Social Science & Medicine 221 (2019) 115–123

Contents lists available at ScienceDirect

Social Science & Medicine

journal homepage: www.elsevier.com/locate/socscimed

Does sleep partially mediate the effect of everyday discrimination on future mental and physical health?

Garrett C. Hisler[a,*], Rachel E. Brenner[b]

[a] Iowa State University, United States
[b] University at Albany, State University of New York, United States

ARTICLE INFO

Keywords:
Discrimination
Sleep
Physical health
Mental health
Multiple marginalized identities

ABSTRACT

Objective: The current study examined whether sleep mediates the effect of discrimination experiences on mental and physical health over time. Prior research suggests a partially mediated relation; however, these studies used cross-sectional designs which provide insufficient causal evidence.

Method: The study used longitudinal data available from the Midlife in the United States Study (MIDUS II, Biomarker project, and MIDUS III) applying structural equation modeling to evaluate whether self-reported sleep (N = 866) mediated the impact of discrimination on mental and physical health outcomes.

Results: Self-reported sleep quality partially mediated the effect of discrimination on mental and physical health. Analyses also indicated self-reported daytime dysfunction (i.e., difficulties maintaining alertness and motivation during the day) as a key component of sleep that mediates the discrimination and mental and physical health relations.

Interestingly, having multiple marginalized identities did not amplify the impact of discrimination on sleep and health.

Conclusions: These findings build upon previous cross-sectional research by better supporting the causal assertion that experiences of discrimination undermine sleep, which in turn worsens both mental and physical health. Altogether, results underscore the harmful impact of discrimination on health indirectly through sleep and offer insight into directions for future research.

1. Introduction

Areas of research attempting to understand the effects of discrimination are rapidly growing due to the detrimental impact of discrimination on physical and psychological functioning (Lewis et al., 2015). Meta-analyses reveal robust associations of discrimination with physical health (Pascoe and Richman, 2009) and psychological well-being (Schmitt et al., 2014) among marginalized populations such as racial and ethnic minorities, LGBTQ identified individuals, and women. This body of literature often focuses on the impact of chronic, everyday discrimination. *Everyday discrimination* occurs routinely in daily life and encapsulates a spectrum of discrimination experiences, including pervasive yet subtle forms of discrimination, such as being treated with less respect than others, to more escalated forms such as being threatened or harassed (Essed, 1991; Williams and Mohammed, 2009). Experiencing daily discrimination appears to be fairly common; population level estimates suggest that between 25 and 60% of people in the United States encounter daily discrimination (Boutwell et al., 2017; Kessler et al., 1999). Importantly, experimental and longitudinal research indicate a causal process wherein exposure to discrimination deteriorates mental and physical health (Brown et al., 2018; Schmitt et al., 2014; Yang et al., 2018). For instance, discrimination can harm wellbeing, increase distress and mental illness symptoms, elevate risk for a wide variety of physical illnesses and conditions, and undermine general indicators of health (Brown et al., 2018; Mossakowski, 2003; Schmitt et al., 2014). Similar to discrimination, sleep problems plague approximately 35% of the U.S. population and contribute to mental and physical health concerns (Liu et al., 2016; Ohayon, 2002). The current study examined whether sleep may partially explain how everyday discrimination deteriorates future physical and mental health.

1.1. Discrimination, sleep, and health

Discrimination may influence health, in part, through its negative impact on sleep. Sleep plays a vital role in the maintenance and restoration of health, aiding in the clearance of harmful proteins (e.g., β-

* Corresponding author. W112 Lagomarcino Hall, 901 Stange Road, Ames, IA, 50014, United States.
E-mail address: hislerg@iastate.edu (G.C. Hisler).

https://doi.org/10.1016/j.socscimed.2018.12.002
Received 9 June 2018; Received in revised form 27 September 2018; Accepted 2 December 2018
Available online 06 December 2018
0277-9536/ Published by Elsevier Ltd.

amyloid) from the brain and body, calibrating emotional reactivity, and regulating appetite and energy expenditure (Everson, 1993; Van Cauter et al., 2007; Xie et al., 2013; Yoo et al., 2007). Insufficient sleep can lead to a myriad of mental and physical health problems such as increased risk of depression, cardiovascular disease, obesity, and diabetes (Baglioni et al., 2011; Buxton and Marcelli, 2010). Discrimination is a stressor that corrodes multiple aspects of sleep, such as its continuity (i.e., staying asleep throughout the night), duration, and subjective quality across a range of marginalized populations (Bao et al., 2016; Lewis et al., 2013; Paine et al., 2016; Sims et al., 2016; Slopen et al., 2016). These differences in sleep due to discrimination likely deter health. For example, approximately 50% of the racial differences in cardiovascular disease have been accounted for by differences in sleep duration and efficiency (Curtis et al., 2017); however, racial differences in sleep disappear or decrease after accounting for discrimination, suggesting that racial health disparities may be partially accounted for by the disruptive influence of discrimination on sleep (Fuller-Rowell et al., 2016; Tomfohr et al., 2012).

Supporting this notion, cross-sectional studies found that sleep quality partially mediated the effect of discrimination on mental and physical health (Chen and Yang, 2014; Steffen and Bowden, 2006; Yang and Park, 2015), although the causality of these pathways remains in question. That is, although these cross-sectional studies utilized theoretical justification and covariates to minimize the potential for reverse causality, the limitation remains that similar results may have been obtained if sleep and health were switched as mediator and outcome, a viable alternative explanation. In fact, mental health characteristics, such as depression symptoms, have been found to mediate the impact of discrimination on sleep (Lewis et al., 2013). As such, Slopen et al. (2016) and others (Owens, et al., 2017; Slopen and Williams, 2014) note the need to longitudinally assess these relations to further delineate temporal relations among discrimination, sleep, and health.

Additionally, prior studies did not fully examine which aspects of sleep are most important for the impact of discrimination on health. Subjective appraisals of sleep quality and duration of sleep have been implicated as playing roles in how discrimination undermines health, though sleep duration may play a small or negligible role after accounting for subjective sleep quality (Yang and Park, 2015). However, discrimination has been linked to sleep disturbances beyond decreased sleep duration and subjective quality including greater sleepiness and fatigue, increased frequency of nightly awakenings, decreased sleep efficiency, and less Rapid Eye Movement Sleep (Beatty et al., 2011; Francis et al., 2017; Lewis et al., 2013). Different aspects of sleep can affect psychological constructs and be impacted by them in distinct manners. For instance, health, mood, and emotion tend to be more strongly tied to subjective perceptions of sleep quality and sleeping continuously throughout the night than sleep duration (Pilcher et al., 1997; Mezick et al., 2009). In addition, sleep disturbances lead to daytime dysfunction by increasing fatigue and sleepiness, both of which are also linked to discrimination and mental and physical health (Grandner et al., 2012; Thomas et al., 2006; Williamson et al., 2005). Feelings of fatigue or sleepiness that result from sleep disturbances are also important to focus on because they may impair engagement in effortful, proactive health behaviors, such as seeking social support, exercising, or scheduling routine physical examinations that prevent deteriorations in health (Feeney and Collins, 2015; Gill et al., 2001; Timmerman et al., 2015). Discrimination is associated with many different types of sleep disturbances which influence health, yet little is known about which of these disturbances uniquely tie discrimination to health.

