Does sleep quality mediate the association between neighborhood disorder and self-rated physical health?

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ABSTRACT **(word count = 176)**

Objectives: We examine whether the association between perceived neighborhood disorder and self-rated physical health is mediated by sleep quality.

Methods: We use data from the 2004 Survey of Texas Adults (n = 1,323) to estimate a series of nested multivariate models.

Results: We find that both neighborhood disorder and poor sleep quality are associated with poorer self-rated health, even with controls for irregular exercise, poor diet quality, smoking, binge drinking, obesity and a host of relevant sociodemographic factors. Using our series of nested models, we observe that the inverse association between neighborhood disorder and self-rated physical health is partially mediated by sleep quality.

Conclusions: Poorer sleep among residents of high disorder neighborhoods may contribute to the cause of the poorer self-rated physical health in these neighborhoods. Targeted interventions to address poor sleep quality among residents of neighborhoods with high levels of disorder should be explored. In addition, efforts to reduce neighborhood disorder may lead to improved sleep and better self-rated health outcomes. Future research on the causal relationships between neighborhood disorder and sleep quality is needed.

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Residents of neighborhoods characterized by low socioeconomic opportunity, social disorganization, and physical disorder (e.g., litter and vandalism) tend to exhibit poorer physical health than residents of more advantaged neighborhoods. This general pattern is observed across a range of outcomes, including chronic conditions (e.g., heart disease), physical functioning (e.g., activities of daily living), and overall self-rated physical health [1-14]. While these studies have contributed to our understanding of the physical health consequences of neighborhood disadvantage, additional research is needed to explain these patterns. Various structural (e.g., socioeconomic status), social (e.g., victimization), psychological (e.g., depression), behavioral (e.g., substance use), and physiological (e.g., allostatic load) mediators have been proposed, but few have been formally tested [4, 9, 11, 15, 16]. Building on previous research, we test whether the association between perceived neighborhood disorder and self-rated health is at least partially mediated or explained by sleep quality.

Previous research demonstrates that residence in socioeconomically disadvantaged neighborhoods and urban residential environments is associated with increased risks of adverse sleep quality and shortened sleep duration [17-21]. Spilsbury et al. [18] find that school-aged children living in neighborhoods characterized by high socioeconomic disadvantage have increased odds of obstructive sleep apnea by 244%, even after adjustment for previously established risk factors. Data on adults in the 1990 National Health Interview Survey (NHIS) show that residents of large metropolitan areas have increased odds of inadequate sleep duration (six or fewer hours) by 43% [17]. Nationally representative data from the National Health and Nutrition Examination Study (NHANES) III show that lower neighborhood socioeconomic status is associated with an increase in self-reporting insomnia symptoms [20]. Similarly, in an analysis of middle-aged and older adults, Steptoe et al. [19] observe that fear of neighborhood crime in the neighborhood is positively associated with insomnia symptoms (e.g., trouble falling asleep and difficulty staying asleep). Finally, in the Survey of Texas Adults, the sample we use for this analysis, Hill et al. [21] found that perceptions of neighborhood disorder are associated with reduced sleep quality.

Studies also show that poor sleep, as indicated by self-reported sleep quality, short sleep duration, or presence of a sleep disorder, is associated with a wide range of health risks. Highly prevalent conditions such as sleep-disordered breathing (SDB) and chronic insomnia pose a large public health risk [22]. For example, SDB is associated with increased risk of hypertension, cardiovascular disease, stroke, depression, metabolic dysregulation, cognitive decrements, and poor daytime functioning [23, 24]. Chronic insomnia has an adverse impact on self-reported health, quality of life, productivity, and amplifies co-morbid conditions, while increasing health care expenses [25-28]. Experimental research shows that chronic partial sleep deprivation (less than 6 hours per night) is linked to metabolic dysregulation [29] and diminished alertness and vigilance [30]. Observational studies into short sleep show a link with excess body weight [31] and cardiovascular morbidity [32] and mortality [33].

If living in a disadvantaged neighborhood can disrupt sleep, and poor sleep can undermine physical health, the association between perceived neighborhood disorder and self-rated physical health could be at least partially mediated or explained by sleep quality. This analysis is intended to complement existing research by expanding upon understudied connections among neighborhood context, sleep quality, and physical health.

