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## Review Article

## Discrimination and sleep: a systematic review

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## ABSTRACT

An increasing body of literature indicates that discrimination has a negative impact on health; poor sleep may be an underlying mechanism. The primary objective of this review was to examine existing studies on the relationship between discrimination and sleep to clarify (a) the potential role of discrimination in shaping population patterns of sleep and sleep disparities, and (b) the research needed to develop interventions at individual and institutional levels. We identified articles from English-language publications in PubMed and EBSCO databases from inception through July 2014. We employed a broad definition of discrimination to include any form of unfair treatment and all self-reported and objectively assessed sleep outcomes, including duration, difficulties, and sleep architecture. Seventeen studies were identified: four prospective, 12 cross-sectional, and one that utilized a daily-diary design. Fifteen of the 17 studies evaluated interpersonal discrimination as the exposure and the majority of studies included self-reported sleep as the outcome. Only four studies incorporated objective sleep assessments. All 17 studies identified at least one association between discrimination and a measure of poorer sleep, although studies with more detailed consideration of either discrimination or sleep architecture revealed some inconsistencies. Taken together, existing studies demonstrate consistent evidence that discrimination is associated with poorer sleep outcomes. This evidence base can be strengthened with additional prospective studies that incorporate objectively measured aspects of sleep. We outline important extensions for this field of inquiry that can inform the development of interventions to improve sleep outcomes, and consequently promote well-being and reduce health inequities across the life course.

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An estimated 50–70 million adults in the United States have disordered or insufficient sleep [1]. Sleep disorders and sleep deprivation have been found to increase the risk of a variety of adverse health outcomes including mood disorders [2], substance abuse disorders [3], central adiposity and obesity [4–6], immune function [7,8], diabetes [9,10], hypertension [11], heart disease [12,13], and mortality [14–17]. Sleep problems are also associated with increased functional impairment, including employee absenteeism, lower work productivity, and medical errors [18]. The Institute of Medicine reports that hundreds of billions of dollars each year are spent on direct and indirect costs associated with sleep loss and sleep disorders [1,18–20], and sleep health is a key goal of the U.S. Department of Health and Human Services' Healthy People 2020 [21].

Nationally representative and community-based studies in the US show that sleep characteristics vary by race and ethnicity [22–27],

immigration history [28], and socioeconomic status (SES) [23,25], with disadvantaged groups typically showing poorer sleep-related outcomes. For example, using objective assessments, the Coronary Artery Risk Development in Young Adults (CARDIA) study found that Black respondents had shorter sleep duration, poorer sleep efficiency, and greater sleep latency compared to White respondents [22]. In order to address the national burden of sleep loss and disorders, and racial/ethnic and socioeconomic inequalities in sleep health, it is critical to identify potentially modifiable risk factors for sleep problems among disadvantaged groups.

Discrimination – defined as differential or unfair treatment based on actual or perceived membership in a group [29] – can occur based on race/ethnicity, national origin, religion, gender, sexual orientation, SES, or other social factors, and it is increasingly recognized as a determinant of health across the life course [30–35]. Discrimination can occur at multiple levels, including institutional discrimination, which refers to unfair institutional policies or practices, as well as interpersonal discrimination, which typically refers to perceived discriminatory interactions within social encounters [35–37]. Building on initial discrimination and health research, there is now great interest in identifying the underlying mechanisms through which discrimination affects health. Insufficient or

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poor-quality sleep may be one pathway that connects perceived discrimination to physical and mental health problems [38,39], and a growing literature has documented sleep as a mediator of the relationship between stressors and health [40–43]. Experiences of discrimination could impact sleep directly through a variety of mechanisms, such as activating feelings of threat, arousal, vigilance [44], psychological distress (eg, depression, anxiety, cynical hostility, or anger) [45–47], or physiological changes (eg, hypothalamic pituitary adrenal axis dysfunction or sympathetic nervous system hyperactivation) [48] that impede high-quality sleep.

