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Prevalence and risk factors of sleep disturbance in adults with underlying health conditions during the ongoing COVID-19 pandemic

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Abstract

To determine the prevalence of sleep disturbance during the coronavirus disease 2019 (COVID-19) pandemic among US adults who are more vulnerable to complications because of age and co-morbid conditions, and to identify associated sociodemographic and psychosocial factors. Cross-sectional survey linked to 3 active clinical trials and 2 cohort studies, conducted between 11/30/2020 and 3/3/2021. Five academic internal medicine practices and 2 federally qualified health centers. A total of 715 adults ages 23 to 91 years living with one or more chronic conditions. A fifth (20%) of participants reported poor sleep. Black adults were twice as likely to report poor sleep compared to Whites. Self-reported poor physical function (51%), stress (42%), depression (28%), and anxiety (36%) were also common and all significantly associated with poor sleep. Age ≥70 years and having been vaccinated for COVID-19 were protective against poor sleep. Sex, education, income, alcohol use, and employment status were not significantly associated with sleep quality. In this diverse sample of adults with chronic conditions, by race, ethnicity, and socioeconomic status, disparities in sleep health amid the ongoing pandemic were apparent. Worse physical function and mental health were associated with poor sleep and should be considered targets for health system interventions to prevent the many subsequent consequences of disturbed sleep on health outcomes. Measurements: self-reported sleep quality, physical function, stress, depression, and anxiety.

Abbreviations: AUDIT-C = the 3-question alcohol use disorders identification test, C3 = the COVID-19 & chronic conditions study, CDC = the centers for disease control and prevention, CHAI = the consumer health activation index, COPD = chronic obstructive pulmonary disease, COVID-19 = coronavirus disease 2019, FDA = US Food and Drug Administration, MESA = multi-ethnic study of atherosclerosis study, PROMIS = Patient-Reported Outcomes Information System, PROMIS-SD = Patient-Reported Outcomes Information System Sleep Disturbance Battery, PSQI = Pittsburgh sleep quality index, PSS-10 = Cohen's 10-item perceived stress scale, VOC = variant of concern.

Keywords: aging, COVID-19, racial disparity, sleep disturbance, vaccination

1. Introduction

Since the initial outbreak in December 2019, the novel coronavirus disease 2019 (COVID-19) has rapidly evolved into a worldwide pandemic,[1] infecting more than 340 million patients globally and leading to more than 5 million deaths as of January 2022.[2] This global health crisis has prompted governments to execute extraordinary restrictions and social distancing measures

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The datasets analyzed during the current study are available from the corresponding author on reasonable request.

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to mitigate the spread of infection and curtail the number of deaths, with downstream effects of severe economic downturn, job insecurity, and unemployment, and a tremendous amount of stress and anxiety for many individuals.[3–5] Substantial changes in daily routines and stressors as a result of the pandemic have also had a major impact on sleep quality, colloquially known as "coronasomnia" or the "COVID-somnia" phenomenon.[6] To date, over 40 reports from 57 countries have been published on the prevalence of sleep problems and changes in sleep patterns among the general population during COVID-19.[7–10] Unfortunately, most of these studies utilized online survey tools or smartphone-collected data,[8] which may limit the pool of potential participants to individuals with access to technologies and the skills and experience to use them effectively.[7,11] As a result, older and/or socially disadvantaged adults – those who tend to have chronic medical conditions – are markedly underrepresented across published reports.[11] In a longitudinal, population-based study of French-speaking Canadian adults where 3 quarters of participants had at least one medical condition, sleep quality, and anxiety symptoms were significantly worse during the initial, government-mandated lockdown phase of the pandemic (April/May 2020), compared to their pre-pandemic baseline. Lower social support and living alone during the lockdown were associated with worse sleep and anxiety, respectively.[9]

As the pandemic has continued to affect peoples' lives past the initial phase, little is known about the sleep quality of older adults and those with chronic conditions – individuals who are at greatest risk of severe infection and complications due to COVID-19.[12] These vulnerable adults also face heightened risk of neurocognitive and mental health problems related to social isolation and other measures intended to protect them from infection with COVID-19. Because sleep problems can further impair cognitive functioning and decision making, decrease immune response, and increase risks of accidents and mortality,[13–18] understanding the prevalence of sleep problems in higher-risk adults during the COVID-19 pandemic and identifying modifiable risk factors are critical steps necessary to strategize targeted prevention and to minimize negative health outcomes.

