


Impact of the Early Phase of the COVID-19 Pandemic on Medical Student Well-Being: a Multisite Survey



Maria L. Alkureishi, MD¹, Devika Jaishankar, BA², Shivam Dave, BS², Swetha Tatineni, BA², Mengqi Zhu, MS³, Katherine C. Chretien, MD⁴, James N. Woodruff, MD³, Amber Pincavage, MD³, and Wei Wei Lee, MD, MPH^{3,5}  for the Medical Student Well-being Being Research Consortium

¹Section of Academic Pediatrics, University of Chicago Medical Center, Chicago, IL, USA; ²Pritzker School of Medicine, University of Chicago, Chicago, IL, USA; ³Section of General Internal Medicine, University of Chicago Medical Center, Chicago, IL, USA; ⁴Division of Hospital Medicine, Department of Medicine, The Johns Hopkins University School of Medicine, Baltimore, USA; ⁵Department of Medicine, University of Chicago, 5841 S. Maryland Avenue MC 3051, Chicago, IL, USA.

BACKGROUND: The COVID-19 pandemic drastically impacted medical student experiences. Little is known about the impact of the pandemic on student well-being and protective factors for burnout.

OBJECTIVE: Assess US medical student burnout, stress, and loneliness during the initial phase of the pandemic, compare results to pre-pandemic data, and identify risk factors for distress and protective factors to inform support interventions.

DESIGN: Cross-sectional survey of medical students conducted between May and July 2020.

PARTICIPANTS: 3826 students from 22 medical schools.

MAIN MEASURES: Burnout (MBI-HSS), stress (PSS-10), loneliness (UCLA scale), and student experiences. Compared burnout and stress to pre-pandemic studies (2010–2020).

KEY RESULTS: Of 12,389 students, 3826 responded (31%). Compared to pre-pandemic studies, burnout was lower (50% vs. 52%, $P = 0.03$) while mean stress was higher (18.9 vs. 16.0, $P < 0.001$). Half (1609/3247) reported high ($\geq 6/9$) loneliness scores. Significant differences were found in burnout and stress by class year ($P = 0.002$ and $P < 0.001$) and race ($P = 0.004$ and $P < 0.001$), with the highest levels in second- and third-year students and Black, Asian, or other racial minority students. Students experiencing financial strain or racism had higher burnout and stress ($P < 0.001$ for all). Respondents with COVID-19 diagnoses in themselves or family members had higher stress ($P < 0.001$). Nearly half (1756/3569) volunteered during the pandemic, with volunteers reporting lower burnout [48% (782/1639) vs. 52% (853/1656), $P = 0.03$].

CONCLUSIONS: While stress was higher compared to pre-pandemic data, burnout was significantly lower. Higher burnout and stress among Black, Asian, and other racial minority students and those who experienced financial strain, racism, or COVID-19 diagnoses likely reflect underlying racial and socioeconomic inequalities

exacerbated by the pandemic and concurrent national racial injustice events. Volunteer engagement may be protective against burnout. Schools should proactively support vulnerable students during periods of stress.

KEY WORDS: medical student well-being; mental health; burnout; stress; COVID-19 pandemic; stress.

J Gen Intern Med 37(9):2156–64

DOI: 10.1007/s11606-022-07497-2

© The Author(s) under exclusive licence to Society of General Internal Medicine 2022

INTRODUCTION

The COVID-19 pandemic impacted all aspects of medical education in the United States (US).^{1,2} The Association of American Medical Colleges (AAMC) recommended suspending direct patient contact for students in March 2020, and many schools removed students from clinical rotations and transitioned to remote learning.^{3,4} As a result, students' academic and social connections with their learning communities and peers were drastically altered.

Studies early on in the pandemic found high rates of burnout, anxiety, and post-traumatic stress in nurses, residents, and physicians.^{5–7} While initial studies among US and international medical students described increased feelings of stress, anxiety, fear, and uncertainty during the pandemic, none have explored burnout, loneliness, or personal experiences of students from different demographic groups.^{8–12} As a natural experiment, student response to pandemic-related stressors may help schools better understand risk factors for distress, identify protective factors, and develop targeted programming to support students in the wake of the pandemic and during other times of stress. This is important since medical students experience higher baseline burnout, stress, depression, anxiety, and other mental distress than non-medical, age-matched peers, and few studies explore protective factors for burnout and distress during times of stress.^{13–19}

We aimed to conduct a national, cross-sectional survey of US medical students during the initial phase of the COVID-19

Previous presentations: Society of General Internal Medicine 2021 National Meeting, April 2021; The Council on Medical Student Education in Pediatrics National Meeting, April 2021; Pediatric Academic Societies 2021 National Meeting, May 2021

Received June 10, 2021

Accepted March 23, 2022

Published online June 16, 2022

pandemic between May and June 2020 to (1) assess burnout, stress, and loneliness prevalence; (2) compare burnout and stress results to baseline pre-pandemic data; and (3) identify risk factors for distress and potential protective factors to inform support interventions.

METHODS

Survey Development

Our survey assessed student demographic characteristics (e.g., age, gender, race/ethnicity, year in school), burnout, stress, loneliness, life experiences likely impacted by the pandemic (e.g., personal experiences with COVID-19 diagnoses, racism, financial strain), and pandemic volunteer activities. Survey questions exploring students' life experiences during the pandemic were developed after a literature review and discussion with wellness leaders at the 22 participating medical schools. Burnout and stress were measured using the most commonly utilized validated instruments in medical education literature [Maslach Burnout Inventory-Human Services Survey (MBI-HSS) and Perceived Stress Scale (PSS-10)].^{20–34} Loneliness was assessed with the University of California Los Angeles (UCLA) Loneliness Scale to assess social distancing impacts on loneliness as a contributor to student well-being. We piloted the survey with eight medical students from participating schools, and their feedback was incorporated. The final survey consisted of 87 items including Likert scale, multiple choice, and free response questions (Supplemental Digital Appendix 1). The institutional review board at the University of Chicago (IRB17-1095) and all participating schools approved the study.

