HHS Public Access

Author manuscript

Behav Sleep Med. Author manuscript; available in PMC 2019 November 01.

Published in final edited form as:

Behav Sleep Med. 2018 ; 16(6): 542–552. doi:10.1080/15402002.2016.1253011.

Neighborhood Economic Deprivation and Social Fragmentation: Associations with Children' Sleep

Erika J. Bagley[a], **Thomas E. Fuller-Rowell**[b], **Ekjyot K. Saini**[b], **Lauren E. Philbrook**[b], and **Mona El-Sheikh**[b]

[a]Muhlenberg College, Allentown, PA

[b]Auburn University, Auburn, AL

Abstract

Background & Objective: A growing body of work indicates that experiences of neighborhood disadvantage place children at risk for poor sleep. This study aimed to examine how both neighborhood economic deprivation, a measure of poverty, and social fragmentation, an index of instability, are associated with objective measures of the length and quality of children's sleep.

Participants: Participants were 210 children (54.3% boys) living predominantly in small towns and semirural communities in Alabama. On average children were 11.3 years old (*SD* = .63); 66.7% of the children were European American and 33.3% were African American. The sample was socioeconomically diverse with 67.9% of the participants living at or below the poverty line and 32.1% from lower middle class or middle class families.

Methods: Indicators of neighborhood characteristics were derived from the 2012 American Community Survey and composited to create two variables representing neighborhood economic deprivation and social fragmentation. Child sleep period, actual sleep minutes, and efficiency were examined using actigraphy.

Results: Higher levels of neighborhood economic deprivation were associated with fewer sleep minutes and poorer sleep efficiency. More neighborhood social fragmentation was also linked with poorer sleep efficiency. Analyses controlled for demographic characteristics, child health, and family socioeconomic status.

Conclusions: Findings indicate that living in economically and socially disadvantaged neighborhoods predicts risk for shorter and lower quality sleep in children. Examination of community context in addition to family and individual characteristics may provide a more comprehensive understanding of the factors shaping child sleep.

Keywords

normal sleep child; actigraphy

Correspondence: Mona El-Sheikh, Ph.D., Human Development and Family Studies, 203 Spidle Hall, Auburn University, Auburn, AL 36849-5214; Tel: 1-334-844-3294, Fax: 1-334-844-4515, elshemm@auburn.edu.

Sleep behavior is widely considered the result of a complex interaction between biological and psychological factors, influenced by social and environmental contexts (Hale, Emanuele, & James, 2015). A primary context that has been the focus of emerging research, particularly in understanding the sleep of children and adolescents, is the family (Dahl & El-Sheikh, 2007). Extant findings highlight the importance of family socioeconomic (Marco, Wolfson, Sparling, & Azuaje, 2012) and social factors (Maume, 2013), as they relate to sleep behavior of youth. Similarly, problematic *neighborhood-level* economic and social environments may also place youth at higher risk of sleep problems (Moore et al., 2011; Smaldone, Honig, & Byrne, 2007).

The majority of research linking neighborhood conditions to sleep has been conducted with adult samples and findings highlight possible pathways through which the neighborhood may influence sleep. For example, in a study of urban, low-income, Latino adults poor housing conditions and neighborhood disorder were linked to greater self-reported sleep disturbances and poorer quality sleep (Chambers, Pichardo, & Rosenbaum, 2016). In another study of urban-dwelling adults that utilized a combination of survey responses and Census data, several factors of the neighborhood social environment (disorder, social cohesion, safety) were found to be adversely related to sleep duration, after accounting for individual and neighborhood SES (Desantis, Diez Roux, Moore, Baron, Mujahid, & Nieto, 2013). Across findings from the adult research, it appears that neighborhood level economic deprivation and social environment are differentially related to both sleep quality and quantity.

A smaller number of studies have previously examined associations between neighborhood conditions and sleep with nationally representative and clinical samples of children. In an examination of the National Survey of Children’s Health between 2003 and 2012, Singh and Kenney (2013) noted the importance of the neighborhood context in understanding variations in sleep problems. In this nationally representative sample, while accounting for family SES, 10% of children residing in the most favorable neighborhoods (assessed using measures including perceived safety, housing quality, vandalism) were reported to experience inadequate sleep more than twice a week, while 16.2% of children in the least favorable neighborhoods were reported to have those sleep problems. Other research also shows links between the neighborhood and clinical sleep problems. Neighborhood disadvantage was shown to increase the risk of obstructive sleep apnea in younger children (Spilsbury et al., 2006) and older children (Spilsbury, Storfer-Isser, Rosen, & Redline, 2015), even after adjusting for several, known health related and demographic risk factors and family level SES indicators.

