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Original article

The impact of traumatic experiences, coping mechanisms, and workplace benefits on the mental health of U.S. public health workers during the COVID-19 pandemic



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ABSTRACT

Purpose: To evaluate the association between risk factors, mitigating factors, and adverse mental health outcomes among United States public health workers.

Methods: Cross-sectional online survey data were collected March to April 2021. The survey was distributed to public health workers who worked in a state, tribal, local, or territorial public health department since March 2020.

Results: In total, 26,174 United States state and local public health workers completed the survey. Feeling isolated was a risk factor for anxiety (PR, 1.84; 95% CI, 1.74–1.95), depression (PR, 1.84; 95% CI, 1.75–1.94), post-traumatic stress disorder (PR, 1.50; 95% CI, 1.43–1.57), and suicidal ideation (PR, 3.23; 95% CI, 2.82–3.69). The ability to take time off was linked to fewer reported symptoms of anxiety (PR, 0.87; 95% CI, 0.83–0.90), depression (PR, 0.86; 95% CI, 0.83–0.89), post-traumatic stress disorder (PR, 0.84; 95% CI, 0.81–0.88), and suicidal ideation (PR, 0.84; 95% CI, 0.77–0.92).

Conclusions: Since COVID-19 was declared a pandemic, respondents who felt isolated and alone were at an increased risk for adverse mental health outcomes. Findings from this study call for public health organizations to provide their workforce with services and resources to mitigate adverse mental health outcomes.

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Abbreviations: APHL, Association of Public Health Laboratories; ASTHO, Association of State and Territorial Health Officials; CDC, Centers for Disease Control and Prevention; CIs, confidence intervals; COVID-19, novel coronavirus disease 2019; CSTE, Council of State and Territorial Epidemiologists; FCS, fully conditional method; GAD-2, 2-item General Anxiety Disorder; IES-6, 6-item Impact of Event Scale; HIPPA, Health Insurance Portability and Accountability Act; HCWs, healthcare workers; LASSO, least absolute shrinkage selection operation; MERS, Middle East respiratory syndrome; NACCHO, National Association of County and City Health Officials; NC, North Carolina; PHQ-9, 9-item Patient Health Questionnaire; PHWs, public health workers; PRs, prevalence ratios; PTSD, post-traumatic stress disorder; RED-Cap, Research Electronic Data Capture; SARS, severe acute respiratory syndrome; STLT, state, tribal, local, and territorial; U.S., United States; WHO, World Health Organization.

The authors have no conflicts of interest to disclose.

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Introduction

Three months after initial reports of a pneumonia outbreak in Wuhan, China, the World Health Organization (WHO) officially characterized the novel coronavirus disease 2019 (COVID-19) as a pandemic on March 11, 2020 [1,2]. Globally—as of January 2022—WHO reported over 328 million confirmed cases of COVID-19 and 5 million deaths, of which the United States has reported more than 63 million cases and 840,000 deaths [3,4]. Despite proven effectiveness of COVID-19 vaccines, allocation and uptake of vaccines have been slow, prolonging the outbreak of COVID-19 and continuing high levels of transmission in the United States and globally [5–8].

The prolonged outbreak of COVID-19 has had long-lasting impacts on countries' healthcare systems, including frontline work-

ers responding to the pandemic [9]. During previous coronavirus outbreaks—severe acute respiratory syndrome (SARS) and Middle East respiratory syndrome (MERS)—healthcare workers (HCWs) reported a high prevalence of post-traumatic stress disorder (PTSD), anxiety, and depression [10–13]. Similar symptoms of mental health conditions were reported in recent studies of the general population and HCWs during the COVID-19 pandemic [14–19].

Previous studies have considered HCWs, but few have documented the impact of COVID-19 on the mental health of public health workers (PHWs) globally or in the United States. Prior to the COVID-19 pandemic, in the 2017 Public Health Workforce Interests and Needs Survey among the U.S. governmental public health workforce, 23% of participants reported work overload and burnout [20]. However, a study conducted in 2020 found that 66.2% of U.S. PHWs reported burnout and less than a quarter planned to remain in the public health field [21]. In 2021, 53% of U.S. PHWs who worked at a state, tribal, local, or territorial (STLT) health department reported at least one symptom of depression, anxiety, or PTSD [22]. Globally, a 2020 survey of PHWs at the Chinese centre for Disease Control and Prevention and primary healthcare institutes evaluated the prevalence of mental health symptoms and found that respondents self-reported high rates of anxiety and depression [23].

From March 29 to April 16, 2021, the U.S. Centers for Disease Control and Prevention (CDC) in collaboration with the Association of Public Health Laboratories (APHL), Association of State and Territorial Health Officials (ASTHO), Council of State and Territorial Epidemiologists (CSTE), and National Association of County and City Health Officials (NACCHO) conducted a survey to measure the impact of COVID-19 on mental health of U.S. PHWs at the state, tribal, local, and territorial level. Our study evaluates the mental health outcomes (anxiety, depression, PTSD, and suicidal ideation) of local and state PHWs responding to COVID-19, as well as the association between risk factors, mitigating factors, and mental health conditions. A complete case univariate analysis on demographics, work history, and mental health outcomes of PHWs was described in a previously published manuscript; however, the manuscript did not impute missing data, therefore, some percentages and prevalence ratios we note will differ to those initially reported [22].

Material and methods

Survey design

A cross-sectional study design was conducted using a convenience sample of U.S. state and local PHWs including all 50 U.S. states, tribal nations, the District of Columbia, American Samoa, Guam, Northern Mariana Islands, Micronesia, Palau, Puerto Rico, and the U.S. Virgin Islands to implement the online survey. Based on a 2014 study that used data sources from organizations such as ASTHO, CSTE, and NACCHO, we estimated our study population to be approximately from 186,437 to 274,950 U.S. local and state PHWs [22,24]. On March 29, 2021, the survey link was distributed to representatives at national public health organizations (APHL, ASTHO, CSTE, and NACCHO) who then disseminated the link to their members (approximately 24,000). Members of these professional organizations in supervisory or leadership roles were asked to circulate the survey to all employees in their organizations. Eligible participants were included if they identified as employees, contractors, fellows, and others who worked at a STLT health department during any time in 2020. Respondents could complete the survey on Research Electronic Data Capture (REDCap) [25]. The survey was accessible to respondents for 19 days and closed on April 16, 2021 at 11:59PM (Samoa Standard Time).

