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Impact of Neighborhood Quality and Recent Life Stressors on Sleep Problems: A Longitudinal Study of Adolescents at Risk for Maltreatment

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Impact of Neighborhood Quality and Recent Life Stressors on Sleep Problems: A Longitudinal Study of Adolescents at Risk for Maltreatment

Adolescent sleep problems and their consequences are a major public health crisis.[1-3] Understanding the various biopsychosocial factors, and the complex interplay between them, is crucial to recognizing the underlying mechanisms involved with poor sleep. It is also important to understand how these mechanisms may operate in the contexts in which children are living. In this paper, we first review how sleep in adolescents is understood; we also look at how sleep is related to life stressors and neighborhood quality. Using a longitudinal sample of adolescents at high risk for maltreatment, we investigate whether these two factors differentially interact with each other and lead to sleep problems from ages 12 to 16.

Sleep in Adolescents

Adolescence is a period of transition from childhood to adulthood that occurs between ages 10-19.[4] This is a period of rapid development in multiple domains--biological, psychological, cognitive, sexual, and social.[5] As these processes occur, optimal sleep has been found to be necessary and important for healthy development. Sleep can be conceptualized in terms of duration of sleep, sleep problems, and subjective quality of sleep.

Sleep Duration

In 2015, the National Sleep Foundation conducted a large-scale systematic literature review to provide recommendations regarding duration of sleep for healthy individuals across all age groups. The panel concluded that school-aged children (6-13 years) and teenagers (14-17 years) required 9-11 hours and 8-10 hours, respectively, of nightly sleep.[6] However, in a 2006 national representative survey of the United States, 45% of adolescents experienced an insufficient amount of sleep (<8 hours) and an additional 31% had a borderline amount of sleep (between 8-9 hours).[7] Concerningly, more than 75% of 12th-graders indicated they got less than 8 hours of sleep.[7] Similar cross-sectional studies across the world showed decreasing average amounts of sleep with age in adolescents in Germany, Italy, China, and Korea.[8-12] Longitudinal studies also showed similar patterns of decreasing average sleep hours with increasing age in adolescents.[13-15]

Biologically, the circadian rhythm is a factor that has been implicated in decreasing sleep. Circadian rhythms are natural 24-hour cycles that are part of the body's internal clock. This cycle tends to drift later in terms of sleep and rise times for children during adolescence, with around 2 to 3 hours of delay compared to adults. As

part of the circadian rhythm, melatonin secretion timing shows a delayed onset, indicating later sleep timing. Additionally, heightened sensitivity to evening light and decreased sensitivity to morning light have also been implicated in this phase delay.[14-15] However, most schools do not consider this delay when setting starting times, and schools in fact begin earlier for high-schoolers than middle-schoolers. As a result, students are forced to wake up at a time that does not match their biological clock, leading to shorter sleep duration. Despite many studies showing benefits of delaying school times for adolescents, there has been no large-scale implementation of public policy in this regard.[14-15]

Sleep Problems

While getting too little sleep is one hallmark of poor sleep, sleep problems also include difficulty falling asleep, staying asleep, or waking up earlier than intended, all of which are key symptoms of Insomnia Disorder in the *Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition* (DSM-5).[16] Sleeping too much, having nightmares, sleepwalking, and sleep talking can be additional indicators of poor sleep.[16] Poor sleep is associated with several downstream consequences. In a nationally representative sample of more than 10,000 US adolescents, insufficient sleep was associated with increased odds of depression, anxiety, substance use, tobacco smoking, and a generally poor perception of physical and mental health.[17-21] Poorer sleep is linked with poorer attention span, lower impulse control, and behavior regulation.[22-25]