Therefore, the objective of this study was to determine the magnitude of sleep disturbance among adults living with one or more chronic conditions and to identify risk and protective factors that might inform future interventions.

2. Participants and Methods

2.1. Sample and procedure

The COVID-19 & Chronic Conditions (C3) study is an ongoing, longitudinal survey; for this investigation, we utilized data collected during the fifth wave of interviews that were conducted between November 30, 2020, and March 3, 2021. This cohort has been previously described in detail.[19,20] Briefly, the C3 cohort is comprised of active participants from one of 5 ongoing, National Institutes of Health-sponsored health services research projects that are taking place among 7 primary care sites (5 academic internal medicine clinics and 2 federally qualified health centers) across the greater Chicago area.

Health Literacy and Cognitive Function Among Older Adults ("LitCog"; R01AG030611) is a cohort study examining cognitive and psychosocial factors associated with self-management and outcomes of chronic disease over time among predominately older adults. Self-Management Behaviors among Chronic Obstructive Pulmonary Disease (COPD) Patients with Multi-morbidity ("COPD"; R01HL126508) is a cohort study examining cognitive and psychosocial factors associated with self-management behaviors among patients with COPD and multi-morbidity. Three randomized controlled trials – Electronic Health Records-Based Universal Medication Schedule to Improve Adherence to Complex Regimens ("Remind"; R01NR015444), A Universal Medication Schedule to Promote Adherence to Complex Drug Regimens ("Portal"; R01AG046352), and Transplant Regimen Adherence for Kidney Recipients by Engaging Information Technologies: The TAKE IT Trial ("TakeIT"; R01DK110172) – evaluate health system strategies that leverage electronic health records and available consumer technologies to improve patient adherence and safe use of complex drug regimens. These studies were selected because they enroll mostly middle-aged or older adults (range, 23–88 years) with one or more chronic conditions who therefore would be at greater risk for severe COVID-19 infection and its associated complications. The studies use common assessments, allowing for uniform measurement of many patient characteristics.

Trained research coordinators contacted study participants outside of their normally scheduled research interviews to invite them to answer a brief survey about COVID-19 by phone. After obtaining verbal consent, interviewers administered a brief survey and recorded participant responses using REDCap® survey software. All research activities were conducted by telephone for the safety of research participants and staff. The study was approved by the Northwestern University Institutional Review Board.

2.2. Measures

2.2.1. Demographic, physical health, and psychosocial characteristics. Across all 5 parent studies, there was a prior, uniform collection of participant demographics (age, sex, race/ethnicity), socioeconomic status (household income, educational attainment, employment status), and self-reported chronic conditions. All studies included a measure of health literacy, and participants were classified as having low, marginal, or adequate health literacy, as previously described in detail.[19] The Consumer Health Activation Index (CHAI) was used to determine patient activation and motivation to participate in healthcare decisions and actions.[21] The 3-question alcohol use disorders identification test (AUDIT-C) was used to detect hazardous alcohol use.[22] Limited English proficiency was determined by patients self-reporting how well they spoke English. Additionally, participants were asked about their current employment status at the time of the interview, given the widespread impact of COVID-19 on employment and jobs.[23]

Patient-Reported Outcomes Information System (PROMIS) short-form batteries were used to measure physical and mental (i.e., depression/sadness, anxiety/fear) health, as summarized in Table 1.[24–27] The raw sum score of each battery was rescaled on the PROMIS score conversion table to determine a standardized T-score where the mean of 50 represents the average level of the domain for the US general adult population and every 10 points represents 1 standard deviation from the mean.[28] A threshold of 0.5 standard deviation from the population mean (i.e., T-score > 55 or T-score < 45) was used to define the presence or absence of low physical function, depression, and anxiety.[29,30]

2.2.2. Sleep quality. The primary outcome of interest was sleep quality, which was measured using the Patient-Reported Outcomes Information System 4-item short-form battery for sleep disturbance (PROMIS-SD). PROMIS-SD items assess self-reported perceptions of sleep quality, sleep depth, and restoration associated with sleep. This includes perceived difficulties and concerns with getting to sleep and staying asleep, as well as perceptions of the adequacy of sleep. Higher scores represent poorer sleep quality. The PROMIS-SD T-score has been calibrated against Pittsburgh Sleep Quality Index (PSQI),[31] a popular measure of sleep quality, with a publicly available conversion table.[32] While PROMIS-SD and PSQI measure a similar construct (i.e., sleep quality), as supported by convergent validity of 0.83, PROMIS-SD was shown to have a

Table 1

Patient-Reported Outcome Measurement Information System (PROMIS) measures.