The primary aim of this study is to review existing studies of the relationship between discrimination and sleep, and to evaluate whether this association is maintained after adjusting for important confounders, as systematic consideration of this literature can elucidate the role of discrimination in shaping population-level patterns of sleep and sleep disparities. The secondary aim is to discuss important directions for research that can inform interventions.

## 1. Methods

We conducted a systematic review of all English-language articles published in PubMed, Web of Science, and EBSCO databases (PsychInfo, ERIC, CINAHL) from 1971 through July 2014. Our search strategy was informed by prior literature reviews on discrimination and health [30,32,49]. Medical Subject Headings (MeSH) of the National Library of Medicine and keywords were used to search PubMed, and a similar search was designed for the EBSCO databases (see Appendix for sample search strategy). We also searched reference lists of selected articles and relevant review articles for applicable studies. Studies identified in the database searches were assessed for relevance based on title and abstract, and selected studies were obtained in full and assessed for inclusion criteria. Studies were included if they analyzed perceived discrimination, unfair treatment, prejudice, or organization injustice in relation to one or more characteristics of sleep such as insomnia, poor sleep quality, or sleep duration. For each selected article, we extracted data related to the following: study design, sample size, sample age, geographic location, measurement of discrimination, measurement of sleep, covariates, and results.

## 2. Results

### 2.1. Description of included studies

Our database search identified 453 records; after excluding duplications ( $n = 96$ ), 17 articles were selected for further evaluation, and two additional studies were identified from reference sections. A total of 17 articles met inclusion criteria for this review (see Fig. 1 for flow diagram). The characteristics of the selected studies are presented in Table 1. The earliest study on discrimination and sleep was published in 2003 [50]. Twelve of the 17 studies were cross-sectional, three were observational prospective studies [50,56,62], one included a 9-day daily-diary component [46], and one included a natural experiment with an intervention [51]. The sample sizes ranged from 93 [54] to 10,039 [63], with a median of 1523 participants. Eleven of the 16 studies took place in the United States; the others were conducted in Finland [50], Brazil [55], Korea [58,63], Sweden [53], and the UK [56]. Only two of the 17 studies used samples comprising children or adolescents [55,61]. Across studies, three measured discrimination using a single item [39,55,59], while the majority used multiple-item scores. The majority of studies evaluated interpersonal discrimination, while one study assessed the impact of unfair treatment at the institutional level (a pay cut to all nurses) on sleep problems [51], and another study evaluated race-related vigilance (ie, the extent to which participants anticipated and prepared for racial discrimination) [64]. Some

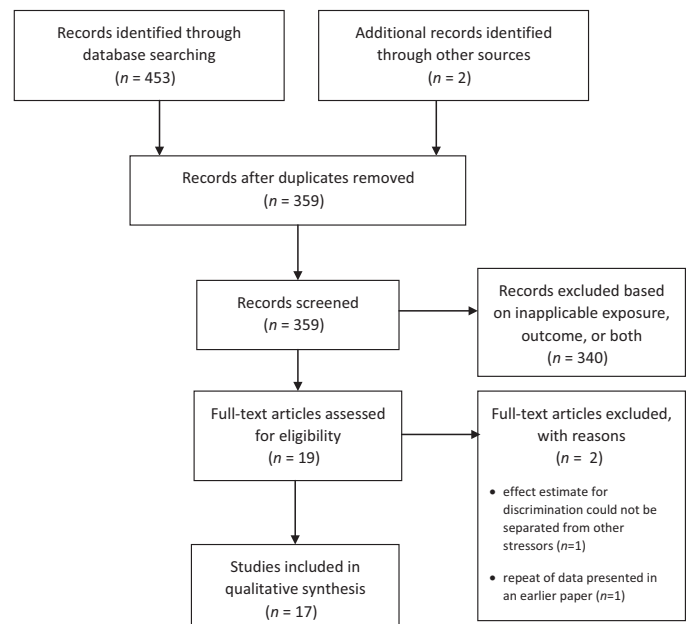


Fig. 1. Flow diagram.

studies specifically evaluated racial/ethnic discrimination [52,54,59–61,64,65], and others focused on unfair treatment in the workplace [50,51,56,58,63,65] or in health care [59].

