PSYCHIATRICS · ORIGINAL ARTICLE

Sleep patterns of US healthcare workers during the first wave of the COVID-19 pandemic

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Abstract

Purpose During the first few months of the COVID-19 outbreak, healthcare workers (HCW) faced levels of personal risk, emotional distress, and professional strain not seen in their lifetimes. This study described how these stressors influenced various aspects of their sleep patterns.

Methods From May 19 to June 20, 2020, an electronic, cross-sectional survey was administered to a convenience sample of in- and outpatient HCW in a large, nonprofit healthcare system. Respondents described the pandemic's initial impact on personal and professional life and various sleep dimensions: regularity, efficiency, duration, timing, quality, and daytime sleepiness.

Results Two hundred seven providers responded, representing 17 different healthcare roles. Most (82%) were women with a median age of 39 years (IQR1–3, 31–53). A majority of respondents (81%) worked in an inpatient setting, with half (46%) primarily on the "frontline." Approximately one-third of respondents (37%) were physicians and one-quarter (28%) were nurses. Overall, 68% of HCW reported at least one aspect of sleep worsened during the beginning of the pandemic; the most impacted were daytime sleepiness (increased in 43%) and sleep efficiency (worse in 37%). After adjusting for COVID exposure and burnout, frontline providers had twofold higher odds of poor pandemic sleep, aOR 2.53, 95%CI 1.07–5.99. Among frontline providers, physicians were fivefold more likely to develop poor pandemic sleep compared to nurses (OR 5.73, 95%CI 1.15–28.57).

Conclusions During the initial wave of COVID-19, a majority of HCW reported a decline in sleep with an increase in daytime sleepiness and insomnia. Frontline workers, specifically physicians, were at higher risk.

Keywords Pandemic · Sleep · Healthcare worker · Insomnia · COVID-19

Introduction

Well before the SARS-CoV-2 (COVID-19) pandemic, healthcare workers (HCW) in the USA were already suffering from poor sleep and high rates of professional burnout. A recently pooled data found that most (61%) nurses sleep poorly [1], and physicians, on average, get an inadequate amount of sleep due to professional demands [2]. Similarly, burnout affects at least 1 in 2 physicians [3] and is increasing in prevalence [4]. Inadequate sleep and professional burnout have been independently linked to poor patient and provider

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outcomes such as medical errors [5], and provider depression, substance abuse, and suicide [3, 6].

Unfortunately, these problems are likely magnified by the uncertainties of a once-in-a-century pandemic, including personal risk of infection and transmission to close contacts, shifting professional obligations, and financial instability [7]. Early international data found that burnout rates and poor sleep patterns among frontline HCW increased after only a few weeks of COVID-19 response in those countries with the largest initial outbreaks (China and Italy) [8, 9]. As the pandemic spread, studies in India [10], Bahrain [11], and the USA [12] have reported similar pandemic-related declines in mental health and sleep quality.

Few US studies have focused specifically on describing changes to HCW sleep patterns as the pandemic began to spread in this country. Furthermore, most HCW studies examine the pandemic impact specifically on frontline providers [12], despite the fact that outpatient practitioners are subject to similar (if not exaggerated) professional strain. Identifying HCW subpopulations who are especially vulnerable to sleep detriment, and its characterization, is necessary for the development of targeted interventions and preparation for future crises. Indeed, initiatives driving sleep and mental hygiene have been shown to have both immediate [13] and long-term consequences [14]. Even in the absence of a healthcare crisis, inadequate sleep impairs the immune system and attenuates vaccine response. As expected, data from the current outbreak found that HCW who slept an hour more than their peers had 12% lower odds of contracting COVID-19. Similarly, those with 3 or more sleep problems prior to the pandemic had 88% greater odds of catching COVID-19 [15]. Previous outbreaks have left lingering effects on the healthcare workforce in terms of post-traumatic stress and anxiety, sometimes for years [14]. The long-term effects on sleep in this and previous pandemics are not well described.

This observational, cross-sectional study was performed to describe changes in multiple aspects of sleep in HCWs in all roles during the first COVID-19 wave in one of the initial US epicenters, New York.

Material and methods

Study design and dissemination

This was an anonymous, cross-sectional survey accessed via an electronic link to the institution's RedCap (Research Electronic Data Capture, LLC) website. The local Institutional Review Board approved the project with a modified consent process to protect subject anonymity.