Burnout

The MBI-HSS contains 22 items and three subscales: emotional exhaustion (EE) (score range 0–54), depersonalization (DP) (score range 0–30), and personal accomplishment (PA) (score range 0–48).^{20–22} Consistent with previous studies, those with high scores on the EE (≥ 27) and/or DP (≥ 10) subscales were considered to have burnout.^{23–25} Personal accomplishment scores of ≤ 33 were considered low.^{23–25}

Stress

The PSS-10 is rated on a 5-point scale, ranging from 0 (never) to 4 (very often). Total possible scores range from 0 to 40, with higher scores correlating with higher stress levels.³⁵

Loneliness

A validated, three-item version of the UCLA Loneliness Scale was included in the survey.³⁶ While this version has not been extensively studied in medical students, it is validated against the original 20-item instrument in the general US population.^{36,37} Each item is rated from 1 (hardly ever) to 3 (often),

for a total score of 3–9. Higher scores indicate greater loneliness, and ≥ 6 indicates high loneliness.³⁸

Comparison with Pre-pandemic Burnout and Stress in Medical Students

To assess whether the pandemic impacted burnout and stress, we conducted a PubMed search for studies published between January 2010 and January 2020 that assessed medical student burnout and stress. The search was limited to studies using the MBI-HSS or PSS-10 to allow for direct comparison of results. Non-English studies conducted outside the US or Canada were excluded.

Participants

In April 2020, two investigators (W.W.L., a student affairs dean, and M.A., a pediatric clerkship director) sent recruitment emails and reminders at weeks 2 and 3 to national electronic listservs for medical student well-being professionals, student affairs deans, and pediatric clerkship directors to invite Liaison Committee on Medical Education (LCME)-accredited schools to join our study. Of the 34 schools who responded, 22 obtained IRB and leadership approval to participate. A faculty leader was designated at each institution. School-related data (e.g., school size, type (public or private), and AAMC geographic region) was obtained through publicly available resources.^{39–46}

Survey Distribution

The survey was open for 4 weeks at each school between May and June 2020. Faculty site leaders emailed all enrolled students to participate and sent weekly reminders. Participation was voluntary, and the anonymous survey was administered using REDCap, a secure application for managing online surveys (v8.9.2 C 2019 Vanderbilt University) (Supplemental Appendix 1). Data was stored on REDCap and only accessible to University of Chicago. Participants were eligible to enter a raffle for one of ten \$50 gift cards if permissible by school policy.

Data Analysis

Standard descriptive statistics were used for analysis, and a two-sided significance level of 0.05 was set for all analyses. *T* tests, chi-square tests, one-way ANOVA, and unadjusted odds ratios examined associations between student experiences, burnout, stress, and loneliness with covariates such as class year, race, gender, AAMC region (e.g., Northeast), school type (public or private), and size. *T* tests and chi-square tests compared burnout rates and stress scores between pre-pandemic and pandemic study data. All analyses were performed in R 4.0.2.

RESULTS

Of 12,389 students, 3826 (31%) responded to the survey. While age, race, year in medical school, and geographic

location were representative of national medical school enrollment data, we had more female students in our study (62%, 2327/3762).^{41–45} Table 1 summarizes respondent characteristics.

Of 22 participating schools, 13 (59%) were public and 9 (41%) were private. Thirteen (59%) schools reported > 500 students enrolled and nine (41%) reported < 500 enrolled. Our sample was representative of enrollment and school-type data for all US medical schools.^{42,46} Most participating schools (8, 36%) were from the AAMC Northeast region, with 6 (27%) from the Southern region, 5 (23%) from the Central region, and 3 (14%) from the Western region. In comparison to the national distribution of AAMC schools, our study overrepresented the Northeast and underrepresented the Southern region.⁴¹

Table 1 Characteristics of 3762 US Medical Student Respondents to a Survey on Medical Student Well-Being During the COVID-19 Pandemic, 2020

Characteristics	N (%)
Medical school type	
Public	2136 (57%)
Private	1626 (43%)
AAMC region	
Northeast	1410 (37%)
Southern	903 (24%)
Central	880 (23%)
Western	569 (15%)
Gender	
Female	2327 (62%)
Male	1391 (37%)
Other	21 (1%)
Missing	23 (1%)
Age	
≤ 25	1896 (50%)
26–30	1612 (43%)
≥ 31	249 (7%)
Missing	5 (0.1%)
Race and ethnicity	
Hispanic	395 (11%)
Non-Hispanic	
White	2045 (54%)
Asian	812 (22%)
Black	236 (6%)
Other	263 (7%)
Missing	11 (0.3%)
Relationship status	
Single	2150 (57%)
Married/partnered	1567 (42%)
Missing	45 (1%)
Year in medical school	
M1	1039 (28%)
M2	843 (22%)
M3	955 (25%)
M4	735 (20%)
Other (year-off, PhD, masters, etc.)	190 (5%)
Path to medical school	
Traditional*	1197 (32%)
Non-traditional†	2565 (68%)
Volunteered during pandemic	
Yes	1756 (47%)
No	1813 (48%)
Missing	193 (5%)

*Traditional defined as students who matriculated into medical school directly after graduating from college

†Non-traditional defined as students who did not directly matriculate into medical school after graduating college (e.g., worked in another field prior to entering medical school)

Student Experiences

Thirty percent (1145/3756) of students reported financial strain during the pandemic. Seventeen percent (624/3756) reported family members being diagnosed with COVID-19, 4% (159/3756) had COVID-19 themselves, and 4% (147/3756) experienced a COVID-19–related death of a loved one. COVID-19–related racism or bias was reported by 8% (319/3756) of students. There were differences across race for students reporting personal experiences with COVID-19 (defined as COVID-19 diagnoses in themselves or a family member, or death of loved one from COVID-19), and those who reported racism due to COVID-19 and financial strain. More Black (35%, 83/234) and Hispanic (26%, 101/395) students had personal experiences with COVID-19 diagnoses, more Asian (26%, 209/811) and Black (14%, 32/234) students experienced COVID-19–related racism, and almost half of Hispanic (47%, 184/395) and Black (45%, 106/234) students experienced financial strain during the pandemic (Table 2). Compared to White students, Black students were more likely to have personal experiences with COVID-19 (OR 2.27, 95% CI 1.70–3.03), experience financial strain (OR 2.31, 95% CI 1.75–3.04), and experience COVID-19–related racism (OR 15.18, 95% CI 8.63–27.27). Compared to White students, Hispanic students were more likely to have personal experience with COVID-19 (OR 1.42, 95% CI 1.10–1.82), experience financial strain (OR 2.43, 95% CI 1.95–3.04), and experience COVID-19–related racism (OR 8.17, 95% CI 4.66–14.61). Compared to White students, Asian students were more likely to experience COVID-19–related racism (OR 33.17, 95% CI 21.49–53.96).