Sixteen of the 17 studies evaluated self-reported sleep difficulties and/or daytime fatigue, and 12 of these studies exclusively relied on self-reported sleep outcomes. There was large variation in the self-report measures of sleep difficulties, ranging from single-item measures of sleep problems or daytime fatigue [39,53,55,59,63], self-reported sleep duration [61,65], to extensively validated scales such as the Pittsburgh Sleep Quality Index [46,52,62], the Epworth Sleepiness Scale [46], and the Multidimensional Fatigue Symptom Inventory-Short Form [54]. One study used actigraphy to measure sleep duration and efficiency [46], and four studies evaluated polysomnography (PSG)-assessed sleep outcomes [46,54,60,62], including duration, efficiency, sleep latency, wake after sleep onset (WASO), rapid eye movement (REM) sleep, light sleep, and Stages 3 and 4 sleep. All studies controlled for basic demographic characteristics, including age, sex, and race (if appropriate based on the sample), and nearly all studies adjusted for SES. Roughly half of the studies adjusted for mental or physical health or health behavior covariates (eg, body mass index or BMI, depression, cigarette smoking, alcohol use, physical activity) [46,50,54,56,58,60,62,63], and five studies adjusted for other psychosocial stressors in addition to discrimination [55,56,61,62,65].

### 2.2. Associations between discrimination and sleep outcomes

#### 2.2.1. Self-reported sleep difficulties

All 16 studies that included a measure of self-reported sleep problems reported positive associations between discrimination and outcomes including sleep difficulties or insomnia [39,50–53,55–59,61–65] and fatigue [54,57,59]. The strongest evidence comes from the three prospective cohort studies [50,56,62] and the natural experiment [51]. For example, a study of 368 African American, White, and Chinese women from the Study of Women's Health Across the Nation (SWAN) Sleep Study found that chronic everyday discrimination (collected annually for four years and averaged) was associated with more sleep complaints, independent of financial strain and a variety of health characteristics, including depressive symptoms [62]. Similarly, among 5209 males and females