Later bedtimes can also be caused by several social and behavioral factors. Increasing use of electronic devices such as phones, televisions, computers, video game consoles, and music players leads to sleep disruption.[3,6] Between 2004-2008, teen cell phone usage increased from 45% to 71% in the US.[26] A 2019 survey indicated that this percentage had increased to 95% in 2019.[27] Use of electronics in the evening has been associated with later bedtimes, difficulty falling asleep, and frequent awakenings.[28-30] In addition to general entertainment, the advent of social media has led to increased use of the internet to keep connected with peers. Further, the need to constantly be connected to peers and engage in activities with peers increase during this age.[31] Physiologically, the light produced by electronic devices has an impact on the circadian rhythm by suppressing nocturnal melatonin secretion.[30] Thus, later bedtimes as a result of social interactions, particularly screen-mediated interactions, also has consequences on quality of sleep that may lead to increased daytime drowsiness. Lastly, caffeine use and use of other drugs, often consumed in response to insufficient and/or poor sleep quality, have also been implicated in lesser amounts of sleep in adolescents.[32-36]

Sleep Quality

A third aspect of sleep that is studied, albeit to a lesser extent, is quality of sleep. Sleep quality can be thought of as a more subjective interpretation of the experience of sleep, including feeling rested, and satisfaction with sleep.[37] Outside of such major physical and mental health concerns, sleep quality is related to general functioning of adolescents. A large population-based study in Norway showed that sleep deficits were associated with highest odds of being in the lowest quartile of academic performance.[25] Other studies show decreased cognitive functioning for adolescents with short- and long-term sleep deficits. Increased difficulties with interpersonal relationships, executive functioning, and cognitive functioning have been shown to be associated with poorer sleep.[22-25] Given these consequences, the role of adequate and quality sleep must not be underestimated. Parents, guardians, teachers, and society at large must strive to provide the best environment for adequate sleep to prevent these negative effects from occurring.

Overall, physiological changes, use of electronics, and use of substances have been relatively well-studied mechanisms of actions about sleep – individually and in interaction with each other. Less well studied factors that have been linked to poor sleep include comorbidities with other mental and physical illnesses, race/ethnicity, parent behavior, and peer behavior, among others.[7,38] In this study, we considered two factors that have not received much attention in the field of adolescent sleep--stressful life experiences and neighborhood factors.

Stress and Trauma in Adolescents

Stress can be defined as environmental events that are threatening to an individual's physical and mental health. Stressors might be experienced in multiple ways--traumatic events, chronic stressors, and/or normative and non-normative life events and daily hassles.[39]

The DSM-5 refers to trauma as "exposure to actual or threatened death, serious injury, or sexual violence."[16] For adolescents, potentially traumatic events include experience of natural disasters, wars, terrorism, kidnapping/captivity, physical abuse, emotional abuse, sexual abuse, sexual assault, and serious accidents. Chronic stressors for adolescents can include a diagnosis of a life-threatening chronic illness such as cancer, chronic maltreatment, neglect, poverty, refugee status, and discrimination due to race/ethnicity/gender/sexual orientation/disability status.[40-44] Adolescents can also experience normative and non-normative stressful life experiences--events that are relatively less intense but are nonetheless appraised as stressful, salient, and threatening to the adolescent's well-being.[45] Normative stressful experiences for adolescents include transition from middle school to high school, preparing for college, platonic and romantic relationships, and learning to drive. Non-

normative stressful events include parental separation or divorce, diagnosis of serious, short-term illnesses, moving to different schools, and parental job loss.[45] Single or cumulative experience of these stressful life events can lead to various physiological and psychological problems.

In one of the earliest studies that retrospectively assessed the presence of adverse childhood experiences (ACEs) in adults, more than 52% of nearly 10,000 respondents in the US had been exposed to at least one ACE.[46] In a prospective study of a nationally representative sample of adolescents, lifetime prevalence of a potentially traumatic event was around 61%.[47] Another population-based study of over 95,000 children across the US found that around 48% of the children experienced at least one stressful experience, which translates to around 34 million children nationwide.[48] Thus, the prevalence rates of childhood adversity indicates it affects around half of people living in the US.