Eligible participants included HCW of any provider role in a large, nonprofit healthcare system affiliated with the University at Buffalo. This system encompasses six distinct hospitals and numerous outpatient facilities. When the pandemic began in the area in March 2020, daily COVID updates were uploaded on institutional website homepages and concurrently emailed to staff. These updates served to highlight epidemiologic trends, identify an expanding resource pool, and (re-)organize staff around changing policies and chains of command. Email recipients included hospital employees, affiliated community providers, faculty physicians, and trainees. For three consecutive days in May (19–21) 2020, a brief description and electronic link to the survey were included in the body of these emails. As this was a survey intended to capture a convenience sample, no personalized invitations were extended. This methodology prohibited the calculation of a true response rate.

In the 3 weeks that the survey link was left open, local COVID prevalence was increasing by approximately one hundred cases, with roughly 10–15 deaths, each day. Buffalo-area schools and non-essential business were closed and elective surgeries had all been canceled, in accordance with the New York State mandates (in effect for approximately 10 weeks).

Survey content

Demographics collected included provider role, age, ethnicity, race, sex, relationship status, and number of children in the home. Respondents reported how the pandemic changed professional, childcare, and household responsibilities (survey included as Supplement 1). Participants were asked to report how often they exhibited healthy sleep habits across six domains: Regularity ("How often do you have a set sleep schedule?"), Duration ("How often do you get 6 to 8 h of sleep per day?"), Efficiency ("How often do you spend less than 30 min awake total while trying to sleep?"), Timing ("How often are you asleep between 2 and 4 am?"), Quality ("How often do you wake up refreshed?") and Daytime Sleepiness ("How often do you stay awake all day without napping or dozing off?") [16]. A six-point Likert scale was used to quantify frequency for both pre- and intra-pandemic sleep patterns, with a higher number indicative of more frequent healthy sleep patterns. This sleep health score was chosen for its brevity and efficiency in gauging multiple aspects of sleep when compared to using individual sleep questionnaires for insomnia, sleep quality, and sleepiness. This sleep health score has been validated in large population studies and has been shown to correlate well with other measures of sleep as well as daytime health [17–21].

A composite sleep health score was calculated for both pre- and intra-pandemic patterns by dividing the point total (maximum of 30) by the number of dimensions answered (maximum of 6). To our knowledge, even though validated thresholds exist for each individual sleep dimension [17], there

are no validated thresholds of an aggregate sleep health score across all 6 dimensions that allow for good or poor sleep patterns. Utilizing an indexed composite allowed for statistical comparisons of pre- and intra-pandemic behaviors. An index of 3 (analogous to self-reporting healthy sleep at least "Often" for all dimensions) served as a cut-point in the stratification of respondents as "good" vs. "poor" sleepers. To exclude HCW who were "poor sleepers" pre-pandemic [1, 2], secondary analyses were performed without those with a pre-COVID index score less than 3. This was intended to identify HCW whose sleep was most impacted by the pandemic.

The survey contained screens for burnout, depression, and stress using an abridged Maslach Burnout Scale [22], 2-items from the Patient Health Questionnaire (PHQ), and a ten-item Perceived Stress Scale (PSS) [23], respectively. PSS scores above 12 indicated moderate to severe stress, as previously reported [23]. Frequency of habits known to impact sleep— screen time, alcohol, caffeine, and tobacco use before bed— were also elicited. Lastly, respondents were asked about occupational COVID exposure and infection status. No question was mandatory.

Statistical analysis

As an anonymous survey, answers were reviewed for plausibility but ensuring data reliability was not possible. Of note, all respondents answered more than one question so every response was included. Missing answers were omitted casewise. Data were summarized as proportions of participants responding to each question. All aspects of professional and personal life changes that were investigated in the survey were compared between the groups described above (e.g., good versus poor sleepers, frontline providers versus others). Kruskal–Wallis or Mann–Whitney U tests compared non-parametric continuous data between categorical variables. Paired t-tests compared parametric data within participants from different time points. Chi-square and odds ratios with 95% confidence intervals compared categorical variables between groups. Any comparisons between groups that reached a p-value of 0.10 were included in logistic regression analyses to control for potential confounders affecting the measures of association. For clarity and brevity, not all analyses performed were presented here. Analyses were performed using IBM SPSS software, version 25 (Chicago, IL) with significance set at a p-value < 0.05 using two-sided comparisons.

