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Psychological impacts of the COVID-19 pandemic on medical students in the United States of America

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ARTICLE INFO

Keywords:
Medical students
COVID-19
Mental health

ABSTRACT

This study aimed to assess the early psychological impacts of the COVID-19 pandemic on United States medical students when compared to graduate students in fields unrelated to healthcare using the perceived stress scale (PSS-10) and the perceived COVID-19-related risk scale (PCRS). This was a cross-sectional study between May and June 2020. We created an anonymous, online questionnaire that was administered to medical students nationwide and local graduate students. We used Student’s t-test, Chi-square test, and regression models. We received 425 completed responses. Contrary to similar stress levels in graduate students, medical students on average experienced significantly more stress after coursework suspension than before (20.6 vs 14.7). Female gender and a mental illness diagnosis were associated with statistically significantly elevated PSS-10 scores before and after suspension in medical students. Medical students reported a low PCRS score. Most medical students were confident in their department’s infection control measures and willing to report to work. Female gender and a mental illness diagnosis remain two important risk factors for medical students’ stress levels during the pandemic. This study highlights the need to foster students’ public health competency and safely involve students as non-frontline workers in public health emergency responses for their mental wellbeing.

1. Introduction

Medical students in the United States (US) faced a uniquely stressful situation during the initial stage of the COVID-19 pandemic, given their elevated stress than the general public (Heinen et al., 2017), elevated workplace exposure risk, and a nationwide personal protection equipment (PPE) shortage (Miroff, 2020). Additionally, medical students faced uncertainty regarding their education. On March 17, 2020, the Association of American Medical Colleges (AAMC) strongly recommended that medical schools suspend clinical activities in order to alleviate the PPE shortage and attempt to reduce community spread of COVID-19 (AAMC, 2020). Medical students preparing for licensure exams were forced to reschedule their test dates because of cancellations related to increased restrictions at testing centers. In April 2020, graduating medical students in states with high disease burden, such as New York and Massachusetts, were allowed to graduate early and enter workforce to help reduce staff shortage (Redford, 2020). While some medical students welcomed this change, others worried about their mental health both in the short-term and long-term (Aldag, 2020).

Existing research studies on medical student mental health during the COVID-19 pandemic were mostly conducted outside the US. Studies in China, Australia and the Middle East demonstrate that medical students experienced worsening anxiety and depression (Abdulghani et al., 2020; Cao et al., 2020; Lyons et al., 2020; Nakhostin-Ansari et al., 2020; Vahedian-Azimi et al., 2020; Xiao et al., 2020; Xie et al., 2020; Zhan et al., 2020). Few studies involved US medical students (USMS). To our knowledge, no studies have compared USMS with graduate student controls in terms of their psychological state or systematically explored students’ perceived stress before versus after clinical suspension. This study aimed to assess USMS’ stress levels using the perceived stress scale (PSS-10) (Cohen and Williamson, 1988) and risk levels using the perceived COVID-19-related risk scale (PCRS), when compared to graduate student controls.
2. Methods

2.1. Study design

This study was a cross-sectional study that occurred between May 5, 2020 and June 20, 2020 to address the following research questions: 1) Did participants experience similar stress levels before versus after coursework suspension in spring 2020? 2) Did medical students experience similar levels of stress and risk compared to graduate students? 3) Did medical students express similar levels of agreement on their confidence in their department’s infection control measures, willingness to report to work, and feeling isolated compared to graduate students? 4) What factors were associated with medical students’ stress levels during the COVID-19 pandemic? This study was approved by the University of Kentucky Medical Institutional Review Board.

2.2. Study sampling

Our target population included all medical students and non-healthcare graduate students at least 18 years of age enrolled in any medical school in the US or University of Kentucky Graduate School during the 2019–2020 academic year. This study had three enrollment groups: Kentucky medical students, Kentucky non-health graduate student control, and medical students at other institutions to capture other USMS’ experiences and increase generalizability of study results.

