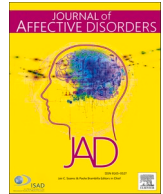




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# The association between sleep and psychological distress among New York City healthcare workers during the COVID-19 pandemic

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## ABSTRACT

**Background:** Healthcare workers (HCWs) treating patients with COVID-19 report psychological distress. We examined whether disturbed sleep was associated with psychological distress in New York City (NYC) HCWs during the initial peak of the COVID-19 pandemic (April–May 2020).

**Methods:** HCWs completed a survey screening for acute stress (4-item Primary Care PTSD screen), depressive (Patient Health Questionnaire-2), and anxiety (2-item Generalized Anxiety Disorder scale) symptoms. Insomnia symptoms (modified item from the Insomnia Severity Index) and short sleep (SS, sleep duration <6 h/day) were assessed. Poisson regression analyses predicting psychological distress from SS and insomnia symptoms, adjusting for demographics, clinical role/setting, redeployment status, shifts worked, and multiple comparisons were performed.

**Results:** Among 813 HCWs (80.6% female, 59.0% white) mean sleep duration was  $5.8 \pm 1.2$  h/night. Prevalence of SS, insomnia, acute stress, depressive, and anxiety symptoms were 38.8%, 72.8%, 57.9%, 33.8%, and 48.2%, respectively. Insomnia symptoms was associated with acute stress (adjusted prevalence ratio [PR]: 1.51, 95% CI: 1.35, 1.69), depressive (PR: 2.04, 95% CI: 1.78, 2.33), and anxiety (PR: 1.74, 95% CI: 1.55, 1.94) symptoms. SS was also associated with acute stress (PR: 1.17, 95% CI: 1.07, 1.29), depressive (PR: 1.36, 95% CI: 1.233, 1.51), and anxiety (PR: 1.38, 95% CI: 1.26, 1.50) symptoms.

**Limitations:** Our cross-sectional analysis may preclude the identification of temporal associations and limit causal claims.

**Conclusions:** In our study, SS and insomnia were associated with psychological distress symptoms in NYC HCWs during the COVID-19 pandemic. Sleep may be a target for interventions to decrease psychological distress among HCWs.

## 1. Introduction

The COVID-19 global pandemic has put a tremendous strain on healthcare systems and healthcare workers (HCWs). To combat the global pandemic, HCWs have had to work long hours, multiple shifts, and under extreme stress. Numerous studies have demonstrated that psychological distress during COVID-19 is prevalent, especially among HCWs (Pappa et al., 2020). Studies examining psychological distress in HCWs during prior infectious disease pandemics, such as the severe

acute respiratory syndrome [SARS] outbreak in 2003, have demonstrated that acute psychological distress in HCWs is associated with increased long term risk of psychological distress, including higher levels of burnout, depression, and post-traumatic stress disorder (PTSD) (Maunder et al., 2006; Lancee et al., 2008; Liu et al., 2012). Further, there are differences in psychological outcomes among frontline versus non-frontline HCWs. Several studies have demonstrated that psychological outcomes such as depression, acute stress, and anxiety may be worse among frontline versus non-frontline HCWs (Alshekaili et al.,

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2020; Shah et al., 2021; Cai et al., 2020). Additionally, psychological distress in HCWs can negatively impact the health of patients. Depression in HCWs has been associated with increased medical errors (Melnyk et al., 2018; Trockel et al., 2020). As such, calls for action to address mental health and psychological distress among HCWs are increasing (Greenberg et al., 2020; Pfefferbaum and North, 2020). Indeed, a recent bill (Kaine et al., 2020) introduced in the United States Congress calls for the development of behavioral health and well-being programs to address the mental health of HCWs during the COVID-19 pandemic. Accordingly, understanding the association between modifiable behavioral risk factors and psychological distress may provide preliminary insights for future areas of intervention development and evaluation that would stem the burden of psychological distress among HCWs during the COVID-19 pandemic and future pandemics.

Sleep is essential to mental health (Sher, 2020) and is a modifiable behavior. Disturbed sleep, including short sleep duration and insomnia, have been linked to the development and progression of psychological symptoms and disorders including anxiety (Breslau et al., 1996; Neckelmann et al., 2007; Ben Simon et al., 2020) and depression (Sun et al., 2018; Zhai et al., 2015). Further, sleep problems and insomnia can have overlapping presentations with mental health conditions. Sleep disturbances may also act as triggers or symptoms of depression and anxiety. Treatment of disturbed sleep can reduce negative psychological symptoms (Sher, 2020). Disturbed sleep and poor sleep quality have been reported during prior infectious disease outbreaks (Chow et al., 2020). Numerous studies have shown that HCWs are experiencing sleep loss and insomnia symptoms during the current COVID-19 pandemic (Lin et al., 2020; Morin and Carrier, 2020). We have previously demonstrated that the prevalence of moderate to severe sleep problems was 71% among New York City (NYC) HCWs during the COVID-19 pandemic (Shechter et al., 2020). The prevalence of poor sleep quality among HCWs during the COVID-19 pandemic has been reported to be as high as 88% (Wu and Wei, 2020). While most studies, including our previously published study, have reported the prevalence of sleep disturbances and/or psychological distress among HCWs during the COVID-19 pandemic, data regarding whether an association exists between sleep and psychological distress and how strong this association may be among US HCWs is lacking. Understanding the magnitude of the association between sleep and psychological distress is important as sleep is a modifiable behavior. Therefore, sleep could be a target for future interventions to decrease psychological distress among HCWs during the COVID-19 pandemic. We examined the associations of insomnia symptoms and separately, short sleep duration with psychological distress (elevated acute stress, depressive, and anxiety symptoms) in HCWs working in NYC in the spring of 2020, when NYC was the epicenter of the US COVID-19 pandemic (New York City Region Is Now an Epicenter of the Coronavirus Pandemic 2020).

