Sleep Health xxx (xxxx) xxx

Contents lists available at ScienceDirect

Sleep Health

Journal of the National Sleep Foundation

journal homepage: sleephealthjournal.org

Neighborhood deprivation predicts infant sleep quality

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ARTICLE INFO

Article history:
Received 26 April 2018
Received in revised form 26 October 2018
Accepted 2 November 2018
Available online xxxx

Keywords:
Neighborhood
Census data
Actigraphy
Sleep
Infancy

ABSTRACT

Objectives: The current study examined the relationship between neighborhood deprivation and infant sleep at 3 months of age.
Methods: Neighborhood and sleep data were collected from 80 African American infants and their caregivers. A composite neighborhood deprivation score was created using census data. Infant sleep was measured via 7 nights of actigraphy monitoring when infants were 3 months of age. Current analyses considered the average number of infant night wakings as an index of sleep quality. Multilevel models were used, in which children (level 1) were nested within census tracts (level 2).
Results: Controlling for level 1 covariates, greater neighborhood deprivation ($b = 0.07$, $P < .01$), was associated with poorer infant sleep, as characterized by a greater number of wakings during the nighttime sleep period.
Conclusions: Findings suggest that infants who reside in communities marked by higher deprivation experience poorer quality sleep, even after controlling for family-level factors.

Sleep is an important biopsychosocial process, as it predicts cognitive, emotional, and behavioral functioning across the life-span.[1] Prior research has examined the effect of proximal influences on the development of sleep, including bedtime routines, parental psychopathology, and cosleeping behaviors (eg, McKenna et al,[2] Philbrook and Teti,[3] and Teti and Crosby[4]). However, there is a need for work examining the broader contexts outside the home environment that might play a role, such as the characteristics of the community within which a child resides.[1] While researchers have begun to analyze the relations between community-level factors and sleep in older children and adolescents (eg, Bagley et al[5] and Pabayo et al[6]), there have been no studies that focus on these associations early in the life course. Given that infancy is a critical period for the development of healthy sleep patterns, and these patterns may predict later sleep problems,[7,8] it is important to examine the broader contextual factors that influence sleep during this period.

The first few months of life represent a period of rapid change for infant sleep (eg, Burnham et al[9]). Prior to 3 months of age, sleep is not yet consolidated, with infants sleeping in short bursts several times throughout the day.[10] However, at 3 months of age, total sleep duration decreases from roughly 16 to 14 hours, with the majority of this occurring during the nighttime period.[11] Notably, studies have found a decrease in number of nighttime wakings from birth through 3 months, and then a plateau for the remainder of the first year (eg, Burnham et al[9]). Since sleep becomes more stable from 3 months of age onward, it is crucial to understand the external factors, such as the neighborhood context, that influence sleep behaviors at this time period.

Studies that have expanded their analyses to broader contexts have found that poor neighborhood conditions are associated with negative sleep outcomes. In a study of school-aged children, higher neighborhood economic deprivation, defined using census data on income and public assistance variables, was related to fewer sleep minutes and poorer sleep efficiency.[5] Similarly, in a sample of Latino adults, greater self-reported neighborhood disorder, as characterized by more unclean areas and crime, was associated with poorer sleep quality and more sleep disturbances.[12] In addition, in the only study to date to examine these associations in an entirely African American adult sample, greater objective neighborhood disorder was related to poorer sleep efficiency and increased likelihood of short sleep duration.[13] Although the exact mechanisms through which the neighborhood impacts sleep are unclear, researchers have proposed links through environmental features such as noise levels and perceptions of safety.[5,6]

In infancy, children indirectly interact with their neighborhood context through their relationships with caregivers and their

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https://doi.org/10.1016/j.sleh.2018.11.001
2352-7218/

exposure to the home environment. Prior studies have found links between disadvantaged neighborhoods and both poor parenting and low-quality features of the home such as an unsafe play area.[14,15] Because sensitive parenting and a safe sleep environment are important for high-quality sleep in infants and children,[3,16] it is crucial to disentangle the links between the neighborhood context and sleep in the early life course. However, before more closely exploring these potential mechanisms, it is important to first establish whether, similar to adolescent and adults, there is an association between neighborhoods and infant sleep.