Burnout

Half (1635/3296) of students experienced burnout with 29% (948/3296) reporting high depersonalization, 40% (1324/3296) reporting high emotional exhaustion, and 42% (1389/3296) reporting low personal accomplishment. No significant difference was found by sex (52%, 623/1209 males vs. 48%, 987/2047 females, $P = 0.07$). There was a significant difference in burnout across year in school ($P = 0.002$) and race ($P = 0.004$), with higher burnout reported among second- (54%, 398/731) and third-year students (51%, 425/840) and those identifying as “other” (e.g., Native American, Pacific Islander, or “other”) racial minority (55%, 126/229), Asian (54%, 378/706), and Black (51%, 98/194).

Burnout prevalence was greater in students reporting financial strain [59% (580/989) vs. 46% (1055/2304), $P < 0.001$] and COVID-19–related racism [63% (168/266) vs. 48% (1467/3027), $P < 0.001$] during the pandemic compared to those without these experiences (Fig. 1). While there was no difference in burnout among students with personal COVID-19 experiences compared to those without these experiences [52% (342/655) vs. 49% (1293/2638), $P = 0.16$], students with personal COVID-19 experiences reported higher emotional exhaustion [44% (289/655) vs. 39% (1035/2639), $P = 0.02$].

Table 2 Experiences of US medical student respondents from a survey on medical student well-being during the COVID-19 pandemic, 2020

Experience	N (%)	OR (95% CI)
Personal experience with COVID-19*	762 (20%)	
Family member with COVID-19	624 (17%)	
Student diagnosed with COVID-19	159 (4%)	
Death of a loved one due to COVID-19	147 (4%)	
Race/ethnicity of students with personal experience with COVID-19*		
Black	83 (35%)	2.27 (1.70–3.03)
Hispanic	101 (26%)	1.42 (1.10–1.82)
Other	52 (20%)	1.02 (0.73–1.40)
White	398 (19%)	1
Asian	125 (15%)	0.75 (0.60–0.94)
Financial strain	1,145 (30%)	
Race/ethnicity of students experiencing financial strain		
Hispanic	184 (47%)	2.43 (1.95–3.04)
Black	106 (45%)	2.31 (1.75–3.04)
Other	95 (36%)	1.58 (1.20–2.07)
Asian	217 (27%)	1.02 (0.85–1.23)
White	539 (26%)	1
Racism/bias related to COVID-19	319 (8%)	
Race/ethnicity of students experiencing racism/bias related to COVID-19		
Asian	209 (26%)	33.17 (21.49–53.96)
Black	32 (14%)	15.18 (8.63–27.27)
Other	24 (9%)	9.65 (5.27–17.79)
Hispanic	31 (8%)	8.17 (4.66–14.61)
White	21 (1%)	1

*Defined as a COVID-19 diagnosis in either the student and/or a family member, and/or having a loved one die from COVID-19

Burnout was higher in private compared to public schools [52% (743/1433) vs. 48% (892/1862), $P = 0.03$]. No significant association was found between burnout and school region or size (Table 3).

Comparison of Burnout Prevalence to Pre-pandemic Data

Five pre-pandemic studies reporting MBI-HSS burnout prevalence in a total of 9493 medical students met inclusion criteria and were used in our analysis.^{15,17,26–28} Compared to pre-pandemic data, burnout in our study was significantly lower [52% (4918/9493) vs. 50% (1635/3296), respectively, $P = 0.03$] (Table 4).

Stress

The overall mean (SD) stress score was 18.9 (6.7, $n = 3250$), with significantly higher mean scores reported in female than male students [19.8 (6.6) vs. 17.4 (6.6), $P < 0.001$]. There was a significant difference across race ($P < 0.001$) and medical school year ($P < 0.001$), with higher mean stress scores among Blacks [20.2 (6.3)] and other racial minorities [20.4 (6.8)], and second- [20.2 (6.7)] or third-year students [19.2 (6.7)] (Table 3).

Mean stress scores were significantly higher among students reporting personal COVID-19 experiences [20.0 (6.8) vs. 18.7 (6.7), $P < 0.001$], COVID-19–related racism [21.0 (6.9) vs. 18.8 (6.7), $P < 0.001$], and financial strain [20.8 (6.6) vs. 18.2 (6.6), $P < 0.001$] during the pandemic compared to those without these experiences.

Mean stress scores were significantly higher in smaller schools (< 500 enrolled students) compared with larger

schools (≥ 500 enrolled students) [19.3 (6.6) vs. 18.7 (6.7), $P = 0.01$]. Southern [19.3 (7.0)] and Western [19.7 (6.6)] region students reported significantly higher mean stress scores ($P = 0.006$). There was no significant association between stress and school type.

Comparison of Mean Stress to Pre-pandemic Data

Four pre-pandemic studies reporting PSS-10 stress scores in a total of 425 medical students met inclusion criteria and were used for analysis.^{31–34} Students in our study reported higher mean stress scores compared to pre-pandemic data [18.9 (6.7) vs. 16.0 (6.2), $P < 0.001$] (Table 4).

Loneliness

Mean (SD) loneliness scores were 5.5 (1.9), and half of the students (1609/3247) reported high levels of loneliness ($\geq 6/9$). Females had significantly higher mean loneliness scores compared with males [5.6 (1.8) vs. 5.4 (1.8), $P = 0.009$]. Significant differences were found across medical school year ($P < 0.001$), with higher mean scores among first- [5.8 (1.8)] and second-year [5.5 (1.8)] students. No significant differences were found across race/ethnicity.

