

## A longitudinal examination of psychosocial mechanisms linking discrimination with objective and subjective sleep



Natalie D. Dautovich, PhD<sup>a,\*</sup>, Morgan P. Reid, MS<sup>a</sup>, Sarah M. Ghose, MA<sup>a</sup>, Giyeon Kim, PhD<sup>b</sup>, Caitlan A. Tighe, PhD<sup>c</sup>, Kristy D. Shoji, PhD<sup>d</sup>, Wendy Kliewer, PhD<sup>a</sup>

<sup>a</sup> Psychology Department, Virginia Commonwealth University, Richmond, Virginia, USA

<sup>b</sup> Department of Psychology, Chung-Ang University, Seoul, South Korea

<sup>c</sup> VISN 4 Mental Illness, Research, Education, and Clinical Center (MIRECC), VA Pittsburgh Healthcare System, Pittsburgh, Pennsylvania, USA

<sup>d</sup> Eastern Colorado Health Care System – Mental Health Service, Kerrville VA CLC, Kerrville, Texas, USA

### ARTICLE INFO

#### Article history:

Received 16 August 2022

Received in revised form 24 April 2023

Accepted 18 June 2023

#### Keywords:

Discrimination

Sleep

Actigraphy

Anxiety

Social well-being

Sleep diary

### ABSTRACT

**Objective:** Although chronic discrimination negatively impacts sleep, the cross-sectional nature of most research limits the understanding of how changes in discrimination over time are associated with sleep health. Therefore, the aims of this study were to explore the: (1) longitudinal association between daily discrimination and subjective and objective sleep; (2) mediating roles of anxiety and social well-being; and (3) moderating role of change in discrimination over time.

**Methods:** An archival analysis was completed using data from the Midlife in the United States study across 3 timepoints. Participants were primarily female-identifying, white, and college-educated. Measures included Pittsburgh Sleep Quality Index ( $N = 958$ ), sleep diaries ( $N = 307$ ), and actigraphy ( $N = 304$ ). Daily discrimination, the Social Well-Being Scale, and the Mood and Anxiety Symptom Questionnaire were also administered. Moderated parallel mediations were performed using the PROCESS macro controlling for depressive symptoms.

**Results:** More discrimination at time 1 was associated with worse global sleep quality ( $b = 0.10$  and  $p = .001$ ) and daily sleep quality ( $b = 0.03$  and  $p = .02$ ) and worse objective sleep-onset latency ( $b = 0.93$  and  $p = .02$ ), wake after sleep onset ( $b = 1.09$  and  $p = .002$ ), and sleep efficiency ( $b = -0.52$  and  $p < .001$ ) at time 3. Social well-being mediated the associations between discrimination and subjective global sleep quality 95% CI [0.00, 0.03] and daily sleep quality 95% CI [0.00, 0.01] and objective TST 95% CI [0.00, 0.96] when discrimination was increasing or chronic. Anxiety mediated the discrimination–global sleep quality association regardless of changes in discrimination.

**Conclusions:** Discrimination showed durable associations with a broad array of sleep outcomes across a 10-year period. Anxiety and social well-being linked discrimination to subjective sleep outcomes, illustrating the importance of psychosocial well-being for sleep health in those experiencing discrimination.

© 2023 National Sleep Foundation. Published by Elsevier Inc. All rights reserved.

Despite ongoing efforts to reduce social inequalities, discrimination remains a common occurrence in the United States with severe implications for physical and mental health. Higher risk of mortality,<sup>1</sup> hypertension,<sup>2</sup> and incident breast cancer,<sup>3</sup> as well as depression and anxiety disorders,<sup>4,5</sup> all are associated with exposure to discrimination. Moreover, individuals who perceive discrimination engage in fewer positive health behaviors.<sup>6</sup> Discrimination is

known to have a particularly adverse impact on sleep. A recent systematic review showed that experiences of discrimination are associated with sleep problems assessed via self-report and objective measures, such as actigraphy and polysomnography.<sup>7</sup> Specifically, discrimination across various aspects of identity is a risk factor for shorter sleep duration, increased sleep complaints, greater wake after sleep onset (WASO), and less slow-wave, restorative sleep.<sup>8–12</sup> Furthermore, although there is evidence that chronic discrimination over time has more harmful effects on sleep than does discrimination at any 1 particular timepoint,<sup>11</sup> the cross-sectional nature of most research in this area prevents exploration of how changes in discrimination over time might impact sleep health. The small body of existing longitudinal research has shown durable associations

\* Corresponding author: Natalie D. Dautovich, PhD, Virginia Commonwealth University, 800 West Franklin St., Room 203, Box 842018, Richmond, VA 23284-2018, USA.

E-mail address: [ndaautovich@vcu.edu](mailto:ndaautovich@vcu.edu) (N.D. Dautovich).

between greater discrimination and worse self-reported sleep in Australian indigenous children (across a 5-year period)<sup>13</sup> and in Latinx and African American undergraduates (across several months).<sup>14,15</sup> The current study aims to build on this research by assessing the discrimination-sleep association across a wide range of sleep outcomes, in an adult sample (majority white, midlife, and female), and across a longer time period.

Ongoing investigations of the mechanisms that underlie the association between discrimination and sleep reveal that these may vary depending on the aspects of identity and type of discrimination (ie, structural versus interpersonal and chronic versus acute) under study.<sup>16</sup> Both discrimination and sleep are complex constructs; thus, biological, psychological, social, and cultural factors are at play. The current study focuses particularly on psychosocial mechanisms. Psychologically, depression has been primarily regarded as a confounding variable within the literature due to the known associations between depression and both discrimination and sleep.<sup>16</sup> There is growing interest in the role of anxiety, as both cognitive (eg, worry and rumination) and physical (ie, autonomic arousal) symptoms of anxiety are linked to discrimination and can also inhibit restorative sleep.<sup>17,18</sup> Exposure to discrimination, or even the anticipation of potential discrimination, induces cognitive and physical hypervigilance, as people worry about the impacts of discrimination and, in some cases, fear for their safety.<sup>16</sup> This state of chronically persistent arousal may negatively impact sleep for individuals experiencing discrimination. Thus, both depression and anxiety were included as covariates or mediators in the present study.

Discrimination and sleep do not simply exist in a personal vacuum, however. Rather, they are constructs embedded within the social world.<sup>19</sup> Social well-being refers to one's appraisal of their own ability to navigate the social world, including one's self-evaluation of their perceived integration into and potential to contribute to society, as well as an appraisal of societal kindness and acceptance.<sup>20</sup> Discrimination is associated with increased loneliness, decreased feelings of safety and trust in society,<sup>21</sup> and overall lower perceived social capital.<sup>8</sup> Particularly when experienced chronically, discrimination can erode one's confidence in their ability to navigate the social landscape, as well as their optimism toward the social world itself.