Past studies have focused on the effects of discrimination conceptualized as originating from belonging to one marginalized group, such as being a racial minority or being LGBTQ. Generally, discrimination seems to impair sleep equally across different marginalized populations, (Beatty et al., 2011; Grandner et al., 2012; Lewis et al., 2013; Paine et al., 2016). However, personal identity is more complex than belonging to a single group. People can have "intersecting identities" wherein they belong to multiple groups, such as a black woman or an elderly bisexual male. Individuals who belong to multiple marginalized groups can face discrimination for more reasons, different reasons, and from more sources, thereby amplifying the consequences of discrimination for sleep and health as compared to individuals who belong to a single or no marginalized group (Crenshaw, 1989; Harnois, 2015; Seng et al., 2012). Along these lines, individuals with multiple marginalized identities can be at greater risk for substance abuse and mental disorders than their singular identity counterparts (Borgogna et al., 2018; Khan et al., 2017; Mereish and Bradford, 2014). While research on the influence of multiple marginalized identities on sleep seems to be nonexistent, individuals with multiple marginalized identities may experience greater sleep disturbances as a result of discrimination. Indirect evidence for this possibility comes from a recent finding that individuals who face higher frequencies of discrimination have greater sleep disturbances (Paine et al., 2016). Thus, holding multiple marginalized identities may moderate the discrimination-sleep-health pathway.

Overall, discrimination has been linked to significant health detriments and sleep may play a role in this relation. While a few studies have examined this possibility, a more stringent and delineated test is needed. Moreover, the consequences of belonging to multiple marginalized populations on this pathway have received little attention, especially in regard to sleep.

1.2. The current study

The current study utilized a large sample of middle-aged adults to examine a structural equation model in which self-reported sleep was measured after initial reports of discrimination and mental and physical health, and health and discrimination were again measured three to nine years after sleep. Moreover, multiple aspects of self-reported sleep were measured, allowing for a more comprehensive examination of which aspects are most important. Finally, this sample provided assessment of many different types of discrimination experiences (e.g., gender, racial, sexual orientation) and quantification of belonging to multiple marginalized populations.

2. Method

2.1. Sample and timeline

Longitudinal data available from the Midlife in the United States Study (MIDUS) was used for this study. Specifically, data were drawn from MIDUS II, MIDUS II Biomarker subsample, and MIDUS III phases of the MIDUS. The goal of MIDUS is to examine behavioral and psychosocial factors underlying age-related differences in health. As such, the MIDUS project is a useful dataset to examine the influence of discrimination in a large and diverse sample. Data collection for MIDUS was approved by the Institutional Review Board at University Wisconsin-Madison. MIDUS recruited a national sample of 7108 adults from 1995 to 1996 via random digit-dialed sampling frames to complete a survey and conducted two follow-ups with participants from this original sample in 2004–2005 (MIDUS II, N = 4963; 69.8% retention from MIDUS I) and in 2013–2014 (MIDUS III, N = 3294; 66.4% retention from MIDUS II). Analysis of participant retention from MIDUS I to MIDUS II suggested that participants who were White, married, more educated, and had better physical health were more likely to participate (Radler and Ryff, 2010). MIDUS II invited a subsample of its participants to conduct the Biomarker project ($N = 1255$), which included additional bio-indicator, health, and sleep assessments from 2004 to 2009 at sites that were part of the University of Wisconsin-Clinical and Translational Research Core. Because sleep data of interest were only available in the Biomarker subsample of MIDUS II, the present study only included Biomarker subsample participants who also completed

the MIDUS III survey. The Biomarker sample is highly similar to the MIDUS II sample in terms of demographic and health characteristics (Love et al., 2010).

Of the total 1255 Biomarker participants, 866 participants also had available MIDUS III survey data (data on 201 participants have not been released yet). The average length of time between participation in MIDUS II and Biomarker project was 2.96 years (range: 0–6 years, SD = 1.54 years), between Biomarker project and MIDUS III was 6.10 years (range: 3–9 years, *SD* = 1.68 years), and between MIDUS II and MIDUS III was 9.06 years (range: 8–10 years, *SD* = 0.56 years). Given this temporal ordering of these projects, within this study MIDUS II is referred to as Time 1, Biomarker as Time 2, and MIDUS III as Time 3.

2.2. Participants

The majority of this sample at Time 1 (M_{age} = 54.7, SD_{age} = 11.0; female = 56%) identified as European American (93%), 2.4% as African American, 2.0% as Hispanic American, 1.3% as Native American, 0.3% as Asian American, and 1.0% as Other or Don't Know. Average income was $45,208. Approximately 43.6% of participants were not currently employed, and 44.0% did not have a college degree.

2.3. Measures

2.3.1. Time invariant control variables (time 1)

Participants' reported age, gender (coded male = 0, female = 1), race (coded *European American* = 0 and *all other races* = 1 due to a predominately European American sample [93%]), and neuroticism at Time 1 were used as time invariance control variables. Propensity to feel negative affect (Goldberg, 1992) was also used as a control variable. Neuroticism was used to control for estimate inflation due to negativity bias when reporting health (Watson and Pennebaker, 1989). Participants also responded to how well the adjectives "moody", "worrying", "nervous", and "calm" (reverse-scored) described them from (1) "not at all" to (4) "a lot" (α = 0.76; Rossi, 2001).

2.3.2. Time-varying control variables (time 1 and 3)

Income, education level, and employment status were assessed at Times 1 and 3. Participants' past-year income from personal earnings, pension, and social security were summed to create a total income index, which the MIDUS data capped at $200,000. Education level was measured by participants indicating the highest grade of school or year of college they completed, coded from *1* "No school or some grade school" to *12* "PH.D., ED.D., MD, DDS, LLB, LLD, JD, or other professional degree". Participants indicated (yes/no) whether they were currently employed (0 = not employed; 1 = employed).

2.3.3. Everyday discrimination (time 1 and time 3)

The daily discrimination scale (Essed, 1991) asks how often participants experience nine different types of discrimination on a daily basis, such as "being treated with less courtesy than other people" or "being threatened or harassed" (αs = 0.91). Participants rated items on a scale from "Never" (1) to "Often (4). This scale was created from qualitative studies of discrimination and has been extensively used to assess the relation of discrimination and health (Robinson et al., 2017; Williams et al., 1997).

2.3.3.1. Multiple marginalized identities. Within the everyday discrimination scale, participants could indicate reasons for their discrimination experiences by checking all applicable reasons from the following list: age, gender, race, ethnicity/nationality, religion, height/weight, some other aspect of appearance, physical disability, sexual orientation, occupation, financial status, education, or other. Of the 518 participants who reported experiencing discrimination, 423 participants indicated specific reasons (*M* = 1.59 reasons; *SD* = 0.88) for their discrimination experiences. Gender was the most frequently cited source of discrimination (*n* = 165), followed by age (*n* = 121), other (*n* = 88), body size (*n* = 83), race (*n* = 68), some other aspect of appearance (*n* = 46), religion (*n* = 38), ethnicity (*n* = 37), sexual orientation (*n* = 20), and physical disability (*n* = 15). The sum of indicated reasons was used to measure number of marginalized identities (Seng et al., 2012). Participants who indicated "never" for all items on the everyday discrimination scale were given scores of 0 for a number of reasons, thereby increasing scale variability and study power. Because sample size was low for people reporting greater than three reasons, all individuals indicating three or more reasons were collapsed in one category. Altogether, 305 participants indicated no reason for discrimination (because they did not indicate experiencing discrimination), 247 participants indicated one reason, 115 indicated two reasons, 61 indicated three or more reasons. Overall, greater scores on this index indicate identifying with more marginalized identities.

2.3.4. Physical health (time 1 and time 3)

Self-ratings of current physical health, physical health concerns over the past month and past year, and body mass index were used to measure physical health (below) and extract an overall physical health latent variable. Prior discrimination and health research have used similar measures to extract latent physical health variables (Gibbons et al., 2014). Except for body mass index, all physical health measures demonstrated strong factor loadings onto their corresponding latent variable at Time 1 and Time 3 (loadings > 0.55; *ps* < .001), which were nearly identical in magnitude for Time 1 and Time 3 (see Supplemental Table 1).