Mean loneliness scores were significantly higher among students reporting personal COVID-19 experiences [5.8 (1.9) vs. 5.5 (1.8), $P = 0.001$], COVID-19–related racism [5.9 (2.0) vs. 5.5 (1.8), $P = 0.002$], and financial strain [5.9 (1.9) vs. 5.4 (1.8), $P < 0.001$] during the pandemic compared to those without these experiences. Significant differences were found across AAMC regions ($P = 0.01$), with the highest mean loneliness scores in Western [5.8 (SD 1.9)] region students.

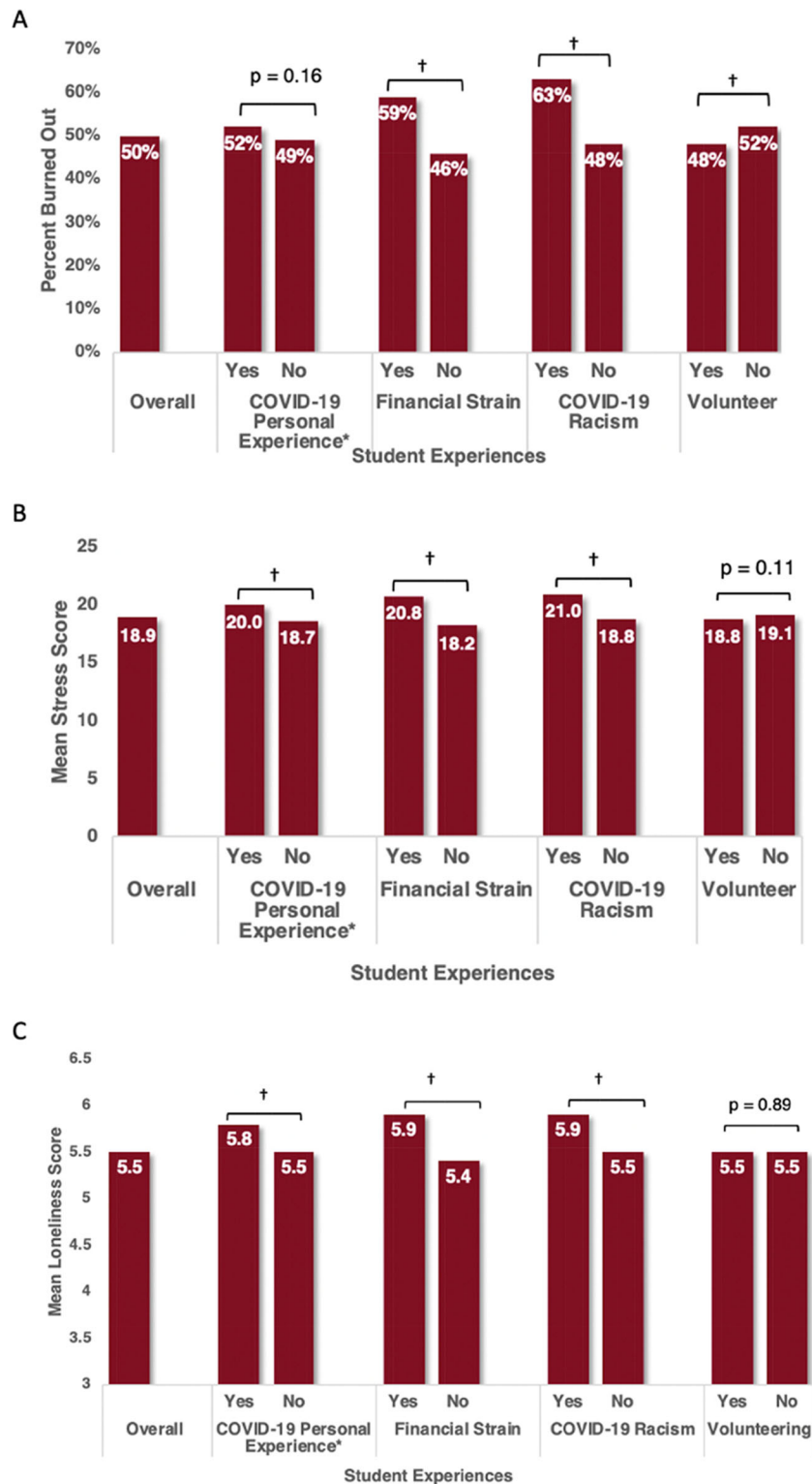


Figure 1 Burnout, stress, and loneliness among US medical student respondents with pandemic-related experiences. **A** Percentage of students who were burned out vs. student experiences ($N = 3296$). Burnout was assessed using the Maslach Burnout Inventory-Human Services Survey (MBI-HSS) which contains three subscales: emotional exhaustion (EE) (score range 0–54), depersonalization (DP) (score range 0–30), and personal accomplishment (PA) (score range 0–48).²⁰ Those with high scores on the EE (≥ 27) and/or DP (≥ 10) subscales were considered to have burnout. Overall percent of all 3296 students who were burned out is included for reference. **B** Mean stress score vs. student experiences ($N = 3250$). Stress was measured using the 10-item Perceived Stress Scale (PSS-10), which has been used to assess stress in medical students. Total possible scores range from 0 to 40, with higher scores indicating higher levels of stress. The overall mean stress score for all 3250 students is included for reference. **C** Mean loneliness score vs. student experiences ($N = 3247$). Loneliness was measured using the 3-item University of California Los Angeles Loneliness Scale. Scores range from 3 to 9, with higher scores indicating greater loneliness. The overall mean loneliness score for all 3247 students is included for reference. * COVID-19 diagnosis in either the student or a family member, or having a loved one die from COVID-19. † $P < 0.05$.