Pabayo, Molnar, Street, and Kawachi (2014) examined associations between neighborhood characteristics and the sleep of community-dwelling, adolescents in the Boston area. They made use of 2010 U.S. Census data to develop composite measures of neighborhood economic deprivation (including indicators of neighborhood level SES) and neighborhood social fragmentation (including indicators of the residential stability of the neighborhood) then tested the associations between these neighborhood variables and self-reported sleep. Economic deprivation and social fragmentation are both indicators of neighborhood disadvantage, but they represent distinct constructs that have been shown to have unique and independent effects on health (Sjarne et al., 2004). Neighborhood economic deprivation may be associated with sleep environments that are less conducive for sleep (e.g., greater street noise, violence, poorer quality housing; Pabayo et al., 2014), whereas social fragmentation may be associated with social environments that are less supportive of sleep (e.g. lower levels of social support and cohesion; Fagg, et al., 2008). Consistent with the conceptualization of neighborhood economic deprivation social fragmentation as distinct constructs, Pabayo and colleages showed that adolescents who resided in neighborhoods with moderate and high levels of social fragmentation were less likely to obtain adequate sleep (>8.5 hrs); findings in regards to economic deprivation were null. Authors discuss the findings as consistent with current frameworks of the social determinants of health (Marmot, 2005), suggesting that socially fragmented neighborhoods are not providing a “stable social environment” that supports adolescents in achieving adequate sleep.

Publically available U.S. Census data present unique opportunities for research on neighborhood level effects on sleep, however it is not without some challenges. For example, researchers must have access to individual level data in order to suggest that neighborhoods exert a unique effect, above and beyond individual level SES. Pabayo and colleagues (2014) lacked information on family SES, thus neighborhood findings are potentially confounded with household income and/or economic stress. Another shortcoming of prior research considering neighborhood effects on sleep has been a reliance on self- or parent-reported sleep, often only providing information on a single aspect of sleep such as duration. Through an examination of associations between family and neighborhood level variables and sleep, assessed using objective actigraphy measures, the current study builds on this literature in meaningful ways. Furthermore, drawing on recommendations in reviews of the literature on neighborhood influences on child health (Rajaratnam, Burke, & O’Campo, 2006; van Vuuren, Reijneveld, van der Wal, & Verhoeff, 2014), which call for more direct comparisons to relevant prior research, the analyses presented herein utilize Census data composite measures of economic deprivation and social fragmentation equivalent to those used by Pabayo et al. (2014). It was hypothesized that economic deprivation and social fragmentation would be associated with shorter and poor quality sleep in children.

Method

Participants

Data for the current study comes from the third wave (collected from 2011 – 2012) of a longitudinal investigation (Auburn University Sleep Study). Children were recruited from public schools in primarily small towns and semirural rural communities in Alabama.

Participants included 210 children (114 boys, 96 girls, *M* age = 11.3 years, *SD* = .63) for whom valid residential geographic information and actigraphy sleep data were available. Similar to the demographic profile of the communities, 66.7% of children were European American (EA) and 33.3% were African American (AA).

Procedures

Letters were sent home with the children and families contacted the laboratory if they were interested in participating. Children were eligible to participate if they did not have a diagnosis of attention deficit hyperactivity disorder, developmental delays, or a clinical sleep disorder (e.g., apnea) based on mother report. The study was approved by the university's institutional review board. Data were collected during the school year excluding holidays. Children wore actigraphs on their non-dominant wrists for seven consecutive nights. Families visited the laboratory 3.86 days (SD =33.96) after conducting the sleep assessment to fill out questionnaires.

Measures

Neighborhood Characteristics.—Home addresses were utilized to geocode census tract information to the residential location of each family. Participants were distributed throughout 34 census tracts in Southeastern Alabama and a few communities in the adjacent state of Georgia. Neighborhood census tract indicators were derived from the 2012 American Community Survey, a representative survey conducted by the U.S Census Bureau during years when the U.S Census is not administered (U.S Department of Commerce, 2012).

Economic Deprivation: Neighborhood level economic deprivation was assessed using census tract indicators of proportion of individuals receiving public assistance, median household income (reverse coded), and proportion of residents living in poverty. These indicators have been frequently used in pertinent literatures examining neighborhood influences on sleep and health (Pabayo et al., 2014; Pampalon & Raymond, 2000). Census level indicators were correlated (rs =.51 to .81, $p < .01$), showed good internal consistency (α =.91), and were standardized to create an average composite of economic deprivation with scores ranging from −2.01 to 2.29 ($M = -.0439$; $SD = .88$).

Social Fragmentation.: Social fragmentation is an indication of neighborhood level instability, which was assessed using census tract information on owner-occupied housing (reverse coded), proportion of vacant homes, and proportion of residents living in the same home for less than 5 years. These indicators have been reliably used in the literature (Flouri, Midouhas, Joshi, & Sullivan, 2015; Pabayo et al., 2014). Indicators were correlated (rs =.49 to .63, $p < .01$) and demonstrated acceptable reliability (α = .72). Indicators were standardized to form a mean composite where scores ranged from −1.57 to 2.11 ($M = .0011$, $SD = .80$).

Sleep—Data were obtained using actigraphs (Motionlogger Octagonal Basic, Ambulatory Monitoring Inc., Ardsley, NY). Motion was measured in 1-min epochs using zero crossing mode from bedtime to wake times, which were cross-validated with daily sleep logs. The analysis software package (AW2, 2002, Ambulatory Monitoring Inc., Ardsley, NY) utilized the well-established Sadeh algorithm (Sadeh, Sharkey, & Carskadon, 1994) to derive sleep variables.