2.3.4.1. Current physical health. Participants rated "In general, would you say your physical health is excellent, very good, good, fair, or poor?" from 1 (*excellent*) to 5 (*poor*). This single-item self-report of current physical health is often used in health research and predicts mortality even above physician assessments (Desalvo et al., 2005; Schnittker and Bacak, 2014).

2.3.4.2. Physical health over the past month. Participants reported how often they experienced eight different common health problems (i.e., headaches, backaches, sweating a lot, hot flushes or flashes, aches or stiffness in joints, leaking urine, pain or discomfort during intercourse, and pain or aches in extremities) over the past 30 days on a 5-point Likert scale from 1 (*Once a month*) to 5 (*Almost every day*). Responses were averaged to create an index of health concerns frequency over the past month (Time 1 α = 0.69; Time 3 = 0.71).

2.3.4.3. Physical health over the past year. Participants indicated whether they had experienced or been treated for 30 different health maladies over the past year (0 = no, 1 = yes). These items were summed to create an overall index of physical health problems over the past year.

Examples include "Asthma, bronchitis, or emphysema", "High blood pressure", "Stroke", or "Migraines".

2.3.4.4. Current body mass index (BMI). Current BMI was calculated based on participant self-report of current weight and height.

2.3.5. Mental health (time 1 and time 3)

Self-report ratings of mental health and positive and negative affect over the past 30 days were used to assess mental health and extract an overall mental health latent variable. All measures had strong loadings onto their corresponding latent variable at Time 1 and Time 3 (i.e. all loadings > |0.60|, *ps* < .001) and the factor loadings were nearly identical in magnitude at Time 1 and Time 3 (see Supplemental Table 1).

2.3.5.1. Current mental health. Participants' responded to "In general, would you say your mental health is excellent, very good, good, fair, or poor?" from 1 (excellent) to 5 (poor). This item was used as a mental health parallel of the single item current physical health.

2.3.5.2. Positive and negative affect over the past month. Participants indicated how much of the time they felt 13 positive emotional states (e.g. cheerful, satisfied, enthusiastic, confident; Time 1 $\alpha = 0.94$, Time 3 $\alpha = 0.95$) and 14 negative emotional states (e.g. nervous, upset, angry, hopeless; Time 1 $\alpha = 0.87$; Time 3 $\alpha = 0.92$) over the past 30 days. Ratings ranged from 1 (none of the time) to 5 (all of the time). Items for these positive and negative affect scales are a combination of two widely used and validated affect measures, namely Positive and Negative Affect Schedule (Watson et al., 1988) with positive and negative affect subscales (PANAS PA and PANAS NA, respectively), and the Positive and Negative Affect Scales (Mroczek and Kolarz, 1998). Positive and negative affect have often been used as indicators of mental health (e.g., Keyes et al., 2002; Hu et al., 2015; Wei et al., 2011). The PANAS NA has demonstrated large correlations with depression, distress, anxiety, and stress, and large inverse associations with life satisfaction and psychological flourishing among university students and community adults; the PANAS PA has demonstrated medium to large correlations with these constructs but in the opposite direction (Brenner et al., 2018). Similarly, positive affect and negative affect subscales from the Positive and Negative Affect Scales have demonstrated large correlations with life satisfaction and self-acceptance (Keyes et al., 2002).

2.3.6. Pittsburgh sleep quality inventory (PSQI; time 2)

The PSQI is a widely used self-report measure of sleep quality during the past 30 days (Buysee et al., 1989). This 19-item measure captures seven components of sleep quality: subjective sleep quality (overall perception of sleep quality), sleep onset latency (number of minutes it takes to fall asleep), sleep duration (hours of sleep), sleep efficiency (hours spent sleep relative to hours spent in bed), sleep disturbances (frequency of experiencing awakenings from sleep), use of sleep medication (frequency of using medicine to help sleep), and daytime dysfunction (frequency of experiencing difficulty remaining awake and motivated during the day). Each of these components are scored from 0 to 3 and then summed to derive a *global sleep quality* index, which ranges from 0 to 21. Greater scores represent *worse* sleep quality. Global sleep quality scores distinguish clinical from non-clinical sleep problems (i.e., those with sleep disturbance that warrants professional help; Buysee et al., 1989; Mollayeva et al., 2016).

2.4. Analytic strategy

MPLUS version 7.4 was used to conduct a three-part analysis (Muthen and Muthen, 2012).

First, latent mental and physical health factors were extracted using mental and physical health measures as indicators and used to test a structural equation model wherein global sleep quality from the PSQI mediated the effect of discrimination on physical and mental health. Mediation was assessed using bootstrapped tests of the indirect effect (Preacher and Hayes, 2008) with a significant indirect effect (a*b) as evidence of mediation. Age, gender, race, neuroticism, Time 1 income, Time 1 education level, Time 1 employment status were controlled for in all pathways. Mental and physical health at Time 1, Time 3 income, Time 3 education level, Time 3 employment status, and Time 3 discrimination were added as covariates when predicting Time 3 mental and physical health. All exogenous variables were allowed to correlate. All other paths were estimated as depicted in Fig. 1. Second, the specific aspects of sleep that may underlie this relation were explored by testing a model in which all specific components of the PSQI were simultaneously entered as mediators. Third, in separate linear regressions, whether the number of reasons for discrimination moderated the effect of discrimination on sleep and time 3 mental and physical health was assessed.

2.4.1. Missing data

Missing data analyses were performed to evaluate the potential influence of participant attrition. Note that MIDUS III data on 201 of the 389 missing participants have not been made publicly available yet and are therefore missing by design; thus these participants were excluded from the missing data analysis. Separate logistic regressions were used to predict missing mental and physical health data at Time 3 from participant race, education level, income, gender, age, mental health, and physical health at time 1. Participants who were older ($OR = 1.02$) and had worse initial physical health ($OR = 1.36$) were more likely to have missing physical health data during Time 3. These effects and their magnitudes were similar when predicting missing mental health data at Time 3. Altogether, results suggest that study analyses involving physical health are likely to be conservative because sample exclusions reduced variation in factors related to physical health. Missing data within analyses were handled using full information maximum likelihood estimation in MPLUS.

3. Results

3.1. Measurement model

A confirmatory factor analysis was first conducted to test the fit of the measurement model wherein mental and physical health were both specified as latent variables at Time 1 and Time 3. To ensure that the same factors were extracted across time, factor loadings were constrained to be equal for each respective latent variable. This analysis provided a moderate fit to data, χ^2 (69, N = 866) = 488.31, $p < .001$, Comparative Fit Index (CFI) = 0.93, Tucker Lewis Index (TLI) = 0.91, Root Mean Square Error Approximation (RMSEA) = 0.08. Modification indices suggested that correlating errors of self-reported mental and physical health within each time would significantly improve model fit. Given that self-reporting mental and physical health rely on similar introspection and evaluative processes, these errors were allowed to correlate.

The refit model showed substantial improvements, χ^2 (67, N = 866) = 265.00, $p < .001$, CFI = 0.97, TLI = 0.96, RMSEA = 0.06.

3.2. Does global sleep quality mediate the effect of everyday discrimination on health?

After fitting the measurement model, descriptive statistics and correlations among all main study variables were calculated (Table 1). Raw correlations from the model supported study predictions that individuals who experienced more frequent everyday discrimination reported significantly worse future global sleep quality ($r = 0.21$), as well as worse future mental ($r = -0.32$) and physical health ($r = -0.27$). Worse global sleep quality, in turn, predicted worse future physical ($r = -.47$) and mental health ($r = -0.41$). All confidence intervals did not contain zero and fell within $\pm$ .07 from correlation coefficient; all *p*-values were less than 0.001.

