Published in final edited form as:
Soc Sci Med. 2013 February ; 79: 16–22. doi:10.1016/j.socscimed.2012.07.021.

Perceived neighborhood quality, sleep quality, and health status: Evidence from the Survey of the Health of Wisconsin

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Abstract

Why does living in a disadvantaged neighborhood predict poorer mental and physical health? Recent research focusing on the Southwestern United States suggests that disadvantaged neighborhoods favor poor health, in part, because they undermine sleep quality. Building on previous research, we test whether this process extends to the Midwestern United States. Specifically, we use cross-sectional data from the Survey of the Health of Wisconsin (SHOW), a statewide probability sample of Wisconsin adults, to examine whether associations among perceived neighborhood quality (e.g., perceptions of crime, litter, and pleasantness in the neighborhood) and health status (overall self-rated health and depression) are mediated by overall sleep quality (measured as self-rated sleep quality and physician diagnosis of sleep apnea). We find that perceptions of low neighborhood quality are associated with poorer self-rated sleep quality, poorer self-rated health, and more depressive symptoms. We also observe that poorer self-rated sleep quality is associated with poorer self-rated health and more depressive symptoms. Our mediation analyses indicate that self-rated sleep quality partially mediates the link between perceived neighborhood quality and health status. Specifically, self-rated sleep quality explains approximately 20% of the association between neighborhood quality and self-rated health and nearly 19% of the association between neighborhood quality and depression. Taken together, these results confirm previous research and extend the generalizability of the indirect effect of perceived neighborhood context on health status through sleep quality.

Keywords

Sleep; Sleep quality; Neighborhood context; Neighborhood quality; Self-rated health; Depression; Wisconsin; USA

Introduction

Studies consistently show that residence in neighborhoods characterized by socioeconomic disadvantage and social disorganization is associated with poorer mental and physical health (Aneshensel & Sucoff, 1996; Burdette & Hill, 2008; Hale, Hill et al., 2010; Hill, Burdette et

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al., 2009; Hill & Maimon, 2013; Hill, Ross et al., 2005; Robert, 1999; Ross & Mirowsky, 2001, 2008). Although previous research has made significant contributions to our understanding of the health consequences of neighborhood disadvantage and neighborhood disorder (e.g., resident perceptions of structural dilapidation, pollution, noise, crime, public intoxication, and other incivilities), we have only begun to explore underlying mechanisms explaining these patterns. Why does living in a disadvantaged neighborhood predict poorer mental and physical health? Various structural (e.g., socioeconomic status), social (e.g., neighborhood social ties), psychological (e.g., the sense of control), behavioral (e.g., substance use), and physiological (e.g., allostatic load) mechanisms have been proposed to answer this question (Cutrona, Wallace et al., 2006; Diez Roux, 2003; Hill & Maimon, 2013; Hill, Ross et al., 2005; Mirowsky & Ross, 2003; Robert, 1999; Ross & Jang, 2000; Ross & Mirowsky, 2001, 2009), but only a few of these links have been formally tested, and to this point, none are firmly established. In this article, we consider whether associations among perceived neighborhood quality and health status are mediated by overall sleep quality.

How might neighborhood context affect sleep?

Recent research suggests that socioeconomically disadvantaged neighborhoods are associated with poorer physical and mental health in part because they undermine sleep quality (Hale, Hill et al., 2010; Hill, Burdette et al., 2009). Data indicate that residence in disadvantaged and urban neighborhood environments is associated with lower sleep quality and shortened sleep duration (Hale & Do, 2007; Hale, Do et al., 2009; Hale, Hill et al., 2010; Hill, Burdette et al., 2009; Steptoe, O'Donnell et al., 2008). In addition, research in a pediatric population shows that severe neighborhood socioeconomic disadvantage is associated with increased risk of pediatric obstructive sleep apnea (OSA), even after adjustment for known risk factors of OSA, such as obesity, African-American ethnicity, and premature birth (Spilsbury, Storfer-Isser et al., 2006). Other research indicates that air pollution, which tends to be worse in low-income neighborhoods, could play a role in increasing sleep apnea (Zanobetti, Redline et al., 2010).