Social well-being has also been tied to sleep. Social isolation has been cross-sectionally and longitudinally associated with insomnia and daytime fatigue,<sup>22,23</sup> and individuals with insomnia endorsed significantly less trust in their neighbors and lower feelings of community belonging.<sup>23</sup> This association between social well-being and sleep may be bidirectional; studies show that those with poor sleep are more likely to mistrust others and rate others as less socially desirable. Conversely, others are more likely to disengage from those with insomnia, furthering feelings of social disconnection.<sup>24</sup>

In sum, the cross-sectional association between discrimination and sleep has been well-established; however, less is known about the longitudinal associations, particularly within adult samples across the long term. Therefore, the first aim of the present study is to explore the longitudinal association (approximately 10 years) between daily discrimination and a wide variety of sleep outcomes, including retrospective self-report, daily diary, and actigraphy methods. In addition, this paper explores the mediating roles of both anxiety and social well-being in this association to better understand both psychological and social factors underpinning the negative discrimination-sleep association. Finally, this paper aims to shed light on how changes in discrimination over time moderate these associations, an underdeveloped realm of literature.

## Methods

### Participants

An archival analysis was completed using data from the Midlife in the United States (MIDUS) datasets, a nationally representative

**Table 1**  
Demographic characteristics for each sleep sample

	PSQI sample (N = 958)	Sleep diary sample (N = 307)	Actigraphy sample (N = 304)
Age	M = 55.16 SD = 11.80 Range = 34–84	M = 54.79 SD = 12.06 Range = 34–83	M = 54.77 SD = 12.05 Range = 34–83
Sex			
Female	528 (55.1%)	169 (55.0%)	168 (55.3%)
Male	430 (44.9%)	138 (45.0%)	136 (44.7%)
Race			
White	901 (94.1%)	296 (96.4%)	293 (96.4%)
Black/African American	25 (2.6%)	5 (1.6%)	5 (1.6%)
Native American/ Aleutian Islander/ Eskimo	5 (0.5%)	1 (0.3%)	1 (0.3%)
Asian/Pacific Islander	2 (0.2%)	1 (0.3%)	1 (0.3%)
Multiracial	7 (0.7%)	2 (0.7%)	2 (0.7%)
Other	18 (1.9%)	2 (0.7%)	2 (0.7%)
Education			
Less than HS	33 (3.4%)	11 (3.6%)	10 (3.3%)
HS or equivalent	200 (20.9%)	71 (23.2%)	70 (23.1%)
Some college	195 (20.4%)	63 (20.6%)	62 (20.5%)
Associates	72 (7.5%)	22 (7.2%)	22 (7.3%)
Bachelors	221 (23.1%)	71 (23.2%)	71 (23.4%)
Masters work or degree	192 (20.0%)	58 (19.0%)	58 (19.1%)
Doctorate or professional degree	43 (4.5%)	10 (3.3%)	10 (3.3%)

PSQI, Pittsburgh Sleep Quality Index. HS, high school

sample across the adult lifespan. MIDUS-I, the baseline study, was conducted between 1995 and 1997. MIDUS-II, the first MIDUS follow-up, was conducted between 2004 and 2009. As part of MIDUS-II, a subset of participants completed Project 4, the Biomarker project, to collect sleep and other biomarker data. Thus, participants included in the current study were those who had complete self-reported sleep data (ie, Pittsburgh Sleep Quality Index [PSQI];  $N = 958$ ), sleep diaries ( $N = 307$ ), and actigraphy ( $N = 304$ ).

Participants in the PSQI sample ( $M_{\text{age}} = 55.16$ ) most commonly identified as female (55.1%), white (94.1%), and college graduates (23.1%). See Table 1 for participant characteristics for each sample (PSQI, sleep diary, and actigraphy).

### Procedures

MIDUS-I and MIDUS-II were selected for the current study as they provided data on perceived discrimination (MIDUS-I and MIDUS-II), social well-being (MIDUS-II), anxiety (MIDUS-II), and sleep (MIDUS-II, Project 4). Both MIDUS-I and MIDUS-II consisted of 30-minute phone interviews and 2 self-administered questionnaires. The Biomarker Project (MIDUS-II, Project 4) consisted of a 2-day clinic visit and 7 days of at-home monitoring carried out at 1 of 3 sites (University of California, Los Angeles (UCLA), the University of Wisconsin, and Georgetown University) based on the region in which each participant lived (West Coast, Midwest, and East Coast, respectively). The midpoints of data collection across the 3 time periods were 1996 (MIDUS-I, time 1), 2005 (MIDUS-II, time 2), and 2007 (Biomarker Project, time 3). Ethical approval for the studies was obtained from the Institutional Review Board at each participating site.

### Measures

#### Perceived discrimination

Daily discrimination was measured by a scale created for MIDUS and administered as part of the survey in MIDUS-I and MIDUS-II. Items used in the scale were taken from a prior study<sup>25</sup> and based on

qualitative studies of discrimination.<sup>26</sup> Participants were asked to report the frequency with which they experienced 9 types of discrimination (eg, “You are treated with less respect than other people”) on a “day-to-day basis,” using a scale from 1 (*never*) to 4 (*often*). Total Discrimination scores range from 4 to 36, with higher scores indicating greater frequency. The scale demonstrated good reliability in the current sample (Cronbach’s  $\alpha = 0.91$ ). A Discrimination Change score was computed for each participant by subtracting their Total Discrimination score at time 2 from their Total Discrimination score at time 1; change scores could range from –36 to 36, with negative numbers suggesting greater discrimination at time 2. Change in discrimination was included as: (1) a continuous variable predicting sleep outcomes in the hierarchical regression and mediation analyses and (2) as a categorical moderating variable in the moderated mediation analyses (consisting of 3 groups—decreasing discrimination stable discrimination and increasing discrimination from time 1 to time 2). In addition, participants were asked whether the following aspects of identity contributed to the discrimination that they faced (yes/no): age, gender, race, ethnicity, religion, height/weight, appearance, physical disability, sexual orientation, and others.