The current study aims to expand upon prior findings and explore the association between neighborhood deprivation and sleep in infancy, as measured by number of night wakings at 3 months of age.

Methods

The current study uses data from the Neonatal and Pediatric Sleep study, a prospective, longitudinal study of 103 African American infants and their caregivers. Women who resided within a 50-mile radius of a large public university in North Carolina and had an infant younger than 3 months were recruited via public birth records, social media, and flyers. The current study includes only the participants ($n = 80$) for which at least 3 nights of actigraphy data were available at 3 months of age.

Procedure

In-home data collection visits took place when infants were 3 months old. During the daytime portion of the home visit, infant-caregiver dyads took part in parent-child interaction tasks and caregivers completed questionnaires. Beginning on the night after the home visit, families completed a 1-week sleep assessment, including 7 days and nights of actigraphy monitoring. At the conclusion of each home visit, infants were given a small gift, and mothers received compensation of up to $130 in the form of a gift card. All procedures were approved by an institutional review board, and participants provided written consent before data collection.

Measures

Neighborhood deprivation

Census tracts were identified using participant addresses. Participants resided in a total of 67 different census tracts. The 2015 American Community Survey was used to collect data on 4 tract-specific measures: percent below poverty, percent receiving food stamps or Supplemental Nutrition Assistance Program, percent with less than a high school diploma, and percent of families with a female head-of-household and children younger than 18 years. These 4 indicators of deprivation were selected for their consistency with prior literature examining the association between neighborhood characteristics and health behaviors.[5,6,17] The American Community Survey is a nationally-representative, yearly survey conducted by the US Census Bureau.[18] The 2015 version was used here because it provides information regarding the conditions the majority (64%) of children were born into (birth range, October 14–March 2016). Census measures were highly correlated (r values = 0.70-0.88, $P < .001$) and showed high internal consistency ($\alpha = .94$). A composite neighborhood deprivation score was created by standardizing and summing these 4 measures.

Infant sleep

Infant sleep was measured via actigraphy throughout the nighttime period (7 PM–7 AM) for 7 nights. A lightweight actogram (Actiwatch-2) was placed on the infant's left ankle at the beginning of the home visit. Caregivers were told to keep the actogram on the infant for the entire study week, except during baths. Motion was measured in 15-second epochs, and data from the actogram were edited using Phillips Actiware software (version 6.0). The activity threshold for scoring the infant as awake was set to the Automatic setting (0.888 × average activity count), which is consistent with prior studies (eg, So et al[19]). A complete description of the actigraphy data collection has been published elsewhere.[20] Actigraphy data were averaged across the 7-night period. Within our sample, 62 participants (77.5%) had 7 nights, 13 participants (16.25%) had 6 nights, 3 participants (3.75%) had 5 nights, and 2 participants (2.5%) had 4 nights of actigraphy data. For our analyses, we examined the average number of night wakings (>5 minutes) at 3 months of age.

Controls

Child sex and family sociodemographic risk were treated as level 1 controls. A composite score for family sociodemographic risk was calculated from 5 dichotomized variables that denote increased risk (single parenthood, less than a high school diploma/general educational diploma, 3 or more children in household, income-to-needs ratio <1.3, age at first childbirth <19 years).[21] Detailed information on each individual risk factor is included in Table 1. The score indicates the proportion of risk factors relative to number of factors for which data are provided; for example, if data are provided for only 3 factors, but there is risk present in all 3 items, the score would be 1. Several other covariates were tested (ie, gestational age, breastfeeding) that were not significant and were therefore not included in final models.

Statistical analyses

To account for the nesting of children within neighborhoods, a multilevel modeling approach was used, where infants (level 1) were nested within census tracts (level 2).