We offer three general pathways through which neighborhood context may be associated with sleep: ambient hazards and physical exposures, psycho-physiological pathways, and health behavior.

First, there is the direct effect of physical and environmental stress of neighborhood elements on an individual's ability to sleep. For example, living in a neighborhood that is characterized by high levels of noise (e.g., from neighbors or highly trafficked streets) or high levels of artificial light (e.g., from street lamps) may directly undermine the initiation or maintenance of sleep (Chepesiuk, 2009; Fyhri & Aasvang, 2010; Muzet, 2007; Pirrera, De Valck et al., 2010). In addition, substandard housing with inadequate heating or air conditioning could impair sleep quality (Valham, Sahlin et al., 2012; Zanobetti, Redline et al., 2010). For example, one study found that among sleep apnea patients, the apnea–hypopnea index is higher at cooler temperatures (16 °C compared to 24 °C), even though sleep quality and efficiency is better in cooler temperatures (Valham, Sahlin et al., 2012). Finally, particulate matter due to pollution could alter optimum lung function, affect breathing and sleep quality, especially sleep apnea (Zanobetti, Redline et al., 2010).

Secondly, psychological and physiological pathways are a possible mechanism through which neighborhood context may affect sleep. Individuals that live in disadvantaged neighborhoods may have a heightened need for vigilance, which has been deemed an opponent process of sleep (Dahl, 1996). This need for vigilance may be due to fear of crime or mistrust of neighbors, or it may be caused by greater uncertainty over financial and

personal futures. Physiologically, such concerns may lead to chronic activation of the physiological stress response and overexposure to stress hormones (Bird, Seeman et al., 2010; Hill, Ross et al., 2005; McEwen, 1998). For example, a highly disadvantaged living environment could elicit short-term feelings of annoyance, fear, and hopelessness (Hale & Do, 2007; Muzet, 2007; Spilsbury, Storfer-Isser et al., 2006). These feelings could activate the stress response and trigger the release of stress hormones (e.g., epinephrine and cortisol) that promote mental and physiological arousal and impair sleep (Espie, 2002; Karren, Hafen et al., 2006; McEwen, 2006; Sapolsky, 2004; Selye, 1978; Steiger, 2002; Van Reeth, Weibel et al., 2000). In addition, neighborhood and social environment may alter cellular functioning through epigenetic modifications to the DNA that may affect gene expression (Meaney, 2010), although specific connections to sleep are not known.

Finally, there are health behavioral mechanisms through which neighborhood context may be associated with impaired sleep. That is, disadvantaged neighborhoods may be less conducive to health behaviors that are associated with both lower body mass index and better sleep. For example, more disadvantaged neighborhoods may not be amenable to physical activity (e.g., due to concerns about safety and lack of pleasant places to walk) or healthy eating practices (e.g., due to limited availability and consumption of fresh fruits and vegetables (Dubowitz, Heron et al., 2008)). Similarly, alcohol consumption may be higher in more disadvantaged neighborhoods (e.g., due to availability of liquor shops) and this could lead to impaired sleep (Hill & Angel, 2005). Studies are beginning to better understand that healthy eating and physical activity are also modified by individual perceptions and cultural influences (Blacksher & Lovasi, 2012).

If living in a disadvantaged neighborhood environment can disrupt or impair sleep, and poor sleep can undermine mental and physical health, the association between perceived neighborhood quality and health status could be partially mediated or explained by sleep quality. Building on previous studies of the Southwestern United States (Hale, Hill et al., 2010; Hill, Burdette et al., 2009), we attempt to replicate these findings using data collected from a Midwestern sample of Wisconsin adults.

How might sleep quality affect health?

