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Full Length Article

Mental health risks differentially associated with immunocompromised status among healthcare workers and family members at the pandemic outset

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ABSTRACT

The mental health of healthcare workers (HCWs) is critical to their long-term well-being and future disaster preparedness. Goal 1 of this study was to identify rates of mental health problems experienced by HCWs. Goal 2 was to test a model of risk stemming from pandemic-related stressors and vulnerability factors.

This cross-sectional study included HCWs (N = 2,246 [1,573 clinical providers; 673 non-clinical staff]) in the Rocky Mountain West who voluntarily completed an online survey in April/May 2020. Respondents completed measures for traumatic stress symptoms, depression, anxiety, alcohol use, and sleep. Logistic regressions stratified by professional role (clinical versus non-clinical) were specified to predict clinical screening cutoff (positive/negative) as a function of five pandemic-related stressors (immunocompromised self; immunocompromised household member; care provision to infected patients; clinical management role; positive cases).

Results showed that more than half of HCWs surveyed (52.5%) screened positive (above cutoff) for traumatic stress, depression, or anxiety, with ~20% reporting problematic alcohol use, and variable insufficient sleep from ~10% off shift to ~50% on shift. Clinical employees with an immunocompromised household member had increased odds of screening positive for a mental health problem. Non-clinical HCWs who were immunocompromised were at elevated risk for screening positive a mental health problem. Being female, minority status, and younger increased odds for mental health problems.

Implications include alleviating a portion of the mental health burden of HCWs involved in response to the SARS-CoV-2 pandemic by considering policies to protect immunocompromised HCWs and their families (e.g., vaccine priorities, telework options).

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1. Introduction

The COVID-19 pandemic caused by the SARS-CoV-2 virus is an ongoing public health emergency (World Health Organization, 2020) with high transmission rates resulting in more deaths than the former MERS and SARS pandemics combined (Mahase, 2020). This pandemic has placed considerable burden on healthcare workers (HCWs), who have been tasked to maintain medical infrastructure for infected persons. The mental health of HCWs is a critical area for investigation to support evidence-informed policy and intervention in efforts to support resilience, post-event recovery, and future disaster preparedness (Bao et al., 2020; Carmassi et al., 2020; Pappa et al., 2020; Vindegaard and Benros, 2020).

Following the earlier SARS epidemic, stress-related mental health risk among HCWs persisted at elevated levels well after the epidemic had ended (Bai et al., 2004; Chen et al., 2005; Poon et al., 2004). Similarly aimed cross-sectional research has begun to emerge during the COVID-19 pandemic, identifying mental health risks among HCWs that exceed the rates shown in response to SARS (Baker et al., 2020; Cai et al., 2020; Lai et al., 2020; Mohindra et al., 2020; Walton2020; Wright et al., 2021). Moreover, risk for enduring mental health problems is likely to be higher for HCWs providing care in the midst of this pandemic relative to previous events considering the novel features of the COVID-19 pandemic (e.g., its length, virulence, global spread). This hypothesis is suggested by evidence that increased mental health risk is driven in-part by exposure intensity (Lin et al., 2007; Jung et al., 2020; Su et al., 2007; Wu et al., 2009) and potential to be infected or infect others (Bai et al., 2004; Chong et al., 2004; Koh et al., 2005; Styra et al., 2008). Emerging research indeed supports increased mental health risks and predictors in the COVID-19 context (Cai et al., 2020; Greene et al., 2021; Mohindra et al., 2020; Pappa et al., 2020; Wright et al., 2021). Continuing this line of investigation is needed to shed light on the mental health consequences and sequalae associated with this pandemic.

1.1. Objectives and hypotheses

The current study surveyed healthcare workers in an academic medical center at the outset of the COVID-19 pandemic. Goal One was to identify the likelihood for screening positive on six mental health outcomes: traumatic stress symptoms, depression, anxiety, risky alcohol use, insufficient sleep on work days ('on-shift sleep'), and insufficient sleep on off-work days ('off-shift sleep'). We hypothesized that a considerable percentage of HCWs would screen positive for mental health problems, and that risk rates would exceed those estimated in previous epidemic contexts (see Green et al., in press; Wright et al., in press). Goal Two was to examine a model of pandemic-related stressors that may increase risk for mental health diagnoses or problems. We selected risk factors based on emerging literature and stressors specific to being a HCW during the early stages of the pandemic, including: (a) having direct contact with potentially infected persons (Kang et al., 2020; Lai et al., 2020; Tam et al., 2004); (b) personally having an immunocompromised medical condition (Novel Coronavirus Pneumonia Emergency Response Epidemiology Team, 2020); (c) having a household member who is immunocompromised (see Adams and Walls, 2020); (d) managing personnel who are in contact with potentially infected patients, and; (e) objective disease spread (number of positive virus cases in the county of work on the day of survey completion).