**Table 1**  
Studies on perceived unfair treatment and sleep outcomes ( $n = 17$ ).

Study	Sample <sup>a</sup>	Design	Exposure	Outcome(s)	Covariates	Findings
Elovainio et al. [50]	Male and female hospital employees in 10 Finnish hospitals ( $N = 3773$ , mean age = 44.4 years)	Prospective	Procedural Justice Scale (eight items) Relational Justice Scale (seven items)	Self-reported sleep difficulties (four items)	Age, sex, income, smoking, alcohol, physical activity	• Positive associations for both
Greenberg [51]	Male and female nurses in four US hospitals ( $N = 467$ )	Prospective, natural experiment with an intervention	Organizational injustice (pay cut)	Self-reported insomnia (four items)	None/NA (demographics balanced between groups)	• Positive association; conditional on supervisor training in interactional justice
Steffen et al. [52]	Community-based sample of Hispanic American male and female immigrants in Provo, UT ( $N = 168$ , mean age = 33 years)	Cross-sectional	Perceived Racism Scale (51 items)	Self-reported sleep disturbance (PSQI, 19 items)	Gender, income, education	• Positive association
Taloyan et al. [53]	Swedish and Kurdish immigrant men in the 1996 Swedish National Survey of Immigrants and Swedish Level-of-Living Survey ( $N = 1523$ , age range = 27–60 years)	Cross-sectional	Perceptions of equal treatment, relative to Swedish citizens (nine items)	Self-reported sleep difficulties (one item)	Age, marital status, education, home ownership, employment, number of children	• Positive association
Thomas et al. [54]	Community sample of employed African American (mean age = 38.1 years) and White (mean age = 35.6 years) males and females in California ( $N = 93$ )	Cross-sectional	Perceived Discrimination subscale of the Scale of Ethnic Experience (nine items)	Self-reported fatigue (MSFI-SF, 30 items) PSG-assessed TST, sleep latency, sleep efficiency, WASO, REM sleep, and slow-wave sleep (Stages 3 and 4)	Age, BMI, hypertension status, cigarette smoking, CES-D score	• Positive association with fatigue (not significant after control for depressive symptoms) • Negative association with Stage 4 sleep (significant after control for depressive symptoms)
Bittencourt et al. [55]	Representative sample of seventh-grade male and female students in Gravatai, South Brazil ( $N = 1170$ , age range = 12–18 years)	Cross-sectional	Discrimination in past 30 days (one item)	Self-reported sleep difficulty (one item)	Sex, ethnicity, SES, school absenteeism, peer relationships, use of alcohol, tobacco, and other drugs, parental empathy, # of friends, body image concerns, loneliness, sadness, suicidal ideation, fear of going to school, fights, insults	• Positive association
Elovainio et al. [56]	Male and females in the Whitehall II study of white-collar British civil servants ( $N = 5209$ , mean age = 44.2 years)	Prospective	Justice scale (10 items)	Self-reported sleep problems (sleep onset: one item; unrefreshing sleep: one item; sleep maintenance: two items)	Age, employment grade, BMI, alcohol consumption, smoking, job strain, baseline sleeping problems, baseline depressive symptoms	• Men: positive association with overall sleep problem score and all three components • Women: positive association with overall sleep problem score and non-refreshing sleep
Beatty et al. [57]	Middle-aged males and females in the Pittsburgh, PA, metropolitan area, recruited as part of HeartSCORE, a larger study ( $N = 210$ , mean age = 59.9 years)	Cross-sectional and daily diary (10 days)	Detroit Area Study Everyday Unfair Treatment Scale (nine items) plus one additional item (10 items total)	Self-report: diary sleep quality (two items), sleep quality (PSQI, 18 items), daytime sleepiness (Epworth Sleepiness Scale, eight items) Objective measures: actigraphy (duration, efficiency), PSG (duration, efficiency), WASO, Stage 3–4 sleep, REM sleep, apnea–hypopnea index)	Age, gender, race/ethnicity, BMI, hypertensive status and/or related medication use, composite SES, and other psychosocial characteristics (anger, anxiety, hostility, and depressive symptoms, analyzed separately)	• In models with basic demographic covariates: positive associations with poorer self-reported sleep quality and greater daytime sleepiness; negative association with actigraphy- and PSG-assessed sleep duration and efficiency and PSG-assessed proportion of REM sleep. • All sig. associations remained after adjustment for depression and hostility; for models adjusting for trait anger and anxiety, there were some exceptions. • Conditional association: unfair treatment associated with > WASO in Whites but not in African Americans.
Kim et al. [58]	Korean male and female employees recruited as part of a nationwide random sample ( $N = 8155$ )	Cross-sectional	Organizational injustice (four items)	Self-reported insomnia (three items)	Age, marital status, education, industrial type, company size, employment status, work schedule, job type, working hours, alcohol, smoking, exercise, BMI, and treated diseases	• Positive association

(continued on next page)

Table 1 (continued)