In this paper, we test the hypothesis that sleep quality is a mediating pathway that helps to explain the association between perceived neighborhood quality and health. In order to establish the existence of this indirect process, we must demonstrate that poor sleep is associated with poorer health. Substantial prior research indicates 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, including increased body weight, cardiovascular morbidity, and overall mortality (Ayas, White et al., 2003; Benca, 2005; Ferrie, Shipley et al., 2007; Kapur, Redline et al., 2002; Katz & McHorney, 2002; Knutson, 2010; Knutson & Van Cauter, 2008; Kripke, Garfinkel et al., 2002; Patel & Hu, 2008; Roth, Hajak et al., 2001; Spiegel, Leproult et al., 2004; Tamakoshi & Ohno, 2004; Young, Finn et al., 2008; Young, Peppard et al., 2002; Young, Skatrud et al., 2004). In addition, numerous studies indicate that poor sleep quality is associated with poorer mental health, including higher rates of depression, anxiety, and non-specific psychological distress (Breslau, Roth et al., 1996; Ford & Kamerow, 1989; Hamilton, Nelson et al., 2007; Lustberg & Reynolds, 2000; McEwen, 2006; Meerlo, Sgoifo et al., 2008; Moore, Adler et al., 2002; Roberts, Shema et al., 2000; Taylor, 2003).

Methods

Sample

The Survey of the Health of Wisconsin (SHOW) protocol and informed consent documents are approved by the UW–Madison Health Sciences Institutional Review Board. In addition, the data are collected under a Certificate of Confidentiality obtained from the US Department of Health and Human Services. SHOW sampling and data collection protocols have been described in detail previously (Nieto, Peppard et al., 2010). The SHOW sampling frame is Wisconsin non-institutionalized/non-active duty adult residents, aged 21–74 years at the time of initial selection. Every year, beginning in 2008, a two-stage cluster sampling approach is used. First, a stratified random sample of census block groups is selected; stratification is by congressional district and percent of households below 100% of the poverty level. Second, a random sample of household addresses is selected from identified census block groups. Recruitment of SHOW participants begins with in-person contact by study staff at selected households. Inclusion criteria for participation in the survey are: 1) selected households are participants' usual place of residence (full-time residence greater than six months per year); 2) participants are age 21–74 years; and 3) participants are mentally capable of giving written informed consent and communicating answers to interview questions. Exclusion criteria include: 1) residents of nursing homes, Indian reservations (except for the Menominee Tribal territory), hospitals, penal institutions, or other institutional settings; 2) full-time members of the armed forces or activated units of the National Guard; and 3) residents who voluntarily disclose a diagnosis of mental incapacity with no representative available to be a proxy respondent. While absolute participation rates are hard to compute since the number of eligible participants in non-respondent households is unknown, response rates among eligible participants who agreed to be screened was 46% in 2008–2009 and 56% in 2010.

Data collection

Data collection protocols are multimodal including in-home interviews, a self-administered questionnaire, and an in-clinic exam (at a mobile or fixed-site exam center). The in-clinic exam includes a brief physical exam and additional audio computer-assisted interview data. For the following analyses, we rely on exposure and outcome data from the self-administered questionnaire for the data collected between 2008 and 2010.

Outcome variable #1: self-rated health

Our outcome variable is self-rated health, which is a commonly used measure of general physical health that has been shown to consistently be an independent predictor of mortality risk across a wide range of studies (Idler & Benyamini, 1997). 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) excellent to (5) poor. We dichotomize the variable to fair–poor health (=1) versus excellent–very good–good health (=0) for use with logistic regression analyses. We explored the possibility of treating the variable as five ordered categories, but the data failed to meet assumptions of proportionality required for an ordered logistic regression.

Outcome variable #2: depression

Depression symptomatology, our second outcome variable, is assessed with the Depression Anxiety Stress Scale (DASS) depression module (Lovibund & Lovibund, 1993) and has been validated for use in adult samples (Brown, Chorpita et al.,1997). Higher scores on the DASS indicate greater depressive symptoms. For ease of interpretation, we use the

standardized *z*-score as our dependent variable, which in this sample has a mean of −0.23 and standard deviation of 0.96.