## 2. Methods

### 2.1. Study design

The COVID-19 Healthcare Provider Study is a cross-sectional survey of HCWs within a large medical center in NYC. A detailed description of the study's design has been previously described (Shechter et al., 2020). Participants were eligible for the study if they were physicians (including residents/fellows), advanced practice providers, or registered nurses, and provided care at the medical center. In brief, participants were recruited using a standardized recruitment email with a link to an electronic Qualtrics survey. The recruitment email was sent to physicians and advanced practice providers, nurses, and housestaff/fellow listservs. The first email was sent on April 9, 2020 (at the initial peak of the COVID-19 pandemic in NYC (Ellison, 2020; Campo-Flores, 2020)), and the first participant enrolled on that date. Between then and May 11, 2020, 1247 participants enrolled in the survey, of whom 918 (73.6%) completed all questions on the survey; 105 participants had missing data

on covariates resulting in a final sample size of 813 participants for this cross-sectional analysis. During the study period, NYC and New York State had a stay-at-home order in effect (Lockdown extended for most of coronavirus-battered New York 2021). Only HCWs and other essential workers were allowed to continue to work in-person. Quarantine was mandatory for anyone exposed to, or infected with, COVID-19. The Columbia University Irving Medical Center Institutional Review Board approved the study protocol. All participants provided electronic informed consent.

### 2.2. Study survey

The survey included questions about demographics, clinical roles and assignments, and assessments of distress due to COVID-19 specific stressors, feeling a sense of meaning/purpose, coping behaviors, and perceived need/availability of wellness resources desired by HCWs. The survey also included questions assessing sleep duration and insomnia symptoms, and brief psychological screens for acute stress, depressive, and anxiety symptoms.

### 2.3. Sleep duration and insomnia symptoms questions

We used single items to assess sleep duration and the presence of insomnia symptoms with questions modified from the Pittsburgh Sleep Quality Index (PSQI) (Buysse et al., 1989) and Insomnia Severity Index (ISI) (Morin et al., 2011). Sleep duration was self-reported and assessed using the question "Over the past week, on average, how many hours of actual sleep did you get per day?" with numerical response options ranging from "0" to "10 +". The severity of insomnia symptoms was assessed using the following question: "Over the past week, what is the severity of any insomnia symptoms you experienced (e.g., poor quality sleep, difficulty falling asleep or staying asleep, waking up too early, feeling that sleep is not refreshing)?" with response options being "None," "Mild," "Moderate," "Severe," and "Very Severe." When our study was being designed and conducted in April-May 2020, New York City was in the midst of the local peak in COVID-19 patient admissions and was then the global epicenter of COVID-19 cases. Our goal was to collect data in a manner that was minimally burdensome to HCWs at the frontlines and to reduce as much as possible any interruption of clinical care during the pandemic. We therefore specifically designed a rapid sleep assessment as part of a larger questionnaire. The current single-item sleep assessment is based on the ISI and was designed to be consistent with the "insomnia problem" section of the ISI (i.e., items 1–3) which measures difficulty falling asleep, difficulty staying asleep, and problems waking up too early with a 5-point Likert scale to rate the severity (i.e., none; mild; moderate; severe; very severe) (Morin et al., 2011). Insomnia symptoms was defined as reporting "Moderate," "Severe," or "Very Severe" symptoms. Short sleep duration was defined as self-reported average past-week sleep duration <6 h/day (Cunningham et al., 2015). Non-short sleep duration was defined as self-reported sleep duration ≥ 6 h/day.

### 2.4. Psychological screen

Brief screening tools were utilized to measure acute stress symptoms, anxiety symptoms, and depressive symptoms. We used the 4-item Primary Care PTSD screen (Prins et al., 2004) (PC-PTSD, range 0–4; score ≥3 indicates a positive screen) as a marker for acute stress symptoms, as less than a month had passed since the start of the pandemic and first participant enrollment in the survey; if symptoms persist at one month, participants may develop PTSD. Positive scores on the PTSD questionnaire were not used as a diagnosis for PTSD. To assess depressive symptoms, we utilized the Patient Health Questionnaire-2 (Kroenke et al., 2003) (PHQ-2, range 0–6; score ≥3 indicates a positive screen for elevated depressive symptoms but does not confirm a diagnosis of depression). Anxiety symptoms were assessed with the 2-item

Generalized Anxiety Disorder (Kroenke et al., 2007) scale (GAD-2, range 0–6; score  $\geq 3$  indicates a positive screen for elevated anxiety symptoms but does not confirm a diagnosis of anxiety).

### 2.5. Statistical analysis

We calculated the prevalence of positive screens for elevated acute stress, depressive, and anxiety symptoms by insomnia symptom category and sleep duration category. To determine the association of insomnia symptoms and short sleep duration with psychological distress, we modeled the prevalence ratio (PR) of elevated acute stress, depressive, and anxiety symptoms using Poisson regression models. For each predictor-outcome combination (i.e., insomnia symptoms and short sleep duration with elevated acute stress, depressive, and anxiety symptoms [six combinations]), we specified an unadjusted model and a fully adjusted model (adjustment for age, sex, race/ethnicity, clinical role (physician vs. non-physician), clinical setting (working in a COVID-19-focused area, defined as working in the emergency department, intensive care unit, inpatient or outpatient COVID-19 areas vs. working in a non-COVID-19 area), redeployment status, and number of shifts worked per week. Two-tailed p-values  $< 0.05$  were considered statistically significant. All analyses were conducted using SAS 9.4 (SAS Institute, Cary, NC).

## 3. Results

A total of 813 HCWs were included in the current analysis. Participant characteristics are shown in Table 1. Participants were 80.6% female, 59.0% White, 12.1% Hispanic, and 56.0% were nurses. Over one-third of participants were redeployed from their usual clinical areas to work in COVID-19 focused settings. The average ( $\pm 1$  standard deviation) number of shifts worked per week was  $4.1 \pm 1.6$ . Mean sleep duration was  $5.8 \pm 1.2$  h/night with 38.8% reporting sleeping  $< 6$  h/night. The prevalence of insomnia symptoms was 72.8%. Overall, 57.9% of participants screened positive for elevated acute stress symptoms, 33.8% screened positive for elevated depressive symptoms, and 48.2% screened positive for elevated anxiety symptoms.

### 3.1. Association of insomnia symptoms with acute stress, depressive, and anxiety symptoms

The prevalence of a positive screen for elevated acute stress symptoms among participants with and without insomnia symptoms was 67.4% and 32.6%, respectively (PR 1.60 [95% CI 1.43, 1.78], Table 2). In the covariate-adjusted model, the prevalence of elevated acute stress symptoms for participants with insomnia symptoms remained greater than for participants without insomnia symptoms (PR 1.51 [95% CI 1.35, 1.69]).

The prevalence of a positive screen for elevated depressive symptoms among participants with and without insomnia symptoms was 41.9% and 12.2%, respectively (PR 2.18 [95% CI 1.90, 2.48], Table 3). Even after adjusting for all covariates, insomnia symptoms was associated with a doubling of the prevalence of elevated depressive symptoms (PR 2.04, [95% CI 1.78, 2.33]).

