EURAMERICA Vol. 50, No. 1 (March 2020), 1-45
DOI: 10.7015/JEAS.202003_50(1).0001
http://euramerica.org

Neighborhood Stressors and Social Integration, Living Arrangements, and Characteristics and Variabilities of Sleep in Old Age

Jen-Hao Chen
Department of Sociology, National Chengchi University
No. 64, Sec. 2, ZhiNan Rd., Taipei 11605, Taiwan
E-mail: jenhao@nccu.edu.tw

Abstract

Decades of research has demonstrated that where individuals live can affect their health and well-being. Using theories and research from sociology and sleep medicine, this study will extend the literature on how neighborhoods affect health to examine how neighborhoods and living conditions affect sleep among the elderly, which is an important but overlooked health topic in the social science literature. This study hypothesizes that neighborhood stressors, such as perceived danger, undermine the elderly's sleep, while factors contributing to neighborhood integration, such as social connectedness and a sense of community, promote the elderly's sleep. Second, the study hypothesizes that

Received August 15, 2018; accepted September 26, 2019; last revised October 7, 2019
Proofreaders: Cheng-Hsien Wu, Yi-Han Huang, Yu-Jy Chen

living arrangements (i.e., living alone or with a spouse, family member, or other person) moderate the relationship between neighborhood and sleep. The analysis uses nationally-representative data from the National Health, Social Life, and Aging Project (N=684), which includes objective assessments of older adults' average sleep characteristics and variabilities. Overall, findings suggest that the social dynamics of neighborhoods can independently predict older adults' sleep characteristics, but the processes are complex and may vary by living arrangements. Specifically, the study finds that neighborhood was not associated with average actigraphic sleep characteristics, but social connectedness was associated with less variability in sleep duration and marginally associated with less variability in wake time after sleep onset. Older adults who lived in intergenerational households had greater variability in sleep fragmentation when they perceived higher degree of danger in their neighborhood, and less variability in sleep fragmentation when they felt social connectedness and a sense of community in their neighborhood. In addition, some gender differences were found.

Key Words: aging, neighborhood effects, living arrangements, sleep

I. Introduction

Growing evidence suggests that the neighborhoods where people live help shape their health, longevity, and well-being (Cagney & Cornwell, 2010). For older adults, the effect of neighborhoods is especially strong because, unlike working-age adults who typically leave home daily to work, older adults spend nearly all of their time in their neighborhoods. As a result, older adults are more heavily reliant on local resources and more sensitive to changes in the residential environment. As such, the effects of one's neighborhood on health is amplified in older adults (Robert & Li, 2001).

Sleep is an important part of older adults' health (Ancoli-Israel, 2009). Poor quality or too little sleep can affect older adults' physiological processes and metabolism, which are linked to increases in likelihood of diabetes (Gangwisch et al., 2007), heart disease (Phillips & Mannino, 2007), and mortality (Cappuccio, D'Elia, Strazzullo, & Miller, 2010). However, the ability of individuals to achieve good sleep differs among sub-groups. A recent U.S. Centers for Disease Control and Prevention report (Liu et al., 2016) demonstrates a higher prevalence of inadequate sleep duration in socially and economically disadvantaged regions, pointing to neighborhoods as a potentially influential factor in individuals' sleep. Other recent research confirms that living in disadvantaged neighborhoods can undermine one' sleep: Several cross-national studies show that living in neighborhoods that are socioeconomically disadvantaged, unsafe, or which have limited access to the natural environment is associated with lower sleep quality and shortened sleep duration (Bierman, Lee, & Schieman, 2018; Chen-Edinboro et al., 2015; Grigsby-Toussaint et al., 2015; Hale et al., 2013; Hill, Burdette, & Hale, 2009; Johnson, Brown, Morgenstern, Meurer, & Lisabeth, 2015; Simonelli et al., 2015).

While many previous studies have been concerned with the influence of negative aspects of neighborhood social environment

on sleep, theories and research from sociology and population health are increasingly interested in positive aspects of neighborhood social environment and its health promotion functions (Carpiano, 2006; Hystad & Carpiano, 2012). For example, a higher level of a sense of community within neighborhoods is associated with better health behaviors (Hystad & Carpiano, 2012). Moreover, higher levels of a sense of community and neighborhood social cohesion may be of particular importance for older adults' health and well-being (Cramm, Van Dijk, & Nieboer, 2013; Inoue, Yorifuji, Takao, Doi, & Kawachi, 2013). However, very few studies have simultaneously investigated both neighborhood stressors and social integration in relation to older adults' sleep. Even fewer studies focus exclusively on older adults' sleep in the United States. Among existing studies, most use objective sleep measures, instead relying on subjective reports of sleep. Due to these limitations, we know very little about how both positive and negative attributes of neighborhood social environment contribute to older adults' sleep. Given the societal interest in healthy aging and the growing evidence that neighborhoods affect heathy aging, it is important to gain more precise knowledge of how sleep affects older adults' objective sleep outcomes.

Using theories and research from sociology and sleep medicine to frame key hypotheses, this study will specify how neighborhood stressors and social integration affect older adults' sleep, as well as how living arrangements moderate the relationships. A large volume of sociological research has already suggested that stressors and social supports from neighborhoods play a key role in shaping residents' health and well-being (Carpiano, 2006; Sampson, 2012). This study extends that line of research to older adults' sleep. The study will add to the literature on neighborhoods and health by not only focusing on older adults, but also by examining neighborhood characteristics other than socioeconomic status (Hale et al., 2013; Hill, Burdette & Hale, 2009; Johnson et al., 2015; Simonelli et al., 2015).

Empirically, this study uses innovative actigraphic sleep data from a nationally representative sample of older adults, which has several important advantages. The actigraphic sleep data distinguishes between different aspects of sleep, including sleep duration, sleep fragmentation, and wake time after sleep onset. Differentiating aspects of sleep is important because sleep is a complex and multi-dimensional construct. A good night of sleep can mean adequate sleep duration and good sleep quality, with few or no wake-ups during the night. Also, there is growing recognition of intra-individual variability in sleep and other factors that contribute to nightly sleep variability (Knutson, Rathouz, Yan, Liu, & Lauderdale, 2007; Mezick et al., 2009). High variability in sleep duration and sleep quality over a short period of time has been linked to higher metabolic risk (Baron, Reid, Malkani, Kang, & Zee, 2017). Given that cognitive impairments and memory problems are more prevalent in later life, older adults may find it difficult to accurately recall their nighttime sleep using subjective, self-report tools. For this reason, the use of actigraphic sleep data, which relies minimally on older adults' cognitive capacity, is a more useful way than self-reports to measure older adults' sleep.

II. Background

A. Theoretical Perspectives on How Neighborhood Can Affect Sleep

There is strong theoretical reason to believe that neighborhood matters for older adults' sleep. Based on the extant research, this study focuses on two key aspects of neighborhoods that can affect individuals' sleep: neighborhood stressors and social integration. Sociological theory points to three pathways through which neighborhood stressors and social integration can influence sleep: (1) psychosocial effects of fear and vigilance (2) effects on healthy behaviors and lifestyles, and (3) social support.