Questionnaire

The survey instrument contained 50 questions that covered demographic information, work history (before and during COVID-19), stressful and traumatic experiences (since March 2020), coping mechanisms, and self-reported symptoms of anxiety, depression, PTSD, and suicidal ideation (past two weeks). The four mental health outcomes were constructed using validated and reliable instruments [26–31]. The 9-item Patient Health Questionnaire (PHQ-9) was used to evaluate symptoms of depression and 1-item from the questionnaire, “How many days have you thought that you would be better off dead, or thought of hurting yourself?”, was used to evaluate suicide-related thoughts (called suicidal ideation here on). Item 9 of the PHQ-9 is a validated and reliable approach for people to self-report symptoms of suicidal ideation [27–29]. Each question was scored from 0 to 3, with a score range of 0–27 or 0–3 for depression and suicidal ideation, respectively [26–29]. The 2-item General Anxiety Disorder (GAD-2) was used to score anxiety: each response option was assigned a value from 0 to 3, for a total range of 0–6 [30]. To evaluate PTSD, the 6-item Impact of Event Scale (IES-6) scored from 0 to 4 for each question for a total score range of 0–24; however, symptoms of PTSD were calculated as the mean of six questions [31]. Respondents were considered symptomatic for depression if they scored ≥ 10 , for suicidal ideation if they scored ≥ 1 , and symptomatic for anxiety and PTSD if they scored ≥ 3 or ≥ 1.75 , respectively.

Covariates were created from survey responses (see eTable 1 in the supplement for list of covariates). The questionnaire included 14 potential stressful and traumatic events, and respondents indicated (yes or no) if they had experienced any of them (eTable 1). Responses related to coping mechanisms and perceived support were transformed from ordinal scales to binary variables to indicate any level versus no level of coping or perceived support. Categorical variable groups were constructed based on input from subject matter experts for age groups, race/ethnicity, educational attainment level, percent time working on COVID-19 response, hours worked per week, and household size/living alone.

Statistical analysis

Descriptive analyses assessed frequency of the mental health outcomes and covariates, which included demographic characteristics, workplace benefits, stressors experienced, perceived lack of personal and work-related support, and coping mechanisms used.

A high level of missingness was identified, 21,286 (81.3%) of the 26,174 respondents had complete data for the mental health outcomes and 16,507 (63.1%) had complete data for all 49 covariates. To preserve the full sample and prevent data loss, multiple imputation was conducted with 10 imputations selected following evaluation of the missing data pattern and further assessment of using additional, 25 and 50, imputations. The imputation dataset used survey responses related to mental health outcomes, covariates of interest (eTable 1), and additional auxiliary variables selected from the mental health survey responses (eTable 2). Multiple imputation was performed using the fully conditional specification (FCS) discriminant function with the class effects option for all binary and ordered categorical variables, and the regression method for age in years limiting the range to 18 to 90 years [32]. Missing responses to each of the GAD-2, IES-6 and PHQ-9 questions were imputed; scores were re-calculated, and the mental health outcomes were dichotomized on this imputed data. The imputed data were pooled and used for all unadjusted and adjusted analyses accounting for the 10 dataset iterations [33,34].

Multivariable models were used to calculate adjusted prevalence ratios of the four mental health outcomes. To account for the large number of covariates and to improve model fit, variables

for the multivariable models were selected using the least absolute shrinkage selection operation (LASSO) method for each mental health outcome on the complete case data [35]. Each LASSO model considered all variables listed in eTable 1 for entry in the model. Variables were selected for inclusion based on the selection model with the lowest Schwarz-Bayes criterion. Age and gender categories were included in each multivariable model, regardless if they were selected using the LASSO method.

Unadjusted and adjusted prevalence ratios (PRs) of the four mental health outcomes were calculated using Poisson regression, with 95% confidence intervals (CIs) estimated using a robust standard error. As a sensitivity analysis, multivariable modeling was also performed on complete case data. Analyses and data transformation were performed using SAS (version 9.4; Cary, NC). Data analyses were conducted from June to November 2021.

Results

Complete case descriptive results

In total, 26,174 state and local PHWs completed the survey, among whom 3,316 (12.7%) had less than one year of experience working in public health; 6,559 (25.1%) had 1–4 years of experience, and 7,125 (27.2%) had worked in public health for over 15 years (Table 1). Since COVID-19 was declared a pandemic, 22,025 (84.1%) PHWs felt supported by their coworkers and over three-fourths [20,496 (78.3%)] felt supported by their supervisor (eTable 3). Complete descriptive statistics of respondents' characteristics, the stressors they experienced, and their coping mechanisms are reported in Table 1, eTable 3, and eTable 4, respectively.

Univariate

Respondents who felt isolated and alone were 2.62–3.33 times as likely to report symptoms of depression (PR, 3.26; 95% CI, 3.10–3.43), anxiety (PR, 3.33; 95% CI, 3.15–3.52), and PTSD (PR, 2.62; 95% CI, 2.50–2.74), whereas symptoms of suicidal ideation (PR, 5.69; 95% CI, 4.98–6.51) increased five-fold for PHWs (Table 2). Furthermore, PHWs who received job-related threats (PR, 1.94; 95% CI, 1.88–2.01) or felt bullied, threatened and/or harassed due to their work (PR, 2.04; 95% CI, 1.98–2.11) reported the highest prevalence of PTSD symptoms (range of 59.0%–61.8%) (Table 3). There is a dose-response relationship between the number of stressors PHWs experienced since COVID-19 was declared a pandemic and their increased risk of reporting adverse mental health outcomes (eTable 5).