#### Social well-being

The Social Well-Being Scale<sup>20</sup> was administered as part of the survey in MIDUS-II. This 14-item scale measures five dimensions of well-being: social coherence, social integration, social acceptance, social contribution, and social actualization. Participants rated their level of agreement with statements (eg, “I feel close to other people in my community”) on a scale from 1 (*strongly agree*) to 7 (*strongly disagree*). Items are reverse coded so that higher aggregate scores (range: 14–98) indicate greater social well-being. The scale demonstrated fair reliability in the current sample (Cronbach’s  $\alpha = 0.63$ ), consistent with prior research.<sup>20</sup>

#### Anxiety and depression

The Anxiety Symptoms subscale of the short version of the Mood and Anxiety Symptom Questionnaire<sup>27</sup> was administered as part of the survey in MIDUS-II. Participants are asked to rate how much they have felt various symptoms (eg, “felt keyed up or ‘on edge’”) over the past week on a scale from 1 (*very slightly or not at all*) to 5 (*extremely*). Total scores range from 11 to 55, with higher scores indicating greater anxiety. The scale demonstrated good reliability in the current sample (Cronbach’s  $\alpha = 0.79$ ). In addition, the Depressive Symptoms subscale of the Mood and Anxiety Symptom Questionnaire<sup>27</sup> was used to assess depressive symptoms. The Depressive Symptoms subscale uses the same format; however, there are 12 items (eg, “felt like crying”) yielding a total score that ranges from 12 to 60, with higher scores indicating greater depression. The scale demonstrated good reliability (Cronbach’s  $\alpha = 0.90$ ).

#### Sleep

Sleep data were collected as part of the Biomarker Project (Project 4) in MIDUS-II in the following ways.

**Pittsburgh Sleep Quality Index.** The PSQI<sup>28</sup> was used as a global subjective measure of sleep. The PSQI consists of 19 items, which are grouped to form 7 component scores: sleep quality (SQ), sleep latency, sleep duration, habitual sleep efficiency (SE), sleep disturbance, use of sleep medications, and daytime dysfunction. Component scores are then summed to yield a global SQ score ranging from 0 to 21, with higher scores indicating worse SQ. In previous research, the PSQI global score has shown good discriminant validity with 89.6% sensitivity and 86.5% specificity for differentiating between good and poor sleepers.<sup>28</sup> In the current sample, the global score demonstrated fair reliability across component scores (Cronbach’s  $\alpha = 0.67$ ).

**Sleep diary.** Participants completed a daily sleep diary<sup>29</sup> for 8 consecutive days. Participants reported bed and wake times, in addition to the number of awakenings, minutes to sleep onset, SQ, napping behavior, caffeine consumption, and use of prescribed and over-the-counter medication. Three sleep diary variables—sleep-onset latency (SOL: minutes to sleep onset after going to bed), number of awakenings, and SQ (perceived SQ on a scale from 1 to 5, with higher scores indicating worse SQ)—were included in the analyses. Unfortunately, WASO or total sleep time (TST) was not available within the sleep diary due to the method of capturing awakenings (frequency rather than duration). The sleep diary has been shown to be a valid and reliable measure of sleep.<sup>29</sup>

**Actigraphy.** The Mini-Mitter 64 activity monitor was used as an objective assessment of sleep. Actigraphy is considered a reliable, convenient alternative to polysomnography for clinical trials and multimeasure studies.<sup>30</sup> The device was worn on the nondominant wrist for 8 consecutive days. Activity movements were used to determine sleep-wake states every 30 s. Actigraphy variables of interest for the present study were SOL, SE (ratio of time spent asleep to total time in bed), WASO, and TST. The sleep diary bed and wake times were used to set the actigraphic sleep period for analysis.

#### Data analysis

Multiple moderated mediation analyses were conducted using Model 59 of Hayes’<sup>31</sup> PROCESS macro for SPSSv.26, in which discrimination at time 1 predicted sleep outcomes at time 3 via social well-being and anxiety (both at time 2) as parallel mediators (see conceptual model; Fig. 1). Separate models were conducted for each sleep variable (ie, PSQI, diary SOL, diary number of awakenings, diary SQ, actigraphy SOL, actigraphy WASO, actigraphy TST, and actigraphy SE). Furthermore, due to the known associations between depression and sleep,<sup>16</sup> depression was included as a covariate in all models. Change in perceived discrimination from time 1 to time 2 was examined as a moderator of all model paths. Change in discrimination was included as a continuous variable for the hierarchical regression and mediation analysis, and a categorical variable consisting of 3 levels—decreasing, stable, or increasing—for the moderation of the mediation. Using PROCESS, we conducted a nonparametric bootstrapping procedure across 5000 samples to compute a confidence interval around the indirect, mediational effects. Missing data were handled by listwise deletion. Power analysis using G\*Power<sup>32</sup> showed that, for a multiple regression analysis with 15 predictors, a sample size of at least 199 is needed to predict an  $R^2$  of at least 0.15 at an alpha level of 0.05 and a power level of 0.80, suggesting that the present study is adequately powered ( $N_s = 304, 307, \text{ and } 958$ ).

## Results

### Discrimination over time

Descriptive statistics for variables of interest were calculated (see Table 2). The most endorsed perceived reasons for discrimination were gender (22.0%) and age (10.0%; see Fig. 2). Both the type of perceived reason for discrimination and the total number of reasons did not moderate the discrimination and sleep associations ( $p > .05$ ). Globally, there was not a significant difference in the frequency of perceived discrimination from time 1 to time 2,  $t(1008) = -0.706$ , and  $p = .480$ . However, categorizing the change in discrimination over time revealed that 34.0% of the sample reported greater discrimination at time 2, 30.4% reported stable discrimination at both timepoints, and the remaining 35.6% reported decreased discrimination at time 2. Change in discrimination was, thus,