Impact of Stress and Trauma in Adolescents

With respect to mechanisms surrounding biological responses to stress, one way the body modulates this response is through the hypothalamic–pituitary–adrenal axis (HPA axis).[49] In simple terms, the activation of the HPA axis leads to the release of glucocorticoids from the adrenal cortex. These glucocorticoids bind to their receptors in the hippocampus and lead to adaptation to the stressful experience, restoration of homeostasis, and eventually recovery from stress.[49,50]

The other pathway that is activated during stressful situations is the autonomic nervous system, which prepares the body for danger and goes into the “fight or flight” response by activating the sympathetic nervous system and inhibiting the parasympathetic nervous system. Once the crisis is over, these two systems work together to promote recovery from the stress.[50] Unfortunately, overactivation of these systems due to chronic or repeated stressful events can lead to HPA dysregulation and has been associated with various psychological and physiological disorders including anorexia nervosa, obsessive-compulsive disorder, anxiety, substance use, post-traumatic stress disorder, depression, and chronic fatigue syndrome.[51,52]

Specifically for sleep problems, nightmares and frequent sleep disturbances have been shown to occur following the experience of stressors in people of all ages. Sleep disturbances in children following a trauma can present as nightmares, sleep talking, bedwetting, and insomnia.[53] Victims of childhood physical and sexual abuse show high rates of sleep problems including nightmares and shorter sleep durations.[54,55] Children and adolescents have also reported increased sleep disturbances following the experience of violence--such as following 9/11, war, and a playground sniper attack.[56-58] Beyond the intensity of trauma, the frequency and chronicity of stressful life events can also impact sleep. That is, chronic and frequent normative and non-normative stressors,

such as poverty, living in unsafe conditions, and frequent illnesses, have also been associated with greater sleep problems in adolescents. In the next section, we look at one such specific stressor--neighborhood quality and chaos--and its impact on sleep characteristics.

It must be noted that the amount of research investigating the link between life stressors and sleep problems in adolescents is limited. Most of the sleep data is primarily focused on traumatic events rather than life stressors. Little is known about the specifics of sleep following potentially nontraumatic stressful events in adolescents. Our study adds to this sparse area of research by investigating the impact of recent stressors in a particularly vulnerable group of individuals during a vulnerable phase of life--adolescents who were categorized as being at high risk for maltreatment.

Impact of Neighborhood Quality on Sleep in Adolescence

Beyond the individual level factors discussed until now, research has begun to investigate the context adolescents find themselves in. Neighborhood quality has been shown to be associated with adolescent physical health, general psychological distress, juvenile delinquency, increased school dropouts, poorer academic outcomes, substance use, and engaging in risky behaviors.[59-69]

In this study, we investigated how neighborhood level factors can impact quality of sleep in adolescents. While factors can include objective measures like urbanicity, population density, neighborhood socioeconomic status, and poverty, we were interested in subjective measures that include social cohesion, perceptions of safety, fear of violence, disorder, and disorganization in the neighborhood.[70-74]

Social cohesion is the connectedness between individuals living in geographical proximity. It can involve feeling part of the community, ability to depend on and trust neighbors, and general friendliness of those living around the individual.[75,76] Strength of ties within neighborhood due to this cohesion is hypothesized to promote increased reinforcement of health behaviors, such as better sleep.[75,76] Conversely, disorder and disorganization in the neighborhood can lead to weaker social networks and perceived lack of safety. Fear of violence and perceiving the neighborhood as being unsafe can lead to increased stress for adolescents. Increased noise, substandard housing, and fear of victimization can lead to difficulties in falling or staying asleep.[77]

A recent systematic review of the impact of various neighborhood factors on pediatric sleep found that only 15 of 85 studies that were reviewed considered adolescent sleep.[73] There were significant associations between perceived safety, social cohesion, social disorder, and sleep quality. Specifically, when children perceived their neighborhood as safe and cohesive, it led to better sleep quality. Conversely, increased social disorder was associated with poorer quality of sleep. For both children and adolescents, living in neighborhoods with high rates of crime and/or lower

perceived safety was associated with poorer sleep. When living in such neighborhoods, children would be dealing with chronic stress and would worry about their safety and well-being. As a result, the aforementioned HPA axis/autonomic nervous systems are consistently on high alert and dysregulation of these systems can lead to several mental health problems.