Symptoms of anxiety and depression were twice as likely to be reported by PHWs who felt unsupported by family or friends (anxiety [PR, 2.10; 95% CI, 1.97–2.24] and depression [PR, 2.25; 95% CI, 2.12–2.38]), coworkers (anxiety [PR, 2.03; 95% CI, 1.92–2.14] and depression [PR, 2.12; 95% CI, 2.01–2.23]), supervisor (anxiety [PR, 1.90; 95% CI, 1.82–1.99] and depression [PR, 1.98; 95% CI, 1.90–2.06]), or their organization (anxiety [PR, 1.96; 95% CI, 1.88–2.04] and depression [PR, 2.03; 95% CI, 1.96–2.11]). While less than a quarter of these respondents self-reported symptoms of suicidal ideation (prevalence range of 17.3%–23.8%), they were 3.37–5.21 times as likely to report symptoms of suicidal ideation compared to those who felt supported by family or friends, coworkers, supervisors, and their organization.

Of the PHWs who increased their dose of antidepressants since the pandemic declaration ($n = 3,079$), 54.8% reported symptoms of anxiety; 57.1% reported symptoms of depression; 56.6% reported symptoms of PTSD, and 18.3% reported symptoms of suicidal ideation (Table 4). PHWs who were able to take time off since COVID-19 was declared a pandemic ($n = 13,507$) reported fewer symptoms of anxiety (PR, 0.52; 95% CI, 0.50–0.54), depression (PR,

Table 1
Descriptive characteristics of respondents in complete sample

Characteristics	Overall n (%) (N = 26,174)
Anxiety*	
No	16,467 (62.9)
Yes	7,143 (27.3)
Missing	2,564 (9.8)
Depression†	
No	15,692 (60.0)
Yes	7,000 (26.7)
Missing	3,482 (13.3)
PTSD‡	
No	14,064 (53.7)
Yes	8,184 (31.3)
Missing	3,926 (15.0)
Suicidal ideation§	
No	21,358 (81.6)
Yes	1,959 (7.5)
Missing	2,857 (10.9)
Region	
Northeast	3,071 (11.7)
Midwest	7,214 (27.6)
South	8,966 (34.3)
West	5,912 (22.6)
Tribal/Territory	51 (0.2)
Missing	960 (3.7)
Lives alone	
No	20,604 (78.7)
Yes	3,433 (13.1)
Missing	2,137 (8.2)
Years working in public health	
Less than 1 year	3,316 (12.7)
1–4 years	6,559 (25.1)
5–9 years	4,868 (18.6)
10–14 years	3,216 (12.3)
15+ years	7,125 (27.2)
Missing	1,090 (4.2)
Supervisor	
No	17,085 (65.3)
Yes	7,957 (30.4)
Missing	1,132 (4.3)

* Respondents who scored ≥ 3.0 out of 6 on the 2-item General Anxiety Disorder (GAD-2) were categorized as symptomatic for anxiety.

† Respondents who scored ≥ 10.0 out of 27 on the 9-item Patient Health Questionnaire (PHQ-9) were categorized as symptomatic for depression.

‡ Respondents who scored ≥ 1.75 out of 4 on the 6-item Impact of Event Scale (IES-6) were categorized as symptomatic for post-traumatic stress disorder (PTSD).

§ Respondents who indicated that they would be better off dead or thought of hurting themselves at any time in the past 2 weeks on the PHQ-9 were categorized as symptomatic for suicidal ideation.

0.50; 95% CI, 0.48–0.52), PTSD (PR, 0.53; 95% CI, 0.51–0.54), and suicidal ideation (PR, 0.46; 95% CI, 0.42–0.50). For comparison of multiple imputed and complete case results, eTable 6 in the supplement provides complete case univariate results for all covariates.

Multivariable

In the multivariable models, we analyzed the association between work-provided resources, traumatic events, coping mechanisms, and each of the four mental health outcomes. PHWs who felt stressed due to civil unrest were more likely to report symptoms of anxiety (PR, 1.26; 95% CI, 1.18–1.34) and PTSD (PR, 1.26; 95% CI, 1.19–1.33) (Table 5). Feeling isolated and alone was a risk factor for symptoms of anxiety (PR, 1.84; 95% CI, 1.74–1.95), depression (PR, 1.84; 95% CI, 1.75–1.94), and PTSD (PR, 1.50; 95% CI, 1.43–1.57). Respondents who felt isolated and alone were three times as likely to report symptoms of suicidal ideation (PR, 3.23; 95% CI, 2.82–3.69). Those who felt disconnected from family and

Table 2
Univariate (on multiple imputed data) of self-reported mental health symptoms among state, tribal, local, and territorial public health workers during the past 2 weeks by stressors experienced, coping mechanisms, and workplace supportive benefits