The prevalence of a positive screen for elevated anxiety symptoms among participants with and without insomnia symptoms was 57.8% and 22.6% respectively (PR 1.83 [95% CI 1.64, 2.04], Table 4). In the covariate-adjusted model, the PR for elevated anxiety symptoms for participants with versus without insomnia symptoms was 1.74 (95% CI, 1.55–1.94).

### 3.2. Association of short sleep duration with elevated acute stress, depressive, and anxiety symptoms

The prevalence of a positive screen for elevated acute stress symptoms was higher among participants sleeping  $< 6$  h/night versus those

**Table 1**

Participant characteristics in analytic sample ( $N = 813$ ).

Characteristic	N (%) or M (SD)
<b>Age range</b>	
18–24	22 (2.7%)
25–34	387 (47.6%)
35–44	191 (23.5%)
45–54	122 (15.0%)
55–64	83 (10.2%)
65–74	6 (0.7%)
$\geq 75$	2 (0.3%)
<b>Gender</b>	
Female	655 (80.6%)
<b>Race</b>	
White	480 (59.0%)
Black	69 (8.5%)
Asian	130 (16.0%)
American Indian/Native American	4 (0.5%)
Hawaiian/Pacific Islander	4 (0.5%)
More than one	50 (6.2%)
Other, unknown	76 (9.4%)
<b>Ethnicity</b>	
Non-Hispanic or Latinx	673 (82.8%)
Hispanic or Latinx	98 (12.1%)
Prefer not to answer	42 (5.2%)
<b>Clinical Role</b>	
Attending Physician	142 (17.6%)
Resident or Fellow	140 (17.2%)
Nurse	455 (56.0%)
Advanced Practice Provider*	60 (7.4%)
Other	15 (1.8%)
<b>Redeployed</b>	
Yes	286 (35.2%)
<b>Practice Setting</b>	
Emergency Department	87 (10.7%)
Intensive Care Unit	332 (40.8%)
Inpatient (non-ICU): COVID-19 focused	189 (23.3%)
Inpatient (non-ICU): not COVID-19 focused	75 (9.2%)
Outpatient: COVID-19 focused	28 (3.4%)
Outpatient: not COVID-19 focused	82 (10.1%)
Other	20 (2.5%)
<b>Number of Clinical Shifts per week <math>\pm</math> SD</b>	$4.1 \pm 1.6$
<b>Sleep Measures</b>	
Mean sleep duration, $\pm$ SD hours/night	$5.8 \pm 1.2$
Insomnia Symptoms (moderate, severe, or very severe symptoms)	592 (72.8%)
Short Sleep Duration (sleeping $< 6$ h/night)	315 (38.8%)
<b>Psychological Measures</b>	
Acute stress	471 (57.9%)
Depressive symptoms	275 (33.8%)
Anxiety	392 (48.2%)

\* Defined as nurse practitioner or physician assistant.

**Table 2**

Prevalence and prevalence ratios for acute stress associated with insomnia symptoms.

	No Insomnia Symptoms $N = 221$	Insomnia Symptoms $N = 592$
Acute stress N (%)	72 (32.6%)	399 (67.4%)
	Prevalence Ratio (95% CI)	
Model 1	1.0 (ref)	1.60 (1.43, 1.78)
Model 2	1.0 (ref)	1.51 (1.35, 1.69)

Model 1: unadjusted.

Model 2: adjusted for age, gender, race, ethnicity, clinical role (physician vs. non-physician), clinical setting, redeployment status, number of shifts worked.

sleeping  $\geq 6$  h/night (67.3% versus 52.0%, PR 1.23 [95% CI, 1.12, 1.34], Supplemental Table 1). The association of short sleep duration with acute stress remained statistically significant in the covariate-adjusted model (PR 1.17 [95% CI 1.07, 1.29]).

Among participants with short sleep duration, the prevalence of a positive screen for elevated depressive symptoms was 46.4% compared



**Table 3**

Prevalence and prevalence ratios for depressive symptoms associated with insomnia symptoms.

	No Insomnia Symptoms N = 221	Insomnia Symptoms N = 592
Depressive symptoms %	27 (12.2%)	248 (41.9%)
	Prevalence Ratio (95% CI)	
Model 1	1.0 (ref)	2.18 (1.90, 2.48)
Model 2	1.0 (ref)	2.04 (1.78, 2.33)

Model 1: unadjusted.

Model 2: adjusted for age, gender, race, ethnicity, clinical role (physician vs. non-physician), clinical setting, redeployment status, number of shifts worked.

**Table 4**

Prevalence and prevalence ratios for anxiety associated with insomnia symptoms.

	No Insomnia Symptoms N = 221	Insomnia Symptoms N = 592
Anxiety%	50 (22.6%)	342 (57.8%)
	Prevalence Ratio (95% CI)	
Model 1	1.0 (ref)	1.83 (1.64, 2.04)
Model 2	1.0 (ref)	1.74 (1.55, 1.94)

Model 1: unadjusted.

Model 2: adjusted for age, gender, race, ethnicity, clinical role (physician vs. non-physician), clinical setting, redeployment status, number of shifts worked.

to 25.9% among participants with non-short sleep duration (PR 1.46 [95% CI 1.33, 1.60], Supplemental Table 2). Short sleep duration remained positively associated with elevated depressive symptoms in the covariate-adjusted model (PR 1.36 [95% CI 1.23, 1.51]).

Participants with short sleep duration also had a higher prevalence of elevated anxiety symptoms (61.6%) compared to participants with non-short sleep duration (39.8%; PR 1.43 [1.32, 1.55], Supplemental Table 3). In the covariate-adjusted model, the PR for elevated anxiety symptoms for participants with short sleep duration versus non-short sleep duration was 1.38 (95% CI, 1.26–1.50). All results examining the association of insomnia symptoms and, separately, short sleep duration with psychological measures remained statistically significant after adjustment for multiple testing.

The association of demographic and occupational-related covariates with each outcome, across all models, are available in Supplemental Table 4. The most consistent statistically significant results were that being a physician was associated with a lower prevalence of acute stress, depressive symptoms, and anxiety symptoms; being male also tended to be associated with a lower prevalence of acute stress, depressive symptoms, and anxiety symptoms.

