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Impact of exposure to patients with COVID-19 on residents and fellows: an international survey of 1420 trainees

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ABSTRACT

Objectives To determine how self-reported level of exposure to patients with novel coronavirus 2019 (COVID-19) affected the perceived safety, training and well-being of residents and fellows.

Methods We administered an anonymous, voluntary, web-based survey to a convenience sample of trainees worldwide. The survey was distributed by email and social media posts from April 20th to May 11th, 2020.

Respondents were asked to estimate the number of patients with COVID-19 they cared for in March and April 2020 (0, 1–30, 31–60, >60). Survey questions addressed (1) safety and access to personal protective equipment (PPE), (2) training and professional development and (3) well-being and burnout.

Results Surveys were completed by 1420 trainees (73% residents, 27% fellows), most commonly from the USA (n=670), China (n=150), Saudi Arabia (n=76) and Taiwan (n=75). Trainees who cared for a greater number of patients with COVID-19 were more likely to report limited access to PPE and COVID-19 testing and more likely to test positive for COVID-19. Compared with trainees who did not take care of patients with COVID-19, those who took care of 1–30 patients (adjusted OR [AOR] 1.80, 95% CI 1.29 to 2.51), 31–60 patients (AOR 3.30, 95% CI 1.86 to 5.88) and >60 patients (AOR 4.03, 95% CI 2.12 to 7.63) were increasingly more likely to report burnout. Trainees were very concerned about the negative effects on training opportunities and professional development irrespective of the number of patients with COVID-19 they cared for.

Conclusion Exposure to patients with COVID-19 is significantly associated with higher burnout rates in physician trainees.

patients with COVID-19 and adapting their medical practice to protect themselves and their patients from contracting the virus. These cumulative stressors can have mental health implications with higher rates of anxiety, depression, insomnia and distress in healthcare workers during this pandemic.^{3 4}

Physicians in graduate medical education programmes, such as residency and fellowship programmes in the United States, are a particularly vulnerable population and have been uniquely affected by changes to their healthcare practice during the COVID-19 pandemic.⁵ Physician trainees serve a vital role in the physician workforce, and their long hours and frontline care may place them at risk of infection, especially if personal protective equipment (PPE) is not universally available. Additionally, the COVID-19 pandemic has affected training in many programmes due to changing workforce needs and social distancing guidelines. These necessary changes can have profound effects on the professional development of physician trainees and may have future implications on the preparedness of this cohort for practice in their specialty.⁶ The physician trainee population already has high rates of burnout at baseline.^{7–11} The stress related to being essential healthcare providers during a pandemic combined with the loss of educational opportunities may have implications for trainee well-being and further exacerbate feelings of burnout.

We aimed to elicit the experiences of physician trainees internationally during March and April 2020 through an anonymous, web-based, self-reported survey. This time period corresponded to the worldwide peak in COVID-19 cases and mortality.¹² The survey aimed to describe the impact the number of patients with COVID-19 that trainees cared for on three domains of trainee experience: (1) safety and access to PPE, (2) training and professional development and (3) well-being and burnout.

METHODS

Study design

We administered a single, web-based survey available in English to a convenience sample of physician trainees internationally. Physician trainees are defined in our study as those who have completed medical school and are engaging in educational opportunities

INTRODUCTION

The severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) began spreading through the Wuhan region of China in December 2019¹ and was declared a global pandemic by the WHO on March 11th, 2020.² The illness that SARS-CoV-2 causes is referred to as the novel coronavirus 2019 (COVID-19). As SARS-CoV-2 spread worldwide, healthcare providers have been asked to rise to the challenge of both treating increasing numbers of



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to prepare them for eventual independent practice in their specialty. The survey was voluntary, anonymous, included no personal identifiers or protected health information, and used no incentives for participation. The study was approved and considered exempt by the Institutional Review Board at the University of Washington prior to dissemination. The survey included 58 questions using Likert scales, single and multiple answer and free response answers (online supplemental materials A). All questions were optional, and respondents could stop taking the survey at any time.

The survey was hosted online using the REDCap® platform. All surveys were completed between April 20th to May 11th, 2020. Respondents were asked to describe their experiences during the months of March and April 2020. This time period was chosen such that it closely followed the peak in COVID-19-related deaths in China (late February),¹³ Europe (April 6th) and the USA (April 15th).¹² This period was chosen to ensure that the experiences reported by physician trainees were recent relative to the peak impact of the COVID-19 pandemic.

We sought to encourage physicians in medical training programmes worldwide to complete the survey. In the survey and recruitment materials, physician training programmes were referred to as ‘residencies’ and ‘fellowships’ per the US paradigm, which is also used in many other countries (eg, Saudi Arabia, Iran). ‘Residencies’ are programs for physician training immediately following graduation from medical school and are typically specialty specific (internal medicine, paediatrics, surgery, etc.), and ‘fellowships’ are programmes for additional training after residency in a surgical or medical subspecialty. Survey respondents self-identified as being either residents (or ‘foundation doctors’) versus fellows (or ‘specialty registrars’) in the first question of the survey.

Survey dissemination

In order to encourage broad participation from a diverse group of trainees within a limited period of time, we employed an opportunistic sampling strategy using a range of dissemination methods. We identified 16 co-investigators from institutions around the world who were tasked with disseminating the survey to trainees in their country, region, or state (for US states). Survey dissemination was conducted via emails to residency/fellowship programme directors and colleagues and personal/professional contacts of the co-investigators. We used the social media platforms Twitter and Facebook to disseminate the survey, to identify co-investigators interested in participating in the study, and to encourage physicians with many followers who are active on Twitter to retweet our post of the survey. The posts were sharable to facilitate snowball sampling. As a result of the dissemination efforts used and the lack of any personal identifiers on the survey, it is not possible to know the ‘denominator’ of eligible medical trainees that could have participated or how each respondent learnt about the survey.