Several sleep parameters were derived and are based on actigraphy: (a) sleep period – number of minutes between sleep onset and wake time; (b) sleep minutes - the number of minutes *scored as sleep* between sleep onset and wake time; and (c) sleep efficiency - the percentage of epochs scored as sleep between sleep onset and wake time. Sleep parameters were averaged across all available nights and night-to-night stability was adequate (α s= .70 - .85). We examined both the sleep period and sleep minutes due to the importance of both time in bed and total time spent asleep.

In total, 37.0% of children had actigraphy data for all seven nights, 21.7% for six nights, 19.2% for five nights, 7.6% for four nights, and 14.5% had less than three nights or no actigraphy data. Due to poor reliable estimation of regular sleep, sleep data points for children with less than five nights of actigraphy data (22.1%) were not included in analyses (Meltzer, Montgomery-Downs, Insana, & Walsh, 2012). On average, children had valid actigraphy data for 5.39 nights (*SD* = 1.9). Reasons for missing data included forgetting to wear the watch, mechanical problems, and medication use in which case the data were excluded from analyses.

Controls—Sex (0 = girls, 1= boys), race/ethnicity (0 = EA, 1 = AA), age, family income-to-needs ratio (annual family income divided by the poverty threshold considering family size; U.S. Department of Commerce, 2013), parent cohabitation (0 = living separately, 1= living together), health status (0 = no chronic illness, asthma, or regular medication use, 1= yes), mother report of pubertal status (1 = pre-pubertal, 2 = early pubertal, 3 = mid-pubertal, 4 = late pubertal, and 5 = post-pubertal; Petersen et al., 1988), and standardized BMI score (zBMI; Centers for Disease Control and Prevention, 2007) were controlled in analyses. Height and weight were measured in the laboratory.

Plan of Analysis—Multilevel models were estimated in MPlus Version 7 to examine neighborhood influences on sleep (Muthén & Muthén, 2012). The use of multilevel modeling is consistent with recent calls in the literature to utilize advanced methodology to better understand children's sleep in various contexts (El-Sheikh & Sadeh, 2015). Two-level models were used, in which individuals (level 1) were nested within neighborhood census tracts (level 2). An examination of analytic assumptions indicated no outliers and that variable distributions were consistent with assumptions of normality.

Missing data on individual predictor variables was dealt with using Full Information Maximum Likelihood (FIML) estimation (Enders, 2010), which is a robust and powerful missing data approach that provides unbiased parameter estimates (Schafer & Graham, 2002). Of the 210 individuals included in analyses, 93.3% had complete data on BMI, 90.9% on puberty status, 87.6% on household income-to-needs ratio, and 81.9% on cohabitation. All other variables had no missing data. Missing data on one or more covariates was associated with slightly greater sleep efficiency ($p = .038$) but was uncorrelated with all other study variables. The assumption under FIML estimation that data are missing at random is therefore tenable, and the amount of missing data is within a range considered to be acceptable for the analyses conducted in the paper (Muthén & Muthén, 2012). Per established guidelines (Raudenbush & Bryk, 2002), initial models were estimated to partition the variance at level 1 and level 2 for each of the sleep measures. We then fit three models for each sleep outcome. The first model estimated the effect of neighborhood economic deprivation, the second model considered neighborhood social fragmentation, and the third model estimated the effects of economic deprivation and social fragmentation simultaneously. Simultaneous testing allowed for examination of the unique association of each neighborhood predictor with the sleep variables, controlling for the other. Towards conservative assessment of our research questions, all models included level 1 controls for age, sex, race, cohabitation, income-to-needs ratio, pubertal status, chronic conditions, and BMI. As an illustration, the equations used to consider neighborhood economic deprivation as a predictor of sleep period are as follows:

Level 1:

$$Sleep\ Period_{ij} = \beta_{0j} + \beta_1\ (age_{ij}) + \beta_2\ (sex_{ij}) + \beta_3\ (race_{ij}) + \beta_4\ (cohabitation_{ij}) + \beta_5\ (income\text{-}to\text{-}needs_{ij}) + \beta_6\ (pubertal\ status_{ij}) + \beta_7\ (chronic\ conditions_{ij}) + \beta_8\ (body\ mass\ index_{ij}) + r_{ij}$$

Level 2:

$$B_{0j} = \gamma_{00} + \gamma_{01}\ (Neighborhood\ Economic\ Deprivation_j) + u_{0j}$$

The subscript j is for neighborhood census tracts and i is for individuals. In the level 1 equation, β_{0j} is the intercept, β_1-β_8 are the level 1 regression coefficients for each of the controls, and r_{ij} is the residual error term. The level 2 equation then shows that the intercept, β_{0j}, is allowed to vary across neighborhoods, u_{0j}, and as a function of neighborhood economic deprivation, γ_{01}. The combined model therefore estimates sleep period for individual i in neighborhood j as a function neighborhood economic deprivation, while also accounting for the effects of individual level covariates and the clustering of individuals within neighborhoods. Unstandardized parameter estimates are reported in the tables and the text for all models.