Target domain	PROMIS battery	Details	Impairment definition
Sleep	Short Form v1.0 Sleep Disturbance 4a	Self-reported perceptions of sleep quality, sleep depth, restoration associated with sleep	T-score > 55
Physical function	Short Form v2.0 Physical Function 10a	Self-reported capability to carry out instrumental activities of daily living	T-score < 45
Depression/sadness	Short Form v1.0 Depression 4a	Affective and cognitive manifestation of depression	T-score > 55
Anxiety/fear	Short Form v1.0 Anxiety 8a	Fear, anxious misery, hyperarousal, and related somatic symptoms	T-score > 55

Patient-Reported Outcomes Information System (PROMIS) short-form batteries were used to measure physical and mental health. The raw sum score of each battery was rescaled on the PROMIS score conversion table to determine standardized T-score where the mean of 50 represents the average level of the domain for US general adult population and every ten points represent one standard deviation (SD) from the mean. A threshold of 0.5 SD from the population mean was used to define the presence or absence of sleep disturbance (T-score >55), low physical function (T-score < 45), and symptoms of depression and anxiety (T-score >55).

greater measurement precision than PSQI despite having fewer total items.[33]

For our primary analysis, a developer-recommended threshold of 0.5 standard deviation from the population mean (i.e., T-score > 55) was used to define the presence or absence of poor sleep (Table 1).[29,30] A T-score of 55 on the PROMIS-SD is equivalent to a PSQI score of >10.[32] Recognizing that many studies examining sleep quality during the pandemic have used lower PSQI scores (>5 or >7) to define impairment,[34–38] we also created alternative thresholds of PROMIS T-scores of > 45 and > 49 that were equivalent to PSQI scores of >5 and >7, respectively, for use in exploratory analyses to enable better comparisons between studies.[27]

2.2.3. COVID-19 concerns. Participants were asked whether they have or had thought they had been infected by COVID-19. An individual was considered to have had COVID-19 if they had responded "yes" to having had or thought they had been infected, and also reported having had a positive COVID-19 test. Participants were also asked about the frequency of feeling nervous or "stressed" because of the coronavirus over the past week (never, some of the time, most of the time, all of the time). Participants were considered "stressed" if they responded with "most of the time" or "all of the time". Additionally, the Cohen 10-item perceived stress scale (PSS-10), adapted to respond to perceived stress in response to COVID-19, was used to measure the perception of stress.[39] Lastly, participants were asked whether they had gotten a COVID-19 vaccine, and if yes, the number of doses and the brand. Individual vaccine eligibility was determined based on age, comorbidity, employment status, and date of interview. According to the phased approach to COVID-19 vaccination in Illinois, healthcare personnel and long-term care facility residents and staff became eligible for a COVID-19 vaccine on December 15, 2020 (Phase 1A); adults aged 65 years and older and frontline essential workers became eligible on January 25, 2021 (Phase 1B); and those aged 16 to 64 years with high-risk medical conditions became eligible on February 25, 2021 (Phase 1B Plus).[40]

2.3. Analysis

Descriptive statistics (mean with standard deviation and percentage frequencies) were calculated for all participant characteristics and survey responses. Associations between participant characteristics and self-reported sleep quality were then examined in bivariate analyses using chi-square test, Wilcoxon rank sum test, or Fisher's exact test as appropriate. Multinomial logistic regression models were used to estimate the odds ratio for the dichotomous outcome of sleep disturbance as defined above. All models included variables that were significantly associated with sleep disturbance in the bivariate analyses, sex, and parent study. Given the overlap between similar, but distinct, constructs related to psychological states and concern for overadjustment, in each model we included only one of the measures of psychological states that were significantly associated with sleep disturbance in the bivariate analyses. This resulted in 4 separate models overall: Model 1 (all covariates + perceived stress); Model 2 (all covariates + COVID-specific stress); Model 3 (all covariates + depressive symptoms); Model 4 (all covariates + anxiety symptoms). Additional exploratory analyses were then conducted to further explore the prevalence of poor sleep and its association with psychosocial characteristics using the alternative PROMIS-SD T-score thresholds listed above to define poor sleep. All statistical analyses were performed using R, version 4.0.3.[41]