2. Materials and methods

2.1. Participants

A total of 22,540 healthcare staff received an email with the survey link through a listserve in April of 2020. A total of 13,817 employees opened the email, and 2,988 who opened the email selected the survey link and consented to participate. Data cleaning resulted in removal of 742 cases (727 removed for non-completion of items after agreeing to consent, and 15 cases removed for not completing an item identifying work role, a variable used to stratify analyses). The final sample of 2,246 HCWs retained for study analyses, comprised of clinical ($n = 1,573$) and non-clinical ($n = 673$) personnel (see Table 1). Respondents were primarily female (75.5%), middle-aged ($M = 39.35$ yrs, $SD = 11.78$ yrs), and European American (90.6%). Clinical providers included physicians (15.1%), nurses (45.5%), and allied health professionals (39.5%). Clinical providers worked in outpatient (40.0%), medical or psychiatric inaptient (24.2%), and emergency/intensive care/surgery (26.2%) services. Non-clinical employees included clerical (32.5%), management (18.4%), research/teaching (19.2%), and other staff (28.8%; e.g., lab, facilities, etc.). See Table 1 for final sample composition (demographics and role).

Table 1
Demographic and Job-Related Characteristics stratified by Professional Role.

Item	Whole Sample ($N = 2246$)	Clinical HCWs ($n = 1573$)	Non-Clinical HCWs ($n = 673$)
Gender			
Male	18.4	17.5	20.7
Female	75.5	75.0	76.5
Other	0.5	0.4	0.7
Missing	5.6	7.1	2.1
Age			
Mean	39.35	38.57	41.13
Standard Deviation	11.78	11.72	11.74
Race			
European American	90.6	90.3	91.2
African American	0.9	0.9	0.9
Asian American	3.8	3.8	3.9
American Indian/Alaskan Native	1.1	1.0	1.3
Native Hawaiian/Pacific Islander	0.3	0.3	0.4
Other	4.5	4.7	3.9
Missing	1.1	1.1	0.3
Hispanic Ethnicity			
Yes	7.8	8.1	7.4
No	91.2	91.1	92.6
Missing	1.0	0.8	1.2
Direct Care Role (Clinical Staff Only)			
Attending, Fellow, or Resident Physician	–	15.1	–
Nurse (APRN, RN, LPN, CNA)	–	45.5	–
Other (e.g., Mental Health, Pharmacy, etc.)	–	39.5	–
Missing	–	0.0	–
Clinical Work Site (Clinical Staff Only)			
Outpatient (Primary Care, Urgent Care, Other)	–	40.0	–
Emergency, ICU or Surgery	–	26.0	–
Inpatient (Medical, Psychiatric)	–	24.2	–
Missing	–	9.9	–
Non-Direct Care Role (Non-Clinical Staff Only)			
Clerical	–	–	32.5
Management/ Administration	–	–	18.4
Research/Teaching	–	–	19.2
Other (e.g., Lab, Facilities, Technology)	–	–	28.8
Missing	–	–	1.0

Note. Values given as rounded percentages unless stated otherwise (i.e., age). Dashes indicate branching logic where respondents received one or another set of questions based on whether they reported being in a clinical or non-clinical role. Race may add to more than 100% because respondents checked any and all races that applied.

2.2. Procedures

Study approval was obtained from the University of Utah IRB prior to survey administration. Participants responded to surveys from April 21, 2020 to May 21, 2020. During this time, the total number of confirmed cases of COVID-19 in the United States was over 800,000 (April 21st) and grew to 1.6 million (May 21st; Johns Hopkins Coronavirus Resource Center). COVID-19 confirmed deaths in the United States went from 39,000 (April 21st) to over 89,000 (May 21st). Relative to estimates from larger coastal urban settings, the state in which the surveyed healthcare system operates experienced lower prevalence of COVID-19 cases and deaths: 3,000 cases (April 21st) to 7,200 cases (May 21st) and 28 deaths (April 21st) growing to 84 deaths by the time of survey close (May 21st). The number of COVID-19 cumulative positive cases increased from 1,714 to 4,417 in the county where respondents worked during the dates when the survey was open.

2.3. Measures

Traumatic stress symptoms. We adapted the Primary Care Post-traumatic Stress Disorder Scale (PC-PTSD; Prins et al., 2015) for this study. The PC-PTSD includes five items that measure five PTSD symptoms: (1) re-experiencing, (2) avoidance, (3) hypervigilance, (4) emotional numbness and/or depersonalization, and (5) guilt and/or self-blame. Instead of having respondents endorse a binary response to each symptom (yes/no), respondents answered on a Likert format (0 = *not at all*, 1 = *a little bit*, 2 = *moderately*, 3 = *quite a bit*, 4 = *extremely*; see PCL-5, Blevins et al., 2015). Each score of 2 or higher was considered a "yes" response (indicating a clinically significant symptom endorsement), and the sum of "yes" responses ranged from 0 to 5. A cutoff of 3 or higher indicated risk for clinically significant traumatic stress symptoms (Prins et al., 2015). These adaptations were made to increase measure specificity, identifying only symptoms being experienced at a 'moderate' or higher level, in an effort to reduce risk of an overly-sensitive interpretation of traumatic stress responses during an ongoing crisis. Notably, we did not require participants to endorse a DSM-5 Criterion A stressor in order to complete the five PC-PTSD items. Internal consistency was high for this sample (Cronbach's $\alpha = 0.83$).

