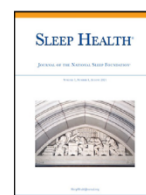


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# Sleep Health

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## Sleep disparities during the COVID-19 pandemic: An investigation of AIAN, Asian, Black, Latinx, and White young adults

Tiffany Yip, PhD\*, Ye Feng, MA, Jillianne Fowle, BA, Celia B. Fisher, PhD

Department of Psychology, Fordham University, Bronx, New York, USA

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### ABSTRACT

**Objectives:** This study investigates race-related disparities in sleep duration and quality among diverse young adults during the coronavirus 2019 (COVID-19) pandemic.

**Design & setting:** Online cross-sectional study of young adults in the United States in April 2020.

**Participants:** About 547 American Indian/Alaskan Native (AIAN), Asian, Black, Latinx, and White young adults ages 18–25 years.

**Measurements:** Participants completed measures of sleep duration and quality, coronavirus victimization distress, depression, age, sex/gender, employment status, essential worker status, student status, residential region, socioeconomic status, concerns about contracting coronavirus and CDC health risks.

**Results:** Black young adults reported the largest disparity in sleep duration and quality. For sleep duration, AIAN, Asian, White, and Latinx young adults reported approximately one additional hour of sleep compared to Black respondents. Mediation analyses suggest that disparities in sleep duration between Asian and Black young adults may be explained by the higher likelihood of Black respondents being essential workers. For sleep quality, Latinx, White, AIAN, and Asian young adults reported higher levels than Black respondents. Including coronavirus victimization distress as an intervening pathway decreased the effect for Asian and White respondents on sleep quality, suggesting that coronavirus victimization distress partially explains Black and Asian, as well as Black and White differences in sleep quality.

**Conclusions:** Black young adults reported the shortest sleep duration and lowest levels of sleep quality relative to AIAN, Asian, Latinx and White peers. Interpersonal experiences of coronavirus victimization and structural inequities may partially explain disparities during the COVID-19 pandemic.

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Disparities related to race have been observed from infancy to adulthood for various sleep indicators, including duration and quality.<sup>1–3</sup> Sleep data collected with self-report, actigraphy, and polysomnographic methods finds that Black Americans are estimated to sleep less than White Americans<sup>4–7</sup> and that these sleep disparities are linked to corresponding health disparities.<sup>8–11</sup> Science is also finding that it is not just sleep duration that matters for health, but that sleep quality has profound and possibly stronger effects.<sup>12,13</sup> In the 2020 National Sleep Foundation poll, 55% of Americans reported not sleeping well, while 44% reported not sleeping enough.<sup>7</sup> A study of pregnant women found that irrespective of sleep duration, Black women reporting poorer sleep quality were 10.2 times more likely to have a preterm birth, while no such effect of sleep quality was observed for White women.<sup>14</sup> Similarly, sleep quality has been observed to be

associated with cellular aging as indicated by telomere length,<sup>15</sup> and mitigates the association between age and telomere length.<sup>16</sup>

Less research has focused on Asian and Latinx populations<sup>6,17</sup> and much less work has focused on American Indian Alaska Natives (AIAN).<sup>18</sup> The limited research suggests that these groups suffer sleep disparities relative to White Americans<sup>18</sup>; however, the differences may be less pronounced than those between Black and White Americans.<sup>6,19–21</sup> Consonant with calls to investigate how structural and social drivers of health inequity and sleep have manifested during the coronavirus 2019 (COVID-19) pandemic,<sup>22</sup> the current study contributes to the science of race-related sleep disparities focusing on sleep duration and quality, among AIAN, Asian, Black, Latinx, and White young adults during the pandemic.

### How sleep is influenced by systems of stratification

Although sleep is a complex physiological process, it is influenced by social contexts<sup>18,23–26</sup> and race-related sleep disparities are linked to social and structural systems.<sup>27–32</sup> For example, stress and

\*Corresponding author: Tiffany Yip, Department of Psychology, Fordham University, 441 E Fordham Rd., 226E Dealy Hall, Bronx, NY 10458, USA  
 E-mail address: [tyip@fordham.edu](mailto:tyip@fordham.edu) (T. Yip).

interpersonal discrimination has been found to at least partially explain, and in some cases, fully explain disparities in sleep.<sup>2,33</sup> Interpersonal victimization is verbal, physical or online harassment related to the suspicion of being infected with the COVID-19 virus. In the United States, communities of color are disproportionately impacted by infection rates.<sup>34</sup> There is also growing evidence that interpersonal victimization and discrimination are implicated in sleep disturbances and disparities.<sup>29,35–38</sup>

From access to quality healthcare to infection and survival rates, the COVID-19 pandemic has magnified how social stratification contributes to existing health disparities, exacerbating existing differences between racial groups.<sup>39</sup> In turn, amplifying disparities has provided a closer investigation of related mechanisms. For example, when shelter-in-place restrictions were implemented in March 2020, millions of Americans lost employment.<sup>40</sup> However, millions more were deemed "essential workers" and did not have the option of sheltering-in-place. Reflecting deep-seated social stratification, essential workers were disproportionately Black and Latinx Americans.<sup>41</sup> As a result, communities have suffered different mortality rates; with Black (43.0%) and Latinx Americans (32.7%) having the highest rates, followed by White Americans (19.3%) and Asian Americans (4.3%).<sup>42</sup> In New York, Latinx Americans had the highest mortality rates around 30.8%, followed by Black (28.0%), White (25.4%), and Asian Americans (7.5%).<sup>43</sup>