MATERIALS AND METHODS

Data

Subsequent analyses employ data from the 2004 Survey of Texas Adults, a statewide probability sample of 1,504 community-dwelling adults (18 and over) residing in Texas [34]. Sampling was conducted using a modified random digit dialing design. The data collection process yielded a household-level cooperation rate of 37% and a respondent-level cooperation rate of 89%. Each computer-assisted telephone interview lasted approximately 30-35 minutes. The survey instrument was translated into Spanish and administered by Spanish-speaking interviewers for respondents who were more comfortable answering in that language. Because the original sample overrepresented women, older adults, non-Hispanic Whites, and respondents with higher levels of education, all subsequent analyses are weighted on these characteristics to match the sample to the Texas population. The use of listwise deletion in multivariate analyses reduced the analytic sample from 1,504 to 1,323.

Measures

Self-rated physical health is the focal outcome variable. It is a widely used measure of general physical health status that is strongly correlated with more objective indicators, including physician diagnoses and mortality [35-38]. Self-rated health is a robust predictor of mortality, over and above numerous specific medical, behavioral, and psychosocial risk factors and other relevant covariates [36]. Respondents were asked: "How would you rate your physical health at the present time? Would you say it is excellent, very good, good, fair, or poor?" Response categories ranged from (1) poor to (5) excellent.

Neighborhood disorder is the focal predictor variable. Disorder is measured as the mean response to three items drawn from the work of Ross and Mirowsky [39] to assess perceptions of problems in the neighborhood, including social disorganization and disorder, ambient hazards, and structural disrepair ($\alpha = 0.58$). Respondents were asked to indicate the extent to which they agreed or disagreed with the following statements: "There is a lot of crime in my neighborhood." "My neighborhood is noisy." "My neighborhood is clean." Response categories ranged from (1) strongly agree to (5) strongly disagree, with reverse codes for "crime" and "noise." Items such as these have been used in prior research to predict depression, non-specific psychological distress, self-rated health, physical activity, obesity, and smoking behavior [15, 21, 40-42]. These particular items have demonstrated sound psychometric properties in previous research [40].

Sleep quality is the focal mediator of the association between neighborhood disorder and self-rated physical health. Sleep quality is measured with the following question: "How would you rate your sleep quality overall for the past 30 days?" Response categories ranged from (1) poor to (5) excellent. This global measure captures the subjective experience of sleep, including sleep disruptions and difficulties falling asleep, staying asleep, and waking up feeling unrefreshed. This measure may also serve as an indirect assessment of common sleep disorders, including insomnia (difficulty falling asleep and/or staying asleep), hypersomnia (excessive sleep), parasomnia (sleepwalking and nightmares), narcolepsy (excessive daytime sleepiness and sleep attacks), and sleep apnea (obstructed breathing during sleep). This item has demonstrated construct validity in prior research. Using data from the Detroit Area Study, Moore and colleagues report a moderate positive correlation ($r = .43$) between overall self-rated sleep quality and average nightly sleep duration [43]. They also show that quality sleep is more commonly reported by respondents who are more highly educated, have greater family incomes, exhibit fewer symptoms of non-specific psychological distress, and are in better physical health.

In a recent analysis of data from the Survey of Texas Adults, Hill and colleagues [44] find quality sleep is more commonly reported by respondents who are older, married, with fewer children, more highly educated, employed, experiencing little financial hardship, and in good physical health.

Several indicators of lifestyle have been identified as significant risk factors for poor sleep and physical health. These indicators include irregular exercise, poor diet quality, smoking, binge drinking, and obesity [17, 45-53]. We assess *irregular exercise* with three questions concerning the frequency of walking, moderate exercise, and strenuous exercise. According to Center for Disease Control and Prevention (CDC) guidelines, regular exercise entails (a) walking or (b) engaging in moderate exercise (e.g., playing golf, dancing, and gardening) on five or more days per week or (c) engaging in strenuous exercise (e.g., running, swimming, and lifting weights) on three or more days per week. Respondents who did not fall into any of these three categories were coded (1) as irregular exercisers and (0) otherwise.