3. Results

In all, 718 participants completed the Wave 5 C3 survey. Three participants (0.4%) who did not complete sleep questionnaires were excluded from this analysis, for a final sample of 715 participants. No significant difference was found between included and excluded participants, in terms of sociodemographic characteristics, parent study, or comorbidity. Table 2[26] summarizes participant characteristics, overall and for those with ("poor sleepers") or without poor sleep ("good sleepers") as defined by a PROMIS sleep disturbance T-score > 55. Participants were 65 years of age on average (SD 10), and nearly two-thirds (65%) were female. The sample was racially and ethnically diverse. Nearly a quarter of individuals (23.2%) reported an income below the poverty level, while three-fourths (75.2%) of participants were not employed at the time of the interview. All participants had at least one chronic condition, and over half (57%) had 3 or more chronic conditions.

One in five (20.4%) perceived their sleep quality to be poor. Half (50.8%) of participants reported low physical function. Moderate-to-high levels of perceived stress due to COVID-19 were observed in 42% of participants, whereas 16% endorsed feeling stressed most or all of the time because of COVID-19. Elevated anxiety (32.9%) and depressive (25.3%) symptoms were reported in approximately one-third of the participants. Median T-scores of PROMIS sleep disturbance, physical function, anxiety, and depression, were 50.5 (IQR 43.8, 54.3), 44.4 (IQR 39.4, 53), 51.2 (IQR 40.3, 57.7), and 49 (IQR 41, 55.7), respectively. At the time of interview, over one-third (34.1%) of participants were eligible for COVID-19 vaccination based on their age or comorbidity; approximately half of the eligible participants (50.8%) received at least one vaccine dose. Over half of vaccine-eligible White (56.2%) and Hispanic/Latino (58.8%) participants received at least one dose of the COVID-19 vaccine, compared to 34.8% of vaccine-eligible Black participants. Vaccination status was unknown in 66 (9.2%) participants who were interviewed before the addition of vaccination questions to the survey on January 13, 2021. Before this date, only healthcare workers, long-term care residents, and staff were eligible for a COVID-19 vaccine in Illinois. A total of 99 (14%) participants reported having had COVID-19, including 58 who were not vaccine-eligible, 18 who received at least one vaccine dose, 14 who were vaccine-eligible yet unvaccinated, and 9 whose vaccination status was unknown.

Table 2

Sample characteristics

Characteristic	Overall, N = 715[1]	Good sleepers, N = 569[1]	Poor sleepers, N = 1461	*P* value[2]
Parent study				**<.001**
TakeIT	100 (14%)	80 (14%)	20 (14%)	
LitCog	306 (43%)	257 (45%)	49 (34%)	
Portal	171 (24%)	117 (21%)	54 (37%)	
COPD	30 (4.2%)	27 (4.7%)	3 (2.1%)	
Remind	108 (15%)	88 (15%)	20 (14%)	
Age	65 (10)	65 (11)	62 (9)	**<.001**
Age group				**<.001**
<60	187 (26%)	131 (23%)	56 (38%)	
60-69	282 (39%)	223 (39%)	59 (40%)	
70+	246 (34%)	215 (38%)	31 (21%)	
Female	464 (65%)	360 (63%)	104 (71%)	.072
Race				**.005**
Non-Hispanic White	348 (49%)	295 (52%)	53 (37%)	
Non-Hispanic Black	203 (29%)	150 (27%)	53 (37%)	
Hispanic/Latino	118 (17%)	87 (15%)	31 (22%)	
Other	38 (5.4%)	32 (5.7%)	6 (4.2%)	
Limited English Proficiency	61 (8.5%)	44 (7.7%)	17 (12%)	.13
Below poverty level	166 (24%)	110 (20%)	56 (39%)	**<.001**
Education				**.007**
High school grad or less	155 (22%)	117 (21%)	38 (26%)	
Some college/technical school	171 (24%)	126 (22%)	45 (31%)	
College grad or higher	388 (54%)	326 (57%)	62 (43%)	
Health Literacy				.084
Limited	150 (21%)	111 (20%)	39 (27%)	
Marginal	163 (23%)	127 (22%)	36 (25%)	
Adequate	401 (56%)	330 (58%)	71 (49%)	
Low health activation	350 (51%)	266 (50%)	84 (59%)	.050
Employed	177 (25%)	143 (25%)	34 (23%)	.6
Number of Chronic Conditions				.8
1	171 (24%)	137 (24%)	34 (23%)	
2	137 (19%)	111 (20%)	26 (18%)	
>=3	407 (57%)	321 (56%)	86 (59%)	
Have you had COVID-19?	99 (14%)	76 (13%)	23 (16%)	.5
Stressed	116 (16%)	75 (13%)	41 (28%)	**<.001**
Hazardous drinking	429 (60%)	353 (62%)	76 (52%)	**.028**
Anxiety[3]	235 (36%)	150 (30%)	85 (62%)	**<.001**
Depression[4]	181 (28%)	104 (21%)	77 (56%)	**<.001**
Low physical function[5]	363 (51%)	259 (46%)	104 (71%)	**<.001**
PSS categories[6]				**<.001**
Low	408 (58%)	366 (65%)	42 (30%)	
Moderate	281 (40%)	190 (34%)	91 (64%)	
High	16 (2.3%)	7 (1.2%)	9 (6.3%)	
Eligible for COVID-19 vaccine[7]	244 (38%)	212 (41%)	32 (24%)	**<.001**
COVID-19 vaccination[8]	124 (19%)	110 (21%)	14 (10%)	**.004**