Table 1
Descriptive statistics of individual risk factors

Neighborhood deprivation risk factor	Mean (SD)	Min	Max
Percent below poverty	18.7 (13.8)	2.4	49.8
Percent receiving food stamps/SNAP	15.5 (13.9)	0	59.8
Percent with less than HS diploma	14.4 (10.6)	0.4	38.8
Percent female HOH with children <18 y	12.5 (9.1)	0	36.1
Family socioeconomic risk factor	**n**		**%**
Marital status			
Risk, single	39		48.8
No risk, married	31		38.8
Missing	10		12.5
Education			
Risk, no degree	1		1.3
No risk, ≥HS diploma/GED	78		97.5
Missing	1		1.3
Children in household			
Risk, ≥3 children	10		12.5
No risk, ≤2 children	68		85.0
Missing	2		2.5
Income-to-needs ratio			
Risk, <1.30	15		18.8
No risk, ≥1.30	35		43.8
Missing	30		3.8
Age at 1st childbirth			
Risk, ≤19 y	8		10.0
No risk, ≥20 y	54		67.5
Missing	18		22.5

Abbreviations: HOH, head-of-household; HS, high school; GED, general educational diploma; SNAP, Supplemental Nutrition Assistance Program.

Please cite this article as: M. Grimes, M. Camerota and C.B. Propper, Neighborhood deprivation predicts infant sleep quality, Sleep Health: Journal of the National Sleep Foundation, https://doi.org/10.1016/j.sleh.2018.11.001

Results

Descriptive statistics

In the final sample of 80 infants, 43.8% were female. Neighborhood deprivation ranged from −4.85 to 9.44 (mean [SD], 0 [3.68]), with negative scores indicating less deprivation. Family sociodemographic risk ranged from 0 to 0.80 (mean [SD], 0.22 [0.20]). Proportion of individual risk factors is shown in Table 1. Throughout the study period, infants woke an average (SD) of 2.23 (0.85) times per night (range, 0.71-5.50). Neighborhood deprivation was correlated with family sociodemographic risk ($r = 0.21, P = .05$) and nighttime wakings ($r = 0.37, P < .01$). Family sociodemographic risk was not correlated with nighttime wakings ($r = 0.17, P = .14$).

Multilevel models

An initial random-effects analysis of variance model yielded an intraclass correlation coefficient of 0.38, which represents the amount of variance in night wakings that can be attributed to differences among neighborhoods. This high level of variance provided support for the use of a multilevel modeling approach, as it was necessary to account for the nesting of individual children within census tracts.

Controlling for level 1 covariates, neighborhood deprivation was significantly associated with greater wakings throughout the nighttime period ($b = 0.07$, SE = 0.02, $P < .01$; Fig. 1). Family sociodemographic risk ($b = 0.51$, SE = 0.46, $P = .29$) and child sex ($b = -0.18$, SE = 0.17, $P = .35$) were not associated with night wakings. Each of the individual census measures that comprised the neighborhood deprivation score was independently associated with greater wakings during the night (b values = 0.021-0.028, $P < .05$), controlling for level 1 covariates.

Discussion

This study assessed the association between neighborhood deprivation and sleep in infancy. We found that, after accounting for family-level sociodemographic characteristics, neighborhood factors significantly predict sleep behaviors at 3 months of age. The results of the current study are consistent with those from prior work examining the association between neighborhood deprivation and sleep in older populations.[5,12,13] Although some of the results are modest in effect size, the current study is the first to produce similar findings in a sample of infants, providing support for the notion that these associations are present very early on in the life course.

The current study adds to the growing body of literature focused on examining the influence of risk on early sleep. Although prior findings regarding the links between socioeconomic status and sleep in childhood are mixed (eg, Acebo et al[22] and Hawkins and Takeuchi[23]), this study advances our understanding of this association through objective measurement of the neighborhood via census information, while also taking into account individual family sociodemographic risk. Although we treated this sociodemographic risk score as a control variable, the lack of significant associations between this score and infant sleep indicates that it is likely something beyond demographic risk alone that matters. Whether it is noise level, fear of violence, or the way in which a deprived neighborhood affects parenting and overall stress in the home, it seems that this context exerts an influence on infant sleep above and beyond familial demographic risk. These findings advance our understanding of the influence of risk on sleep by underscoring the need to examine contexts larger than demographic risk when considering the many ways in which risk can impact sleep in infancy.