Diet quality is measured with the following question: "Overall, how would you rate the quality of your diet?" Response categories ranged from (1) excellent to (5) poor. To indicate suboptimal diet quality this item has been recoded (1) for fair or poor and (0) otherwise. This global measure of diet quality is intended to assess patterns of excessive caloric intake and unhealthy food choices. This item has demonstrated predictive validity in prior research. For example, Burdette and Hill find that poor self-rated diet quality increases the risk of obesity by approximately 77% [40].

We measure *smoking* and *binge drinking* with two items. Smoking is measured with the following question: "Are you a current smoker, a former smoker or have you never smoked?" This item is coded (1) for current smoker and (0) otherwise. We measure drinking with the following question: "On those days that you drank alcohol, about how many drinks did you usually have?" In order to capture the binge drinking practices of women and men, this item is coded (1) for five or more drinks per drinking occasion and (0) otherwise.

Obesity is measured using self-reports of height and weight. We first calculated body mass by dividing weight in pounds (lbs) by height in inches (in) squared and multiplying by a conversion factor of 703 (Formula = weight (lb) / [height (in)]^2 x 703). Following CDC guidelines, we coded respondents with a body mass score equal to or greater than 30 as (1) obese and (0) otherwise.

Subsequent multivariate analyses control for several potentially relevant background factors. These factors include: (a) *Age* (measured in continuous years); (b) *Gender* (1 = male, 0 = female); (c) *Race/ Ethnicity* (four dummy variables for African American, Mexican/Mexican American, other Hispanic, and other minority, with non-Hispanic white serving as the reference category); (d) *Citizenship Status* (1 = non-citizen, 0 = U.S. citizen); (e) *Interview Language* (1 = Spanish language interview, 0 = English language interview); (f) *Education* (0 = less than a high school degree to 4 = graduate degree); (g) *Employment* (1= currently employed, 0= other work status); (h) *Family Income* (1 = $0 - $14,900 to 6 = $85,000 or more); (i) *Financial Strain* (0 = no difficulty paying monthly bills to 4 = extreme difficulty); (j) *Marital Status* (1 = married, 0 = otherwise); and (j) *Number of Children* (0 to 4 or more). Missing values on family income were replaced with the mode of the original income measure ($35,000-$49,000); as a precaution, our models control for whether or not the respondent was missing on income (1 = missing income, 0 = otherwise).

Statistical Procedures

Table 1 provides weighted descriptive statistics for selected variables. Table 2 presents our main regression results. Our mediation analysis proceeds in three steps. We establish a baseline in Model 1 by regressing self-rated physical health on neighborhood disorder and all background factors. Because previous research has linked neighborhood disorder with irregular exercise, poor diet quality, smoking, binge drinking, and obesity, we adjust for these particular health and lifestyle factors in Model 2. Finally, Model 3 controls for sleep quality. To formally assess whether sleep quality mediates the association between neighborhood disorder and self-rated physical health, we employ the Clogg statistic [54] to test for significant changes in the effects of disorder across nested models (i.e., before and after adjusting for sleep quality). A statistically significant reduction in the magnitude of the coefficient for neighborhood disorder—from Model 2 to Model 3—would suggest mediation.

RESULTS

Descriptive Statistics

According to Table 1, the average respondent reports fairly low levels of neighborhood disorder (mean=2.3) and "good" physical health (mean=3.4) and sleep quality (mean=2.8). With respect to lifestyle factors, we observe moderate to low rates of irregular exercise (40%), fair or

poor diet quality (37%), smoking (24%), binge drinking (10%), and obesity (23%). The average respondent is approximately 41.5 years of age. The sample consists of non-Hispanic Whites (47%), Blacks (11%), Mexicans (29%), and other races/ethnicities (13%). The majority of respondents are men (51%) and U.S. citizens (85%). Most respondents were interviewed in English (83%). The typical respondent is currently married (53%) and reports approximately one child per household. In terms of socioeconomic status, the average respondent has at least a high school diploma or GED, is currently employed (56%), reports a family income between $35,000 and $49,000, and has little to no difficulty paying bills.