Participant characteristics are summarized, overall and for those with ("Poor sleepers") or without poor sleep ("Good sleepers") as defined by a PROMIS Sleep Disturbance T-score >55.

1n (%); Mean (SD)

2Pearson's Chi-squared test; Wilcoxon rank sum test; Fisher's exact test.

3PROMIS anxiety T-score > 55.

4PROMIS depression T-score > 55.

5PROMIS physical function T-score < 45.

6PSS = Perceived stress scale.

7Based on age and high-risk conditions according to the State of Illinois COVID-19 vaccination plan.

8Received at least one dose of COVID-19 vaccine.

In bivariate analyses, poor sleepers were more likely to be younger, poor, less educated, Black or Hispanic/Latino, and less likely to be vaccinated against COVID-19, as compared to good sleepers. Poor sleepers were also more likely to report anxiety, depression, stress, and poor physical function (Table 2).[26] In all multivariable models, participants who were Black (Models 1-4 ORs 2.2–2.5, all *P*< .05) and had low physical function (Models 1-4 ORs 2.4–3.3, all *P*< .05) were more likely to report poor sleep. In contrast, compared to adults <60, adults aged 60–69 had a lower likelihood of poor sleep in 3 out of 4 models (Models 1-3 ORs 0.32–0.40, all *P*< 0.05), while adults aged ≥70 years exhibited lower likelihood of poor sleep in all models (Model 1-4 ORs 0.18–0.24, all *P*< .01). Having received at least one dose of COVID-19 vaccination was associated with a lower likelihood of poor sleep in 3 out of 4 models (Models 1, 3-4 ORs 0.34–0.43, all *P*< .05). All indicators of emotional distress remained significantly associated with poor sleep after controlling for all other covariates: moderate-to-high perceived stress (Model 1: OR 6.6, 95% CI 3.5–13.1, *P*< .001), COVID-19-specific stress (Model 2: OR 2.7, 95% CI 1.32–5.29, *P*< .01), depression (Model 3: OR 4.7, 95% CI 2.51–9.16, *P*< .001), and anxiety (Model 4: OR 3.7, 95% CI 2.05–6.72, *P*< .001). (Table 3)[27]

In exploratory analyses using PROMIS T-score > 45 (equivalent to PSQI > 5) to define poor sleep, 509 (71.2%) responders

Table 3

Multivariable models.