Results

Study population

Among the 207 participants, the median age was 39 years (IQR1–3, 31–53) and mostly identified as White (89.7%)

and female (82.3%). Figure 1 shows the respondent breakdown by work location (including inpatient, outpatient), and "frontline" status (defined as reporting a primary work location of an Emergency Room or Intensive Care Unit). Respondents did represent seventeen distinct roles (Table 1); however, physicians (36.7%) and nurses (27.5%) constituted the largest proportion of participants. Over half (58.2%) of respondents were married and many (42.6%) were primary caregivers to at least one child.

The survey link was sent to an email distribution list of approximately 2000 emails including expired and redundant emails for the same person. Therefore, this study population is a convenience sample of an estimated 10–20% of the target population.

Sleep patterns before and during the pandemic

Before the pandemic, most HCWs reported good (i.e., "Often" through "Always") sleep regularity (70.1%), efficiency (58.7%), duration (73.7%), and timing (74.2%), as well as a lack of daytime sleepiness (79.4%). Just under half of HCWs reported experiencing refreshing sleep "often" (48.4%). There was a significant decrease in the proportion of participants reporting frequent healthy sleep patterns during the beginning of the pandemic (Fig. 2). Over two-thirds (67.8%) had at least one sleep dimension worsen from pre-pandemic levels, with most (55%) having at least two. Nearly one in ten participants saw a decline in all six dimensions of sleep.

Two aspects of sleep saw the greatest intra-pandemic deterioration when compared to pre-COVID levels: excessive daytime sleepiness and sleep efficiency. While one-fifth of participants (20.6%) reported excessive daytime sleepiness before the pandemic, this doubled to nearly 1 in 2 (49.4%) during the pandemic ($p < 0.001$). Additionally, nearly half (42.6%) of all participants reported an increase in their frequency of daytime sleepiness during the pandemic. As a metric of insomnia, "sleep efficiency" declined in over one-third (37.4%) of respondents as the pandemic began. The number of HCW reporting good sleep efficiency "often" dropped from 58.7 to 36.7% ($p < 0.001$).

Poor sleep, defined as a composite sleep index less than 3, was found in 55% ($n = 114$) of all respondents when assessing intra-pandemic sleep behaviors. Excluding those with poor pre-pandemic sleep ($n = 79$, 38%), the comparison between those who maintained good sleep behaviors during the pandemic and those who deteriorated is shown in Table 2. Participants with higher odds of developing poor sleep habits were frontline (ICU/ER) workers (OR 2.16, 95%CI 1.01–4.61) and physicians (OR 3.30, 95%CI 1.57–6.94), especially resident physicians (OR 4.29, 95%CI 1.75–10.5). There was a trend towards poor sleep for those who reported a decrease in their work responsibilities,
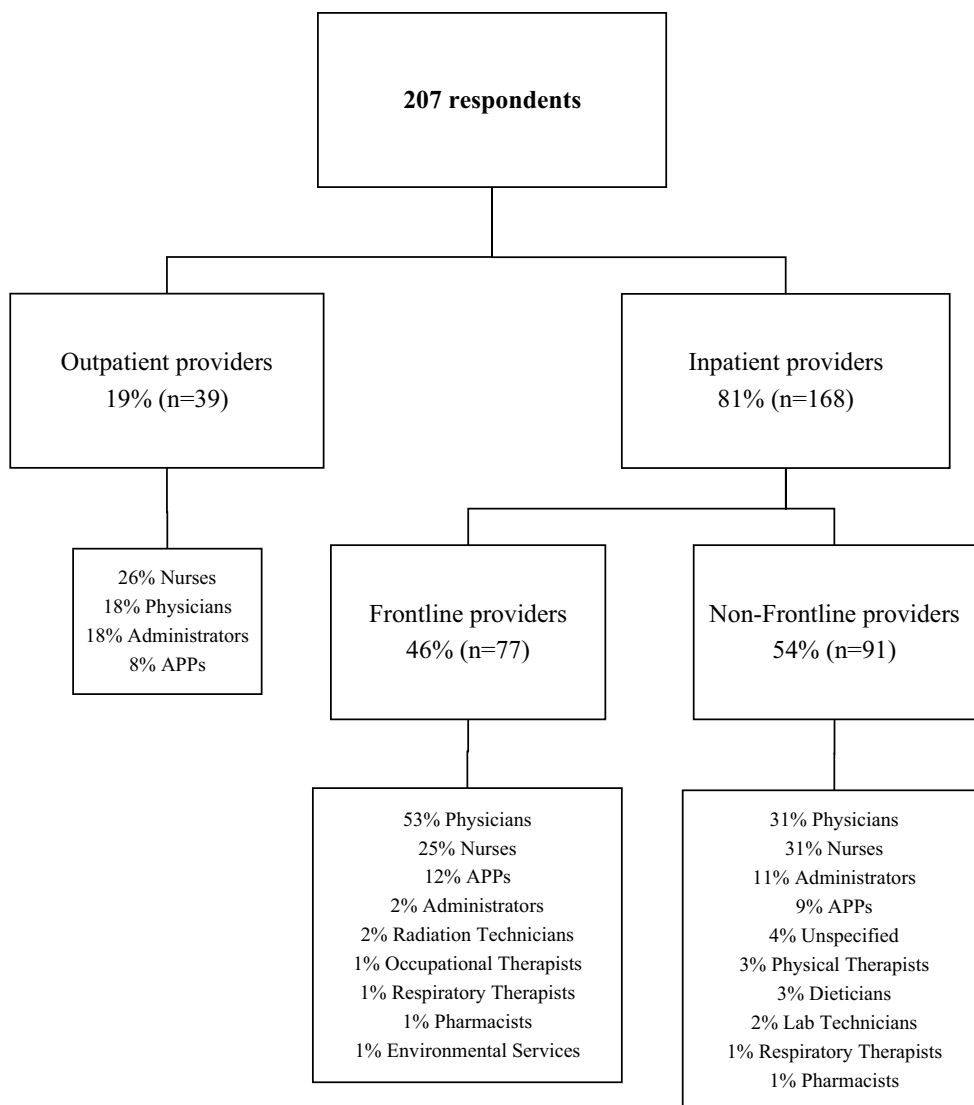
Fig. 1 Breakdown of the participants' healthcare work type and location during the first wave of the COVID-19 pandemic. Frontline providers are defined as those who reported working primarily in an emergency room or intensive care unit. APP = advanced practice provider

