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Neighborhood Determinants of Sleep and the Moderating Role of Cultural Factors Among Native Adolescents

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Abstract

Objective—This study examined the association between neighborhood social environment and sleep among urban American Indian and Alaska Native (AI/AN) adolescents as well as the moderating role of cultural factors in this association.

Methods—The analytic sample included 133 urban AI/AN adolescents (age 12-16, 57.1% female, M_{age}=14.03, SD_{age}=1.35). Perceived neighborhood social environment included safety and cohesion. Cultural factors included AI/AN cultural identification and historical loss. Sleep duration, efficiency, and wake after sleep onset (WASO) were measured via actigraphy. Sleep disturbance was measured via a questionnaire.

Results—Greater neighborhood safety was significantly associated with lower sleep disturbance (b = −2.17, SE = .8, p = .008) and higher sleep efficiency (b = 1.75, SE = .64, p = .006), and lower WASO (b = −8.60, SE = 3.34, p = .01). Neighborhood cohesion was not associated with any sleep outcomes. Cultural factors moderated the association between neighborhood social environment and sleep outcomes (p<.05). Specifically, both neighborhood safety and cohesion were associated with lower sleep disturbance, only among individuals reporting higher levels of AI/AN cultural identification. Further, neighborhood safety was associated with greater sleep efficiency and lower WASO (i.e., better sleep) only among adolescents with higher contemplation of historical loss.

Conclusions—Findings highlight the importance of considering cultural factors in addressing sleep and health disparities. AI/AN cultural identification and a sense of historical loss may be important targets for identifying adolescents who might benefit the *most* from policies and interventions focused on improving the social environment in order to improve sleep and other health outcomes.

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Abstract

Este estudio examinó la asociación entre el entorno social del vecindario y el sueño entre adolescentes urbanos Indios Americanos y Nativos de Alaska (AI/AN, por sus siglas en inglés), así como el papel moderador de los factores culturales en esta asociación.

La muestra analítica incluyó a 133 adolescentes AI/AN urbanos (edad 12-16, 57.1% mujeres, edad media= 14.03, DE edad= 1.35). El entorno social percibido en el vecindario incluía seguridad y cohesión. Los factores culturales incluyeron la identificación cultural AI/AN y la pérdida histórica. La duración del sueño, la eficiencia y la vigilia después del inicio del sueño (WASO, por sus siglas en inglés) se midieron mediante actigrafía. Las alteraciones del sueño se midieron mediante cuestionario.

Una mayor seguridad en el vecindario se asoció significativamente con una menor alteración del sueño (b = −2.17, SE = .8, p = .008) y una mayor eficiencia del sueño (b = 1.75, SE = .64, p = .006), y una menor WASO (b = −8.60, EE = 3.34, p = .01). La cohesión del vecindario no se asoció con ningún resultado del sueño. Los factores culturales moderaron la asociación entre el entorno social del vecindario y los resultados del sueño (p<.05). Específicamente, tanto la seguridad como la cohesión del vecindario se asociaron con una menor alteración del sueño, solo entre las personas que reportaron niveles más altos de identificación cultural AI/AN. Además, la seguridad del vecindario se asoció con una mayor eficiencia del sueño y un WASO más bajo sólo entre los adolescentes con una mayor contemplación de la pérdida histórica.

Los hallazgos resaltan la importancia de considerar los factores culturales al abordar las disparidades en el sueño y la salud. La identificación cultural de AI/AN y un sentido de pérdida histórica pueden ser objetivos importantes para identificar a los adolescentes que podrían beneficiarse más de las políticas e intervenciones centradas en mejorar el entorno social para mejorar el sueño y otros resultados de salud.

American Indian/Alaska Native (AI/AN) individuals have experienced trauma across generations throughout history, such as forced relocation from tribal lands, as well as current psychosocial and environmental stressors including residential fragmentation, limited access to health care, and poverty (Burt, 1986; Dickerson et al., 2019; Duran & Duran, 1995). Exposure to these historic and current stressors has contributed to disproportionately higher rates of various mental and physical health problems among AI/AN people, including mood disorders, and substance use (D'Amico, Dickerson, et al., 2021; Dickerson et al., 2019; Dickerson & Johnson, 2012), obesity (DHHS, 2018), cardiovascular diseases (CVD), diabetes (Nuyujukian et al., 2016, 2019), and sleep problems (Ehlers et al., 2017).

Sleep plays an important role in health. In fact, poor sleep is associated with both short-term and long-term physical and mental health problems including metabolic diseases, CVD, cancer, obesity, mood, and substance use disorders (Baglioni et al., 2011; Chen et al., 2018; Cox & Olatunji, 2020; Dong et al., 2019; Hall et al., 2018; Harvey, 2008; Hsieh & Martin, 2019; Irwin, 2015), and likely contributes to some of the health disparities experienced by AI/AN people. However, sleep problems are understudied in AI/AN communities (Chapman et al., 2013). there has been little scientific investigation of sleep problems among Native people, particularly youth.

Adolescence is a critical stage of development for examining determinants and sequelae of sleep as developing sleep problems during this time can have long-lasting effects on health (Dahl et al., 2018). For example, sleep problems, including poor sleep quality, short sleep duration, low sleep efficiency (the percent of time asleep from the amount of time spent in bed), and long wake after sleep onset (WASO, the total amount of minutes awake after the sleep onset) are associated with behavior problems and low academic performance (Dewald et al., 2010), increased risk of injuries and accidents, poorer mental health (Paruthi et al., 2016), and CVD risk factors (Hart et al., 2011; Matthews & Pantesco, 2016a). In contrast, optimizing sleep health during adolescence may improve both physical and mental health (Dong et al., 2019; Lovato & Gradisar, 2014a; Tarokh et al., 2016).

Although a robust body of literature has focused on individual-level determinants of sleep among adolescents, only recently have studies focused on social factors. Within a socio-ecological framework, characteristics of the individual, family, peers, and school environment, and the broader neighborhood and sociocultural context, may independently or together contribute to aspects of sleep (Hale et al., 2020). Feeling physically and emotionally safe is critical to downregulate vigilance and threat response systems that are antithetical to sleep (Dahl, 1996, 2002). One of the important factors that can shape an individual's sense of safety is their perceived social environment. Increasing evidence suggests neighborhood social environment may be an important predictor of sleep outcomes (e.g., DeSantis et al., 2013; Hale et al., 2013; Troxel et al., 2018). The perceived neighborhood social environment includes *perceived safety* and *social cohesion* (i.e., the strength of the relationships and community spirit) in the neighborhood. A positive neighborhood social environment may increase individuals' sense of safety and connection and contribute to better sleep outcomes (Hale et al., 2010, 2013).