A major limitation of studies investigating the relation between neighborhood factors and sleep is the lack of longitudinal studies. Only 1 of the 15 adolescent studies used longitudinal data in looking at the impact of neighborhood safety on sleep and obesity. However, neighborhood safety and sleep duration were both only assessed in the first wave, raising questions about long-term implications, particularly as sleep itself is changing during this developmental period. Longitudinal data also allows us to look at trajectories of sleep patterns and time-varying covariates such as changing neighborhood characteristics.

To our knowledge, this is the first longitudinal study of adolescent sleep to consider the role of neighborhood characteristics. Moreover, the present study uses data collected from five different regions in the United States, greatly expanding the diversity of the neighborhoods assessed. Finally, participants in this study were at high risk for maltreatment or experienced maltreatment in early childhood. Taken together, this study uses multilevel models to assess (a) change in adolescent sleep problems from age 12 to 16, (b) the impact of life stressors, and (c) three aspects of neighborhood quality: efficacy, chaos, and stability.

Methods

The data used for the current study was collected by the Longitudinal Studies of Child Abuse and Neglect (LONGSCAN) consortium.[78] Developed in 1991, LONGSCAN is a collaboration of research projects examining the etiology and consequences of childhood maltreatment at five different sites in the United States. Although each of the five sites drew their samples from different communities, the sites utilized shared assessment measures, training, similar techniques and schedules for data collection, data entry, and data management.

The combined sample consisted of 1354 children from the five data collection sites. The East (EA) site selected their participants from clients at three pediatric clinics that primarily served low-income, inner-city patients in Baltimore. The sample consisted of 237 children (52.1% male) and primarily consisted of African Americans (92.1%), followed by Caucasian (5.0%), Hispanic (0.4%), Mixed (1.1%), and Other including Native American, Asian, and Pacific Islander (0.7%). Two at-risk groups were defined based on a child's inadequate growth in the first 2 years of life and prenatal drug use by HIV-infected mothers.

The Midwest (MW) sample consisted of families that were reported to child protective services (CPS) for maltreatment. This sample consisted of 245 participants (46.9% male) drawn from an urban community in Chicago and comprised the following racial/ethnic groups: Caucasian (13.1%), African American (53.5%), Hispanic (13.9%), Mixed (17.1%), and Other including Native American, Asian, and Pacific Islander (2.4%).

The Northwest (NW) sample was selected from a pool of children from Seattle who were reported to CPS when they were younger than 5 years old and were noted to be at moderate risk for maltreatment. The sample consisted of 254 children (50.8% male) with the following racial/ethnic breakdown: Caucasian (50.0%), African American (20.5%), Hispanic (2.8%), Mixed (24.0%), and Other including Native American, Asian, and Pacific Islander (2.8%).

The Southern (SO) sample consisted of 243 children (45.3% male) identified as “high-risk” for maltreatment by North Carolina's public health department's infant tracking program (HPIP), based on “poverty, single parenthood, young maternal age, low birth weight, and other medical and psychosocial risk factors.” The sample consisted of the following racial/ethnic groups: Caucasian (35.8%), African American (63.0%), and Mixed (1.2%). Unlike the other samples, no Southern-site participants identified as Hispanic, Native American, Asian, or Pacific Islander.