2.3. Participant recruitment

All 639 medical students from University of Kentucky College of Medicine were informed about this study via direct emailing and weekly Medical Student Notes. Medical students from other US institutions were recruited through American Medical Association Medical Student Section (AMA-MSS) social media groups (e.g. Facebook and GroupMe) and reminders were sent at 2 and 4 weeks after the initial message. The authors contacted the student representative of Association of American Medical Colleges Organization of Student Representative (OSR) at University of Kentucky who emailed the OSR listserv about our study. Graduate students were informed about the study via the Graduate Student Congress newsletter at University of Kentucky. An online survey using Qualtrics (Qualtrics, Provo, UT) was created for data collection and potential participants were invited to access this survey through an anonymous link at the end of the project information. Qualtrics’ anonymize responses setting was enabled to ensure that participants’ IP address and location data were scrubbed (hence not collected) before their questionnaire responses were saved in the data. Protections were enabled to prevent multiple submissions. To encourage study participation, the department of Psychiatry offered ten $25 Amazon gift cards to ten randomly selected participants with completed responses. Participants could choose to enter their email addresses in a separate Qualtrics survey that was intended for collecting emails only and was not linked with their responses in the Qualtrics study questionnaire.

All potential subjects read a cover letter describing the study and were asked to indicate their agreement to continue participation. Exclusion criteria included incomplete questionnaire responses, graduate students from other institutions, graduate students enrolled in health-related programs, and failure to answer the attention question correctly. Health-related graduate programs that were excluded from the study included but were not limited to fields that involve 1) direct patient or animal care (e.g. dentists, pharmacists, nurses, psychologists, social workers, nutritionists, and veterinarians); 2) biomedical sciences and research (biology, biomedical engineering and genetics); or 3) health promotion or management (e.g. public health) (University of Kentucky, 2020).

A total of 621 anonymous responses were received, of which 520 participants completed the study questionnaire. We further excluded 95 responses per exclusion criteria. Hence, a total of 425 participants (353 USMS and 72 graduate students; an eligible completion rate of 68.4%) were included for analysis. The response rate could not be accurately calculated. For Kentucky medical students, all 639 University of Kentucky medical students were reached and 185 out of the 353 USMS’ completed responses were from Kentucky. Despite the high likelihood that the majority of these 185 responses were from University of Kentucky, there is another medical school in the state where students might be reached via AAMC and AMA. For graduate students, over 8000 students from University of Kentucky were reached, including both medical students and graduate students in healthcare and non-healthcare related areas. For medical students at other US institutions, over 90,000 (AAMC, 2021) students could be potentially reached and the authors were unable to ascertain the actual number reached.

2.4. Study questionnaire

This manuscript focused on three out of the six parts of the study questionnaire.

2.4.1. Participant information

Demographic and social questions were adapted from published surveys (CBHSQ, 2018; NAMCS, 2019). Other key variables included home county, self-reported mental illness diagnosis status, coursework suspension, program year and previous training in public health (adapted from Kaiser et al. (Kaiser et al., 2009)).

2.4.2. PSS-10

Our primary outcome variable is the Perceived Stress Scale score calculated according to the PSS-10 scale. The PSS-10 is a commonly used psychological scale that measures perceived stress levels in response to stressful situations (Cohen and Williamson, 1988). It is commonly categorized into three groups based on the total points: low stress (0–13), moderate stress (14–26) and high stress (27–40) (MDApp, 2022). This scale was previously used in the SARS epidemic in China (Chua et al., 2004; McAlonan et al., 2007; Wong et al., 2004). Participants with coursework suspension were asked to answer the PSS-10 once based on their recollection of their feelings from one month before suspension and then again based on their feelings one month after the suspension.

2.4.3. PCRS

The perceived COVID-19-related risk scale (PCRS) in our study is a combination of questions adapted from an existing scale (9 items) with 5 novel questions. Our numerical outcome variable is PCRS-9 score calculated according to the Perceived SARS-Related Risk Scale (internal consistency of 0.71 by Cronbach’s alpha) that was used in the SARS epidemic (Wu et al., 2009). We added five questions on confidence in the department’s infection control measures, willingness to report to duty (adapted from Kaiser et al. (Kaiser et al., 2009)) and feeling of social isolation. These five questions were assessed individually.