Self-reported exposure to patients with COVID-19

The survey (online supplemental material A) asked respondents to estimate the number of patients with COVID-19 that they provided care for in March and April 2020, categorised as 0, 1–30, 31–60, >60. This was our study’s primary exposure of interest. In making these categories, we considered the typical burden of exposure for trainees in low, high and moderate COVID-19 burden regions during March/April 2020, as well as the number of patients a trainee could feasibly estimate caring for.

Domains of trainee experience evaluated by the survey

Survey questions explored the trainee experience during this time period in the following domains:

- a. Safety and access to PPE
Survey questions addressed access to PPE and testing for SARS-CoV-2 and whether the respondent or anyone in their training programme tested positive for the virus. Questions regarding trainees’ perception of their own safety and concerns about contracting and transmitting COVID-19 inside and outside their training locations were also included.
- b. Training, professional development and scope of work
The survey included questions about specific changes to training schedules related to COVID-19 and trainee attitudes regarding schedule changes, the volume of patient encounters and procedures, the transition to telehealth and the perceived impact of using telehealth on both patient care and physician training, and changes to didactic learning.
- c. Well-being and burnout
The survey included two validated single-item measures of emotional exhaustion and depersonalisation.¹¹ Respondents indicated on a Likert scale how often they identified with statements that reflect emotional exhaustion (‘I feel burned out by my work’) and depersonalisation (‘I have become a more callous person since I started this job’). These two statements have been shown to perform similarly to longer burnout scales such as the Maslach Burnout Inventory, and have been widely used in the assessment of physician burnout.^{7 8} We defined physician burnout as in previous studies^{8 11} in trainees who responded to either the statement ‘I feel burned out by my work’ or the statement ‘I have become a more callous person since I started this job’ with a rate of ‘at least weekly’.

The survey also collected key demographic, geographic and residency/fellowship information, without identifying the institutions or medical centres that the training programme operated in. We included questions about demographic information at the end of the survey recognising that some respondents might choose not to answer questions about their personal information.

Statistical analysis

Descriptive statistics were performed and we used the χ^2 test (2-tailed $p < 0.05$ considered statistically significant) to determine whether there was an association between self-reported number of patients with COVID-19 cared for (categorised as above) and the responses regarding safety and access to PPE, training and professional development, and well-being and burnout. Based on a sample size of 1420 respondents, our study had 80% power (alpha 0.05, two-sided) to detect a difference as small as 0.12 between the categories of patients with COVID-19 cared for, in the proportion of respondents who reported each outcome, using the Cochran–Armitage test.

We evaluated the association between exposure to patients with COVID-19 and physician burnout as well as independent predictors of physician burnout using multivariable logistic regression models that included 11 potential predictors of burnout that were selected a priori. We chose physician burnout as the outcome to investigate in greater detail because of the great importance and high prevalence of burnout among trainees and because our questionnaire included a validated measure of burnout.

All analyses were performed with StataMP version 15 (StataCorp) statistical software.

RESULTS

Characteristics of residents and fellows who completed the survey

The survey was completed by 1420 medical trainees (1031 residents and 280 fellows) (table 1). The majority of the residents were

Table 1 Characteristics of 1420 residents and fellows who completed an online COVID-19-related survey

