

Discrimination and Sleep Difficulties during Adolescence: The Mediating Roles of Loneliness and Perceived Stress

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Abstract Irregular and insufficient sleep place youth at risk for adverse psychological and physical health outcomes. Recent research indicates that discrimination constitutes a type of stressor that interferes with adolescent sleep; however, the mechanisms through which discrimination affects sleep are not well understood. This study examined whether ethnic and non-ethnic (i.e., gender, age, and height/weight) discrimination were associated with adolescents' sleep duration, variability, and quality, and whether loneliness and perceived stress mediated these associations. An ethnically-diverse sample (42% Latino, 29% European American, 23% Asian) of adolescents ($N = 316$; $M_{\text{age}} = 16.40$ years, 57% girls) reported on their experiences of discrimination, perceived stress, and loneliness. Sleep duration and variability were assessed by actigraphy and sleep quality through self-reports. Ethnic discrimination was related to shorter sleep duration and both ethnic and non-ethnic discrimination were associated with

worse sleep quality. Loneliness and perceived stress partially mediated the relation between discrimination and sleep quality. Discriminatory experiences can heighten feelings of loneliness and stress, which, in turn, may contribute to diminished sleep quality during adolescence.

Keywords Ethnic discrimination · Adolescents · Sleep · Loneliness · Non-ethnic discrimination · Stress

Introduction

Problematic sleep during adolescence is a rising national health concern (United States Department of Health and Human Services, Healthy People 2020, 2016). Increasing research shows that insufficient sleep and irregular sleep patterns have a negative impact on psychological (Barnes and Meldrum 2015) and physical health (Kuo et al. 2015) as well as academic outcomes (Asarnow et al. 2014). Biobehavioral perspectives on sleep posit that environmental threat and psychosocial stressors heighten vigilance and alertness, which are antithetical to restful sleep (Dahl and Lewin 2002). In the current study, we focus specifically on adolescents' experiences of discrimination as an important type of stressor that can compromise sleep. Many studies that have examined the impact of discrimination on sleep have focused on adult populations, rather than adolescents (e.g., Grandner et al. 2012; Slopen and Williams 2014; Tomfohr et al. 2012). Of the few studies that have recently focused on discrimination and sleep during adolescence, researchers found that ethnic discrimination was related to poor sleep quality and shorter sleep duration (Huynh and Gillen-O'Neel 2013; Yip 2015). The impact of other types

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of discrimination (e.g., age, gender) on adolescent sleep, however, is less understood and there has been limited attention to potential mediating factors. In the current study, we examined the association between ethnic and non-ethnic discrimination and various indices of adolescent sleep. Additionally, we explored the mediating role of loneliness and perceived stress in the association between discrimination and sleep.

Discrimination and Sleep

Studies suggest that optimal sleep is facilitated by psychological perceptions of safety and social belonging (Dahl and Lewin 2002). Therefore, threatening and stressful events that heighten vigilance and arousal can disrupt sleep. Adolescence is a period of increased sensitivity to social evaluation (Somerville 2013), contributing to teenagers' vulnerability to social experiences that can undermine their feelings of safety and belonging. In particular, experiences of ethnic discrimination have been associated with diminished feelings of social belonging, poor academic outcomes (Benner and Graham 2011) and increased feelings of anxiety and depression (Greene et al. 2006; Grossman and Liang 2008; Huynh and Fuligni 2010; Yip 2015). These studies have documented occurrences of discrimination in different contexts including social, educational, and institutional settings (Benner and Graham 2011; Grossman and Liang 2008), with the perpetrators ranging from school personnel (Benner and Graham 2011) to other adults and peers (Greene et al. 2006; Huynh and Fuligni 2010). Recent studies have documented that discrimination is also detrimental to sleep and contributes to various sleep disturbances, such as daytime fatigue (Grandner et al. 2012), shorter sleep duration and poor sleep quality (Slopen and Williams 2014). With a few exceptions (e.g., Huynh and Gillen-O'Neel 2013; Yip 2015), the majority of these studies have focused on adult populations and experiences specific to ethnic discrimination; less is known about how other forms of discrimination may also impact sleep among adolescents.

Although the prevalence of ethnic discrimination is concerning for adolescents from ethnic minority backgrounds (Greene et al. 2006; Rosenbloom and Way 2004), adolescents are also susceptible to other forms of discrimination based on characteristics such as their gender, age, and physical attributes (Grollman 2012). For instance, Leaper and Brown (2008) found that gender-based discrimination, such as academic and athletic sexism, were commonly experienced among adolescent girls. Additionally, adolescents can face discrimination due to their age. According to Zebrowitz and Montepare (2000), adolescents are often negatively misconceived by adults as moody, irresponsible, and self-absorbed. In fact, in an article from

the current sample by Huynh and colleagues (2016), adolescents reported experiencing age discrimination as often as they encounter ethnic discrimination. Lastly, the significant transformations that occur during puberty contribute to adolescents' increased self-awareness of their changing bodies. Experiences of victimization due to their physical attributes (e.g., height and weight) have damaging effects on adolescents' psychological well-being (Eisenberg et al. 2003; Greenleaf et al. 2006; Tang-Peronard and Heitmann 2008).