although this did not reach statistical significance (OR 2.15, 95%CI 0.95–4.88). Interestingly, those who indicated frequent alcohol use had significantly lower odds of poor pandemic sleep (OR 0.35, 95%CI 0.14–0.89).

After adjusting for significant differences in the groups, the sole variable independently associated with higher odds of poor pandemic sleep was "frontline" status (aOR 2.53, 95%CI 1.07–5.99). To control for the elevated COVID exposure and positive burnout screens seen in frontline providers, a logistic regression model found the association between being an ICU/ER worker and the development of poor sleep remained independent of these factors as well (aOR 2.48, 95%CI 1.01–6.09).

No statistically significant differences were found in the stress scores or frequency of burnout symptoms or depression symptoms in those with good pandemic sleep when compared to those with poor pandemic sleep (Table 2).

Personal and professional impact of the pandemic

Table 3 describes survey items relating to respondent perceptions of the impact of COVID-19. Self-reported difficulties during the pandemic were essentially universal (98% of respondents), as were changes in job requirements (81%). Nearly one-quarter (23%) of participants screened positive for depression, with the vast majority (91%) reporting an increase in the frequency of depressive emotions during the pandemic.

Half (50%) of respondents reported weekly burnout symptoms. These HCW were more likely to be residents

Table 1 Demographics of healthcare workers responding to a survey on sleep health during the first wave of the COVID-19 pandemic in Buffalo, New York

		All respondents ($n=207$)
Median age, in years		39 (31–53)
Female sex		163/198 (82.3%)
Race	White	175/195 (89.7%)
	African American	8/195 (4.1%)
	Asian	11/195 (5.6%)
Relationship status	Single	37/201 (18.4%)
	Married	117/201 (58.2%)
	Unmarried, dating	35/201 (17.4%)
	Divorced or separated	6/201 (3%)
Healthcare role	Physician	76 (36.7%)
	Registered nurse	57 (27.5%)
	Physician's assistant or advanced nurse practitioner	20 (9.7%)
	Radiology technician	2 (1%)
	Laboratory technician	5 (2.4%)
	Respiratory therapist	3 (1.4%)
	Physical or occupational therapist	5 (2.4%)
	Administration or registration staff	19 (9.2%)
	Pharmacist	2 (1%)
	Medical assistant	1 (0.5%)
	Environmental service worker	1 (0.5%)
	Registered dietician	3 (1.4%)
	Other: Educator ($n=1$), psychologist ($n=1$), research staff ($n=2$), social worker ($n=1$), information technologist ($n=1$), unspecified ($n=7$)	13 (6.3%)
Physician role	Resident	39/76 (51.3%)
	Fellow	4/76 (5.3%)
	Attending	33/76 (43.4%)
Work primarily in outpatient setting		39/204 (18.8%)
Work primarily in intensive care unit or emergency room		77/203 (37.9%)
Have at least 1 child for whom he/she is primary caregiver		86/202 (42.6%)