#### 4. Discussion

In this cross-sectional study, approximately 3 in 4 HCWs reported moderate, severe, or very severe insomnia symptoms during the initial peak of the NYC COVID-19 pandemic. More than half of those surveyed screened positive for elevated acute stress symptoms, 1 in 3 screened positive for elevated depressive symptoms, and nearly half screened positive for elevated anxiety symptoms. Insomnia symptoms was associated with a 50%, 100%, and 70% higher prevalence of elevated acute stress, depressive, and anxiety symptoms, respectively. Sleeping <6 h/night was also associated with a higher prevalence of elevated acute stress, depressive, and anxiety symptoms. Our study provides one of the initial investigations of whether insomnia symptoms and short sleep duration may be associated with the mental health of US HCWs during the early phase of a pandemic and how strong this association may be.

We and others have previously reported the prevalence of psychological distress in HCWs during the COVID-19 pandemic. In a systematic review and meta-analysis of 13 studies ( $n = 33,062$ ) conducted in April

2020 (Pappa et al., 2020), the pooled prevalence of HCWs meeting diagnostic criteria for anxiety and depression disorders during the COVID-19 pandemic was 23.2% and 22.8%, respectively. Zhang et al. (2020) demonstrated that among 1563 HCWs from Wuhan China, the initial epicenter of the COVID-19 pandemic, 73.4%, 50.7%, and 44.7% reported elevated levels of acute stress, depression, and anxiety symptoms, respectively. In our study, the prevalence of elevated acute stress, depressive, and anxiety symptoms was 57.9%, 33.8%, and 48.2%, respectively. This high prevalence may be due to the fact that NYC, like Wuhan China, was an early epicenter of the COVID-19 pandemic. However, living and working in a COVID-19 epicenter may not fully account for the high rates of psychological distress among HCWs. For example, Pappa et al. (2021) showed that in Greece, which had lower rates of COVID-19 cases during the early phase of the pandemic (May 2020–June 2020), HCWs still reported high levels of mental health distress.

In the time since female gender and working on the frontline were demonstrated to be associated with elevated acute stress, depressive, and anxiety symptoms in a large study of 1257 HCWs in China (Lai et al., 2020), there have been several calls to action to address mental health among HCWs by identifying modifiable risk factors associated with psychological distress among this group (Greenberg et al., 2020; Kaine et al., 2020). One such risk factor may be disturbed sleep. Disturbed sleep was also prevalent among HCWs during prior infectious disease epidemics, including the SARS (Su et al., 2007) and Ebola (Ji et al., 2017) outbreaks. Studies examining rates of psychological distress among HCWs and the general population during the COVID-19 pandemic have demonstrated that during the COVID-19 pandemic, HCWs have had comparable or higher rates of insomnia when compared to the general population. In a study of 1242 residents from Wuhan China, the overall prevalence of insomnia when assessed using the Athens Insomnia Scale (AIS) was 30%. HCWs ( $n = 454$ ) reported a higher rate of insomnia than non-HCWs ( $n = 788$ ; 36.6% vs. 27.0%,  $p = 0.000$ ) (Fu et al., 2020). Results from a large systematic review and meta-analysis (Jahrami et al., 2020) of studies from 13 countries demonstrated that the pooled prevalence of sleep problems in the general population was 32.3% (95% CI, 25.3–40.2%) whereas the pooled prevalence among HCWs was slightly higher although comparable (36.0%, 95% CI, 21.1–54.2%).

Among studies examining disturbed sleep and/or poor sleep quality in HCWs, the prevalence has varied, having been reported to be as high as 88.3% (Wu and Wei, 2020). In a meta-analysis of 11 studies of non-US HCWs ( $n = 18,546$ ) which assessed insomnia using different questionnaires (AIS, ISI, and PSQI), the overall prevalence was 27.8% (95% CI: 21.4–35.3,  $p < 0.001$ ) (Batra et al., 2020). In our study, the prevalence of moderate, severe, or very severe insomnia symptoms was 72.8%. While this prevalence is high, our study results are consistent with a recent survey of 1119 US HCWs that reported 70% of US HCWs during the COVID-19 pandemic had trouble sleeping (defined as “difficulty falling or staying asleep”) (America, 2021). Studies have demonstrated that older age (Zhou et al., 2020), female gender (Li et al., 2020; Şahin et al., 2020), clinical role (being a nurse) (Zhou et al., 2020), shift work (Herrero San Martin et al., 2020), and working in COVID-19 settings (Alshekaili et al., 2020; van Roekel et al., 2020) may be risk factors for poor sleep quality and insomnia among HCWs during the COVID-19 pandemic. We adjusted for these potential confounders within the current study when assessing the association between sleep and psychological distress.

Additionally, there are other factors that may affect sleep and/or cause psychological distress among HCWs. Bozan et al. (2021) demonstrated in a cross-sectional study of 248 HCWs infected with COVID-19 that sleep quality, as assessed by PSQI scores, worsened after COVID-19 infection compared to before COVID-19 infection ( $p < 0.001$ ), suggesting that there may be psychosomatic consequences of COVID-19 infection. In a recent study (Stocchetti et al., 2021) conducted in Italy during the second wave of COVID-19, approximately 60% of intensive care unit

(ICU) HCWs met the criteria for burnout. Insomnia was associated with a 2-fold higher odds of burnout in univariate analyses (odds ratio 2.98 95% CI 1.39–6.38). Prolonged exposure to COVID-19 patients may contribute to the increased burnout for ICU HCWs. A cross-sectional survey (Pappa et al., 2021) conducted across 6 different hospitals in Greece found that over 60% of HCWs surveyed experienced burnout during the COVID-19 pandemic. In that sample, the prevalence of depression symptoms, anxiety and traumatic stress were 30%, 25% and 33%, respectively. Further, fear, risk of infection, lack of protective equipment and low social support were reported as factors predictive of adverse psychological outcomes in HCWs. In contrast, Yuksel et al. (2021) demonstrated that having a partner was associated with better sleep health, which is consistent with findings from other studies showing that increased social support protects against psychological distress (Jahrami et al., 2020; Cornelius et al., 2021) and burnout (Pappa et al., 2021).