Characteristic (n, %)	Overall	Number of patients with COVID-19-positive the trainee provided care for during March and April 2020 (N=1420)				P value
		0 N=636	1–30 N=529	31–60 N=130	>60 N=125	
Trainee status						<0.001
Resident	1101 (78)	478 (75)	401 (76)	111 (85)	111 (89)	
Fellow	319 (23)	158 (11)	128 (24)	19 (15)	14 (11)	
Residency specialty						<0.001
Total	1301	478	401	111	111	
Internal medicine	436 (40.0)	97 (20.3)	198 (49)	64 (58)	77 (69)	
Family medicine	141 (13)	94 (20)	33 (8.2)	10 (9.0)	4 (3.6)	
Surgery (all subspecialties)	130 (12)	71 (15)	35 (8.7)	16 (14)	8 (7.2)	
Paediatrics	67 (6.1)	50 (11)	15 (3.7)	2 (1.8)	0 (0.0)	
Emergency medicine	53 (4.8)	15 (3.1)	25 (6.2)	6 (5.4)	7 (6.3)	
Obstetrics and gynaecology	45 (4.1)	21 (4.4)	24 (6.0)	0 (0.0)	0 (0.0)	
Anaesthesia	22 (2.0)	8 (1.7)	12 (3.0)	1 (0.9)	1 (0.9)	
Other residencies	205 (19)	120 (25)	59 (14.7)	12 (11)	14 (13)	
Missing	2 (0.20)	2 (0.40)	0 (0.0)	0 (0.0)	0 (0.0)	
Fellowship specialty						<0.001
Total	280	158	128	19	14	
Gastroenterology/hepatology	85 (27)	38 (24)	41 (32)	5 (26)	1 (7.1)	
Other internal medicine subspecialties†	53 (17)	27 (17)	20 (16)	5 (26)	1 (7.1)	
Cardiology	22 (6.9)	6 (3.8)	13 (10.2)	2 (11)	1 (7.1)	
Surgery subspecialties	18 (5.6)	12 (7.6)	3 (2.3)	2 (11)	1 (7.1)	
Pulmonary/critical care	18 (5.6)	4 (2.5)	12 (9.4)	1 (5.3)	1 (7.1)	
ID	16 (5.0)	2 (1.3)	8 (6.3)	2 (11)	4 (29)	
Other fellowships	65 (20.4)	35 (22)	26 (20.3)	0 (0.0)	4 (29)	
Missing	42 (13)	34 (22)	5 (3.9)	2 (11)	1 (7.1)	
Country						<0.001
USA	670 (47)	206 (32)	328 (62)	72 (55)	64 (51)	
China	150 (11)	120 (19)	16 (3.0)	5 (3.8)	9 (7.2)	
Saudi Arabia	76 (5.4)	41 (6.4)	23 (4.3)	7 (5.4)	5 (4.0)	
Taiwan	75 (5.3)	65 (10.2)	9 (1.7)	0 (0.0)	1 (0.8)	
Other countries	53 (3.7)	13 (2.0)	25 (4.7)	9 (6.9)	6 (4.8)	
Missing	396 (28)	191 (30)	128 (24)	37 (29)	40 (32)	
US states by COVID-19 burden†						<0.001
Total	670	206	328	72	64	
High	188 (25)	28 (10.0)	73 (22)	38 (57)	49 (77)	
Moderate	305 (41)	99 (35)	175 (53)	21 (31)	10 (16)	
Low	251 (34)	153 (55)	85 (26)	8 (12)	5 (7.8)	
Gender*						0.7
Male	511 (45)	208 (43)	212 (48)	49 (46)	42 (43)	
Female	607 (54)	269 (56)	226 (51)	56 (53)	56 (57)	
Other	7 (0.60)	4 (0.80)	2 (0.50)	1 (0.90)	0 (0.0)	
Age						<0.001
≤25	77 (6.9)	57 (12)	13 (3.0)	4 (3.8)	3 (3.1)	
26–30	664 (59)	286 (60)	246 (56)	67 (63)	65 (67)	
31–35	318 (28)	111 (23)	150 (34)	32 (30.2)	25 (26)	
36–40	46 (4.1)	18 (3.8)	23 (5.3)	3 (2.8)	2 (2.1)	
>40	14 (1.3)	7 (1.5)	5 (1.1)	0 (0.0)	2 (2.1)	
Race*						<0.001
White	518 (46)	170 (36)	240 (55)	54 (52)	54 (55)	
Black/African American	29 (2.6)	14 (2.9)	10 (2.3)	3 (2.9)	2 (2.0)	
Asian/Pacific Islander	412 (37)	232 (48)	123 (28)	30 (29)	27 (28)	
American Indian/Native Hawaiian	8 (0.7)	3 (0.60)	4 (0.9)	0 (0.0)	1 (1.0)	
Other	151 (14)	60 (13)	60 (14)	17 (17)	14 (14)	

Continued

Table 1 Continued

Characteristic (n, %)	Overall	Number of patients with COVID-19-positive the trainee provided care for during March and April 2020 (N=1420)				P value
		0 N=636	1–30 N=529	31–60 N=130	>60 N=125	
Ethnicity*						0.12
Hispanic	89 (8.1)	45 (9.7)	27 (6.3)	6 (5.8)	11 (12)	
Non-Hispanic	1004 (92)	419 (90.3)	404 (94)	97 (94)	84 (88)	
Marital status*						<0.01
Single	405 (36)	195 (41)	139 (32)	33 (31)	38 (39)	
Married	418 (37)	174 (36)	182 (41)	35 (33)	27 (28)	
Unmarried, in a relationship	292 (26)	105 (22)	118 (27)	37 (35)	32 (33)	
Other	7 (0.6)	6 (1.3)	1 (0.20)	0 (0.0)	0 (0.0)	
Pregnancy status*						0.27
Yes (self or partner)	95 (8.5)	46 (9.7)	31 (7.0)	7 (6.6)	11 (12)	
No	1018 (92)	428 (90.3)	409 (93)	99 (93)	82 (88)	
Parental status*						0.06
Yes	165 (15)	70 (15)	76 (17)	8 (7.6)	11 (11)	
No	958 (85)	409 (85)	366 (83)	97 (92)	86 (89)	

*About 20% (300/1420) of respondents chose not to complete the demographic questions. We presented the demographic characteristics among those who responded (ie, without a 'missing' category) for ease of interpretation.

†Internal medicine subspecialties included endocrinology, geriatrics, haematology/oncology, nephrology, palliative care and hospice medicine and rheumatology.

‡Burden of COVID-19 in a US state is defined by COVID-19-related mortality in each state as of 5/19/20¹⁴ categorised as low (<100 deaths/million), moderate (100–800 deaths/million) and high (>800 deaths/million).

training in internal medicine programmes (40%, 436/1031), followed by family medicine (13%, 141/1031) and general surgery and surgical subspecialties (12%, 130/1031). Most of the fellows who responded to the survey were training in gastroenterology/hepatology (27%, 85/280) followed by cardiology (6.9%, 22/280) or other subspecialties (17%, 53/280). Respondents originated from 20 countries and US respondents originated from 36 states. Approximately, 20% (300/1420) of respondents chose not to respond to the demographic questions at the end of the survey. Among respondents who provided answers, 54% (607/1125) were female, 54% (600/1118) were non-white, 37% (418/1122) were married and 15% (165/1123) had children.