2.4.4. Respondent attention

To test attention, we included a multiple-choice question that asked them to choose the color Green with 6 options: purple, yellow, green, blue, orange, prefer not to answer. If participants chose a response other than green, their study questionnaire responses were excluded from analysis.

2.5. Statistical analysis

Statistical software Stata version 16.1 (StataCorp, College Station, Texas) was used for data analysis. We employed a stepwise approach to evaluate our four research questions. For our first question, paired T-test was used to compare PSS-10 scores before and after coursework suspension among USMS, Kentucky medical students and graduate students separately. For our second question, two-sample student’s T-test and
Mann-Whitney U test were used to compare PSS-10 scores and PCRS-9 scores between comparison groups, Kentucky medical students and graduate students. For the third question, Chi-square test and Fisher’s exact test were used to test if Kentucky medical students and graduate students showed similar levels of agreement on all 14 PCRS items. For our fourth question, we were interested in the effects of female gender, Hispanic status, Caucasian status, age group, program year, Kentucky status, public health background, mental illness diagnosis and living situation on the PSS-10 scores before and after suspension. We dichotomized these nine variables and created multivariable linear regression models based on a stepwise backward-selection approach (variables removed if $p > 0.2$). If demographic variables (age, gender and Caucasian status) were excluded from the backward-selection process, they were added back to the final multivariable model. For the PSS-10 before suspension multivariable linear regression model, we noticed a mild deviation from normality in the residuals. Given that the residuals were close to a normal distribution, we accepted this mild deviation and continued to use multivariable linear regression. Logistic regression was utilized to calculate the odds ratio (OR) for the associations between Kentucky status and agreement of new items 10–14 in the PCRS as well as between program year and agreement of willingness to report to duty. Statistical significance was achieved if the two-sided $p$-value was less than 0.05.

3. Results

3.1. Baseline characteristics

Among all USMS, the majority of respondents were female (67%), Caucasian (77%), at least 25 years old (52%), and attend school in Kentucky (52%) (Table 1). Medical student geographical distribution is shown in Fig. 1. The top four non-Kentucky states, including Texas, Rhode Island, New York and Connecticut, accounted for 70% of non-Kentucky USMS.

3.2. PSS-10

For USMS group (including all Kentucky medical students) and Kentucky medical student group with coursework suspension, their mean PSS-10 scores after the suspension were significantly higher than their scores prior to suspension (USMS 20.6 vs 14.7, $p < 0.001$; Kentucky medical students 20.1 vs 14.2, $p < 0.001$).

In the graduate student group, PSS-10 scores did not differ significantly before and after program suspension (18.5 vs 20.9, $p = 0.19$). Two-sample t-test indicated that graduate students had significantly higher PSS-10 scores than Kentucky medical students before coursework suspension (18.5 vs 14.2, $p < 0.001$) but showed similar PSS-10 scores after suspension (20.9 vs 20.1, $p = 0.66$).

Of note, the above groups’ stress levels before and after the program/coursework suspension remained in the moderate stress category (PSS-10 between 14 and 26).

In the finalized multivariable regression model for PSS-10 score before coursework suspension in USMS, five variables were included: female status, Caucasian status, age, public health background and self-reported mental illness diagnosis (Table 2). Female students and students with a mental illness diagnosis scored 2.40 (95% confidence interval [CI] 1.89 to 3.03, $p < 0.001$) points higher on PSS-10 prior to suspension than non-female students and students without mental illness diagnosis respectively after adjustment. Caucasian students and students with a background in public health scored 2.78 (95% CI 2.36 to 3.20, $p = 0.001$) and 2.28 (95% CI 1.93 to 2.64, $p < 0.001$) points lower on PSS-10 prior to suspension than non-Caucasian students and students without a background in public health respectively after adjustment.