Different types of discriminatory experiences can be a significant source of social threat to adolescents' feelings of social inclusion and safety (Liu et al. 2014), which can adversely affect their sleep. Given that research on ethnic discrimination and sleep is only emerging and there are fewer studies on the association between non-ethnic discrimination and sleep, the current study will focus on the extent to which experiences of both ethnic and non-ethnic discrimination including discrimination due to gender, age, and physical attributes are associated with different aspects of sleep, including sleep duration, variability, and quality. We utilized sleep actigraphy to obtain objective measurements of sleep duration and variability. We used actigraphy as it detects wrist movements from which time-based sleep estimates that are closely linked to similar estimates from polysomnography can be derived (Marino et al. 2013; Sadeh et al. 1994). Data from sleep actigraphy provides information on participants' naturalistic sleep-wake patterns, including when they fell asleep, woke up, and any awakenings from sleep during the night. Additionally, participants completed a self-report survey regarding their quality of sleep. Together, sleep actigraphy provided objective assessments of sleep duration and variability, whereas the survey provided subjective reports on participants' sleep quality.

The Role of Loneliness and Stress in the Link Between Discrimination and Sleep

The second aim of our study was to examine the underlying pathways that can explain why discrimination interferes with sleep. Drawing from separate studies that have documented the associations between discrimination and poor psychological well-being, and between discrimination and sleep, we examine the potential mediating roles of loneliness and perceived stress in explaining how discrimination may adversely impact sleep. Experiences of discrimination have been linked to greater feelings of social isolation and loneliness (Liu et al. 2014, McCabe 2009; Neto 2002; Sutin et al. 2015; Torres et al. 2010; Watson and Nesdale 2012; Wen and Wang 2009), and increased feelings of stress (American Psychological Association 2016; Flores et al. 2008; Pascoe and Smart Richman 2009; Thoits 2010;

Williams et al. 2008). Furthermore, research indicates that both loneliness and stress are contributing factors to poor sleep, including shorter sleep duration (Dewald et al. 2014; Doane and Thurston 2014; Major et al. 2013). Based on the extant literature cited above, we propose that experiences of discrimination will be associated with higher levels of loneliness and perceived stress, which in turn, would be related to poorer sleep outcomes (i.e., shorter duration, greater variability, worse sleep quality). Although longitudinal data is preferred to conduct mediation analyses, cross-sectional data can also provide valuable information about the associations between variables (MacKinnon 2008). In our cross-sectional study, we explore whether loneliness and stress will both play a role in explaining the relation between both ethnic and non-ethnic discrimination, thus helping to better understand how different forms of discrimination may be harmful for sleep.

Current Study

In the current study with adolescents from Latino, Asian, European American and other ethnic backgrounds, we examined the associations between ethnic and non-ethnic discrimination (i.e., age, gender, and height/weight) and three sleep indices: duration, variability, and quality. Sleep duration and variability were measured using wrist actigraphy. A survey provided subjective reports on participants' sleep quality, as well as experiences of ethnic and non-ethnic discrimination and feelings of loneliness and perceived stress. We addressed the following research questions: (1) Are experiences of ethnic and non-ethnic discrimination associated with adolescents' sleep duration, variability and quality? (2) Are these associations mediated by loneliness and perceived stress?

Methods

Participants

The current study included 316 tenth and eleventh grade adolescents (57% girls, $M_{\text{age}} = 16.40$ years, $SD = .74$) from diverse ethnic backgrounds (42% Latino, 29% European American, 23% Asian, and 6% other ethnic background) and one of their primary caregivers ($M_{\text{age}} = 45.67$, $SD = 6.96$, 91% mothers, 7% fathers, 2% grandmothers). Although a small proportion of the sample (12%) were first-generation adolescents (i.e., foreign-born), the majority of adolescents (43% and 45%) were of the second (i.e., adolescent was born in the U.S., but at least one parent was born outside of the U.S.) or third generation (i.e., adolescent and parents both were born in the U.S) status, respectively.

Most of the adolescents of Latino background were of the second generation, (6% 1st generation, 55% 2nd generation, 39% 3rd generation), as were the adolescents of Asian, (38% 1st generation, 60% 2nd generation, 1% 3rd generation) and Other backgrounds (6% 1st generation, 63% 2nd generation, 31% 3rd generation), whereas adolescents of European background were primarily of the third generation (10% 2nd generation, 90% 3rd generation).

Parents reported their own and their partner's highest level of educational attainment by selecting one of the following categories: 1 = *some elementary school*, 2 = *completed elementary school*, 3 = *some junior-high school*, 4 = *completed junior-high school*, 5 = *some high school*, 6 = *graduated from high school*, 7 = *trade or vocational school*, 8 = *some college*, 9 = *graduated from college*, 10 = *some medical, law or graduate school*, 11 = *graduated from medical, law or graduate school*. Educational level was calculated by averaging both parents' level of education. Eighteen percent of parents averaged less than high school education, 17% were high school graduates, 43% attended trade school or completed some college, 13% graduated from college, and 8% attended or graduated from medical, law or graduate school. Parents from European American and other ethnic backgrounds reported higher levels of education than those from Asian American and Latino backgrounds, $F(3, 309) = 16.08$, $p < .001$.