Neighborhood social environment is associated with both subjective and objective sleep outcomes among adults (DeSantis et al., 2013; Hale et al., 2013; Hill et al., 2009, 2016; Johnson et al., 2017; Simonelli et al., 2017; Troxel et al., 2018). Yet, there is little research addressing the association between neighborhood social environment and sleep among adolescents (Mayne et al., 2021). Work to date among adolescents has focused on self-reported sleep and showed that lower neighborhood safety and social cohesion were associated with greater sleep problems, lower sleep quality (Owens et al., 2006; Troxel et al., 2017), shorter self-reported sleep duration (Pabayo et al., 2014), and increased risk of insufficient sleep (Meldrum et al., 2018).

Subjective assessment of sleep (e.g., self-report) is widely used to screen, diagnose, and monitor sleep, and is associated with mental health (e.g., El-Sheikh et al., 2013; Lovato & Gradisar, 2014), cardiovascular risk (e.g., Matthews & Pantesco, 2016), and cognitive functioning (e.g., Bub et al., 2011); however, self-reported sleep may be limited due to lack of accuracy or recall bias (Girschik et al., 2012; Markovich et al., 2015; Sadeh et al., 1994). Objective assessments of sleep may help overcome these limitations. Further, objectively measuring sleep using wearables such as actigraphy offers an ecologically valid way of monitoring adolescents' sleep as well as efficiently and precisely assessing constructs such as sleep efficiency, and wake after sleep onset (Aili et al., 2017; Hsiao et al., 2018; O'donnell et al., 2009). Subjective and objective assessments of sleep are additive rather

than redundant and provide complementary information (Aili et al., 2017; Hsiao et al., 2018; Hughes et al., 2018; O'donnell et al., 2009). Yet, to our knowledge, only two studies have examined the association between neighborhood social environment and sleep using both subjective and objective sleep outcomes in adolescents (Bagley et al., 2016; Nahmod et al., 2022). Findings indicated that greater community violence concerns were associated with greater subjectively measured sleep problems and worse objectively measured sleep (e.g., lower actigraphy-measured sleep efficiency, and higher WASO).

Although promising, the current literature is limited, and no prior studies have assessed subjective and objective sleep among urban AI/AN adolescents. The association between neighborhood social environment and sleep outcomes may be particularly pronounced for racially/ethnically diverse individuals (Jackson et al., 2015; Johnson et al., 2019), including urban AI/AN adolescents (Johnson et al., 2019), who face not only the historic and contemporary stressors experienced by all AI/AN people but also the stress of living in urban environments, with less access to resources and support that may be available on tribal lands (Burt, 1986; Dickerson et al., 2019; Duran & Duran, 1995). More than 87% of AI/AN individuals live outside of reservations and tribal territories (U.S. Bureau of the Census, 2020), and approximately 27% of this population is under the age of 18 (DHHS, 2018). Yet urban AI/AN young people are one of the most underrepresented groups in health and sleep research. There has been considerable interest in contextualizing our understanding of the role of the immediate context in the health of AI/AN communities by considering cultural elements in this dynamic (Jernigan, et al., 2020; D'Amico, Palimaru, et al., 2021; Henson et al., 2017). Furthermore, work with AI/AN people has highlighted the importance of considering culture and tradition in reducing health disparities (e.g., D'Amico, Dickerson, et al., 2021; D'Amico, Palimaru, et al., 2021; Dickerson et al., 2020). In fact, several studies have shown that identifying with AI/AN culture and engaging in traditional practices such as drumming, dancing, beading, and attending AI/AN cultural events are associated with better behavioral and mental health for both adolescents (e.g., Brown et al., 2016, 2022; D'Amico, Palimaru, et al., 2021) and adults (Dickerson et al., 2014). Therefore, higher identification with AI/AN culture and engagement in traditional practices may be protective in the association between neighborhood social environment and sleep outcomes. On the other hand, perceived historical loss (i.e., thinking about the loss of land and losing culture) may be a source of stress (e.g., Dickerson et al., 2019), and has previously been shown to have adverse effects on physical and mental health (Whitbeck et al., 2009). Thus, we predicted that individuals who perceive better neighborhood conditions (i.e., greater safety and cohesion) and report a lower sense of historical loss would have better sleep outcomes.

The present study adds to the scant literature on neighborhood social environment and sleep among AI/AN young people. Specifically, we examined the association between neighborhood safety and cohesion, and subjective and objective sleep outcomes among AI/AN adolescents, and the moderating role of cultural factors in this association (see Figure 1). We expected that adolescents with greater perceived neighborhood safety and cohesion would have better sleep, as indicated by lower self-reported sleep disturbances and better actigraphy-assessed sleep [e.g., longer total sleep time (TST), higher sleep efficiency, and lower wake after sleep onset (WASO)]. We also expected that AI/AN cultural identification and frequency of thinking about historical loss would moderate associations

between neighborhood factors and sleep, such that individuals with greater neighborhood safety and cohesion and higher levels of AI/AN cultural identification would report better sleep outcomes. We also hypothesized that individuals who reported greater neighborhood safety and cohesion and a lower sense of historical loss would have better sleep outcomes.

Methods

Participants

The baseline sample included 142 AI/AN adolescents residing in urban settings in California. Participants were from the Native American Youth Sleep Health and Wellness (NAYSHAW) study and completed a baseline assessment between March 2018 and March 2020. Adolescents were eligible if they were in the age range of 12-16 at the baseline assessment, verbally self-identified as American Indian or Alaska Native (AI/AN) or were identified as AI/AN by a parent or community member. Thus, all participants in the study were identified as AI/AN, either by themselves or by a family or community member. Eligibility also required that they live in an urban community (i.e., outside of reservations and tribal territories) Those with major neurologic conditions (e.g., intellectual disability), chronic medical conditions (e.g., cancer, diabetes, cardiovascular disease), or diagnosis of sleep apnea or restless legs syndrome were excluded. We included participants who had at least 3 nights of actigraphy data in the analyses, resulting in a final analytic sample of 133 AI/AN adolescents.

Procedure

We used a community-based participatory research approach to recruit participants in collaboration with our community partner, Sacred Path Indigenous Wellness Center (SPIWC). This approach included advertisements at community events and community partner sites, holding community events, and informational meetings to address questions (Palimaru et al., 2020). All procedures were approved by the institution's Internal Review Board. We obtained parental consent and youth assent. Data collection involved a home visit, including survey and anthropometric assessments, followed by 7 days of actigraphy and diary data collection. Participants were compensated $25 for the baseline assessment, $10 for the completion of each day of sleep diaries and actigraphy, and a bonus of $15 if 7 days of sleep diaries and actigraphy were completed.