The Southwest (SW) sample recruited children in San Diego who had been removed from their home due to confirmed reports of maltreatment and remained in out-of-home care or foster care for a minimum of 5 months before the age of 4. The sample consisted of 330 children (47.3% male) with the following racial/ethnic groups: Caucasian (28.5%), African American (37.6%), Hispanic (16.7%), Mixed (15.8%), and Other including Native American, Asian, and Pacific Islander (1.5%).

As seen above, the sites demonstrated distinct differences in racial and ethnic compositions. Additionally, there were geographic and cultural differences among the five sites. This level of diversity provides a unique opportunity to look at the impact of these sites on sleep patterns in adolescents.

Procedures

The LONGSCAN consortium followed 1354 children, their parents, and their teachers at ages 4, 6, 8, 10, 12, 14, 16, 18, and 20 years old. Children and their primary caregivers were interviewed separately at these age points, and teachers responded to mailed paper forms beginning at age 6. Caregiver interviews at ages 4, 6, and 8 were conducted by an interviewer. From age 12 and onward, LONGSCAN utilized the Audio-Computer Assisted Self Interview (A-CASI) to assure uniformity across different sites and provide participants with maximum privacy in responding to highly sensitive items.

Annual telephone contact was made at child ages 7, 9, 10, 11, 13, 15, and 17 to track families to prevent attrition, obtain information regarding important life events, and assess yearly service utilization. The attrition rate from baseline (age 4) to age 18 was 31.2%. For our study, we used data of children aged 12, 14, and 16 (*N* = 1126) with data on sleep problems, life stressors, and neighborhood characteristics.

Measures

To measure sleep problems in adolescents, we used caregiver-rated items from the Child Behavior Checklist/4-18 (CBCL/4-18).[79] The CBCL is a widely used, standardized measure of child and adolescent emotional/behavioral problems. Although the CBCL has been widely used for clinical and research work, there is no specific subscale for sleep. However, prior studies have demonstrated that items measuring sleep problems in the CBCL provide valuable information and are significantly correlated with measures of sleep latency assessed through other means such as sleep diaries and actigraphy.[80] For the current study, we used 7 items measuring sleep problems in children(e.g.,“overtired”; “sleeps less than most kids”; “sleeps more than most kids during day and/or night”; “trouble sleeping”). Caregivers rated each of these items from a score of 0 (not true in the last 6 months) to 2 (very true or often true in the last 6 months). CBCL was measured at ages 12, 14, and 16.

To measure significant stressful life events in a child’s life, we used the LONGSCAN-developed measure called the Child’s Life Events.[78] This instrument consists of 31 items of normative and non-normative stressors such as changes in family composition, changes in living arrangements, illness, injuries, death of close one, child’s exposure to violence, etc. Caregivers are asked whether a specific life event occurred in the past year, with 0 indicating that it did not occur and 1 indicating that it did. A cumulative score was calculated by adding all the life events occurring, with a higher score indicating more life events experienced in the past year.

Lastly, neighborhood quality was assessed using another LONGSCAN-developed measure called Quality of Neighborhood, Residential Stability & Organizational and Religious Affiliation.[78] Quality of the neighborhood is the scale we specifically used. This measure consists of 30 items with 3 subscales; the caregiver rates items from 1 (strongly disagree) to 4 (strongly agree). The *neighborhood chaos* subscale is the average of 14 items asking the caregiver about neighborhood problems, with higher scores indicating greater chaos. Statements in this subscale include, “There is graffiti on buildings and walls” and “There is open drug activity.” The *collective efficacy* subscale is the average of 11 items asking the caregiver about cohesion in the neighborhood and willingness to help and intervene, with higher scores indicating greater cohesion. This subscale includes statements such as “People around here help their neighbors” and “Neighbors can be trusted.” The *neighborhood stability* subscale is

the average of 5 items asking the caregiver about people moving in and out of neighborhood, with higher scores indicating greater instability in the neighborhood. This subscale includes statements such as ”People don’t live in neighborhood long” and “Most of the people are renters.”