First, the physical environment of a neighborhood matters because it affects whether residents can sleep quietly and also because it signals the level of social disorder. In the United States, physical incivilities in a neighborhood, such as abandoned storefronts, unkempt lots, litter, noise, etc. correlate with the level of perceived social disorder (Perkins, Meeks, & Taylor, 1992). This disorder may create feelings and perceptions that affect sleep. For example, fear of crime or mistrust of neighbors can lead to the feeling that one must be constantly vigilant, which in turn can impair sleep (Dahl, 1996). Consistent alertness and fear can also lead to chronic activation of physiological responses and overproduction of stress hormones, such as cortisol (Bird et al., 2010). These stress hormones increase mental and physiological arousal and influence sleep physiology, which in turn undermine sleep (Åkerstedt, 2006). In this way, individuals who live in disadvantaged neighborhoods with high levels of crime and social disorder may have a heightened need for vigilance that takes a psychological toll and ultimately affects their chances of getting a good night's sleep.

Second, neighborhoods differ on how well they support positive health behaviors, such as walking and other forms of exercise, that are associated with better sleep (Frank, Cerdá, & Rendón, 2007; Piro, Nœss, & Claussen, 2006). Disadvantaged neighborhoods often have fewer resources to promote positive health behaviors (e.g., walking trails, sidewalks) and closer proximity to establishments that promote negative health behaviors (e.g., liquor stores, fast food restaurants). These neighborhood characteristics may impact sleep. For example, safety concerns and a lack of facilities may lead residents in disadvantaged neighborhoods to exercise less frequently. Also, the concentration of liquor stores in disadvantaged neighborhoods may lead to more alcohol consumption. As a healthy lifestyle is a prerequisite for good sleep, individuals living in neighborhoods that undermine positive heath behaviors are more likely to have poor sleep. Alternatively, living in a safe and socially integrated neighborhood may encourage residents

to go out for exercise and participate in community activities, which are positive health behaviors that may lead to better sleep.

Finally, the social support in neighborhoods is likely to play a key role in shaping individuals' sleep, based on a long tradition in sociology of understanding how social connectedness and integration is related to health and well-being. In 1897, Emile Durkheim, one of sociology's founding scholars, argued that social integration serves both regulative and integrative functions that reduce the propensity to commit suicide (Durkheim, 1951). Durkheim's key insight, that individual pathology in health is a function and outcome of social dynamics, has guided a great deal of subsequent research on social connection and integration and health (Berkman, Glass, Brissette, & Seeman, 2000). Sociologists have since examined how social ties between neighbors and the degree of connectedness and integration within neighborhoods affects health (Carpiano, 2006; Sampson, 2012). Sociologist Robert Sampson coined the term "collective efficacy" to describe neighborhoods with high levels of social capital (Browning & Cagney, 2002; Sampson, Morenoff, & Gannon-Rowley, 2002). When a neighborhood has high collective efficacy, important information circulates easily among residents, and residents trust each other and are more likely to provide tangible resources and support when someone needs help. A large volume of sociological research has demonstrated that such closely connected neighborhoods help promote health and reduce morbidity and mortality among residents (Browning & Cagney, 2002; Klinenberg, 2002). Disadvantaged neighborhoods often have a lower level of collective efficacy, which translates to a lack of key social resources for residents and fewer ways to buffer the impact of negative events. Empirically, of the studies that examine neighbor-hoods and health, few examine sleep, in particular. Among these studies, several found that the positive effects of social support extend to better sleep, but the strength of the associations differed by how sleep was measured and by the samples (Chung, 2017; Kent, Uchino, Cribbet, Bowen, & Smith,

2015; Troxel, Buysse, Monk, Begley, & Hall, 2010). Taken together, there is strong support to suggest that living in a close-knit neighborhood is conducive for older adults' sleep, whereas residing in a socially disconnected neighborhood undermines sleep.

B. Moderating Effect of Living Arrangements

Households also provide social support that is important for health and well-being, making them likely to moderate the relationship that neighborhood has on sleep for older adults. For older adults, in particular, prior research makes clear that different living arrangements, i.e., living alone or with a spouse or other roommate, pose different challenges and advantages (Hughes & Waite, 2002; Li, Zhang, & Liang, 2009). In the United States, living with a spouse is the most common living arrangement for older adults after retirement. However, in the past few decades, families in the United States have become more diverse, so older adults' living arrangements have also changed. Recent studies suggest that a growing number of older adults live alone, with extended family, or in a complex household (Manning & Brown, 2011) with family as well as members who are not related.

There is a strong literature showing that living arrangements can be a key source of support and strain that affects health (Hughes & Waite, 2002), including sleep. Hale (2005) found that marriage is associated with a lower likelihood of short sleep duration. Chen, Waite, and Lauderdale (2015) found that married older adults have better actigraphic sleep outcomes, specifically that a supportive relationship is associated with better sleep quality in terms of less fragmentation and shorter wake time after sleep onset. However, the literature on living arrangements and sleep is currently limited to marital status. No study has examined how older adults' sleep is affected by different living arrangements, even though they are increasingly common among older adults.

There are also strong theoretical reasons to believe living

arrangements may moderate the effects of neighborhood on older adults' sleep. Different living arrangements may bring additional resources and support that older adults can use to cope with the challenges that their neighborhood presents, including the challenges of living in a disordered neighborhood. For example, older adults who live in neighborhoods with high levels of crime, but also in a married or complex household, may feel more secure compared to their single counterparts because they gain material, social, and emotional support from spouses or other family members. That said, living arrangements may also add burden, stress, and responsibilities (Hays, 2002; Kim & Waite, 2016) that dampen the benefits of living in a socially integrated neighborhood. For example, living with extended family or in a complex household may add caregiving responsibilities and may mean that older adults have to negotiate their daytime and sleep schedules with other people in the same household. As such, older adults living extended family or in complex households may be less likely to participate in community activities or establish relationships with neighbors. In this way, types of living arrangements may moderate the relationship between neighborhood and sleep.

In summary, this study will explore key questions about older adults' living arrangements, neighborhood context, and sleep. Can some types of living arrangements (e.g., living with a spouse) mitigate the negative consequences of living in a disordered neighborhood? Do older adults who live with others benefit less from their supportive neighborhood in terms of sleep outcomes? Based on the discussion above, this study hypothesizes that living arrangements with few socioeconomic resources (i.e., living alone) or with complex social relationships (i.e., extended family or complex household) will exacerbate the effect of neighborhood on sleep because the strain and demands within these households makes it more difficult for them to cope with neighborhood conditions. Older adults in these types of households may also benefit more than their traditional family counterparts from living in a close-knit

neighborhood because the neighborhood provides social and emotional resources that are lacking in the household. Figure 1 summarizes the conceptual model of this study. It should be noted that the conceptual model includes the social processes through which neighborhood context functions, i.e., neighborhood stressors and social integration, and does not argue that neighborhood context directly changes sleep physiology. Rather than suggest a direct effect or direct link between neighborhood context and sleep, the preceding discussion and resulting conceptual model aims to flesh out a framework that captures the complex social-biological and social-psychological processes through which neighborhood context can influence sleep.