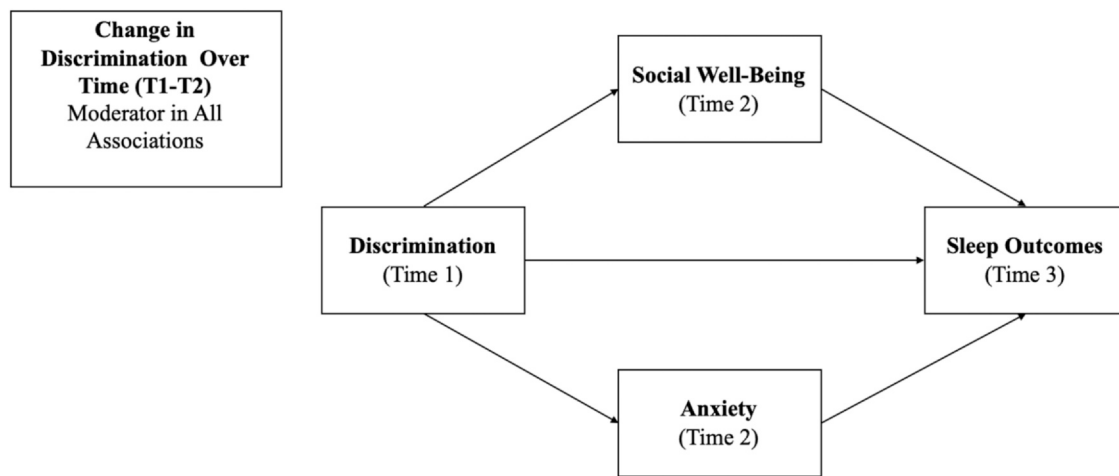


Fig. 1. Conceptual model of moderated mediations

Table 2  
Descriptive statistics for each sleep sample

	PSQI sample (N=958)	Sleep diary sample (N= 307)	Actigraphy sample (N= 304)
Discrimination at time 1	12.58 (4.25)	12.26 (4.01)	12.21 (3.93)
Discrimination at time 2	12.67 (4.29)	12.35 (3.96)	12.31 (3.90)
Change in discrimination	-0.09 (3.93)	-0.09 (3.80)	-0.10 (3.81)
Social well-being	68.93 (12.76)	68.35 (12.99)	68.47 (12.98)
Anxiety	16.55 (4.52)	16.20 (4.22)	16.20 (4.24)
Depression	18.35 (6.53)	18.19 (6.18)	18.17 (6.20)
Sleep	PSQI 5.87 (3.43)	Sleep-onset latency 18.99 (14.43) Sleep quality 2.34 (0.72) Number of awakenings 2.03 (1.43)	Sleep-onset latency 25.03 (22.10) Sleep efficiency 82.21 (8.47) Wake after sleep onset 43.93 (18.92) Total sleep time 381.10 (61.46)

PSQI, Pittsburgh Sleep Quality Index

conceptualized as a moderator in these 3 groups (ie, increased discrimination at time 2, stable discrimination over time, and decreased discrimination at time 2).

Using Pillai’s trace, there was a significant difference in socio-demographics across the 3 types of discrimination change,  $V = 0.07$ ,  $F(14, 1952) = 5.22$ , and  $p < .001$  in terms of age, gender, self-rated health, neighborhood quality, education, and depressive symptoms. In particular, the stable discrimination group was more likely to be older, male, and have worse self-rated health compared to individuals reporting decreasing or increasing frequency of discrimination. Those reporting stable discrimination also reported lower perceived neighborhood quality compared to those reporting decreasing discrimination but higher neighborhood quality compared to those with increasing discrimination. Education was significantly higher in those reporting increasing discrimination compared to those reporting decreasing discrimination, and those with stable experiences of discrimination reported less depression than those with increasing or decreasing experiences of discrimination.

Self-reported PSQI global sleep outcomes

Greater perceived discrimination at time 1 was associated with worse global SQ at time 3 (see Table 3). However, change in discrimination over time neither buffered nor enhanced the association between discrimination and global SQ. Social well-being mediated the association between perceived discrimination and global SQ, but only for particular groups. Specifically, for participants reporting increased discrimination, but not those with stable or decreased

discrimination, discrimination at time 1 predicted poorer social well-being at time 2, which was associated with worse global SQ at time 3. In contrast, anxiety mediated the association between perceived discrimination and global SQ for all participants regardless of changes in reported discrimination (see Table 3). Thus, regardless of the change in discrimination over time, greater discrimination at time 1 predicted higher anxiety at time 2, which then predicted poorer SQ at time 3.

Sleep diary outcomes

Discrimination at time 1 did not predict SOL or number of awakenings as measured by the sleep diary at time 3 (see Table 4), and there was no moderating effect of change in discrimination over time. There were no indirect effects of either social well-being or anxiety.

Discrimination at time 1 predicted SQ as reported via sleep diary at time 3 (see Table 4), with greater discrimination associated with poorer day-to-day SQ; change in discrimination over time did not moderate this effect. Social well-being mediated the association between discrimination at time 1 and SQ as reported via sleep diary for participants with stable discrimination over time but not for participants with increased or decreased discrimination (see Table 4). Thus, for those who experienced similar discrimination at both timepoints, greater discrimination at time 1 predicted worse social well-being at time 2, which then predicted worse SQ at time 3. Anxiety did not significantly mediate the association between discrimination and SQ for any group, as anxiety was not significantly related to SQ assessed with this method.