<TABLE 1 ABOUT HERE>

Mediation Analysis

Model 1 of Table 2 shows that neighborhood disorder is inversely associated with self-rated physical health. In other words, those respondents who live in neighborhoods they characterize as being unclean, unsafe, and noisy report poorer physical health than those who live in areas that are perceived as clean, quiet, and safe, even after adjustment for individual-level background characteristics. This general pattern is consistent across Models 2 and 3, with additional controls for lifestyle factors in Model 2 and for sleep quality in Model 3. An examination of standardized regression coefficients suggests that neighborhood disorder is a modest predictor of self-rated physical health. In Model 3, the magnitude of the standardized regression coefficient for neighborhood disorder ($\beta = .06$) is comparable to other statistically significant predictors of self-rated physical health like current smoker ($\beta = .07$) and financial strain ($\beta = .08$), but noticeably smaller than sleep quality ($\beta = .23$), obesity ($\beta = .15$), and age ($\beta = .21$).

<TABLE 2 ABOUT HERE>

Model 2 adds lifestyle factors to Model 1. These adjustments explain approximately 18% ([.11 – .09] / .11) of the association between neighborhood disorder and self-rated physical health; however, the coefficient for disorder remains statistically significant across all three models. In Model 3, sleep quality accounts for an additional 11% ([.09 – .08] / .09) of the association between neighborhood disorder and self-rated physical health, which is a statistically significant reduction ($t = 2.50$, $P < .05$). However, the coefficient for neighborhood disorder remains statistically significant in the Model 3. Taken together, these results suggest that sleep is

a partial mediator of the association between neighborhood disorder and self-rated physical health.

Results from the full multivariate model show that other statistically significant (all at P <.01) potentially modifiable factors associated with poorer self-reported health outcomes include irregular exercise, smoking, poor diet, obesity, financial strain and unemployment.

DISCUSSION

Although studies show that neighborhood disadvantage is associated with a range of poor physical health outcomes, explanations for these patterns are largely based on speculation. Building on previous research, we used data collected from a statewide probability sample of Texas adults to formally test whether the association between neighborhood disorder and self-rated physical health is mediated by sleep quality.

We find that residence in a neighborhood that is perceived as noisy, unclean, and crime-ridden is associated with a modest but statistically significant reduction in self-rated physical health. Our results also indicate that the relationship between neighborhood disorder and self-rated physical health is partially mediated by poor sleep quality. The Clogg statistic shows this to be a statistically significant reduction ($t = 2.50$, $P < .05$).

The association between neighborhood disorder and poor sleep quality is consistent with previous studies of disadvantaged neighborhood conditions and adverse sleep outcomes [17-19], and the association between neighborhood disorder and self-rated health also confirms prior research [40, 41, 55, 56]. However, to the best of our knowledge, we are the first to empirically show that the association between neighborhood disorder and self-reported health is mediated by sleep quality. Although we emphasize the mediating influence of sleep quality, additional research is needed to explore other potential mechanisms linking neighborhood context and physical health.

The cross-sectional nature of the data makes it difficult to establish the causal order of the observed associations. For example, does poor quality sleep cause poor self-rated health, or is it the other way around? There is also concern about selection bias in disadvantaged neighborhoods. Do healthier people (and often those with more opportunities) select out of living in disadvantaged neighborhoods? Current and future research efforts seek to investigate these causality issues more carefully. We further advise that future research confirm these

patterns by looking at various subgroups (e.g., gender, race, and age) and more specific measures of physical health.

Another limitation is our measurement of sleep quality. While self-rated sleep quality has demonstrated construct validity [43, 44] and is one of the stronger correlates of self-rated health in our models, this single-item measure could be more nuanced or more objective. Rather than relying solely on a global indicator of sleep quality, future research should follow previous studies [18, 57] and measure specific sleep outcomes, including objectively measured sleep duration and sleep disorders (e.g., insomnia and sleep apnea).