Few data are available on the association between sleep and psychological distress in HCWs during the COVID-19 pandemic. Zhang et al. (2020) demonstrated that HCWs with insomnia had a higher prevalence of elevated depressive symptoms (85.5%) compared to those without insomnia (31.0%,  $p < 0.001$ ) in a study of 1563 HCWs in China. HCWs with insomnia also had a higher prevalence of elevated anxiety symptoms (80.7%) compared to their counterparts without insomnia (24.4%,  $p < 0.001$ ). In a study (Tu et al., 2020) of 100 frontline nurses (mean age  $34.4 \pm 5.8$  years) in Wuhan China working in February 2020 during the COVID-19 pandemic, poor sleep quality in the prior month (defined as Pittsburgh Sleep Quality Index: PSQI  $> 7$ ) was associated with 3-fold higher odds of elevated depressive symptoms (assessed using PHQ-9) after adjusting for sociodemographic variables (odds ratio 3.16, 95% CI 1.17–8.52). However, some limitations of that study include its small sample size and the inclusion of only nurses. Further, neither study provide data on sleep duration and psychological distress. In our study, sleeping  $< 6$  h/night was also associated with a high prevalence of psychological distress. Interestingly, we found that the prevalence of elevated acute stress symptoms was also relatively high among those sleeping  $\geq 6$  h, a finding that needs confirmation in future studies.

While we have previously reported the prevalence of disturbed sleep and psychological distress (Shechter et al., 2020), the current study is novel and different than our previous study as it provides one of the initial investigations of the magnitude of the association of insomnia symptoms and separately, short sleep duration with the mental health of US HCWs during the COVID-19 pandemic. A recent study among 1013 US adults demonstrated that insomnia severity predicted psychological distress, specifically suicidal ideation, during the COVID-19 pandemic (Killgore et al., 2020). Whether improving sleep would directly reduce psychological distress among HCWs during the COVID-19 pandemic is currently unknown. It is well established that sleep problems can overlap with mental health conditions and/or act as triggers or symptoms of depression and anxiety. Meaklim et al. (2021) recently demonstrated that individuals experiencing insomnia symptoms originating during the COVID-19 pandemic reported higher elevated depressive, anxiety, and stress symptoms compared to individuals with pre-pandemic insomnia symptoms as well as to individuals with no insomnia symptoms. A cross sectional survey (Yuksel et al., 2021) of the general adult population across 59 countries similarly found that poorer sleep health was associated with increased depression, anxiety, and stress. Perhaps cognitive behavior therapy for insomnia (CBTI), which is an effective treatment, would be an efficacious treatment option to help reduce psychological distress among individuals including HCWs during the COVID-19 pandemic. When used to treat insomnia in non-pandemic settings, CBTI has been shown to reduce depressive symptoms in individuals experiencing both insomnia and psychological distress (Jansson-Frojmark and Norell-Clarke, 2016). Treating insomnia may be important as it has been hypothesized that disturbed sleep that develops during the COVID-19 pandemic increase the risk of long-term adverse psychological outcomes (Morin and Carrier, 2020). Longitudinal studies

to determine how insomnia and psychological distress change over time and their individual and combined impact on HCWs' well-being are needed.

#### 4.1. Strengths and limitations

The current study has several strengths. It included a large sample of HCWs with different medical backgrounds, including nurses, physicians, and advanced practice providers. As most of the literature published to date on sleep and psychological distress among HCWs during the pandemic is from non-US settings, our study adds to the growing knowledge base about the prevalence of disturbed sleep among HCWs in the US, which currently has the largest number of COVID-19 cases in the world (Covid map 2021). All sleep and psychological distress measures in our study were assessed simultaneously. The timing of assessments allowed us to study how sleep and psychological distress may be related in HCWs. However, there are several limitations of this study. As previously mentioned, our study is a cross-sectional analysis, precluding the identification of temporal associations and limiting causal claims. We also do not know the prevalence of psychological distress, or habitual sleep duration or quality, in our study sample prior to the COVID-19 pandemic. While it is feasible that the prevalence of insomnia symptoms and psychological distress may have been high among our HCWs even before the pandemic, this seems unlikely as data from other US studies show that the prevalence of disturbed sleep pre-pandemic was substantially lower. In a study of 1165 nurses at a tertiary academic center published in 2019, the prevalence of self-reported chronic insomnia was 31% (Christian et al., 2019). Further, the mean sleep duration in that study was 6.6 h/night.

Another limitation of our study is the use of a self-report measure of sleep duration, as this has been shown to have low agreement with objectively-estimated sleep (Girschik et al., 2012). We also used a single-item assessment to capture broad insomnia symptoms, as opposed to a more thorough and validated questionnaire for assessment like the ISI. This item was based on the ISI and captures many of the same symptoms (difficulty falling or staying asleep, waking up too early) on the same severity scale (none to very severe), but may be less sensitive (Jahrami et al., 2020), and therefore the prevalence of sleep disturbances may be under-reported. Further, the present single-item assessment is presumably less reliable than the ISI, causing our estimates of the association between insomnia and mental health to be attenuated (i.e., biased towards zero, and hence conservative). We also did not assess subjective measures of stress such as lack of childcare or elder care, which were likely additional sources of stress for some HCWs during the COVID-19 pandemic, and therefore there may be residual confounding. However, we did adjust for several objective work-related features that were perceived as stressful by HCWs and previously reported in the literature including clinical setting (i.e., frontline status and taking care of COVID-19 patients vs. not), redeployment status, as well as the number of shifts worked. Although our main analyses focused on the association of sleep and psychological outcomes, there were surely other explanatory factors that were deemed stressful by participants but were not measured in our study. Likely candidates include HCW burnout, Emergency Department and intensive care unit (ICU) crowding, and structural changes to the hospital workplace environment including conversion of patient wards into makeshift ICUs at our institution in order to deal with the influx of patients during the COVID-19 pandemic (Kumaraiah et al., 2020). Finally, our participants were recruited from a large medical center in NYC which may not be representative of all hospitals, and the HCWs who chose to participate in our study may not be representative of non-participating HCWs.

#### 5. Conclusions

In summary, insomnia symptoms and psychological distress were prevalent among NYC HCWs taking care of patients with COVID-19

during the initial peak of the pandemic. Sleeping < 6 h/night and having moderate, severe, or very severe insomnia symptoms were both associated with a higher prevalence of elevated acute stress symptoms, depressive symptoms, and anxiety symptoms. Future research should explore the longitudinal associations between sleep quality and psychological distress during the COVID-19 pandemic in order to develop interventions to help stem the burden of psychological distress in HCWs.