Procedures

Participants were recruited from four high schools in Southern California. Two of the schools had a student body composed primarily of students from Latino and European American backgrounds and from middle to upper-middle class socioeconomic backgrounds, with 22% of the students being eligible for free or reduced lunch. The other two schools had a student body that included mostly students from Latino and Asian backgrounds and from lower- to middle-class families, with 71–88% of the students being eligible for free or reduced lunch.

Research staff conducted in-class presentations about the study in 10th and 11th grade classrooms and distributed flyers, which were also mailed to the students' homes to ensure that parents received the information regarding the study. Interested families provided their contact information on the flyers and returned them to school personnel.

At the start of the interview, primary caregivers provided their consent and adolescents provided their assent to participate in the study. Adolescents completed a self-administered questionnaire, whereas parents participated in an interview with a research staff member who guided parents through a similar questionnaire and recorded their responses. Questionnaires included items that assessed family background, social experiences, quality of sleep and

psychological well-being, and took approximately 45–60 min to complete. With the exception of parental reports on their level of education, analyses in this study include data only from the adolescent questionnaires. After completion of their questionnaire, adolescents were supplied with an actigraph wristwatch (Micro Motionlogger Sleep Watch, Ambulatory Monitoring, Inc.) and were instructed that they would be wearing the watch for the next eight consecutive nights, beginning the evening they completed their questionnaire. Approximately 2 weeks later, research staff returned to the participants' homes to retrieve the watch. Adolescents received \$50 and caregivers received \$80 for their participation.

Measures

Sleep duration and variability

Adolescents wore a sleep actigraph watch (Micro Motionlogger Sleep Watch, Ambulatory Monitoring, Inc.) for eight consecutive nights, which meets the recommended number of days to obtain reliable sleep measurements (Acebo et al. 1999). Starting on the evening that they completed their questionnaire, adolescents placed the actigraph on their non-dominant wrist when they went to bed each night and to keep it on until the following morning when they woke up. Additionally, they were asked to press a button on the watch to indicate when they (1) turned off the lights to go to sleep, (2) got out of bed in the middle of the night and (3) got out of bed in the morning. An 'event marker' is recorded each time the participant presses the button and is utilized in the scoring of the actigraphy data, as described below. Adolescents wore the wrist actigraph watch on an average of 6.58 out of 8 nights ($SD = 1.45$).

After participants returned their actigraphs, their data were downloaded onto a computer via an interface device. Next, we utilized Action4 (Ambulatory Monitoring, Inc.), a software package to code and score the actigraphy data. The in-bed period began at the time of the first event marker (i.e., time marked by the first press of the button when the participant turned off the lights to go to sleep) and ended at the last event marker (i.e., time marked by the last press of the button when the participant got out of bed in the morning). To calculate sleep duration, we used the Sadeh actigraph scoring algorithm, which transforms the data into one-minute epochs and calculates the probability that the participant is awake or asleep at each minute. This algorithm has been validated and used in studies with children and adolescents and shows high agreement to sleep estimates from polysomnography (El-Sheikh et al. 2006; Sadeh et al. 1994; Wolfson et al. 2003). Based on the Sadeh algorithm, sleep onset (i.e., time when participant fell asleep) was determined as the first of at least three

consecutive minutes of sleep and sleep offset (i.e., time when participant woke up) was the time of the last five or more consecutive minutes of sleep (Acebo et al. 2005). The total sleep duration for each night was the total amount of sleep that was calculated between sleep onset to sleep offset. We averaged adolescents' sleep duration across the eight nights to assess their mean sleep duration. To assess adolescents' sleep variability, we took the average of the absolute differences between a participant's average sleep duration across the eight nights and sleep duration on each night (Fuligni and Hardway 2006).

Sleep quality

We measured sleep quality retrospectively within the past month with the self-administered questionnaire in two distinct ways using the Pittsburgh Sleep Quality Index (PSQI; Buysse et al. 1989). The PSQI included 19 items, which yielded seven dimensions of sleep: duration, disturbance, latency, daytime dysfunction, efficiency, quality, and sleeping medication use. The PSQI included open-ended items such as "During the past month, how many hours of actual sleep did you get at night?" and questions with likert-scale response options such as "During the past month, how would you rate your sleep quality overall?" (1 = *very good*, 4 = *very bad*) and "During the past month, how often have you had trouble sleeping because you had bad dreams?" (1 = *not during the past month*, 4 = *three or more times a week*). In our first approach, we followed the procedure by Buysse and colleagues (1989) to obtain the PSQI global score by summing across all seven components. Each component has a maximum score of three points; the highest possible global score is 21. Higher PSQI global scores indicated poorer sleep quality. Scores greater than five are associated with worse sleep quality (Buysse et al. 1989).

In our second approach, we used Cole and colleagues' (2006) 3-factor scoring method, which yielded three separate sleep factors from the seven components of the PSQI scale: perceived sleep quality, sleep efficiency, and daily disturbances. Perceived sleep quality included the sleep quality, sleep latency and use of sleeping medications components. Sleep efficiency was composed of the sleep duration and sleep efficiency components. Daily disturbances included the sleep disturbances and daytime dysfunction components. Each of these three factors was calculated by averaging across the appropriate components, therefore each factor has a maximum score of three points, such that higher numbers indicate worse sleep quality, less sleep efficiency, and more sleep disturbances.