Sleep measure

Self-rated sleep quality is measured through the self-rating of usual sleep quality in the past month with the question, “Over the past month, how would you rate your sleep quality overall?” This item has been used in our previous work and has demonstrated good construct validity through associations with both mental and physical health (Hale, Hill et al., 2010; Hill, Burdette et al., 2009). This five-point response to this question – excellent, very good, good, fair, and poor – is then dichotomized into individuals who report fairepoor sleep, versus all else. Approximately 26 percent of the sample is categorized into the fair–poor category. We chose the fair–poor cutoff point because this is a qualitatively different group of sleepers than those who are reporting good, very good, or excellent sleep. Others have clustered the fair and poor categories together in a similar manner (Foley, Ancoli-Israel et al., 2004; Qiu, Sautter et al., 2011).

Perceptions of neighborhood quality

We create a mean index of perceived neighborhood quality similar to Ross and Mirowsky’s scale of perceived neighborhood disorder (Ross & Mirowsky, 1999). The Ross and Mirowsky scale is composed of three items addressing perceptions of neighborhood safety, noise, and graffiti, using a self-administered questionnaire with Likert-style questions. Our variation on the perceived neighborhood quality measure also includes questions about pleasantness for physical activity and interestingness. Specifically, the items address perceptions of pleasantness for physical activity, safety from crime, safety from traffic, “interestingness,” community maintenance, and lack of litter. Each of these variables is coded on a scale of 1–4, with lower values representing lower perceived neighborhood quality (e.g., for the safety from crime and safety from traffic questions, the answers are (1) not at all safe, (2) not very safe, (3) somewhat safe and (4) very safe; for the pleasantness for physical activity question, the answers are (1) not at all pleasant, (2) not very pleasant, (3) somewhat pleasant, (4) very pleasant). The median response for all of these items is 3.33, with an interquartile range between 3 and 3.5. We then create a dichotomous variable for perceived neighborhood environment with scores below 3 indicating low neighborhood quality. This categorization scheme, while broad, does have construct validity, with 18% of residents of low quality neighborhoods reporting fair or poor health compared to only 9% of other neighborhoods. Similarly, residents of perceived low quality neighborhoods have above average depression (mean standardized DASS score = 0.03) and residents of other neighborhoods are nearly a third of a standard deviation below the mean (mean standardized DASS score = −0.29).

Additional covariates

Based on prior research, subsequent analyses adjust for additional demographic and health covariates known to be associated with neighborhood context and sleep (Hale, Hill et al., 2010; Hill, Burdette et al., 2009). Specific covariates include interview- and questionnaire-assessed race/ethnicity (Black, White, other race), educational attainment (categorized as high school, some college or college, any graduate school), marital status (married, not married), annual household income (<$25,000, $25,000–$44,999, $45,000–$74,999, $75,000–$124,999, ≥$125,000), history of smoking (a dichotomous measure of whether the respondent had smoked 100 cigarettes in his/her life), and clinically-measured body mass index (BMI, weight in kilograms divided by height in meters squared) divided into typical categories of normal (<25), overweight (25–29.9) and obese (≥30). An indicator variable for missing data on the income measure is also included in the models.

Statistical analysis

We use Stata 11.0 to estimate whether self-reported sleep quality contributes to the association between neighborhood quality and both self-rated health and depression, using both adjusted and unadjusted regression models (logistic regression for the self-rated health outcome and ordinary least squares for the depression outcome). First, we test for a cross-sectional association between sleep quality and perceptions of high neighborhood quality. Then, we use a Sobel–Goodman test of mediation (the Stata command sgmediation), for the continuous outcome variable (i.e. the depression measure). With our dichotomous outcome variable (i.e. self-rated health), we use an algorithm available by Nathaniel Herr online (http://nrherr.bol.ucla.edu/Mediation/logmed.html) and developed by others (MacKinnon & Dwyer, 1993). In the fully adjusted models, we adjust for the following additional covariates: age, sex, race, education, marital status, smoking history, and body mass index. For each outcome, (1) self-rated health and (2) depression, we estimate three models. The first model shows the direct association between neighborhood quality and each of these outcomes. Model 2 adds the covariates described above. Model 3 adds self-rated sleep quality. The Sobel test of mediation allows us to formally test the indirect effect of neighborhood quality on health (self-rated and depressive symptomology) through the proposed mediator variable of self-reported sleep quality.