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## CRediT authorship contribution statement

**Francesca Diaz:** Methodology, Software, Data curation, Writing – original draft, Writing – review & editing. **Talea Cornelius:** Conceptualization, Methodology, Data curation, Formal analysis, Writing – original draft, Writing – review & editing. **Sean Bramley:** Data curation, Formal analysis. **Hadiah Venner:** Methodology, Data curation. **Kaitlin Shaw:** Methodology, Software, Data curation. **Melissa Dong:** Methodology, Software, Data curation, Writing – review & editing. **Patrick Pham:** Methodology, Software, Data curation. **Cara L. McMurphy:** Methodology, Software, Data curation. **Diane E. Cannone:** Conceptualization, Methodology. **Alexandra M. Sullivan:** Methodology, Writing – review & editing. **Sung A.J. Lee:** Methodology, Software, Data curation. **Joseph E. Schwartz:** Conceptualization, Methodology, Writing – review & editing. **Ari Shechter:** Conceptualization, Methodology, Writing – review & editing. **Marwah Abdalla:** Conceptualization, Methodology, Data curation, Writing – original draft, Writing – review & editing, Project administration, Supervision.

## Declaration of Competing Interest

None.

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## Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:[10.1016/j.jad.2021.10.033](https://doi.org/10.1016/j.jad.2021.10.033).

## References

- Pappa, S., Ntella, V., Giannakas, T., Giannakoulis, V.G., Papoutsis, E., Katsaounou, P., 2020. Prevalence of depression, anxiety, and insomnia among healthcare workers during the COVID-19 pandemic: a systematic review and meta-analysis. *Brain Behav. Immun.* 88, 901–907.

- Maunder, R.G., Lancee, W.J., Balderson, K.E., Bennett, J.P., Borgundvaag, B., Evans, S., Fernandes, C.M., Goldbloom, D.S., Gupta, M., Hunter, J.J., McGillis Hall, L., Nagle, L.M., Pain, C., Peczenik, S.S., Raymond, G., Read, N., Rourke, S.B., Steinberg, R.J., Stewart, T.E., VanDeVelde-Coke, S., Veldhorst, G.G., Wasylenko, D.A., 2006. Long-term psychological and occupational effects of providing hospital healthcare during SARS outbreak. *Emerg. Infect. Dis.* 12 (12), 1924–1932.
- Lancee, W.J., Maunder, R.G., Goldbloom, D.S., 2008. Coauthors for the Impact of SS. Prevalence of psychiatric disorders among Toronto hospital workers one to two years after the SARS outbreak. *Psychiatr. Serv.* 59 (1), 91–95.
- Liu, X., Kakade, M., Fuller, C.J., Fan, B., Fang, Y., Kong, J., Guan, Z., Wu, P., 2012. Depression after exposure to stressful events: lessons learned from the severe acute respiratory syndrome epidemic. *Compr. Psychiatry* 53 (1), 15–23.
- Alshekaili, M., Hassan, W., Al Said, N., Al Sulaimani, F., Jayapal, S.K., Al-Mawali, A., Chan, M.F., Mahadevan, S., Al-Adawi, S., 2020. Factors associated with mental health outcomes across healthcare settings in Oman during COVID-19: frontline versus non-frontline healthcare workers. *BMJ Open* 10 (10), e042030.
- Shah, J., Monroe-Wise, A., Talib, Z., Nabiswa, A., Said, M., Abeid, A., Ali Mohamed, M., Mohamed, S., Ali, S.K., 2021. Mental health disorders among healthcare workers during the COVID-19 pandemic: a cross-sectional survey from three major hospitals in Kenya. *BMJ Open* 11 (6), e050316.
- Cai, Q., Feng, H., Huang, J., Wang, M., Wang, Q., Lu, X., Xie, Y., Wang, X., Liu, Z., Hou, B., Ouyang, K., Pan, J., Li, Q., Fu, B., Deng, Y., Liu, Y., 2020. The mental health of frontline and non-frontline medical workers during the coronavirus disease 2019 (COVID-19) outbreak in China: a case-control study. *J. Affect. Disord.* 275, 210–215.
- Melnik, B.M., Orsolini, L., Tan, A., Arslanian-Engoren, C., Melkus, G.D.E., Dunbar-Jacob, J., Rice, V.H., Millan, A., Dunbar, S.B., Braun, L.T., Wilbur, J., DA, Chyun, G., Gawlik, K., Lewis, L.M., 2018. A national study links nurses' physical and mental health to medical errors and perceived worksite wellness. *J. Occup. Environ. Med.* 60 (2), 126–131.
- Trockel, M.T., Menon, N.K., Rowe, S.G., Stewart, M.T., Smith, R., Lu, M., Kim, P.K., Quinn, M.A., Lawrence, E., Marchalik, D., Farley, H., Normand, P., Felder, M., Dudley, J.C., Shanafelt, T.D., 2020. Assessment of physician sleep and wellness, burnout, and clinically significant medical errors. *JAMA Netw. Open* 3 (12), e2028111.
- Greenberg, N., Brooks, S.K., Wessely, S., Tracy, D.K., 2020. How might the NHS protect the mental health of health-care workers after the COVID-19 crisis? *Lancet Psychiatry* 7 (9), 733–734.
- Pfefferbaum, B., North, C.S., 2020. Mental health and the Covid-19 pandemic. *N. Engl. J. Med.* 383 (6), 510–512.
- Kaine, Young, Reed, & Cassidy Introduce Bipartisan legislation to support health care professionals' mental health amid COVID-19 2020 [2/4/2021]. Available from: <https://www.kaine.senate.gov/press-releases/kaine-young-reed-and-cassidy-introduce-bipartisan-legislation-to-support-health-care-professionals-mental-health-a-mid-covid-19>.
- Sher, L., 2020. COVID-19, anxiety, sleep disturbances and suicide. *Sleep Med.* 70, 124.
- Breslau, N., Roth, T., Rosenthal, L., Andreski, P., 1996. Sleep disturbance and psychiatric disorders: a longitudinal epidemiological study of young adults. *Biol. Psychiatry* 39 (6), 411–418.
- Neckelmann, D., Mykletun, A., Dahl, A.A., 2007. Chronic insomnia as a risk factor for developing anxiety and depression. *Sleep* 30 (7), 873–880.
- Ben Simon, E., Rossi, A., Harvey, A.G., Walker, M.P., 2020. Overanxious and underslept. *Nat. Hum. Behav.* 4 (1), 100–110.
- Sun, Y., Shi, L., Bao, Y., Sun, Y., Shi, J., Lu, L., 2018. The bidirectional relationship between sleep duration and depression in community-dwelling middle-aged and elderly individuals: evidence from a longitudinal study. *Sleep Med.* 52, 221–229.
- Zhai, L., Zhang, H., Zhang, D., 2015. Sleep duration and depression among adults: a meta-analysis of prospective studies. *Depress. Anxiety* 32 (9), 664–670.
- Chow, K.M., Law, B.M.H., Ng, M.S.N., Chan, D.N.S., So, W.K.W., Wong, C.L., Chan, C.W. H., 2020. A review of psychological issues among patients and healthcare staff during two major coronavirus disease outbreaks in China: contributory factors and management strategies. *Int. J. Environ. Res. Public Health* 17 (18).
- Lin, K., Yang, B.X., Luo, D., Liu, Q., Ma, S., Huang, R., Lu, W., Majeed, A., Lee, Y., Lui, L. M.W., Mansur, R.B., Nasri, F., Subramaniampillai, M., Rosenblatt, J.D., Liu, Z., McIntyre, R.S., 2020. The mental health effects of COVID-19 on health care providers in China. *Am. J. Psychiatry* 177 (7), 635–636.
- Morin, C.M., Carrier, J., 2020. The acute effects of the COVID-19 pandemic on insomnia and psychological symptoms. *Sleep Med.*
- Shechter, A., Diaz, F., Moise, N., Anstey, D.E., Ye, S., Agarwal, S., Birk, J.L., Brodie, D., Cannone, D.E., Chang, B., Claassen, J., Cornelius, T., Derby, L., Dong, M., Givens, R. C., Hochman, B., Homma, S., Kronish, I.M., Lee, S.A.J., Manzano, W., Mayer, L.E.S., McMurphy, C.L., Moitra, V., Pham, P., Rabbani, L., Rivera, R.R., Schwartz, A., Schwartz, J.E., Shapiro, P.A., Shaw, K., Sullivan, A.M., Vose, C., Wasson, C., Edmondson, D., Abdalla, M., 2020. Psychological distress, coping behaviors, and preferences for support among New York healthcare workers during the COVID-19 pandemic. *Gen. Hosp. Psychiatry* 66, 1–8.
- Wu, K., Wei, X., 2020. Analysis of psychological and sleep status and exercise rehabilitation of front-line clinical staff in the fight against COVID-19 in China. *Med. Sci. Monit. Basic Res.* 26, e924085.
- New York City Region Is Now an Epicenter of the Coronavirus Pandemic 2020 [2/19/2021]. Available from: <https://www.nytimes.com/2020/03/22/nyregion/Coronavirus-new-york-epicenter.html>?
- Ellison A. COVID-19 peak dates: updated projections for each state 2020 [4/30/2020]. Available from: COVID-19 peak dates: Updated projections for each state.
- Campo-Flores, A., 2020. What does a Coronavirus peak in New York Mean? Wall Street J.