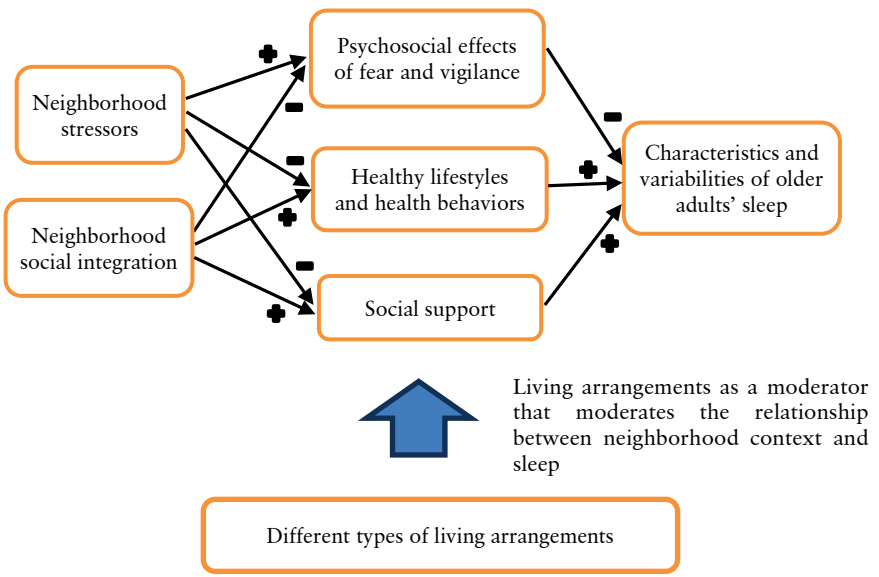

Figure 1 A Brief Conceptual Model that Summaries Theoretical Perspectives on How Neighborhood Can Affect Sleep

C. Why Older Adults?

The present study focuses on sleep in old age for two reasons. First, older adults have a higher prevalence of problem sleep. Estimates are that 25%-40% of older adults report at least one insomnia symptom (Foley, Monjan, Brown, & Simonsick, 1995; Lauderdale et al., 2014). Second, poor sleep in old age is associated with heightened morbidity and mortality (Cappuccio et al., 2010). Sleep is clearly important for older adults' health and, as explained above, there are strong reasons to believe it is affected by neighborhood. Despite this, there are no studies examining neighborhood effects on older adults' sleep. To date, existing studies have linked neighborhood context to sleep only in young adults (Hale et al., 2013; Hill et al., 2009; Johnson et al., 2015; Simonelli et al., 2015). These prior studies are also limited because they often use non-representative samples and rely on simple, self-reported measures of sleep.

D. Actigraphic Sleep Measures

The present study also uses actigraphic sleep measures because they are superior to subjective self-reports, especially for older adults. In most studies of sleep, sleep characteristics are usually assessed by survey questions that ask respondents to report their sleep duration and to evaluate their sleep quality within a period of time. A few sociological studies have adopted objective sleep measures (Chen et al., 2015). However, even when objective sleep measures are used, researchers usually average several nights. This approach overlooks one key aspect of sleep—sleep variability—which is defined as the variations of sleep characteristics over several days. For example, adequate sleep duration is a marker of good sleep health, but so is low sleep variability of sleep duration. In fact, high variability in sleep is a type of sleep disorder (Buysse, 2014). Research shows that individuals with chronic insomnia show higher night-to-night variability in sleep (Buysse et al., 2010). This study will address the

empirical and methodological limitations of prior studies and therefore be able to examine how neighborhood affects both average sleep characteristics and sleep variability.

III. Methods

A. National Social Life, Health, and Aging Project

This study uses data from the second wave of National Social Life, Health, and Aging Project (NSHAP). The NSHAP is a population-based, longitudinal study of health, social life, and well-being drawn from a nationally representative probability sample of older adults, aged 57–85, selected from screened households across the United States in 2004. The NSHAP over-sampled for African-Americans, Latinos, men, and the oldest-old, i.e., individuals aged 75-84 years at the time of screening. Currently, NSHAP has two waves of data: 2005-2006 (Wave 1) and 2010-2011 (Wave 2). In Wave 2, the sample was extended to include the spouses and cohabiting partners of respondents who were in Wave 1. Partners were eligible to participate in Wave 2 if they were at least 18 years of age and resided in the household with the Wave 1 respondent at the time of the Wave 2 interview.

For Wave 2 data collection, approximately one-third of the primary respondents were randomly selected to participate in a supplemental activity and sleep study. Of 1,117 selected individuals, 897 agreed (220 refused) to participate. After agreeing to participate, respondents were again contacted so arrangements could be made to have a wrist actigraph (i.e., acti-watch) and a booklet on activity and sleep mailed to them. The actigraph and booklet collected information about the respondent's activity levels and sleep over three full days (72 hours total). Taken together, data collected from the wrist actigraph and sleep booklet provided rich information on the sleep characteristics of a representative sample of older adults. In total, 819 individuals were successfully re-contacted and completed the activity study. After excluding 39 individuals with no

useable actigraphy data, the activity study yielded a sample of 780 individuals with at least one night of actigraphy data.

As this study investigates sleep characteristics as well as sleep variability, three nights of data are needed to calculate the standard deviation and range of sleep parameters. Older adults with fewer than three nights of actigraphy data were excluded from the analysis, which led to a final sample of 684 older adults. Because the activity and sleep study subsample were randomly selected from the NSHAP original sample, a sampling weight was created and used in this study so that results are nationally representative of older adults (Lauderdale et al., 2014).

B. Measures of Sleep Outcomes

Sleep measures in this study were derived from the actigraphy data collected in Wave 2 of the NSHPAP (Lauderdale et al., 2014). The actiwatch recorded intensity and frequency of movement using a piezoelectric linear accelerometer with 15-second epochs. The actiwatch continually registers wrist movements; the sum of all wrist movements during each epoch was saved as an activity score. Participants were instructed to wear the watch for three full days. Data from the actiwatch were downloaded and analyzed using the manufacturer's actiware software version 5.59, using the manufacturer's recommended settings for the software.

Actigraphy is a different approach to assess individuals' sleep characteristics that has several advantages over traditional survey questions. As discussed above, actigraphy does not rely on recall to complete a sleep diary, which is advantageous when studying older adults who are more likely to have poor memory. Also, actigraphy can be easily incorporated into large-scale, population-based samples. The Rotterdam Study (Hofman et al., 2007) and Survey of Mid-Life in the United States (Lemola, Ledermann, & Friedman, 2013) both use actigraphy. Second, prior studies that compare polysomnography (PSG) to wrist actigraphy suggest that actigraphy

provides valid and acceptable measures of sleep (Martin & Hakim, 2011; Slater et al., 2015). A recent review concludes that actigraphy has reasonable validity and reliability when used to capture data on individuals who do not have a sleep-related disorder (Sadeh, 2011). Finally, unlike PSG, actigraphy does not require participants to sleep in a lab, which likely provides a more accurate picture of participants' sleep habits.

Actigraphy's main shortcoming is that it may produce bias in some instances, such as when attempting to measure a sleep disorder. But, since the purpose of this study does not require making a clinical diagnosis of a sleep disorder, the use of actigraph-derived sleep measures is reasonable and, given the study's focus on older adults, superior to other more subjective measures. In this study, actigraph data was used to measure two sleep outcomes: average sleep characteristics and sleep variability.

(A) Average Sleep Characteristics

The study uses a three-night average of three actigraph-estimated sleep characteristics: (1) actigraphic sleep duration, defined as the total duration of all epochs scored as sleep within the sleep interval (i.e., the time from the first epoch scored as sleep to the last epoch scored as sleep for the sleep interval in each 24-hour period); (2) a sleep fragmentation index ranging from 0–100 that indicates sleep disruption, defined as the sum of the percentage of the sleep interval spent moving and the percentage of immobile periods (i.e., contiguous epochs with no movement) that are no longer than one minute; and (3) wake time after sleep onset (WASO), defined as the total minutes awake during the sleep interval. The first measure captures sleep duration and the second two (i.e., sleep fragmentation and WASO) capture sleep quality.

(B) Sleep Variability

To measure sleep variability, the study uses *standard deviations* and *ranges* for each of the three actigraph-estimated sleep

characteristics (i.e., sleep duration, sleep fragmentation, WASO) for each participant over the 3-night period. As NSHAP has only three nights of actigraphy data, this study could not adopt a more advanced, recently-developed measure of sleep variability. That said, the use of three-night actigraphy data follows a prior study of sleep variability in a large-scale survey (Knutson et al., 2007) and remains informative because it enables one of the first assessments of sleep variability in a nationally-representative sample of older adults.