Depression. The Patient Health Questionnaire-2 (PHQ-2; Kroenke et al., 2003) is answered on a 4-point Likert scale (0 = *not at all* to 3 = *nearly every day*). The two items were summed to obtain a total score, and a recommended clinical cutoff score of 3 was used to indicate probable depressive disorder (Kroenke et al., 2003). Internal consistency for the two-item scale was acceptable for this sample ($r = 0.74$).

Anxiety. The Generalized Anxiety Disorder Scale-2 (GAD-2; Kroenke et al., 2007) is answered on a four-point Likert scale (0 = *not at all* to 3 = *nearly every day*). The two items, representing the core symptoms of anxiety, were summed and a recommended clinical cutoff of 3 was used. Internal consistency for the two-item scale was acceptable for this sample ($r = 0.76$).

Alcohol use. The Alcohol Use Disorders Identification Test-Consumption Questions (AUDIT-C; Bush et al., 1998) is a 3-item measure to assess alcohol use frequency and quantity. The question prompt was adapted to refer to alcohol use 'within the past month'; to prevent conflation in follow-up longitudinal research and additional wording changes were made to the response format to reflect the time frame. A total sum score was utilized with the recommended clinical cutoff of 4 for men and 3 for women indicating probable alcohol use disorder (Bush et al., 1998). Internal consistency was adequate for this sample (Cronbach's $\alpha = 0.59$).

Sleep. Participants reported the number of hours of sleep they obtained per night when on and off duty, with insufficient sleep defined as six or fewer hours of sleep per night (Soderstrom, Jeding, Ekstedt, Perski, Akerstedt, 2012).

Exposure to pandemic-related stressors. Four questions were used to assess exposure to pandemic-related stressors in a yes/no answer format: (1) 'directly engaged in responding to people with elevated temperatures or people with confirmed COVID-19' (Lai et al., 2020), (2) 'manage personnel who have direct contact with patients who might be infected with COVID-19', (3) 'have a compromised immune system due to a medical condition', and (4) 'does someone in your household have a compromised immune system due to a medical condition.'

Disease spread. Using data available in the Johns Hopkins Coronavirus Resource Center (https://coronavirus.jhu.edu/map.html), we derived a variable representative of the cumulative number of confirmed COVID-19 cases reported in the county where the medical center under study is located on the day that each respondent completed the survey. Due to reporting irregularities (e.g., delays around weekends) and an increased number of participants who completed the survey closer to the launch date, we created a variable that divied the total number of cases into four discrete categories. Respondents (17.1%) assigned to the first category completed the survey on April 21, 2020 when there were 1,714 cumulative cases, followed by those who completed the survey on April 22, 2020 and there were 1,795 cumulative cases (30.5%), then those who completed the survey between April 23, 2020 and May 3, 2020 during which there was an average of 2,218 cumulative cases (23.5%), and finally those who completed the survey between May 4, 2020 and May 21, 2020 during which there was an average of 2,946 cumulative cases (28.9%).

2.4. Data handling

Percentages of missing data for the main outcomes were as follows: 0.58% traumatic stress, 0.20% depression severity, 0.15% anxiety severity, 0.20% alcohol use, 1.19% sleep on-shift, and 0.88% sleep off-shift. Tests of missing completely at random (MCAR; Jamshidian and Jalal, 2010) were conducted to evaluate patterns of missing data. Results of the MCAR tests showed that the missing data for these variables were MCAR, Hawkins tests (all $p < .001$) and non-parametric tests ($p = .09, .44, 0.48$) for traumatic stress, depression, and anxiety respectively. Singular value decomposition-based methods were used for imputation (Troyanskaya et al., 2001). Listwise deletion was used to handle missingness for analyses examining sleep (on shift and off shift), as well as alcohol use. Bivariate associations for study variables stratified by professional role (clinical versus non-clinical HCWs) are reported in Supplemental Table 1.

3. Results

3.1. Mental health problems

More than half of the total sample (52.5%) reported clinically significant traumatic stress-related, depressive, or anxious symptoms, with 33.2% screening positive for two or more of these (see Table 2). Problematic alcohol use was endorsed by a considerable portion of respondents (22.1%). Those who reported insufficient sleep fluctuated, with nearly half of respondents (49.2%) reporting getting 6 or fewer hours of sleep on-shift, which dropped to 11.7% when off-shift. Comparisons between clinical and non-clinical HCWs revealed that clinical employees had higher odds of screening positive for insufficient sleep on-shift (OR = 1.71, 95% CI = 1.42-2.05) and lower odds of screening positive for stress-related (OR = 0.70, 95% CI = 0.58-0.84), depressive (OR = 0.81, 95% CI = 0.67-0.99), and anxious (OR = 0.82, 95% CI = 0.68-0.99) symptoms relative to non-clinical employees.

3.2. Exposure to pandemic-related stressors

Overall, about 30% of respondents reported contact with potentially infected patients or managing personnel who had direct contact with potentially infected persons. Ten to twenty percent reported being either immunocompromised themselves or having an immunocompromised household member (see Table 3). Relative to non-clinical employees, clinical providers had greater odds of providing care to potentially

Table 2
Rates of Probable Diagnosis stratified by Professional Role.