Measures

Neighborhood Social environment

Neighborhood safety.: Participants reported perceived neighborhood safety with 6 items (e.g., "There is a lot of crime in my neighborhood") on a 5-point scale ranging from 1-5 (1 ="strongly agree", 5 = "strongly disagree") (Winstanley et al., 2008). Higher scores indicated higher perceived neighborhood safety (α =.88).

Neighborhood cohesion.: Participants reported neighborhood cohesion with 4 items, including 2 positive items (e.g., "People in my neighborhood are willing to help their neighbors"), and 2 negative items (e.g. "People in my neighborhood generally don't get along with each other") on a 5-point scale ranging from 1-5 (1 = "strongly agree", 5 =

"strongly disagree") (Mujahid et al., 2007; Sampson et al., 1997). Two positive items were reverse coded and combined with the 2 negative items (α =.57) such that higher scores indicated higher neighborhood cohesion.

Cultural Factors

AI/AN cultural identification.: We used the Multigroup Ethnic Identity Measure (MEIM; Phinney, 1992) to assess adolescents' sense of AI/AN cultural pride and sense of belonging. The MEIM has adequate reliability and validity data (Phinney & Ong, 2007; Ponterotto et al., 2003). Participants were asked to rate 12 items on a 5-point scale ranging from 1-5 (1 = "strongly disagree", 5 = "strongly agree"). Based on focus group findings (Brown et al., 2016) and consistent with prior data collection and analysis (D'Amico, Dickerson, et al., 2021), items were modified to focus on AI/AN heritage (e.g., "I feel a strong attachment towards my AI/AN tribal group"). We averaged scores and higher scores indicated higher levels of identification with AI/AN cultural background (α =.92). Given some empirical and theoretical support for a two-factor solution for the MEIM subscale, we also considered 2-factors, representing "commitment to" and "exploration" of cultural identity (Phinney & Ong, 2007; Roberts et al., 1999); however, analyses with these two factors were virtually identical to that of the full scale (see Supplemental Table; analyses available upon request). Therefore, for parsimony, we present the composite score results only.

Historical loss.: Participants were asked about the frequency of thinking about 10 items such as "The loss of our land" or "Losing our culture" (Whitbeck et al., 2004) using a 6-point scale ranging from 1-6 (1 = "several times a day", 2 = "daily", 3 = "weekly", 4 = "monthly", 5 = "yearly or only at special times", 6 = "never"). We reversed and then averaged the scores so that a higher total score indicated thinking more often about historical loss (α =.97).

Sleep Outcomes

Subjective sleep outcomes.: We measured sleep disturbance via 10 items from the School Sleep Habits Survey for Adolescents (Wolfson & Carskadon, 1998) assessing the frequency of erratic sleep/wake behaviors over the past 2 weeks (e.g., had an extremely hard time falling asleep) using a scale of 0 (never), 1 (once), 2 (twice), 3 (several times), to 4 (every day/night). The sleep disturbance score was calculated as a summary score of all items; with higher scores indicating greater sleep disturbance (α =.80).

Objective sleep outcomes.: To assess sleep-wake patterns objectively, participants wore the Respironics Actigraph-2 (Phillips/Respironics), a lightweight, water-proof wrist-worn accelerometer for 7 consecutive days as recommended in the literature (Acebo et al., 1999). Consistent with recommendations regarding minimum number of days necessary to derive reliable estimates of sleep outcomes from actigraphy data (Ancoli-Israel et al., 2015), we required at least 72 hours of actigraphy data to be included in the analysis. We programmed actigraphs to record in 30-second epochs at a medium sensitivity level. We used diary-reported bedtimes and wake-up times to set rest intervals and then based on rest intervals, sleep parameters were computed using the Actiware program validated scoring algorithms (Cole et al., 1992). We used actigraphy data to calculate sleep duration as the

total time slept (time in bed – sleep onset latency – wake after sleep onset – terminal wakefulness), sleep efficiency as the percent of the time in bed spent asleep (total sleep time/time in bed x 100), and wake after sleep onset (total amount of minutes awake after the sleep onset). We averaged data for the sleep indices across the days of data collection. On average participants wore the Actiwatch for 7.15 days (*SD*=1.07 days, range=3-9 days).

Covariates—Based on the previous literature, we assessed the following demographic variables via self-report and included them as covariates in the regression models: age (Gariepy et al., 2020), sex, and mother's education (Stamatakis et al., 2007). Next, based on previous research on predictors of sleep outcomes (Beebe et al., 2007; Lovato & Gradisar, 2014a; McMakin & Alfano, 2015), we also measured the following mental and physical health variables and included them as covariates in the regression models: body mass index (BMI; calculated from measured height and weight), depression, and anxiety. Depressive symptoms were measured using the Patient Health Questionnaire-2 (PHQ-2). PHQ-2 has been validated in adolescent samples as a screener for major depression (Richardson et al., 2010). Anxiety symptoms were measured using General Anxiety Disorder-7 (GAD-7). The GAD-7 has also been validated in adolescents for detecting clinically-significant anxiety symptoms (Mossman et al., 2017).

Statistical Methods

We examined all variables for normality and heteroscedasticity. To determine the main effect of neighborhood social environment (i.e., neighborhood safety and cohesion) on sleep outcomes, we conducted multiple regression models using RStudio in 3 different steps: Model 1 - Unadjusted (i.e., without covariates); Model 2 - Adjusted for demographic covariates (i.e., age, sex, mother's education); and Model 3 - Adjusted for mental and physical health covariates (i.e., depression, anxiety, and BMI) in addition to demographic covariates in Model 2. Next, we examined whether AI/AN cultural identification or historical loss moderated the association between neighborhood social environment and sleep outcomes. Specifically, to examine moderation, we conducted models adding the main effects of moderators and interaction terms to the regression analysis using PROCESS (Version 3.4) in R (Hayes, 2012). If moderation was present and significant (reliable at $p < 0.05$), for interpretation purposes, we estimated the association between neighborhood social environment and sleep outcomes for the moderator at high (*Mean* + 1 *SD*), average (at the *mean level)*, and low (*Mean* − 1 *SD*) values. The association between neighborhood social environment and sleep outcomes is depicted in Figure 2A–D at different levels of each moderator (i.e., Mean − 1 SD, Mean, Mean + 1 SD).

Results

We present sociodemographic characteristics of the sample in Table 1 and descriptive statistics for key variables in Table 2. The average age of adolescents was 14.03 years (*SD* = 1.37 years), and more than half of the participants were female (*n* = 84, 59.2%). On average, adolescents slept for 7 hours at night (*SD* = 54.15 minutes). Participants had an average sleep efficiency of 81.09% (*SD* = 6.87%) and WASO of 75.54 minutes (*SD* = 35.95 minutes). Table 2 shows correlations of primary variables. There was a modest but

significant association between neighborhood safety and cohesion (r = .33, p <.01) and between AI/AN cultural identification and historical loss (r = .36, p <.01). There were also significant bivariate associations between neighborhood cohesion and sleep disturbances, as well as neighborhood safety and sleep disturbances, sleep efficiency and WASO (all Ps<.05).