Next, a model in which testing whether global sleep quality mediated the effect of everyday discrimination on these health outcomes was examined. The model demonstrated good fit, χ^2 (204, N = 866) = 625.76, CFI = 0.94, TLI = 0.92, RMSEA = 0.05. As hypothesized, global sleep quality partially mediated the effect of everyday discrimination on both physical (indirect $\beta = -.02$, 95% CI = [-0.030, −0.001], $p = .05$) and mental health outcomes (indirect $\beta = -0.02$, 95% CI = [-0.03, −0.003], $p = .02$; see Fig. 1). In a separate analysis we investigated the potential effects of controlling for

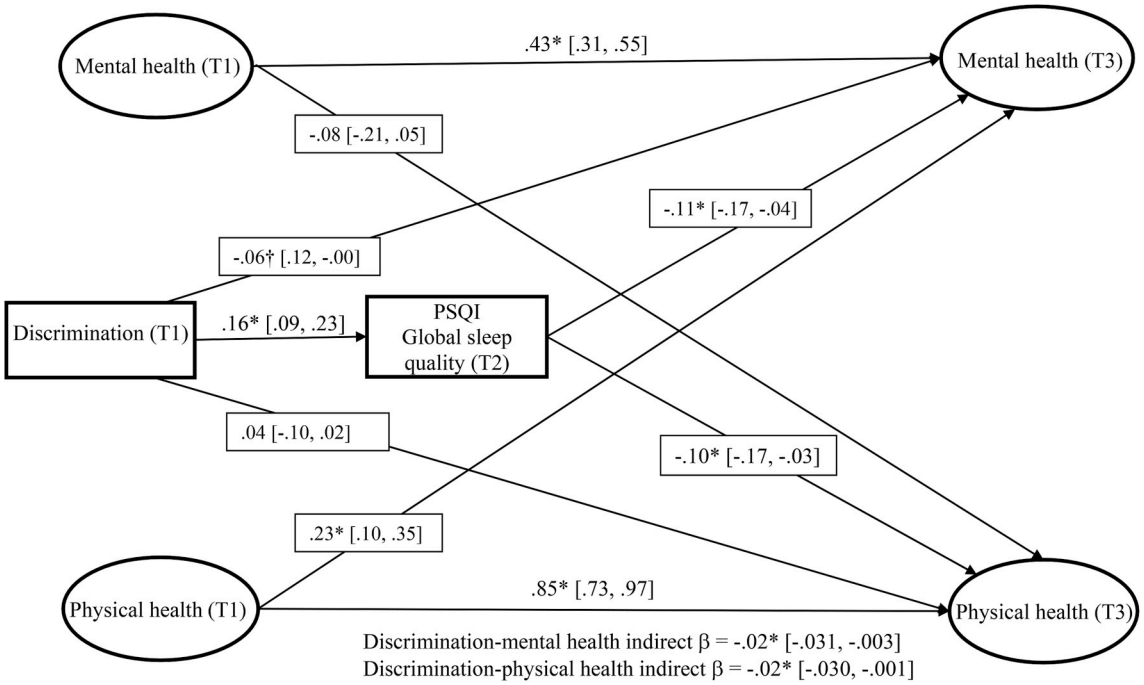

Fig. 1. Age, gender, race, income, employment status, education level, and neuroticism are controlled for in all portrayed pathways. Standardized coefficients are shown along with their associated 95% confidence interval in brackets. Non-depicted paths are allowed to correlate *$p < .05$, †$p < .10$.

the effect of Time 1 mental and physical health when predicting Time 2 sleep from Time 1 discrimination in this model (see supplemental material 3).

3.2.1. Which components of the PSQI are mediators?

To examine whether specific components of the PSQI uniquely mediate this discrimination-health relation, the mediation analysis was repeated, but with all PSQI components simultaneously entered as mediators. Though PSQI components are inter-correlated (see Supplemental Table 2), there was no evidence that the assumption of multicollinearity would be violated, as the Variance Inflation Factor was low (between 1.14 and 1.53) for all PSQI components when predicting physical and mental health. Only daytime dysfunction emerged as a significant mediator of physical and mental health (both indirect $\beta s = -0.02$, 95% *CI* [-0.027, −0.003], $ps = .02$). Full results appear in Supplemental Table 4.

3.2.2. Do multiple marginalized identities moderate the impact of discrimination on future sleep and health?

Interactions between daily discrimination and number of marginalized identities were calculated and used to predict global sleep quality and Time 3 physical and mental health.

Contrary to hypotheses, all interaction terms were nonsignificant, indicating that belonging to more marginalized groups did not further increase the impact of discrimination on sleep and health (all $ps > .23$; see Supplemental Table 5). In post-hoc analyses, we investigated

Table 1
Correlations among main study variables ($N = 866$).

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	M	SD
1. Discrimination (T1)	–																	12.64	4.22
2. Discrimination (T3)	.53*	–																12.07	3.80
3. Global sleep quality (T2)	.21*	.13*	–															5.75	3.41
4. Physical health (T1)	-.34*	-.32*	-.47*	–														0.00	0.95
5. Physical health (T3)	-.27*	-.35*	-.47*	.85*	–													0.00	0.87
6. Mental health (T1)	-.31*	-.28*	-.39*	.61*	.51*	–												0.00	0.91
7. Mental health (T3)	-.32*	-.36*	-.41*	.57*	.67*	.73*	–											0.00	0.91
8. Multiple marginalized identities	.65*	.48*	.13*	-.26*	-.21*	-.16*	-.18*	–										.91	.95
9. Age	-.17*	-.16*	-.05	-.10*	-.02	.25*	.22*	-.11*	–									54.74	10.99
10. Gender	.05	.06	.18*	-.24*	-.21*	-.07*	-.08*	.16*	-.03	–								55.70%	–
11. Race	.17*	.13*	.05	-.09*	-.07*	-.04	-.06†	.08*	-.08*	.01	–							7.00%	–
12. Income (T1)	-.04	-.12*	-.12*	.26*	.29*	.09*	.16*	-.05	-.11*	-.29*	-.03	–						$45,208	$40,572
13. Income (T3)	-.06	-.06	-.05	-.10*	-.06	.03	.02	-.04	-.13*	-.11*	.03	.32*	–					$62,459	$87,050
14. Education level (T1)	-.10*	-.12*	-.11*	.24*	.27*	.09*	.10*	.00	-.10*	-.09*	-.05	.31*	-.03*	–				7.79	2.43
15. Education level (T3)	-.10*	-.12*	-.10*	.26*	.26*	.09*	.12*	-.01	-.12*	-.06	.07*	.19*	.21*	.89*	–			7.79	2.42
16. Employment status (T1)	-.03	.02	-.02	.23*	.18*	.02	-.01	-.03	-.42*	.03	.04	.27*	.19*	.14*	.13*	–		56.40%	–
17. Employment status (T3)	.13*	.06	.02	.18*	.12*	.14*	-.10*	.11*	-.53*	-.03	.13*	.11*	.21*	.19*	.14*	.54*	–	44.30%	–
18. Neuroticism	.17*	.15*	.21*	-.29*	-.25*	-.61*	-.48*	.14*	-.18*	.10*	.05	.00	.16*	-.04	-.04	.02	.10*	2.04	0.72

Note. Gender coded 0 = Male, 1 = Female; Race coded 0 = European American, 1 = all other races, Employment status coded 0 = Unemployed, 1 = Employed. *p < .05, †p <

whether age moderated the effect of discrimination on sleep and health. All interaction effects were small and nonsignificant ($\beta = \sim|.05|$, $ps > .13$).