Data Analysis

Analyses were conducted with R version 4.0.0 with the lme4 and sjPlot packages.[81-83] A series of multilevel models using maximum likelihood estimation were fit to the data with a random effect for participants to account for repeated measures across sampling periods. Fixed effects were used to assess change over time (centered at age 12) in years (scaled as 0, 2, 4), data collection site (NW, SW, SO, EA, and MW), the neighborhood factor, stress experienced prior to age 12, and the interaction between neighborhood and stress. None of the interaction effects were statistically significant and, therefore, only the main effect models are presented.

Results

Descriptive Information

Descriptive statistics and bivariate correlations are presented in Table 1. Site-specific information is available elsewhere.[78] In general, there was modest rank order stability across time within measures for sleep and neighborhood characteristics with the greatest cross-time stability in neighborhood chaos and efficacy. Overall, greater life stressors in the year prior to the age 12 assessment were associated with greater sleep difficulties at all future time points (12, 14, and 16). Of the neighborhood characteristics, there were no systematic, consistent concurrent or longitudinal associations with sleep problems.

Table 1: Means, Standard Deviations (SD), and Bivariate Pearson Correlations for Sleep Problems, Neighborhood Quality, and Life Stress at 12-, 14-, and 16-Year Assessments

	M (SD)	1	2	3	4	5	6	7	8	9	10	11	12
1. Sleep 12	0.17 (0.23)												
2. Sleep 14	0.16 (0.22)	.57***											
3. Sleep 16	0.14 (0.21)	.45***	.54***										
4. Chaos 12	2.05 (0.51)	.08*	.04	.03									
5. Chaos 14	2.01 (0.47)	.12**	.04	.00	.56***								
6. Chaos 16	1.98 (0.49)	.11**	.03	.04	.44***	.54***							
7. Efficacy 12	2.90 (0.55)	-.06	-.02	-.01	-.66***	-.35***	-.27***						
8. Efficacy 14	2.92 (0.50)	-.13***	-.08*	-.07*	-.43***	-.62***	-.38***	.51***					
9. Efficacy 16	2.94 (0.53)	-.13***	-.03	-.11**	-.35***	-.36***	-.64***	.36***	.49***				
10. Stability 12	2.47 (0.29)	.05	.02	.02	.46***	.33***	.28***	-.27***	-.22***	-.22***			
11. Stability 14	2.45 (0.28)	.11**	.00	.02	.24***	.45***	.30***	-.10**	-.26***	-.19***	.28***		
12. Stability 16	2.44 (0.28)	.05	.01	.00	.20***	.28***	.44***	-.19***	-.20***	-.27***	.16***	.28***	
13. Life events	3.69 (2.58)	.17***	.13***	.19***	.06	.02	.05	-.10**	-.07*	-.08*	.05	.04	.06

Sleep was measured with the CBCL. Neighborhood Chaos, Efficacy, and Stability were measured with Quality of Neighborhood, Residential Stability & Organizational and Religious Affiliation scale. Life event stress was measured with Child's Life Events scale and was only assessed at 12 years.

*p < .05. **p < .01. ***p < .001.

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Longitudinal analyses

After accounting for change in sleep over time, a likelihood ratio test indicated that adding data collection sites along with age improved model fit [$\chi 2$ (2) = 46.97, $p < .001$, $\Delta R2 = .031$]. Post-hoc Tukey tests indicated that respondents from the Northwest and Southwest reported more sleep problems than respondents from the East, South and Midwest (Table 2). Respondents from the Northwest also reported more sleep problems compared to those in the South.

Table 2 presents the parameter estimates for the best fitting models predicting sleep problems from age (indexed as years 0, 2, 4), site, life stress, and neighborhood characteristics. Separate models were fit for each neighborhood characteristic: chaos, collective efficacy, and stability. For all models, inclusion of life stressors and neighborhood characteristics resulted in the lack of significant age-related change in sleep problems. After accounting for site differences, more life stressors the year before the age 12 assessment predicted more sleep problems. Additionally in separate models, increased neighborhood chaos and lower collective efficacy predicted more sleep problems.