Data are reported as median (IQR1–3) or frequency (column proportion) unless otherwise specified

Fig. 2 The comparison of the percentage of respondents who reported good sleep habits "Often" or more in each individual aspect of sleep before the pandemic and during the beginning of the COVID-19 pandemic. Differences from before the pandemic to during the first wave were all statistically significant when compared using chi-square testing, $*p < 0.05$, $**p < 0.001$
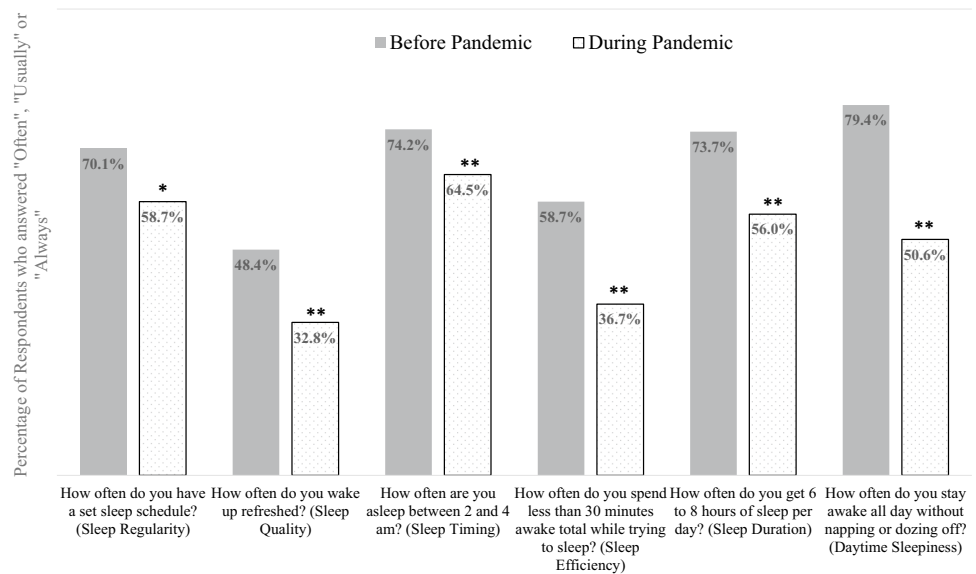
Table 2 Comparing healthcare workers with good pandemic sleep to those who developed poor pandemic sleep during the first wave of COVID-19

		Good pandemic sleep health (n = 76)	Poor pandemic sleep health (n = 52)	p	Odds ratio for poor pandemic sleep health
Median age, in years		42.5 (32–54.8)	35 (31–49.8)	0.124	
Female sex		58/74 (78%)	44/50 (88%)	0.239	
Healthcare role	Physician	21 (28%)	29 (56%)	0.107 comparing all roles	
	Registered nurse	22 (29%)	10 (19%)		
	Respiratory therapist	2 (3%)	0		
	Administration or registration	12 (16%)	3 (6%)		
	Physician's assistant or advanced nurse practitioner	6 (8%)	4 (8%)		
	Radiology technician (n = 2), laboratory technician (n = 2), educator (n = 1), researcher (n = 1), environmental services worker (n = 1), social worker (n = 1), registered dietician (n = 2), information technologist (n = 1), other (n = 6)	12 (16%)	5 (10%)		
Work primarily in intensive care unit or emergency room		19/75 (25%)	22 (42%)	0.044	OR 2.16 (95%CI 1.01–4.61, p = 0.046)
Physicians as proportion of group total		21 (28%)	29 (56%)	0.001	OR 3.30 (95%CI 1.57–6.94, p = 0.002)
Resident physicians as proportion of group total		9 (12%)	19 (37%)	0.001	OR 4.29 (95%CI 1.75–10.5, p = 0.001)
Registered nurses as proportion of group total		22 (29%)	10 (19%)	0.212	
Work primarily in outpatient setting		20 (26%)	8 (15%)	0.142	
Reported daily COVID exposure		18/72 (25%)	15/50 (30%)	0.541	
Tested COVID-positive		10 (13%)	3 (6%)	0.144*	
Relationship status	Single	13/75 (17%)	7 (14%)	0.984	
	Married	44/75 (59%)	31 (60%)		
	Dating, unmarried	13/75 (17%)	10 (19%)		
	Divorced/separated	2/75 (3%)	2 (4%)		
Race	White	65/74 (88%)	48/51 (94%)	0.482	
	African American	4/74 (5%)	1/51 (2%)		
	Asian	5/74 (7%)	2/51 (4%)		
How the pandemic has changed one's job	No change	13 (17%)	14 (27%)	0.181	
	Increased work	17 (22%)	11 (21%)	0.870	
	Decreased work	14 (18%)	17 (33%)	0.064	OR 2.15 (95%CI 0.95–4.88, p = 0.067)
	Changed primary work location	18 (24%)	8 (15%)	0.252	
	Changed job type	13 (17%)	4 (8%)	0.099*	
	Now work primarily from home	8 (11%)	5 (10%)	0.867*	
	Furloughed	1 (1%)	0	1.000*	
Have at least 1 child for whom he/she is primary caregiver		37/72 (51%)	19 (37%)	0.101	
Pandemic caused a change in child care		18/37 (49%)	12/19 (63%)	0.303	
Providing child care affected the ability to do his/her job		10/37 (27%)	7/19 (37%)	0.449	