Item	Whole Sample	Clinical HCWs	Non-Clinical HCWs	χ^2	OR	95% CI
Traumatic Stress				14.92***	0.70	0.58–0.84
Positive	38.5	35.9	44.6			
Negative	61.5	64.1	55.4			
Missing	0.0	0.0	0.0			
Depression				4.22*	0.81	0.67–0.99
Positive	27.5	26.3	30.5			
Negative	72.1	73.4	69.1			
Missing	0.4	0.4	0.4			
Anxiety				4.45*	0.82	0.68–0.99
Positive	37.7	36.3	41.0			
Negative	62.0	63.4	58.7			
Missing	0.3	0.3	0.3			
Problematic Alcohol Use				0.04	1.02	0.82–1.27
Positive	22.1	21.9	22.6			
Negative	71.8	70.6	74.6			
Missing	6.1	7.5	2.8			
Insufficient Sleep (on-shift)				32.51***	1.71	1.42–2.05
Positive	49.2	53.1	40.0			
Negative	49.6	45.8	58.7			
Missing	1.2	1.1	1.3			
Insufficient Sleep (off-shift)				3.33	0.78	0.59–1.02
Positive	11.7	10.9	13.5			
Negative	87.4	88.5	85.0			
Missing	0.8	0.6	1.5			

Note. Traumatic stress threshold = PC-PTSD ≥ 3, depression threshold = PHQ-2 ≥ 3; anxiety threshold = GAD-2 ≥ 3; problematic alcohol use threshold, AUDIT-C ≥ 3 (for women), ≥4 (for men); insufficient sleep threshold ≤ 6 h. Values are given as percentages. Chi-square tests ($df = 1$) indicate a difference between healthcare workers (HCWs) who provide patient care relative to those who do not (reference category). Abbreviations include: OR = odds ratio, 95% CI = 95% confidence interval. *$p < .05$, **$p < .01$, ***$p < .001$.

Table 3
Rates of Exposure to Pandemic-Related Stressors stratified by Professional Role.

Item	Whole Sample	Clinical HCWs	Non-Clinical HCWs	χ^2	OR	95% CI
Contact with Possible COVID-19 Patients				311.10***	11.10	8.12–15.18
Yes	33.9	45.5	7.0			
No (ref.)	65.9	54.4	92.7			
Missing	0.2	0.2	0.3			
Manage Personnel				75.65***	2.61	2.09–3.26
Yes	31.3	36.8	18.3			
No (ref.)	68.4	62.8	81.4			
Missing	0.4	0.4	0.3			
Immunocompromised Self				20.60***	0.58	0.45–0.73
Yes	14.7	12.5	19.9			
No (ref.)	85.1	87.2	80.1			
Missing	0.2	0.3	0.0			
Immunocompromised Household Member				7.52**	0.74	0.60–0.92
Yes	21.7	20.1	25.4			
No (ref.)	78.0	79.4	74.6			
Missing	0.4	0.5	0.0			

Note. Values are given as percentages. Chi-square tests ($df = 1$) indicate a difference between healthcare workers (HCWs) who provide patient care relative to those who do not (reference category). Abbreviations include: OR = odds ratio, 95% CI = 95% confidence interval. *$p < .05$, **$p < .01$, ***$p < .001$.

infected persons (OR = 11.10, 95% CI = 8.12-15.18) and manging personnel in contact with potentially infected persons (OR = 2.61, 95% CI = 2.09-3.26). Conversely, clinical providers were less likely than non-clinical HCWs to be immunocompromised themselves (OR = 0.58, 95% CI = 0.45-0.73) or live with someone with an immunocompromised medical condition (OR = 0.74, 95% CI = 0.60-0.92).

3.3. Exposure to pandemic-related stressors and mental health

We specified a series of logistic regressions to examine the influence of exposure to pandemic-related stressors on screening results for traumatic stress, depression, anxiety, problematic alcohol use, and insufficient sleep (on- and off-shift). Models were stratified by professional role (i.e., clinical versus non-clinical), and we controlled for the effects of gender, minority racial status, age, and number of positive COVID-19 cases (COVID-19 case quartiles). Adjusted odds ratios and corresponding 95% confidence intervals are reported in Table 4.

3.3.1. Clinical faculty and staff

Among clinical faculty and staff who reported psychological problems, the full model predicted traumatic stress, χ^2 (8, $N = 1377$) = 87.98, $p < .001$, Nagelkerke $R^2 = 0.085$, and addition of exposure to pandemic-related stressors significantly improved the model, χ^2 (4, $N = 1377$) = 26.83, $p < .001$. The full model also predicted depression, χ^2 (8, $N = 1372$) = 93.49, $p < .001$, Nagelkerke $R^2 = 0.096$, and addition of exposure to pandemic-related stressors significantly improved the model, χ^2 (4, $N = 1372$) = 31.63, $p < .001$. Similarly, the full model predicted anxiety, χ^2 (8, $N = 1373$) = 128.60, $p < .001$, Nagelkerke $R^2 = 0.122$, and addition of exposure to pandemic-related stressors marginally improved the model, χ^2 (4, $N = 1373$) = 32.00, $p < .001$. Clinical HCWs who were women, younger, and reported having immunocompromised household members had the highest odds of screening positive for traumatic stress, depression, and anxiety, with the exception that no gender difference was observed for depression. Those who reported being immunocompromised themselves also had higher odds of screening positive for anxiety.