C. Measures of Neighborhood Stressors and Support

Wave 2 of the NSHAP included a series of questions on respondents' subjective evaluation of their neighborhood, which was defined as the area within a 20-minute walk or a mile of the respondent's home. The first set of questions asked for information about social interactions within the neighborhood: "How often do you and people in this area visit in each other's homes or meet on the street?", "How often do you and other people in this area do favors for each other?", and "How often do you and other people in this area ask each other for advice about personal things?" The possible answers were "often," "sometimes," "rarely," and "never." The remaining questions asked respondents to rate the condition of their neighborhoods. The statements that participated rated were: "This is a close-knit area," "People around here are willing to help their neighbors," "People in this area generally don't get along with each other," "People in this area don't share the same values," "People in this area can be trusted," "Many people in this area are afraid to go out at night," "There are places in this area where everyone knows trouble is expected," and, "You're taking a big chance if you walk in this area alone after dark." Following the example of Cornell and Cagney (2014), I created three scales of neighborhood social processes based on respondents' rating of their neighborhood: neighborhood social connectedness (five items),

sense of community (three items), and perceived neighborhood danger (three items). For detail on the questions that constitute the three scales of neighborhood social processes, see Appendix A.

D. Living Arrangements

The household roster in NSHAP was used to distinguish four types of living arrangements for respondents: (1) spouse only family, (2) single family, (3) intergenerational family, and (4) complex family. Spouse only family was defined as those who were married or cohabitating. Single family was defined as older adults who live alone. Intergenerational family was defined as older adults who lived with their grandchildren, regardless of the number of adults in the household and older adults' relationships with those other adults. For example, an older adult living with her spouse, daughter, and grandson was considered an intergenerational family, or an older adult living with her sister and grandson. The complex family category was defined as individuals whose living arrangements could not be classified as spouse only, single, or intergenerational family.

E. Measures of Control Variables

Respondents' education was categorized as less than high school, high school or equivalent, some college education, or bachelor's degree or higher. Race and ethnicity distinguished White, African American, Hispanic, and Other. A dichotomous variable indicated whether the respondent was retired at the time of the interview. Log household income and log household assets were used as indicators of respondents' economic standing. Regressions also controlled for dichotomous gender and age in years.

F. Statistical Strategy

The analysis began with weighted descriptive statistics, which offer a first look at average sleep characteristics and sleep variability

in a nationally representative sample of U.S. older adults. Next, the relationship between neighborhood social processes and *average sleep characteristics* and *sleep variability* was examined using ordinary least squares (OLS) regressions, clustered by household. All regressions were properly weighted to account for NSHAP's complex survey design.

The analysis does not use multilevel models to account for the unobserved correlation within couples because several issues make them not the best approach for this study. The NSHAP data are not nested in the usual sense because the survey did not use households as the primary sampling unit. Instead, randomly sampled spouses of eligible older adults were invited to participate in the study. Additionally, because NSHAP was not originally designed to study individuals nested within dyads, fitting the data using multilevel models may run into the problem of data sparseness (Clarke, 2008; Clarke & Wheaton, 2007). As Clarke (2008) suggested, in the case of extreme data sparseness (i.e., less than two cases per unit), the standard error of random effects will be overestimated, thus giving the statistical models less power in detecting a significant effect. With a relatively small sample size, the overestimation of standard error becomes an important issue. Prior analysis of NSHAP's sleep data has pointed out this issue (Chen et al., 2015) and suggested the use of weighted OLS. In the present study, as a check, sensitivity analyses were conducted with a multilevel model, calculating the intraclass correlation after estimation. The intraclass correlations ranged from 0.01 to 0.1; such low intraclass correlations suggest an alternative method to deal with clustering effects (Huang, 2018).

The first regression analysis (Model 1) estimated the association between neighborhood measures and sleep. Model 2 adds age, gender, race/ethnicity, education, household income, retirement status, self-rated physical health, and self-rated mental health as control variables. This analytical strategy, with progressive adjustment, allows for an investigation of whether the association between neighborhood and sleep that was observed in Model 1 is

due to the influence of potential confounders. After estimating the relationship between neighborhood and sleep, a series of interaction terms were added to determine whether the relationship between neighborhood measures and sleep varies by living arrangements.

Multiple imputation (Allison, 2001) was used to account for potential biases that were created by missing data in the control variables. Multiple imputation involves replacing missing values with predictions based on other observed variables. In contrast to single imputation, which replaces each missing value with a predicted value, multiple imputation replaces several missing values with a repeated imputation inference, which creates several complete datasets. Multiple imputation produces better estimates of the missing values that create uncertainty in the data (Allison, 2001; Hawkley, Kocherginsky, Wong, Kim, & Cagney, 2014).

IV. Results

Table 1 shows the descriptive statistics for the whole sample and by living arrangements. The table suggests that social and demographic characteristics vary among older adults with different living arrangements. Overall, older adults who lived with spouses were more advantaged with respect to almost all social and economic resources. Older adults with other living arrangements had fewer resources, but it is not clear which type of living arrangement is most disadvantaged in terms of socioeconomic resources. More specifically, older adults in spouse only and intergenerational families were younger, more likely to be White and to self-report excellent health. Older adults in single households were older, mostly White, and self-reported better mental health than older adults in all other types of living arrangements. Older adults living in intergenerational families were younger, but more likely to be a member of a minority and to rate poorly in terms of self-reported health. Finally, older adults in complex living arrangements were older and more likely to be Black. Older adults

in spouse only families had the highest household income and single older adults had the lowest. Older adults with single or complex living arrangements were more likely to be retired. Older adults in intergenerational and complex living arrangements were less likely to have completed high school than older adults in spouse only and single families.

Table 2 presents average sleep characteristics by level of sleep variability. Low sleep variability refers to individuals with measures of sleep variability that are below the median, and high variability refers to individuals with measures of sleep variability that are above the median. Results suggest that older adults with low sleep variability across all three measures—sleep duration, fragmentation, and WASO—show no difference in average sleep duration. However, older adults with high variability in sleep fragmentation also, on average, have higher sleep fragmentation and more WASO. Similar patterns were found for WASO: older adults with high variability in WASO also show higher fragmentation and more WASO.

Table 3 presents results from the OLS regressions that link the three neighborhood social processes—neighborhood social connectedness, sense of community, and perceived neighborhood danger—to the three-night average sleep characteristics (i.e., duration, fragmentation, and WASO). Overall, Table 3 suggests that neighborhood social processes were associated with actigraphic sleep measures over the three nights. Model 1 included measures of neighborhood social processes only, and entered all three variables of neighborhood social processes at the same time. Model 2 adds the control variables. Results from Model 1 show that perceived danger was positively associated with sleep fragmentation and WASO, and that sense of community was positively associated with sleep fragmentation. However, in Model 2, the associations were substantially reduced and became non-significant. The exception was sense of community, which remained marginally ($p<.1$) associated with a higher level of sleep fragmentation, even after control variables were added.