The current study investigates the explanatory association of COVID-19-related structural factors (ie, essential worker status) and interpersonal victimization on race-related sleep disparities. In a diverse sample of young adults ages 18–25 sampled from across the United States, the study considers interpersonal experiences of victimization, and structural inequities related to which racial groups are more likely to be deemed "essential workers," elucidating possible pathways through which the pandemic might exacerbate race-related sleep disparities.

## The current study

The current sample of 547 young adults ages 18–25 investigated race-related sleep disparities among AIAN, Asian, Black, Latinx, and White respondents during the COVID-19 pandemic. The study also investigated structural (ie, essential worker status) and interpersonal victimization (target of COVID-19-related victimization) as pathways through which disparities are manifested.

## Methods

### Participants and design

Participants were recruited for a cross-sectional survey on the biological, psychological, and social impact of the COVID-19 pandemic in April 2020. Recruitment was conducted by Qualtrics XM and reached approximately 57,000 individuals. Qualtrics maintains lists of individuals who are willing to complete surveys. Eligible participants (age 18–25 years) self-identified as AIAN, Asian, Black, Latinx, and White, had to live in the United States for a minimum of 1 year, and have an eighth-grade reading level. Participants were recruited by email and provided a link to a screener. The screener included questions on participants' age, race/ethnicity, assigned sex at birth, gender, sexual orientation, the US state and zip code in which they lived, length of time living in the US, geographic region, living situation, employment, and student status.

Following the screener, eligible individuals were immediately sent to a page providing informed consent information first page of the survey. Human subjects' approval was obtained from the Fordham University institutional review board. Manual data validation protocols were established to exclude fraudulent or repeat

participants (eg, consistency between age and date of birth; inconsistency between reported city in which the survey was taken and zip code). The 10–20-minute survey (average = 14.02 minutes, SD = 33.84) included embedded data quality measures such as attention checks, and data quality screening (eg, deleting surveys that did not pass a speed check). A speed check excluded participants who respond in less than half the time of the median survey response. Participants were able to quit the survey at any time by closing the survey window, these data were not included in analysis. All responses were voluntary. No identifying information was collected, and the investigators are unable to trace data to the respondents. Participants were compensated with points corresponding to a value of \$16.50. Online resources on health and coronavirus prevention were provided at the end of the survey.

The original sample included 600 young adults from across the United States. Due to uncertainty about how COVID affects sleep, participants who reported having/had the coronavirus were excluded ( $n = 53$ ), yielding an analytical sample of 547 participants. Participants self-reported their race/ethnicity by answering the question, "Of these categories, what do you consider to be your PRIMARY race/ethnicity?" The response categories include: 1 = "American Indian/Native American or Alaska Native," 2 = "Asian," 3 = "Black, African American, or West Indian/Caribbean," 4 = "Hispanic or Latinx," 5 = "Native Hawaiian or Other Pacific Islander," 6 = "White." Responses included: American Indian/Alaska Natives (16.09%), Asian (17.18%), Black (24.13%), Latinx (16.82%), and White (25.78%) young adults. Among Asian participants, 54.3% reported being East Asian (ie, Chinese, Korean, Japanese), and 45.7% reported being South East Asian (ie, Vietnamese, Thai, Filipinos). Most Black participants were African American (78.8%), with 12.1% from Africa and 9.1% from the Caribbean or other areas. Half of the Latinx participants reported being Mexican (47.8%), 17.4% Puerto Rican, and 34.8% reported other areas (eg, Central American, Dominican, and South American). Respondents were also given the opportunity to indicate a secondary race, using the same question format as for primary race. Combining primary/secondary race,  $n = 155$  respondents (26.5%) indicated both a primary and a secondary race. Sensitivity analyses were conducted for the primary analyses covarying of multiracial status; however, results did not differ with the inclusion or exclusion of a multiracial status covariate. Therefore, the results reported here consider only respondents' primary race/ethnicity.