Characteristics of residents and fellows by estimated number of patients they cared for with COVID-19

The subgroups by number of patients with COVID-19 a trainee cared for during March and April 2020 were similar in terms of gender, ethnicity, marital status, parental status and pregnancy status (table 1). There were statistically significant differences between subgroups for characteristics such as age, race, residency or fellowship specialty, country of practice, and the burden of COVID-19 in US state of practice.

Impact of caring for patients with COVID-19 on trainee safety and access to PPE

As the number of patients with COVID-19 that a trainee cared for increased (from 0, to 1–30, 31–60 and >60), they were increasingly likely to report limited access to PPE and COVID-19 testing, to test positive for COVID-19 or have a colleague in their training programme who tested positive, and to express concern about contracting COVID-19 or transmitting it to friends and family (table 2, figure 1A). Among trainees who reported taking care of >60 COVID-19 positive patients, only 35% (44/125) reported always having access to PPE and COVID-19 testing, while 76% (95/125) reported that someone in their programme tested positive for COVID-19. Of the trainees with the greatest exposure to patients with COVID-19, 34% (43/125) reported

feeling extremely concerned about contracting COVID-19 and 47% (59/125) reported extreme concern about spreading the virus to their friends and family. In comparison, trainees who did not care for any patients with COVID-19 reported extreme concern about contracting COVID-19 and spreading it to friends and family at rates of 18% (254/636) and 34% (479/636) respectively ($p < 0.001$).

Impact of caring for patients with COVID-19 on training and professional development

As the number of patients with COVID-19 a trainee cared for increased, so did the likelihood of reporting working more hours due to the change in their schedule. Of trainees who cared for >60 patients with COVID-19, 73% (74/102) reported working more hours, while of trainees who did not care for any patients with COVID-19, 56% (214/337) reported working fewer hours (table 3, figure 1B).

More than half of trainees indicated some degree of concern about the effect of the COVID-19 pandemic on their future preparedness for independent practice (59%, 835/1420). Trainees who cared for >60 patients with COVID-19 compared with those who did not care for any patients with COVID-19 reported similar levels of concern about their preparedness for independent practice (56%, 372/636 vs 58%, 71/125, respectively, p value 0.57) (figure 1B). Trainees who cared for a greater number of patients with COVID-19 compared with those who did not care for any patients with COVID-19 were also similarly likely to agree that the pandemic affected their progress towards their career goals (20%, 282/636 vs 25%, 32/125, p value 0.75; table 3, figure 1B).

Impact of caring for patients with COVID-19 on trainee well-being and burnout

A total of 1148 respondents provided answers to the questions on burnout. As trainees cared for a higher number of patients with COVID-19, they were more likely to report symptoms of burnout on both emotional exhaustion and depersonalisation

Table 2 Impact of COVID-19 on medical trainees' safety and access to PPE

N (%)	Overall N=1420	Number of COVID-19-positive patients the trainee provided care for in March and April 2020				P value*
		0 N=636	1–30 N=529	31–60 N=130	>60 N=125	
Were you provided with appropriate personal protective equipment (PPE) when you cared for patients with or suspected to have COVID-19?						
Always	774 (55)	360 (57)	323 (61)	47 (36)	44 (35)	<0.001
Most of the time	368 (26)	129 (20)	132 (25)	57 (44)	38 (30)	
Sometimes	135 (9.5)	42 (6.6)	52 (9.8)	16 (12)	25 (20)	
Rarely	41 (2.9)	18 (2.8)	14 (2.7)	7 (5.4)	2 (1.6)	
Never	54 (3.8)	45 (7)	4 (0.76)	1 (0.77)	4 (3.2)	
Missing	48 (3.4)	42 (6.6)	4 (0.76)	2 (1.5)	0 (0.0)	
Were you provided with adequate access to testing for COVID-19 if you had symptoms or had been exposed?						
Always	751 (53)	372 (58)	288 (54)	47 (36)	44 (35)	<0.001
Most of the time	256 (18)	89 (14)	106 (20)	27 (21)	34 (27)	
Sometimes	184 (13)	51 (8.0)	75 (14)	30 (23)	28 (22)	
Rarely	70 (4.9)	21 (3.3)	26 (4.9)	14 (11)	9 (7.2)	
Never	98 (6.9)	54 (8.5)	26 (4.9)	10 (7.7)	8 (6.4)	
Missing	61 (4.3)	49 (7.7)	8 (1.5)	2 (1.5)	2 (1.6)	
Have you or any colleagues in your residency or fellowship training programme tested positive for SARS-CoV2 (the virus that causes COVID-19)?						
Yes, I have tested positive	69 (4.9)	28 (4.4)	18 (3.4)	10 (7.7)	13 (10)	<0.01
Yes, colleagues have tested positive	539 (38)	112 (18)	245 (46)	87 (67)	95 (76)	<0.001
No, neither myself nor my colleagues have tested positive	605 (43)	370 (58)	199 (38)	24 (18)	12 (9.6)	<0.001
I don't know	217 (15)	117 (18)	75 (14)	13 (10)	12 (9.6)	0.01
How concerned were you about contracting COVID-19 while at work or while fulfilling requirements of your training programme?						
Not at all concerned	88 (6.2)	61 (9.6)	18 (3.4)	5 (3.9)	4 (3.2)	<0.001
Somewhat concerned	277 (20)	139 (22)	108 (20)	17 (13)	13 (10)	
Slightly concerned	262 (18)	126 (20)	93 (18)	21 (16)	22 (18)	
Moderately concerned	427 (30)	148 (23)	195 (37)	48 (37)	36 (29)	
Extremely concerned	254 (18)	102 (16)	78 (15)	31 (24)	43 (34)	
Missing	112 (7.9)	60 (9.4)	37 (7.0)	8 (6.2)	7 (5.6)	
How concerned were you about spreading COVID-19 to your friends or family outside of the hospital?						
Not at all concerned	133 (9.4)	83 (13)	39 (7.4)	7 (5.4)	4 (3.2)	<0.001
Somewhat concerned	169 (12)	89 (14)	55 (10)	13 (10)	12 (9.6)	
Slightly concerned	214 (15)	98 (15)	82 (16)	16 (12)	18 (14)	
Moderately concerned	312 (22)	130 (20)	128 (24)	29 (22)	25 (20)	
Extremely concerned	479 (34)	176 (28)	187 (35)	57 (44)	59 (47)	
Missing	113 (8.0)	60 (9.4)	38 (7.2)	8 (6.2)	7 (5.6)	
Would you like to have been more involved in the care of patients confirmed to have COVID-19						
No	774 (55)	331 (52)	288 (54)	80 (61)	75 (60)	0.33
Yes	528 (37)	245 (39)	202 (38)	41 (32)	40 (32)	
Missing	118 (8.3)	60 (9.4)	39 (7.4)	9 (6.9)	10 (8.0)	