Table 2: Model Estimated Parameters from Multilevel Models Predicting Sleep Problems

	Neighborhood factor predicting sleep problems								
	Chaos			Efficacy			Stability		
Predictors	*b*	β	95% CI_b	*b*	B	95% CI_b	*b*	β	95% CI_b
Intercept	0.01	-0.20	-0.05 – 0.07	0.15 ***	-0.18	0.09 – 0.21	0.07	-0.18	-0.02 – 0.16
Age centered at 12 y	0.00	-0.02	-0.01 – 0.00	-0.01	-0.02	-0.01 – 0.00	-0.01	-0.02	-0.01 – 0.00
Site: Midwest	0.02	0.07	-0.02 – 0.05	0.01	0.06	-0.02 – 0.05	0.01	0.06	-0.02 – 0.05
Site: Northwest	0.10 ***	0.45	0.06 – 0.14	0.09 ***	0.41	0.06 – 0.13	0.09 ***	0.41	0.05 – 0.13
Site: South	0.03	0.13	-0.01 – 0.07	0.03	0.11	-0.01 – 0.06	0.03	0.12	-0.01 – 0.07
Site: Southwest	0.07 ***	0.31	0.03 – 0.11	0.07 ***	0.29	0.03 – 0.10	0.06 ***	0.27	0.03 – 0.10
Life events	0.01 ***	0.14	0.01 – 0.02	0.01 ***	0.14	0.01 – 0.02	0.01 ***	0.14	0.01 – 0.02
Neighborhood factor	0.03 **	0.07	0.01 – 0.05	-0.03 *	-0.06	-0.04 – -0.01	0.00	0.01	-0.03 – 0.04
Random effects									
σ^2	0.02			0.02			0.02		
τ_{00}	0.03			0.03			0.03		
ICC	0.55			0.55			0.55		
N	1077			1077			1077		
Observations	1828			1826			1826		
Marginal R^2	0.051			0.050			0.046		
Conditional R^2	0.572			0.574			0.574		

Age was centered at 12 such that time was coded as 0, 2, 4 years. The intercept reflects data from the Eastern site.
*p < .05. **p < .01. ***p < .001

Discussion

Consistent with existing research, we found that sleep problems tended to decrease with age. However, these effects were no longer detected once we considered regional and neighborhood characteristics. The findings suggest that life stressors, not just traumatic events, have negative consequences for adolescent sleep. Furthermore, these negative effects are exacerbated by increased neighborhood chaos and less neighborhood-level collective efficacy. Importantly, the negative consequences of life stressors and neighborhood characteristics were observed in five different regions in the United States, highlighting the generalizability of these findings beyond this specific sample. Moreover, these findings point to community-level policies that may help promote feelings of safety that, in turn, could support healthy sleep development during adolescence.

On a policy level, this study has some practical implications. Given that increased neighborhood chaos and lower collective efficacy were predictive of increased sleep problems, intervention on this front would be prudent. For instance, reducing factors that lead to increased neighborhood chaos, such as vandalism, open drug activity, and other criminal activities can lead adolescents to feel increasingly unsafe and lead to various mental and physical health problems, including sleep problems. Interventions on this level would possibly require a multipronged approach. While increased police action toward crime may provide initial reprieve, there is a sense of diminishing returns.[84,85] Especially in communities of color and lower socioeconomic status, there is a distinct sense of emotional distress in interactions with law enforcement.[85,86] As such, it is necessary to develop alternate programs that seek to understand and improve upon the underlying issues that lead to these unsafe activities. For instance, evidence shows that programs that provide job opportunities to adolescents of disadvantaged backgrounds led to lower crime rates following these programs.[87] In terms of collective efficacy, development of community programs to increase neighborhood connectedness and interactions between neighbors can help with increased perceptions of safety and therefore less stress and worry. Programs that involve voluntary community service can fulfill both these areas--cohesion and safety.