Table 1 Descriptive Statistics of Older Adults in the National Health, Social Life, and Aging Project by Living Arrangements (N=684)

	Total sample	**By Living Arrangements**			
		Spouse only	**Single**	**Inter-generational**	**Complex**
	Mean or proportion (SD)	Mean or proportion (SD)	Mean or proportion (SD)	Mean or proportion (SD)	Mean or proportion (SD)
Average sleep characteristics (mean)					
Sleep duration (hour)	7.17 (1.42)	7.19 (1.95)	7.14 (1.24)	7.03 (0.93)	7.33 (1.38)
Fragmentation	14.30 (8.74)	13.91 (8.17)	15.06 (6.20)	14.58 (7.48)	15.41 (5.50)
WASO (minutes)	38.15 (32.5)	35.96 (27.74)	42.12 (24.11)	40.66 (35.16)	43.78 (20.08)
Sleep variability: SD (mean)					
Sleep duration (hour)	0.92 (0.70)	0.90 (0.92)	0.94 (0.66)	0.96 (0.89)	0.97 (0.63)
Fragmentation	3.76 (3.31)	3.63 (2.82)	3.82 (3.23)	4.33 (2.83)	4.39 (4.49)
WASO (minutes)	44.04 (25.12)	39.99 (25.77)	50.62 (26.66)	51.82 (23.45)	52.98 (36.25)
Sleep variability: range (mean)					
Sleep duration (hour)	1.75 (1.29)	1.72 (1.75)	1.82 (1.33)	1.81 (1.57)	1.84 (1.20)
Fragmentation	7.17 (4.76)	6.91 (5.37)	7.31 (3.23)	8.29 (2.83)	8.34 (4.49)
WASO (minutes)	83.40 (53.04)	75.57 (49.89)	96.25 (52.07)	98.02 (43.33)	100.78 (58.40)
Neighborhood (mean)					
Perceived danger	0.03 (1.54)	-0.09 (1.33)	0.26 (1.28)	0.13 (0.98)	0.28 (1.57)
Social connectedness	-0.05 (1.26)	-0.03 (1.68)	0.14 (1.03)	-0.21 (1.23)	-0.12 (1.08)
Sense of community	-0.01 (1.44)	0.01 (1.67)	-0.03 (1.06)	-0.07 (1.24)	-0.03 (1.21)
Age (mean)	70.87 (10.03)	68.73 (12.1)	74.91 (9.70)	69.73 (8.81)	71.11 (8.85)
Female (proportion)	0.56	0.52	0.68	0.64	0.48

Race/ethnicity (proportion)					
White	0.83	0.87	0.83	0.69	0.72
Black	0.07	0.06	0.08	0.08	0.15
Hispanic	0.07	0.05	0.05	0.14	0.08
Others	0.03	0.03	0.04	0.08	0.05
Education (proportion)					
<High school	0.14	0.10	0.10	0.23	0.17
High school	0.24	0.22	0.32	0.16	0.21
Some college	0.39	0.43	0.37	0.44	0.36
College	0.23	0.25	0.20	0.17	0.26
Income (mean)	62169 (5851)	77454 (8081)	34661 (3172)	64621 (9116)	48142 (7506)
Retirement status (proportion)	0.69	0.65	0.76	0.66	0.77
Self-rated health (proportion)					
Poor	0.04	0.03	0.03	0.13	0.02
Fair	0.16	0.15	0.19	0.17	0.10
Good	0.32	0.31	0.38	0.36	0.24
Very good	0.33	0.35	0.29	0.27	0.52
Excellent	0.15	0.15	0.11	0.07	0.12
Self-rated mental health (proportion)					
Poor	0.01	0.01	0.02	0.00	0.00
Fair	0.08	0.07	0.06	0.19	0.10
Good	0.32	0.33	0.29	0.36	0.38
Very good	0.38	0.39	0.36	0.37	0.39
Excellent	0.21	0.19	0.29	0.08	0.12
Sample size	684	450 (66%)	155 (23%)	54 (8%)	25 (4%)

Table 2 Average Sleep Characteristics by Sleep Variability (N=684)

	Sleep duration	**Fragmentation**	**WASO**
Sleep duration (SD)			
Low variability	7.19	14.10	38.97
High variability	7.12	15.64	40.96
Fragmentation (SD)			
Low variability	7.30	13.95	36.16
High variability	7.01	15.79	43.77
WASO (SD)			
Low variability	7.16	12.68	30.00
High variability	7.16	17.06	49.92

Table 3 Associations Between Neighborhood Social Disorder and Average Sleep Characteristics of Older Adults (N=684)

	Three-night average sleep characteristics					
	Sleep duration		**Fragmentation**		**WASO**	
	Model 1 Coefficient (SE)	Model 2 Coefficient (SE)	Model 1 Coefficient (SE)	Model 2 Coefficient (SE)	Model 1 Coefficient (SE)	Model 2 Coefficient (SE)
Explanatory variables: neighborhood stressors and social integration						
Perceived danger	-0.038 (0.055)	-0.050 (0.061)	0.689* (0.291)	0.328 (0.317)	3.281** (1.198)	1.289 (1.278)
Social connectedness	-0.055 (0.065)	-0.041 (0.058)	-0.420 (0.269)	-0.198 (0.278)	-1.071 (0.956)	-0.609 (0.833)
Sense of community	-0.002 (0.055)	-0.009 (0.063)	0.549* (0.252)	0.511 (0.258)	1.080 (0.925)	0.694 (0.988)
Control variables						
Age		0.021*** (0.006)		0.089** (0.028)		0.182 (0.110)
Female		0.330** (0.095)		-1.62*** (0.448)		-1.577 (1.739)
Race/ethnicity						
Black		-0.202 (0.152)		2.084** (0.716)		7.482** (2.802)
Hispanic		0.097 (0.160)		-0.325 (0.756)		-0.866 (2.936)
Others		-0.418 (0.240)		-0.098 (1.136)		-2.920 (4.405)
Education						
High school		-0.040 (0.158)		-1.219 (0.745)		-6.716* (2.887)
Some college		-0.055 (0.151)		-0.697 (0.711)		-6.25* (2.757)
College		-0.026 (0.178)		-1.438 (0.837)		-8.389* (3.329)
Income		-0.004 (0.068)		-0.122 (0.308)		-0.586 (1.169)
Self-rated health		0.056 (0.050)		-0.787** (0.235)		-2.069* (0.911)
Self-rated mental health		-0.052 (0.055)		-0.092 (0.260)		-0.860 (1.009)

Potential moderator						
Living arrangements						
Single		-0.241* (0.113)		0.654 (0.586)		4.827* (2.265)
Inter-generational		-0.072 (0.167)		0.183 (0.790)		3.230 (3.062)
Complex		0.252 (0.178)		1.119 (1.144)		6.863 (4.440)

Notes: 1. † P< .1 * P< .05 ** P< .01 ***P< .001

2. Model 1 included measures of neighborhood social processes only. Model 2 controlled for age, gender, race/ethnicity, education, household income, living arrangements, self-rated physical health, and self-rated mental health. All regressions were properly weighted.

Table 4 presents results from the OLS regressions that link the three aspects of neighborhood social processes—neighborhood social connectedness, sense of community, and perceived neighborhood danger—to three-night sleep variability in sleep duration, fragmentation, and WASO. Overall, Table 4 demonstrates that when moving from sleep characteristics to sleep variability, the patterns remained similar. Perceived danger and sense of community was not associated with any type of sleep variability, but social connectedness was associated with less variability in sleep duration. The association between sense of community and less variability in WASO was marginally significant ($p<.1$). The associations remained statistically significant after the inclusion of control variables.

Taken together, the results in Table 3 and Table 4 suggest that on the whole, neighborhood perceived danger, social connectedness, and sense of community were not associated with actigraphic sleep measures. That said, an important exception is social connectedness. Higher neighborhood social connectedness was associated with one aspect of sleep: less variability in sleep duration.