4. Discussion

The current study's findings build upon prior cross-sectional research (Chen and Yang, 2014; Steffen and Bowden, 2006; Yang and Park, 2015) by providing the first longitudinal examination of the discrimination-sleep-health pathway. Self-reported sleep mediated the effect of everyday discrimination on future mental and physical health, even after accounting for key covariates. This pattern is consistent with prior cross-sectional findings (Chen and Yang, 2014; Steffen and Bowden, 2006; Yang and Park, 2015). Yet, the cross-sectional designs of such studies obscure directional conclusions of the pathway; thus, researchers noted the need for examining these relations over time (Owens et al., 2017; Slopen et al., 2016; Slopen and Williams, 2014). Overall, by longitudinally demonstrating that discrimination predicted worse future health through sleep, these results garner additional support for the temporal order of this potentially causal pathway.

Findings also suggest that daytime dysfunction (i.e., frequency of difficulty remaining awake and motivated during the day) may lie at the core of the discrimination-health relation although this finding was based upon exploratory analyses and should be interpreted with caution and replicated. However, note that the daytime dysfunction component of the PSQI has been strongly associated with fatigue (Salahuddin et al., 2009) suggesting that these results were foreshadowed by past research linking discrimination to daytime fatigue and sleepiness (Grandner et al., 2012; Thomas et al., 2006). Daytime dysfunction should relate to mental and physical health because it assesses interference with daytime operations due to sleepiness and lack of enthusiasm.

Individuals struggling with such daytime dysfunction likely lack the mental or physical resources to enact effortful, proactive health behaviors that may reduce deteriorations in health, such as seeking social support, exercising, or scheduling routine physical examinations, (Feeney and Collins, 2015; Gill et al., 2001; Timmerman et al., 2015). At first glance, this finding seems to contrast with past findings that sleep quality and duration mediate the discrimination-health relation (Chen and Yang, 2014; Steffen and Bowden, 2006; Yang and Park, 2015). However, these prior studies did not examine daytime dysfunction in their analyses, and daytime dysfunction results from sleep disturbances. It may be that discrimination disrupts sleep which leads to daytime sleepiness and fatigue, which undermine proactive health behaviors and thereby health.

In general, findings that sleep may mediate the relation between discrimination and health provide insight in how to potentially reduce the effect of discrimination on health. For instance, mindfulness may reduce the impact of discrimination on health because it has been associated with improved sleep quality (Grossman et al., 2010; Howell et al., 2008) and has reduced the relation between perceived discrimination and depressive symptoms (Brown-iannuzzi et al., 2014). Additionally, greater consciousness of race-based stigma amplifies sleep disturbances that result from discrimination (Ong et al., 2017). Because self-compassion can buffer the internalization of stigma of seeking psychological help (Heath et al., 2018), self-compassion might also reduce internalized stigma caused by everyday discrimination, such as internalized racism or homophobia, especially given that self-compassion has been linked to expectations of rejection and distress among sexual minorities, both of which undermine sleep (Liao et al., 2015). Thus, future research and interventions could evaluate mindfulness and self-compassion as moderators of the effect of discrimination on sleep.

Finally, contrary to expectations, multiple marginalized identities demonstrated a negligible role in moderating the effect of discrimination on sleep and health. One potential reason is that our methodological approach reflected an additive model of multiple marginalized identities, which contends that discrimination increases as the number of marginalized identities increases (Crenshaw, 1989; Seng et al., 2012). There has been a movement in the literature toward an interactive model of intersectionality, which posits that the impact of holding multiple marginalized identities is contingent on how they intersect (Crenshaw, 1989; Hancock, 2007; McCall, 2005; Purdie-Vaughns and Eibach, 2008). Some researchers view the interactive approach as intersectionality in and of itself, whereas others contend that the interactive and additive approaches both comprise intersectionality (Cole, 2009). Although some researchers still use an additive lens (e.g., Seng et al., 2012), the intersectionality framework can allow for a more nuanced understanding of discrimination. An intersectional lens can delineate the unique experiences between culturally distinct marginalized groups within an identity (e.g., black women and Latino men, rather than men and women of color; bisexual women and lesbian women, rather than non-heterosexual women), whereas our methodology simply measured whether each participant felt marginalized within a given identity. Thus, although this study sample did not contain a large enough number of participants with unique combinations of multiple identities to examine intersectionality, a larger sample could examine the interaction of specific identities (e.g., race, sexual identity). A finer grained examination of specific types of intersecting identities could also speak to burgeoning identity issues, such as xenophobia, religious persecution, and nativity, and may reveal an amplified impact of discrimination on sleep and health. Further, our analyses treated each identity equally, but some people may embrace a particular marginalized identity more than others. That is, the potential order among marginalized identities and the individual's experience of the identity is overlooked. This is important given that identity salience can be a protective factor in coping with everyday discrimination towards that salient identity (Mossakowski, 2003). Thus, future research should consider the meaning and salience of specific identities and how they intersect.

Another reason that study findings do not support an interaction may be that the sum of the reasons for discrimination and the frequency of discrimination as measured by the everyday discrimination were moderately correlated ($r = 0.65$). Because the everyday discrimination scale measures frequency of discrimination, it may largely already capture the effect of marginalized intersecting identity given that individuals with more marginalized identities experience discrimination more frequently.

4.1. Future research and limitations

Although the current study found evidence for sleep as a mediator of the discrimination-health relation, it is important that interpretation of these results be circumspect. While the mental health items used in this study have been used as indicators of mental health (e.g., Keyes et al., 2002; Hu et al., 2015) and converge with other measures of mental health (e.g., Brenner et al., 2018), this study predominantly utilized affective components of mental health. Future researchers could assess this mediation relationship using measures which focus more on severe mental health symptoms or general well-being.

Additionally, the observed mediation effects of sleep for mental and physical health were small ($\beta s = .02$), leaving the practical importance of sleep in this pathway open to interpretation. However, given the length of time between MIDUS II, Biomarker, and MIDUS III assessments and the number of extraneous factors that may diminish the relations among discrimination, sleep, and health between time points, it would be surprising if the observed mediation effect were large. Assessing this relation over shorter time periods may reveal stronger effects as more recent discrimination has a stronger effect on mental health than less recent discrimination (Pascoe and Richman, 2009). For instance, the meta-analytic effect of discrimination on wellbeing is −0.23 in cross-sectional studies, but in longitudinal studies the magnitude of the effect decreases by 0.02 for each year between

assessments (Schmitt et al., 2014). These findings suggest that while discrimination can impact future health, the time between assessments of discrimination and health does reduce its impact. Similar to discrimination, poor sleep also undermines future mental and physical health, though the impact of sleep is not always reduced by time (Cappuccio et al., 2009; Cappuccio et al., 2011). These far reaching impacts of discrimination and sleep may be partially due to their sizeable stability over time. The stability of discrimination in the current study was .53 and estimates of the stability of PSQI scores over a single year is 0.68. Altogether, this evidence suggests that while time may reduce the relations among discrimination, sleep, and health, the associations among these factors should still be present at modest time intervals.

While intervening directly on sleep may be one way to reduce health disparities caused by discrimination, future work should also explore mechanisms through which discrimination corrodes sleep. So far, rumination and psychological distress from discrimination and vigilance for discrimination have all been linked with a variety of deteriorated dimensions of sleep (Hicken et al., 2013; Hoggard and Hill, 2016; Vaghela and Sutin, 2016). Perhaps influencing these mechanisms may be more effective in reducing the detrimental impact of discrimination or could be targeted in conjunction with sleep.

