⁷ | Yes | Yes | Yes | Yes | Yes | No | No | N/A | Yes | No | Yes | No | N/A | No | Intermediate |
| Paesano (2020) ²⁹ | Yes | Yes | Yes | Yes | No | No | No | N/A | Yes | No | Yes | No | N/A | No | Intermediate |
| Pandey (2020) ⁴ | Yes | Yes | Yes | Yes | No | No | No | N/A | Yes | No | Yes | No | N/A | No | Intermediate |
| Que (2020) ³⁰ | Yes | No | Yes | Yes | Yes | No | No | N/A | Yes | No | Yes | No | N/A | No | Intermediate |
| Saraswathi (2020) ³³ | Yes | Yes | Yes | Yes | Yes | No | No | N/A | Yes | Yes | Yes | No | Yes | No | Low |
| Torun (2020) ³⁴ | Yes | Yes | Yes | Yes | No | No | No | N/A | Yes | N/A | Yes | No | N/A | No | Intermediate |
| Xiao (2020) ³⁵ | Yes | Yes | Yes | Yes | No | No | No | N/A | Yes | N/A | Yes | No | N/A | No | Intermediate |

Criteria: I. Was the research question or objective in this paper clearly stated? II. Was the study population clearly specified and defined? III. Was the participation rate of eligible persons at least 50%? IV. Were all the subjects selected or recruited from the same or similar populations (including the same time period)? Were inclusion and exclusion criteria for being in the study prespecified and applied uniformly to all participants? V. Was a sample size justification, power description, or variance and effect estimates provided? VI. For the analyses in this paper, were the exposure(s) of interest measured prior to the outcome(s) being measured? VII. Was the timeframe sufficient so that one could reasonably expect to see an association between exposure and outcome if it existed? VIII. For exposures that can vary in amount or level, did the study examine different levels of the exposure as related to the outcome (eg, categories of exposure, or exposure measured as a continuous variable)? IX. Were the exposure measures (independent variables) clearly defined, valid, reliable, and implemented consistently across all study participants? X. Was the exposure(s) assessed more than once over time? XI. Were the outcome measures (dependent variables) clearly defined, valid, reliable, and implemented consistently across all study participants? XII. Were the outcome assessors blinded to the exposure status of participants? XIII. Was loss to follow-up after baseline 20% or less? XIV. Were key potential confounding variables measured and adjusted statistically for their impact on the relationship between exposure(s) and outcome(s)? Global risk of bias: if more YES than NO, then low risk; if more NO than YES, then high risk; if equal YES and NO, then intermediate.

Table 5. Bias assessment of systematic reviews.

| NHLBI-NIH quality assessment tool for systematic reviews | | | | | | | | | |
|--|------------|-------------|--------------|-------------|------------|-------------|--------------|---------------|---------------------|
| Study (year) | Criteria I | Criteria II | Criteria III | Criteria IV | Criteria V | Criteria VI | Criteria VII | Criteria VIII | Global risk of bias |
| Dedeilia (2020) ² | Yes | Yes | Yes | Yes | Yes | No | No | N/A | Low |
| Giordano (2020) ¹⁸ | Yes | Yes | Yes | No | No | Yes | No | No | Intermediate |

Criteria: I. Is the review based on a focused question that is adequately formulated and described? II. Were eligibility criteria for included and excluded studies predefined and specified? III. Did the literature search strategy use a comprehensive, systematic approach? IV. Were titles, abstracts, and full-text articles dually and independently reviewed for inclusion and exclusion to minimize bias? V. Was the quality of each included study rated independently by two or more reviewers using a standard method to appraise its internal validity? VI. Were the included studies listed along with important characteristics and results of each study? VII. Was publication bias assessed? VIII. Was heterogeneity assessed? (This question applies only to meta-analyses). Global risk of bias: if more YES than NO, then low risk; if more NO than YES, then high risk, if equal YES and NO, then intermediate.

Table 6. Bias assessment of qualitative studies.

| CASP quality assessment tool for qualitative studies | | | | | | | | | | | |
|--|------------|-------------|--------------|-------------|------------|-------------|--------------|---------------|-------------|------------|---------------------|
| Study (year) | Question I | Question II | Question III | Question IV | Question V | Question VI | Question VII | Question VIII | Question IX | Question X | Global risk of bias |
| Rambaldini (2005) ¹⁰ | Yes | Yes | Yes | Yes | Yes | No | Yes | Yes | Yes | Valuable | Low |
| Dhillon (2020) ¹⁶ | Yes | Yes | No | No | No | No | No | No | No | Valuable | High |
| Hilburg (2020) ²⁰ | Yes | No | No | NA | No | NA | No | No | Yes | Valuable | High |
| Hoopes (2020) ²² | Yes | Yes | Yes | Yes | Yes | NA | No | No | Yes | Valuable | Low |

Questions: I. Was there a clear statement of the aims of the research? II. Is a qualitative methodology appropriate? III. Was the research design appropriate to address the aims of the research? IV. Was the recruitment strategy appropriate to the aims of the research? V. Was the data collected in a way that addressed the research issue? VI. Has the relationship between the researcher and participants been adequately considered? VII. Have ethical issues been taken into consideration? VIII. Was the data analysis sufficiently rigorous? IX. Is there a clear statement of findings? X. How valuable is the research? Global risk of bias: if more YES than NO, then low risk; if more NO than YES, then high risk, if equal YES and NO, then intermediate.

the infection rate worsens and rules and regulations tighten in response.