In terms of strengths, as noted earlier, as far as we are aware, this is the first study that looks at the impact of neighborhood characteristics on sleep problems longitudinally. Next, because of LONGSCAN's recruiting process, we were able to use a sample that was diverse in terms of biological sex, race/ethnicity, and geographical location. Many studies that have previously used LONGSCAN data failed to account for these site differences and used the entire dataset as one single sample. Specifically, participants from the NW (which had confirmed CPS reports and were at moderate risk of further maltreatment) and SW (which had children removed from their homes due to confirmed maltreatment reports) sites showed more sleep problems than the other three

sites. In the other sites, children either were only considered high risk without CPS reports (SO and EA sites) or had only CPS reports with no risk assessment (MW site). This indicates that assessing CPS reports and risk assessments for future maltreatment might be relevant to understanding risk/resilience factors involved in sleep outcomes for children.

With our study showing that including different sites as a covariate improved model fit, future research should consider accounting for site differences in research with this dataset. Including the data collection site variable strengthens the findings by demonstrating that while there are regional differences in adolescent sleep problems, regardless of where they live, more life stressors, greater neighborhood chaos, and lower collective efficacy predict poorer sleep outcomes.

As expected with novel research, the limitations of this study suggest important next steps to advance our knowledge and improve public policy surrounding neighborhood characteristics to promote healthy adolescent sleep development. While the CBCL-based sleep items were found to be adequate for measuring sleep problems, it fails to consider other sleep characteristics such as duration of sleep and sleep quality. Furthermore, caregivers and adolescents may differ in how problematic they see their sleep. For instance, parents were found to be more likely to report less sleep problems and better quality of sleep for their adolescent children; however, adolescents in the same studies reported greater sleep issues and poorer sleep quality.[88,89]

It must also be noted that the data used in this study was collected between 2000 and 2010. Therefore, an additional limitation for this study is the generalizability of the study to teenagers in the current year. For instance, the advent of social media and technology has led to major changes in sleep habits in children. As noted earlier, teen cell phone usage increased from 45% in 2004 to around 95% in 2019.[26,27] This increased use of electronics has been associated with poorer sleep quality.[28-30] While this study cannot account for this increased use of electronics in this study, future studies would certainly benefit from including this additional variable in assessing long-term sleep problems.

The results of this study speak to caregiver perceptions of sleep behavior highlighting the need for more research that includes adolescent's perception of their sleep quality, objective measurement of sleep with non-invasive methods such as actigraphy, and polysomnography or videosomnography done at home to gain a better understanding of the biopsychosocial processes linking adolescent development, home and peer relationships, and neighborhood characteristics. Thus, where possible, it is important for researchers to consider using multiple sources of information.

Next, the sample we used specifically included children who had experienced maltreatment or were at high risk for experiencing maltreatment. This is a specific subsample of children and might not account for children who either have not experienced childhood abuse and neglect, or children who have experienced other

forms of trauma or stressors. Future research would benefit from looking at sleep problems in other samples and other forms of stressors for adolescents. With COVID-19 appearing to be one such long-term stressor, adolescents are dealing with feelings of social isolation, depression, anxiety, and a whole host of other mental health issues.[90,91] Sleep also seems to be impacted for adolescents during this period, and understanding the long-term impacts of COVID-19 on sleep might be prudent.[92]

Overall, this paper serves as an additional step in understanding the context in which sleep problems can develop and provides valuable insights into potential clinical and policy intervention targets that may allow for better sleep in adolescence. This period of life is a time of rapid growth and development, and sleep is a necessary factor that aids proper development during this time. By understanding the role of changeable factors such as neighborhood safety and efficacy on sleep problems, we can take steps to build up resilience against poor sleep in adolescence.

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