Another limitation of the study is its focus on everyday discrimination. Although this fit the current study objective of understanding the long-term impact of day-to-day discrimination because chronic discrimination exposure can disrupt quality of sleep (Vaghela and Sutin, 2016), it is important to note that both everyday discrimination and major discrimination experiences (i.e., being denied a promotion, unfair treatment by police) can independently impact sleep. For example, Slopen and Williams (2014) found that everyday discrimination and major discrimination experiences related to race/ethnicity were each uniquely linked with lower duration of sleep. Therefore, it is important for future researchers to examine both forms of discrimination in order to identify the differential influence of these forms of discrimination over time. Relatedly, though the definition of everyday discrimination might seem particularly applicable to race, the study sample was not highly diverse in terms of race/ethnicity, and the majority of participants reported discrimination based on age and gender. Moreover, the rates experiencing discrimination due to race and ethnicity, as well as other reasons such as religion and sexual orientation, were low in the study sample. Therefore, we caution readers in the potential generalization of these findings to minorities in these populations and encourage future research to more specifically examine the relations among discrimination, sleep, and health in these populations.

Along these lines, the current study was unable to disentangle the relations between initial health and discrimination; future research using longitudinal data should try to do so by using a sample in which health is not a reason for experiences of discrimination. Because the outcome of interest is health, using a sample in which health is the source of discrimination and then attempting to control for health in model pathways may indirectly remove some of the effect discrimination rather than control for potentially confounding effects of health (see Footnote 1). Alternatively, it would be valuable to monitor a sample of initially healthy individuals and examine how exposure to discrimination may relate to changes in their health over time.

Final limitations to consider are methodological in nature. First, all variables were measured through self-report and were reported by the same person. Such overlap in measurement can artificially inflate associations among variables due to responses' characteristics such as social desirability bias or a negative responses style (though note the current study used neuroticism as a covariate to control negative response style; Podsakoff et al., 2003; Watson and Pennebaker, 1989). Thus, even though the current study attempted to control for negative response style, the observed estimates in the current sample are likely to be influenced by other common method biases. Second, we chose to use the existing MIDUS data because it allowed for assessment of discrimination, sleep, and health. Because our study relies upon already existing data, using the MIDUS data could be framed as using a convenience sample. However, MIDUS study is designed for researchers to use to examine psychological and social factors on health. Therefore, it was designed to be used for studies such as ours.

Regardless, researchers should replicate these findings with new data, perhaps collected with the sole intention of examining the relations among sleep, discrimination, and health. Third, it is important to consider the impact of how the current study sample was selected and how it may differ from the overall MIDUS sample. Participants in this study were drawn from the MIDUS II Biomarker sample (which is a subsample of the full MIDUS II sample) and individuals who completed MIDUS III assessments. Critically, participants in MIDUS II are already a subsample of MIDUS I. Prior evidence shows that participants who stayed in the MIDUS project to participate in MIDUS II were more likely to be White, married, more educated, and have better physical health (Radler and Ryff, 2010). Thus, MIDUS II is a more homogeneous and healthy participant pool than the general population it is intended to represent. Moreover, while the MIDUS II Biomarker subsample demonstrates similar demographic and health characteristics with the MIDUS II overall sample (Love et al., 2010), the additional requirement of having to complete the MIDUS III survey likely altered this similarity. Indeed, the missing data analysis indicated that participants from the MIDUS II Biomarker subsample were more likely to be younger and have better health. Overall, the current study sample is likely to produce conservative estimates of the relations among discrimination, sleep, and health given that attrition reduced variance in demographic and health variables of interest.

5. Conclusions

The current study extended the cross-sectional understanding of the potentially causal discrimination-sleep-health pathway by examining these relations longitudinally. Findings indicated that sleep mediated the relation between discrimination and future mental and physical health. Exploratory analyses suggested daytime dysfunction as a core aspect of sleep in these pathways. Future studies should seek to replicate our findings, continue to investigate the influence of having multiple marginalized identities, and further dissect how discrimination impairs sleep.

Acknowledgements

MIDUS data collection was supported by a grant from the National Institute on Aging (P01-AG020166). The original study was supported by the John D. and Catherine T. MacArthur Foundation Research Network on Successful Midlife Development. We thank the staff of the Clinical Research Centers at the University of Wisconsin-Madison, UCLA, and Georgetown University for their support in conducting this study. Supported by the following grants M01-RR023942 (Georgetown), M01-RR00865 (UCLA) from the General Clinical Research Centers Program and 1UL1RR025011 (UW) from the Clinical and Translational Science Award (CTSA) program of the National Center for Research Resources, National Institutes of Health.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.socscimed.2018.12.002.

References

Baglioni, C., Battagliese, G., Feige, B., Spiedelhalder, K., Nissen, C., Voderholzer, U., et al., 2011. Insomnia as a predictor of depression: a meta-analytic evaluation of longitudinal epidemiological studies. J. Affect. Disord. 135, 10–19.