Stressors experienced:	Anxiety (N = 26,174)		Depression (N = 26,174)		PTSD (N = 26,174)		Suicidal Ideation (N = 26,174)	
	Unadjusted PR (95% CI)	P value	Unadjusted PR (95% CI)	P value	Unadjusted PR (95% CI)	P value	Unadjusted PR (95% CI)	P value
Got divorced or separated	1.75 (1.63, 1.88)	<.0001	1.77 (1.66, 1.89)	<.0001	1.52 (1.43, 1.62)	<.0001	3.28 (2.87, 3.74)	<.0001
Felt stressed due to civil unrest	2.12 (2.00, 2.25)	<.0001	1.97 (1.86, 2.08)	<.0001	2.25 (2.14, 2.37)	<.0001	1.96 (1.75, 2.20)	<.0001
Felt stressed due to racial tensions	1.84 (1.74, 1.94)	<.0001	1.74 (1.65, 1.83)	<.0001	2.03 (1.94, 2.12)	<.0001	1.86 (1.68, 2.06)	<.0001
Worried about the health of family and loved ones	3.01 (2.63, 3.44)	<.0001	2.77 (2.44, 3.15)	<.0001	3.55 (3.12, 4.04)	<.0001	2.09 (1.65, 2.65)	<.0001
Death of a loved one	1.27 (1.22, 1.33)	<.0001	1.34 (1.29, 1.39)	<.0001	1.28 (1.24, 1.32)	<.0001	1.39 (1.27, 1.52)	<.0001
Felt isolated and alone	3.33 (3.15, 3.52)	<.0001	3.26 (3.10, 3.43)	<.0001	2.62 (2.50, 2.74)	<.0001	5.69 (4.98, 6.51)	<.0001
Felt disconnected from family and friends due to workload	2.87 (2.71, 3.03)	<.0001	2.90 (2.75, 3.07)	<.0001	2.91 (2.78, 3.05)	<.0001	2.97 (2.66, 3.31)	<.0001
Felt overwhelmed by workload and/or family/work balance	3.25 (3.03, 3.49)	<.0001	3.30 (3.08, 3.52)	<.0001	3.27 (3.09, 3.47)	<.0001	3.01 (2.65, 3.41)	<.0001
Felt inadequately compensated for your work	1.94 (1.85, 2.04)	<.0001	2.10 (2.00, 2.20)	<.0001	1.93 (1.85, 2.01)	<.0001	2.04 (1.85, 2.25)	<.0001
Felt unappreciated at work	2.04 (1.95, 2.13)	<.0001	2.15 (2.05, 2.25)	<.0001	1.90 (1.83, 1.97)	<.0001	2.68 (2.41, 2.98)	<.0001
Experienced stigma or discrimination due to your work	1.83 (1.75, 1.90)	<.0001	1.88 (1.81, 1.95)	<.0001	1.95 (1.89, 2.01)	<.0001	2.20 (2.02, 2.40)	<.0001
Received job-related threats due to your work	1.87 (1.79, 1.96)	<.0001	1.97 (1.89, 2.05)	<.0001	1.94 (1.88, 2.01)	<.0001	2.94 (2.67, 3.24)	<.0001
Felt bullied, threatened and/or harassed due to your work	1.97 (1.90, 2.04)	<.0001	2.00 (1.93, 2.07)	<.0001	2.04 (1.98, 2.11)	<.0001	2.56 (2.34, 2.80)	<.0001
Worried about workplace exposure to COVID-19	1.39 (1.34, 1.45)	<.0001	1.43 (1.37, 1.48)	<.0001	1.41 (1.36, 1.46)	<.0001	1.58 (1.45, 1.72)	<.0001
Perceived level of personal and work-related support:	Anxiety (N = 26,174)		Depression (N = 26,174)		PTSD (N = 26,174)		Suicidal Ideation (N = 26,174)	
	Unadjusted PR (95% CI)	P value	Unadjusted PR (95% CI)	P value	Unadjusted PR (95% CI)	P value	Unadjusted PR (95% CI)	P value
Felt unsupported by family /friends	2.10 (1.97, 2.24)	<.0001	2.25 (2.12, 2.38)	<.0001	1.72 (1.61, 1.85)	<.0001	5.21 (4.67, 5.81)	<.0001
Felt unsupported by coworkers/peers	2.03 (1.92, 2.14)	<.0001	2.12 (2.01, 2.23)	<.0001	1.64 (1.55, 1.74)	<.0001	4.91 (4.41, 5.47)	<.0001
Felt unsupported by supervisor/leadership	1.90 (1.82, 1.99)	<.0001	1.98 (1.90, 2.06)	<.0001	1.63 (1.56, 1.70)	<.0001	3.60 (3.27, 3.97)	<.0001
Felt unsupported by organization/agency	1.96 (1.88, 2.04)	<.0001	2.03 (1.96, 2.11)	<.0001	1.69 (1.63, 1.75)	<.0001	3.37 (3.09, 3.69)	<.0001
<i>Coping mechanisms:</i>								
Reached out and talked to a friend(s) to feel better	0.92 (0.85, 0.98)	.014	0.84 (0.79, 0.90)	<.0001	1.12 (1.04, 1.20)	.0027	0.51 (0.44, 0.60)	<.0001
Relied on co-worker(s) for support	0.90 (0.86, 0.94)	<.0001	0.86 (0.83, 0.90)	<.0001	1.09 (1.04, 1.13)	.0001	0.55 (0.50, 0.61)	<.0001
Used deep breathing or meditation	1.22 (1.17, 1.28)	<.0001	1.15 (1.10, 1.20)	<.0001	1.29 (1.24, 1.34)	<.0001	1.07 (0.97, 1.19)	.1702
Used prayer or other religious/spiritual practice	0.77 (0.74, 0.80)	<.0001	0.81 (0.78, 0.85)	<.0001	0.83 (0.80, 0.86)	<.0001	0.70 (0.63, 0.77)	<.0001
Contacted a counselor or therapist	1.79 (1.72, 1.86)	<.0001	1.64 (1.58, 1.70)	<.0001	1.55 (1.50, 1.60)	<.0001	2.19 (2.01, 2.39)	<.0001
Watched more TV/streamed shows more than usual	1.40 (1.32, 1.48)	<.0001	1.44 (1.36, 1.52)	<.0001	1.41 (1.34, 1.48)	<.0001	1.35 (1.16, 1.58)	.0005
Increased dose of antidepressants	2.17 (2.08, 2.26)	<.0001	2.20 (2.12, 2.29)	<.0001	1.75 (1.69, 1.81)	<.0001	3.04 (2.77, 3.35)	<.0001
Had unhealthier than usual eating habits	2.50 (2.34, 2.67)	<.0001	3.23 (2.99, 3.49)	<.0001	2.33 (2.20, 2.47)	<.0001	2.58 (2.22, 3.01)	<.0001
Coping mechanisms:	Anxiety (N = 26,174)		Depression (N = 26,174)		PTSD (N = 26,174)		Suicidal ideation (N = 26,174)	
	Unadjusted PR (95% CI)	P value	Unadjusted PR (95% CI)	P value	Unadjusted PR (95% CI)	P value	Unadjusted PR (95% CI)	P value
Started or increased alcohol consumption	1.65 (1.59, 1.71)	<.0001	1.67 (1.61, 1.73)	<.0001	1.64 (1.59, 1.70)	<.0001	1.78 (1.63, 1.95)	<.0001
Increased use of legal or illegal substances	2.00 (1.90, 2.10)	<.0001	2.00 (1.91, 2.10)	<.0001	1.79 (1.71, 1.87)	<.0001	3.45 (3.12, 3.81)	<.0001
Improved physical activity and exercise	0.76 (0.73, 0.79)	<.0001	0.63 (0.60, 0.65)	<.0001	0.83 (0.80, 0.87)	<.0001	0.70 (0.64, 0.76)	<.0001
Found yourself buying items/shopping more than usual	1.66 (1.59, 1.74)	<.0001	1.69 (1.62, 1.77)	<.0001	1.58 (1.52, 1.64)	<.0001	1.76 (1.59, 1.95)	<.0001
Worked more to relieve stress	1.43 (1.37, 1.49)	<.0001	1.43 (1.37, 1.49)	<.0001	1.61 (1.55, 1.67)	<.0001	1.44 (1.29, 1.60)	<.0001
Used humor and/or laughter	0.84 (0.78, 0.89)	<.0001	0.84 (0.79, 0.90)	<.0001	1.01 (0.95, 1.08)	.7888	0.55 (0.47, 0.64)	<.0001
<i>Workplace support/benefits:</i>								
Since COVID-19 was declared a pandemic, able to take time off	0.52 (0.50, 0.54)	<.0001	0.50 (0.48, 0.52)	<.0001	0.53 (0.51, 0.54)	<.0001	0.46 (0.42, 0.50)	<.0001
Workplace offers assistance to pay for childcare/childcare subsidy	0.93 (0.86, 1.02)	0.122	0.90 (0.82, 0.98)	.0139	0.95 (0.88, 1.03)	0.251	1.00 (0.81, 1.25)	.9682
Flexible work schedule	0.72 (0.70, 0.75)	<.0001	0.69 (0.67, 0.72)	<.0001	0.80 (0.77, 0.83)	<.0001	0.58 (0.53, 0.63)	<.0001
Workplace offers training to prevent stress or burnout	0.70 (0.67, 0.73)	<.0001	0.68 (0.65, 0.70)	<.0001	0.79 (0.76, 0.81)	<.0001	0.65 (0.58, 0.74)	<.0001
Paid time-off for personal and family needs	0.86 (0.82, 0.90)	<.0001	0.85 (0.81, 0.89)	<.0001	0.91 (0.87, 0.95)	<.0001	0.61 (0.56, 0.67)	<.0001
Workplace offers an Employee Assistance Program	0.85 (0.81, 0.88)	<.0001	0.88 (0.85, 0.92)	<.0001	0.95 (0.92, 0.99)	.0106	0.75 (0.69, 0.81)	<.0001