- Lockdown extended for most of coronavirus-battered New York [9/01/ 2021 ]. Available from: <https://www.cbsnews.com/news/new-york-stay-at-home-extended-coronavirus-lockdown/>.
- Buyse, D.J., Reynolds 3rd, C.F., Monk, T.H., Berman, S.R., Kupfer, D.J., 1989. The Pittsburgh sleep quality index: a new instrument for psychiatric practice and research. *Psychiatry Res.* 28 (2), 193–213.
- Morin, C.M., Belleville, G., Belanger, L., Ivers, H., 2011. The Insomnia Severity Index: psychometric indicators to detect insomnia cases and evaluate treatment response. *Sleep* 34 (5), 601–608.
- Cunningham, T.J., Wheaton, A.G., Giles, W.H., 2015. The association between psychological distress and self-reported sleep duration in a population-based sample of women and men. *Sleep Disord.* 2015, 172064.
- Prins, A., Ouimette, P., Kimerling, R., R.P. C., D.S. H., Shaw-Hegwer, J., Thraillkill, A., F. D. G., Sheikh, J., 2004. The primary care PTSD screen (PC-PTSD): development and operating characteristics. *Int. J. Psychiatry Clin. Pract.* 9, 9–14.
- Kroenke, K., Spitzer, R.L., Williams, J.B., 2003. The Patient Health Questionnaire-2: validity of a two-item depression screener. *Med. Care* 41 (11), 1284–1292.
- Kroenke, K., Spitzer, R.L., Williams, J.B., Monahan, P.O., Lowe, B., 2007. Anxiety disorders in primary care: prevalence, impairment, comorbidity, and detection. *Ann. Intern. Med.* 146 (5), 317–325.
- Zhang, C., Yang, L., Liu, S., Ma, S., Wang, Y., Cai, Z., Du, H., Li, R., Kang, L., Su, M., Zhang, J., Liu, Z., Zhang, B., 2020. Survey of insomnia and related social psychological factors among medical staff involved in the 2019 novel coronavirus disease outbreak. *Front. Psychiatry* 11, 306.
- Pappa, S., Athanasiou, N., Sakkas, N., Patrinos, S., Sakka, E., Barmparessou, Z., Tsikrika, S., Adraktas, A., Pataka, A., Migdalis, I., Gida, S., Katsaounou, P., 2021. From recession to depression? prevalence and correlates of depression, anxiety, traumatic stress and burnout in healthcare workers during the COVID-19 pandemic in Greece: a multi-center, cross-sectional study. *Int. J. Environ. Res. Public Health* 18 (5).
- Lai, J., Ma, S., Wang, Y., Cai, Z., Hu, J., Wei, N., Wu, J., Du, H., Chen, T., Li, R., Tan, H., Kang, L., Yao, L., Huang, M., Wang, H., Wang, G., Liu, Z., Hu, S., 2020. Factors associated with mental health outcomes among health care workers exposed to coronavirus disease 2019. *JAMA Netw. Open* 3 (3), e203976.
- Su, T.P., Lien, T.C., Yang, C.Y., Su, Y.L., Wang, J.H., Tsai, S.L., Yin, J.C., 2007. Prevalence of psychiatric morbidity and psychological adaptation of the nurses in a structured SARS caring unit during outbreak: a prospective and periodic assessment study in Taiwan. *J. Psychiatr. Res.* 41 (1–2), 119–130.
- Ji, D., Ji, Y.J., Duan, X.Z., Li, W.G., Sun, Z.Q., Song, X.A., Meng, Y.H., Tang, H.M., Chu, F., Niu, X.X., Chen, G.F., Li, J., Duan, H.J., 2017. Prevalence of psychological symptoms among Ebola survivors and healthcare workers during the 2014–2015 Ebola outbreak in Sierra Leone: a cross-sectional study. *Oncotarget* 8 (8), 12784–12791.
- Fu, W., Wang, C., Zou, L., Guo, Y., Lu, Z., Yan, S., Mao, J., 2020. Psychological health, sleep quality, and coping styles to stress facing the COVID-19 in Wuhan, China. *Transl. Psychiatry* 10 (1), 225.
- Jahrami, H., BaHammam, A.S., Bragazzi, N.L., Saif, Z., Faris, M., Vitiello, M.V., 2020. Sleep problems during COVID-19 pandemic by population: a systematic review and meta-analysis. *J. Clin. Sleep Med.* 0(0):jcs.m.8930.
- Batra, K., Singh, T.P., Sharma, M., Batra, R., Schvaneveldt, N., 2020. Investigating the psychological impact of COVID-19 among healthcare workers: a meta-analysis. *Int. J. Environ. Res. Public Health* 17 (23).
- America M.H. The mental health of healthcare workers in COVID-19 2021 [2/5/2021]. Available from: <https://mhanational.org/mental-health-healthcare-workers-covid-19>.