Neighborhood social environment and sleep

Higher perceived neighborhood safety was associated with lower self-reported sleep disturbance (b = −2.17, SE = .80, p = .008), higher actigraphy-assessed sleep efficiency (b = 1.75, SE = .64, p = .006), and lower WASO (b = −8.60, SE = 3.34, p = .01) (see Table 3). These associations remained significant after adjusting for age, sex, mother's education, depression, anxiety, and BMI. Neighborhood cohesion was not associated with any subjectively or objectively measured sleep outcomes.

The moderating role of culture in the association between neighborhood social environment and sleep

AI/AN cultural identification as moderator.—AI/AN cultural identification moderated the association between neighborhood safety and self-reported sleep disturbance (b= −1.59, SE= .69, p= .02) (see Table 4), adjusting for all the covariates. Greater neighborhood safety was associated with lower self-reported sleep disturbance, but only among individuals who reported high AI/AN cultural identification (Figure 2A) (b= −2.43, SE= .95, p=.011). This association was not significant among individuals with average (b= −1.19, SE= .71, p=.09) or low (b= .04, SE= .83, p= .96) AI/AN cultural identification.

Although neighborhood cohesion was not associated with any sleep outcomes, AI/AN cultural identification moderated the association between neighborhood cohesion and sleep disturbances (Table 4) (b= −2.50, SE= 1.11, p= .03) after adjusting for covariates. Specifically, greater neighborhood cohesion was associated with lower sleep disturbance, but only among individuals with high levels of identification with AI/AN culture (Figure 2B) (b= −2.80, SE= 1.14, p=.02). This association was not significant among individuals with average (b= −.86, SE= .98, p=.38) or low (b= 1.08, SE= 1.45, p= .46) AI/AN cultural identification. AI/AN cultural identification did not moderate associations between neighborhood safety or cohesion and actigraphy-measured sleep outcomes.

We also added historical loss as a covariate in the analysis of cultural identity moderating the association between neighborhood social environment and sleep outcomes, and results for the moderation analysis stayed consistent and significant. Specifically, AI/AN cultural identification moderated the association between neighborhood safety and self-reported sleep disturbance (b= −1.62, SE= .74, p= .03), adjusting for all the covariates and historical loss. Similarly, AI/AN cultural identification moderated the association between neighborhood cohesion and sleep disturbances (b= −2.39, SE= 1.13, p= .04) after adjusting for covariates and historical loss.

Perceived historical loss as moderator.—Frequency of contemplating historical loss moderated the association between neighborhood safety and sleep efficiency (b= .13, SE= .05, p= .008), adjusting for covariates, whereby greater perceived neighborhood safety was

associated with higher (i.e., better) sleep efficiency, but only among individuals with high reports of historical loss (b= 2.63, SE= .86, p= .003) (see Figure 2C). This association was not significant among adolescents with average (b= 1.01, SE= .66, p= .13) or low (b= −.61, SE= .92, p= .51) reports of historical loss.

Similarly, historical loss moderated the association between neighborhood safety and WASO (b= −.78, SE= .25, p= .002), adjusting for covariates. Consistent with findings for sleep efficiency, higher perceived neighborhood safety was associated with lower (i.e., better) WASO, but only among individuals with high reports of historical loss (b= −15.80, SE= 4.48, p<.002), and not among adolescents with average (b= −5.85, SE= 3.43, p= .09) or low (b= 4.09, $SE = 4.83$, p= .40) reports of historical loss (Figure 2D). Historical loss did not moderate the association between neighborhood safety or cohesion and other sleep outcomes.

We also added cultural identity as a covariate in the analysis of historical loss moderating the association between neighborhood social environment and sleep outcomes and found that the results for the moderation analysis stayed consistent and significant. Specifically, frequency of contemplating historical loss moderated the association between neighborhood safety and sleep efficiency (b= .13, SE= .05, p= .006), adjusting for covariates and AI/AN cultural identification. Similarly, historical loss moderated the association between neighborhood safety and WASO (b= −.81, SE= .25, p= .002), adjusting for covariates and AI/AN cultural identification.

Discussion

This study is the first to examine the association between neighborhood social environment and sleep among AI/AN adolescents and the moderating role of cultural factors in this association. As with other work, we found that a higher sense of neighborhood safety was associated with lower sleep disturbance, higher sleep efficiency, and lower WASO, even after controlling for variables known to be associated with both neighborhood conditions and sleep, including sociodemographics, BMI, anxiety, and depressive symptoms. Prior research and theory suggest that feeling unsafe in one's neighborhood may contribute to emotional and physiological hyperarousal (Fowler et al., 2009), which in turn, can negatively impact sleep (Bagley et al., 2016; Dahl, 1996, 2002). On the other hand, feeling safe in one's neighborhood may facilitate healthy sleep, by reducing exposure to stress, promoting positive mood states, and downregulating vigilance and threat response systems (Dahl, 1996, 2002). Findings emphasize the important contribution of the neighborhood social environment to sleep among AI/AN adolescents, especially as sleep disturbances may contribute to adverse physical and mental health outcomes, such as diabetes, inflammation, and mood disorders (Dong et al., 2019; Harvey, 2008; Irwin, 2015, 2019). Results are also consistent with policy-related research highlighting the need to improve neighborhood conditions in order to reduce racial and socioeconomic determinants of sleep and health disparities (Hale et al., 2013; Hill et al., 2009; Sandel et al., 2016; Troxel et al., 2017, 2018). Improving the neighborhood social environment, particularly neighborhood safety among AI/AN communities may be an important step towards achieving sleep health equity.

A significant contribution of this paper is the focus on the moderating role of culture in the association between neighborhood social environment and sleep outcomes. Findings highlighted the importance of considering how sleep is embedded in multiple social-environmental contexts, which intersect to influence key health outcomes. As hypothesized, better perceptions of neighborhood safety and cohesion were associated with lower self-reported sleep disturbances, but only among adolescents who reported *higher levels of* AI/AN cultural identification. In contrast to our expectations, better perceptions of neighborhood safety were associated with better sleep efficiency and less nighttime wakefulness (i.e., lower WASO) only among adolescents who reported *greater* frequency of thinking about historical loss. This finding was contrary to what we hypothesized, as we conceptualized historical loss as a stressor and thus predicted that individuals who report greater neighborhood conditions (i.e., greater safety and cohesion) and lower contemplation of historical loss would have better sleep outcomes.