Study	Sample <sup>a</sup>	Design	Exposure	Outcome(s)	Covariates	Findings
Grandner et al. [59]	Male and female adults from the Michigan and Wisconsin 2006 Behavioral Risk Factor Surveillance System (N = 7148, mean age = 50.9 years)	Cross-sectional	Racism in health-care setting (one item)	Self-reported sleep disturbance (one item) and daytime fatigue (one item)	Age, gender, race/ethnicity, education, income, marital status, employment	• Positive associations
Tomfohr et al. [60]	African American (mean age = 38.2 years) and White (mean age = 33.4 years) male and female San Diego residents participating in larger study on vascular health disparities (N = 164)	Cross-sectional	Perceived Discrimination subscale from the Scale of Ethnic Experience (nine items)	Objectively measured sleep via PSG (TST, sleep efficiency, sleep latency, WASO, Stages 1 and 2, slow-wave sleep (composed of Stages 3 and 4), REM)	Age, BMI, SES, smoking, race/ethnicity	• Positive association with proportion of Stage 2 sleep (light sleep) • Inverse association with proportion of slow-wave sleep (deep sleep)
Huynh et al. [61]	Latino and Asian American 11th- and 12th-grade male and female students recruited from two Southern California high schools (N = 360, mean age = 17.2 years)	Cross-sectional	Overt discrimination by peers and adults (14 items) Ethnic Microaggressions Scale ("subtle discrimination"; 12 items)	Self-reported sleep quality (two items) Self-reported average hours of nighttime sleep	Sex, race/ethnicity, perceived stress, socioeconomic status	• Positive associations between overt and subtle discrimination and sleep quality; association between overt discrimination and sleep quality conditional on school belonging • Negative association between subtle discrimination and sleep duration
Lewis et al. [62]	African American, White, and Chinese women from Study of Women's Health Across the Nation Sleep Study (N = 368, mean age = 51 years)	Prospective	Everyday Discrimination Scale (10 items)	Self-reported subjective sleep complaints (PSQI, 19 items) Objectively measured sleep via PSG (sleep latency, WASO, total sleep time, Stages 3 and 4, and REM)	Age, race/ethnicity, financial strain, BMI, menopausal status, depressive symptoms, uses of medication that impact sleep, education	• Positive association with subjective sleep complaints and PSG-assessed WASO
Park et al. [63]	Representative sample of working male and female adults in the First Korean Working Conditions Survey (N = 10,039, mean age = 42 years)	Cross-sectional	Discrimination by age (one item) and sex (one item)	Self-reported sleep problems (one item)	Sex, age, education, income, smoking status, alcohol consumption, presence of illness, employment status, job type, employment contract, working hours, work schedule	• Positive associations for sex discrimination and age discrimination
Chen et al. [39]	Male and female respondents in the Public Health Management Corporation's 2008 Southeastern Pennsylvania Household Health Survey (N = 9880, mean age = 52.3 years)	Cross-sectional	Single item	Self-report sleep quality (one item)	Age, sex, marital status, income, education, race/ethnicity	• Positive association
Hicken et al. [64]	White, Black, and Hispanic males and females in the Chicago Community Adult Health Study (N = 3,094, mean age = 42.4 years)	Cross-sectional	Racism-related vigilance (three items)	Self-reported sleep difficulty (three items)	Age, gender, education, income,	• Positive association
Slopen et al. [65]	White, Black, and Hispanic males and females in the Chicago Community Adult Health Study (N = 2983, mean age = 42.3 years)	Cross-sectional	Everyday discrimination (five items) Major experiences of discrimination (four items) Workplace harassment and incivilities (two items)	Self-reported sleep difficulty (three items) Self-reported sleep duration	Age, sex, race/ethnicity, income, education, acute events, childhood adversity, and financial, community, employment, and relationship stressors	• Positive associations between racial and nonracial everyday discrimination and sleep difficulties • Inverse association between major experiences of discrimination attributed to race/ethnicity and sleep duration

<sup>a</sup> Mean age provided when available. PSG = polysomnography; WASO = wakefulness after sleep onset; REM = rapid eye movement; BMI = body mass index; TST = total sleep time; PSQI = Pittsburgh Sleep Quality Index; MFSI-SF = Multidimensional Fatigue Symptom Inventory-Short Form; CES-D = Center for Epidemiologic Studies-Depression scale; and SES = socioeconomic status.

in the Whitehall II study of white-collar British civil servants, organizational injustice (defined as perceived unfairness to employees by the system or its agents [56]) was associated with poorer sleep, even after controlling for baseline sleeping problems, depressive symptoms, health behaviors, and employment grade [56]. In a natural experiment of 467 nurses, organizational injustice (resulting from a change in payment policy in two of four study hospitals) was associated with greater insomnia among nurses who experienced organizational injustice relative to nurses who did not [51]. Notably, this study also found that the degree of insomnia was moderated by supervisor training in interactional justice, whereby insomnia ratings were lower among nurses whose supervisors had received this training.