*P value considered significant if <0.05.

questions: 66% (78/125) of trainees who cared for >60 patients with COVID-19 reported burnout, compared with 39% (207/636) of trainees who cared for no patients with COVID-19 ($p < 0.001$, [figure 1C](#), [table 3](#)).

In a multivariable logistic regression model that simultaneously adjusted for 11 trainee characteristics listed in [table 4](#) that may be potential predictors of burnout, the most important independent predictor was the number of patients with COVID-19 that a trainee cared for. Compared with trainees who did not take care of patients with COVID-19, those who took care of 1–30 patients (adjusted OR (AOR) 1.80, 95% CI 1.29 to 2.51), 31–60 patients (AOR 3.30, 95% CI 1.86 to 5.88) and >60 patients (AOR 4.03, 95% CI 2.12 to 7.63) were increasingly more likely to report burnout. Access to adequate PPE 'Most of the time'

(AOR 1.99, 95% CI 1.41 to 2.80) or 'Sometimes' (AOR 2.81, 95% CI 1.60 to 4.91) was significantly associated with burnout when compared with 'Always'; however, this association did not extend to those who responded 'Rarely' (AOR 1.02, 95% CI 0.43 to 2.41) or 'Never' (1.02, 95% CI 0.47 to 2.21). Other independent predictors of reporting burnout were country of origin and having colleagues test positive for COVID-19 ([table 4](#)).

DISCUSSION

This international survey of 1420 residents and fellows revealed that during the peak of the COVID-19 pandemic, those trainees with greater exposure to patients with COVID-19 reported greater limitations in access to PPE and COVID-19 testing, higher levels of concern about their safety and that of their friends and