Although speculative, there are a number of reasons that may account for the direction of effects for cultural factors. First, AI/AN cultural identification and historical loss were modestly associated, thus, adolescents who reported strong feelings of pride and belonging for their culture also tended to report thinking more frequently about the losses that their people have experienced. In other words, adolescents who are aware of and think about their culture's past, including the losses experienced by their ancestors, may also feel more connected to their culture. Furthermore, consistent with prior work suggesting that there are individual differences in the responsiveness or awareness to different aspects of the social environment (e.g., gender (Mousavi et al., 2022)), findings suggest that adolescents who report stronger cultural identity (e.g., Brown et al., 2016) or who report greater historical loss may be more aware of their immediate social context and more specifically, the effects of neighborhood social environment. It is possible that adolescents who report stronger cultural identity or who report greater historical loss think more about their identity and are motivated to protect and promote their cultural group's positive identity, and this motivation may influence their perception of social environment and social cues and therefore, their responses to social interactions. Thus, if their social environment is perceived as supportive and safe, they may experience better sleep outcomes including higher sleep quality and decreased sleep fragmentation.

Finally, it is important to understand that the AI/AN adolescents in this study were living in urban settings, separated from their tribal community or communities (Brown et al., 2016). Thus, urban AI/AN adolescents who report higher AI/AN cultural identification and contemplation of historical loss may tend to rely more heavily on their immediate social context and thus, be more susceptible to the effects of their surrounding neighborhood conditions (i.e., safety and cohesion). Overall, findings suggest that policy-level interventions to improve neighborhood conditions (e.g., reducing crime, and enhancing community cohesion) should take into account cultural factors in the community, as such interventions might be particularly beneficial for those who feel more connected to their culture.

Racial/ethnic disparities in sleep are well established, yet sleep disparities are understudied in AI/AN communities. Other ethnic minorities, on average, have shorter total sleep time,

poorer sleep efficiency and greater sleep fragmentation (e.g., Fuller-Rowell et al., 2016; Gillis et al., 2021) than non-Hispanic Whites. For instance, Gillis et al., (2021) examined racial differences in sleep outcomes among White and Black participants and compared sleep duration of these two groups. On average, Black adolescents slept for 6.46 hours at night compared to White adolescents who slept for 6.89 hours at night. In our study, on average, AI/AN adolescents slept for 7 hours at night, had an average sleep efficiency of 81.09% and wake after sleep onset of 174.82 minutes. Future studies may benefit from examining the differences in sleep outcomes of AI/AN adolescents and other samples in hopes of better understanding racial inequities in sleep and therefore health disparities.

The findings of this study have important implications for examining the intersecting influences of multiple social determinants on sleep outcomes. First, AI/AN adolescents reporting high levels of identification with their Native American culture and strong historical loss may be most affected by the effects of neighborhood safety and cohesion on sleep outcomes. Thus, research focused on social determinants of health, including neighborhood conditions, should consider the role of cultural factors as these may be important for identifying adolescents who might benefit the *most* from interventions focused on improving the social environment as well as developing interventions to reduce the adverse consequences of low neighborhood safety and cohesion for sleep and health disparities. Further, considering the strong ties of this population with their Native American culture, it is particularly important to consider the role of culture in both risk and resilience research in hopes of improving prevention and intervention efforts and reducing health disparities. Cultural identity plays an important role in the psychosocial development of AI/AN youth and in their functioning (Brown et al., 2016, 2021, 2023). The fragmentation of AI/AN communities in urban areas and its consequences for identity and health outcomes have been discussed before (Brown et al., 2016). One important policy-level strategy could be supporting institutions that provide opportunities for AI/AN youth to participate in cultural activities and events (Brown et al., 2016). Further, our findings support previous research (Jernigan et al., 2020; Jernigan et al., 2020; Dickerson et al., 2020; Kaholokula et al., 2017, 2018; Rasmus et al., 2019, 2020; Walters et al., 2020) highlighting the importance of developing interventions embedded in a broader sociocultural context and recognize the potentially critical role of culture in shaping health behaviors and outcomes for AI/AN young people, and therefore integration of culture into existing prevention and intervention (Brown et al., 2016, 2023; Dickerson et al., 2020; Dickerson et al., 2022; Kennedy et al., 2022). Finally, it may be that members of this population who report high levels of cultural identity or contemplation of historical loss are also more attuned to or sensitive to their overall social environments, making them both more vulnerable to negative features of neighborhoods but also allowing them to benefit more from neighborhood or community improvements. Collectively, findings emphasize the importance of using multilevel interventions that address both historical and contemporary factors to reduce health disparities among AI/AN people.

Limitations

It is important to note our methodological limitations. First, this study is limited by its cross-sectional design and a causal relationship cannot be inferred. Furthermore, this study

relied on self-reported neighborhood social environment. Future research may benefit from examining the association between neighborhood environment and sleep among AI/AN adolescents utilizing both the subjective and objective characteristics of the neighborhood (e.g., crime data or neighborhood disorder). It is also important to note that although we used validated measures of neighborhood social environment in our study, the internal consistency of neighborhood cohesion in our sample was not ideal (.57), which may be a function of the number of the items and therefore, the neighborhood cohesion findings should be interpreted with caution. We were also geographically limited as participants lived in California, and thus, findings may not generalize to other urban communities.

Conclusions

The current study provides an important contribution to limited literature in this area and has important implications for policies addressing the neighborhood social environment to reduce racial and socioeconomic determinants of sleep and health disparities. It is critical to consider how neighborhood conditions and cultural factors intersect to promote health equity. Our work emphasizes that policies and interventions aimed at improving neighborhood conditions should integrate cultural factors including historical and contemporary factors contributing to current conditions.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Public Significance Statement

The present study provides an important contribution to limited literature in this area and highlights the importance of considering how sleep is embedded in multiple social-environmental contexts. Our work emphasizes that policies and interventions aimed at improving neighborhood conditions should integrate cultural factors including historical and contemporary factors contributing to current conditions.