Results

Descriptive statistics for individual (level 1) and neighborhood (level 2) variables are shown in Table 1. Family income-to-needs ratio indicated that 67.9% of families were living below or near the poverty line (ratio ≤ 2) and 32.1% were lower or middle class (ratio > 2). On average, boys were pre-pubertal (M = 1.80, SD = 0.53) and girls were early pubertal (M = 2.35, SD = 0.61). Further, 67.6% of the children were primarily from two parent households (e.g., both biological parents or one biological parent and cohabiting partner) and 13.8% were from single-parent households (mostly mothers). Parent report about health status indicated that 22.4% of children had a chronic illness (e.g., allergies), asthma, and/or took regular medication for those conditions.

Neighborhood economic deprivation and social fragmentation were highly correlated (r = .69, p < .001). With respect to associations with sleep, higher body mass index was associated with shorter sleep period (r = −.27, p < .001), fewer sleep minutes (r = .28, p < .001), and poorer efficiency (r = −.15, p = .036). Males had fewer sleep minutes (r = −.16, p =.025) and poorer sleep efficiency (r = −.17, p = .016) than females. Additionally, African Americans had shorter sleep period (r = −.23, p = .001) and fewer sleep minutes (r = −.17, p

= .012) than European Americans. Lastly, more advanced puberty status was associated with shorter sleep period ($r = -.16$, $p = .031$).

Initial null models (with no predictors) yielded intra-class correlation coefficients (ICCs) of .03, .05, and .04 for sleep period, minutes, and efficiency, respectively. ICCs can be interpreted as the proportion of the total variance in each outcome that exists between neighborhoods (at level 2), with the remaining variance existing across individuals within neighborhoods (at level 1). The ICCs are therefore consistent with prior work in showing that a relatively small portion of the total variance in sleep is unique to the neighborhood level (Pabayo et al., 2014). It should be noted, however, that even with small ICCs, neighborhood variables can be important predictors of sleep (Pabayo et al., 2014).

Neighborhood Economic Deprivation

Parameter estimates from multilevel models considering economic deprivation as a predictor of sleep period, minutes, and efficiency are shown in the first column of Table 2. Controlling for level 1 covariates, economic deprivation was not associated with sleep period. However, higher levels of economic deprivation were associated with fewer total sleep minutes ($B = -13.47$, $SE = 5.04$, $p = .008$) and poorer sleep efficiency ($B = -1.79$, $SE = .66$, $p = .007$).

Neighborhood Social Fragmentation

Parameter estimates from multilevel models considering social fragmentation as a predictor of sleep period, minutes, and efficiency are shown in the second column of Table 2. Controlling for level 1 covariates, social fragmentation was not associated with sleep period or minutes. However, higher levels of social fragmentation were associated with lower levels of sleep efficiency ($B = -1.00$, $SE = .30$, $p = .001$).

Neighborhood Economic Deprivation and Social Fragmentation

Parameter estimates from multilevel models simultaneously estimating the effects of economic deprivation and social fragmentation as predictors of sleep period, minutes, and efficiency are shown in the third column of Table 2. Controlling for level 1 covariates, only economic deprivation, and not social fragmentation, was associated with child sleep. Higher levels of economic deprivation were associated with fewer sleep minutes ($B = -15.01$, $SE = 5.22$, $p = .004$) and lower sleep efficiency ($B = -1.99$, $SE = .98$, $p = .042$). Neither neighborhood economic deprivation nor social fragmentation was significantly related to sleep period.

Supplemental Analyses

To discern whether missing data influenced the results, secondary analyses were conducted to consider findings for models including only participants who did not have missing data on any covariates ($N = 146$). Findings from these models revealed the same pattern of results reported above and all findings remained statistically significant except the link between neighborhood social fragmentation and sleep efficiency. The effect size for this association slightly increased in magnitude but the p-value dropped below the threshold of statistical significance ($p = .13$) due to the reduced sample size.

In order to determine whether the relatively small number of census tracts influenced the results, secondary regression analyses were also conducted that did not account for the nesting of the data. The findings were nearly identical, except that the association between social fragmentation and sleep efficiency did not reach significance, though the size of the parameter estimate was similar. Therefore, we chose to present the more powerful and appropriate multilevel analyses accounting for the nesting of the data.

Discussion

The results of the study show that after accounting for demographic characteristics, health related variables, and family SES, associations between aspects of the neighborhood and adolescent sleep remained significant, explaining a modest amount of variance in sleep. Specifically, greater neighborhood level economic deprivation was associated with shorter and worse quality sleep among adolescents and social fragmentation was associated with worse sleep quality. Findings provide support for the importance of the neighborhood context and reinforce the notion that sleep is embedded within not only family, but also community contexts.