Table 4
Logistic regressions predicting mental health by exposure to pandemic-related stressors.

Traumatic Stress Symptoms						
	Clinical HCWs			Non-Clinical HCWs		
	AOR	95% CI	*p*	AOR	95% CI	*p*
Gender	1.83	1.33–2.51	.000	1.29	0.86–1.95	.221
Minority Race	1.32	0.91–1.90	.142	1.49	0.85–2.59	.161
Age	0.98	0.96–0.99	.000	0.97	0.96–0.99	.000
Cumulative Pos. Cases	0.84	0.75–0.93	.001	0.74	0.62–0.89	.001
Manage Personnel	1.07	0.83–1.38	.593	1.19	0.75–1.88	.464
Contact with COIVD-19	1.18	0.93–1.51	.180	1.03	0.51–2.09	.928
Immunocompromised Self	1.13	0.80–1.59	.496	1.74	1.14–2.65	.010
Immunocompromised Other	1.95	1.47–2.58	.000	1.33	0.90–1.95	.155
Depression						
	Clinical HCWs			Non-Clinical HCWs		
	AOR	95% CI	*p*	AOR	95% CI	*p*
Gender	1.27	0.91–1.79	.164	1.06	0.68–1.64	.810
Minority Race	1.42	0.97–2.09	.074	1.12	0.63–2.01	.694
Age	0.97	0.96–0.98	.000	0.98	0.96–0.99	.010
Cumulative Pos. Cases	0.75	0.67–0.85	.000	0.71	0.58–0.86	.001
Manage Personnel	1.16	0.88–1.54	.284	0.97	0.59–1.58	.888
Contact with COIVD-19	1.00	0.79–1.30	.968	1.29	0.62–2.70	.500
Immunocompromised Self	1.34	0.93–1.92	.112	1.88	1.21–2.91	.005
Immunocompromised Other	2.09	1.56–2.81	.000	0.96	0.63–1.45	.828
Anxiety						
	Clinical HCWs			Non-Clinical HCWs		
	AOR	95% CI	*p*	AOR	95% CI	*p*
Gender	1.84	1.33–2.53	.000	1.36	0.89–2.06	.153
Minority Race	1.05	0.7201.53	.784	1.04	0.60–1.80	.901
Age	0.96	0.95–0.97	.000	0.97	0.95–0.98	.000
Cumulative Pos. Cases	0.78	0.70–0.87	.000	0.78	0.65–0.94	.008
Manage Personnel	1.02	0.79–1.32	.887	1.19	0.75–1.89	.455
Contact with COIVD-19	1.25	0.98–1.69	.075	1.01	0.50–2.04	.980
Immunocompromised Self	1.55	1.10–2.18	.013	1.82	1.19–2.79	.005
Immunocompromised Other	1.85	1.39–2.47	.000	0.94	0.63–1.39	.746
Problematic Alcohol Use						
	Clinical HCWs			Non-Clinical HCWs		
	AOR	95% CI	*p*	AOR	95% CI	*p*
Gender	1.91	1.32–2.76	.001	1.25	0.76–2.04	.374
Minority Race	1.18	0.79–1.76	.430	1.47	0.81–2.67	.207
Age	1.01	1.00–1.02	.077	1.01	0.99–1.03	.296
Cumulative Pos. Cases	1.04	0.92–1.17	.522	1.13	0.92–1.38	.259
Manage Personnel	1.41	1.07–1.86	.014	0.99	0.59–1.67	.979
Contact with COIVD-19	1.01	0.77–1.32	.970	1.07	0.48–2.39	.863
Immunocompromised Self	1.02	0.69–1.50	.928	1.19	0.74–1.90	.477
Immunocompromised Other	0.95	0.68–1.31	.738	1.04	0.67–1.62	.856
Insufficient Sleep – On Shift						
	Clinical HCWs			Non-Clinical HCWs		
	AOR	95% CI	*p*	AOR	95% CI	*p*
Gender	0.99	0.74–1.31	.937	0.79	0.53–1.19	.259
Minority Race	1.77	1.20–2.60	.004	1.45	0.84–2.51	.184
Age	0.99	0.98–0.99	.003	1.01	0.99–1.02	.278
Cumulative Pos. Cases	1.07	0.97–1.19	.182	1.01	0.84–1.21	.950
Manage Personnel	1.21	0.95–1.55	.126	1.12	0.71–1.75	.628
Contact with COVID-19	1.72	1.36–2.18	.000	1.91	0.95–3.83	.068
Immunocompromised Self	1.16	0.83–1.63	.382	1.03	0.68–1.58	.879
Immunocompromised Other	1.49	1.12–1.99	.006	1.73	1.18–2.54	.005
Insufficient Sleep – Off Shift						
	Clinical HCWs			Non-Clinical HCWs		
	AOR	95% CI	*p*	AOR	95% CI	*p*
Gender	0.79	0.52–1.21	.287	0.51	0.29–0.88	.016
Minority Race	1.51	0.92–2.47	.102	2.80	1.44–5.45	.002
Age	1.00	0.99–1.02	.798	1.02	1.00–1.04	.033
Cumulative Pos. Cases	1.00	0.85–1.17	.993	0.87	0.67–1.15	.334
Manage Personnel	1.00	0.69–1.45	.990	0.96	0.49–1.91	.910
Contact with COIVD-19	1.32	0.92–1.90	.136	0.54	0.15–2.00	.356
Immunocompromised Self	1.33	0.83–2.14	.240	1.46	0.81–2.63	.211
Immunocompromised Other	1.81	1.23–2.67	.003	1.22	0.71–2.10	.476