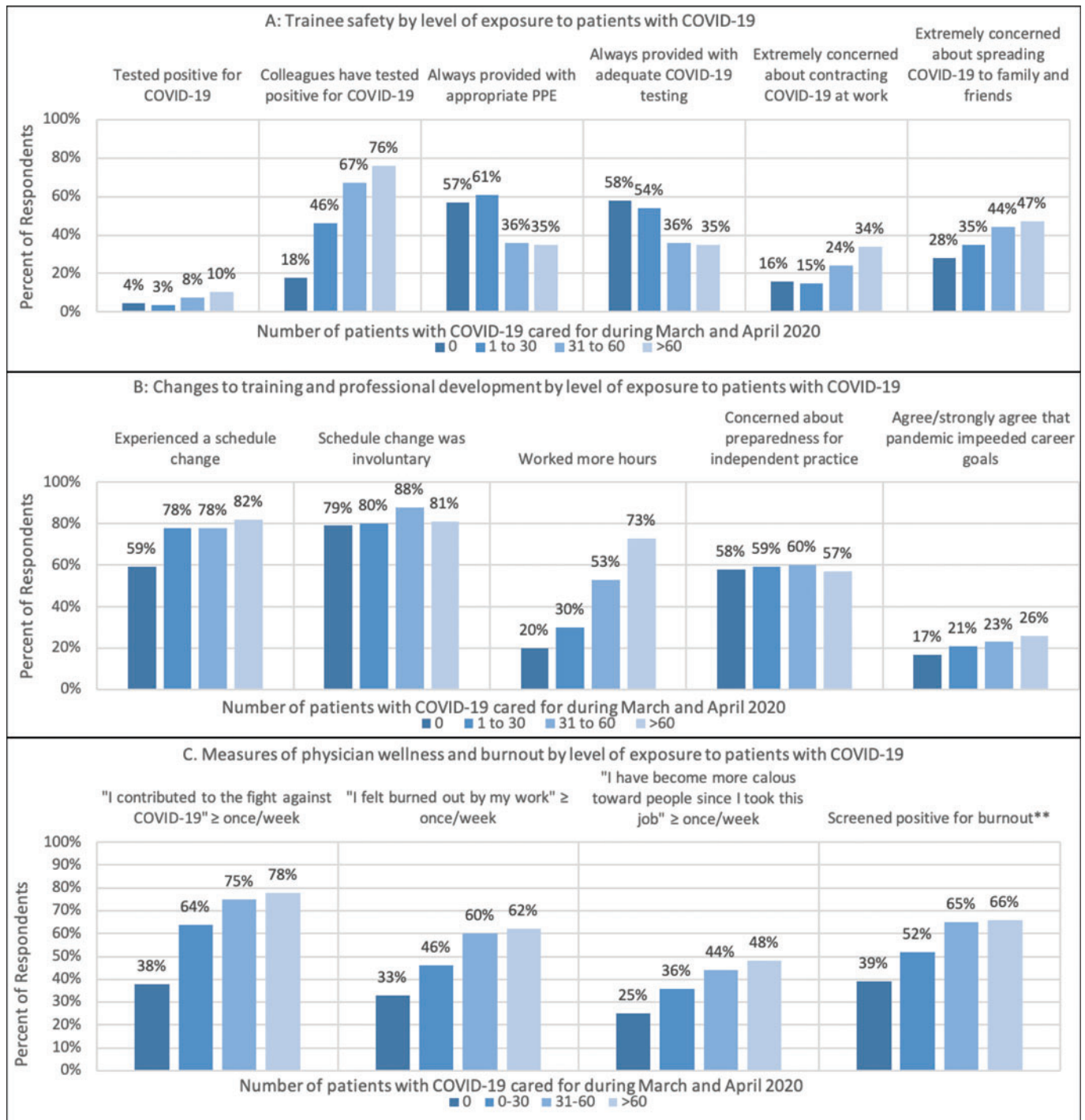


Figure 1 Association between the number of patients with COVID-19 that a trainee cared for during March and April 2020 and self-reported outcomes regarding safety, professional development and physician burnout.

family, and significantly higher rates of burnout. In contrast, concerns about the negative effects of COVID-19 on training and professional development were high irrespective of the level of exposure to patients with COVID-19.

Impact of caring for patients with COVID-19 on trainee safety and access to PPE

Trainees who cared for a higher number of patients with COVID-19 were more likely to report limited access to PPE and COVID-19 testing. This may reflect equipment shortages in healthcare settings with a high burden of patients with COVID-19. As access

to PPE and COVID-19 testing is important in limiting the transmission of COVID-19^{15 16} limitations in these safety measures may have contributed to the higher prevalence of reported cases of COVID-19 among respondents and their colleagues who cared for greater than 30 patients with COVID-19. Survey respondents with greater exposure to patients with COVID-19 were also significantly more likely to report concern about spreading COVID-19 to patients as well as to their friends and family. This concern may reflect a lack of confidence in the safety measures in place to keep trainees safe while caring for patients with COVID-19.

Table 3 Impact of COVID-19 on medical trainees' training schedule, professional development and burnout

N (%)	Overall N=1420	Number of patients with COVID-19-positive the trainee provided care for during March and April 2020				P value*
		0 N=636	1–30 N=529	31–60 N=130	>60 N=125	
Did your schedule change?						
Yes	995 (70)	377 (59)	414 (78)	102 (78)	102 (82)	<0.001
No	278 (20)	185 (29)	68 (13)	16 (12)	9 (7.2)	
Missing	147 (10)	74 (12)	47 (8.9)	12 (9.2)	14 (11)	
Was this schedule change voluntary?						
Total	995	377	414	102	102	0.38
Yes	193 (19)	80 (21)	82 (20)	12 (12)	19 (19)	
No	800 (80)	296 (79)	331 (80)	90 (88)	83 (81)	
Missing	2 (0.20)	1 (0.27)	1 (0.24)	0	0	
Did you work more or fewer hours due to this change?						
Total	995	377	414	102	102	<0.001
Significantly more	157 (16)	30 (8.0)	52 (13)	25 (25)	50 (49)	
Slightly more	170 (17)	45 (12)	72 (17)	29 (28)	24 (24)	
The same	217 (22)	87 (23)	91 (22)	21 (21)	18 (18)	
Slightly less	254 (26)	96 (25)	129 (31)	22 (22)	7 (6.9)	
Significantly less	196 (20)	118 (31)	70 (17)	5 (4.9)	3 (2.9)	
Missing	1 (0.10)	1 (0.27)	0	0	0	
Are you concerned that the COVID pandemic adversely affected your preparedness to practice in your field after residency or fellowship?						
Not at all concerned	358 (25)	144 (23)	148 (28)	34 (26)	32 (26)	0.57
Somewhat concerned	347 (24)	151 (24)	145 (27)	25 (19)	26 (21)	
Slightly concerned	264 (19)	126 (20)	94 (18)	25 (19)	19 (15)	
Moderately concerned	141 (9.9)	59 (9.3)	52 (9.8)	15 (12)	15 (12)	
Extremely concerned	83 (5.9)	36 (5.7)	23 (4.4)	13 (10)	11 (8.8)	
Missing	227 (16)	120 (19)	67 (13)	18 (14)	22 (18)	
The COVID-19 pandemic has impeded my progress towards my career goals						
Strongly agree	71 (5.0)	24 (3.8)	25 (4.7)	13 (10)	9 (7.2)	0.75
Agree	211 (15)	86 (14)	85 (16)	17 (13)	23 (18)	
Neutral	311 (22)	131 (21)	112 (21)	40 (31)	28 (22)	
Disagree	332 (24)	154 (24)	129 (24)	22 (17)	27 (22)	
Strongly disagree	252 (18)	112 (18)	106 (20)	19 (15)	15 (12)	
Missing	243 (17)	129 (20)	72 (14)	19 (15)	23 (18)	
I felt I contributed to the fight against COVID-19						
Never	87 (6.1)	70 (11)	13 (2.5)	3 (2.3)	1 (0.80)	<0.001
Once a month or less	110 (7.8)	80 (13)	25 (4.7)	2 (1.5)	3 (2.4)	
A few times a month	172 (12)	96 (15)	71 (13)	4 (3.1)	1 (0.80)	
Once a week	200 (14)	96 (15)	78 (15)	13 (10)	13 (10)	
A few times a week	283 (20)	89 (14)	146 (28)	26 (20)	22 (18)	
Everyday	294 (21)	61 (9.6)	112 (21)	59 (45)	62 (50)	
Missing	274 (19)	144 (23)	84 (16)	23 (18)	23 (18)	
I felt burned out from my work						
Never	141 (9.9)	88 (13)	44 (8.3)	4 (3)	5 (4.0)	<0.001
Once a month or less	205 (14)	116 (18)	70 (13)	11 (8.5)	8 (6.4)	
A few times a month	190 (13)	78 (12)	86 (16)	15 (12)	11 (8.8)	
Once a week	235 (17)	94 (15)	102 (19)	21 (16)	18 (14)	
A few times a week	221 (16)	65 (10)	91 (17)	33 (25)	32 (26)	
Everyday	152 (11)	48 (7.6)	52 (9.8)	24 (18)	28 (22)	
Missing	276 (19)	147 (23)	84 (16)	22 (17)	23 (18)	
I have become more callous towards people since I took this job						
Never	260 (18)	145 (23)	83 (16)	17 (13)	15 (12)	<0.001
Once a month or less	228 (16)	101 (16)	95 (18)	15 (12)	17 (14)	
A few times a month	194 (14)	90 (14)	77 (15)	18 (14)	9 (7.2)	
Once a week	206 (15)	78 (12)	89 (17)	21 (16)	18 (14)	