Table 5 shows the results of the additional regressions that added interaction terms for living arrangements that might moderate the relationships between neighborhood social processes and sleep. Results are displayed in Table 5, with Panel A showing results for average sleep characteristics and Panel B showing results

Table 4 Associations Between Neighborhood Social Disorder and Sleep Variability of Older Adults (N=684)

Panel A: Standard deviation as measure of sleep variability						
	Sleep duration		**Fragmentation**		**WASO**	
	Model 1 Coefficient (SE)	Model 2 Coefficient (SE)	Model 1 Coefficient (SE)	Model 2 Coefficient (SE)	Model 1 Coefficient (SE)	Model 2 Coefficient (SE)
Explanatory variables: neighborhood stressors and social integration						
Perceived danger	1.132 (1.845)	-1.040 (2.011)	0.229 (0.135)	0.131 (0.135)	1.449 (1.933)	-1.934 (2.055)
Social connectedness	-4.296* (1.857)	-3.664* (1.687)	-0.073 (0.123)	-0.068 (0.112)	-2.199 (1.645)	-2.697 (1.489)
Sense of community	2.385 (2.212)	3.274 (2.486)	0.121 (0.142)	0.099 (0.134)	1.909 (1.894)	0.871 (1.574)
Control variables						
Age		-0.188 (0.199)		-0.008 (0.014)		0.484* (0.210)
Female		-0.410 (3.146)		-0.018 (0.218)		-3.244 (3.297)
Race/ethnicity						
Black		1.857 (5.038)		0.560 (0.349)		11.480* (5.328)
Hispanic		-5.218 (5.546)		-0.263 (0.383)		-3.932 (5.826)
Others		-3.085 (7.766)		-0.217 (0.537)		-11.487 (8.141)
Education						
High school		-8.648 (5.399)		-0.276 (0.373)		2.801 (5.656)
Some college		-8.341 (5.091)		-0.255 (0.353)		-0.294 (5.337)
College		-8.674 (0.597)		-0.372 (0.416)		-3.435 (6.273)
Income		1.294 (2.160)		-0.010 (0.157)		-2.002 (2.262)
Self-rated health		-3.137* (1.475)		-0.219* (0.105)		-2.112 (1.753)
Self-rated mental health		-1.061 (1.833)		0.170 (0.127)		-0.971 (1.924)

Potential moderator						
Living arrangements						
Single		1.499 (4.155)		0.007 (0.288)		5.801 (4.342)
Inter-generational		-3.030 (5.737)		0.429 (0.396)		9.451 (6.001)
Complex		0.577 (8.080)		0.430 (0.558)		11.833 (8.462)
Panel B: Range as measure of sleep variability						
	Sleep duration		**Fragmentation**		**WASO**	
	Model 1 Coefficient (SE)	Model 2 Coefficient (SE)	Model 1 Coefficient (SE)	Model 2 Coefficient (SE)	Model 1 Coefficient (SE)	Model 2 Coefficient (SE)
Measures of neighborhood stressors and social integration						
Perceived danger	1.798 (3.537)	-2.436 (3.805)	0.423 (0.254)	0.247 (0.256)	3.034 (3.745)	-3.430 (3.929)
Social connectedness	-8.130* (3.459)	-6.909* (3.161)	-0.119 (0.232)	-0.115 (0.212)	-4.069 (3.097)	-5.040 (2.795)
Sense of community	4.771 (4.244)	6.409 (4.822)	0.214 (0.268)	0.170 (0.254)	3.677 (3.584)	1.653 (2.975)
Control variables						
Age		-0.360 (0.380)		-0.015 (0.026)		0.956* (0.385)
Female		-1.120 (5.995)		-0.068 (0.409)		-5.970 (6.219)
Race/ethnicity						
Black		3.674 (9.604)		1.048 (0.656)		20.910* (10.045)
Hispanic		-9.982 (10.569)		-0.526 (0.721)		-6.885 (10.985)
Others		-4.067 (14.800)		-0.365 (1.011)		-22.588 (15.352)
Education						
High school		-15.823 (10.287)		-0.569 (0.704)		6.538 (10.664)
Some college		-15.294 (9.699)		-0.562 (0.663)		0.326 (10.060)
College		-16.515 (11.368)		-0.711 (0.781)		-6.689 (11.823)

Income		2.346 (4.097)		0.011 (0.292)		-3.625 (4.272)
Self-rated health		-6.253 (3.192)		-0.366 (0.218)		-4.442 (3.307)
Self-rated mental health		-1.426 (3.494)		0.283 (0.238)		-1.795 (3.628)
Potential moderator						
Living arrangements						
Single		3.377 (7.918)		0.116 (0.541)		11.191 (8.186)
Inter-generational		-6.763* (3.092)		0.847 (0.746)		18.919 (11.328)
Complex		-1.426 (3.494)		0.844 (1.050)		23.731 (15.958)

Notes: 1. † P< .1 * P< .05 ** P< .01 ***P< .001

2. Model 1 included measures of neighborhood social processes only. Model 2 controlled for age, gender, race/ethnicity, education, household income, living arrangements, self-rated physical health, and self-rated mental health. All regressions were properly weighted.

for three-night sleep variability. To avoid having too many interaction terms, only one set of interaction terms was added to the regression at a time. For example, the first row of Panel A includes only interaction terms between perceived danger and living arrangements; the second row includes only interaction terms between social connectedness and living arrangements, etc. At first glance, Table 5 shows that, with one exception, the association between neighborhood social processes and average sleep characteristics did not vary by living arrangements. The exception is WASO, where higher perceived danger was associated with more WASO for older adults in single families compared to older adults living with spouses.

Moving to Panel B, there is evidence that living arrangements moderate the associations between neighborhood social processes and variability in sleep fragmentation. For example, a high level of perceived danger was associated with greater variability in sleep fragmentation for older adults in intergenerational and complex

Table 5 Summary of Interaction Effects between Neighborhood Social Disorder and Living Arrangements on Average Sleep Characteristics and Sleep Variabilities of Older Adults (N=684)

	Sleep duration	Fragmentation	WASO
Panel A: Outcome variables = Average sleep characteristics			
Perceived danger × living arrangement	No significant interaction terms	No significant interaction terms	High perceived danger associated with more WASO for older adults in single families
Social connectedness × living arrangement	No significant interaction terms	No significant interaction terms	No significant interaction terms
Sense of community ×living arrangement	No significant interaction terms	No significant interaction terms	No significant interaction terms
Panel B: Outcome variables = Sleep variability			
Perceived danger ×living arrangement	No significant interaction terms	High perceived danger associated with greater variability in fragmentation for older adults in intergenerational and complex families	No significant interaction terms
Social connectedness ×living arrangement	No significant interaction terms	High social connectedness associated with less variability in fragmentation for older adults in intergenerational families	No significant interaction terms
Sense of community ×living arrangement	No significant interaction terms	High sense of community associated with less variability in fragmentation for older adults in intergenerational families	No significant interaction terms

Note: Each cell represents results from one regression analysis that included main effects, interaction terms, and all control variables (i.e., age, gender, race/ethnicity, education, household income, living arrangements, self-rated physical health, and self-rated mental health). All regressions were properly weighted.

families. Conversely, a high level of social connectedness and sense of community were associated with less variability in sleep fragmentation for older adults in intergenerational families. These findings suggest that for older adults in intergenerational families, the effects of neighborhood on sleep, including the negative effect of perceived danger and the protective effects of social connectedness and sense of community, may be larger. In short, compared to older adults who live with only their spouse, the sleep variability of older adults in intergenerational families may be more vulnerable to neighborhood stressors but also benefit more from a neighborhood's social strengths. However, these results are only associational. Although the associations suggest a causal effect is possible, further studies are needed to establish definitive causality.