Note. Abbreviations include Adjusted Odds Ratio (AOR) and 95% Confidence Interval (95% CI). Thresholds were as follows: Traumatic stress symptom threshold = PC-PTSD $\geq$ 3, depression threshold = PHQ-2 $\geq$ 3; anxiety threshold = GAD-2 $\geq$ 3; problematic alcohol use threshold, AUDIT-C $\geq$ 3 (for women), $\geq$4 (for men); insufficient sleep threshold $\leq$ 6 h. The reference category for gender is male in comparison to female. The reference category for minority race is European American in comparison to any other racial identity. Age is measured in years. The number of COVID-19 cumulative positive cases increased from 1,714 to 4,217 in the county where respondents worked during the dates when the survey was open and was represented by four discrete categories (0–3), with higher values indicating a greater number of cumulative cases (see Methods for details). Adjusted odds ratios represent the relative difference in odds associated with endorsing them item as opposed to not endorsing the item.

Of note, odds of screening positive for a psychological problem decreased as the cumulative number of confirmed COVID-19 cases in the geographic area under study increased.

Among clinical faculty and staff, the full model predicted problematic alcohol use, χ^2 (8, $N = 1377$) = 22.77, $p = .004$, Nagelkerke $R^2 = 0.025$, although addition of exposure to pandemic-related stressors did not significantly improve the model, χ^2 (4, $N = 1377$) = 6.94, $p = .139$. The full model predicted insufficient sleep on-shift, χ^2 (8, $N = 1365$) = 66.59, $p < .001$, Nagelkerke $R^2 = 0.064$, and addition of exposure to pandemic-related stressors significantly improved the model, χ^2 (4, $N = 1365$) = 39.53, $p < .001$. Similarly, the full model predicted insufficient sleep off-shift, χ^2 (8, $N = 1372$) = 18.44, $p = .008$, Nagelkerke $R^2 = 0.027$, and addition of exposure to pandemic-related stressors significantly improved the model, χ^2 (4, $N = 1372$) = 13.94, $p = .008$. Having an immunocompromised household member was the most consistent predictor of insufficient sleep among clinical HCWs on- and off-shift; whereas, those who had contact with potentially infected persons, were younger, and identified as a racial minority also had elevated odds of insufficient sleep on-shift. Preliminary evidence suggests that those who manage personnel exposed to potentially infected persons may have higher odds of problematic alcohol use, although further exploration is needed given that the combined contribution of pandemic-related exposures did not significantly improve the model.

3.3.2. Non-clinical faculty and staff

Among non-clinical faculty and staff who reported psychological problems, the full model predicted traumatic stress, χ^2 (8, $N = 626$) = 43.16, $p < .001$, Nagelkerke $R^2 = 0.089$, and addition of exposure to pandemic-related stressors significantly improved the model, χ^2 (4, $N = 626$) = 11.22, $p = .024$. The full model also predicted depression, χ^2 (8, $N = 623$) = 28.02, $p < .001$, Nagelkerke $R^2 = 0.062$, although addition of exposure to pandemic-related stressors marginally improved the model, χ^2 (4, $N = 623$) = 8.53, $p = .074$. The full model predicted anxiety, χ^2 (8, $N = 624$) = 40.36, $p < .001$, Nagelkerke $R^2 = 0.084$, and addition of exposure to pandemic-related stressors marginally improved the model, χ^2 (4, $N = 624$) = 8.32, $p = .080$. Non-clinical HCWs who were younger and immunocompromised themselves had the highest odds of screening positive for traumatic stress, depression, and anxiety. Odds of screening positive for a psychological problem decreased as the cumulative number of confirmed COVID-19 cases in the area increased.

Among non-clinical HCWs who reported behavioral problems, the full model failed to predict problematic alcohol use, χ^2 (8, $N = 626$) = 6.39, $p = .604$. In contrast, the full model predicted insufficient sleep on-shift, χ^2 (8, $N = 619$) = 18.52, $p = .018$, Nagelkerke $R^2 = 0.040$, and addition of exposure to pandemic-related stressors significantly improved the model, χ^2 (4, $N = 619$) = 13.94, $p = .007$. The full model also predicted insufficient sleep off-shift, χ^2 (8, $N = 617$) = 21.88, $p = .005$, Nagelkerke $R^2 = 0.065$, although addition of exposure to pandemic-related stressors did not improve the model, χ^2 (4, $N = 617$) = 3.42, $p = .490$. Non-clinical HCWs with an immunocompromised household member had greater odds of insufficient sleep on-shift, and those who were women, racial minorities, and younger had greater odds of insufficient sleep off-shift.