Compared to the findings of the Pabayo and colleagues (2014), the results of the current study show more robust effects of neighborhood economic deprivation as opposed to social fragmentation. Methodologically, the studies differed in the assessment (self-report versus actigraphy), age of participants (adolescence versus late childhood), and statistical treatment (dichotomized versus continuous) of the sleep variables and this may explain the inconsistent results. Another potentially important difference between the studies is the relative urbanicity of the neighborhoods studied. Pabayo's sample was drawn from the Boston metropolitan area, which has higher population density than the Census tracts in our study, which were primarily semirural and small towns. Differences related to the type of housing and access to resources may underlie the differences in findings. Differences in collective efficacy (Sampson, Raudenbush, & Earls, 1997) between urban and rural communities may also have contributed to the differences in findings. Further research is warranted to provide a more nuanced understanding of possible interactions between neighborhood socioeconomic characteristics and urban-rural classifications as they impact sleep.

It is worth noting that our findings in regard to relations between neighborhood variables and sleep period were non-significant. Comparing across the different aspects of sleep we examined, sleep period best assesses the opportunity for sleep. The null effects for sleep period, keeping in mind significant effects for sleep minutes and efficiency, suggests that neighborhood affects the ability to maintain high quality sleep and not necessarily time in bed or opportunities for sleep. Research that explores the specific mechanisms linking neighborhoods to the sleep of children is needed to better understand the observed differential effects.

There are a number of ways in which neighborhood level SES might directly influence sleep behavior. Pabayo and colleagues (2014) examined smoking, alcohol consumption, physical inactivity, depressive symptoms, social cohesion and perception of neighborhood safety as possible mediators of links between social fragmentation and sleep, yet in adjusted models none of these behaviors explained relations between the neighborhood and sleep. Still, one might speculate that greater neighborhood economic deprivation may accompany increased risk of exposure to social stressors that have been shown to negatively affect sleep, such as neighborhood violence (Umlauf, Bolland, Bolland, Tomek, & Bolland, 2015), noise (Basner, Müller, & Elmenhorst, 2011) and crowded living conditions (Saegert & Evans, 2003). Research showing higher levels of salivary cortisol among adolescents from disadvantaged neighborhoods (Rudolph et al., 2014) further suggests the possible role of stress reactivity in the relations between neighborhoods, sleep, and overall health.

Neighborhoods may also influence adolescent sleep indirectly through effects on adults in the home. As compared to the literature examining youth, a larger body of research has established associations between neighborhood disadvantage and sleep problems in adults (e.g., Johnson et al., 2015; Bassett & Moore, 2014, Hill, Burdette, & Hale, 2009). In light of recent research showing concordance between parent and adolescent sleep habits (Fuligni, Tsai, Krull, & Gonzales, 2015) it is not unlikely that, in addition to direct effects, the neighborhood might also have indirect effects on sleep of youth through its effect on parental sleep patterns. Future research is likely to benefit from exploring both direct and indirect mechanisms linking neighborhood to sleep variables in youth.

Through the use of actigraphy measured sleep and consideration of family and neighborhood level influences, this study addressed some shortcomings of prior research. However, it is not without limitations. Research suggests that U.S. Census tracts may not necessarily overlap with how adolescents would define their neighborhoods (Robinson & Oreskovic, 2013), which may reduce the validity of neighborhood data. The convenience sample is drawn from a relatively small number of census tracts in geographically restricted, suburban and semirural communities in the Southeastern United States and participants with clinically diagnosed sleep disorders were excluded. The non-probability sampling method used limits generalizability and may affect interpretation of p-values. Further replication studies with larger samples in other geographic locations are warranted.

Overall, the findings of this study add to a small but growing body of research that suggests neighborhood environments should be considered a relevant social determinant of children’s sleep (Hawkins & Takeuchi, 2016). Given the importance of sleep for overall well-being, pediatricians should be especially proactive in inquiring about sleep when working in disadvantaged communities. Future research that explores various possible psychosocial and biological mechanisms for the observed neighborhood effects, as well as risk and protective factors at various levels of analysis, is of importance for addressing why and for whom neighborhood adversity could affect sleep. Research along these lines will likely illuminate potential targets for intervention and prevention efforts. Furthermore, national agendas to improve health and well-being through community-level improvement should carefully consider potential impacts of any policy change on sleep, and its determinants.

Acknowledgements:

This research was supported by Grant Number R01HL093246 from the National Heart, Lung, and Blood Institute awarded to Mona El-Sheikh. We thank the staff of the Child Sleep, Health, and Development Laboratory, most notably Bridget Wingo, for data collection and preparation, and the children and parents who participated.

References

ActionW User's Guide version 2.4. (2002). Ardsley, NY: Ambulatory Monitoring, Inc.