### Measures

#### Sleep

Sleep was the primary outcome and was assessed on 2 dimensions: duration and quality using the Pittsburgh Sleep Quality Index.<sup>44</sup> Duration was the self-reported number of minutes of sleep each night ("During the past month, how many hours of actual sleep did you get at night?"). Participants who were 3 standard deviations above the mean ( $N = 21$ , approximately 17.7 hours) were removed as outliers.<sup>45</sup> Because this exclusion criterion did not rule out the participants with less than 1 hours of sleep; we removed participants with less than 1.5 hours ( $N = 18$ ) and more than 14 hours ( $N = 7$ ) of sleep to eliminate improbable values. Therefore, additional 39 participants were removed resulting in a final analytical sample of 508 participants for sleep duration (Fig. 1). Sensitivity analysis were performed to examine excluding participants reporting less than 2 hours or more than 23 hours of sleep, and the results were consistent with those presented here. The mean sleep duration was 432.41 (SD = 130.2) minutes averaging 7.44 hours of sleep at night (SD = 3.41), within the recommended 7–9-hour range for this age group.<sup>46</sup> Sleep quality was assessed with the nine-item disturbance subscale (eg, "during the past month, how much did you have trouble sleeping due to the following reasons felt too cold, had bad dreams,

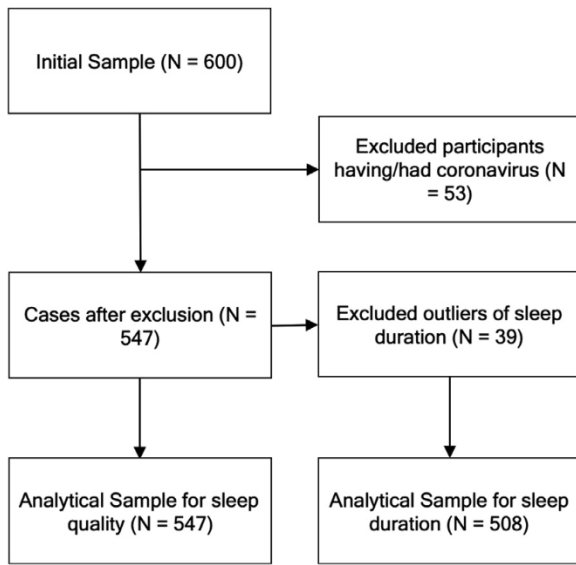


Fig. 1. PRISMA diagram for final analytical sample.

cannot breathe comfortably, etc...”). Items were rated on a 4-point scale from 1 (= not at all) to 4 (= 3 or more times a week) (M = 2.78, SD = 0.61,  $\alpha = 0.75$ ). Scores were reverse coded so that higher scores reflect better sleep quality. There were no missing or outlying responses for sleep quality, yielding a final analytical sample of 547 participants for sleep quality.

**Coronavirus victimization distress**

The distress of being victimized (eg, “teased or bullied”) because of the coronavirus was assessed using the 5-item Coronavirus Victimization Distress Scale (Fisher & Yip, 2020)<sup>74</sup> adapted from the Daily Heterosexist Experiences Questionnaire,<sup>47</sup> the LGBT People of Color Microaggressions Scale,<sup>48</sup> and the Adolescent Discrimination Distress Index.<sup>49</sup> Participants indicated the degree of COVID-19-related victimization experiences (eg, “I have been teased or bullied because someone thought I was infected with the coronavirus”, see Table 1). Responses ranging from 1 (“never happened”), 2 (“It happened and did not upset me”), 3 (“It happened and upset me a little”), 4 (“It happened and upset me moderately”) to 5 (“It happened and upset me quite a bit”). Confirmatory factor analysis shows that all 5 items loaded on one factor (CFI = 0.995, RMSEA = 0.068 with 90% confidence interval [0.032, 0.108]). All items loaded significantly on the latent construct with standardized loadings ranging from 0.80 to 0.86 (Table 1) and the scale had strong internal consistency ( $\alpha = 0.93$ ). The standardized loadings suggested that the observed items are strongly related to the latent factor. Factor loadings can be interpreted as standardized regression coefficients, meaning that all the items have a high correlation with the latent COVID-19-related victimization stress. Measurement invariance across the 5 racial groups was examined, and partial scalar invariance was achieved (compared with partial metric invariance model  $\Delta\chi^2(12) = 17.63, p = .13,$

$\Delta$ RMSEA < 0.01) by freeing the factor loading and intercept of item 4 (“I have been verbally taunted or called bad names in public because someone thought I was infected with the coronavirus”). The results suggest that mean differences can be meaningfully compared between racial groups.

**Demographics**

Demographic information on gender, age, race and ethnicity, employment (not employed, employed full-time or employed part-time), essential worker status (essential or nonessential), student status (current student or not), region (ie, urban, suburban, exurban, rural) were collected. Socioeconomic indices included household income and financial security (eg, “How would you describe your current financial situation?”: 1 (“I can’t make ends meet”), 2 (“I have just enough”) or 3 (“I am comfortable”). To investigate racial differences four dummy variables were created with Black as the reference group.

**Covariates**

Gender, age, subjective financial situation, region and student status (0 = not a current student, 1 = current student), employment status (1 = not employed, 2 = employed part-time, 3 = employed full-time) were covariated. CDC COVID-19 health risk factors that are related since related to sleep<sup>50-52</sup> such as concerns about contracting the coronavirus, and depression were also included as covariates. CDC risk factors (eg, asthma/chronic lung disease, immune-compromised disease) were coded as 1 indicating the presence of at least one risk factor. Concerns related to contracting coronavirus (“How much do you worry that you may get the coronavirus?”) was assessed from 1 (= worried all the time) to 5 (= never worried). Depression was measured using the 9-item Patient Health Questionnaire<sup>53</sup> module.