Finally, because women are more likely to have living arrangements with fewer resources and complex social relationships (i.e., in single, intergenerational, or complex households) in later life, and also more likely to be affected by family responsibilities (Burgard, 2011; Venn, Arber, Meadows, & Hislop, 2008), a separate sensitivity analysis was conducted to check for gendered patterns between neighborhood, living arrangements, and sleep. The results of this analysis are presented in Appendix B and Appendix C. Overall, the results show some gender differences. In particular, women living in households with complex social relationships (i.e., intergenerational or complex families) appear to have less sleep variability than men when they live in neighborhoods with high levels of social connectedness and sense of community. This result suggests that neighborhood social connectedness and sense of community may provide a greater protective effect for women's sleep than men's, but the results are only associational. More studies are needed to establish a causal relationship.

V. Discussion and Conclusion

Social scientists have long acknowledged that neighborhood

characteristics, such as neighborhood stressors and levels of social integration, have an impact on individuals' health and well-being. However, until recently, how neighborhoods affect sleep has received relatively little attention in the sociology and social epidemiology literature. This study adds to the growing literature on neighborhoods and sleep by assessing the link between neighborhood stressors, social integration, and sleep in a nationally representative sample of older adults. The study is notable for its use of objective, actigraphic sleep data and by investigating sleep variability over three days, which adds to the prior literature that has so far has focused mostly on the social determinants of average sleep characteristics over several days. The prior, population-based studies of average sleep characteristics (e.g., Chen et al., 2015; Chen, Lauderdale, & Waite, 2016) could be masking an important way that neighborhood conditions contribute to sleep inequality, that is by reducing the regularity of certain individuals' sleep. By including sleep variability, this study deepens the understanding of how neighborhoods can create inequality in sleep.

The results provide some evidence that neighborhood conditions may influence older adults' sleep. Although perceived danger, social connectedness, and sense of community were not associated with average sleep characteristics, regression results show that high level of social connectedness was associated with decreases in two types of sleep variability: in sleep duration and WASO. These results add to the growing literature on the relationship between neighborhood and sleep (e.g., Bierman et al., 2018; Chen-Edinboro et al., 2015; Grigsby-Toussaint et al., 2015; Hale et al., 2013; Hill et al., 2009; Johnson et al., 2015; Simonelli et al., 2015). Also, some evidence was found that, when living in neighborhoods with high levels of social connectedness and sense of community, older adults who lived in intergenerational and complex households had less variability in sleep fragmentation than older adults who lived only with spouses. This result is consistent with recent evidence that social status moderates the relationship between neighborhood

disorder and self-reported sleep problems (Bierman et al., 2018). There was also evidence of gender differences: Women who lived in neighborhoods with high levels of social connectedness appear to have less variability in sleep duration.

Overall, there are two key findings in this study that deserve additional discussion. First, contrary to prior studies that use self-reported sleep measures, this study found no effect of neighborhood social processes on three-night average actigraphic sleep characteristics. The measures of neighborhood stressors and social integration were associated with neither average sleep duration nor average sleep quality, i.e., sleep fragmentation and WASO. These findings suggest that objective sleep characteristics may be less susceptible to the influence of neighborhood than subjective perceptions of sleep. Another possibility is that the mechanisms through which neighborhood stressors and social integration affect objective sleep may be amplifying or buffering negative events. In that way, neighborhood characteristics may be associated with increased or decreased sleep variability instead of average sleep characteristics.

Second, this study finds some evidence that living arrangements moderate the association between neighborhood and sleep. First, the study finds that older adults in intergenerational households, and to some extent complex households, may have more consistent sleep habits (i.e., lower sleep variability) when they live in a socially connected community. But, these older adults were also associated with increased variability in sleep fragmentation when living in neighborhoods with a high degree of perceived danger. In short, the data suggest that older adults in intergenerational families, for better or worse, may be more susceptible to the influence of neighborhood stressors and social integration. Older adults who live alone show no difference in the association between neighborhood and sleep when compared to older adults who live with their spouse. This finding could be because older adults who live alone compensate for the lack of

family members by increasing their social participation, or that living alone means no additional caregiving responsibilities like living in intergenerational families does. This finding is consistent with some prior studies that find living alone in old age was not associated with an increased risk of health problems (Hays, 2002; Michael, Berkman, Colditz, & Kawachi, 2001).

Several limitations of the study must be acknowledged. First, this study did not consider selection into neighborhood and living arrangements. Older adults were not randomly assigned to their neighborhoods, nor were they randomly assigned to different living arrangements. Older adults' socioeconomic backgrounds, personalities, social relationships, employment, and family history may have each influenced their current neighborhood and living arrangement. However, this limitation has limited impact because with cross-sectional data, the study sought to be associational rather than causal. Second, this study was not able to distinguish between short-term and long-term exposure to neighborhood disorder. Measures of neighborhood social processes in NSHAP provided a snapshot of the neighborhood condition but did not offer a history of respondents' neighborhood conditions. As such, it is not possible to determine whether older adults who were chronically exposed to socially disordered neighborhoods had worse sleep than older adults who had temporary exposure to such neighborhoods. Third, because the actigraphic was only for three days, the data may underestimate the potential variation in older adults' sleep. As such, estimates from this study may be conservative; collection of actigraphy data over more days may reveal greater variation in older adults' sleep characteristics than was found here. Finally, it is possible that the observed non-effect may be due to the limited measures of neighborhood social processes. Although the questions were designed to capture the essence of the concept of neighborhood social conditions (Cornwell & Cagney, 2014), the NSHAP did not use a multi-level design in data collection and researchers could not have obtained macro-level measures of

neighborhood characteristics. Thus, the neighborhood social processes in NSHAP reflected an individual's perception of the neighborhood processes instead of measuring the "collective" neighborhood social processes as does some survey-based research in the neighborhood literature.

In summary, this study has combined sociological and sleep theory with empirical research that uses innovative measures of sleep outcomes to highlight the potentially important role that older adults' neighborhood context has on their ability to get good sleep. This study makes important contributions to the research on how neighborhoods affect health by extending the outcome to sleep, which is an important component of health that many older adults struggle with as they age. Socially disordered neighborhoods were found to be associated with poorer sleep quality and more irregularity in sleep habits. Nevertheless, future studies and additional data collection are warranted to fully understand the causal relationship between exposure to disordered neighborhoods and sleep over time. With the next wave of NSHAP data collection, which will include repeated actigraph measures of sleep, it may be possible for researchers to deepen the analysis that was started here and obtain a greater understanding of these relationships.

Appendix A

Questions and Scales of Neighborhood Social Processes in National Social Life Health and Aging Project

Perceived Danger (alpha = 0.812)	**Social Connectedness** (alpha = 0.756)	**Sense of Community** (alpha = 0.681)
Many people in this area are afraid to go out at night.	How often do you and people in this area visit in each other's homes or when you meet on the street?	People in this area can be trusted.
There are places in this area where everyone knows trouble is expected.	How often do you and other people in this area do favors for each other?	People in this area don't share the same value.
You are taking a big chance if you walk in this area along after dark.	How often do you and other people in this area ask each other for advice about personal things?	This is a close-knit area.
		People around here are willing to help their neighbors.
		People in this area generally don't get along with each other.