A major strength of this study is its use of objective measurement, including census data and actigraphy, which has been lauded as a more accurate tool for measuring infant night wakings than traditionally relied-upon methods of parent report.[24] In addition, the consideration of risk at multiple levels is a strength of this study. By controlling for individual-level risk factors, we demonstrate the independent contributions that neighborhood and individual contexts make to infant sleep. Furthermore, this study is strengthened by its use of an African American sample. Because prior research has provided evidence of race-related sleep disparities throughout the life course (eg, Petrov and Lichstein[25]), it is crucial to understand the early manifestations of these disparities. To our knowledge, this study provides the first descriptive evidence of sleep quality in 3-month-old African American infants in a naturalistic setting.

It is important to consider these findings in terms of the study's limitations. Although census data provide objective information on an individual's neighborhood, it does not tell us how the individual perceives his or her environment. Individual perceptions might drive the associations between the neighborhood context and sleep, such that a mother perceiving a neighborhood as more

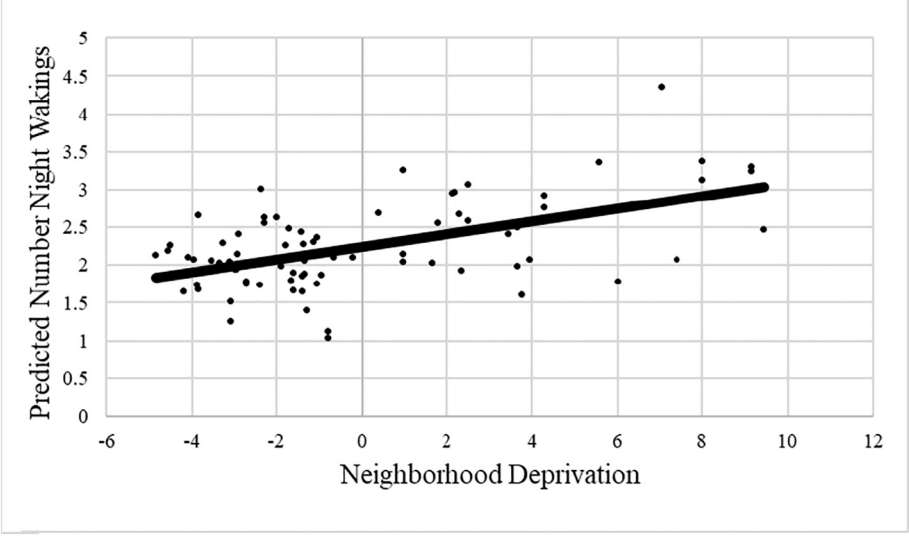

Fig. 1. Predicted values of infant night wakings based on neighborhood deprivation score.

Please cite this article as: M. Grimes, M. Camerota and C.B. Propper, Neighborhood deprivation predicts infant sleep quality, Sleep Health: Journal of the National Sleep Foundation, https://doi.org/10.1016/j.sleh.2018.11.001

disadvantaged could influence her behaviors in ways that hinder sleep for her child. Furthermore, although the participants of this study resided in a number of census tracts, they were all residents of the same larger region. Thus, it may be difficult to generalize these findings to the entire population. In addition, we were unable to test for mechanistic pathways that may link neighborhood deprivation to infant sleep, including, but not limited to, caregiving behaviors and parental stress.

This study is among the first to examine the role of neighborhoods in the development of infant sleep. Although others have examined these important influences on sleep and health more broadly, the focal populations of such studies have been older children and adults. Future research should aim to explain how the neighborhood environment trickles down to impact infant sleep. Examining the more proximal mechanisms by which the environment might impact infant sleep, such as parent-child relations and the physical sleep environment, could help bring these processes to light.

Disclosure

The authors have nothing to disclose.

Acknowledgments

Support for this project was provided by the Eunice Kennedy Shriver National Institute of Child Health and Human Development (Grant No. 1R21HD077146).

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