Basner M, Müller U, & Elmenhorst E-M (2011). Single and combined effects of air, road, and rail traffic noise on sleep and recuperation. SLEEP, 34(1), 11–23. [PubMed: 21203365]

Bassett E, & Moore S (2014). Neighbourhood disadvantage, network capital and restless sleep: Is the association moderated by gender in urban-dwelling adults? Social Science & Medicine, 108, 185–193. doi: 10.1016/j.socscimed.2014.02.029 [PubMed: 24650740]

Centers for Disease Control and Prevention. (2014). Body Mass Index (BMI) percentile calculator for child and teen, from http://nccd.cdc.gov/dnpabmi/Calculator.aspx

Chambers EC, Pichardo MS, & Rosenbaum E (2016). Sleep and the housing and neighborhood environment of urban Latino adults living in low-income housing: the AHOME study. Behavioral Sleep Medicine, 14(2), 169–184. doi: 10.1080/15402002.2014.974180 [PubMed: 25386692]

Dahl RE, & El-Sheikh M (2007). Considering sleep in a family context: Introduction to the special issue. Journal of Family Psychology, 21, 1–3. doi: 10.1037/0893-3200.21.1.1 [PubMed: 17371104]

DeSantis AS, Diez Roux AV, Moore K, Baron KG, Mujahid MS, & Nieto FJ (2013). Associations of neighborhood characteristics with sleep timing and quality: The Multi-Ethnic Study of Atherosclerosis SLEEP, 36(10), 1543–1551. doi: 10.5665/sleep.3054 [PubMed: 24082314]

El-Sheikh M, & Sadeh A (2015). Sleep and development: Advancing theory and research: I. Sleep and development: Introduction to the monograph. Monographs of the Society for Research in Child Development, 80(1), 1–14. doi: 10.1111/mono.12141

Enders CK (2010). Applied missing data analysis. Chicago: Guilford Press.

Fagg J, Curtis S, Stansfeld SA, Cattell V, Tupuola A-M, & Arephin M (2008). Area social fragmentation, social support for individuals and psychosocial health in young adults: Evidence from a national survey in England. Social Science & Medicine, 66(2), 242–254. doi: 10.1016/j.socscimed.2007.07.032 [PubMed: 17988774]

Flouri E, Midouhas E, Joshi H, & Sullivan A (2015). Neighbourhood social fragmentation and the mental health of children in poverty. Health & Place, 31, 138–145. doi: 10.1016/j.healthplace.2014.11.009 [PubMed: 25532101]

Fuligni AJ, Tsai KM, Krull JL, & Gonzales NA (2015). Daily concordance between parent and adolescent sleep habits. Journal of Adolescent Health, 56(2), 244–250. doi: 10.1016/j.jadohealth.2014.09.013 [PubMed: 25620309]

Hale L, Emanuele E, & James S (2015). Recent updates in the social and environmental determinants of sleep health. Current Sleep Medicine Reports, 1(4), 212–217. doi: 10.1007/s40675-015-0023-y [PubMed: 27540510]

Hawkins S & Takeuchi D (2016). Social determinants of inadequate sleep in US children and adolescents. Public Health.

Hill TD, Burdette AM, & Hale L (2009). Neighborhood disorder, sleep quality, and psychological distress: testing a model of structural amplification. Health & Place, 15(4), 1006–1013. doi: 10.1016/j.jadohealth.2014.09.013 [PubMed: 19447667]

Johnson DA, Brown DL, Morgenstern LB, Meurer WJ, & Lisabeth LD (2015). The association of neighborhood characteristics with sleep duration and daytime sleepiness. Sleep Health, 1(3), 148–155. doi: 10.1016/j.sleh.2015.06.002 [PubMed: 29073435]

Marco CA, Wolfson AR, Sparling M, & Azuaje A (2012). Family socioeconomic status and sleep patterns of young adolescents. Behavioral Sleep Medicine, 10(1), 70–80. doi: 10.1080/15402002.2012.636298

Marmot M (2005). Social determinants of health inequalities. The Lancet, 365(9464), 1099–1104. doi: 10.1016/S0140-6736(05)74234-3

Maume DJ (2013). Social ties and adolescent sleep disruption. Journal of Health and Social Behavior, 54(4), 498–515. doi: 10.1177/0022146513498512 [PubMed: 24311758]

Meltzer LJ, Montgomery-Downs HE, Insana SP, & Walsh CM (2012). Use of actigraphy for assessment in pediatric sleep research. Sleep Medicine Reviews, 16(5), 463–475. doi: 10.1016/j.smrv.2011.10.002 [PubMed: 22424706]

Moore M, Kirchner HL, Drotar D, Johnson N, Rosen C, & Redline S (2011). Correlates of adolescent sleep time and variability in sleep time: The role of individual and health related characteristics. Sleep Medicine, 12(3), 239–245. doi: http://dx.doi.org/10.1016/j.sleep.2010.07.020 [PubMed: 21316300]

Muthén LKM, B.O. (2012). Mplus User's Guide (Seventh ed.). Los Angeles, CA: Muthén & Muthén.

Pabayo R, Molnar BE, Street N, & Kawachi I (2014). The relationship between social fragmentation and sleep among adolescents living in Boston, Massachusetts. Journal of Public Health, 587–598. doi: 10.1093/pubmed/fdu001 [PubMed: 24496556]

Pampalon R, & Raymond G (2000). A deprivation index for health and welfare planning in Quebec. Chronic Diseases and Injuries in Canada, 21(3), 104–113. doi: 10.1016/j.healthplace.2014.05.010

Petersen AC, Crockett L, Richards M, & Boxer A (1988). A self-report measure of pubertal status: Reliability, validity, and initial norms. Journal of Youth and Adolescence, 17(2), 117–133. doi: 10.1037/0012-1649.40.6.1188 [PubMed: 24277579]

Rajaratnam JK, Burke JG, & O'Campo P (2006). Maternal and child health and neighborhood context: the selection and construction of area-level variables. Health & Place, 12(4), 547–556. doi: 10.1016/j.healthplace.2005.08.008 [PubMed: 16188483]

Raudenbush SW, & Bryk AS (2002). Hierarchical linear models: Applications and data analysis methods (2nd ed.). Thousand Oaks: Sage Publications.