**Analytic strategy**

Descriptive statistics and multivariate analysis of variance were conducted to examine racial differences in sleep. The potential moderation effects between race and covariates were tested (Table S1. Supplemental Materials) and not included in the main analyses considering that there was a lack of literature support to do so. Mediation analyses were conducted using the counterfactual framework and causal definitions of direct and indirect effects.<sup>54,55</sup> In a causal effect framework, the pure natural direct effect is specified as the expected value of outcome variable (Y) if participants are influenced by predictor (X) only, while the mediator is held constant.<sup>56,57</sup> The total natural indirect effect is defined as the expected value of the outcome variable attributable to the predictor due to its influence through the mediating variable. When the mediator and outcomes are continuous with no interaction between the predictor and mediator, the mediation effects inform causal inferences akin to conventional coefficient effects.<sup>58</sup> A counterfactual framework allows for a binary mediator (eg, essential worker status). Two models were estimated employing the counterfactual framework in Mplus 8.3 (Fig. 2).<sup>59</sup> The first model examined whether being an essential

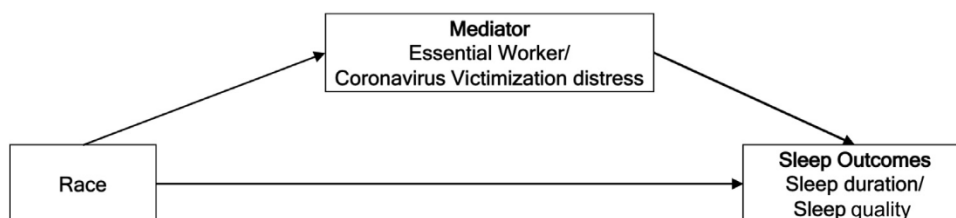


Fig. 2. Conceptual path diagram of mediation model.

**Table 1**  
Factor loadings for Coronavirus Victimization Distress Scale items

Factor	Item	Factor loading	Cochrane's alpha
Coronavirus victimization distress	I have been teased or bullied because someone thought I was infected with the coronavirus	0.796	0.93
	I have been physically threatened, hit or beaten up because someone thought I was infected with the coronavirus	0.867	
	I have been treated rudely or unfairly because someone thought I was infected with the coronavirus	0.846	
	I have been verbally taunted or called bad names in public because someone thought I was infected with the coronavirus	0.838	
	I have been cyberbullied because someone thought I was infected with the coronavirus	0.858	

worker explained racial differences in sleep duration. The second model assessed coronavirus victimization distress as an explanatory pathway for racial differences in sleep quality. In the first model, 41.9% of responses were missing on the mediator variable. To examine whether the variable was missing complete at random, we calculated the correlation between missingness with demographic variables and being an essential worker. The average correlation was small in terms of magnitude ( $r_s = 0.12$ ,  $SD = 0.04$ ) except for employment status ( $r = 0.86$ ), indicating that employment status should be included as an auxiliary variable in the analysis. Missing data were handled by full information maximum likelihood estimation approach. Even though a missing rate around 40% is non-negligible, Collins et al (2001)<sup>75</sup> found that the inclusion of auxiliary variables reduces bias to acceptable levels even when missing rate is as high as 50%, and FIML is conclusively better than traditional procedures such as listwise deletion (Little & Su, 1987).<sup>76</sup> For continuous variables, maximum likelihood estimation with robust standard errors was used. For categorical variables, maximum likelihood estimation with logit link were used. To test the significance of mediation effects, a bootstrapping procedure was used to estimate the bias-corrected confidence intervals.<sup>60</sup> Model fit was evaluated using the CFI, RMSEA (and the 90% CI of the RMSEA), TLI. A fit of  $> 0.9$  for the CFI and TLI and  $< 0.08$  for RMSEA was considered to indicate adequate fit.<sup>61</sup>

## Results

### Descriptive statistics

Demographic data are provided in Table 2. The sample mean and percentages do not control for covariates. Racial group differences in sleep, demographic variables, and covariates, are presented in the last column of Table 2. There were significant racial differences in sleep duration ( $F(4,494) = 5.04$ ,  $P < .01$ ). Table 3 shows the post hoc comparisons using the Bonferroni correction, Black young adults reported less sleep duration than AIAN ( $M_{diff} = -60.44$ ,  $SE = 18.42$ ,  $p < .05$ ), Asian ( $M_{diff} = -50.26$ ,  $SE = 17.96$ ,  $p < .05$ ), Latinx ( $M_{diff} = -59.67$ ,  $SE = 17.98$ ,  $p < .05$ ) and White ( $M_{diff} = -61.69$ ,  $SE = 15.78$ ,  $p < .05$ ). Racial group differences in sleep quality were also significant ( $F(4,533) = 3.91$ ,  $p < .01$ ), post hoc comparisons suggested that Asian young adults reported better sleep quality compared to White ( $M_{diff} = .22$ ,  $SE = 0.07$ ,  $p < .05$ ), Latinx ( $M_{diff} = 0.21$ ,  $SE = 0.07$ ,  $p < .05$ ), and Black ( $M_{diff} = 0.25$ ,  $SE = 0.07$ ,  $p < .05$ ) respondents. The chi-square difference test suggested that there was a significant racial difference in being an essential worker (compared to not being an essential worker,  $\chi^2_{(4)} = 20.68$ ,  $p < .01$ ). Bonferroni adjusted post hoc tests suggested that Asians were significantly less likely to be essential workers (26.2% vs 7.5%,  $p < .05$ ). There were no significant racial differences on coronavirus victimization distress ( $F(4,533) = 2.26$ ,  $p = .06$ ). All tests of racial differences control for gender, age, employment status, subjective financial security, student status, region, depression, concerns about contracting coronavirus, and CDC coronavirus risk.