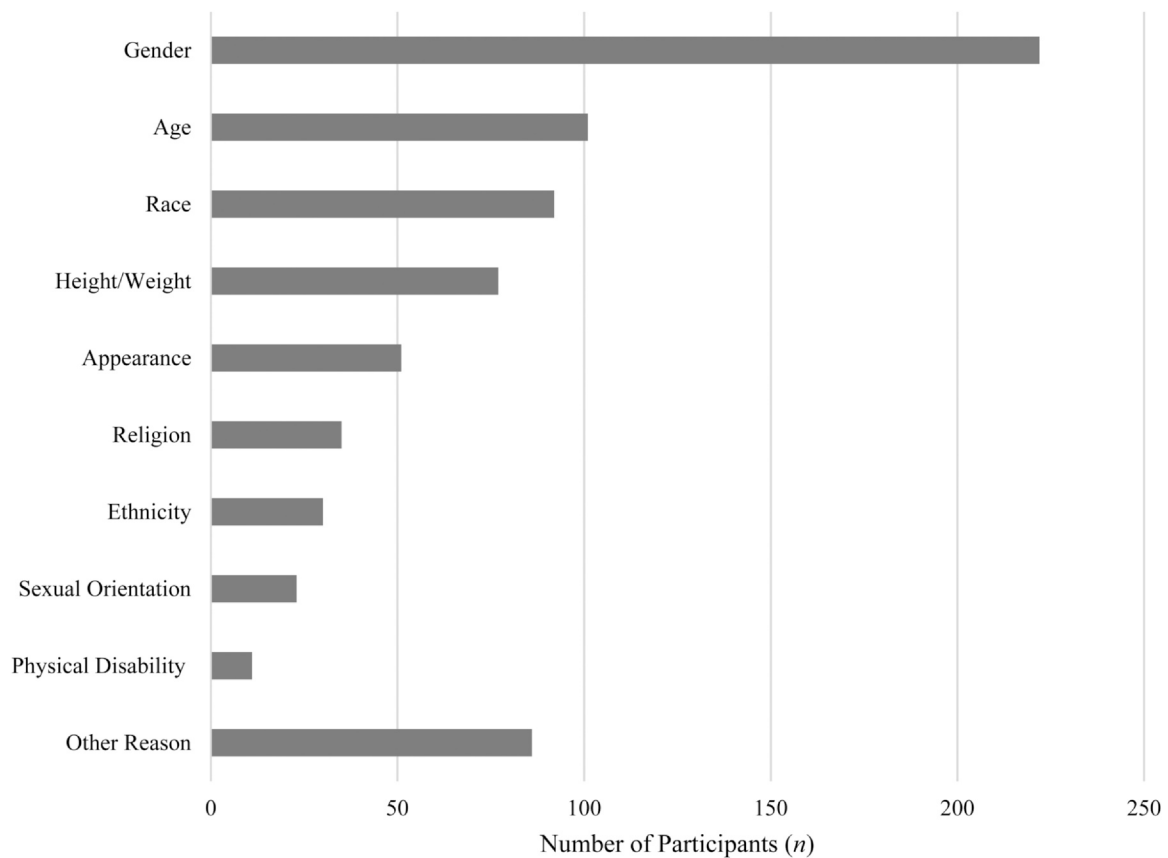


Fig. 2. Perceived causes of discrimination

**Table 3**  
Unstandardized coefficients for moderated mediation model with self-reported global sleep quality

	Social well-being (M1)	Anxiety (M2)	PSQI sleep quality (Y)
Daily discrimination time 1 (X)	-0.50(0.11)***	0.09(0.03)***	0.10(0.03)***
Social well-being (M1)			-0.01(0.01)***
Anxiety (M2)			0.18(0.03)***
Change in discrimination (W)	0.49(0.32)	-0.10(0.09)	-0.58(0.22)*
X x W	-0.01(0.02)	-0.00(0.01)	-0.00(0.01)
M1 x W			0.01(0.00)*
M2 x W			0.01 (0.01)*
Depression (U)	-0.65 (0.06)***	0.45 (0.02)***	-0.10 (0.02)***
	F(4, 947) = 45.87	F(4, 947) = 201.80	F(8, 943) = 29.43
	p < .001	p < .001	p < .001
	R <sup>2</sup> = 0.16	R <sup>2</sup> = 0.46	R <sup>2</sup> = 0.20

Note: X refers to the independent variable; Y refers to the dependent variable; M1 and M2 refer to the 2 parallel mediators (social well-being and anxiety, respectively); W refers to the moderator (change in discrimination measured as a continuous variable for the hierarchical regression and mediation analysis, and a categorical variable consisting of 3 levels—decreasing, stable, or increasing—for the moderation of the mediation); and U refers to the covariate. \* signifies  $p < .05$ , \*\* signifies  $p < .01$ , and \*\*\* signifies  $p < .000$  PSQI, Pittsburgh Sleep Quality Index

### Actigraphy outcomes

Discrimination at time 1 predicted worse sleep-onset latency, WASO, and SE as measured by actigraphy but not TST (see Table 5). However, more discrimination at time 1 predicted worse social well-being at time 2, and worse social well-being at time 2 predicted longer TST at time 3. Social well-being also mediated the discrimination and total-sleep time association for those with stable experiences of discrimination. Neither social well-being nor anxiety predicted SOL, SE, or WASO, and there were no significant mediation or moderation effects for these sleep outcomes.

### Discussion

The overall objective of the current study was to assess whether discrimination was longitudinally associated with sleep and which psychosocial factors accounted for this association. In addition, we explored whether changes in the frequency of discrimination over time exacerbated these associations. Overall, greater exposure to discrimination at time 1 was associated with worse global and daily subjective sleep and worse objective sleep at time 3. The current findings add to existing research on discrimination and sleep, which has primarily found links between discrimination and subjective

**Table 4**  
Unstandardized coefficients for moderated mediation model with sleep diary outcomes

	Social well-being (M1)	Anxiety (M2)	Sleep diary: sleep-onset latency (Y)	Sleep diary: sleep quality (Y)	Sleep diary: number of awakenings (Y)
Daily discrimination time 1 (X)	-0.54 (0.21)*	0.20 (0.06)**	0.34 (0.26)	0.03 (0.01)*	0.00 (0.03)
Social well-being (M1)			-.10(0.07)	-.01(0.00)*	-0.01 (0.01)
Anxiety (M2)			-.04(0.26)	0.02(0.01)	0.02 (0.03)
Change in discrimination (W)	0.26(0.59)	-.31(0.17)	-0.07(1.76)	-.11(0.08)	0.08 (0.18)
X x W	0.01(0.04)	0.01(0.01)	-0.00(0.05)	-.00(0.00)	0.00 (0.01)
M1 x W			-.00(0.02)	0.00(0.00)	-0.00 (0.00)
M2 x W			.01(0.06)	0.00(0.00)	0.00 (0.01)
Depression (U)	-0.75 (0.11)***	0.37 (0.03)**	0.02 (0.18)	0.02 (0.01)	-0.01 (0.02)
	F(4, 299) = 15.38	F(4, 299) = 43.51	F(8, 295) = 0.71	F(8, 295) = 6.15	F(8, 295) =
	p < .001	p < .001	p = .69	p < .001	p = .88
	R <sup>2</sup> = 0.17	R <sup>2</sup> = 0.37	R <sup>2</sup> = 0.02	R <sup>2</sup> = 0.14	R <sup>2</sup> = 0.01

Note: X refers to the independent variable; Y refers to the dependent variables; M1 and M2 refer to the 2 parallel mediators (social well-being and anxiety, respectively); W refers to the moderator (change in discrimination measured as a continuous variable for the hierarchical regression and mediation analysis, and a categorical variable consisting of 3 levels—decreasing, stable, or increasing—for the moderation of the mediation); and U refers to the covariate. \* signifies p < .05, \*\* signifies p < .01, and \*\*\* signifies p < .000