Abbreviations: PTSD = post-traumatic stress disorder; PR = prevalence ratio.

Table 3
Prevalence of self-reported mental health symptoms by stressors

Stressors	Anxiety (N = 26,174) Prevalence, (%)	Depression (N = 26,174) Prevalence, (%)	PTSD (N = 26,174) Prevalence, (%)	Suicidal Ideation (N = 26,174) Prevalence, (%)
Got divorced or separated	44.7	46.0	49.6	16.1
Felt stressed due to civil unrest	35.7	35.9	43.5	9.8
Felt stressed due to racial tensions	35.3	35.4	43.4	9.9
Worried about the health of family and loved ones	32.4	32.8	39.4	8.9
Death of a loved one	34.8	36.4	42.3	9.6
Felt isolated and alone	43.4	44.1	49.8	13.2
Felt disconnected from family and friends due to workload	40.3	42.4	49.0	11.1
Felt overwhelmed by workload and/or family/work balance	37.5	38.2	45.4	10.2
Felt inadequately compensated for your work	37.2	38.7	45.2	10.2
Felt unappreciated at work	39.2	40.6	46.5	11.4
Experienced stigma or discrimination due to your work	43.9	45.6	56.2	12.4
Received job-related threats due to your work	47.9	51.6	61.8	16.2
Felt bullied, threatened and/or harassed due to your work	46.7	48.3	59.0	13.8
Worried about workplace exposure to COVID-19	35.0	35.9	42.6	9.8
Felt unsupported by family /friends	51.0	59.4	53.1	21.8
Felt unsupported by coworkers/peers	52.0	57.3	52.4	23.8
Felt unsupported by supervisor/leadership	49.0	52.1	53.7	18.2
Felt unsupported by organization/agency	49.4	52.0	54.7	17.3

PR = prevalence ratio; PTSD = post-traumatic stress disorder.

Table 4
Prevalence of self-reported mental health symptoms by coping and work-related benefits