In the finalized multivariable regression model for PSS-10 scores after coursework suspension in USMS, four variables were included:

| Total participant, no. (%) | USMS, no. (%) | Kentucky medical students, no. (%) | Graduate students, no. (%) |
|---------------------------|--------------|----------------------------------|---------------------------|
| Female                    | 294 (69.8%)  | 235 (66.8%)                      | 115 (62.2%)               | 59 (85.5%)               |
| Hispanic                  | 22 (5.4%)    | 18 (5.3%)                        | 4 (2.2%)                  | 4 (5.9%)                 |
| Caucasian                 | 331 (80.9%)  | 263 (77.4%)                      | 154 (85.1%)               | 68 (98.6%)               |
| Age group                 |              |                                  |                           |                          |
| 18–24                     | 183 (43.4%)  | 170 (48.3%)                      | 104 (56.2%)               | 13 (18.6%)               |
| >25                       | 239 (56.6%)  | 182 (51.7%)                      | 81 (43.8%)                | 57 (81.4%)               |
| Program Year              |              |                                  |                           |                          |
| Year 1–2                  | 277 (65.6%)  | 234 (66.3%)                      | 124 (67.0%)               | 43 (62.3%)               |
| Year 3 and beyond         | 145 (34.4%)  | 119 (33.7%)                      | 61 (33.0%)                | 26 (37.7%)               |
| Program location\AAMC central | 30 (7.1%) | 30 (8.5%)                        | /                         | /                        |
| AAMC northeastern         | 78 (18.4%)   | /                                 | /                         | /                        |
| AAMC southern             | 314 (73.9%)  | 242 (68.6%)                      | 185 (100.0%)              | 72 (100.0%)              |
| Kentucky                  | 3 (0.7%)     | 3 (0.9%)                         | /                         | /                        |
| Coursework suspension     | 340 (80.6%)  | 313 (88.9%)                      | 153 (83.2%)               | 72 (27.8%)               |
| US as home country         | 409 (96.5%)  | 340 (96.6%)                      | 179 (96.8%)               | 69 (95.8%)               |
| Public health background   | 45 (10.6%)   | 40 (11.4%)                       | 11 (6.0%)                 | 5 (6.9%)                 |
| Worry about housing, food and/or finances | 114 (27.2%) | 82 (23.5%) | 35 (19.1%) | 32 (45.7%) |
| Formal diagnosis of mental illness (self-report) | 123 (29.5%) | 99 (28.3%) | 49 (26.6%) | 24 (35.8%) |
| Currently in treatment    | 103 (83.7%)  | 83 (83.8%)                       | 39 (79.6%)                | 20 (83.3%)               |
| Use of tobacco products, alcohol, marijuana and other drugs in the past month | 239 (56.8%) | 200 (56.8%) | 104 (56.5%) | 39 (56.5%) |
| Lived with others in the past month | 368 (87.0%) | 314 (89.2%) | 167 (90.8%) | 54 (76.1%) |
| Diagnosed with COVID-19   | 2 (0.5%)     | 1 (0.3%)                         | 0 (0.0%)                  | 1 (1.4%)                 |

Abbreviations: USMS, United States medical students; AAMC, Association of American Medical Colleges.

Participants who chose “prefer not to answer” to a single variable were excluded from analysis of that variable.

* : Kentucky medical students and graduate students are 100% in AAMC southern region and hence the other three AAMC regions are labelled ‘/’.

Among all USMS, the majority of respondents were female (67%), Caucasian (77%), at least 25 years old (52%), and attend school in Kentucky (52%) (Table 1). Medical student geographical distribution is shown in Fig. 1. The top four non-Kentucky states, including Texas, Rhode Island, New York and Connecticut, accounted for 70% of non-Kentucky USMS.

| Female | Hispanic | Caucasian | Age group | Program Year | Program location\AAMC central | AAMC northeastern | AAMC southern | Kentucky | Coursework suspension | US as home country | Public health background | Worry about housing, food and/or finances | Formal diagnosis of mental illness (self-report) | Currently in treatment | Use of tobacco products, alcohol, marijuana and other drugs in the past month | Lived with others in the past month | Diagnosed with COVID-19 |
|--------|----------|-----------|-----------|--------------|-------------------------------|-------------------|---------------|----------|----------------------|---------------------|--------------------------|---------------------------------------------|-----------------------------------------------|--------------------------|-------------------------------------------------|----------------------|---------------------|
| 294 (69.8%) | 22 (5.4%) | 331 (80.9%) | 183 (43.4%) | 277 (65.6%) | 30 (7.1%) | 78 (18.4%) | 314 (73.9%) | 3 (0.7%) | 340 (80.6%) | 409 (96.5%) | 45 (10.6%) | 114 (27.2%) | 123 (29.5%) | 103 (83.7%) | 239 (56.8%) | 368 (87.0%) | 2 (0.5%) |
3.3. PCRS