Discrimination

We used the Expanded Everyday Discrimination Scale (Williams et al. 1997) to assess occurrences of discrimination in adolescents' daily life during the past 12 months using the self-administered questionnaire. A four-point scale (1 = *never*, 4 = *four or more times*) was used to determine the frequency of experiences of discrimination in the 10 scenarios (e.g., "You were treated with less respect than other people"). The average frequency of discriminatory experiences was calculated by taking the mean of the scores across the 10 items, with higher scores indicating higher levels of perceived discrimination. The scale has been utilized in other studies with adolescents from diverse ethnic backgrounds (Clark et al. 2004; Dulin-Keita et al. 2011) and had good validity ($\alpha = .84$).

In other studies (Hunte and Williams 2009; Slopen and Williams 2014), participants have been asked about their primary attribution (e.g., race) across all discriminatory experiences listed. In our study, we revised this measure to examine adolescents' attribution for each discriminatory experience they endorsed. In order to assess what participants perceived to be the cause of each discriminatory experience that they reported to have experienced at least once, participants were asked to attribute the experience to one of the following categories: race, gender, age or height/weight (Reeve et al. 2011). The inclusion of multiple discrimination attributions for participants to select from helps to reduce attributional ambiguity, minimize measurement error when examining ethnic/racial discrimination exclusively, and capture other sources of unfair treatment that adolescents encounter (Williams and Mohammed 2009). Although participants could have experienced discrimination due to more than one factor, research staff advised participants to indicate the cause that they perceived to be the primary reason of the discriminatory experience. Therefore, participants selected only one of the four choices, which ensured that researchers could assess *primary* attributions for each scenario. Perceived ethnic discrimination was computed by summing the number of discrimination items that were attributed to ethnicity, with possible scores ranging from 0–10. Based upon our analyses described in the results section, the associations between sleep and the other types of discrimination (i.e., gender, age, and height/weight) yielded similar patterns. Therefore, we grouped these non-ethnic discriminatory experiences together and will refer to them as experiences as non-ethnic discrimination. We computed adolescents' perceived non-ethnic discrimination by taking the total number of attributions to gender, age, and height/weight, with possible scores ranging from 0–10. This categorization of ethnic and non-ethnic discrimination has been utilized in

other studies (Hunte and Williams 2009; Slopen and Williams 2014).

Loneliness

The UCLA Loneliness scale version 3 (Russell 1996) is a 20-item scale that measures subjective feelings of loneliness and social isolation. On the self-administered questionnaire, adolescents responded to items such as "How often do you feel left out?" on a scale from 1 (*never*) to 4 (*often*). Their responses were averaged across the 20 items, with higher scores indicating greater feelings of loneliness and social isolation. This measure had strong validity ($\alpha = .91$).

Perceived stress

The 10-item Perceived Stress Scale (Cohen et al. 1983) measured adolescents' feelings of stress in the last month. Adolescents were asked to indicate how often (0 = *never*, 4 = *very often*) they perceived situations to be stressful (e.g., "In the last month, how often have you felt that you were unable to control the important things in your life?") using the self-administered questionnaire. Their responses were averaged across the 10 items, with higher scores indicating greater feelings of perceived stress. The scale had good validity ($\alpha = .84$).

Results

Group Differences and Bivariate Associations among Key Variables

We conducted a series of ANOVAs to examine ethnic differences among the key variables. As indicated in Table 1, neither actigraphic sleep duration nor variability varied according to ethnicity. However, there were ethnic differences in self-reported sleep quality as measured by Cole's 3-factor approach, indicating higher scores in sleep efficiency among adolescents of Asian background compared to their European American peers. There were also ethnic differences in adolescents' discrimination experiences. Adolescents from Latino and Asian backgrounds reported higher levels of perceived ethnic discrimination than their European American peers. Despite an overall ethnic difference in adolescents' report of non-ethnic discrimination, Bonferroni post hoc tests revealed that no particular ethnic group reported significantly more non-ethnic discrimination compared to a different ethnic group, $p > .05$. Finally, ethnic differences were found in adolescents' feelings of loneliness with adolescents from Asian backgrounds reporting higher levels of loneliness than their peers of