	Model 1	Model 2	Model 3	Model 4
Variable	**OR (95% CI)**[1]	**OR (95% CI)**[1]	**OR (95% CI)**[1]	**OR (95% CI)**[1]
Age group				
<60	–	–	–	–
60–69	**0.32* (0.13, 0.77)**	**0.40* (0.17, 0.90)**	**0.40* (0.16, 0.95)**	0.43 (0.18, 1.00)
70+	**0.18** (0.06, 0.52)**	**0.21** (0.08, 0.55)**	**0.21** (0.07, 0.59)**	**0.24** (0.09, 0.67)**
Female	0.75 (0.37, 1.50)	0.95 (0.51, 1.79)	0.77 (0.40, 1.51)	0.90 (0.47, 1.74)
Race				
Non-Hispanic White	–	–	–	–
Non-Hispanic Black	**2.2* (1.05, 4.74)**	**2.2* (1.10, 4.33)**	**2.5* (1.19, 5.20)**	**2.3* (1.12, 4.78)**
Hispanic/Latino	0.60 (0.21, 1.63)	0.83 (0.31, 2.08)	0.71 (0.26, 1.83)	0.86 (0.32, 2.22)
Other	0.76 (0.11, 3.40)	0.76 (0.11, 3.13)	0.36 (0.02, 2.24)	0.41 (0.02, 2.45)
Education				
High school grad or less	–	–	---	---
Some college/technical school	1.3 (0.57, 3.27)	1.2 (0.52, 2.65)	1.1 (0.45, 2.53)	1.1 (0.49, 2.71)
College grad or higher	1.8 (0.79, 4.48)	1.3 (0.58, 2.86)	1.5 (0.67, 3.57)	1.3 (0.58, 3.08)
Below poverty level	0.63 (0.29, 1.35)	0.64 (0.31, 1.31)	0.78 (0.36, 1.64)	0.70 (0.32, 1.46)
Hazardous drinking	0.80 (0.43, 1.51)	0.91 (0.51, 1.64)	0.88 (0.48, 1.65)	0.92 (0.50, 1.73)
Low physical function[2]	**2.9** (1.43, 5.90)**	**3.3*** (1.76, 6.46)**	**2.6** (1.30, 5.34)**	**2.4* (1.20, 4.84)**
COVID-19 vaccination[3]	**0.43* (0.19, 0.92)**	0.52 (0.24, 1.06)	**0.34* (0.14, 0.77)**	**0.36* (0.15, 0.80)**
PSS moderate/high stress[4]	**6.6*** (3.50, 13.1)**			
Stressed		**2.7** (1.32, 5.29)**		
Depression[5]			**4.7*** (2.51, 9.16)**	
Anxiety[6]				**3.7** (2.05, 6.72)**

Multivariable models including the parent study, age, sex, race, education, poverty, hazardous drinking, low physical function, COVID-19 vaccination, and one of the measures of psychological distress (moderate-to-high level of perceived stress, COVID-19-specific stress, depression symptoms, anxiety symptoms) are summarized.

All models included the parent study as a covariate. OR = odds ratio; CI = confidence interval.

1

* $P < .05$;

** $P < .01$;

*** $P < .001$.

2PROMIS Physical Function T-score < 45.

3Received at least one dose of COVID-19 vaccine.

4PSS = Perceived Stress Scale.

5PROMIS Depression T-score > 55.

6PROMIS Anxiety T-score > 55.

were categorized as poor sleepers (see Table S1, Supplementary Digital Content, http://links.lww.com/MD/H360, which demonstrates characteristics of participants categorized as good vs. poor sleepers using the threshold of PROMIS T-score >45). Based on a threshold of PROMIS T-score > 49 (equivalent to PSQI > 7), 372 (52%) were categorized as poor sleepers (see Table S2, Supplementary Digital Content, http://links.lww.com/MD/H361, which demonstrates the characteristics of participants categorized as good vs. poor sleepers using the threshold of PROMIS T-score >49). Similar to the primary analysis, age ≥70 years was protective against poor sleep while stress, depression, anxiety, and low physical function remained independent predictors of poor sleep in multivariable models (see Table S3 and Table S4, Supplementary Digital Content, http://links.lww.com/MD/H362, which demonstrate multivariable models to predict poor sleep defined by PROMIS T-score >45 and >49, respectively). Race and COVID-19 vaccination status were no longer associated with poor sleep as defined by these lower PROMIS thresholds.

4. Discussion

The pandemic has been influencing lives across the globe at an unprecedented scale since late 2019, and its negative effects on sleep quality and emotional well-being have been widely rep orted.[7,9,10,18,42] However, prior studies have primarily focused on the general public or utilized online survey methods, which have limited generalizability to older adults who are at greater COVID-19 risk due to age and/or comorbid medical conditions. The main objective of this study was to extend upon the existing literature by examining the prevalence of self-reported sleep disturbances among mostly older, higher-risk adults with one or more chronic medical conditions during the prolonged phase of the COVID-19 pandemic, and to identify factors associated with sleep quality. Within this sample, one in 5 participants reported poor sleep. Black participants were more than twice as likely to report poor sleep compared to their White counterparts in multivariable models. Impaired physical function, perceived stress, and symptoms of anxiety and depression were highly prevalent, and all were significantly associated with poor sleep. Older age and having received at least one dose of the COVID-19 vaccine were protective against poor sleep.