The 14 articles initially generated reported emphasis on acute and emergency medicine and limitation of clinical exposure because of lack of PPE as further academic changes. Staff deployment aimed to saturate emergency medicine and intensive care services.² The articles generated from the secondary search detailed concerns with professional identity formation, decrease in supervision, increase in working hours and innovation of virtual educational tools as other academic impacts of major health crises. The difference between the results of these searches may be explained by chronology. Loss of professional identity may be endowed by the diminishing time spent outside of work, thus blurring the line between personal and professional identity, but also steering learners away from their program objectives in an effort to concentrate on helping hands to alleviate the COVID-19 strain.³⁴ The second search conducted nearly 6 months after the first produced results affected by time; that is, pandemic time length. It is reasonable to see long-term effects, such as didactic innovation and worry about professional identity formation, develop

as the crisis lengthens. Such consequences may not have time to evolve in an otherwise acute situation. Educational innovation proving efficient span from maximizing the use of video conference tools (ie whiteboard function and breakout rooms), telehealth precepting, and surgical platforms accessible from home including virtual operation room simulations, laparoscopic box training, and intraoperative videos.^{3,18,27}

In regard to the personal impact, the main differences uncovered between both searches were changes in sleep patterns and mental health issues exacerbated in urban and lower-income households or having an underlying psychiatric condition, in the second search.^{17,19} Once more, this may be elucidated by the long-term effects of a pandemic as a more serious toll is taken on well-being and income as it progresses. Sleep disturbance, particularly, including falling asleep late or not at all, has led to further psychological distress.^{24,28,34} Torun et al identified exacerbated sleep impairment since the onset of the COVID-19 pandemic in a third of its participants ($n=275$), while Saraswathi et al points out an association between poor sleep quality and an increase in stress, anxiety and depression.^{24,28}

The secondary goal of this paper was to identify solutions within the literature that tackled the academic and personal problems sparked by the health crisis. All were suggestions found within articles pertaining to the unfolding COVID-19 pandemic. Both searches recommended solutions addressing mental health and the availability of its resources as well as encouraged the development of online learning tools. Particularly, anticipation of the reverberations of a sanitary crisis in both academic and personal spheres would undoubtedly alleviate them.³⁶ Ways of doing so include mulling over previous crises to stay ahead of future ones, prioritizing the safety of the staff, learners and patients by ensuring access to protective gear, being attentive to burnout within the healthcare team and further asseverate the need for mental health support prior to and during tumultuous times. Another suggestion was an innovation of platforms through which learners can participate remotely, complement their education and prepare to catch up when normalcy resumes.³⁶ The main difference in regard to solutions lies within the perspective of longevity taken by each search. The first search focused on addressing issues in the earlier stages of the pandemic, or in a more acute setting (ie following up on resident experience shortly after tough clinical interactions), ensuring PPE availability and tending to their basic needs, that is need for water, food, sleep and proper shelter.^{13,25,30} The second search further emphasized long-term solutions, such as telemedicine as a permanent implementation in medicine and guaranteeing technological support and training for the long-term use of virtual platforms.

This is the first narrative review, to our knowledge, pooling the literature pertaining to SARS-CoV-1, H1N1 and SARS-CoV-2 and their respective impacts on medical trainees. The strengths of this narrative review lie in the explanation of divergent results and in the reproducibility of the systematic search, especially as the COVID-19 pandemic continues to unravel. Moreover, articles generated were from North America, South America, Europe, Asia and Oceania, revealing a relative idea of the impact of recent health crises in a substantial portion of the world. Nonetheless, because of the nature of this study, as a qualitative narrative review, it reflects our judgment, and thus, involves selective and subjective bias, in both the selection and interpretation of articles.³¹ The search media were *MedLine*, *PubMed*, and *EducationSource*, only. Further limitations include the lack of articles discussing H1N1 and the few discussing SARS-CoV-1 in comparison to those addressing SARS-CoV-2. Perhaps this discrepancy is explained by the length of the SARS-CoV-2 pandemic and its associated mortality and healthcare burden.¹ However, academic and personal repercussions of both SARS viruses seem similar. The evidence suggested in each article included must be considered within the bias each inevitably has. Lastly, we did not examine specific causality and the results we detailed are not statistically representative. Implications of this review remain mostly in the solutions proposed in most of the articles

analyzed in an attempt to remedy the distress induced by such health crises. Checking in on learners frequently, encouraging virtual didactic innovation and increasing vigilance regarding mental health are seemingly the easiest and quickest solutions to implement and may provide some prompt aid and relief to residents. Supplementary research would, however, be needed to investigate the impact of countries' level of development on trainees, as well as the impact of their specialty.

Conclusion

The current narrative review has explored the impact current and past health crises have had on the academic and personal lives of medical trainees. It has highlighted some of the issues with isolation and virtuality implicated by such situations and proposed solutions to help learners better adapt to these new realities, all the while supporting them throughout their academic journey. As the COVID-19 pandemic continues, it is critical that future research addresses the long-term impact of this disease on trainees, their professional development and personal wellbeing. It is up to individual institutions to implement strategies to both support and enhance the medical learner's experience during trying times and assess whether those strategies are effective and sufficient or rather, need revision and innovation.

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Supplemental Material

Supplemental material for this article is available online.

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