Table 1 Gender and ethnic differences in study variables

	Gender		Ethnicity				Group differences
	Boys <i>M</i> (SD)	Girls <i>M</i> (SD)	Latino <i>M</i> (SD)	Asian <i>M</i> (SD)	European <i>M</i> (SD)	Other <i>M</i> (SD)	
Ethnic discrimination	1.08 (2.00)	0.92 (1.58)	1.31 (2.23)	1.25 (1.56)	0.26 (0.81)	1.32 (1.38)	A, L > E*
Non-ethnic discrimination	2.00 (2.28)	2.61 (2.46)	1.90 (2.24)	2.71 (2.29)	2.67 (2.60)	2.47 (2.61)	G > B*
Sleep duration	7.27 (1.07)	7.60 (0.89)	7.42 (1.02)	7.33 (1.04)	7.63 (0.93)	7.47 (0.86)	G > B**
Sleep variability	0.91 (0.53)	0.99 (0.47)	0.92 (0.49)	1.08 (0.58)	0.94 (0.44)	0.85 (0.43)	
Global PSQI score	4.61 (2.80)	5.18 (2.74)	4.91 (2.90)	4.97 (2.67)	4.76 (2.59)	5.89 (3.18)	
PSQI perceived quality factor	0.75 (0.57)	0.83 (0.50)	0.77 (0.51)	0.76 (0.52)	0.79 (0.52)	1.11 (0.68)	
PSQI sleep efficiency factor	0.29 (0.60)	0.43 (0.71)	0.37 (0.71)	0.56 (0.74)	0.22 (0.50)	0.29 (0.59)	A > E**
PSQI daily disturbances factor	1.01 (0.60)	1.13 (0.62)	1.07 (0.63)	1.05 (0.58)	1.08 (0.61)	1.22 (0.67)	
Loneliness	1.92 (0.48)	2.01 (0.46)	1.98 (0.50)	2.08 (0.45)	1.85 (0.43)	2.08 (0.40)	A > E*
Perceived stress	1.77 (0.60)	2.06 (0.60)	1.95 (0.65)	1.94 (0.55)	1.91 (0.65)	1.97 (0.56)	G > B***

Higher scores in PSQI measures indicate worse sleep quality

A Asian, L Latino, E European, O Other, G Girls, B Boys

* $p < .05$; ** $p < .01$; *** $p < .001$

Table 2 Correlations among study variables

	1	2	3	4	5	6	7	8	9	10
1. Ethnic discrimination	1									
2. Non-ethnic discrimination	-.01	1								
3. Sleep duration	-.21**	-.00	1							
4. Sleep variability	.07	.07	-.12*	1						
5. Global PSQI score	.20**	.28**	-.16**	.24**	1					
6. PSQI perceived quality factor	.11	.22**	-.05	.20**	.84**	1				
7. PSQI sleep efficiency factor	.22**	.12*	-.29**	.17**	.58**	.29**	1			
8. PSQI daily disturbances factor	.15**	.30**	-.13*	.18**	.76**	.42**	.28**	1		
9. Loneliness	.17**	.29**	-.04	.01	.38**	.26**	.19**	.41**	1	
10. Perceived stress	.05	.31**	.04	.06	.44**	.35**	.16**	.46**	.52**	1

Higher scores in PSQI measures indicate worse sleep quality.

* $p < .05$, ** $p < .01$, *** $p < .001$

European descent. No ethnic differences were found on levels of perceived stress.

We also conducted a series of independent sample *t*-tests to examine gender differences among our variables of interest. Several gender differences emerged. As shown in Table 1, girls slept longer, experienced more non-ethnic discrimination, and reported higher levels of perceived stress compared to boys.

We then examined the bivariate associations among the key variables of interest. As shown in Table 2, ethnic discrimination was associated with shorter sleep duration and worse sleep quality (i.e., higher scores for global PSQI, sleep efficiency, and daily disturbances). Non-ethnic discrimination was associated with all four indicators of sleep quality (i.e., higher global PSQI scores, perceived sleep quality, sleep efficiency, and daily disturbance factors),

reflecting poorer sleep quality. No measures of discrimination were related to sleep variability. Whereas both ethnic and non-ethnic discrimination were associated with feelings of loneliness, only non-ethnic discrimination was related to greater perceived stress. Both loneliness and perceived stress were related to all measures of sleep quality, indicating that higher levels of loneliness and perceived stress were associated with poorer sleep quality. Lastly, feelings of loneliness were positively associated with perceived stress.

Associations between Discrimination and Sleep

To address our first research question regarding the relation between discrimination and adolescent sleep, we conducted a series of hierarchical linear regressions to examine

Table 3 Ethnic discrimination predicting sleep outcomes

Actigraphic sleep measures												
	Duration			Variability								
	<i>b</i>	(SE)	β	<i>b</i>	(SE)	β						
Intercept	7.61***	.30		.76***	.16							
Latino	−.14	.15	−.07	−.03	.08	−.03						
Asian	−.26	.17	−.11	.13	.09	.11						
Other	−.02	.25	−.01	−.11	.13	−.05						
Gender	.32**	.12	.16	.08	.06	.08						
Parental education	−.01	.03	−.03	.02	.02	.06						
Ethnic discrimination	−.11**	.03	−.19	.02	.02	.07						
<i>R</i> ² (<i>Adj. R</i> ²)	.08 (.06)**			.03 (.01)								
Self-report sleep measures												
	PSQI global score			PSQI perceived quality			PSQI sleep efficiency			PSQI daily disturbances		
	<i>b</i>	(SE)	β	<i>b</i>	(SE)	β	<i>b</i>	(SE)	β	<i>b</i>	(SE)	β
Intercept	4.39***	.83		.79***	.16		−.01	.20		1.09***	.19	
Latino	−.26	.39	−.05	−.07	.08	−.06	.07	.09	.06	−.09	.09	−.07
Asian	−.17	.45	−.03	−.07	.09	−.05	.27*	.11	.17	−.12	.10	−.08
Other	.79	.71	.07	.27 [†]	.14	.12	.01	.17	.00	.06	.16	.02
Gender	.72*	.31	.13	.11 [†]	.06	.10	.16*	.07	.12	.13 [†]	.07	.10
Parental education	−.02	.09	−.01	−.01	.02	−.03	.01	.02	.04	−.01	.02	−.03
Ethnic discrimination	.31**	.09	.20	.03 [†]	.02	.10	.07***	.02	.20	.06**	.02	.17
<i>R</i> ² (<i>Adj. R</i> ²)	.06 (.04)**			.04 (.02)*			.09 (.07)***			.04 (.02)*		

Higher scores in PSQI measures indicate worse sleep quality

[†] $p < .10$, * $p < .05$, ** $p < .01$, *** $p < .001$

whether ethnic and non-ethnic discrimination were associated with each dimension of sleep in separate models. Preliminary analyses included gender, age, and height/weight discrimination in individual models and yielded similar results. Therefore, we grouped gender, age and height/weight together to reflect experiences of non-ethnic discrimination.