Our finding that Black adults were more likely to experience sleep disturbance during the COVID-19 pandemic is consistent with disparities observed before the pandemic. In the Multi-Ethnic Study of Atherosclerosis (MESA) study, older Black adults were more likely to have objectively measured sleep apnea syndrome, short sleep duration, poor sleep quality, and daytime sleepiness, as compared with their White counterparts.[43] In other studies, despite having poorer overall sleep quality by objective measures, Black Americans were less likely to report sleep complaints than Whites.[44,45]

It is important to note that data analyzed in the present study were collected between November 30 of 2020 and March 3 of 2021. During this time frame, the US Food and Drug Administration (FDA) approved 2 mRNA COVID-19 vaccines under emergency use authorization (Pfizer-BoiNTech Vaccine on December 11, 2020, and Moderna Vaccine on December 18, 2020) and the initial wave of inoculation began.

While a series of positive vaccine trials and targeted vaccine distribution in older adults and those with chronic conditions might have resulted in a positive impact on sleep and mood in general, racial/ethnic differences in vaccine availability and acceptance may have contributed to the observed disparity in sleep quality. Only 34.8% of vaccine-eligible Black participants had received at least one dose of COVID-19 vaccine in this study, compared to 56.2% of White participants. Racial/ethnic disparity in COVID-19 vaccination has been widely recognized, with Black and Hispanic individuals having received smaller shares of vaccinations compared to their shares of cases, deaths, and the total population in more than half of states in the United States that report data to the Centers for Disease Control and Prevention (CDC), including Illinois.[46] The present study illustrates a pattern partially consistent with the national trend in the initial wave of vaccination. Since then, growing shares of vaccinations have been going to Black and Hispanic adults between March 1 and September 20, 2021.[46] Separately from the timeline of vaccination, it may be worth noting the emergence of SARS-CoV-2 variants. During the time frame of this study, Alpha, the first of the highly publicized variants, comprised 17.3% of all sequenced samples in the United States[47] and was on its upward trajectory to becoming the dominant variant through May 2021, after being classified as a variant of concern (VOC) by CDC on December 29, 2020.[48] A follow-up examination of the ongoing C3 study sample will be useful in understanding the interaction between vaccination, virus variants, demographic and psychosocial factors, and sleep quality.

Over half of the participants in this study reported impaired physical functioning, which was associated with over 2-fold higher odds of poor sleep. Although we are unable to determine directionality of this association due to a cross-sectional design, the relationship between physical function and sleep quality is likely bi-directional.[49] Individuals with low physical function may have reduced activity levels and an increased risk of physical discomfort and pain, all of which are risk factors for poor sleep quality. In a study by Morin et al, adults with reduced physical activity during the early months of the pandemic reported higher insomnia severity, compared to those with unchanged or increased physical activity.[9] On the other hand, poor sleep quality in older adults has been associated with earlier and more severe decline in physical function and development of frailty and disability in instrumental activities of daily living.[49–52] Therefore, the combination of poor sleep and impaired physical functioning in higher-risk adults may accelerate functional decline and increase the risk for losing functional independence. In addition to impaired physical functioning, psychological distress was also significantly associated with poor sleep. For instance, adults with elevated stress, depression, and anxiety levels were anywhere from 2- to nearly 7 times more likely to report poor sleep compared to those without such symptoms. This finding is consistent with prior reports from younger adults during COVID-19 pandemic.[42] Interestingly, in a study of 667 participants aged 16 to 91 years using online surveys, psychological distress such as negative affect and worry was associated with changes in sleep quality throughout the pandemic; more psychological distress in pre-pandemic good sleepers was associated with worsening sleep quality whereas less psychological distress in pre-pandemic poor sleepers was associated with improved sleep quality during the pandemic.[10] Therefore, recognizing both the physical and psychological consequences of the ongoing pandemic on vulnerable adults and their additive effects on sleep quality may be a critical step in identifying potentially modifiable factors of worse health outcomes.