Table 3 shows the percentages of strongly agree and agree for all 14 items. USMS, Kentucky medical students, and graduate students had similar mean 9-item PCRS scores (2.1 vs 2.1 vs 2.2). No significant difference was found in the mean PCRS-9 between Kentucky medical students and graduate students (Mann–Whitney U, \( p = 0.51 \)).

For items 10–13, compared to graduate students, a significantly higher percentage of Kentucky medical students expressed confidence in department’s infection control measures (\( p = 0.02 \)) and willingness to report to work (\( p < 0.01 \)). No significant difference was observed between Kentucky medical students and graduate students in terms of feeling isolated.

Univariable logistic regressions were utilized to assess the relationship between Kentucky status and agreement of items 10–14 in the PCRS. The odds of confidence in the department’s infection control measures were 1.86 (OR = 1.86, 95% CI 1.18 to 2.91, \( p = 0.007 \)) times greater in Kentucky medical students than non-Kentucky USMS. The odds of willingness to report to duty if required by program, if asked but not required by program, and regardless of severity were 1.71 (OR = 1.71, \( p = 0.12 \)), 1.51 (OR = 1.51, \( p = 0.08 \)) and 1.95 (OR = 1.95, 95% CI 1.25 to 3.02, \( p = 0.003 \)) times greater in Kentucky medical students than non-Kentucky USMS, respectively. The odds of feeling socially isolated were 0.68 (OR = 0.68, \( p = 0.11 \)) times lower in Kentucky medical students than non-Kentucky USMS.

One participant commented that they did not feel prepared to work...
### Table 3
Perceived COVID-19-related risk scale (PCRS) results for 425 participants (353 medical students and 72 graduate students) in the United States, 2020.

| Personal Risk Item                                                                 | Strongly agree and agree, no. (%) | Kentucky medical students | Graduate students | P-value  |
|-----------------------------------------------------------------------------------|-----------------------------------|---------------------------|------------------|----------|
| 1. I believe that my program coursework puts me at great risk.                    | 28 (8.1%)                         | 16 (8.7%)                 | 1 (1.4%)         | 0.047**  |
| 2. I feel extra stress when doing program coursework                             | 165 (47.4%)                       | 87 (47.8%)                | 39 (54.2%)       | 0.36     |
| 3. I am afraid of falling ill with COVID-19.                                       | 123 (35.1%)                       | 56 (30.4%)                | 34 (47.9%)       | 0.009*   |
| 4. I feel I have little control over whether I will get infected or not.          | 122 (34.9%)                       | 62 (33.7%)                | 27 (38.0%)       | 0.52     |
| 5. I think I would be unlikely to survive if I were to get COVID-19.              | 7 (2.0%)                          | 1 (0.6%)                  | 6 (8.5%)         | 0.002**  |
| 6. I think about quitting school because of COVID-19                               | 8 (2.3%)                          | 3 (1.6%)                  | 4 (5.6%)         | 0.10     |
| 7. I am afraid I will pass COVID-19 on to others.                                  | 229 (65.1%)                       | 115 (62.2%)               | 41 (57.8%)       | 0.52     |
| 8. My family and friends are worried that they may get infected through me.      | 65 (18.6%)                        | 31 (16.9%)                | 7 (9.7%)         | 0.17     |
| 9. People avoid my family because of my program coursework.                      | 11 (3.2%)                         | 6 (3.3%)                  | 0 (0.0%)         | NA       |
| 10. I am confident in my department’s infection control measures.                 | 227 (65.8%)                       | 131 (72.4%)               | 39 (56.5%)       | 0.02*    |
| 11. If I were required by my program to report to duty, I would report.          | 307 (88.7%)                       | 167 (91.3%)               | 46 (66.7%)       | -0.001*  |
| 12. If I were asked, but not required, by my program to report to duty, I would report. | 243 (69.6%)     | 135 (73.8%)               | 38 (55.1%)       | 0.004*   |
| 13. I would be willing to report to duty regardless of severity.                   | 216 (62.4%)                       | 127 (69.8%)               | 19 (28.4%)       | -0.001*  |
| 14. I feel socially isolated because of COVID-19.                                  | 249 (70.7%)                       | 124 (67.0%)               | 56 (77.8%)       | 0.09     |