In the first step of our model, ethnic and non-ethnic discrimination were individually regressed onto each sleep index in separate models. All models controlled for participants' demographic characteristics (i.e., gender, ethnicity, parental education). Findings revealed similar results to the bivariate associations. Ethnic discrimination was related to shorter sleep duration, and worse sleep quality (higher global PSQI, sleep efficiency and daily disturbance scores; Table 3). Non-ethnic discrimination was associated with worse sleep quality (PSQI global score, perceived sleep quality, sleep efficiency, and daily disturbances) but not duration or variability (Table 4).

Loneliness and Perceived Stress as Mediators

Next, we addressed whether feelings of loneliness and perceived stress mediated the association between discrimination and sleep. Based upon the findings from the regression models indicating that ethnic and non-ethnic discrimination were related to all sleep quality indicators (i.e., global PSQI score and each of the 3-factor components) and bivariate associations indicating that both ethnic and non-discrimination were related to loneliness and non-ethnic discrimination was associated with perceived stress, we tested the mediating roles of loneliness and perceived stress in the association between ethnic and non-ethnic discrimination and the sleep quality indices (MacKinnon et al. 2007). Actigraphic sleep duration and variability were not related to the mediators; however, sleep duration was associated with ethnic discrimination, therefore actigraphic sleep duration and variability were included in the mediation analyses.

Table 4 Non-ethnic discrimination predicting sleep outcomes

Actigraphic sleep measures												
	Duration			Variability								
	<i>b</i>	(SE)	β	<i>b</i>	(SE)	β						
Intercept	7.54***	.31		.76	.16							
Latino	−.24	.15	−.12	−.10	.08	−.01						
Asian	−.34*	.17	−.15	.14 [†]	.09	.12						
Other	−.12	.26	−.03	−.09	.13	−.04						
Gender	.34**	.12	.17	.07	.06	.07						
Parental education	−.01	.03	−.01	.02	.02	.05						
Non-ethnic discrimination	−.01	.03	−.03	.01	.01	.04						
<i>R</i> ² (<i>Adj.</i> <i>R</i> ²)	.04 (.02)*			.03 (.01)								
Self-report sleep measures												
	PSQI global score			PSQI perceived quality			PSQI sleep efficiency			PSQI daily disturbances		
	<i>b</i>	(SE)	β	<i>b</i>	(SE)	β	<i>b</i>	(SE)	β	<i>b</i>	(SE)	β
Intercept	4.08***	.81		.73***	.16		.01***	.20		1.01***	.18	
Latino	.28	.38	.05	.00	.07	.00	.17	.09	.13	.02	.09	.01
Asian	.08	.43	.01	−.04	.08	−.04	.33	.11	.22	−.08	.10	−.05
Other	1.12	.69	.09	.30*	.13	.13	.08	.17	.03	.12	.16	.04
Gender	.45	.30	.08	.07	.06	.07	.12	.07	.09	.07	.07	.05
Parental education	−.06	.09	−.04	−.02	.02	−.05	.01	.02	.02	−.02	.02	−.06
Non-ethnic discrimination	.35***	.06	.30	.05***	.01	.24	.03***	.02	.12	.08***	.01	.31
<i>R</i> ² (<i>Adj.</i> <i>R</i> ²)	.11 (.09)***			.09 (.07)***			.06 (.04)**			.10 (.09)***		

Higher scores in PSQI measures indicate worse sleep quality

[†] $p < .10$, * $p < .05$, ** $p < .01$, *** $p < .001$

Twelve separate models were tested for ethnic and non-ethnic discrimination regressed onto each sleep index (i.e., duration, variability, global PSQI score, perceived sleep quality, sleep efficiency, and daily disturbances factors). Loneliness and perceived stress were entered simultaneously in the models. Testing multiple mediators in the same model is advantageous as it allows us to examine the extent to which one factor mediates the effect of the independent variable on the dependent variable, conditional on the presence of other mediators in the model (Preacher and Hayes 2008). To test the presence of significant mediational effects, we conducted bootstrapping analyses (Preacher and Hayes 2008). As indicated in Table 5, results showed a partial mediation by loneliness in the association between ethnic discrimination and global PSQI score, as well as the association between ethnic discrimination and daily disturbances. Additionally, the association between non-ethnic discrimination and global PSQI scores was partially mediated by both loneliness and stress. The association between non-ethnic discrimination and perceived sleep quality was partially mediated by stress only. Finally, the association between non-ethnic discrimination and daily

disturbances was partially mediated by loneliness and stress.