**Table 5**  
Unstandardized coefficients for moderated mediation model with actigraphy outcomes

	Social well-being (M1)	Anxiety (M2)	Actigraphy: sleep-onset latency (Y)	Actigraphy: sleep efficiency (Y)	Actigraphy: total sleep time (Y)	Actigraphy: wake after sleep onset (Y)
Daily discrimination time 1 (X)	-0.49(0.21)*	0.21(0.06)***	0.93(0.41)*	-0.52(0.15)**	-2.09(1.12)	1.09(0.34)**
Social well-being (M1)			0.02(0.11)	-0.03(0.04)	-0.80(0.30)**	-0.05(0.09)
Anxiety (M2)			-0.42(0.39)	0.07(0.15)	0.79(1.07)	-0.04(0.33)
Change in discrimination (W)			-1.76(2.66)	0.44(1.01)	-4.11(7.34)	-2.72(0.23)
X x W	0.01(0.04)	0.01(0.01)	0.00(0.08)	-0.01(0.03)	-0.20(0.23)	0.02(0.07)
M1 x W			0.03(0.03)	-0.01(0.01)	0.05(0.07)	0.01(0.02)
M2 x W			-0.02(0.09)	0.02(0.03)	0.19(0.24)	0.07(0.07)
Depression (U)	-0.76(0.11)***	0.37(0.03)***	0.19(0.27)	-0.01(0.10)	-1.49(0.73)	-0.28(0.23)
	F(4, 296) = 14.98	F(4, 296) = 43.60	F(8, 292) = 1.51	F(8, 292) = 2.20	F(8, 292) = 2.08	F(8, 292) = 1.80
	p < .001	p < .001	p = .15	p = .02	p = .04	p = .08
	R <sup>2</sup> = 0.17	R <sup>2</sup> = 0.37	R <sup>2</sup> = 0.04	R <sup>2</sup> = 0.06	R <sup>2</sup> = 0.05	R <sup>2</sup> = 0.05

Note: X refers to the independent variable; Y refers to the dependent variables; M1 and M2 refer to the 2 parallel mediators (social well-being and anxiety, respectively); W refers to the moderator (change in discrimination measured as a continuous variable for the hierarchical regression and mediation analysis, and a categorical variable consisting of 3 levels—decreasing, stable, or increasing—for the moderation of the mediation); and U refers to the covariate. \* signifies p < .05, \*\* signifies p < .01, and \*\*\* signifies p < .000

sleep.<sup>16</sup> In particular, in terms of subjective sleep, participants in the current study reporting greater exposure to discrimination at time 1 reported worse overall global SQ and worse daily SQ about 10 years later while controlling the potential confounding influence of depression. In addition to contributing to the prospective literature on this topic, the length of time between assessments adds to our understanding of the duration of this association. Discrimination was longitudinally associated with subjective sleep outcomes across a 10-year period, which adds to existing research identifying links across a 1–5 years period in children and undergraduate students.<sup>13–15</sup> Although subjective sleep outcomes may diverge from objective sleep measurements, they remain an important predictor of health outcomes<sup>33</sup> and are the key marker for individuals' experiences of SQ, including insomnia diagnoses.

More discrimination exposure at time 1 was also linked to actigraphic measures of longer sleep onset latency, more WASO, and less efficient sleep 10 years later. Fewer studies have examined discrimination in association with objective assessments of sleep,<sup>16</sup> and none has studied this association longitudinally. The current findings provide objective support for the subjective perceptions of sleep problems in relation to discriminatory experiences and suggest the durability of these associations over time. Objective findings also add to our understanding of the specific components of sleep, which are linked to discrimination. Given the potential anxiety-provoking and threatening effects of discrimination (as described in the following), it is not surprising to see worse sleep onset, WASO, and

efficiency tied to discrimination as has been demonstrated previously.<sup>34,35</sup>

The second aim of the current study was to try to understand how discrimination may be tied to sleep outcomes. We examined the psychosocial mechanisms of social well-being and anxiety as mediators of discrimination and sleep associations while controlling depressive symptoms. Social well-being emerged as a mediator of the association between discrimination and subjective SQ (global and daily) and objectively assessed TST. However, these mechanistic effects only emerged when discrimination was chronic (eg, worsened over time or remained stable). Thus, for those who reported worsening or stable discrimination over time, social well-being accounted for the association between discrimination and worse sleep. For SQ assessed via daily diary and actigraphic TST, social well-being underlays the association between discrimination and sleep only for those with stable discriminatory experiences. Thus, more exposure to discrimination was linked to worse social well-being (ie, the perception of one's integration into society) for this group. Examining sociodemographic differences across the 3 types of discrimination change suggest that those experiencing stable/chronic discrimination over time were more likely to be older, have worse self-rated health and lower perceived neighborhood quality, identify as male, and have fewer depressive symptoms compared to those with increasing and/or decreasing discrimination. Although the current study did not isolate specific identity targets of discrimination, the results suggest that, for this group, social disconnection was

linked to experiencing discrimination and supports existing research tying discrimination to loneliness and feelings of societal mistrust.<sup>21,36</sup> Second, trust in one's community and social world is a basic requirement for the perceptions of safety necessary for healthy sleep.<sup>37</sup> As such, 1 pathway from daily experiences of discrimination to poorer subjective sleep and longer actigraphic sleep duration appears to be lower overall social well-being. For actigraphic TST, more experiences of discrimination at time 1 predicted worse social well-being at time 2, which was associated with longer TST at time 3. Although longer TST may initially appear to be a positive outcome, it is apparent that some participants exceeded recommended sleep duration guidelines of 7–9 h for adults and 7–8 h for older adults<sup>38</sup> (TST maximum of approximately 10 h). Therefore, the poorer social well-being–longer TST association for actigraphic sleep may not necessarily reflect healthy sleep and could indicate hypsomnia associated with mood or health conditions. The group experiencing more stable discrimination was more likely to report worse self-rated health but fewer depressive symptoms.

Relatedly, anxiety also emerged as a mechanism underlying the longitudinal discrimination–sleep association, but only for PSQI global SQ. Individuals with more discrimination at time 1 reported greater anxiety at time 2, which, in turn, was associated with worse global SQ at time 3. This mediation effect was robust: anxiety emerged as a mediator regardless of a change in discrimination over time. Exposure to discrimination or even anticipation of discriminatory experiences can create a cognitive and physical hypervigilance<sup>17</sup> that results in an aroused state that is a barrier to healthy, restorative sleep.

Importantly, both anxiety and social well-being concurrently mediated the association between discrimination and sleep, suggesting a unique role for both mechanisms. Social well-being may reflect more macroperceptions or diffuse perceptions of belonging, whereas anxiety may reflect the micromanifestation of this lack of belongingness. Regardless, both psychosocial factors are important targets for future investigations into the development and maintenance of poorer sleep in individuals who experience discrimination. We did not find psychosocial mechanisms tying discrimination to objective sleep outcomes beyond the association with actigraphic TST. Discrimination has traditionally been more strongly tied to subjective perceptions of sleep,<sup>16</sup> perhaps due to actigraphy's inability to capture restorative sleep or shared measure variance across self-appraisal measures. Regardless, continuing to employ multiple measures of sleep will help to create a more nuanced understanding of sleep's links with discrimination.