Table 3 Burnout, stress, and loneliness in US medical student respondents from a survey on medical student well-being during the COVID-19 pandemic, 2020

Characteristics	Burnout scale* No. (%), N = 3296	Perceived stress scale† Mean (SD), N = 3250	Loneliness scale‡ Mean (SD), N = 3247
Overall score	1635 (50%)	18.9 (6.7)	5.5 (1.9)
Sex	P = 0.07	P < 0.001	P = 0.009
Female	987 (48%)	19.8 (6.6)	5.6 (1.8)
Male	623 (52%)	17.4 (6.6)	5.4 (1.8)
Race/ethnicity	P = 0.004	P < 0.001	P = 0.41
Other§	126 (55%)	20.4 (6.8)	5.7 (1.8)
Asian	378 (54%)	19.6 (6.5)	5.6 (1.9)
Black	98 (51%)	20.2 (6.3)	5.6 (2.1)
White	885 (49%)	18.5 (6.8)	5.5 (1.8)
Hispanic	147 (42%)	18.5 (6.5)	5.4 (1.8)
Year in medical school	P = 0.002	P < 0.001	P < 0.001
M1	422 (46%)	18.3 (6.6)	5.8 (1.8)
M2	398 (54%)	20.2 (6.7)	5.5 (1.8)
M3	425 (51%)	19.2 (6.7)	5.4 (1.9)
M4	299 (47%)	17.8 (6.8)	5.3 (1.8)
School size	P = 0.86	P = 0.01	P = 0.34
< 500 enrolled students	580 (50%)	19.3 (6.6)	5.6 (1.9)
≥ 500 enrolled students	1055 (49%)	18.7 (6.7)	5.5 (1.8)
School type	P = 0.03	P = 0.73	P = 0.28
Public	892 (48%)	18.9 (6.7)	5.6 (1.9)
Private	743 (52%)	19.0 (6.7)	5.5 (1.8)
AAMC region	P = 0.16	P = 0.006	P = 0.01
Western	258 (53%)	19.7 (6.6)	5.8 (1.9)
Central	412 (52%)	18.6 (6.9)	5.6 (1.8)
Northeast	603 (48%)	18.6 (6.5)	5.4 (1.8)
Southern	362 (48%)	19.3 (7.0)	5.5 (1.9)

*Burnout was assessed using the 22-item MBI-HSS scale, which contains three subscales: emotional exhaustion (EE) (score range 0–54), depersonalization (DP) (score range 0–30), and personal accomplishment (PA) (score range 0–48).²⁰ Burnout on the MBI-HSS scale is indicated by a score of 27 or higher on the emotional exhaustion subscale and/or a score of 10 or higher on the depersonalization subscale

†Stress was measured using the PSS-10 scale; scores ranged from 0 to 40, with higher scores indicating greater stress

‡Loneliness was measured using the 3-item UCLA Loneliness Scale; scores range from 3 to 9, with higher scores indicating greater loneliness

§Other includes students who identified as multiracial, American Indian/Alaska Native/Native Hawaiian, or “other”

There were no significant associations between loneliness and school size or type (Table 4).

volunteer students for stress [18.8 (6.5) vs. 19.1 (6.9), $P = 0.11$] and loneliness [5.5 (1.8) vs. 5.5 (1.9), $P = 0.89$].

Volunteer Activities

Those who volunteered during the pandemic were less likely to report burnout [48% (782/1639) vs. 52% (853/1656), $P = 0.03$], high EE [38% (616/1640) vs. 43% (708/1656), $P = 0.003$], and low PA [37% (606/1639) vs. 47% (783/1657), $P < 0.001$] than those who did not volunteer. No significant differences were found between pandemic volunteer and non-

DISCUSSION

This is the first study to assess how the pandemic affected burnout and loneliness among US medical students and to describe differential impacts across demographic and student experiences (e.g., race/ethnicity, class year, financial strain, racism, etc.). Stress levels among medical students were

Table 4 Burnout and stress among us medical student respondents: comparison of student respondents to a well-being survey during COVID-19 Pandemic (2020) to Pre-pandemic burnout and stress studies

	Current survey data/N	Pre-pandemic data/N	P value
MBI-HSS sample size	3296	9493	
No. burned out (%)	1635 (50%)	4918 (52%)	$P = 0.03$
High depersonalization (DP score ≥ 10)	948 (29%)	n/a	
High emotional exhaustion (EE score ≥ 27)	1324 (40%)	n/a	
Low personal accomplishment (PA score ≤ 33)	1389 (42%)	n/a	
PSS-10† sample size	3250	425	
Mean PSS (stress) score (SD)	18.9 (6.7)	16.0 (6.2)	$P < 0.001$

We conducted a literature search on prior studies from 2010 to 2020 that measured medical student burnout^{15,17,26–28} and stress^{31–34}. Studies were excluded if they were not published in English, did not use the MBI-HSS or PSS-10 scales to assess burnout and stress, or were not conducted in US or Canadian medical schools

*Burnout was assessed using the 22-item MBI-HSS scale. Burnout on the MBI-HSS scale is indicated by a score of 27 or higher on the emotional exhaustion subscale and/or a score of 10 or higher on the depersonalization subscale

†PSS-10 total possible scores range from 0 to 40, with higher PSS scores correlating with higher perceived levels of stress

higher compared to pre-pandemic data, and stress levels were higher in medical students during the pandemic compared with the general population.⁴⁷ Our results were also concordant with other studies that found higher levels of medical student stress during the pandemic compared to baseline.^{31–34}

We are the first study to report burnout rates among US medical students during the pandemic, and our finding of lower burnout suggests that higher stress may not necessarily lead to higher burnout, which differs from pre-pandemic studies.^{48–51} Decreased burnout may be related to removal of students from clinical responsibilities, transition to flexible curricular policies (e.g., pass-fail grading) at some schools, and increased time for self-care. Unsurprisingly, loneliness was high, with findings comparable to those in the general young adult US population during the same period.⁵²

Our results highlight the inequities of the pandemic, which disproportionately impacted stress and burnout among Black and other racial minority students, and those experiencing financial strain or COVID-19–related racism.³⁸ Second- and third-year students also experienced high levels of burnout and stress, which may be related to testing center closures for the United States Medical Licensing Examination Step 1 exams and clerkship students' concerns about disruptions to their clinical training and career planning.^{1,5} Additionally, first- and second-year students had higher levels of loneliness, which could be related to isolation due to remote learning. Strikingly, Black and Hispanic students experienced markedly higher rates of financial strain and COVID-19 diagnoses in themselves or loved ones, and Asian students experienced the highest rates of pandemic-related racism. Together, these findings reinforce the need for *proactive* and *tailored* support for students during times of distress. For example, moving forward, schools should proactively support students with financial stressors, which is often a hidden identity and one heavily impacted by the pandemic. Additionally, in light of national events centered on racially motivated violence, schools should initiate targeted support for vulnerable student groups, with specific attention to understanding Black and Asian student experiences when developing anti-racism initiatives.