### Sleep duration

Table 4 presents a correlation matrix. The results for sleep duration are presented in panel A of Table 5. To investigate if racial differences in sleep duration were explained by essential worker status and coronavirus victimization distress (Fig. 1), the first model estimated the main effect of race on sleep duration (and separately for sleep quality), including covariates. Consistent with the mean-level differences reported above, results suggested racial differences in sleep duration such that AIAN, Asian, White, and Latinx young adults reported approximately one additional hour of sleep compared to Black respondents. Essential worker status also varied by race, with Asian respondents less likely than Black respondents to report being an essential worker ( $\beta = -1.31$ ,  $SE = 0.48$ ,  $OR = 0.27$ ). No other racial/ethnic differences emerged. Being an essential worker was negatively associated with sleep duration ( $\beta = -33.35$ ,  $p < .05$ ). The total natural indirect effect suggested that sleep duration among Asians was significantly explained by essential worker status ( $\beta = 4.62$ , 95% CI [0.02, 15.96]). The total effect suggests that disparities in sleep duration between Asian and Black young adults can be explained by the higher likelihood of Black respondents serving as essential workers. Coronavirus victimization distress was also considered as a mediator, but there were no significant effects (Table 5, panel B).

### Sleep quality

The study also investigated essential worker status and coronavirus victimization distress to explain racial differences in sleep quality. The results are presented in Table 5, panel C. Coronavirus victimization distress predicted sleep quality ( $\beta = -0.07$ ,  $p < .01$ ). Compared with Black respondents, Asian and White respondents reported lower levels of coronavirus victimization distress. The total natural indirect effect of race on sleep quality explained through coronavirus victimization distress was significant for both Asian ( $\beta = 0.02$ , 95% CI [0.00, 0.04]) and White ( $\beta = 0.02$ , 95% CI [0.00, 0.05]) young adults. Including the coronavirus victimization distress as an intervening pathway decreased the direct effect on sleep quality for Asian ( $\beta = 0.23$ ,  $p < .01$ ) and White ( $\beta = 0.01$ ,  $p = .89$ ) respondents, suggesting that coronavirus victimization distress partially explains Black and Asian, as well as Black and White differences in sleep quality. On the other hand, the indirect effect on sleep quality explained through coronavirus victimization was not significant for AIAN and Latinx young adults (AIAN:  $\beta = 0.01$ , 95% CI [-0.02, 0.03], Latinx:  $\beta = 0.01$ , 95% CI [-0.01, 0.04]). In contrast, to the pattern of results for sleep duration, models including essential worker status did not explain disparities in sleep quality.

### Sensitivity analyses

To define natural direct and indirect effects, requires that there are no unobserved confounding variables related to the predictor-mediator or predictor-outcome associations and there are no unobserved mediator-outcome confounding variables. Sensitivity analyses