4. Discussion

4.1. Mental health problem rates summarized and placed in context

The current study assesses mental health risk for hospital personnel in April/May of 2020 in an academic medical center in the Rocky Mountain West region of the United States. This study stratified analyses by clinical faculty/staff to non-clinical faculty/staff on five mental health measures: traumatic stress, depression, anxiety, alcohol use, and insufficient sleep (on shift and off shift days). In total, more than half of the HCWs screened positive for either traumatic stress, depression, or anxiety, with about one third of the HCWs screening positive for co-occurring psychological problems, rates that were similar to other recent reports (Greene et al., 2021). These rates are higher than those reported in previous viral epidemic contexts (Bai et al., 2004; Chong et al., 2004; Poon et al., 2004), lower than those observed in China early in the COVID-19 outbreak (Lai et al., 2020), while falling in-between estimates in samples from the United States collected in a similar time period (higher than Wright et al., 2021 and lower than Schechter et al., 2020). Problematic alcohol use was evident for nearly a quarter of the current sample, compared to rates of 12.9%–21.4% demostrated among healthcare workers in non-crisis contexts (Oreskovich et al., 2015). Our findings regarding sleep disruption revealed potential circadian rhythem disruptions for clinical providers between on and off duty sleep (Kuhn, 2001).

4.2. Primary findings for pandemic stress-exposures associated with mental health problems

Six sets of findings were revealed in the regressions. First, for clinical providers, the most consistent predictor of increased psychological risk was having an immunocompromised household member. Throughout the pandemic, HCWs have been asked to balance individual and family needs (e.g., vulnerable household members) with community and organizational needs, especially during times of medical crisis. This balancing act is not without consequence for many, and may a significant impact mental health (e.g., role conflicts, moral injury; see Griffin et al., 2019; Hines et al., 2020), perhaps serving as a catalyst for future mental health risks that will be important for longitudinal research to follow up with.

Given these findings, ongoing vaccination roll-outs might prioritize not only healthcare workers, but also their household members. Leaders and administrators have undoubtedly difficult choices to make with regard to vaccination roll-outs that are complex from healthcare, social, ethical, economic, and political perspectives. Notwithstanding the complexities, the risk for mental health problems may be considerably increased for direct clinical providers who are concerned about infecting vulnerable and/or immunocompromised household members.

Choosing to prioritize the family members of healthcare providers in vaccination protocols can operationalize a protective factor for long-term mental health, resilience, and endurance of HCWs. Implications of prioritizing HCWs family members are for protecting against downstream mental health crises for HCWs and their families and to facilitate better attention to job duties from these HCWs. By time of publication of this study, vaccinations will largely have been offered and completed in the United States among a majority of willing HCWs and a sizeable proportion of their families. Nonetheless, worldwide vaccine rollout is much slower, and we can learn from these data that prioritization of HCWs family members can lead to direct and potentially sustained benefits for our HCWs and the people that they care for.

Second, for non-clinical faculty/staff, having an immunocompromised condition predicted increased mental health risks for depression, anxiety, and traumatic stress. This finding might be explained by the fact that COVID-19 poses increased threats for more severe responses and death for those with pre-existing health problems (Novel, Coronavirus Pneumonia Emergency Response Epidemiology, 2020). Additionally, contextual differences exist between non-clinical faculty/staff and their clinical counterparts which may serve to influence increased mental health risks in those with immunocompromised conditions such as differences in pay and financial security resulting in stress about potential leave from work if infected.

Third, being in management role was associated with increased risk for alcohol abuse, consistent with findings among managers in emergency responder settings (Wright et al., 2021). Management in the early phase of the pandemic involved an unprecedented set of decisions fraught with changing protocols and information about the virus and ambivalence for how to proceed with safe clinical care provision. For short term stress relief, alcohol can function as a strategy to avoid negative emotions (Wardell et al., 2020), and may yet incur risks for mental and physical health problems (e.g., Mueller et al., 1994; Boffetta et al., 2006). As the pandemic continues, finding strategies to effectively

help staff to replace unsustainable coping strategies (e.g., alcohol use coping) with more sustainable ones (e.g., social-support focused coping; exercise) will be important. Employers may consider their role and responsibility to protect their employees by promoting self-care and wellness, especially in work settings involving significant stress expsoures (Kerig, 2019).

Fourth, for clinical providers, insufficient sleep during on-shift days was predicted by having direct contact with potentially infected patients. Research conducted early in the pandemic identified an association between increased stress and sleep disruptions among healthcare workers (Jahrami et al., 2020). Providers in this position are working longer hours than usual, combining increased stress with disruption in typical work/sleep/self-care routines. This notion may be evidenced by the large difference in 'insufficient sleep' between on-shift work days compared to off-shift work days. The implication is that, for clinical providers, disrupted circadian rhythm has the potential to significantly reduce resilience and increase risks for distress and burnout if not addressed (Amanullah and Shankar, 2020; Agorastos, Agorastos and Olff, 2020; Heath et al., 2020).