Coping Mechanisms	Anxiety (N = 26,174) Prevalence, (%)	Depression (N = 26,174) Prevalence, (%)	PTSD (N = 26,174) Prevalence, (%)	Suicidal ideation (N = 26,174) Prevalence, (%)
Reached out and talked to a friend(s) to feel better	30.5	30.7	37.5	8.1
Relied on co-worker(s) for support	30.2	30.5	38.0	7.9
Used deep breathing or meditation	32.4	32.4	39.7	8.8
Used prayer or other religious/spiritual practice	27.3	28.4	34.2	7.1
Contacted a counselor or therapist	45.5	43.7	50.6	14.5
Watched more TV/streamed shows more than usual	32.5	33.2	39.4	9.1
Increased dose of antidepressants	54.8	57.1	56.6	18.3
Had unhealthier than usual eating habits	35.6	37.4	42.7	9.9
Started or increased alcohol consumption	40.0	41.1	48.4	11.7
Increased use of legal or illegal substances	52.7	54.6	59.9	21.1
Improved physical activity and exercise	27.5	25.4	34.6	7.5
Found yourself buying items/shopping more than usual	35.8	36.9	42.8	10.1
Worked more to relieve stress	35.9	36.6	45.7	10.1
Used humor and/or laughter	30.2	30.8	37.1	8.3
Workplace support/benefits				
Assistance to pay for childcare/childcare subsidy	28.7	27.2	35.9	8.7
Flexible work schedule	27.3	27.2	34.3	7.2
Workplace offers training to prevent stress or burnout	25.2	25.0	32.4	6.7
Paid time-off for personal and family needs	29.7	30.2	36.4	7.9
Workplace offers an Employee Assistance Program	29.0	30.0	36.6	7.9

PTSD = post-traumatic stress disorder.

friends due to workload were more likely to report symptoms of mental health conditions (anxiety [PR, 1.21; 95% CI, 1.13–1.29], depression [PR, 1.20; 95% CI, 1.12–1.28], PTSD [PR, 1.24; 95% CI, 1.17–1.32], and suicidal ideation [PR, 1.27; 95% CI, 1.13–1.43]). Additionally, feeling overwhelmed by workload and/or family/work balance was a predictor for symptoms of anxiety (PR, 1.44; 95% CI, 1.33–1.56), depression (PR, 1.43; 95% CI, 1.32–1.55), and PTSD (PR, 1.44; 95% CI, 1.34–1.54). Those who felt unappreciated at work were more likely to report symptoms of suicidal ideation (PR, 1.33; 95% CI, 1.20–1.48). Receiving job-related threats due to work was a risk factor for suicidal ideation (PR, 1.38; 95% CI, 1.24–1.53), and PHWs who felt bullied and harassed due to their work were more likely to report symptoms of PTSD (PR, 1.21; 95% CI, 1.17–1.26). Feeling unsupported by their organization was an additional risk factor associated with suicidal ideation (PR, 1.66; 95% CI, 1.52–1.83). Reporting symptoms of suicidal ideation was associated with respondents who increased their dose of antidepressants (PR, 1.63; 95% CI, 1.49–1.78) or use of legal or illegal substances (PR, 1.56; 95% CI, 1.42–1.71) since COVID-19 was a declared a pandemic.

Respondents who worked for organizations that provided flexible work schedules (PR, 0.93; 95% CI, 0.90–0.97), trainings to prevent stress/burnout (PR, 0.91; 95% CI, 0.88–0.95), and Employee Assistance Program (EAP) (PR, 0.93; 95% CI, 0.90–0.97) were less likely to report symptoms of anxiety. Furthermore, trainings to prevent stress/burnout were associated with respondents who reported fewer symptoms of depression (PR, 0.89; 95% CI, 0.86–0.93) and PTSD (PR, 0.94; 95% CI, 0.91–0.98). PHWs who employed the following coping mechanisms were less likely to self-report symptoms of anxiety and depression: reached out and talked to friends (anxiety [PR, 0.87; 95% CI, 0.83–0.92] and depression [PR, 0.86; 95% CI, 0.82–0.91]), relied on co-workers for support (anxiety [PR, 0.88; 95% CI, 0.84–0.92] and depression [PR, 0.85; 95% CI, 0.82–0.89]), and improved physical activity and exercise (anxiety [PR, 0.88; 95% CI, 0.84–0.92] and depression [PR, 0.74; 95% CI, 0.72–0.77]).

Overall, respondents' ability to take time off was significantly associated with fewer mental health symptoms (anxiety [PR, 0.87; 95% CI, 0.83–0.90], depression [PR, 0.86; 95% CI, 0.83–0.89], PTSD [PR, 0.84; 95% CI, 0.81–0.88], and suicidal ideation [PR, 0.84; 95%

Table 5
Multivariable analysis (on multiple imputed data) of self-reported mental health symptoms among state, tribal, local, and territorial public health workers during the past 2 weeks by stressors experienced, coping mechanisms, and workplace supportive benefits*