**Table 2**  
Descriptive statistics for racial groups and statistical test results of race differences

Variables	Total (N = 547)		AIAN (N = 88)		Asian (N = 94)		Black (N = 132)		Latinx (N = 92)		White (N = 141)		Racial differences F(or $\chi^2$ )
	M (or %)	SD	M (or %)	SD	M (or %)	SD	M (or %)	SD	M (or %)	SD	M (or %)	SD	
Sleep duration (in minutes)	432.41 (N = 508)	130.2	441.31 (N = 77)	114.22	448.69 (N = 90)	112.68	384.67 (N = 120)	140.48	441.58 (N = 84)	146.75	452.91 (N = 137)	120.31	<b>5.04</b>
Sleep quality	1.78	0.61	1.74	0.64	1.98	0.65	1.71	0.6	1.69	0.58	1.81	0.56	<b>3.92</b>
COVID-19 victimization	1.55	0.92	1.63	1	1.41	0.84	1.71	0.99	1.65	0.89	1.36	0.82	2.26
Essential worker	52.61% (N = 306)		10.13% (N = 52)		3.92% (N = 50)		14.38% (N = 73)		11.11% (N = 59)		13.07% (N = 72)		<b>20.68</b>
Covariates													
Concerns about contracting COVID-19	3.17	1.19	3.18	1.21	3.29	1.02	3.18	1.34	2.98	1.1	3.21	1.18	0.72
Depression	2.26	0.79	2.37	0.82	2.2	0.77	2.29	0.81	2.32	0.76	2.17	0.77	0.81
CDC COVID-19 risk symptoms	0.78	1.52	1.02	1.83	0.37	1.14	0.8	1.4	0.91	1.43	0.78	1.64	2.34
Age	21.96	2.25	22.39	2.44	21.64	2.17	21.67	2.13	21.63	2.03	22.4	2.32	<b>3.5</b>
Financial security	1.99	0.7	1.99	0.74	2.06	0.58	1.89	0.77	1.97	0.67	2.05	0.7	0.86
Gender													<b>29.23</b>
Cisgender male	23.95%		4.20%		3.83%		6.03%		3.29%		6.58%		
Cisgender female	56.86%		8.40%		10.05%		12.43%		9.69%		16.27%		
Transgender male	2.56%		1.10%		0.00%		0.37%		0.73%		0.36%		
Transgender female	0.55%		0.18%		0.18%		0.00%		0.18%		0.00%		
Nonbinary	6.95%		1.10%		1.65%		2.38%		0.73%		1.10%		
Other	9.14%		1.10%		1.46%		2.92%		2.19%		1.46%		
Student	59.78%		8.41%		13.34%		13.71%		10.24%		14.08%		<b>17.61</b>
Region													<b>76.34</b>
Urban	27.97%		4.75%		5.30%		6.76%		5.67%		5.48%		
Suburban	41.68%		6.58%		10.60%		8.23%		7.68%		8.59%		
Exurban	8.04%		1.65%		0.91%		0.73%		1.65%		3.11%		
Rural	22.30%		3.11%		0.37%		8.41%		1.83%		8.59%		
Employment													6.7
Not employed	42.60%		6.22%		8.05%		10.42%		5.85%		12.07%		
Employed part-time	30.90%		5.67%		5.30%		7.50%		6.03%		6.40%		
Employed full-time	26.51%		4.20%		3.84%		6.22%		4.94%		7.31%		

Note. Sleep duration and sleep quality were measured by Pittsburgh Sleep Quality Index (PSQI). COVID victimization was measured by Coronavirus Victimization Distress Scale. Depression was measured by PHQ-9 scale. Bolded values are significant at  $\alpha = 0.05$  level. Covariates include gender, age, employment status, subjective financial security, student status, region, depression, concerns about contracting coronavirus, and CDC coronavirus risk are controlled in the ANOVA test.

**Table 3**  
ANOVA comparisons of race differences on sleep outcomes

Group	n	Mean	SE	Mean differences (SE) in sleep duration			
				AIAN	Asian	Latinx	White
Black	120	387.84	11.48	<b>-60.44 (18.42)</b>	<b>-50.26 (17.96)</b>	<b>-59.67 (17.98)</b>	<b>-61.69 (15.78)</b>
AIAN	77	448.28	14.29		-10.17 (19.87)	0.77 (19.89)	-1.25 (17.87)
Asian	90	438.11	13.56			-9.41 (17.96)	-11.42 (17.73)
Latinx	84	447.52	13.78				-2.01 (17.87)
White	137	449.53	10.88				

Group	n	Mean	SE	Mean Differences (SE) in Sleep Quality			
				AIAN	Asian	Latinx	White
Black	132	1.72	0.04	-0.07 (0.07)	<b>-0.25 (0.07)</b>	-0.04 (0.07)	-0.03 (0.06)
AIAN	88	1.79	0.05		-0.18 (0.07)	0.03 (0.07)	0.05 (0.07)
Asian	94	1.97	0.05			<b>0.21 (0.07)</b>	<b>0.22 (0.07)</b>
Latinx	92	1.76	0.05				0.02 (0.07)
White	141	1.74	0.04				

Note. Sleep duration and sleep quality were measured by Pittsburgh Sleep Quality Index (PSQI). Bolded values are significant at  $\alpha = 0.05$  level. Covariates include gender, age, employment status, subjective financial security, student status, region, depression, concerns about contracting coronavirus, and CDC coronavirus risk are controlled in the ANOVA test.

**Table 4**  
Bivariate correlations between study variables

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Age	/												
2. Gender	0.03	/											
3. Region	-0.04	-0.02	/										
4. Student	0.31**	-0.01	0.04	/									
5. Essential Worker	0.04	-0.08	0.23**	0.10	/								
6. Concerns about contracting Covid-19	-0.10*	0.02	0.08	-0.03	0.01	/							
7. Financial Security	-0.06	-0.05	-0.03	-0.08	-0.04	0.05	/						
8. Covid-19 risk symptoms	-0.01	0.00	-0.04	-0.04	0.06	-0.19**	-0.11**	/					
9. Depression	-0.07	0.05	-0.01	-0.08	0.04	-0.20**	-0.26**	0.24**	/				
10. Covid-19 victimization distress	-0.01	0.11*	-0.06	-0.08	0.01	-0.17**	-0.10*	0.34**	0.27**	/			
11. Sleep disturbance	0.02	0.07	-0.09*	0.00	0.07	-0.24**	-0.19**	0.21**	0.55**	0.29**	/		
12. Sleep duration	-0.03	-0.09*	-0.01	-0.08	-0.14*	0.03	0.14**	-0.17**	-0.17**	-0.20**	-0.24**	/	
13. Race	0.05	-0.06	0.16**	0.05	0.06	-0.01	0.02	0.01	-0.06	-0.08	0.02	0.05	/
14. Employment	0.23**	0.01	-0.06	0.21**	0.07	-0.13**	0.07	0.12**	0.06	0.15**	0.22**	-0.13**	0.02