In the present study, advanced age was protective against poor sleep. While mixed findings on the effects of age on poor sleep during the COVID-19 pandemic have been reported in a younger, mostly working-age population,[7,42] limited data exist in the advanced age group. In a large international survey of over 3500 individuals conducted between March and April 2020, adults over 60 were less likely to have poor sleep.[53] The mechanism underlying age's effects on sleep quality is currently unclear. It is possible that older adults were relatively protected from drastic changes in day-to-day life compared to younger adults who were more likely to experience pandemic-related unemployment and increased burden of childcare or eldercare responsibilities. Alternatively, a potential survivor bias and more specifically a community survival effect may confound interpretation of any age effects observed here. As all older adults included in the parent studies were connected to a primary care physician and without severe cognitive impairment, the protective effects of older age may be due to attrition of low-functioning adults (who may be more vulnerable to sleep disturbances) to death or institutionalization. It should be noted, however, that in our sample, over half of the participants reported low physical function and had 3 or more chronic conditions, suggesting our sample still comprised a sizeable number of older adults with complex medical care needs.

While poor sleep was reported by 20% of participants in this study, a recent meta-analysis of sleep problems during the COVID-19 pandemic reported an estimated pooled prevalence rate of 32.3% in the general population.[7] However, significant challenges exist in comparing reported prevalence rates between studies due to heterogeneity in measures and thresholds used to define abnormality. For example, in the above meta-analysis, the most common measure of sleep quality was the PSQI, used in half of included studies. However, of the studies that used the PSQI, most used a score of >5 or >7 to define impairment,[34–38] limiting interpretability of the estimated pooled prevalence rate. The PROMIS sleep disturbance T-score >55, a developer-recommended threshold that was used in this investigation, is equivalent to PSQI > 10.[30] Thus, our analysis would not have captured individuals with milder sleep disturbance that would have been categorized to poor sleepers in other studies using either PSQI > 7 or PSQI > 5. When we applied thresholds of PROMIS T-scores that convert to PSQI > 7 and PSQI > 5, the prevalence of poor sleep increased to 52% and 71%, respectively. Therefore, the burden of sleep disturbance in this sample of higher-risk adults is at least on par with, and likely higher than, younger and healthier adults during the early peak of the pandemic. With lower thresholds to define poor sleep, most predictors of sleep quality remained significant, except for race and COVID-19 vaccination. This suggests that Black adults with one or more chronic conditions may be more vulnerable to severe, but not mild, sleep disturbance compared to their White counterparts.

This study has several limitations. Foremost, as this study was done in a subset of active participants in 5 ongoing research projects focused on primarily older adults with at least one chronic condition conducted in one large city in the United States. Thus, the results may not be generalizable to other populations, especially those who are younger and without chronic health concerns. Second, sleep data were not collected in earlier waves of the longitudinal C3 study or as part of the parent studies, limiting our ability to make comparisons to sleep quality before the pandemic or to examine how it might have changed as the pandemic progressed. Planned follow-up waves of the survey will be used to capture evolving effects of the pandemic on sleep quality among vulnerable adults. Third, objective sleep or other physiological measures were not collected, and self-reported sleep quality may underestimate racial disparity in objective sleep quality[44,45] Finally, vaccine eligibility was estimated based on age, comorbidity, interview date, and employment status. Because we did not have data on occupation, this method may have misclassified healthcare workers, long-term care staff, and frontline essential workers as vaccine-ineligible, in a small number of participants (up to 5.6%).

The strengths of this study include recruitment of higher-risk adults who are markedly under-represented in the existing

literature yet are among the most vulnerable to the ongoing effects of the pandemic. The diversity of our sample regarding socioeconomic and race/ethnicity should also be noted. In addition, the inclusion of relatively understudied factors (e.g., COVID-19 vaccination) provides a unique opportunity to examine the role of external, potentially modifiable factors in sleep health disparity during the ongoing pandemic.

5. Conclusions

In this socioeconomically and racial/ethnically diverse cohort of adults with chronic conditions, racial disparities in sleep health amid ongoing COVID-19 pandemic were apparent. Impaired physical function and mental health were associated with poor sleep, and advanced age and COVID-19 vaccination were protective against poor sleep. Public health and health system interventions should address sleep quality in the ongoing management of chronic conditions to optimize health and well-being.

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