Table 2 (continued)

	Good pandemic sleep health (n=76)	Poor pandemic sleep health (n=52)	p	Odds ratio for poor pandemic sleep health
Sleep health *before* the pandemic (out of a maximum score of 5)	3.6 (±0.7)	3.9 (±0.5)	0.004	
Sleep health *during* the pandemic	3.5 (±0.5)	2.0 (±0.6)	<0.001	
Insomnia *before* the pandemic	3 (4%)	4 (8%)	0.360	
Anxiety *before* the pandemic	20 (26%)	16 (31%)	0.582	
Depression *before* the pandemic	19 (25%)	12 (23%)	0.803	
Screened positive for depression *during* the pandemic	17/71 (24%)	8/51 (16%)	0.408	
Average PSS score	18.5 (±4.5)	17.8 (±5.2)	0.414	
PSS Score > 13 (at least moderate stress)	69 (91%)	46 (89%)	0.668	
Burnout symptoms *weekly*	43/75 (57%)	30/51 (59%)	0.868	
Drinks alcohol "Often", "Most days," or "Every day"	21/59 (36%)	8/49 (16%)	0.024	OR 0.35 (95%CI 0.14–0.89, p=0.028)
Reports using tobacco with any frequency	1/61 (2%)	5/49 (10%)	0.087	

Data are shown as frequency (column proportion) unless otherwise specified, mean (±SD) or median (IQR1–IQR3). *P*-values were obtained using independent *t*-tests, one-sided *Fisher's exact tests, or chi-square. Unadjusted odds ratios were obtained via logistic regression using those with good pandemic sleep health as the reference group. *PSS* perceived stress scale

(OR 2.99, 95%CI 1.39–6.40), frontline providers (OR 1.87, 95%CI 1.04–3.34), and/or to report pre-pandemic depression (OR 2.01, 95%CI 1.00–4.03) or anxiety (OR 1.85, 95%CI 1.00–3.34).

The mean PSS score was 18.6 (±4.6), with 91% of respondents scoring at least 13, indicative of at least moderate stress [23]. Every respondent reported changes to at least 1 PSS item during the pandemic and half (51%) reported that all ten items worsened.

Of respondents with children (*n*=86), 52% reported a loss of childcare resources during the pandemic. About one-third (30%) indicated childcare changes had a negative impact on their work. One in ten respondents had to change their primary residence during the pandemic in an attempt to insulate family members from COVID; this was associated with fourfold higher odds of weekly burnout (OR 4.372, 95%CI 1.41–13.59).

Impact of the pandemic on sleep patterns of specific providers

Of the respondents who were inpatient providers, 46% were considered frontline. Most were physicians (53%), nurses (25%), or advanced practice providers (12%) (Fig. 1). Table 4 compares the responses of frontline HCWs with those of their colleagues. Frontline providers were twice as likely to indicate poor pandemic sleep (OR 2.65, 95%CI 1.40–5.02) and weekly burnout symptoms (OR 1.87, 95%CI 1.04–3.34). Among frontline workers, physicians saw a larger change in overall sleep, translating to fivefold higher

odds of ICU/ER physicians meeting criteria for poor sleep compared to frontline nurses (OR 5.73, 95%CI 1.15–28.57).