The current study has implications for our understanding of psychosocial factors underlying the discrimination–sleep association, the role of changes in discrimination over time, and the durability of these associations. The findings suggest the important role of psychosocial well-being for sleep in those experiencing discrimination. Although sleep is a physiological process, it is embedded in a social world<sup>19</sup> and is modulated by our mental well-being. Both microfactor (anxiety) and macrofactor (social well-being) are negatively associated with discrimination and have poor links with sleep; thus, behavioral sleep interventions for those experiencing discrimination need to attend to both microfactor and macrofactor. In addition, two-thirds of the sample reported worsening or stable discrimination over time, alongside poorer global SQ. Thus, those who are at higher risk for more chronic discrimination over time should be prioritized in future sleep research and intervention development. Longitudinal studies of discrimination and sleep are comparatively rare,<sup>16</sup> and examinations across multiple timescales are needed to understand these temporal links.

A major limitation of the current study was the lack of racial or ethnic diversity in the sample. Although discrimination often

occurs based on other aspects of identity—including age, sex, gender identity, religion, sexual orientation, height, weight, and disability—racial and ethnic discrimination are pervasive in the United States and are a critical area of study. Furthermore, although we examined specific aspects of identity (eg, age, race, and gender) as moderators of the discrimination–sleep association, we were unable to conduct nuanced examinations of specific intersections of identity (eg, Black female and older female). With the use of the MIDUS dataset, however, we aimed to identify psychosocial mechanisms in a longitudinal dataset that can be explored in future, more diverse samples with consideration of marginalized intersections of identity. Although we examined the macromechanism of social well-being, we recognize that social well-being is likely conflated with other factors, such as neighborhood quality and socioeconomic status. Future research should continue to delve into the complex interplay of microfactor and macrofactor associated with one's social location and the implications of these factors for sleep. Similarly, although we examined multiple sleep outcomes, the nature of the sleep diary prevented us from including sleep diary TST and WASO. In addition, although we incorporated actigraphically assessed TST and WASO, this approach is limited given that subjectively assessed sleep duration is only modestly correlated with objectively assessed duration, especially for Black individuals.<sup>39,40</sup> Our inability to control for obstructive sleep apnea or insomnia also prevents us from accounting for the role of disordered sleep in the discrimination–sleep outcomes association. Future research is needed to assess associations with these covariates and outcomes in longitudinal designs. The 10-year time period in the current study revealed information about the durability of the discrimination and sleep associations. However, future research is needed to assess intermediate timepoints as well (eg, monthly, annually, and five years) to ascertain the temporal associations between discrimination and sleep. Relatedly, although we identified flux in the experience of discrimination as a moderator in the current study, it emerged as a direct predictor over time only for global SQ. The overall lack of direct associations runs counter to research suggesting that chronic discrimination is a risk factor for poorer sleep.<sup>11</sup> Future research such as daily diaries designs are needed to unpack the role of dynamic changes in discrimination as a predictor of sleep.

In conclusion, discrimination showed durable associations with a broad array of sleep outcomes across a 10-year period. Anxiety and social well-being linked discrimination to subjective and objective sleep outcomes, illustrating the importance of psychosocial well-being for sleep health in individuals reporting discrimination.

## Declaration of conflicts of interest

None.

## Funding

This work was supported by the John D. and Catherine T. MacArthur Foundation; the Research Network on Successful Midlife Development; the United States Department of Health and Human Services; the National Institutes of Health, National Institute on Aging (5-P01-AG20166–04); and the National Institutes of Health, National Institute on Aging (P01-AG20166). Dr. Tighe received support from Career Development/Capacity Building Award Number IK2 RX003393 from the United States (U.S.) Department of Veterans Affairs Rehabilitation R&D (Rehab RD) Service. The views expressed in this article are those of the authors and do not necessarily represent the position or policy of the Department of Veterans Affairs or the United States Government.