PCRS-9 score (Item 1–9)

| Mean (standard deviation) | P-value |
|---------------------------|---------|
| 2.1 (1.5)                 | 2.1 (1.5) | 2.2 (1.6) | 0.51 |

Abbreviations: USMS, United States medical students; NA, not applicable (graduate students—0).

Participants who chose “prefer not to answer” to a single item were excluded from analysis of that item. Only participants with completed responses to all nine original questions were included in the PCRS-9 cumulative score analysis.

**p < 0.05.

a : New questions that were not part of the original PCRS-9 scale.

b : Kentucky medical students and graduate students were compared using the Chi-square test and the Fisher’s exact test (if applicable).

c : Fisher’s exact.

d : Mann-Whitney U Test.

Because they were in pre-clinical years. The odds of willingness to report to duty if required by program, if asked but not required by program, and regardless of severity were 3.11 times higher (OR=3.11, 95% CI 1.27 to 7.66, p = 0.01), 0.88 times lower (OR=0.88, p = 0.60), and 0.76 times lower (OR=0.76, p = 0.24) in medical students in year 3 and beyond than medical students in year 1 or 2.

## 4. Discussion

Our study demonstrated that medical students on average experienced more stress after coursework suspension than before as measured by PSS-10. Their after-suspension average PSS-10 score was higher than healthcare workers’ during the SARS epidemic in 2003 [18.6 (Chua et al., 2004), normal range:12–14 (Cohen and Williamson, 1983)]. Based on the additional comments some participants offered at the end of our questionnaire, students’ major stressor was the negative impacts of COVID-19 on medical education, also seen in medical students’ report in other countries (Lyon et al., 2020). Some felt out of control about their exams, residency application and other plans they had made while others felt guilty that they were not in the hospital to help due to clinical suspension. Although coursework suspension largely reduced the risk of COVID-19 exposure at workplace, medical students faced inaction and could not contribute to the initial and most dire COVID-19 response. In comparison, medical students in other countries might have benefited psychologically from their meaningful involvement in the COVID-19 response team. Aebsicher et al. showed Swiss medical students voluntarily involved in the COVID-19 response had lower levels of anxiety, depression and burnout than non-involved peers and had similar physical health in terms of COVID-19 (Aebsicher et al., 2020). However, their high access to PPE might be a confounding factor in students’ choice to participate and their mental health. Access to PPE was a tremendous challenge for the US initially. Thus, it was unrealistic to involve non-essential medical students in the COVID-19 response as frontline workers in the US. However, as the pandemic continues, involving students as non-frontline workers using remote technology might be beneficial for students’ mental health as they could engage in this shared public health emergency and make meaningful contribution. This is reflected in the comments from medical student participants in Icahn School of Medicine at Mount Sinai’s COVID-19 student workforce (Bahethi et al., 2021).

Female gender and self-reported mental illness diagnosis remain two important risk factors of medical students’ stress levels, consistent with existing literature. Recent studies show that female gender is a risk factor for anxiety, depression and distress in medical students (Essangri et al., 2021; Halperin et al., 2021; Lyons et al., 2020; Pandey et al., 2021; Torun and Torun, 2020; Xiao et al., 2020) and that USMS with a previous existing mental illness diagnosis had higher stress and anxiety during the pandemic (Guo et al., 2021). In our study, 28.3% of medical students indicated they have a self-reported diagnosis of mental illness, consistent with national data -25% of students had probable depression (Goebert et al., 2009). The uncertainty and increased social isolation brought by the pandemic may worsen the existing psychological illness. Caucasian race and a background in public health were protective factors on medical students’ stress levels prior to program suspension. This protective effect disappeared after program suspension. One potential cause is the similar isolation from family, friends and faculty both minority and non-minority medical students experienced after program suspension, given that feeling of isolation was reported to negatively influence minority medical students’ life (Dyrbye et al., 2007). Students with a background in public health might have more knowledge about COVID-19 in the initial stage of COVID-19 pandemic that may play a
protective role in their mental health. Studies in Turkey and China showed the protective effect of familiarity with COVID-19 on students’ perceived stress levels (Torun and Torun, 2020; Ye et al., 2020).