Weighting

The SHOW has individual-level sampling weights for each of the three sections of the survey that take into consideration the complex survey design and demographic correlates of non-response. The sampling weights for the initial in-home part of the survey (time 1) are the product of the inverse of the probability of selection for the sample, weighting class nonresponse adjustment with adjustment cells determined by CHAID (Chi-squared Automatic Interaction Detection), and post-stratification calibration to age by gender categories from the American Community Survey estimates over the same time period. The weights for the subsequent parts of the survey are equal to the time 1 weights multiplied by an additional weighting class non-response adjustment factor and post-stratification factor based on age by gender categories. All analyses presented in Tables 2–4 adjust for weighting using the STATA command, svyset, with pweights, and singleunit (certainty) (Heeringa, West et al., 2010).

Results

Sample characteristics

Descriptive characteristics of our sample are shown in Table 1. Using only complete cases, we analyze data from 1298 participants with 45% male; 68% married; 4% Black; 4% other race/ethnicity; 63% with some college, a bachelor's degree or an associate degree; and 11% with some graduate education. Approximately 72% of the sample is either overweight or obese. Approximately 11% of the population reports having fair or poor health, and the standardized depression *z*-score is −0.23, with higher scores indicating more depression.

Association between neighborhood quality and sleep

As shown in Table 2, fair–poor sleep quality is associated with increased odds of the respondent living in a perceived low neighborhood quality (OR = 1.76, $p < 0.001$). After adjustment for the sociodemographic and health characteristics included in Table 1 (age, race, education, gender, weight, marital status, and household income), the association OR reduces to 1.42 ($p < 0.05$).

Association between perceived neighborhood context and self-rated health

Table 3 displays the unadjusted and adjusted associations between perceived neighborhood quality measure and self-rated health. As shown in Model 1, there is a positive association between low neighborhood quality and fair–poor health. Compared to living in a neighborhood perceived to have high neighborhood quality, those perceiving their neighborhood quality to be low report 2.3 fold odds of fair–poor health ($\beta = 0.84$, OR = 2.32, $p < 0.001$). As shown in Model 2, with the addition of sociodemographic and health variables, the β coefficient drops from 0.84 to 0.52 (OR = 1.68, $p < 0.05$). Model 3 adds in self-rated sleep quality and results in an additional reduction in the low neighborhood quality β to 0.42 (OR = 1.52, $p < 0.05$). The Sobel test for binary mediation meets a significance level of $p = 0.02$, indicating that adjustment for self-rated sleep quality reduces the association between neighborhood disorder and self-rated health sufficiently to justify a partial mediation interpretation. Specifically, self-rated sleep quality mediates about 20% of the association of neighborhood disorder and self-rated health.

Other variables in Model 3 that have a strong association with self-rated health include education, income, weight, smoking history, and sleep quality variables. Both college and graduate education and higher incomes are associated with higher self-rated health (results not shown). In addition, obesity and history of smoking are associated with poorer self-rated health (results not shown). Fair or poor quality sleep is also directly associated with fair or poor self-rated health, with a β-coefficient of 1.63 (OR = 5.10, $p < 0.001$), a much larger magnitude than the coefficient for neighborhood quality.

Association between perception of neighborhood environment and depression

Table 4 shows the associations between neighborhood quality and depression. As shown in Model 1, residents of perceived low quality neighborhoods compared to high quality neighborhoods have a 0.37 ($p < 0.001$) standard deviation higher depressive DASS z-score. The addition of sociodemographic and health variables reduces this larger depression z-score to 0.27 ($p < 0.01$). As with the outcome of self-rated health, the addition of self-rated sleep quality to Model 3, reduces the low neighborhood quality coefficient to 0.21 ($p < 0.01$), with the Sobel test of mediation being significant at the $p = 0.01$ level. As with the self-rated health outcome, the Sobel test finds statistically significant mediation with the self-rated sleep quality variable, which explains about 19% of the association between perceived neighborhood quality and depressive symptoms.