Robinson AI, & Oreskovic NM (2013). Comparing self-identified and census-defined neighborhoods among adolescents using GPS and accelerometer. International Journal of Health Geographics, 12(1), 1. doi: 10.1186/1476-072X-12-57 [PubMed: 23305074]

Rudolph KE, Stuart EA, Glass TA, Marques AH, Duncko R, & Merikangas KR (2014). The association between cortisol and neighborhood disadvantage in a US population-based sample of adolescents. Health & Place, 25, 68–77. doi: 10.1016/j.healthplace.2013.11.001 [PubMed: 24367996]

Sadeh A, Sharkey KM, & Carskadon MA (1994). Activity-based sleep-wake identification: An empirical test of methodological issues. SLEEP, 17(3), 201–207. [PubMed: 7939118]

Saegert S, & Evans GW (2003). Poverty, housing niches, and health in the United States. Journal of Social Issues, 59(3), 569–589. doi: 10.1111/1540-4560.00078

Sampson RJ, Raudenbush SW, & Earls F (1997). Neighborhoods and violent Crime: A multilevel study of collective efficacy. Science, 227(5328), 918–924. doi: 10.1126/science.227.5328.918

Schafer JL, & Graham JW (2002). Missing data: Our view of the state of the art. Psychological Methods, 7(2), 147–177. doi: 10.1037/1082-989X.7.2.147 [PubMed: 12090408]

Singh GK, & Kenney MK (2013). Rising prevalence and neighborhood, social, and behavioral determinants of sleep problems in US children and adolescents, 2003–2012. Sleep Disorders, 15. doi: 10.1155/2013/394320

Smaldone A, Honig JC, & Byrne MW (2007). Sleepless in America: Inadequate sleep and relationships to health and well-being of our nation's children. Pediatrics, 119(Supplement 1), S29–S37. doi: 10.1542/peds.2006-2089F [PubMed: 17272582]

Spilsbury JC, Storfer-Isser A, Kirchner HL, Nelson L, Rosen CL, Drotar D, & Redline S (2006). Neighborhood disadvantage as a risk factor for pediatric obstructive sleep apnea. The Journal of Pediatrics, 149(3), 342–347. doi: 10.1016/j.jpeds.2006.04.061 [PubMed: 16939744]

Spilsbury JC, Storfer-Isser A, Rosen CL, & Redline S (2015). Remission and incidence of obstructive sleep apnea from middle childhood to late adolescence. SLEEP: Journal of Sleep and Sleep Disorders Research, 38(1), 23–29. doi: 10.5665/sleep.4318

Stjärne MK, de Leon AP, & Hallqvist J (2004). Contextual effects of social fragmentation and material deprivation on risk of myocardial infarction—results from the Stockholm Heart Epidemiology Program (SHEEP). International Journal of Epidemiology, 33(4), 732–741. doi: 10.1093/ije/dyh087 [PubMed: 15155706]

U.S. Census Bureau. (2012). American Community Survey, from https://www.census.gov/programs-surveys/acs/

U.S. Department of Commerce. (2013). How the Census Bureau measures poverty from http://www.census.gov/hhes/www/poverty/about/overview/measure.html

Umlauf MG, Bolland AC, Bolland KA, Tomek S, & Bolland JM (2015). The effects of age, gender, hopelessness, and exposure to violence on sleep disorder symptoms and daytime sleepiness among adolescents in impoverished neighborhoods. Journal of Youth and Adolescence, 44(2), 518–542. doi: 10.1007/s10964-014-0160-5 [PubMed: 25070645]

van Vuuren CL, Reijneveld SA, van der Wal MF, & Verhoeff AP (2014). Neighborhood socioeconomic deprivation characteristics in child (0–18 years) health studies: a review. Health & Place, 29, 34–42. doi: 10.1016/j.healthplace.2014.05.010 [PubMed: 24954613]

Table 1.

Descriptive statistics for all study variables.