Overall, findings indicate that ethnic discrimination was associated with higher levels of loneliness, which in turn, was associated with poorer sleep quality, as measured by the global PSQI score, and more daily disturbances. Perceived stress did not significantly mediate any of the associations between ethnic discrimination and any of the sleep indices. On the other hand, stress partially mediated the association between non-ethnic discrimination and sleep quality, as measured by the 3-factor approach and both loneliness and perceived stress partially mediated the associations between non-ethnic discrimination and poorer sleep quality, as measured by the global PSQI score, and more daily disturbances. That is, more frequent experiences of non-ethnic discrimination were associated with increased feelings of loneliness and stress, which in turn predicted poorer overall quality of sleep and more daily disturbances. Neither loneliness nor stress mediated the relation between ethnic and non-ethnic discrimination and sleep efficiency.

Table 5 The mediating role of loneliness and perceived stress on sleep outcomes

Sleep Outcome	Mediator	Ethnic discrimination			Non-ethnic discrimination		
		Indirect effect	Confidence interval		Indirect effect	Confidence interval	
		<i>b</i>	SE	Lower-Upper	<i>b</i>	SE	Lower-Upper
Duration	Loneliness	−.002	.006	−.017, .008	−.005	.009	−.025, .011
	Stress	.001	.003	−.003, .010	.004	.007	−.010, .017
Variability	Loneliness	−.002	.004	−.012, .003	−.003	.005	−.013, .006
	Stress	.002	.002	−.001, .008	.004	.004	−.004, .013
Global PSQI score	Loneliness	.042	.022	.010, .099 ^a	.059	.024	.019, .117 ^a
	Stress	.045	.026	−.001, .102	.111	.029	.064, .177 ^a
PSQI quality	Loneliness	.004	.003	−.001, .013	.005	.005	−.003, .015
	Stress	.008	.004	.000, .018	.019	.005	.010, .031 ^a
PSQI efficiency	Loneliness	.005	.005	−.002, .018	.008	.006	−.003, .023
	Stress	.003	.003	−.000, .011	.008	.006	−.001, .020
PSQI daily disturbances	Loneliness	.011	.005	.003, .024 ^a	.016	.006	.007, .030 ^a
	Stress	.010	.006	.000, .023	.024	.007	.013, .039 ^a

Bootstrapping was utilized to test the indirect effects. Loneliness and perceived stress were simultaneously included as mediators in all models.

^a Denotes significant partial mediation

Discussion

Social stressors considerably interfere with sleep during adolescence because they compromise feelings of safety and social belonging necessary for healthy sleep (Dahl and Lewin 2002). In support of the biobehavioral perspective on sleep, our findings indicated that both ethnic and non-ethnic discrimination were deleterious to adolescent sleep quality, particularly via increased daily disturbances. Additionally, we found that ethnic and non-ethnic discrimination diminish adolescent sleep quality through different pathways—whereas ethnic discrimination contributed to feelings of loneliness, non-ethnic discrimination contributed to both feelings of loneliness and perceived stress, which in turn were related to poorer overall sleep quality, including increased daily disturbances.

Consistent with previous research, (Huynh and Gillen-O'Neel 2013; Slopen and Williams 2014; Steffen and Bowden 2006), our findings confirmed that ethnic discrimination is associated with shorter sleep duration and worse sleep quality, such as less sleep efficiency and greater sleep disturbances. Additionally, our study also provides new information regarding the impact of non-ethnic discrimination on adolescent sleep, indicating that other forms of discrimination not specifically attributed to one's ethnicity were similarly detrimental to sleep quality. Discrimination due to age, gender and physical appearance was negatively associated with various dimensions of sleep quality, including perceived sleep quality, sleep efficiency,

and daily disturbances. Furthermore, our findings suggest that there are distinct mechanisms by which ethnic and non-discrimination threaten sleep quality—loneliness partially mediated the effect of ethnic discrimination on overall sleep quality and daily disturbances, whereas both loneliness and perceived stress partially mediated the effect of non-ethnic discrimination on overall sleep quality and daily disturbances.

This variation suggests that distinct discriminatory experiences have a differential effect on psychological well-being, and in turn, sleep. Our results indicate that over and above the effect of perceived stress, feelings of isolation account for the detrimental effect of ethnic discrimination on overall sleep quality and daily disturbances. In our study, adolescents from two ethnic minority groups (i.e., Asian and Latino) reported greater experiences of ethnic discrimination than their European American peers. Experiences of ethnic discrimination for ethnic minority youth can heighten the salience of their minority status and further increase their feelings of marginalization (Molina et al. 2015). As peers are common perpetrators of ethnic discrimination (Greene et al. 2006), discrimination based on one's ethnic background can further exacerbate feelings of loneliness and social exclusion from their peers. On the other hand, non-ethnic discrimination contributed to feelings of both loneliness and perceived stress, which in turn, reduced overall sleep quality and increased sleep disturbances. Given that multiple forms of non-ethnic discrimination were assessed and combined into one construct,

it is possible that these varied experiences contributed equally to both feelings of loneliness and stress. Additionally, research with adults has suggested that whereas discrimination due to fixed characteristics, such as race, may become less stressful over time as individuals build resilience to these experiences, discrimination attributed to characteristics that can change over time, such as height, weight, and age, may pose unfamiliar challenges and heighten perceptions of stress (Sutin et al. 2015). Further research is warranted to understand how different forms of discriminatory experiences shape individuals' psychosocial adjustment and health.