### 2.2.2. Sleep duration (self-reported and objectively measured)

Two of the six studies that evaluated discrimination in relation to sleep duration used self-reported duration [61,65], and these studies had partially consistent findings. A study of 360 high-school students found an inverse association between subtle ethnic discrimination (but not overt discrimination) and sleep duration [61]. A probability sample of 2983 adults in Chicago found an inverse association between major experiences of discrimination attributed to race/ethnicity (but not everyday discrimination attributed to race/ethnicity) and sleep duration in models adjusted for other forms of discrimination and multiple other types of psychosocial stress [65]. The four studies that used PSG and/or actigraphy to assess sleep duration had mixed results [54,57,60,62]: one study of 210 adults in Pittsburgh found that everyday discrimination was associated with shorter actigraphy- and PSG-assessed sleep duration [46], while significant associations were not observed in the three other studies [54,60,62].

### 2.2.3. Other objectively measured sleep quality characteristics

All four studies that assessed sleep using objective measures [54,57,60,62] reported at least one association in the expected direction; however, these studies did not include identical outcomes for comparison and there was variation across associations that were observed. For example, all four studies examined discrimination in relation to WASO, but associations were observed in only two of the four studies [62]: the SWAN Sleep Study found a positive association between everyday discrimination and PSG-assessed WASO [62], and a study of adults in Pittsburgh ( $N = 210$ ) found a conditional association with race whereby everyday discrimination was associated with greater WASO among Whites, but not among African Americans [46]. All four studies also evaluated discrimination in relation to REM sleep, but only one study found that discrimination was associated with a smaller proportion of REM sleep [46]. Two of the four studies documented an inverse association between discrimination and proportion of slow-wave sleep (Stages 3 and 4) [54,60]. One study examined discrimination in relation to light sleep (Stage 2) and found a positive association [60]. Of the three studies that examined discrimination in relation to sleep efficiency, two reported null associations [54,60] and one documented an inverse association [46].

## 2.3. Control for depressive symptoms

Three cross-sectional [46,54,55] and two longitudinal [56,62] studies controlled for depressive symptoms either prior to [56] or concurrent with [46,54,55,62] sleep outcomes. Across studies, associations were generally attenuated (to varying extents) by inclusion of depressive symptoms, yet in 17 of 20 tests of associations (given multiple outcomes in several of these studies) the significant associations were maintained.

## 3. Discussion

This systematic review displays consistent evidence that experiences of discrimination are associated with disordered sleep and objectively assessed sleep characteristics, although clarification is needed for nuanced aspects of this association. Although the majority of studies presented cross-sectional associations, three prospective studies and a natural experiment provide supporting evidence for the hypothesized temporal ordering [50,51,56,62]. Among the studies using PSG- or actigraphy-assessed sleep measures, there was variation across studies with regard to the specific sleep components that were associated with discrimination; however, each study reported at least one association between discrimination and a sleep parameter that is suggestive of poorer sleep quality. Importantly, five of the included studies adjusted for depressive symptoms [46,54–56,62]. These studies suggest the relationship between discrimination and poorer sleep is independent of depression. Given the well-documented associations between discrimination and depression [35] and sleep difficulties and depression [66] – so much so that disrupted sleep is one of the diagnostic criteria for depression on almost every scale – it is notable that the relationship between discrimination and sleep problems is not fully confounded or mediated by depressive symptoms.