Note. Sleep duration and sleep quality were measured by Pittsburgh Sleep Quality Index (PSQI). COVID victimization was measured by Coronavirus Victimization Distress Scale. Depression was measured by PHQ-9 scale. \*  $P < .05$ . \*\*  $P < .01$ .

are important to test the fulfillment of these assumptions and were conducted following steps proposed by Imai et al (2010a, b).<sup>62,63</sup> Alternative models were estimated by including a sensitivity

parameter (the correlation between the errors of mediation and outcome models) and estimating the indirect effect. The sensitivity analysis estimates how large the sensitivity needs to be to change the

**Table 5**  
Mediation model results for racial differences in sleep outcomes

	Main effect		Predictor → outcome		Predictor → mediator		Mediator → outcome		Mediation effect			
	$\beta$	SE	$\beta$	SE	$\beta$	SE	$\beta$	SE	$\beta$	SE	CI lower	CI upper
(A) Race → Sleep duration, essential worker as mediator												
AIAN	<b>60.44</b>	18.42	<b>60.91</b>	18.66	0.06	0.42	<b>-33.35</b>	15.75	-0.30	2.73	-7.04	4.52
Asian	<b>50.26</b>	17.96	<b>40.74</b>	17.95	-1.31	<b>0.48</b>			<b>4.62</b>	4.24	<b>0.02</b>	<b>15.96</b>
Hispanic	<b>59.67</b>	17.98	<b>60.67</b>	20.10	0.04	0.40			-0.20	2.49	-6.01	4.58
White	<b>61.68</b>	15.78	<b>58.42</b>	17.93	-0.27	0.38			1.35	2.36	-3.13	6.51
(B) Race → Sleep duration, COVID victimization distress as mediator												
AIAN	<b>60.44</b>	18.42	<b>60.54</b>	18.02	-0.06	0.12	0.15	0.08	9.28	5.52	0.65	22.62
Asian	<b>50.26</b>	17.96	<b>50.38</b>	18.39	-0.17	0.12			7.73	4.8	0.23	19.08
Hispanic	<b>59.67</b>	17.98	<b>62.61</b>	16.44	<b>-0.26</b>	0.10			9.6	5.42	0.53	21.96
White	<b>61.68</b>	15.78	<b>57.8</b>	20.04	-0.11	0.11			8.86	5.61	0.23	21.22
(C) Race → Sleep quality, COVID victimization distress as mediator												
AIAN	0.07	0.07	0.07	0.07	-0.11	0.14	<b>-0.07</b>	0.03	0.01	0.01	-0.02	0.03
Asian	<b>0.25</b>	0.07	<b>0.23</b>	0.07	<b>-0.22</b>	0.13			<b>0.02</b>	0.01	<b>0</b>	<b>0.04</b>
Hispanic	0.04	0.07	0.03	0.05	-0.13	0.12			0.01	0.01	-0.01	0.04
White	0.03	0.06	0.01	0.05	<b>-0.27</b>	0.12			<b>0.02</b>	0.01	<b>0</b>	<b>0.05</b>

Note. Sleep duration and sleep quality were measured by Pittsburgh Sleep Quality Index (PSQI). COVID victimization was measured by Coronavirus Victimization Distress Scale. Depression was measured by PHQ-9 scale. Bolded results are significant at 0.05 level. PNDE represents the pure natural direct effect, TNIE represents the total natural indirect effect.

interpretation of indirect effect. If a small change in the sensitivity parameter causes substantive change in the interpretation of the indirect effect, this indicates that the study is sensitive to potential mediator-outcome confounds. The first sensitivity analysis includes a residual covariance estimate between essential worker status and sleep duration (Fig. S1, Supplemental Materials). The 95% confidence band of indirect effect of essential worker status on differences in sleep duration between Asian and Black respondents suggested that a small negative correlation (approximately  $r = 0.2$ ) would change the direction of the indirect effect from positive to negative. The second sensitivity analysis examined a potential confounding association between coronavirus victimization distress and sleep quality. The sensitivity plot (Fig. S2, Supplemental Materials) suggested that correlation greater than 0 would change the direction of the indirect effects between Asian and Black respondents, and between Latinx and Black respondents for sleep quality. Taken together, both sets of analyses suggest that these results may be sensitive to possible confounding associations between the mediators and the outcomes.