COVID infection rates and risk factors

A total of 25 respondents (12%) reported testing positive for COVID-19 before the closure of the survey on June 10, 2020. Nurses had the highest infection rate (*n*=11, 44%). Resident physicians were more likely to be infected than fellows or attending physicians (*p*=0.033). The frequency of COVID exposure at work was not associated with reported COVID infection (*p*=0.879 when comparing infection rates at all exposure levels).

Discussion

This is one of the first studies focused on multi-dimensional sleep patterns in healthcare workers in the first few months of the COVID-19 pandemic in an American epicenter. Other studies that have reported an impact on HCW sleep in the USA have focused primarily on sleep as a secondary component of overall mental health [11] or within particular provider groups, e.g., ambulatory practitioners [24], nurses [12], and surgeons [25]. Available data describing changes to various sleep dimensions (e.g., quality, regularity) are lacking. However, appreciating this granularity is essential to achieving overall sleep health as it has been shown to directly correlate with overall health in large population studies [17]. Our data suggest that the components of sleep in HCW most impacted during the

Table 3 Description of the effects of the pandemic on healthcare workers' lives during the first wave of COVID-19

		All respondents ($n = 207$)
How the pandemic has changed one's job	Increased amount of time working	55/206 (27%)
	Decreased amount of time working	46/206 (22)
	Changed the primary work location within healthcare building(s) (e.g., reassigned from clinics to inpatient ward)	39/206 (19%)
	Changed primary work responsibilities (e.g., formerly in scheduling, now screener at hospital entrance)	24/206 (12%)
	Charged with working primarily from home	23/206 (11%)
	Furloughed	3/206 (2%)
	The pandemic has not changed my job	40/206 (19%)
Reasons why the pandemic has been difficult	Concern about self/loved ones getting sick	177 (86%)
	Increased emotional stressors	165 (80%)
	Increased work demands	116 (56%)
	Increased technology use	65 (31%)
	Increased home responsibilities	65 (31%)
	Financial difficulties	43 (21%)
	None—it has not been personally difficult	5 (2%)
Changed living arrangement to protect vulnerable family members		20/205 (10%)
Mental health questions:		
Screened positive for depression		44/191 (23%)
The frequency of the depressive symptoms changed from before the pandemic		40/44 (91%)
Burnout symptoms *weekly*		101/203 (50%)
Burnout symptoms *daily*		19/203 (9%)
Average score on the 10-item Perceived Stress Scale (PSS)		18.6 (± 4.6)
PSS > 13 (at least moderate stress)		189 (91%)
Reported changes in all 10 PSS items since onset of pandemic		105 (51%)
Having frequent nightmares		32/116 (28%)
Of the respondents with at least one child to care for at home ($n = 86$):		
The pandemic took away or changed child care plans		45/86 (52%)
There is not another adult in the home to help with child care		14/85 (17%)
Spending more than 15 min per day on helping with your children's schooling or educational tasks		53/86 (62%)
Providing child care has impacted your ability to do job		26/86 (30%)

Data are reported as mean ($\pm$ SD) or frequency (column proportion) unless otherwise specified

beginning of this crisis were sleep efficiency and daytime energy levels.

Our results are consistent with those noted in other studies, both for poor sleep habits and for rates of positive depression and burnout screens. The reported pre- and intra-pandemic rates of poor sleep health (32% and 55%, respectively) coincide with those found in a large cohort of Chinese HCWs assessed at a similar time in their outbreak [26]. Similar to our data, pandemic-related rates of depression and burnout in HCW have been reported consistently around 50% [27, 28] and elevated stress levels have been seen in nearly three-quarters of providers [28].

Internationally, the most consistently impacted healthcare workers during COVID-19 have been females, nurses, and/ or frontline providers [7, 9, 26, 28, 29]. We also found that frontline providers were largely affected by the decline in sleep. Instead of nurses, we found physicians, especially resident physicians, were more impacted than others. Trainees may be at higher risk of variations in sleep patterns due to inconsistent, shift-based schedules, relative inexperience, and a lack of autonomy, all noted to be risk factors in prior studies [14, 30]. These findings suggest that there are reproducible high-risk groups of healthcare providers that should receive interventions intended to acknowledge and improve sleep patterns during this and future crises. International studies have looked at mental health support at this time, our findings add evidence that future efforts should include sleep support as well.