Our review has identified several gaps and important extensions for this field of inquiry that can inform the development of interventions. First, identifying mediators of the association between discrimination and sleep problems is an important goal for future research. By examining underlying mechanisms within prospective observational studies, we can identify promising targets for future interventions. Several cross-sectional studies have explored potential mediators of the association between discrimination and sleep outcome [46,61]. For example, in a study of Latino and Asian American adolescents, Huynh and Gillen-O'Neel [61] found that the association between discrimination and sleep quality is partially explained by perceived stress [61]. In another study, Beatty and colleagues [46] report that nightly worry partially mediate the associations of unfair treatment with sleep quality, daytime sleepiness, sleep efficiency, and proportion of REM sleep. Mediation studies with prospective data are needed in order to evaluate temporality and improve causal inference.

Second, little is known about whether discrimination impacts sleep differently across different demographic groups. In future studies, it will be valuable to explore potential subgroup differences (ie, effect modification) by age and sex, given that both sleep problems [26] and self-reported experiences of discrimination [67] vary based on these characteristics. Further, only two studies examined discrimination in relation to sleep outcomes in children or adolescents [34,68]. Studies indicate that racial/ethnic disparities in sleep are evident before the age of two [69], discriminatory experiences are common among children [70,71], and that sleep is associated with children's emotional and behavioral difficulties [72] and academic outcomes [73]; therefore, this represents an important area of further inquiry.

Third, further research is needed to evaluate sleep as a mechanism linking discrimination to poorer health. Two cross-sectional studies in this review provide evidence that sleep may mediate associations between discrimination and depressive symptoms [52] and self-rated health [39]; however, prospective studies and studies with non-self-report outcomes are needed. For example, poor sleep is a known risk factor for metabolic syndrome and incident hypertension, and self-reported discrimination has been linked to metabolic indices (eg, visceral fat [4] and blood pressure dysregulation [74]); studies have yet to examine whether the association between self-reported discrimination and these outcomes is partially or fully explained by poor sleep. If sleep does in fact function as a mediating mechanism, it suggests a potentially modifiable

target for interventions to address health disparities resulting from discrimination. A meta-analysis [75] of 23 randomized controlled trials documented that behavioral interventions (eg, relaxation and exercise [76] and cognitive-behavioral treatment [77]) can lead to improvements in sleep quality, sleep latency, and waking after sleep onset. More recent research suggests that web-based interventions to address sleep problems are also effective [78,79]. It is possible that implementing these types of interventions in individuals with high levels of self-reported discrimination might ultimately reduce the negative impact of discriminatory stressors on health. However, the initial, prospective studies establishing sleep as an important mechanism between discrimination and objective health outcomes have yet to be conducted.

Fourth, identifying individual- and contextual-level modifiers of the relationship between discrimination and sleep problems is also important for intervention development. For example, in their study, Huynh and Gillen-O'Neel [61] found that feelings of school belonging buffered against the negative impact of overt discrimination on sleep quality and duration reported by Latino and Asian American adolescents. Several related studies examining other health outcomes suggest that multiple forms of discrimination could interact synergistically to influence sleep [80–82]. One study of sexual minority men found an interaction between interpersonal and structural forms of discrimination in predicting tobacco and alcohol use [80]; other studies identified interactions between interpersonal discrimination and internalized negative racial group bias in predicting cellular aging [81] and cardiovascular disease [82] among African American men. Fifth, recent research shows that occupation significantly modifies the association between sleep duration and race, whereby racial disparities for Blacks and Asians compared to Whites are widest among those holding professional occupations [83,84]. In future research, it will be valuable to examine the extent to which discrimination contributes to this pattern so that effective interventions can be developed.