## Discussion

Race-related health disparities are well established but have been further illuminated and exacerbated by the COVID-19 pandemic.<sup>22,41</sup> This study highlights sleep disparities across an ethnically/racially diverse sample of young adults from across the United States to elucidate the impact of structural inequities and interpersonal victimization on sleep disparities during the pandemic. Specifically, Black young adults reported the largest disparity in sleep duration and quality. For sleep duration, Black respondents reported approximately one less hour of sleep compared to AIAN, Asian, White, and Latinx young adults. Mediation analyses suggest that disparities in sleep duration between Asian and Black young adults may be explained by the higher likelihood of Black respondents serving as essential workers. For sleep quality, Black respondents reported lower levels than Latinx, White, AIAN, and Asian young adults. Including coronavirus victimization distress as an intervening pathway on sleep quality decreased differences between Asian and White respondents, suggesting that coronavirus victimization distress partially explains differences between Black and Asian, as well as Black and White young adults.

While the sample sleep duration average of 7.44 hours was within recommendations for this age group, consistent with prior research, Black young adults reported the shortest sleep duration of any group, approximately 1 hour less each night in comparison to White, Asian, Latinx, and AIAN young adults.<sup>38</sup> Indeed, Black respondents reported an average of 6.4 hours of sleep, the only group in this study to fall below recommendations. Importantly, this study extends prior research by illustrating that during the pandemic, this disparity may be partially due to a higher percentage of Black young adults being employed as essential workers. This observation aligns with research observing that healthcare workers have reported compromised sleep quality during the COVID-19 pandemic.<sup>64</sup> Taken together, structural inequities may put Black young adults at higher health risk by exacerbating existing disparities in sleep.

Additionally, findings from this study indicated that racial differences in sleep quality can be partially explained by COVID-related interpersonal victimization. Black young adults experienced higher levels of sleep disturbance than Asian and White young adults during COVID-19, which was partially due to victimization distress specific to COVID-19. A burgeoning area of research finds that underrepresented racial groups with higher rates of interpersonal discrimination experience worse sleep outcomes.<sup>4,38</sup> This study demonstrates that the COVID-19 pandemic may have an additive impact on victimization distress among Black young adults in the United States, exacerbating existing sleep disparities. The data are clear that Black

individuals in the United States higher infection rates, are less likely to receive quality healthcare and treatment,<sup>65</sup> and more likely to face mortality in the current pandemic.<sup>34</sup> These disparities are in addition to, and exacerbate, pre-existing health disparities already faced by Black Americans<sup>66</sup>; disparities related to residential segregation,<sup>67,68</sup> socioeconomic status,<sup>69,70</sup> stress,<sup>18</sup> and the virus of racism.<sup>22,71</sup>

Together, the data show that race-related disparities in sleep duration and quality persisted during the first few months of COVID-19 pandemic, with Black young adults reporting the shortest sleep duration of any group and the highest levels of sleep disturbance. There were no consistent patterns for the other racial groups; however, AIAN respondents reported the second highest levels sleep duration and sleep quality. Latinx young adults reported the third highest levels of duration and the second lowest levels of sleep quality. Asian respondents reported the second lowest levels of sleep duration (only Black respondents reported shorter duration), yet they also reported the highest levels of sleep quality. Finally, White young adults reported the longest sleep duration and the third highest levels of sleep quality. The current study thus extends the existing literature on sleep disparities by illustrating how COVID-19-related systemic stratification (ie, employment patterns that are unevenly distributed among racial minorities and are disproportionately employing Black Americans) and interpersonal victimization may serve as explanatory pathways for sleep disparities.

## Limitations and future directions

Given the cross-sectional nature of the data, sensitivity analyses raise the possibility of reciprocal dynamics between sleep outcomes and mediating processes such as coronavirus victimization distress. Although we controlled for neighborhood type (urban, rural, etc.), living contexts such as proximity to high traffic areas or household crowding impact sleep.<sup>46</sup> Also, this study was conducted in April 2020 in the earlier days of the pandemic, precluding investigation of the longer-term impact of explanatory processes for sleep and health along the timeline of COVID-19 pandemic. Finally, data collection was limited to self-reported sleep. Scholars have observed moderate associations between self-reported and actigraphy-measured sleep, with estimates varying by age and racial group.<sup>17</sup> Moreover, self-reported sleep typically overestimates duration compared to actigraphy with differences approximating or exceeding an hour.<sup>17</sup> As such, it is possible that the current report underestimates sleep disruption and it is imperative that future research consider triangulating across self-report and objective sleep and health indicators.

## Conclusion

Nearly all facets of everyday life and activities have been impacted by the COVID-19 pandemic, the current study contributes to the literature on how disparities in sleep are linked to pandemic-related experiences such as essential worker status and interpersonal victimization. In the latest Healthy People poll, 25% of US adults reported insufficient sleep, an estimate that has increased over the past few decades.<sup>72</sup> The current study suggests that aggregated statistics mask important differences across racial groups. Sleep is a critical component of individual and public health for Americans of all ages and backgrounds.<sup>73</sup> As we begin to unpack the multitude of ways in which health has been impacted by the pandemic, it is important to consider how pandemic-related disparities in sleep are further implicated in a range of health outcomes.

## Declaration of conflict of interest

The authors have no conflict of interest to declare.

## Supplementary materials

Supplementary material associated with this article can be found in the online version at doi:10.1016/j.sleh.2021.05.008.

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