- Zhou, Y., Yang, Y., Shi, T., Song, Y., Zhou, Y., Zhang, Z., Guo, Y., Li, X., Liu, Y., Xu, G., Cheung, T., Xiang, Y.T., Tang, Y., 2020. Prevalence and demographic correlates of poor sleep quality among frontline health professionals in Liaoning Province, China during the COVID-19 outbreak. *Front. Psychiatry* 11, 520.
- Li, X., Yu, H., Bian, G., Hu, Z., Liu, X., Zhou, Q., Yu, C., Wu, X., Yuan, T.F., Zhou, D., 2020. Prevalence, risk factors, and clinical correlates of insomnia in volunteer and at home medical staff during the COVID-19. *Brain Behav. Immun.* 87, 140–141.
- Şahin, M.K., Aker, S., Şahin, G., Karabekiroğlu, A., 2020. Prevalence of depression, anxiety, distress and insomnia and related factors in healthcare workers during COVID-19 pandemic in Turkey. *J. Community Health.*
- Herrero San Martin, A., Parra Serrano, J., Diaz Cambriles, T., Arias Arias, E.M., Munoz Mendez, J., Del Yerro Alvarez, M.J., Gonzalez Sanchez, M., 2020. Sleep characteristics in health workers exposed to the COVID-19 pandemic. *Sleep Med.* 75, 388–394.
- van Roekel, H., van der Fels, I.M.J., Bakker, A.B., Tummers, L.G., 2020. Healthcare workers who work with COVID-19 patients are more physically exhausted and have more sleep problems. *Front. Psychol.* 11, 625626.
- Bozan, O., Atis, S.E., Cekmen, B., Senturk, M., Kalkan, A., 2021. Healthcare workers' sleep quality after COVID-19 infection: a cross-sectional study. *Int. J. Clin. Pract.* e14772.
- Stocchetti, N., Segre, G., Zanier, E.R., Zanetti, M., Campi, R., Scarpellini, F., Clavenna, A., Bonati, M., 2021. Burnout in intensive care unit workers during the second wave of the COVID-19 pandemic: a single center cross-sectional Italian study. *Int. J. Environ. Res. Public Health* 18 (11).
- Yuksel, D., McKee, G.B., Perrin, P.B., Alzueta, E., Caffarra, S., Ramos-Usuga, D., Arango-Lasprilla, J.C., Baker, F.C., 2021. Sleeping when the world locks down: correlates of sleep health during the COVID-19 pandemic across 59 countries. *Sleep Health* 7 (2), 134–142.
- Cornelius, T., Duran, A.T., Diaz, F., Bramley, S., Shaw, K., Schwartz, J.E., Edmondson, D., Shechter, A., Abdalla, M., 2021. The association of transmission concerns and social distance from loved ones with distress in medical professionals providing care during the COVID-19 pandemic in New York City. *Fam. Syst. Health.*
- Tu, Z.H., He, J.W., Zhou, N., 2020. Sleep quality and mood symptoms in conscripted frontline nurse in Wuhan, China during COVID-19 outbreak: a cross-sectional study. *Medicine (Baltimore)* 99 (26), e20769.
- Killgore, W.D.S., Cloonan, S.A., Taylor, E.C., Fernandez, F., Grandner, M.A., Dailey, N.S., 2020. Suicidal ideation during the COVID-19 pandemic: the role of insomnia. *Psychiatry Res.* 290.
- Meaklim, H., Junge, M.F., Varma, P., Finck, W.A., Jackson, M.L., 2021. Pre-existing and post-pandemic insomnia symptoms are associated with high levels of stress, anxiety and depression globally during the COVID-19 pandemic. *J. Clin. Sleep Med.*
- Jansson-Frojmark, M., Norell-Clarke, A., 2016. Cognitive behavioural therapy for insomnia in psychiatric disorders. *Curr. Sleep Med. Rep.* 2 (4), 233–240.
- Covid map: Coronavirus cases, deaths, vaccinations by country [2/10/ 2021 ]. Available from: <https://www.bbc.com/news/world-51235105>.
- Christian, F., Muppavarapu, K., Aston, C., Bauer, C., Doshi, V., 2019. Sleep health of nursing staff in an academic medical center: results of a survey study. *Sleep* 42 (Supplement\_1), A251.
- Girschik, J., Fritsch, L., Heyworth, J., Waters, F., 2012. Validation of self-reported sleep against actigraphy. *J. Epidemiol.* 22 (5), 462–468.
- Kumaraiah D., Yip N., Ivascu N., Hill L. Innovative ICU physician care models: Covid-19 pandemic at NewYork-presbyterian 2020 [09/03/2021]. Available from: [https://catalyst.nejm.org/doi/full/10.1056/CAT.20.0158?tk=eo\\_7f79f000-09b6-4575-9694-f4aeb2a2d038\\_f27gXJKpNjb2QTz1Mj6mynPIxYRLUegXqx8](https://catalyst.nejm.org/doi/full/10.1056/CAT.20.0158?tk=eo_7f79f000-09b6-4575-9694-f4aeb2a2d038_f27gXJKpNjb2QTz1Mj6mynPIxYRLUegXqx8).