Other statistically significant predictors of depression include being obese, being unmarried, low income, and having fair or poor sleep. As with self-rated health, the magnitude of the coefficient of fair or poor sleep quality on predicting depression is larger ($\beta = 0.63$, $p < 0.001$) than the magnitude of perceived low quality neighborhood environment.

Discussion

The aim of this study was to test the potential role of sleep quality in mediating the association between neighborhood context, measured by self-reported measures of neighborhood quality and health. Consistent with prior investigations, we observed that self-rated sleep quality may be a partial mediator of both self-rated health and depression (Hale, Hill et al., 2010; Hill, Burdette et al., 2009). By replicating these previous findings in another population-based sample, we extend the generalizability these findings (Hale, Hill et al., 2010; Hill, Burdette et al., 2009). Specifically, one prior study found that self-reported sleep quality mediated about 11% of the association between neighborhood disorder and self-rated health (Hale, Hill et al., 2010), which is less than the mediation size between neighborhood quality and self-rated health found in the present analysis of 20%. The

previous study found that self-reported sleep quality mediates approximately 22% of the association between high neighborhood disorder and psychological distress (Hill, Burdette et al., 2009), which is similar to the 19% mediation size between neighborhood quality and depression found in this study.

In ancillary analyses, we tested two other measures of sleep quality – specifically sleep apnea diagnosis and an index of insomnia symptoms – and failed to find mediation with both outcomes of self-rated health and depression (results not shown). However, lack of mediation may be due to the limitations of the sleep measures. For example, sleep apnea is widely under-diagnosed (Young, Palta et al., 1993), which would likely lead to an underestimation of the potential mediating effects of sleep apnea on health. Future research should seek to replicate this type of mediation analysis using better measures of sleep disorders, such as obstructive sleep apnea and insomnia.

One implication of our finding that self-reported sleep quality mediates the association between neighborhood quality and health is that directed efforts to improve sleep quality may partially interrupt the putative causal chain from perceptions of poor neighborhood environment to poor health. This may be important for persons living in neighborhood environments that are crowded, noisy, and otherwise not conducive to sleep and for whom relocation is not feasible. Further research is necessary to further understand what aspects of sleep quality mediate the association.

As with our prior research, limitations of this work include that the analyses are based on cross-sectional data, and therefore it is impossible to tease apart the causal directions between perceptions of the neighborhood environment, sleep quality, and health outcomes. Future research might utilize longitudinal data to better establish causal associations among neighborhood context, sleep, and health outcomes. In particular, we need to understand whether the associations between neighborhood context and sleep are driven by physical differences in neighborhoods (e.g., traffic, environmental toxins, crowdedness of housing), psychological factors (e.g., fear for one's safety or financial insecurity, individual perceptions versus reality), or sociocultural factors. The important role of sociocultural factors (e.g., timing of evening meals, dietary and behavioral preferences, and noise levels in household) in determining sleep patterns should not be overlooked and may present barriers or opportunities to effecting change in high-risk communities.

It is both a strength and a limitation of this research that we rely upon self-reported measures of sleep, health, and neighborhood context. Self-reported measures, such as perceptions of neighborhood context, may capture otherwise unobservable characteristics of a neighborhood experience that may affect the body's physiological functioning and ability to sleep that an objective measure would miss. As far as limitations, however, there are concerns that the measures of sleep and neighborhood context we use have not yet been validated. For example, although our measure of sleep quality is identical to the one-item Overall Sleep Quality subscale of the Pittsburgh Sleep Quality Index (PSQI), the item in the SHOW survey has an answer range that extends one point higher than in PSQI; the SHOW scale ranges from 1 to 5, whereas PSQI ranges from 1 to 4. Future investigations should also explore direct measures of physiological health, sleep, and environmental factors.