In our study, medical students had lower levels of perceived COVID-19 risk than healthcare workers in the 2003 SARS epidemic (2.1 vs 3.7 (Wu et al., 2009)). This might be explained by the reduced exposure due to clinical suspension. During the COVID-19 pandemic, about 89%, 70% and 62% of medical students showed willingness to report to duty if required by program, if asked but not required by program, and regardless of severity in our study. These percentages are lower than what medical students previously reported in the event of a pandemic influenza from 2007 to 2008 (96%, 94%, and 88% respectively (Kaiser et al., 2009)). Potential barriers to report to duty include lack of access to PPE, inadequate knowledge and preclinical status. A study in the United Kingdom reported that medical students were more likely to work if they were well-informed and well-trained for PPE or if they were older (Georgiou et al., 2020). Kentucky medical students were more likely to be confident in their department’s infection control measures and report to duty than non-Kentucky medical students. This could be explained partly by the relatively low COVID-19 disease burden and relatively adequate PPE supply in Kentucky than other states. On May 14, 2020, Kentucky had a total of 7080 confirmed cases and was ranked number 33 in all 50 states and Washington, DC (number 1 was New York state; (CDC, 2020)).

Our study also compared Kentucky medical students with Kentucky graduate students. Graduate students had more stress than Kentucky medical students prior to coursework suspension. Kentucky medical students showed a similar level of perceived COVID-19 risk as graduate students, likely due to suspension of in-person activities both medical students and graduate students experienced. Although speculative, it is possible that the increased stress graduate students reported may be associated with less medical and public health training compared to Kentucky medical students.

There are several limitations in our study. Due to study design (survey distribution using social media), we could not provide an accurate response rate. This study asked participants to complete PSS-10 one month prior to and after program suspension, which introduced potential recall bias. Thirdly, selection bias was possible given that our medical student participants were predominantly female, Caucasian, and located in Kentucky. Nonresponse bias may also exist. Our respondents might be more altruistic and optimistic than non-respondents. These non-respondents could have higher levels of stress and perceived COVID-19 related risk.

In conclusion, our study assessed medical students’ overall perceived stress level and perceived COVID-19-related risk level during the early months of COVID-19 pandemic in the US in 2020. We identified risk factors associated with a higher perceived stress level (female gender and self-reported mental illness diagnosis), a protective factor associated with a lower perceived stress level (older age) and contingent factors associated with higher or lower stress levels (public health background and Caucasian status). Medical students reported a low perceived COVID-19-related risk level and most of them indicated confidence in department’s infection control measures and willingness to report to work. This study filled the literature gap of US medical student well-being during COVID-19 and shed light on vulnerable groups among medical students to psychological stress. One important implication on medical education is that while complete in-person coursework suspension protected students’ physical health, students’ mental wellbeing could potentially benefit from continued, virtual involvement with the national COVID-19 response. This study highlights the need to foster students’ public health preparedness and safely involve students in a public health emergency response via telehealth. Longitudinal research is needed to assess the evolving psychological state of medical students and soon-to-be junior residents, especially related to COVID fatigue.

Funding
This study received funding from the Department of Psychiatry in the University of Kentucky College of Medicine.

Ethical approval
This study was approved by the University of Kentucky’s Medical Institutional Review Board (exempt study originally approved on April 29, 2020, IRB number 59103).

No conflict of interest to report

Declaration of Competing Interest
YZ, JG, FHK and SH report no conflict of interest.

Acknowledgments
The authors would like to thank the University of Kentucky College of Medicine leadership and the University of Kentucky Graduate Student Congress leadership for support of this project. The authors wish to thank Ms. Virginia Lacefield, University of Kentucky Institutional Research, for her assistance in adapting the study questionnaire to online survey on Qualtrics.

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