Although a recent study by Huynh and Gillen-O'Neel (2013) found that perceived stress partially mediated the relation between ethnic discrimination and sleep quality, our findings did not support this conclusion. Despite similar levels of perceived stress and frequency of ethnic discrimination across our studies, perceived stress was correlated with non-ethnic discrimination, but not ethnic discrimination. One potential explanation for the differences in our findings may be our approach to measuring discrimination. In contrast to the Huynh and Gillen-O'Neel's study (2013) which only assessed ethnic discrimination, we first evaluated frequency of discriminatory experiences and then asked participants to indicate what they perceived to be the primary reason for the experience (i.e., ethnicity, gender, age, and height/weight). Although ethnicity may have contributed to certain discriminatory experiences, asking participants about what they believed to be the primary reason for the experience could have limited our ability to estimate the prevalence of ethnic discrimination that adolescents encounter. Additionally, Huynh and Gillen-O'Neel's study (2013) examined experiences of overt and subtle discrimination among Asian and Latino adolescents only, whereas our study focused on overt discrimination and also included European American adolescents whose experiences of ethnic discrimination are less understood than those of ethnic minority youth.

Taken together, these results indicate that experiences of discrimination, whether attributed to ethnicity or other characteristics, are detrimental to the perceived sleep quality, particularly sleep disturbances, among adolescents. With the exception of the significant association between ethnic discrimination and shorter sleep duration, there was little support that discrimination was linked to actigraphic sleep duration or variability in sleep duration across the week. Thus, findings suggest that discrimination may be more disruptive to the quality rather than quantity of sleep (Huynh and Gillen-O'Neel 2013; Slopen and Williams 2014; Yip 2015). Specifically, we found that both ethnic and non-ethnic discrimination contributed to greater sleep disturbances, such as having trouble sleeping due to bad dreams, during the night. There are several methodological

reasons that can explain the weaker association between discrimination and actigraphic sleep outcomes. It is possible that it is more difficult to observe significant associations between subjective reports on experiences (e.g., discrimination) and objective measurements of behaviors, such as actigraphic sleep estimates. Additionally, both discrimination (within the last year) and perceived sleep quality (within the last month) were assessed via a one-time, self-administered questionnaire, whereas sleep duration was assessed daily via sleep actigraphy across eight consecutive days. Thus, it is possible that participant's retrospective accounts of discrimination overlapped with their recall of their sleep quality, which can explain for the more robust associations between discrimination and perceived sleep quality, rather than actigraphic sleep duration and variability. Future studies should continue to incorporate multiple sleep dimensions to further our understanding of how social experiences shape various aspects of sleep. Additionally, the inclusion of both self-report and actigraphic measurements of sleep would also better inform our knowledge about how findings replicate across different sleep assessments.

Despite key strengths of our article, including the use of sleep actigraphy, our ethnically diverse sample, and the examination of various dimensions of sleep and types of discrimination, a few limitations should be acknowledged. Sleep quality was assessed at the beginning of the study using a self-report measure of sleep quality for the past month, which may be subject to recall bias, whereas actigraphic sleep estimates were based on daily sleep patterns across eight consecutive days. This cross-sectional approach limits our ability to draw conclusions about the causal order of the associations we found (Mackinnon 2008). Future research using a time sampling approach may be able to more precisely capture the immediate impact of daily discrimination on daily psychological well-being and sleep. Lastly, our discrimination measure required participants to select only one attribution (i.e., race, gender, height/weight, age) for each of the discrimination events they encountered, which could have limited our ability to capture the full range of reasons why adolescents were discriminated against. For instance, it is possible for participants to have attributed a discrimination event to both their race and gender. It would be valuable for research measurements on discrimination to acknowledge that discriminatory events can be attributed to multiple reasons (e.g., ethnicity and gender).

Conclusion

Findings from our study further support the biobehavioral perspective of sleep that emphasizes the importance of

emotional security and safety for optimal sleep (Dahl and Lewin 2002). Both ethnic- and non-ethnic discrimination are social stressors that may threaten an individual's sense of security and social belonging, as our results indicate that discrimination heightens feelings of loneliness and stress, which in turn disrupts adolescents' quality of sleep. At a developmental period during which adolescents begin to expand and establish their peer networks (Buhrmester 1990), they are also more sensitive to social evaluations (Somerville 2013). Therefore, our results have important implications for adolescents' psychosocial adjustment. Experiences of discrimination can contribute to and exacerbate feelings of social isolation, which can interfere with adolescents' development of peer relationships and affect their sense of belonging in their social environments. It is important for future research to continue investigating how compromised sleep influences different aspects of adolescent psychosocial functioning. Additionally, our findings may point to discrimination as a possible factor contributing to poorer sleep among ethnic minority individuals (Roberts et al. 2002) as ethnic minorities face greater ethnic discrimination compared to their ethnic majority peers. Further research with adolescents from diverse ethnic backgrounds will be critical in aiding our understanding of potential ethnic disparities in adolescent sleep and health, more generally.

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Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no competing interests.

Ethical Approval All procedures were approved by the Institutional Review Board.

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