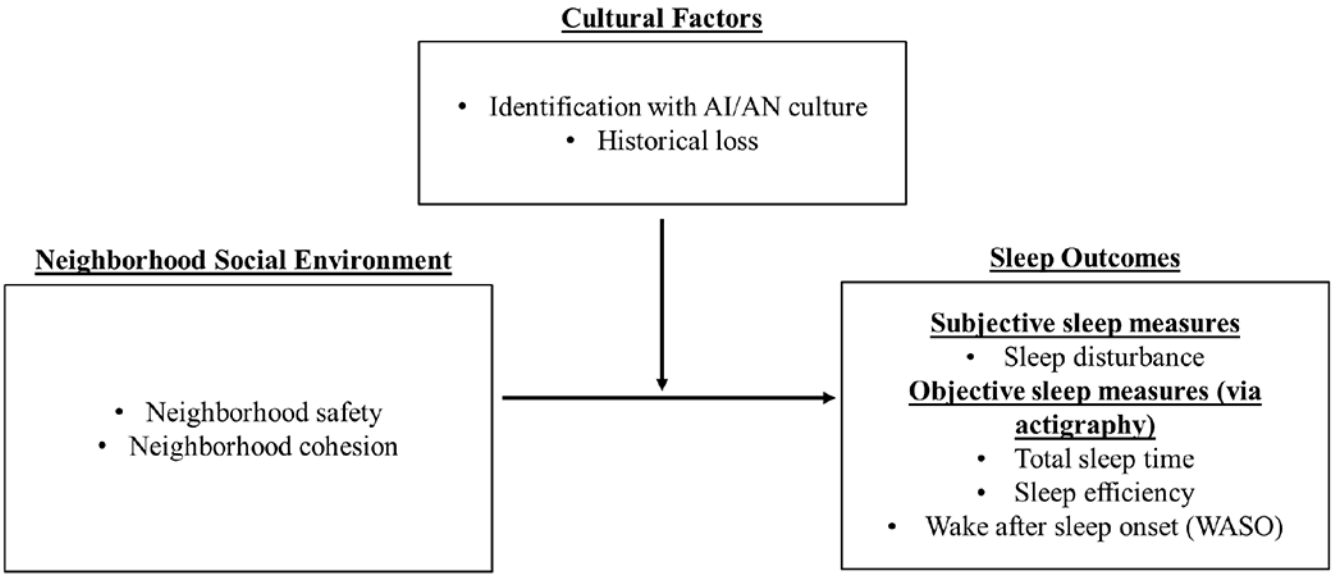
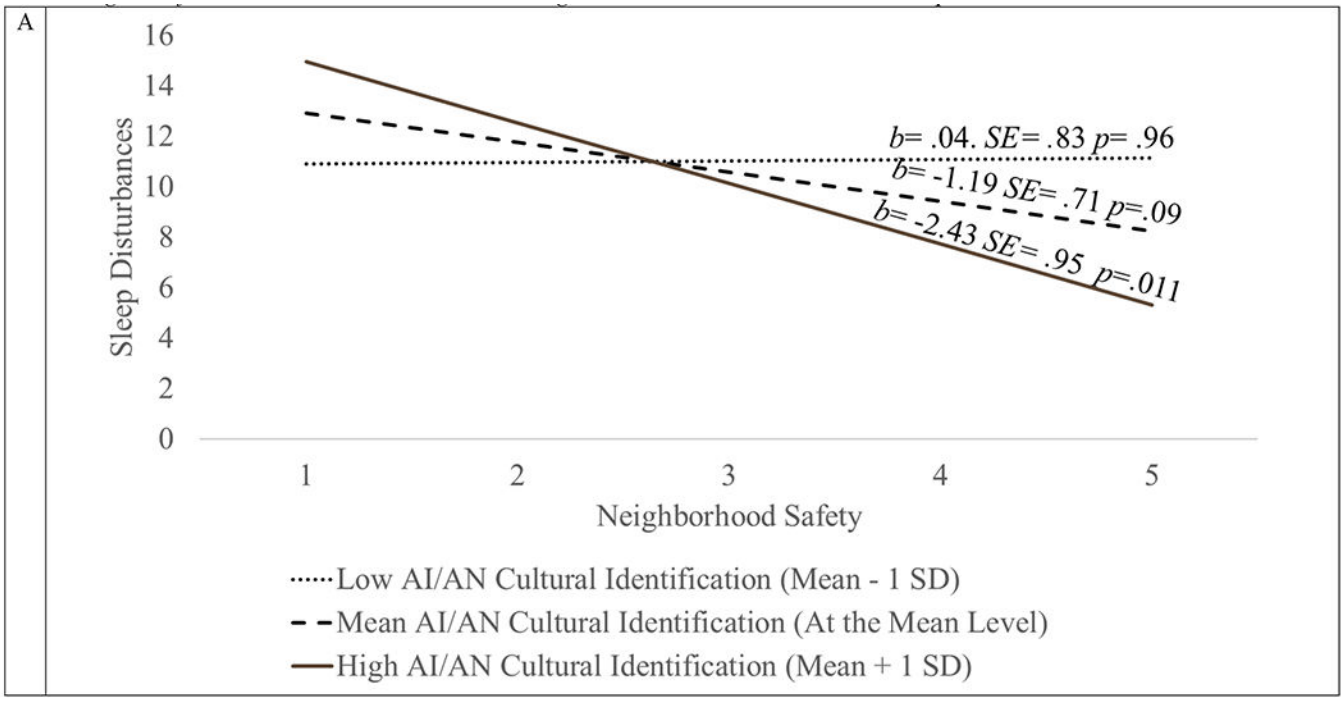
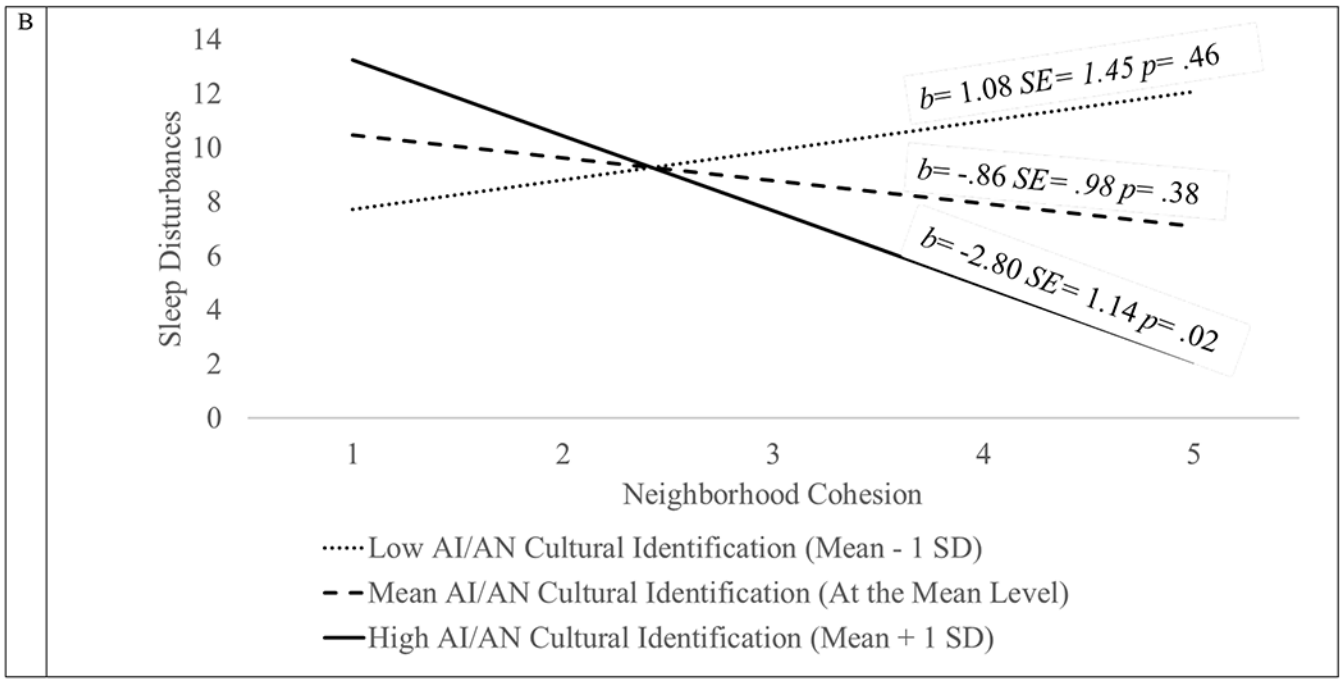