Fifth, we observed an inverse association between disease spread and mental health, such that increase in the cumulative number of COVID-19 cases was associated with lower odds of traumatic stress, depression and anxiety. This finding is consistent with dynamics revealed among emergency responders (Wright et al., 2021), likely derivative of the timing of this survey (in the beginning stages of the pandemic in April of 2020). This finding may represent a disaster 'honeymoon' period during which resources are being allocated and community/co-workers are coming together to reduce distress and actively solve problems (Gersons et al., 2020; DeWolfe, 2000). As this study progressed, intentional "curve-flattening" efforts may have allowed hospitalizations to increase at a manageable pace, likely producing an environment in which healthcare providers could develop a sense of efficacy by actively applying existing skills to new protocols in a measured manner rather than being anxious and fearful in anticipation of the threat to come as they witnessed it from afar.

Sixth, demographic factors were associated with mental health risks. Being older

was associated with lower mental health risks. This was not a strong effect, and was possibly a proxy for other factors, such as financial security, experience, or stress inoculation. Being female was associated with elevated risk for anxiety related disorders (i.e., traumatic stress and anxiety) and risky alcohol use. Whereas females generally experience higher rates of risk for internalizing disorders (Hasin et al., 2018; Olff, 2017; West et al., 2018), contextual features associated with COVID-19 (e.g., increased caregiver burdens; see Power, 2020) may place females at heightened mental health risk (Barello et al., 2020; Lai et al., 2020).

4.3. Limitations

Limitations are important to note. First, these data are cross-sectional and not capable of determining causality. Longitudinal studies are needed to understand how mental health risk might fluctuate as disease numbers and hospitalization rates rise and fall. Second, traumatic stress reactions may be normative responses during stressful events, and perhaps in the short term offer an adaptive advantage involved in heightening senses to respond apaptively. It is when these responses persist and cause generalized impairments that individuals are considered to have a developed a disorder. Trajectories of change in traumatic stress response and resilience— and for those in whom these responses persist, remit, or emerge in a delayed onset— are important (see Galatzer-levy, Huang, & Bonanno, 2018). Third, a comprehensive model of risk prediction must include distal/historical factors that we did not prioritize for the purposes of this study (our focus was on proximal stressors), including history of prior trauma exposure, mental health diagnosis/treatment, and familial history of stress or mental health problems. Fourth, our sampling methods and size did not allow more precise stratification to distinguish HCWs in the most intense exposure settings (e.g., ICU, ER, Outpatient, Inpatient), an area for future research to more precisely inform allocations of mental health resources. Fifth, this study did not provide a comparison sample from another region, although we used normalized measures to enable replication and comparison to other locales.

Sixth, our sample was racially homogenous (91% white-identifying), which guided our use of a binary ethnicity variable as a covariate (white vs. non-white). This is an especially poignant limitation given that persons of color were disproportionately adversely affected by the pandemic, experiencing elevated risk for infection and death (Price--Haywood et al., 2020; Rossen et al., 2020). Such disproportionate adverse effects are layered on top of ongoing mistrust in the medical establishment, perhaps exemplified by increased vaccine hesitancy and skepticism among healthcare workers of color, with implications for further exacerbating existing health disparities (Grumbach et al., 2021). Future research should prioritize racial and ethnic minorities.

Our novel adaptation of the PC-PTSD measure was not administered as designed, given that we (a) placed responses on a 0 to 4 Likert scale (identical to the PCL-5 response scale, Blevins et al., 2015) as opposed to the original 'yes/no' binary response scale (Prins et al., 2015) and (b) did not require respondents to endorse criterion A trauma exposure as a pre-requisite to complete PC-PTSD item. Our choices to alter the PC-PTSD were made to improve specificity of the measure for the purposes of a population-based deployment, improve variability for modeling purposes, and to avoid over-pathologizing a sample of participants in the midst of an ongoing stressor. In application to research and practice, there is a need for brief PTSD measures with good psychometric validy and reliability (test-retest; convergent; divergent). Future research should examine the reliability of this adaptation of the PC-PTSD measure on a Likert scale, in comparative analyses with the PC-PTSD answered on the original binary scale, other self-report measures (PCL-5, Blevins et al., 2015), and gold-standard semi-structured interview (not used due to the observational nature of this study; e.g., Clinician Administered PTSD Scale; Weathers et al., 2018). Finally, emerging evidence indicates that differential, gender-specific cutoff points for "diagnosis" using the PC-PTSD may be more clinically accurate and useful (studied in a veteran population; Bovin et al., 2021). Taken together, our reported diagnostic rates should be considered with these caveats and limitations in mind.

5. Conclusions

The high rates mental health distress in this study raises substantial concerns for acute and long-term mental health consequences in already high-risk professions. Being able to screen and identify those at highest risk provides foundational data for targeted interventions. Additionally, less intense and technology driven interventions can be more broadly applied to entire populations of HCWs. The pandemic is an opportunity to normalize responses to grief and trauma which could reduce widespread stigma and increase future resilience, if handled appropriately. Focused attention and resources dedicated to resilience, coping skills, and treatment of mental health disorders may minimize long-term consequences and increase preparedness for disasters to come.

Declaration of competing interest

The authors whose names are listed immediately below certify that they have NO affiliations with or involvement in any organization or entity with any financial interest or non-financial interest in the subject matter or materials discussed in this manuscript.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.bbih.2021.100285.

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