Medical students volunteered in large numbers and in a variety of roles, such as helping to secure masks, staffing call centers, and conducting contact tracing.⁵³ Students who volunteered had lower burnout and emotional exhaustion, and greater levels of personal accomplishment compared to non-volunteers. While volunteers may be a self-selected group of students with lower baseline burnout, prior studies suggest volunteering may promote feelings of purpose, value, personal achievement, and empathy, which may contribute to the lower burnout among volunteers in our study.^{54–57} Similarly, a recent survey of US healthcare workers conducted in the same time period as our study found that feeling valued was associated with lower burnout and enhanced meaning and purpose.⁵⁸ At a time when students were pulled from clinical duties, volunteering may have been an adaptive coping mechanism that helped them feel more accomplished and connected

to their communities which may have contributed to lower burnout.

Additionally, some students may have experienced professional growth and heightened motivation as a direct consequence of the stressful and disorienting effects of the pandemic. Such development is consistent with the concept of transformative learning where disorienting experiences prompt critical reflection and favorably change an individual's perspective of themselves and their place in the world.⁵⁹ Post-traumatic growth documented in Japanese medical students after the Fukushima nuclear disaster is an example of this possible effect.^{54,56} These findings suggest further research is needed to identify specific personal attributes, support systems, and protective factors that promote growth and resilience, as opposed to burnout, as trainees face the inherent challenges of medical training and practice.

Our study has several limitations. While we report on experiences from a large group of diverse students around the country, we had a low overall response rate. The survey was administered between May and June of 2020 which may have limited fourth-year participation due to graduation. In addition, concurrent national stressors of racial injustice following George Floyd's death and the polarized presidential election may have influenced responses. We did not assess timelines for the implementation of pandemic-related curricular changes (e.g., transition to virtual learning) at each school and were unable to assess whether specific curricular changes impacted student well-being. Lastly, students who were more distressed may not have participated, resulting in non-response bias, and our study represented a snapshot in time in the early phase of the pandemic. Longitudinal data is needed to assess ongoing impacts on student well-being and identify areas for ongoing support.

As the pandemic continues to evolve, medical schools should acknowledge the high levels of stress and burnout in their students and proactively support vulnerable students. This is particularly important since studies after the 2003 SARS outbreak found stress and burnout can persist long term among healthcare workers.^{5,60} Understanding and addressing sustained impacts of COVID-19–related distress on the well-being of trainees and physicians are critical to the development of a healthy healthcare workforce in the years ahead. Recognizing both drivers and protective factors for burnout and stress can inform programming that supports trainees through the rigors of medical training. Our data suggests that program leadership should promote initiatives to foster community and connectedness. Educational programs may also consider augmenting volunteer opportunities to promote engagement and professional fulfillment to help protect against burnout. In addition, institutional wellness and professional development programs should proactively support vulnerable trainees and develop tailored interventions for specific stressors. Given our finding that higher levels of stress do not necessarily correlate with higher burnout, medical educators should design interventions to help trainees develop adaptive coping skills in the

face of stress, uncertainty, and loss to promote growth from stressful experiences.

Acknowledgements: The authors wish to thank all students who completed the survey and the Medical Student Well-Being Research Consortium members:

Patti T. Anderson, MPH PhD
 Nicholas Barbari, MD
 Claudia Boucher-Berry, MD
 Jennifer Caceres, MD
 Nathaly S. Desmarais, PsyD MEd
 YuAn Fang
 Megan Fiorillo
 Lauren J. Germain, PhD, MEd
 Elizabeth Goodman, MD
 Kama Gulama, MD
 Maxwell Hart, MD
 Melissa Held, MD
 Haneme Idrizi, MD
 Lori Kim
 Allison Knight, MD
 Jody Lack, MD
 Michelle Lizotte-Waniewski, PhD
 Allyson McDermott, MD
 Myo Thuwin Myint, MD
 Kaushal B. Nanavati, MD
 Maria Noel
 Michelle Noelck, MD
 Natalie Pellittier
 Adam E. Perrin, MD
 Kim Pham, ND
 Deborah Rana, MD
 Padmini Ranasinghe, MD
 Rohan Rao
 Mary Rzeszut, MSW, LCSW
 Steven Shelov, MD
 Samantha A. Vergan, MD
 Sarah K. Wood

Corresponding Author: Wei Wei Lee, MD, MPH; Department of Medicine, University of Chicago, 5841 S. Maryland Avenue MC 3051, Chicago, IL 60637, USA (e-mail: wlee6@uchicago.edu).

Funding This work was supported by the University of Chicago Bucksbaum Institute for Clinical Excellence.

Declarations:

Ethics Approval: This study has been approved by the University of Chicago Institutional Review Board and the respective IRBs of participating schools.

Other Disclosures: None

Disclaimers: None

Conflict of Interest: Authors have no conflict of interests to disclose.