Continued

Table 3 Continued

N (%)	Overall N=1420	Number of patients with COVID-19-positive the trainee provided care for during March and April 2020				P value*
		0 N=636	1–30 N=529	31–60 N=130	>60 N=125	
A few times a week	165 (12)	48 (7.6)	67 (13)	26 (20)	24 (19)	
Everyday	90 (6.3)	30 (4.7)	32 (6.1)	10 (7.7)	18 (14)	
Missing	277 (20)	144 (23)	86 (16)	23 (18)	24 (11)	
Scoring on physician burnout metric†						
Positive	695 (48.9)	250 (39.3)	277 (52.4)	85 (65.4)	83 (66.4)	<0.001
Negative	453 (31.9)	243 (38.2)	168 (31.8)	23 (17.7)	19 (15.2)	
Missing	272 (19.2)	143 (22.5)	84 (15.9)	22 (16.9)	23 (18.4)	

*P value considered significant if <0.05.

†Scoring positive for burnout defined as identifying with the statements 'I felt burned out from my work' or 'I have become more callous towards people since I took this job' with at least once/week.

Table 4 Predictors of medical trainee self-reported burnout during the COVID-19 pandemic*

Characteristic	N	Burnout N (%)	Crude OR	Adjusted† OR	Adjusted† OR for increasing category
Number of patients with COVID-19 the trainee cared for in March–April 2020					
0	410	204 (48)	1	1	1.67 (1.38–2.02)
1–30	390	236 (61)	1.55 (1.16–2.04)	1.80 (1.29–2.51)	
31–60	92	71 (77)	3.41 (2.02–5.77)	3.30 (1.86–5.88)	
>60	84	69 (82)	4.65 (2.57–8.39)	4.03 (2.12–7.63)	
PPE available					
Always	570	294 (52)	1	1	1.44 (0.95–2.20)
Most of the time	249	177 (71)	2.31 (1.68–3.18)	1.99 (1.41–2.80)	
Sometimes	94	74 (79)	3.47 (2.06–5.85)	2.81 (1.60–4.91)	
Rarely	27	16 (59)	1.37 (0.62–2.99)	1.02 (0.43–2.41)	
Never	36	19 (53)	1.05 (0.53–2.06)	1.02 (0.47–2.21)	
COVID-19 positive: colleague					
No	572	300 (52)	1	1	
Yes	404	280 (59)	2.05 (1.57–2.68)	1.73 (1.26–2.37)	
COVID-19 positive: self					
No	929	545 (59)	1	1	
Yes	47	35 (74)	2.06 (1.05–4.01)	1.59 (0.78–3.24)	
Schedule changed					
No	200	111 (56)	1	1	
Yes	776	469 (60)	1.22 (0.89–1.68)	1.21 (0.84–1.73)	
Country					
USA & Canada	652	369 (57)	1	1	
China	138	84 (61)	1.19 (0.82–1.74)	1.86 (1.08–3.19)	
Saudi Arabia	71	54 (76)	2.44 (1.38–4.29)	3.45 (1.87–6.37)	
Taiwan	74	44 (59)	1.12 (0.69–1.84)	2.68 (1.51–4.78)	
Other countries	41	29 (71)	1.85 (0.93–3.67)	1.53 (0.73–3.22)	
Trainee level					
Resident	754	460 (61)	1	1	
Fellow	222	120 (59)	0.75 (0.56–1.02)	0.82 (0.57–1.18)	
Gender					
Female	545	331 (61)	1	1	
Male	426	246 (58)	0.88 (0.68–1.14)	0.84 (0.63–1.11)	
Other‡	5	3 (60)	0.97 (0.16–5.85)	0.56 (0.07–4.34)	
Age					
≤25	71	47 (66)	1	1	1.08 (0.72–1.81)
26–30	582	344 (59)	0.74 (0.44–1.24)	0.70 (0.39–1.28)	
31–35	272	159 (58)	0.72 (0.42–1.24)	0.94 (0.47–1.87)	
36–40	37	24 (65)	0.94 (0.41–2.17)	1.35 (0.51–3.54)	