	Mean (%)	*SD*
Level 1 Sleep Outcomes:		
Sleep Period (minutes)	495.8	38.2
Actual Sleep Minutes	441.2	52.8
Efficiency (%)	89.1	7.6
Level 1 Covariates:		
Age (years)	11.3	.63
Child Sex		
Female	(45.7)	
Male	(54.3)	
Race		
African American	(33.3)	
European American	(66.7)	
Parental Cohabitation		
Living together	(67.6)	
Living separately	(13.8)	
Income-to-needs ratio	1.62	1.00
Pubertal Status	2.07	.64
Chronic Conditions		
Does not have conditions	(77.6)	
Has one or more conditions	(22.4)	
zBody Mass Index	.77	1.17
Level 2 Neighborhood Variables:		
Economic Deprivation	−.04	.88
Median income	$45,900	$17,100
Poverty rate (%)	18.1	
Household public assistance (%)	15.9	9.8
Social Fragmentation	.00	.80
Vacancy rate (%)	12.9	6.1
Mobility (%; same house <5 years)	11.4	5.9
Owner occupied (%)	60.7	16.0

Note. Neighborhood economic deprivation and social fragmentation are scored as the mean of their three standardized constituent variables. The poverty threshold level in 2012 was $23,283 for a family of four (U.S Census Bureau, 2012).

Table 2.

Multilevel model results showing effects of both neighborhood economic deprivation and social fragmentation on sleep period, minutes, and efficiency.

	Model 1	Model 2	Model 3
Sleep Period	**Estimate (SE)**	**Estimate (SE)**	**Estimate (SE)**
Intercept, γ00	503.60 (9.26) **	502.61 (9.35) **	503.40 (9.45) ***
Age, β1	−.39 (.49)	−.32 (.46)	−.39 (.49)
Sex, *β*2	−7.93 (6.87)	−7.45 (7.07)	−7.97 (6.91) *
Race, *β*3	−14.81 (7.00) *	−15.18 (7.18)	−15.01 (7.15)
Cohabitation, *β*4	.39 (10.79)	.53 (10.97)	.90 (11.23)
Income-to-needs, *β*5	−2.43 (2.76)	−1.84 (2.92)	−2.51 (2.85)
Puberty status, *β*8	−5.18 (8.06)	−6.06 (7.62)	−5.04 (8.00)
Chronic conditions, *β*7	3.14 (6.67)	3.28 (6.42)	3.15 (6.68)
BMI, *β*8	−7.27 (2.88)	−7.38 (2.86) *	−7.23 (2.89) *
Neigh. Economic Deprivation, γ01	−4.70 (3.76)	---	−5.77 (4.42)
Neigh. Social Fragmentation, γ02	---	−2.30 (3.81)	1.69 (3.94)
Sleep Minutes	Estimate (SE)	Estimate (SE)	Estimate (SE)
Intercept, γ00	445.10 (11.32) ***	447.32 (11.79) ***	444.75 (11.3) ***
Age, *β*1	−.74 (.68)	−.64 (.64)	−.71 (.68)
Sex, *β*2	−19.91 (7.76) *	−19.61 (7.44) **	−20.00 (7.93) *
Race, *β*3	−9.31 (8.96)	−12.33 (10.19)	−9.61 (9.17)
Cohabitation, *β*4	11.35 (11.21)	9.41 (11.47)	11.94 (11.20)
Income-to-needs, *β*5	−3.79 (4.17)	−2.32 (4.21)	−3.83 (4.17)
Puberty status, *β*8	−3.37 (9.88)	−5.52 (8.73)	−3.39 (9.99)
Chronic conditions, *β*7	1.63 (8.79)	1.48 (8.12)	1.64 (8.83)
BMI, *β*8	−11.00 (3.42) **	−10.89 (3.35) **	−10.99 (3.41) **
Neigh. Economic Deprivation, γ01	−13.47 (5.04) **	---	−15.01 (5.22) **
Neigh. Social Fragmentation, γ02	---	−6.85 (5.43)	2.76 (4.60)
Sleep Efficiency	Estimate (SE)	Estimate (SE)	Estimate (SE)
Intercept, γ00	89.04 (1.91) ***	89.00 (1.38) ***	89.00 (1.88) ***
Age, *β*1	−.08 (.08)	−.08 (.08)	−.07 (.08)
Sex, *β*2	−2.70 (.97) **	−2.49 (1.00) *	−2.71 (.97) **
Race, *β*3	.59 (1.13)	.26 (1.24)	.55 (1.19)
Cohabitation, *β*4	1.70 (1.44)	1.65 (1.52)	1.78 (1.40)
Income-to-needs, *β*5	−.27 (.51)	−.03 (.50)	−.28 (.50)
Puberty status, *β*8	.28 (1.16)	.14 (1.17)	.28 (1.17)
Chronic conditions, *β*7	−.11 (1.13)	−.07 (1.12)	−.12 (1.13)

	Model 1	Model 2	Model 3
Sleep Period	**Estimate (SE)**	**Estimate (SE)**	**Estimate (SE)**
BMI, $\beta 8$	−.93 (.56)	−.92 (.53)	−.93 (.57)
Neigh. Economic Deprivation, $\gamma 01$	−1.79 (.66) **	---	−1.99 (.98) *
Neigh. Social Fragmentation, $\gamma 02$	---	−1.00 (.30) **	.36 (.99)

Note. Unstandardized parameter estimates and standard errors are reported. Sex is coded as 0 = female and 1 = male. Race is coded as 0 = European American, 1 = African American. Neighborhood economic deprivation and social fragmentation are coded as standardized continuous variables with *Mean* = 0 and *SD* = 1.

* $p < .05$

** $p < .01$

*** $p < .001$.