REFERENCES

1. Kaul V, Gallo de Moraes A, Khateeb D, et al. Medical education during the COVID-19 pandemic. *Chest*. Published online December 2020:S0012369220355148.
2. Miller DG, Pierson L, Doernberg S. The role of medical students during the COVID-19 pandemic. *Ann Intern Med*. 2020;173(2):145-146.
3. Menon A, Klein EJ, Kollars K, Kleinhenz ALW. Medical students are not essential workers: examining institutional responsibility during the COVID-19 pandemic. *Academic Medicine*. 2020;95(8):1149-1151.
4. Whelan A, Prescott J, Young G, Catanese VM. Guidance on medical students' clinical participation: effective immediately. Association of

- American Medical Colleges. Updated March 17, 2020; Accessed May 1, 2021. <https://lcme.org/wp-content/uploads/filebase/March-17-2020-Guidance-on-Medical-Students-Clinical-Participation.pdf>
5. Collins et al. Stress and the surgical resident in the COVID-19 pandemic
6. Chen, et al. A large-scale survey on trauma, burnout, and posttraumatic growth among nurses during the COVID-19 pandemic
7. Morgantini LA, Naha U, Wang H, et al. Factors contributing to healthcare professional burnout during the COVID-19 pandemic: a rapid turnaround global survey. *PLOS ONE*. 2020;15(9):e0238217.
8. Guo AA, Crum MA, Fowler LA. Assessing the psychological impacts of covid-19 in undergraduate medical students. *International Journal of Environmental Research and Public Health*. 2021;18(6):2952. <https://doi.org/10.3390/ijerph18062952>
9. Lee CM, Juarez M, Rae G, et al. Anxiety, PTSD, and stressors in medical students during the initial peak of the COVID-19 pandemic. *PLOS ONE*. 2021;16(7). 10.1371/journal.pone.0255013
10. O'Byrne L, Gavin B, Adamis D, Lim YX, McNicholas F. Levels of stress in medical students due to covid-19. *Journal of Medical Ethics*. 2021;47(6):383-388. <https://doi.org/10.1136/medethics-2020-107155>
11. Aebischer O, Weilenmann S, Gachoud D, Man M, Spiller T. Physical and psychological health of medical students involved in the CORONAVIRUS disease 2019 response in Switzerland. *Swiss Medical Weekly*. 2020. <https://doi.org/10.4414/sm.w.2020.20418>
12. Gallagher TH and Schleyer AM. We signed up for this!" -student and trainee responses to the Covid-19 pandemic. *N Engl J Med* 2020; 382:e96
13. Brazeau CMLR, Shanafelt T, Durning SJ, et al. Distress among matriculating medical students relative to the general population. *Acad Med*. 2014;89(11):1520-1525.
14. Dyrbye LN, West CP, Satele D, et al. Burnout among U.S. medical students, residents, and early career physicians relative to the general U.S. population. *Acad Med*. 2014;89(3):443-451.
15. Dyrbye LN, Massie FS, Eacker A, et al. Relationship between burnout and professional conduct and attitudes among US medical students. *JAMA*. 2010;304(11):1173-1180.
16. Dyrbye LN, Moutier C, Durning SJ, et al. The problems program directors inherit: medical student distress at the time of graduation. *Med Teach*. 2011;33(9):756-758.
17. Dyrbye LN, Thomas MR, Massie FS, et al. Burnout and suicidal ideation among U.S. medical students. *Annals of Internal Medicine*. 2008;149(5):334-341.
18. Houpy JC, Lee WW, Woodruff JN, Pincavage AT. Medical student resilience and stressful clinical events during clinical training. *Med Educ Online*. 2017;22(1).
19. Rotenstein LS, Ramos MA, Torre M, et al. Prevalence of depression, depressive symptoms, and suicidal ideation among medical students: a systematic review and meta-analysis. *JAMA*. 2016;316(21):2214-2236. <https://doi.org/10.1001/jama.2016.17324>
20. Maslach C, Jackson SE, Leiter MP. *Maslach Burnout Inventory Manual*. 1996.3rd ed. Palo Alto, CA: Consulting Psychologists Press.
21. Schaufeli WB, Bakker AB, Hoogduin K, Schaa C, Kladler A. On the clinical validity of the Maslach burnout inventory and the burnout measure. *Psychol Health*. 2001;16(5):565-582.
22. Dyrbye LN, West CP, Shanafelt TD. Defining burnout as a dichotomous variable. *J Gen Intern Med*. 2009;24(3):440.
23. Shanafelt TD, Boone S, Tan L, et al. Burnout and satisfaction with work-life balance among US physicians relative to the general US population. *Arch Intern Med*. 2012;172(18):1377-1385. <https://doi.org/10.1001/archinternmed.2012.3199>
24. Thomas NK. Resident burnout. *JAMA*. 2004;292(23):2880. <https://doi.org/10.1001/jama.292.23.2880>
25. Dyrbye LN, Thomas MR, Power DV, et al. Burnout and serious thoughts of dropping out of medical school: a multi-institutional study. *Academic Medicine*. 2010;85(1):94-102. 10.1097/acm.0b013e3181c46aad [added as new reference # X]
26. Thompson G, McBride RB, Hosford CC, Halaas G. Resilience among medical students: the role of coping style and social support. *Teach Learn Med*. 2016;28(2):174-182.
27. Enoch L, Chibnall JT, Schindler DL, Slavin SJ. Association of medical student burnout with residency specialty choice. *Med Educ*. 2013;47(2):173-181.
28. Dyrbye LN, Satele D, Shanafelt TD. Healthy exercise habits are associated with lower risk of burnout and higher quality of life among U.S. medical students. *Acad Med*. 2017;92(7):1006-1011.
29. Caulfield M, Andolsek K, Grbic D, Roskovensky L. Ambiguity tolerance of students matriculating to U.S. medical schools. *Academic Medicine*.