Stressors experienced:	Anxiety (N = 26,174)		Depression (N = 26,174)		PTSD (N = 26,174)		Suicidal ideation (N = 26,174)	
	Adjusted PR [†] (95% CI)	P value	Adjusted PR [‡] (95% CI)	P value	Adjusted PR [§] (95% CI)	P value	Adjusted PR (95% CI)	P value
Felt stressed due to civil unrest	1.26 (1.18, 1.34)	<.0001	1.15 (1.09, 1.22)	<.0001	1.26 (1.19, 1.33)	<.0001		
Felt stressed due to racial tensions	1.07 (1.01, 1.13)	.0197	1.06 (1.01, 1.12)	.0267	1.21 (1.15, 1.28)	<.0001		
Death of a loved one	1.05 (1.02, 1.09)	.004	1.09 (1.05, 1.13)	<.0001				
Felt isolated and alone	1.84 (1.74, 1.95)	<.0001	1.84 (1.75, 1.94)	<.0001	1.50 (1.43, 1.57)	<.0001	3.23 (2.82, 3.69)	<.0001
Felt disconnected from family and friends due to workload	1.21 (1.13, 1.29)	<.0001	1.20 (1.12, 1.28)	<.0001	1.24 (1.17, 1.32)	<.0001	1.27 (1.13, 1.43)	<.0001
Felt overwhelmed by workload and/or family/work balance	1.44 (1.33, 1.56)	<.0001	1.43 (1.32, 1.55)	<.0001	1.44 (1.34, 1.54)	<.0001		
Felt inadequately compensated for your work	1.02 (0.97, 1.08)	.3922	1.10 (1.05, 1.15)	.0002	1.06 (1.02, 1.11)	.0051		
Felt unappreciated at work	1.15 (1.10, 1.20)	<.0001	1.15 (1.10, 1.21)	<.0001	1.09 (1.05, 1.13)	<.0001	1.33 (1.20, 1.48)	<.0001
Experienced stigma or discrimination due to your work	1.03 (0.99, 1.07)	.1757	1.03 (0.99, 1.08)	.1092	1.13 (1.09, 1.17)	<.0001		
Received job-related threats due to your work			1.05 (1.00, 1.10)	.0553			1.38 (1.24, 1.53)	<.0001
Felt bullied, threatened and/or harassed due to your work	1.18 (1.13, 1.23)	<.0001	1.13 (1.09, 1.17)	<.0001	1.21 (1.17, 1.26)	<.0001	1.19 (1.08, 1.32)	.0007
Worried about workplace exposure to COVID-19					1.06 (1.03, 1.10)	.0003		
<i>Perceived level of personal and work-related support:</i>								
Felt unsupported by organization/agency	1.16 (1.11, 1.21)	<.0001	1.15 (1.10, 1.19)	<.0001	1.11 (1.07, 1.15)	<.0001	1.66 (1.52, 1.83)	<.0001
Coping Mechanisms:	Anxiety (N = 26,174)		Depression (N = 26,174)		PTSD (N = 26,174)		Suicidal ideation (N = 26,174)	
	Adjusted PR [†] (95% CI)	P value	Adjusted PR [‡] (95% CI)	P value	Adjusted PR [§] (95% CI)	P value	Adjusted PR (95% CI)	P value
Reached out and talked to a friend(s) to feel better	0.87 (0.83, 0.92)	<.0001	0.86 (0.82, 0.91)	<.0001				
Relied on co-worker(s) for support	0.88 (0.84, 0.92)	<.0001	0.85 (0.82, 0.89)	<.0001			0.65 (0.59, 0.71)	<.0001
Used deep breathing or meditation					1.06 (1.03, 1.10)	.0005		
Used prayer or other religious/spiritual practice	0.96 (0.92, 1.00)	.036					0.93 (0.86, 1.00)	.0458
Contacted a counselor or therapist	1.17 (1.13, 1.22)		1.11 (1.07, 1.15)	<.0001	1.08 (1.04, 1.11)	<.0001	1.20 (1.10, 1.30)	<.0001
Increased dose of antidepressants	1.33 (1.28, 1.39)	<.0001	1.33 (1.28, 1.39)	<.0001	1.16 (1.12, 1.20)	<.0001	1.63 (1.49, 1.78)	<.0001
Had unhealthier than usual eating habits	1.36 (1.28, 1.45)	<.0001	1.75 (1.63, 1.88)	<.0001	1.33 (1.26, 1.40)	<.0001		
Started or increased alcohol consumption	1.11 (1.07, 1.15)	<.0001	1.13 (1.09, 1.17)	<.0001	1.13 (1.10, 1.17)	<.0001	1.12 (1.03, 1.21)	.0055
Increased use of legal or illegal substances	1.14 (1.09, 1.20)	<.0001	1.17 (1.11, 1.22)	<.0001	1.13 (1.09, 1.18)	<.0001	1.56 (1.42, 1.71)	<.0001
Improved physical activity and exercise	0.88 (0.84, 0.92)	<.0001	0.74 (0.72, 0.77)	<.0001				
Found yourself buying items/shopping more than usual	1.12 (1.07, 1.17)	<.0001	1.17 (1.13, 1.22)	<.0001	1.12 (1.08, 1.16)	<.0001		
Worked more to relieve stress	1.08 (1.04, 1.12)	.0002	1.08 (1.04, 1.12)	<.0001	1.16 (1.12, 1.20)	<.0001		
Workplace Support/Benefits:	Anxiety (N = 26,174)		Depression (N = 26,174)		PTSD (N = 26,174)		Suicidal Ideation (N = 26,174)	
	Adjusted PR [†] (95% CI)	P value	Adjusted PR [‡] (95% CI)	P value	Adjusted PR [§] (95% CI)	P value	Adjusted PR (95% CI)	P value
Since COVID-19 was declared a pandemic, able to take time off	0.87 (0.83, 0.90)	<.0001	0.86 (0.83, 0.89)	<.0001	0.84 (0.81, 0.88)	<.0001	0.84 (0.77, 0.92)	.0001
Flexible work schedule	0.93 (0.90, 0.97)	.0003	0.93 (0.89, 0.96)	<.0001				
Workplace offers training to prevent stress or burnout	0.91 (0.88, 0.95)	<.0001	0.89 (0.86, 0.93)	<.0001	0.94 (0.91, 0.98)	.0033		
Workplace offers an Employee Assistance Program	0.93 (0.90, 0.97)	.0002						

PR = prevalence ratio; PTSD = post-traumatic stress disorder.

* Empty cells are variables considered for inclusion in multivariable model but not selected using LASSO method. Age groups and gender were included in all multivariable models, even if not selected by LASSO method. Other demographic variables considered for inclusion in multivariable models were: race/ethnicity, level of education, region, living alone, years worked in public health, supervisory role, public facing position, >75% time working COVID-19 response, and hours worked per week categories.

[†] Multivariable model on anxiety adjusted for age group, gender, >75% time working on COVID-19; in addition to stressors experienced, coping mechanisms and workplace benefits included in table.

[‡] Multivariable model on depression adjusted for age group, gender, >75% time working on COVID-19; in addition to stressors experienced, coping mechanisms and workplace benefits included in table.

[§] Multivariable model on PTSD adjusted for age groups, gender, >75% time working on COVID-19; in addition to stressors experienced, coping mechanisms and workplace benefits included in table.

^{||} Multivariable model on suicidal ideation adjusted for age group, and gender; in addition to stressors experienced, coping mechanisms and workplace benefits included in table.

CI, 0.77–0.92]). Additionally, all covariates remained significant in the multiple imputed and complete case analyses (eTable 7).