Continued

Table 4 Continued

Characteristic	N	Burnout N (%)	Crude OR	Adjusted† OR	Adjusted† OR for increasing category
>40	14	6 (43)	0.38 (0.11–1.23)	0.49 (1.81)	
Marital status					
Married	353	193 (55)	1	1	
Single	353	210 (59)	1.22 (0.90–1.64)	1.17 (0.81–1.69)	
In relationship	264	173 (66)	1.58 (1.13–2.19)	1.57 (1.06–2.33)	
Other‡	6	4 (67)	1.66 (0.30–9.17)	2.59 (0.36–18.4)	
Parental status					
No	843	503 (60)	1	1	
Yes	133	77 (58)	0.93 (0.64–1.35)	1.08 (0.68–1.73)	

*Assessed in a subset of 976 trainees who did not have missing values in any of these covariates. All covariates were modelled as dummy categorical variables.

†Adjusted for all the covariates shown in the table.

‡‘Other’ was a response option for this question in the survey.

Impact of caring for patients with COVID-19 on training and professional development

Trainees reported concerns about how the pandemic will affect their preparedness for independent practice irrespective of the number of patients with COVID-19 they cared for (table 3, figure 1B). This reflects the widespread changes to graduate medical training due to the pandemic in areas with both high and low prevalence of COVID-19. Residency and fellowship training consists primarily of experience-based learning and apprenticeship, and this educational model has been disrupted significantly due to changes such as cancelled clinical rotations, redeployment to services outside of one’s specialty, decreased procedure volumes, and a transition to telehealth. Medical educators have raised concerns about the implications of these changes on the professional development of physician trainees.^{6 17} Our findings suggest that changes to educational opportunities affected trainees regardless of their role in the pandemic response, and thus interventions to address training interruptions should target all trainees regardless of their exposure to patients with COVID-19.

Impact of caring for patients with COVID-19 on trainee well-being and burnout

The level of exposure to patients with COVID-19 was the strongest predictor of burnout among the characteristics that we examined (figure 1C, table 3). It is notable that trainees who took care of more patients with COVID-19 were more likely to report burnout despite also being more likely to report that they felt as if they contributed to the fight against COVID-19. This finding suggests that the opportunity to care for those patients in greatest need during the pandemic and the sense of purpose and pride that might come with that role did not prevent higher rates of physician burnout. The association between decreased access to PPE and burnout did not extend to those with the least access to adequate PPE (those who responded that they ‘Rarely’ or ‘Never’ had adequate access to PPE). This result is likely affected by the low number of responses for these two answer choices (27 and 26 responses, respectively). This finding suggests that limitations in access to PPE likely contribute to burnout, but more research is needed to further investigate this association. Having colleagues who tested positive for COVID-19 were also independently associated with burnout (table 4), which may reflect the emotional burden of concern for colleagues who are infected, and of realising one’s own vulnerability to infection in the workplace.^{4 18} Burnout is of particular concern in the trainee population given the high baseline rates of burnout and the

known consequences of trainee burnout, which include increases in medical errors and motor vehicle accidents.^{19 20}

Limitations and strengths

As we used opportunistic sampling in this study, we cannot guarantee the generalisability of the findings to all physician trainees. Our sampling strategy precludes calculation of a response rate and makes it harder to interpret the absolute rates reported for each question due to potential response bias. As all questions in the survey were optional, there is also potential response bias affecting the data for each question. However, all our results are reported as comparisons between different levels of exposure to patients with COVID-19, which are internally consistent. For example, even if absolute rates of burnout are higher (or lower) in our study population than in unselected physician trainees, the association between higher level of COVID-19 exposure and higher burnout rate in our population is still valid and likely to apply to other populations of trainees. Second, international participation, extent of outreach and accuracy of question interpretation could have been improved by developing surveys in non-English languages. Our study has notable strengths. We captured the experience of a large number of medical trainees during the worldwide peak of the pandemic. Our sample is diverse in terms of geographic location and burden of COVID-19 exposure, and our survey included questions that spanned a range of relevant topics from workplace safety to well-being, including validated burnout questions.

In summary, physician trainees are vulnerable during this pandemic as they serve as both learners and employees. Residents and fellows typically have less agency over their schedule and are dependent on training programme leadership to facilitate progression towards their career goals. Awareness of the impact of caring for patients with COVID-19 on trainee safety, health, wellness, education and future preparedness that we described will be essential in maintaining our physician workforce during this pandemic.

Main messages

- ▶ Exposure to patients with COVID-19 is significantly associated with higher burnout rates in physician trainees.
- ▶ Trainees who cared for a higher number of patients with COVID-19 were more likely to report limited access to PPE and COVID-19 testing.
- ▶ Trainees reported concerns about how the pandemic will affect their preparedness for independent practice irrespective of the number of patients with COVID-19 they cared for.

Current research questions

- ▶ Do trainee perspectives on remote didactic education and transition to telehealth vary based on burden of exposure to patients with COVID-19?
- ▶ Does there continue to be high rates of physician burnout among trainees taking care of patients with COVID-19 beyond April and May 2020?
- ▶ What other personal and institutional factors are associated with burnout among medical trainees during the COVID-19 pandemic?

What is already known on the subject

- ▶ The COVID-19 pandemic has forced changes in the structure of graduate medical education.
- ▶ Physicians taking care of COVID-19 patients experience higher rates of anxiety, depression, insomnia, and distress.
- ▶ There is a high rate of burnout among medical trainees.

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