Bao, Z., Chen, C., Zhang, W., Zhu, J., Jaing, Y., Lai, X., 2016. Family economic hardship and Chinese adolescents' sleep quality: a moderated mediation model involving perceived economic discrimination and coping strategy. J. Adolesc. 50, 81–90.
Beatty, D.L., Hall, M.H., Kamarck, T.A., Buysse, D.J., Owens, J.F., Reis, S.E., Mezick, E.J., Strollo, P.J., Matthews, K.A., 2011. Unfair treatment is associated with poor sleep in African American and Caucasian adults: Pittsburgh SleepSCORE project. Health Psychol 30, 351–359.
Boutwell, B.B., Nedelec, J.L., Winegard, B., Shackelford, T., Beaver, K.M., Vaughn, M., et al., 2017. The prevalence of discrimination across racial groups in contemporary America: results from a nationally representative sample of adults. PloS One 12, e0183356.
Borgogna, N.C., McDermott, R.C., Aita, S.L., Kridel, M.M., 2018. Anxiety and Depression across Gender and Sexual Minorities: Implications for Transgender, Gender Nonconforming, Pansexual, Demisexual, Asexual, Queer, and Questioning Individuals. Psychology of Sexual Orientation and Gender Diversity. Advance online publication.
Brenner, R.E., Vogel, D.L., Lannin, D.G., Engel, K.E., Seidman, A.J., Heath, P.J., 2018. Do self-compassion and self-coldness distinctly relate to distress and well-being? A theoretical model of self-relating. J. Counsel. Psychol. 65, 346–357. https://doi.org/10.1037/cou0000257.
Brown-iannuzzi, J.L., Adair, K.C., Payne, B.K., Richman, L.S., Fredrickson, B.L., 2014. Discrimination hurts, but mindfulness may help: trait mindfulness moderates the relationship between perceived discrimination and depressive symptoms. Pers. Indiv. Differ. 56, 1–12. https://doi.org/10.1016/j.paid.2013.09.015. Discrimination.
Brown, T.T., Partanen, J., Chuong, L., Villaverde, V., Griffin, A.C., Mendelson, A., 2018. Discrimination hurts: the effect of discrimination on the development of chronic pain. Soc. Sci. Med. 204, 1–8.
Buxton, O.M., Marcelli, E., 2010. Short and long sleep are positively associated with obesity, diabetes, hypertension, and cardiovascular disease among adults in the United States. Soc. Sci. Med. 71, 1027–1036.
Buysee, D., Charles, R., Berman, S., 1989. The Pittsburgh Sleep Quality Index- A new instrument for psychiatric practice and research. Psychiatr. Res. 28, 193–213.
Cappuccio, F.P., D'elia, L., Strazzullo, P., Miller, M.A., 2009. Quantity and quality of sleep and incidence of type 2 diabetes: a systematic review and meta-analysis. Diabetes Care 33, 414–420.
Cappuccio, F.P., Cooper, D., D'elia, L., Strazzullo, P., Miller, M.A., 2011. Sleep duration predicts cardiovascular outcomes: a systematic review and meta-analysis of prospective studies. Eur. Heart J. 32, 1484–1492.
Chen, D., Yang, T., 2014. The pathways from perceived discrimination to self-rated health: an investigation of the roles of distrust, social capital, and health behaviors. Soc. Sci. Med. 104, 64–73. https://doi.org/10.1016/j.socscimed.2013.12.021. The.
Cole, E.R., 2009. Intersectionality and research in psychology. Am. Psychol. 64, 170–180.
Crenshaw, K., 1989. Demarginalizing the Intersection of Race and Sex: a Black Feminist Critique of Antidiscrimination Doctrine, Feminist Theory and Antiracist Politics. U. Chi. Legal F., pp. 139–167.
Curtis, D.S., Fuller-rowell, T.E., El-sheikh, M., Carnethon, M.R., Ryff, C.D., 2017. Habitual sleep as a contributor to racial differences in cardiometabolic risk. Proc. Natl. Acad. Sci. 114, 8889–8894.
Desalvo, K.B., Bloser, N., Reynolds, K., He, J., Muntner, P., 2005. Mortality prediction with a single general self-rated health question. J. Gen. Intern. Med. 20, 267–275.
Essed, P., 1991. Understanding Everyday Racisim: an Interdisciplinary Theory. Sage, Newbury Park, CA.
Everson, C., 1993. Sleep deprivation impairs host defense. Am. J. Phsyiol. 265 (5), R1148–R1154.
Feeney, B.C., Collins, N.L., 2015. A new look at social support: a theoretical perspective on thriving through relationships. Pers. Soc. Psychol. Rev. 19 (2), 113–147.
Francis, B., Klebanoff, M., Oza-Frank, R., 2017. Racial discrimination and perinatal sleep quality. Sleep Health 3, 300–305.
Fuller-Rowell, T.E., Curtis, D.S., El-Sheikh, M., Duke, A.M., Ryff, C.D., Zgierska, A.E., 2016. Racial discrimination mediates race differences in sleep problems: a longitudinal analysis. Cult. Divers Ethnic Minor. Psychol. 23, 165–173.
Gibbons, F.X., Kingsbury, J.H., Weng, C.Y., Gerrard, M., Cutrona, C., Wills, T.A., Stock, M., 2014. Effects of perceived racial discrimination on health status and health behavior: a differential mediation hypothesis. Health Psychol. 33, 11–19.
Gill, T., Desai, M., Gahbauer, E., Holford, T., Williams, C., 2001. Restricted activity among community-living older persons: incidence, precipitants, and health care utilization. Ann. Intern. Med. 135, 313–321.
Goldberg, L.R., 1992. The development of markers for the Big-Five factor structure. Psychol. Assess. 4, 26–42.
Grandner, M.A., Hale, L., Jackson, N., Patel, N.P., Gooneratne, N.S., Troxel, W.M., 2012. Perceived racial discrimination as an independent predictor of sleep disturbance and daytime fatigue. Behav. Sleep Med. 10, 235–249.
Grossman, P., Kappos, L., Gensicke, H., D'Souza, M., Mohr, D., Penner, I.K., Steiner, C., 2010. MS quality of life, depression, and fatigue improve after mindfulness training. Neurology 75, 1141–1149.
Hancock, A., 2007. Intersectionality as a normative and empirical paradigm. Polit. Gend. 3, 248–254.
Harnois, C.E., 2015. Jeopardy, consciousness, and multiple discrimination: intersecting inequalities in contemporary Western Europe. Socio. Forum 30, 971–994.
Heath, P.J., Brenner, R.E., Lannin, D.G., Vogel, D.L., 2018. Self-compassion moderates the relationship of perceived public and anticipated self-stigma of seeking help. Stigma Health 3, 65–68.
Hicken, M.T., Lee, H., Ailshere, J., Burgard, S.A., Williams, D.R., 2013. Every shut eye, ain't sleep": the role of racism-related vigilance in racial/ethnic disparities in sleep difficulty. Race Soc. Probl. 5, 100–112. https://doi.org/10.1007/s12552-013-9095-9.
Hoggard, L.S., Hill, L.K., 2016. Examining how racial discrimination impacts sleep quality in African Americans: is perseveration the answer? Behav. Sleep Med. 1–14. https://doi.org/10.1080/15402002.2016.1228648.
Howell, A.J., Digdon, N.L., Buro, K., Sheptycki, A.R., 2008. Relations among mindfulness, well-being, and sleep. Pers. Indiv. Differ. 45, 773–777.
Hu, T., Zhang, D., Wang, J., 2015. A meta-analysis of the trait resilience and mental health. Pers. Indiv. Differ. 76, 18–27.
Kessler, R.C., Mickelson, K.D., Williams, D.R., 1999. The prevalence, distribution, and mental health correlates of perceived discrimination in the United States. J. Health Soc. Behav. 208–230.
Keyes, C.L., Shmotkin, D., Ryff, C.D., 2002. Optimizing well-being: the empirical encounter of two traditions. J. Pers. Soc. Psychol. 82, 1007–1022.
Khan, M., Ilcisin, M., Saxton, K., 2017. Multifactorial discrimination as a fundamental cause of mental health inequities. Int. J. Equity Health 16, 43.
Lewis, T., Cogburn, C.D., Williams, D.R., 2015. Self-reported experiences of discrimination and health: scientific advances, ongoing controversies, and emerging issues. Annu. Rev. Clin. Psychol. 11, 407–440.
Lewis, T.T., Troxel, W.M., Kravitz, H.M., Bromberger, J.T., Matthews, K.A., Hall, M., 2013. Chronic exposure to everyday discrimination and sleep in a multi-ethnic sample of middle-aged women. Health Psychol. 32, 810–819.
Liao, K.Y., Kashubeck-west, S., Weng, C.-Y., Deitz, C., 2015. Testing a mediation framework for the link between perceived discrimination and psychological distress among sexual minority individuals. J. Counsel. Psychol. 62, 226–241.
Liu, Y., Wheaton, A.G., Chapman, D.P., Cunningham, T.J., Lu, H., Croft, J.B., 2016. Prevalence of healthy sleep duration among adults—United States, 2014. MMWR (Morb. Mortal. Wkly. Rep.) 65, 137–141.
Love, G.D., Seeman, T.E., Weinstein, M., Ryff, C.D., 2010. Bioindicators in the MIDUS National Study: protocol, measures, sample, and comparative context. J. Aging Health 22, 1059–1080. https://doi.org/10.1177/0898264310374355.
McCall, L., 2005. The complexity of intersectionality. Signs 30, 1771–1800.
Mereish, E.H., Bradford, J.B., 2014. Intersecting identities and substance use problems: sexual orientation, gender, race, and lifetime substance use problems. J. Stud. Alcohol Drugs 75, 179–188.
Mezick, E.J., Matthews, K.A., Hall, M., Kamarck, T.W., Buysse, D.J., Owens, J.F., Reis, S.E., 2009. Intra-individual variability in sleep duration and fragmentation: associations with stress. Psychoneuroendocrinology 34, 1346–1354.
Mollayeva, T., Thurairajah, P., Burton, K., Mollayeva, S., Shapiro, C.M., Colantonio, A., 2016. The Pittsburgh sleep quality index as a screening tool for sleep dysfunction in clinical and non-clinical samples: a systematic review and meta-analysis. Sleep Med. Rev. 25, 52–73. https://doi.org/10.1016/j.smrv.2015.01.009.
Mossakowski, K.N., 2003. Coping with perceived discrimination: does ethnic identity protect mental health? J. Health Soc. Behav. 318–331.
Mroczek, D.K., Kolarz, C.M., 1998. The effect of age on positive and negative affect: a developmental perspective on happiness. J. Pers. Soc. Psychol. 75, 1333–1349.
Muthen, L., Muthen, B., 2012. Mplus Version 7 User's Guide. Muthen & Muthen, Los Angeles, CA.
Ohayon, M.M., 2002. Epidemiology of insomnia: what we know and what we still need to learn. Sleep Med. Rev. 6, 97–111.
Ong, A.D., Cerrada, C., Lee, R.A., Williams, D.R., 2017. Stigma consciousness, racial microaggressions, and sleep disturbance among Asian Americans. Asian Am. J. Psychol. 8, 72.
Owens, S.L., Hunte, H.E.R., Sterkel, A., Johnson, D.A., Johnson-lawrence, V., 2017. Association between discrimination and objective and subjective sleep measures in the Midlife in the United States Study adult sample. Psychosom. Med. 79, 469–478.
Paine, S., Harris, R., Chb, M.B., Cormack, D., Stanley, J., 2016. Racial discrimination and ethnic disparities in sleep disturbance: the 2002/03 New Zealand health survey. Sleep. 39, 477–485.
Pascoe, E.A., Richman, L.S., 2009. Perceived discrimination and health: a meta-analytic review. Psychol. Bull. 135, 531–554.
Pilcher, J.J., Ginter, D.R., Sadowsky, B., 1997. Sleep quality versus sleep quantity: relationships between sleep and measures of health, well-being and sleepiness in college students. J. Psychosom. Res. 42, 583–596.
Podsakoff, P.M., MacKenzie, S.B., Lee, J.-Y., Podsakoff, N.P., 2003. Common method biases in behavioral research: a critical review of the literature and recommended remedies. J. Appl. Psychol. 88, 879–903.
Preacher, K.J., Hayes, A.F., 2008. Asymptotic and resampling strategies for assessing and comparing indirect effects in multiple mediator models. Behav. Res. Methods 40, 879–891.
Purdie-Vaughns, V., Eibach, R.P., 2008. Intersectional invisibility: the distinctive advantages and disadvantages of multiple subordinate-group identities. Sex. Roles 59, 377–391.
Radler, B.T., Ryff, C.D., 2010. Who participates? Accounting for longitudinal retention in the MIDUS national study of health and well-being. J. Aging Health 22, 307–331.
Robinson, E., Sutin, A., Daly, M., 2017. Perceived weight discrimination mediates the prospective relation between obesity and depressive symptoms in U.S. and U.K. adults. Health Psychol. 36, 112–121.
Rossi, A.S. (Ed.), 2001. Caring and Doing for Others: Social Responsibility in the Domains of Family, Work, and Community. University of Chicago Press.
Salahuddin, N., Barroso, J., Leserman, J., Harmon, J.L., Pence, B.W., 2009. Daytime sleepiness, nighttime sleep quality, stressful life events, and HIV-related fatigue. J. Assoc. Nurses AIDS Care 20, 6–13.
Schmitt, M.T., Schmitt, M.T., Branscombe, N.R., Garcia, A., 2014. The consequences of perceived discrimination for psychological well-being: a meta-analytic review. Psychol. Bull. 140, 921–949. https://doi.org/10.1037/a0035754.
Schnittker, J., Bacak, V., 2014. The increasing predictive validity of self-rated health. PloS One 9, e84933.
Seng, J.S., Lopez, W.D., Sperlich, M., Hamama, L., Meldrum, C.D.R., 2012. Marginalized