- 2014;89(11):1526-1532. <https://doi.org/10.1097/acm.0000000000000485>
30. McKerrow I, Carney PA, Caretta-Weyer H, Furnari M, Juve AM. Trends in medical students' stress, physical, and emotional health throughout training. *Medical Education Online*. 2020;25(1):1709278.
 31. Levant B, Villwock JA, Manzardo AM. Impostorism in American medical students during early clinical training: gender differences and intercorrelating factors. *Int J Med Educ*. 2020;11:90-96.
 32. Erogul M, Singer G, McIntyre T, Stefanov DG. Abridged Mindfulness intervention to support wellness in first-year medical students. *Teaching and Learning in Medicine*. 2014;26(4):350-356.
 33. Thompson G, Wrath A, Trinder K, Adams GC. The roles of attachment and resilience in perceived stress in medical students. *Can Med Educ J*. 2018;9(4):e69-e77.
 34. Yorks DM, Frothingham CA, Schuenke MD. Effects of group fitness classes on stress and quality of life of medical students. *J Am Osteopath Assoc*. 2017;117(11):e17-e25.
 35. Cohen S, Kamarck T, Mermelstein R. A global measure of perceived stress. *J Health Soc Behav*. 1983;24(4):385-396.
 36. Hughes ME, Waite LJ, Hawkey LC, Cacioppo JT. A short scale for measuring loneliness in large surveys. *Res Aging*. 2004;26(6):655-672.
 37. Phelan SM, Burgess DJ, Puhl R, et al. The adverse effect of weight stigma on the well-being of medical students with overweight or obesity: findings from a national survey. *J Gen Intern Med*. 2015;30(9):1251-1258.
 38. Steptoe A, Shankar A, Demakakos P, Wardle J. Social isolation, loneliness, and all-cause mortality in older men and women. *Proceedings of the National Academy of Sciences*. 2013;110(15):5797-5801. <https://doi.org/10.1073/pnas.1219686110>
 39. Accredited U.S. Programs | LCME. <http://lcme.org/directory/accredited-u-s-programs/>.
 40. The Organizational Characteristics Database (OCD) - data and analysis - AAMC. Accessed May 1, 2021. <https://www.aamc.org/data/ocd/>.
 41. Regional Membership by State - Regions - Group on Student Affairs (GSA) - Member Center - AAMC. Accessed May 1, 2021. <https://www.aamc.org/members/gsa/regions/309964/regionalmembershipbystate.html>.
 42. Table B-1: Total Enrollment by U.S. Medical School and Sex - Enrollment, Graduates, and MD/PhD Data - Facts: Applicants, Matriculants, Enrollment, Graduates, MD/PhD, and Residency Applicants Data - Data and Analysis - AAMC. Accessed May 1, 2021. <https://www.aamc.org/data/facts/enrollmentgraduate/158808/total-enrollment-by-medical-school-by-sex.html>.
 43. AAMC Organization Directory Search Result. Accessed May 1, 2021. <https://members.aamc.org/eweb/DynamicPage.aspx?webcode=AAMCOrgSearchResult&orgtype=Medical%20School>.
 44. Total U.S. Medical School Enrollment by Race/Ethnicity (Alone) and Sex, 2016-2017 through 2020-2021. Updated November 3, 2020. Accessed May 1, 2021. https://www.aamc.org/system/files/2020-11/2020_FACTS_Table_B-3.pdf
 45. Age of Applicants to U.S. Medical Schools at Anticipated Matriculation by Sex and Race/Ethnicity, 2014-2015 through 2017-2018. Updated 11/30/2017. Accessed May 1, 2021. <https://www.aamc.org/system/files/d/1/321468-factstablea6.pdf>
 46. AAMC Medical School Admission Requirements, 2020-2021. Accessed May 1, 2021. <https://apps.aamc.org/msar-ui/#/landing>
 47. Gamonal-Limcaoco S, Montero-Mateos E, Lozano-López MT, et al. Perceived stress indifferent countries at the beginning of the coronavirus pandemic. *The International Journal of Psychiatry in Medicine*. July 2021. Epub ahead of print. <https://doi.org/10.1177%2F00912174211033710>
 48. Lin, Y.K., Lin, CD., Lin, B.Y.J. et al. Medical students' resilience: a protective role on stress and quality of life in clerkship. *BMC Med Educ* 19, 473 (2019).
 49. Dyrbe LN, Power DV, Massie FD et al. Factors associated with resilience to and recovery from burnout: a prospective, multi-institutional study of US medical students. *Medical Education* 2010; 44: 1016-1026
 50. Liselotte N. Dyrbye, William Harper, Steven J. Durning, Christine Moutier, Matthew R. Thomas, F. Stanford Massie Jr, Anne Eacker, David V. Power, Daniel W. Szydlo, Jeff A. Sloan & Tait D. Shanafelt (2011) Patterns of distress in US medical students, *Medical Teacher*, 33:10, 834-839
 51. Santen SA, Holt DB, Kemp JD, Hemphill RR. Burnout in medical students: examining the prevalence and associated factors. *Southern Medical Journal*. 2010 Aug;103(8):758-763.
 52. Liu CH, Zhang E, Wong GTF, Hyun S, Hahm H "Chris." Factors associated with depression, anxiety, and PTSD symptomatology during the COVID-19 pandemic: clinical implications for U.S. young adult mental health. *Psychiatry Res*. June 2020
 53. Rose S. Medical student education in the time of COVID-19. *JAMA*. 2020;323(21):2131.
 54. Kaye-Kauderer HP, Levine J, Takeguchi Y, et al. Post-traumatic growth and resilience among medical students after the March 2011 disaster in Fukushima, Japan. *Psychiatr Q*. 2019;90(3):507-518.
 55. Yeo CJJ, Román GC, Kusnerik D, et al. Trainee responses to hurricane harvey: correlating volunteerism with burnout. *Front Public Health*. 2018;6.
 56. Taku K, Prioleau PG, Anderson DS, et al. Medical student reactions to disaster after the 2011 Great East Japan Earthquake: Motivation and Posttraumatic Growth. *Psychiatr Q*. 2018;89(4):1007-1018.
 57. Deci EL, Vallerand RJ, Pelletier LG, Ryan RM. Motivation and education: the self-determination perspective. *Educational psychologist*. 1991 Jun 1;26(3-4):325-46.
 58. Prasad K, McLoughlin C, Stillman M, et al. Prevalence and correlates of stress and burnout among U.S. healthcare workers during the COVID-19 pandemic: a national cross-sectional survey study. *EClinicalMedicine*. 2021;35:100879.
 59. Cranton P. Understanding and promoting transformative learning: a guide to theory and practice. Stylus Publishing, LLC; 2016 Jun 13.
 60. McAlonan GM, Lee AM, Cheung V, et al. Immediate and sustained psychological impact of an emerging infectious disease outbreak on health care workers. *Can J Psychiatry*. 2007;52(4):241-247.

Publisher's Note: Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.