In summary, by closely replicating results from an independent regional sample, these results support the generalizability of an indirect process that links neighborhood quality and health status through sleep quality. Future research should examine ways to translate these findings into meaningful interventions that aim to simultaneously improve neighborhood context, sleep quality, and health.

Acknowledgments

The authors thank all the current and former SHOW staff that makes this project possible, including, but not limited to, Kathy Massoth, Kathy Roberg, Susan Wright, Lulu Zhang, Phoebe Frenette, Mary Farrell-Stieve, Christine McWilliams, Bev Scullion, Jennifer Tratnyek, and Matt Walsh.

Funding sources The Survey of the Health of Wisconsin is supported by funding from the Wisconsin Partnership Program (233 PRJ 25DJ), a National Institutes of Health's Clinical and Translational Science Award (5UL 1RR025011), and a Grand Opportunities grant from the National Heart, Lung, and Blood Institute (1 RC2 HL101468). Additional support for this analysis was provided by NIH/NIA grant R01AG036838.

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Table 1

Selected descriptive statistics (n = 1298) (unweighted).

	Range	% or Mean (S.D.)
Outcome variables		
Depression	−0.91–5.1	−0.23 (0.96)
Fair–poor health	0–1	11%
Neighborhood quality		
Low	0–1	19%
Moderate–high	0–1	81%
Sleep quality		
Fair or poor	0–1	31%
Age (years)	21–74	47.70 (14.39)
Race		
Black	0–1	4%
White	0–1	92%
Other	0–1	4%
Education		
High school	0–1	26%
College	0–1	63%
Graduate school	0–1	11%
Gender		
Male	0–1	45%
Female	0–1	55%
Weight		
Normal weight	0–1	28%
Overweight	0–1	33%
Obese	0–1	39%
Marital status		
Married	0–1	68%
Unmarried	0–1	32%
Annual household income		
<$25,000	0–1	19%
$25,000–$44,999	0–1	18%
$45,000–$74,999	0–1	27%
$75,000–$124,999	0–1	23%
≥$125,000	0–1	6%
Income unknown	0–1	4%
Smoking history		
100+ cigarettes (Y/N)	0–1	45%

Table 2

Unadjusted and adjusted associations between low neighborhood quality and fair or poor sleep quality (n = 1298) (weighted).

	OR	95% CI
Low neighborhood quality (unadjusted)	1.76***	1.33–2.31
Low neighborhood quality (adjusted)	1.42*	1.07–1.87

* $p < 0.05$.

*** $p < 0.001$.

Table 3

Logistic regression coefficients for self-rated health (n = 1298) (weighted).

Focal measure	Model 1		Model 2		Model 3	
	β	SE	β	SE	β	SE
Low neighborhood quality	0.84***	0.22	0.52*	0.24	0.42	0.28
Fair or poor sleep quality					1.63***	0.24
Sobel test of mediation: z-score = 2.34, p = 0.02						
% Explained by addition of sleep quality = 20%						

* $p < 0.05$.

*** $p < 0.001$.

Note: Coefficients are unexponentiated. Model 1 adjusts only for neighborhood quality. Model 2 adds in adjustment of sociodemographic and health factors, including age, race, education, gender, weight category, marital status, smoking history, and annual household income. Model 3 adds in adjustment for fair or poor sleep quality.

Table 4

Linear regression models for depression score (n = 1297) (weighted).

Focal measure	Model 1		Model 2		Model 3	
	β	SE	β	SE	β	SE
Low neighborhood quality	0.37***	0.07	0.27**	0.08	0.22**	0.08
Fair or poor sleep quality					0.63***	0.06
Sobel test of mediation: z-score = 2.43, p = 0.01						
% Explained by addition of sleep quality = 19%						

** $p < 0.01$.

*** $p < 0.001$.

Note: Model 1 adjusts only for neighborhood quality. Model 2 adds in adjustment of sociodemographic and health factors, including age, race, education, gender, weight category, marital status, smoking history, annual household income. Model 3 adds in adjustment for fair or poor sleep quality.