## References

- Barnes LL, de Leon CFM, Lewis TT, Bienias JL, Wilson RS, Evans DA. Perceived discrimination and mortality in a population-based study of older adults. *Am J Public Health*. 2008;98(7):1241–1247.
- Dolezsar CM, McGrath JJ, Herzog AJM, Miller SB. Perceived racial discrimination and hypertension: a comprehensive systematic review. *Health Psychol*. 2014;33(1):20–34.
- Taylor TR, Williams CD, Makambi KH, et al. Racial discrimination and breast cancer incidence in US Black women: the black women's health study. *Am J Epidemiol*. 2007;166(1):46–54.
- McLaughlin KA, Hatzenbuehler ML, Keyes KM. Responses to black, hispanic, female, and lesbian, gay, and bisexual individuals. *Am J Public Health*. 2010;100(8):1477–1484.
- Soto JA, Dawson-Andoh NA, BeLue R. The relationship between perceived discrimination and generalized anxiety disorder among African Americans, Afro Caribbeans and non-Hispanic Whites. *J Anxiety Disord*. 2011;25(2):258–265.
- Gibbons FX, Gerrard M, Fleischli ME, Simons RL, Kingsbury JH. Perceived racial discrimination and healthy behavior among African Americans. *Health Psychol*. 2021;40(3):155–165.
- Slopen N, Lewis TT, Williams DR. Discrimination and sleep: a systematic review. *Sleep Med*. 2016;18:88–95.
- Chen D, Yang TC. The pathways from perceived discrimination to self-rated health: an investigation of the roles of distrust, social capital, and health behaviors. *Soc Sci Med*. 2014;104:64–73.
- Slopen N, Williams DR. Discrimination, other psychosocial stressors, and self-reported sleep duration and difficulties. *Sleep*. 2014;37(1):147–156.
- Hicken MT, Lee H, Ailshire J, Burgard SA, Williams DR. "Every shut eye, ain't sleep": The role of racism-related vigilance in racial/ethnic disparities in sleep difficulty. *Race Soc Probl*. 2013;5(2):100–112.
- Lewis TT, Troxel WM, Kravitz HM, Bromberger JT, Matthews KA, Hall MH. Chronic exposure to everyday discrimination and sleep in a multiethnic sample of middle-aged women. *Health Psychol*. 2013;32(7):810–819.
- Grandner MA, Hale L, Jackson N, Patel NP, Gooneratne NS, Troxel WM. Perceived racial discrimination as an independent predictor of sleep disturbance and daytime fatigue. *Behav Sleep Med*. 2012;10(4):235–249.
- Shepherd CCJ, Li J, Cooper MN, Hopkins KD, Farrant BM. The impact of racial discrimination on the health of Australian Indigenous children aged 5–10 years: analysis of national longitudinal data. *Int J Equity Health*. 2017;16(1):116.
- Gordon AM, Prather AA, Dover T, Espino-Pérez K, Small P, Major B. Anticipated and experienced ethnic/racial discrimination and sleep: a longitudinal study. *Pers Soc Psychol Bull*. 2020;46(12):1724–1735.
- Fuller-Rowell TE, Curtis DS, El-Sheikh M, Duke AM, Ryff CD, Zgierska AE. Racial discrimination mediates race differences in sleep problems: a longitudinal analysis. *Cultur Divers Ethnic Minor Psychol*. 2017;23(2):165–173.
- Lewis P, Tené T, McKinnon II. *Exposure to discrimination and sleep*. The Social Epidemiology of Sleep. New York, NY: Oxford University Press; 2019.
- Lewis TT, Cogburn CD, Williams DR. Self-reported experiences of discrimination and health: scientific advances, ongoing controversies, and emerging issues. *Annu Rev Clin Psychol*. 2015;11:407–440.
- MacNeil S, Deschênes SS, Caldwell W, Brouillard M, Dang-Vu TT, Gouin JP. High-frequency heart rate variability reactivity and trait worry interact to predict the development of sleep disturbances in response to a naturalistic stressor. *Ann Behav Med*. 2017;51(6):912–924.
- Hale L. Sleep as a mechanism through which social relationships affect health. *Sleep*. 2010;33(7):862–863.
- Keyes CLM. Social well-being. *Soc Psychol Q*. 1998;61(2):121–140.
- Castaneda AE, Rask S, Koponen P, et al. The association between discrimination and psychological and social well-being: a population-based study of Russian, Somali and Kurdish migrants in Finland. *Psychol Dev Soc*. 2015;27(2):270–292.
- Griffin SC, Mladen SN, Williams AB, et al. Sleep disturbance mediates the association between loneliness and health in older Americans. *Int J Behav Med*. 2021;28(1):64–72.
- Jensen E, Dehlin O, Hagberg B, Samuelsson G, Svensson T. Insomnia in an 80-year-old population: relationship to medical, psychological and social factors. *J Sleep Res*. 1998;7(3):183–189.
- Ben Simon E, Walker MP. Sleep loss causes social withdrawal and loneliness. *Nat Commun*. 2018;9(1):3146.
- Williams DR, Yu null Yan, Jackson JS, Anderson NB. Racial differences in physical and mental health: socio-economic status, stress and discrimination. *J Health Psychol*. 1997;2(3):335–351.
- Essed P. *Understanding Everyday Racism: An Interdisciplinary Theory*. Newbury Park, CA: Sage Publications; 1991.
- Watson D, Weber K, Assenheimer JS, Clark LA, Strauss ME, McCormick RA. Testing a tripartite model: I. evaluating the convergent and discriminant validity of anxiety and depression symptom scales. *J Abnorm Psychol*. 1995;104(1):3–14.
- Buyse DJ, Reynolds CF, Monk TH, Berman SR, Kupfer DJ. The Pittsburgh Sleep Quality Index: a new instrument for psychiatric practice and research. *Psychiatry Res*. 1989;28(2):193–213.
- The Pittsburgh Sleep Diary - MONK - 1994 - Journal of Sleep Research - Wiley Online Library. Accessed May 16, 2022. (<https://onlinelibrary.wiley.com/doi/10.1111/j.1365-2869.1994.tb00114.x>).
- Ancoli-Israel S, Cole R, Alessi C, Chambers M, Moorcroft W, Pollak CP. The role of actigraphy in the study of sleep and circadian rhythms. *Sleep*. 2003;26(3):342–392.
- Hayes Andrew F. *Introduction to Mediation, Moderation, and Conditional Process Analysis: Third Edition: A Regression-Based Approach*. New York, NY: Guilford Press; 2022 Accessed May 16, 2022 (<https://www.guilford.com/books/Introduction-to-Mediation-Moderation-and-Conditional-Process-Analysis/Andrew-Hayes/9781462549030>).
- Erdfelder E, Faul F, Buchner A. GPOWER: a general power analysis program. *Behav Res Methods Instrum Comput*. 1996;28(1):1–11.
- Buyse DJ. Sleep health: can we define it? does it matter? *SLEEP*. 2014;37(1):9–17.
- Beatty DL, Hall MH, Kamarck TA, et al. Unfair treatment is associated with poor sleep in African American and Caucasian adults: Pittsburgh SleepSCORE Project. *Health Psychol*. 2011;30(3):351–359.
- Owens SL, Hunte HER, Sterkel A, Johnson DA, Johnson-Lawrence V. Association between discrimination and objective and subjective sleep measures in the Midlife in the United States study adult sample. *Psychosom Med*. 2017;79(4):469–478.
- García-Cid A, Gómez-Jacinto L, Hombrados-Mendieta I, Millán-Franco M, Moscato G. Discrimination and psychosocial well-being of migrants in Spain: the moderating role of sense of community. Accessed May 11, 2022. [https://www.frontiersin.org/article/ Front Psychol. 2020;11\(2235\):11](https://www.frontiersin.org/article/ Front Psychol. 2020;11(2235):11).
- Cacioppo JT, Hawkley LC, Bernston GG, et al. Do lonely days invade the nights? potential social modulation of sleep efficiency. *Psychol Sci*. 2002;13(4):384–387.
- National Sleep Foundation's sleep time duration recommendations: methodology and results summary. *Sleep Health: Journal of the National Sleep Foundation*. Available at: [http://www.sleephealthjournal.org/article/S2352-7218\(15\)00015-7/abstract](http://www.sleephealthjournal.org/article/S2352-7218(15)00015-7/abstract). Accessed April 24, 2018.
- Jackson CL, Patel SR, Jackson WB, Lutsey PL, Redline S. Agreement between self-reported and objectively measured sleep duration among white, black, Hispanic, and Chinese adults in the United States: multi-ethnic study of atherosclerosis. *Sleep*. 2018;41(6):zsy057.
- Jackson CL, Ward JB, Johnson DA, Sims M, Wilson J, Redline S. Concordance between self-reported and actigraphy-assessed sleep duration among African-American adults: findings from the Jackson heart sleep study. *Sleep*. 2020;43(3):zsz246.