Although our results show that sleep quality is an important link between neighborhood disorder and self-rated physical health, we cannot simply endorse strategies to improve sleep in disadvantaged neighborhoods (e.g., community-based health promotion efforts and public policy affecting noise and school start times). Neighborhood context is a fundamental cause of poor sleep and poor physical health. This implies that only polices designed to improve neighborhoods will have a lasting positive impact on the health of residents.

TABLE 1: Weighted Descriptive Statistics, 2004 Survey of Texas Adults (n = 1,323)

	Range	M	SD	α
Focal Measures				
Neighborhood disorder	1 – 5	2.28	.82	.58
Sleep quality	1 – 5	2.82	1.19	
Physical health	1 – 5	3.42	1.11	
Lifestyle Factors				
Irregular exercise	0 – 1	.40		
Diet quality (fair or poor)	0 – 1	.37		
Current smoker	0 – 1	.24		
Binge drinker (5 or more drinks)	0 – 1	.10		
Obese	0 – 1	.23		
Background Factors				
Age	18 – 94	41.54	17.25	
Male	0 – 1	.51		
Non-Hispanic White	0 – 1	.47		
Black	0 – 1	.11		
Mexican	0 – 1	.29		
Other race or ethnicity	0 – 1	.13		
Non-citizen	0 – 1	.15		
Spanish interview	0 – 1	.17		
Education	0 – 4	1.26	1.17	
Employed	0 – 1	.56		
Family income	1 – 6	3.03	1.51	

Income missing	0 – 1	.17	
Financial strain	0 – 4	1.20	1.18
Married	0 – 1	.53	
Number of children	0 – 4	1.03	1.22

TABLE 2: Weighted Ordinary Least Squares Regression of Self-Rated Physical Health, 2004 Survey of Texas Adults (n = 1,323)

	Model 1				Model 2				Model 3			
	b	SE	β		b	SE	β		b	SE	β	
Focal Measures												
Neighborhood disorder	-.11	.04	-.08	**	-.09	.04	-.07	*	-.08	.03	-.06	*
Sleep quality									.21	.02	.23	***
Lifestyle Factors												
Irregular exercise					-.24	.06	-.11	***	-.24	.06	-.11	***
Diet quality (fair or poor)					-.39	.06	-.17	***	-.25	.06	-.11	***
Current smoker					-.21	.07	-.08	**	-.19	.07	-.07	**
Binge drinker (5 or more drinks)					.18	.09	.05		.16	.09	.04	
Obese					-.41	.07	-.15	***	-.39	.06	-.15	***
Background Factors												
Age	-.01	.00	-.22	***	-.01	.00	-.19	***	-.01	.00	-.21	***
Male	-.02	.06	-.01		-.04	.06	-.02		-.07	.06	-.03	
Black	-.02	.10	-.00		-.06	.10	-.02		-.03	.09	-.01	
Mexican	-.32	.08	-.13	***	-.29	.08	-.12	***	-.28	.08	-.12	***
Other race or ethnicity	-.34	.09	-.10	***	-.29	.09	-.09	**	-.23	.09	-.07	*
Non-citizen	.06	.11	.02		.04	.10	.01		.03	.10	.01	
Spanish interview	.12	.11	.04		.07	.11	.02		.06	.10	.02	
Education	.09	.03	.09	**	.06	.03	.06	*	.05	.03	.05	
Employed	.30	.06	.13	***	.31	.06	.14	***	.28	.06	.13	***
Family income	.05	.02	.07	*	.03	.02	.04		.03	.02	.04	
Income missing	-.10	.08	-.03		-.16	.07	-.05	*	-.18	.07	-.06	*

Financial strain	-.13	.03	-.14	***	-.10	.03	-.10	***	-.07	.03	-.08	**
Married	-.00	.06	-.00		-.00	.06	-.00		-.03	.06	-.01	
Number of children	.00	.03	.01		.03	.03	.03		.04	.02	.05	
Model Statistics												
Model F			16.27	***			20.84	***			24.77	***
Nested F							29.28	***			78.51	***
R-squared			.16				.24				.29	

Shown are unstandardized OLS regression coefficients (b), standard errors (SE), and standardized coefficients (β). The regression coefficients represent the change in units (1-5) in self-rated health status with each unit change in the explanatory variable.
*P < .05, **P < .01, ***P < .001

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