Table 4 Comparison of frontline providers (intensive care unit and emergency room) healthcare workers to other respondents during the first wave of the COVID-19 pandemic

	Non-frontline providers $n=126$	Frontline providers $n=77$	p	Unadjusted odds ratio
Role	R$n=36$, MD$=35$, APP$=10$, Support staff$=45$	MD$=41$, R$n=19$, APP$=9$, Support staff$=8$	0.016	
Median age, in years	40 (31.0–53.5)	39 (31.3–53.0)	0.749	
Female sex	94/117 (80%)	66 (86%)	0.336	
Reported daily COVID exposure	24/119 (20%)	37/75 (49%)	<0.001	OR 3.854 (95%CI 2.04–7.29)
Reported having COVID	11 (9%)	14 (18%)	0.047	OR 2.323 (95%CI 0.99–5.42)
Average score on the perceived stress scale (PSS)	18.8 (±4.0)	17.9 (±5.7)	0.232	
Moderate level of stress (PSS>13)	117 (93%)	68 (88%)	0.269	
Sleep health *before* the pandemic (scale of 0 to 5)	3.3 (±0.9)	3.2 (±0.9)	0.572	
Poor sleep *before* the pandemic	41/115 (36%)	28/71 (39%)	0.604	
Sleep health *during* the pandemic	2.7 (±0.9)	2.5 (±0.8)	0.120	
Poor sleep *during* the pandemic	59/115 (51%)	53/72 (74%)	0.002	OR 2.648 (95%CI 1.40–5.02)
Burnout at least *weekly*	55/122 (45%)	46/76 (61%)	0.034	OR 1.868 (95%CI 1.04–3.34)
Reported depression symptoms "Fairly" or "Very Often"	25/115 (22%)	17/72 (24%)	0.765	
Reported depression symptoms are new during the pandemic	14/116 (12%)	4/73 (6%)	0.202[*]	

Data are presented as mean ($\pm$ standard deviation), median (IQR1–3), or frequency (column proportion, unless otherwise notated). *P*-values were obtained using *t*-tests or chi-square or *Fischer's exact tests. Odds ratios were calculated with the non-frontline HCW as the reference group. *RN* registered nurse, *MD* physician, *APP* advance practice provider

Describing the impact of an ongoing public health crisis on the sleep and mental health of healthcare workers has both immediate and long-lasting importance [31, 32]. There is a well-documented interrelation between HCW stress, distress, sleep, and health. While providers with psychological stress can manifest physical symptoms mimicking COVID infection [27], superimposing poor sleep health onto emotional strain has been linked to impaired immunity and poor vaccine response [13, 30]. This explains the international finding that less sleep during the pandemic or poor baseline sleep pre-pandemic was associated with increased odds of contracting COVID-19 [15]. Unfortunately, data from previous pandemics suggest the detriment to mental health has been a long-lasting one in affected HCW. A full 2 years after the dissipation of a previous SARS outbreak, nearly one-third of HCWs still reported pandemic-related burnout [33]. Rates of post-traumatic stress disorder among HCWs after other pandemics were reportedly as high as 40% years after their conclusion [14]. The duration of any impact on provider sleep habits remains unknown and longitudinal data are sorely needed in this area.

One of the major limitations of this study was relying on self-reporting of sleep that occurred at two time points in one survey as this introduces recall bias and potential inaccuracies. In addition, we did not collect objective sleep measures to confirm subjective sleep reports. Importantly, our study design, survey distribution, and patient population are consistent with those of other pandemic studies. In fact, nearly all (88%) studies in one and 89% in another large systematic review of studies measuring pandemic-related mental health or sleep problems were cross-sectional, electronic, and utilized convenience sampling [34, 35]. One drawback to the convenience sample approach was that it led to a small sample size which did not have statistical power to analyze data from under-represented healthcare roles such as Environmental Services workers.

Conclusions

During the first wave of the COVID-19 pandemic, healthcare workers in all roles suffered from a decline in multiple aspects of their sleep. Self-reported insomnia and daytime sleepiness were the most affected. Being a resident physician or working in an ICU or ER were associated with higher odds of poor sleep health during the beginning of the COVID-19 pandemic.

Author contribution ABH performed the study design, survey dissemination, IRB paperwork, data analysis, and primary manuscript preparation and revisions. RKB assisted with study design and manuscript preparation and revisions. AM assisted with study design, survey dissemination, and manuscript revisions.

Data availability Not applicable.

Code availability Not applicable.

Declarations

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the Institutional Review Board of the University at Buffalo and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Modified informed consent was obtained from all individual participants included in the study.

Conflict of interest The authors declare no competing interests.

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