Finally, nearly all of the identified studies evaluated experiences of interpersonal discrimination, with the exception of one study that used a direct measure of organizational injustice (rather than perceptions) [51] and one study on racism-related vigilance [64]. Future research on discrimination and health (including sleep outcomes) will benefit from more extensive consideration of other forms of discrimination that co-occur with interpersonal discrimination [35,37,85], such as institutional or structural forms of discrimination [36,86,87], internalized discrimination [68,88,89], and culturally salient events that evoke prejudice or race-related stress (ie, “macro-racial stressors” [68]), which have been shown to predict a variety of health outcomes [90–92]. There could also be sleep-related consequences of state-level discriminatory policies shown to negatively impact other health outcomes among sexual minorities [93,94] and immigrants [95]. Experiences of discrimination could also impact sleep via circumstantial sequela or downstream consequences of discrimination, such as shift work, multiple jobs, crowded housing, unsafe neighborhood conditions, or financial strain. The threat of exposure to discrimination (or racism-related vigilance) has also received limited attention to date [68,88]. An emerging field of research that includes both observational [64,96–99] and experimental [100] studies suggests that anticipation of prejudice may be a significant and unique source of stress that has a detrimental influence on sleep [64], self-reported psychological and physical health [98,99], and adverse cardiovascular traits, such as lower larger arterial elasticity among males [96], hypertension among Blacks [97], and greater blood pressure reactivity in a threat paradigm [100].

There are several limitations of the present review including the potential for underrepresentation of studies with null results due to publication bias [101]. General limitations of the summarized studies include the cross-sectional design of many of the

included studies, which limits causal inference and also our ability to understand the potential role of depressive symptoms for observed associations (in studies where depression was included a potential confounder or mediator [46,54–56,62]). Only a few studies [54,60,65] evaluated the contribution of discrimination to racial/ethnic disparities in sleep duration or difficulties; thus, we have a poor understanding of the role of discrimination for sleep disparities by race/ethnicity [22–27] or SES [23,25] in the US. Despite these limitations, the existing literature has notable strengths, including many studies with multi-item measures of exposures and outcomes, several studies with PSG- or actigraphy-assessed outcomes, and a subset of studies with large and diverse samples representing a variety of racial/ethnic and socioeconomic groups.

In conclusion, the existing literature indicates that discrimination is associated with sleep problems and shorter sleep duration. Findings are fairly consistent across a range of study designs and populations. Scientific evidence for this association can be strengthened with additional prospective studies that incorporate objectively measured aspects of sleep [102]. This review also shows that there are many unanswered questions (1) with regard to the mediators of the association between discrimination and sleep problems; (2) how discrimination influences sleep in children or adolescents; (3) sleep as a mechanism linking discrimination to poorer health; (4) modifiers of the relationship between discrimination and sleep problems, including interactions between multiple forms of discrimination; (5) the extent to which discrimination contributes to disparities in sleep; and (6) the contributions of threat of discrimination, internalized discrimination, and structural or institutional forms of discrimination to sleep outcomes. Further research in these directions will advance our capacity to develop interventions at the individual and institutional levels to improve sleep-related outcomes, and consequently to promote well-being and reduce health inequities across the life course.

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## Conflict of interest

The ICMJE Uniform Disclosure Form for Potential Conflicts of Interest associated with this article can be viewed by clicking on the following link: <http://dx.doi.org/10.1016/j.sleep.2015.01.012>.

## Appendix

### PubMed search strategy

(“Sleep”[Mesh] OR “Sleep Disorders”[Mesh] OR “Polysomnography”[Mesh] OR “sleep”[tiab] OR “sleep disorders”[tiab] OR “polysomnography”[tiab] OR “insomnia”[tiab]) AND (racism[Mesh] OR sexism[Mesh] OR ageism[Mesh] OR “Discrimination (Psychology)”[Mesh] OR “Social Discrimination”[Mesh] OR “Prejudice”[Mesh] OR “racial discrimination”[tiab] OR “perceived discrimination”[tiab] OR prejudice[tiab] OR “race discrimination”[tiab] OR “ethnic discrimination”[tiab] OR “social discrimination”[tiab] OR racialized[tiab] OR racialization[tiab] OR “Racism”[tiab] OR “sexism”[tiab] OR ageism[tiab] OR “unfair treatment”[tiab] OR “organizational injustice”[tiab]) AND English[lang] NOT (Editorial[ptyp] OR Letter[ptyp] OR Practice Guideline[ptyp] OR Case Reports[ptyp]).

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