Figure 1.
Theoretical Model





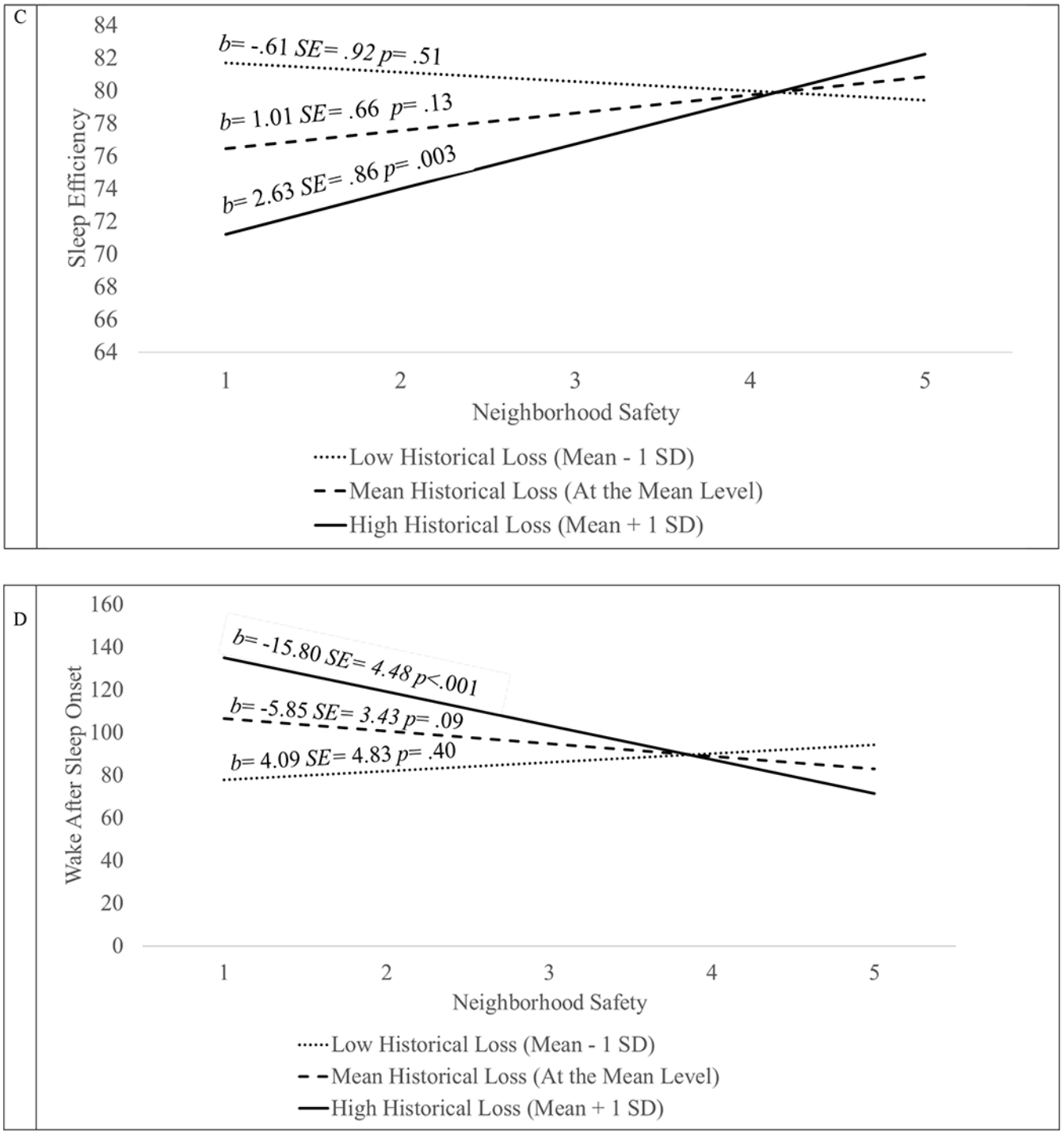


Figure 2.
Moderating role of culture in the association between neighborhood social environment and sleep.

Table 1.

NAYSHAW sample demographics (N = 142)

	N	Percent
Age		
12 years old	23	16
13 years old	33	23
14 years old	32	23
15 years old	25	18
16 years old	29	20
Sex		
Male	58	41
Female	84	59
Race/Ethnicity [^]		
Hispanic/Latino(a)	73	51
AI/AN	128	90
Asian/Asian American/Pacific Islander	16	11
Black/African American	13	9
White/Caucasian	25	18
Other	3	2

[^] Note that all youth had to self-identify as Native American to be part of the project. They then completed a survey asking them to label their race/ethnicity. These numbers and percentages reflect what youth reported on the survey and often overlaps as youth often identified with more than one race/ethnicity. Fourteen youth did not check AI/AN on the survey, although they self-identified verbally or were identified by a family or community member as Native American to be in the study.

Table 2

Means, standard deviations, and correlations between neighborhood social environment, culture, and sleep

		Correlations							
	M(SD)	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Neighborhood Social Environment									
1. Neighborhood cohesion	3.29 (.69)	1							
2. Neighborhood safety	4.01 (.96)	.33**	1						
Culture									
3. AI/AN culture identification	3.47 (.82)	.19*	.22*	1					
4. Historical loss	23.21 (12.60)	−.07	−.04	.36**	1				
Sleep outcomes									
5. Sleep disturbances	15.41 (8.71)	−.26**	−.28**	−.15	.02	1			
6. Total sleep time (TST)	425.37 (54.53)	−.08	.002	−.04	−.09	.01	1		
7. Sleep efficiency	81.09 (6.78)	−.09	.174*	.03	−.02	.02	42**	1	
8. Wake after sleep onset (WASO)	74.82 (34.97)	−.03	−.19*	−.06	−.09	−.01	−.07	−.74**	1

Note: N= 133 Reflects participants with no missing values for primary variables.