Discussion

The findings of this study described the impact of the COVID-19 pandemic on the mental health of U.S. STLT PHWs reported during March 29 – April 16, 2021. Our results found that feeling isolated and alone was a risk factor for reporting symptoms of anxiety, depression, PTSD, and especially suicidal ideation among STLT PHWs responding to the COVID-19 outbreak. Fifty-three percent of PHWs (14,051) felt disconnected from their family and friends because of their workload and 12,944 (49.5%) reported feeling isolated and alone [22]. Furthermore, respondents who did not feel supported by their organization or felt unappreciated at work had a higher risk for reporting symptoms of suicidal ideation. Our finding highlights the significance of loneliness and isolation as a predictor of adverse mental health outcomes as described in other studies [36–38].

In contrast to the challenges of loneliness and isolation, respondents who could rely on their coworkers for support or reached out to friends were less likely to report symptoms of anxiety, depression, and suicidal ideation. Social support has had a mediating role in abating symptoms of anxiety and other mental health conditions and is a strong predictor of resiliency for people who have been exposed to stressors, including COVID-19 [39–41]. Studies of COVID-19 frontline HCWs demonstrate that HCWs who felt supported by their organizational leadership, colleagues, friends, and families have fewer mental health outcomes [42,43]. Additionally, studies of various populations have demonstrated that virtual interventions and tools can reduce loneliness and isolation and build social support [44–46]. PHWs who were offered organizational support such as ability to take time off, flexible work schedule, and training to prevent stress or burnout were less likely to report symptoms of mental health conditions. Organizational implementation of flexible work schedules and trainings such as Psychological First Aid have proven to decrease stress and improve the mental health of employees [40,47]. However, due to persistent underfunding and understaffing of U.S. public health organizations, not all STLT agencies have the capabilities to provide their employees flexible work schedules, stress trainings, or general organizational support [48].

PHWs who reported receiving job-related threats or feeling bullied and/or harassed due to their work were more likely to report symptoms of PTSD or suicidal ideation. Previous research has documented negative mental health consequences due to bullying and harassment at work, and recent studies have discussed increased COVID-19-related bullying of employees such as HCWs [49–51]. While feeling overwhelmed by workload and/or work-life balance is associated with anxiety, depression, and PTSD, a study demonstrated that individuals with high levels of work-life balance were less likely to report symptoms of anxiety and depression [52].

As expected, respondents who reported improved physical activity and exercise as a coping mechanism were less likely to report symptoms of anxiety, depression, PTSD, and suicidal ideation. However, PHWs who reported they had unhealthier than usual eating habits since COVID-19 were more likely to report symptoms of all mental health outcomes compared to respondents who do not increase their unhealthy eating habits. In general, healthier lifestyles such as exercising regularly and healthy diets have been identified as protective factors against adverse mental health outcomes [53–55].

These results are in line with previous studies that have documented the prevalence of adverse mental health conditions in various populations [14–16,21–23]. Consequently, the results also indicate a higher prevalence of symptoms of PTSD among U.S. PHWs

compared to other studied populations. Symptoms of PTSD were greater in U.S. PHWs compared to findings from mental health surveys conducted with national humanitarian aid workers in Jordan (19%), Sri Lanka (19%), and Uganda (26%) [56–58]. Compared to Chinese PHWs, U.S. state and local PHWs had higher symptoms of anxiety (19.0% - China, 27.3% - U.S.) and depression (21.3% - China, 26.7% - U.S.) [23].

Since COVID-19 is an ongoing pandemic, very few longitudinal studies have documented the long-term consequences on the mental health of people such as PHWs who are continuously exposed to the traumatic stressor that is COVID-19 [59]. However, studies in humanitarian settings and of previous viral outbreaks, including SARS, MERS, and Ebola, have illustrated that exposure to chronic stressors can increase adverse mental health outcomes [10–12,56–58,60]. Consistent with the literature, PHWs experienced a dose-response relationship with stressors: the more stressors they experienced, the more likely they were to report symptoms of anxiety, depression, PTSD, and suicidal ideation.

Our study had several limitations. We recruited a convenience sample of local and state PHWs, and as a result, our findings of symptoms of adverse mental health conditions may not be generalizable to the entire U.S. public health workforce. Our data were from a cross-sectional study which required respondents to recall their experiences over various timeframes. For example, respondents were asked to self-report on their mental health during the previous one to two weeks, or experiences of traumatic events since March 2020. Therefore, our data are subject to response and recall bias. Additionally, only associations between exposure variables (self-reported stressors experienced, coping strategies, and workplace support and benefits) and outcome variables (reported symptoms of mental health conditions) can be determined rather than causal relationships. Future studies may benefit from employing a longitudinal approach in order to establish definitive cause-and-effect relationships between exposure variables and mental health conditions.

Conclusions

These findings have implications for local and state public health agencies. U.S. local and state PHWs working on COVID-19 response reported feeling isolated and alone, and as a result are at a high risk for symptoms of anxiety, depression, PTSD, and suicidal ideation. While these public health institutions are under intense strain due to years of underfunding and the prolonged response to COVID-19, it is important that agency leadership make concerted efforts to acknowledge the stress and trauma PHWs are experiencing and take meaningful action to reduce their sense of loneliness and isolation. Organization-facilitated social support groups, virtual social interactions, and other activities that aim to reduce loneliness and isolation may be impactful on the mental health of PHWs. Public health agencies could provide other resources including trainings to prevent and manage stress and trauma, encourage the use of EAP, offer PHWs the opportunities to take time off, and allow for flexible work schedules that may further reduce symptoms of adverse mental health outcomes.

Authors' contributions

C.Y.R., R.B., and B.L.C. were responsible for the supervision of the research project. A.K., L.H., and B.L.C. conceptualized the design and analysis plan. L.H. was primarily responsible for data analysis, under the mentorship of C.R. A.K. and L.H. wrote initial drafts of the article, and all authors critically revised and edited the article for important intellectual content. All authors have reviewed and approved the final manuscript.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.annepidem.2022.07.001.

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