identities, discrimination burden, and mental health: empirical exploration of an interpersonal-level approach to modeling intersectionality. Soc. Sci. Med. 75, 2437–2445.
Sims, M., Diez-Roux, A., Gebreab, S., Brenner, A., Dubbert, P., Wyatt, S., et al., 2016. Perceived discrimination is associated with health behaviors among African Americans in the Jackson Heart Study. J. Epidemiol. Community Health 70, 187–194.
Slopen, N., Lewis, T., Williams, D.R., 2016. Discrimination and sleep: a systematic review. Sleep Med. 18, 88–95. https://doi.org/10.1016/j.sleep.2015.01.012.
Slopen, N., Williams, D.R., 2014. Discrimination, other psychosocial stressors, and self-reported sleep duration and difficulties. Sleep 37, 147–156.
Steffen, P.R., Bowden, M., 2006. Sleep disturbance mediates the relationship between racism and depressive symptoms. Ethn. Dis. 16, 16–21.
Thomas, K.S., Bardwell, W.A., Ancoli-Israel, S., Dimsdale, J.E., 2006. The toll of ethnic discrimination on sleep architecture and fatigue. Health Psychol. 25, 635.
Timmerman, J.J., Kurvers, R., Bloo, H., Hermens, H., Vollenbroek-Hutten, M.M.R., 2015. Daily physical activity patterns in cancer survivors: a pilot study. Eur. J. Oncol. Nurs. 19, 162–168. https://doi.org/10.1016/j.ejon.2014.09.005.
Tomfohr, L., Pung, M., Edwards, K., Joel, D., 2012. Racial differences in sleep architecture: the role of ethnic discrimination. Biol. Psychol. 89, 34–38.
Vaghela, P., Sutin, A.R., 2016. Discrimination and sleep quality among older US adults: the mediating role of psychological distress. Sleep Health 2, 100–102.
Van Cauter, E., Knutson, K., Leproult, R., Miller, A., Nedeltcheva, A., Pannain, S., et al., 2007. Impact of sleep and sleep loss on neuroendocrine and metabolic function. Horm. Res. 67, 2–9.
Watson, D., Clark, L.A., Tellegen, A., 1988. Development and validation of brief measures of positive and negative affect: the PANAS scales. J. Pers. Soc. Psychol. 54, 1063–1070.
Watson, D., Pennebaker, J.W., 1989. Health complaints, stress, and distress: exploring the central role of negative affectivity. Psychol. Rev. 96, 234.
Wei, M., Liao, K., Ku, T., Shaffer, P.A., 2011. Attachment, self-compassion, empathy, and subjective well-being among college students and community adults. J. Pers. 79, 191–221. https://doi.org/10.1111/j.1467-6494.2010.00677.x.
Williams, D.R., Mohammed, S.A., 2009. Discrimination and racial disparities in health: evidence and needed research. J. Behav. Med. 32, 1–38.
Williams, D.R., Yu, Y.A.N., Jackson, S., Anderson, N.B., 1997. Racial differences in physical and mental health. J. Health Psychol. 2, 335–351.
Williamson, R.J., Purcell, S., Sterne, A., Wessely, S., Hotopf, M., Farmer, A., Sham, P.C., 2005. The relationship of fatigue to mental and physical health in a community sample. Soc. Psychiatr. Psychiatr. Epidemiol. 40, 126–132.
Xie, L., Kang, H., Xu, Q., Chen, M.J., Liao, Y., Thiyagarajan, M., et al., 2013. Sleep drives metabolite clearance from the adult brain. Science 342, 373–378.
Yang, T.C., Chen, I.C., Choi, S.W., Kurtulus, A., 2018. Linking perceived discrimination during adolescence to health during mid-adulthood: self-esteem and risk-behavior mechanisms. Soc. Sci. Med Advance online publication.
Yang, T., Park, K., 2015. To what extent do sleep quality and duration mediate the effect of perceived discrimination on health? Evidence from Philadelphia. J. Urban Health 92, 1024–1037. https://doi.org/10.1007/s11524-015-9986-8.
Yoo, S., Gujar, N., Hu, P., Jolesz, F.A., Walker, M.P., 2007. The human emotional brain without sleep — a prefrontal amygdala disconnect. Curr. Biol. 17, 877–878.