† $p<.10$.

* $p<.05$.

** $p<.01$.

Table 3

Associations between neighborhood social environment and sleep outcomes

	Sleep disturbance					Total sleep time					Sleep efficiency					Wake after sleep onset				
	b	***SE***	***p***	**95% CI**		***b***	***SE***	***p***	**95% CI**		***b***	***SE***	***p***	**95% CI**		***b***	***SE***	***p***	**95% CI**	
Model 1 [a]				*LL*	*UL*				*LL*	*UL*				*LL*	*UL*				*LL*	*UL*
Neighborhood cohesion	−1.96	1.11	.08	−.32	.02	−6.68	7.21	.34	−.26	.09	−1.52	.88	.09	−.32	.02	1.29	4.62	.78	−.15	.20
Neighborhood safety	−2.17	.8	.008	−.40	−.06	2.52	5.16	.61	−.13	.22	1.75	.64	.006	.07	.41	−8.60	3.34	.01	−.40	−.05
R^2	.1					.01					.06					.05				
F	7.66	<.001				.47	.63				4.17	.017				3.5	.03			
Model 2 [b]																				
Neighborhood cohesion	−2.03	1.09	.06	−.32	.01	−8.55	7.22	.24	−.29	.07	−1.69	.89	.06	−.34	.01	2.67	4.67	.57	−.12	.23
Neighborhood safety	−2.18	.79	.006	−.40	−.07	1.65	5.20	.75	−.15	.21	1.61	.64	.01	.05	.40	−7.71	3.37	.02	−.38	.−03
R^2																				
F			<.001					.52					.025					.048		
Model 3 [c]																				
Neighborhood cohesion	−1.49	.97	.13	−.26	.03	−8.25	7.05	.24	−.28	.07	−1.66	.89	.06	−.34	.01	2.16	4.69	.65	−.14	.22
Neighborhood safety	−1.41	.71	.049	−.30	.00	1.16	5.14	.82	−.16	.20	1.55	.65	.018	.04	.39	−8.23	3.42	.017	−.39	−.04
R^2	.37					.11					.12					.1				
F	9.68	<.001				1.99	.053				2.23	.028				1.91	.06			

Note:

[a] Non-adjusted model, *n*=142 for sleep disturbance outcome and *n*=137 for total sleep time, sleep efficiency, and wake after sleep onset outcomes;

[b] Adjusted for age, gender, mother education, *n*=127 for sleep disturbance outcome and *n*=122 for total sleep time, sleep efficiency, and wake after sleep onset outcomes;

[c] Adjusted for age, gender, mother education, depression, anxiety, and BMI, *n*=124 for sleep disturbance outcome and *n*=119 for total sleep time, sleep efficiency, and wake after sleep onset outcomes

Table 4

Associations between neighborhood social environment and sleep outcomes, moderated by AI/AN cultural identification

	Sleep disturbance[a]					Total sleep time[b]					Sleep efficiency[b]					Wake after sleep onset[b]				
	b	***SE***	***p***	**95% CI**		***b***	***SE***	***p***	**95% CI**		***b***	***SE***	***p***	**95% CI**		***b***	***SE***	***p***	**95% CI**	
Model 1				*LL*	*UL*				*LL*	*UL*				*LL*	*UL*				*LL*	*UL*
Neighborhood safety	4.43	2.45	.07	−.42	9.28	−5.45	19.38	.78	−43.86	32.95	2.55	2.41	.29	−2.23	7.34	−14.41	12.71	.26	−39.61	10.79
AI/AN cultural identification	4.19	2.66	.11	−1.09	9.47	−9.36	21.11	.66	−51.20	32.48	.84	2.63	.75	−4.38	6.05	−7.85	12.85	.57	−35.31	19.60
Safety * identification	−1.59	.69	.02	−2.97	−.22	1.54	5.48	.78	−9.33	12.41	−.38	.68	.57	−1.74	.97	2.22	3.60	.54	−4.91	9.35
R^2	.40					.10					.12					.10				
F	8.31	<.001				1.39	.20				1.60	.12				1.40	.19			
Model 2																				
Neighborhood cohesion	7.96	4.27	.06	−.49	16.42	−49.20	33.99	.15	−116.57	18.16	−1.05	4.33	.81	−9.64	7.53	−12.17	22.99	.60	−57.74	33.39
AI/AN cultural identification	6.06	3.55	.09	−.97	13.10	−34.41	28.10	.22	−90.10	21.28	.22	3.58	.95	−6.87	7.32	−11.95	19.01	.53	−49.62	25.73
Cohesion * identification	−2.50	1.11	.03	−4.71	−.29	10.40	8.82	.24	−7.08	27.89	−.06	1.12	.95	−2.29	2.16	3.26	5.97	.59	−8.57	15.08
R^2	.40					.13					.10					.07				
F	8.30	<.001				1.78	.08				1.39	.20				.96	.47			
Model 3																				
Neighborhood safety	−1.97	1.43	.17	−4.81	.86	−7.02	11.11	.53	−29.04	15.01	−1.99	1.34	.14	−4.64	.66	12.57	6.98	.07	−1.8	26.41
Perceived historical loss	−.17	.21	.43	−.59	.25	−1.30	1.64	.43	−4.55	1.95	−.54	.20	.007	−.94	−.15	3.01	1.03	.004	.97	5.05
Safety * loss	.02	.05	.64	−.08	.12	.25	.39	.51	−.52	1.03	.13	.05	.008	.03	.22	−.78	.25	.002	−1.26	−.29
R^2	.37				.10						.17					.18				
F	7.17	<.001			1.38	.21					2.37	.02				2.59	<.01			
Model 4																				
Neighborhood cohesion	−.45	2.22	.84	−4.86	3.96	−29.51	17.54	.09	−64.28	5.25	−4.80	2.19	.03	−9.15	−.46	12.35	11.80	.30	−11.05	35.75
Perceived historical loss	.12	.26	.65	−.39	.63	−2.64	2.02	.19	−6.65	1.35	−.46	.25	.07	−.96	.04	1.37	1.36	.31	−1.32	4.06
Cohesion * loss	−.06	.08	.45	−.21	.09	.73	.61	.23	−.48	1.94	.13	.08	.09	−.2	.28	−.46	.41	.26	−1.28	.35
R^2	.37					.13					.13					.08				
F	7.28	<.001				1.74	.09				1.77	.08				1.09	.37			

Note: All models were adjusted for age, gender, mother education, depression, anxiety, and BMI

[a] n=123;

[b] n=117