Appendix B

Summary of Associations Between Neighborhood Social Disorder and Sleep by Gender (N=307 for Male; N=377 for Female)

Panel A: Average sleep characteristics over 3 nights						
	Sleep duration		**Fragmentation**		**WASO**	
	Male Coefficient (SE)	Female Coefficient (SE)	Male Coefficient (SE)	Female Coefficient (SE)	Male Coefficient (SE)	Female Coefficient (SE)
Perceived danger	-0.026 (0.084)	-0.030 (0.074)	-0.068 (0.415)	0.365 (0.356)	1.020 (1.533)	1.402 (1.540)
Social connectedness	-0.067 (0.082)	-0.039 (0.061)	0.001 (0.382)	-0.169 (0.288)	-0.756 (1.368)	-0.971 (1.228)
Sense of community	0.156* (0.070)	-0.039 (0.066)	-0.301 (387)	0.190 (0.308)	-1.152 (1.416)	0.235 (1.248)
Panel B: Range as measure of sleep variability						
	Sleep duration		**Fragmentation**		**WASO**	
	Male Coefficient (SE)	Female Coefficient (SE)	Male Coefficient (SE)	Female Coefficient (SE)	Male Coefficient (SE)	Female Coefficient (SE)
Perceived danger	0.702 (2.834)	0.292 (2.539)	0.110 (0.178)	0.252 (0.185)	-1.071 (3.104)	-1.694 (2.739)
Social connectedness	-1.819 (2.616)	-4.462* (2.112)	0.070 (0.166)	-0.005 (0.149)	-3.995 (2.721)	-0.958 (2.187)
Sense of community	1.670 (2.561)	-0.195 (2.349)	-0.282 (0.166)	0.121 (0.158)	-2.620 (2.686)	-1.221 (2.417)
Panel C: Range as measure of sleep variability						
	Sleep duration		**Fragmentation**		**WASO**	
	Male Coefficient (SE)	Female Coefficient (SE)	Male Coefficient (SE)	Female Coefficient (SE)	Male Coefficient (SE)	Female Coefficient (SE)
Perceived danger	1.089 (5.372)	0.404 (4.850)	0.233 (0.338)	0.448 (0.345)	-1.197 (5.860)	-3.366 (5.173)
Social connectedness	-3.325 (4.992)	-8.583* (4.055)	0.131 (0.314)	-0.004 (0.279)	-7.387 (5.125)	-1.749 (4.131)
Sense of community	2.109 (4.872)	-0.283 (4.515)	-0.523 (0.315)	0.219 (0.297)	-4.801 (5.063)	-2.196 (4.579)

Note: Each column in each panel represents results from one regression analysis that controlled for age, gender, race/ethnicity, education, household income, living arrangements, self-rated physical health, and self-rated mental health. For brevity, coefficients for controlled variables are excluded. All regressions were properly weighted.

Appendix C

Summary of Interaction Effects between Neighborhood Social Disorder and Living Arrangements on Average Sleep Characteristics and Sleep Variabilities of Older Adults by Gender (N=307 for Male; N=377 for Female)

	Sleep duration	Fragmentation	WASO
Panel A: Outcome variables = Average sleep characteristics			
Perceived danger × living arrangement	Men: No significant interaction terms Women: No significant interaction terms	Men: No significant interaction terms Women: No significant interaction terms	Men: No significant interaction terms Women: High perceived danger associated with more WASO for older adults in single families
Social connectedness × living arrangement	Men: No significant interaction terms Women: No significant interaction terms	Men: No significant interaction terms Women: No significant interaction terms	Men: No significant interaction terms Women: No significant interaction terms
Sense of community × living arrangement	Men: No significant interaction terms Women: No significant interaction terms	Men: No significant interaction terms Women: No significant interaction terms	Men: No significant interaction terms Women: No significant interaction terms

Panel B: Outcome variables = Sleep variability			
Perceived danger × living arrangement	Men: No significant interaction terms Women: No significant interaction terms	Men: High perceived danger associated with greater variability in fragmentation for older adults in complex families Women: High perceived danger associated with greater variability in fragmentation for older adults in intergenerational families	Men: No significant interaction terms Women: No significant interaction terms
Social connectedness × living arrangement	Men: No significant interaction terms Women: No significant interaction terms	Men: No significant interaction terms Women: High social connectedness associated with smaller variability in fragmentation for older adults in single families	Men: No significant interaction terms Women: No significant interaction terms
Sense of community × living arrangement	Men: No significant interaction terms Women: No significant interaction terms	Men: No significant interaction terms Women: High social connectedness associated with smaller variability in fragmentation for older adults in intergenerational families	Men: No significant interaction terms Women: No significant interaction terms

Note: Each cell represents results from one regression analysis that included main effects, interaction terms, and all control variables (i.e., age, gender, race/ethnicity, education, household income, living arrangements, self-rated physical health, and self-rated mental health). All regression were properly weighted.

References

Åkerstedt, T. (2006). Psychosocial stress and impaired sleep. *Scandinavian Journal of Work, Environment & Health*, 32, 6: 493-501.

Allison, P. D. (2001). *Missing data* (Sage University papers series on quantitative applications in the social sciences, series no. 07-136). Thousand Oaks, CA: Sage.

Ancoli-Israel, S. (2009). Sleep and its disorders in aging populations. *Sleep Medicine*, 10 (Suppl. 1): S7-S11. https://doi.org/10.1016/j.sleep.2009.07.004

Baron, K. G., Reid, K. J., Malkani, R. G., Kang, J., & Zee, P. C. (2017). Sleep variability among older adults with insomnia: Associations with sleep quality and cardiometabolic disease risk. *Behavioral Sleep Medicine*, 15, 2, 144-157. https://doi.org/10.1080/15402002.2015.1120200

Berkman, L. F., Glass, T., Brissette, I., & Seeman, T. E. (2000). From social integration to health: Durkheim in the new millennium. *Social Science & Medicine*, 51, 6: 843-857. https://doi.org/10.1016/S0277-9536(00)00065-4

Bierman, A., Lee, Y., & Schieman, S. (2018). Neighborhood disorder and sleep problems in older adults: Subjective social power as mediator and moderator. *The Gerontologist*, 58, 1: 170-180. https://doi.org/10.1093/geront/gnx049

Bird, C. E., Seeman, T., Escarce, J. J., Basurto-Dávila, R., Finch, B. K., Dubowitz, T., et al. (2010). Neighborhood socioeconomic status and biological 'wear and tear' in a nationally representative sample of US adults. *Journal of Epidemiology & Community Health*, 64, 10: 860-865. https://doi.org/10.1136/jech.2008.084814

Browning, C. R., & Cagney, K. A. (2002). Neighborhood structural disadvantage, collective efficacy, and self-rated physical health in an urban setting. *Journal of Health and Social Behavior,* 43, 4: 383-399. https://doi.org/10.2307/3090233

Burgard, S. A. (2011). The needs of others: Gender and sleep interruptions for caregivers. *Social Forces*, 89, 4: 1189-1215. https://doi.org/10.1093/sf/89.4.1189

Buysse, D. J. (2014). Sleep health: Can we define it? Does it matter? *Sleep*, 37, 1: 9-17. https://doi.org/10.5665/sleep.3298

Buysse, D. J., Cheng, Y., Germain, A., Moul, D. E., Franzen, P. L., Fletcher, M., et al. (2010). Night-to-night sleep variability in older adults with and without chronic insomnia. *Sleep Medicine*, 11, 1: 56-64. https://doi.org/10.1016/j.sleep.2009.02.010

Cagney, K. A., & Cornwell, E. Y. (2010). Neighborhoods and health in later life: The intersection of biology and community. *Annual Review of Gerontology and Geriatrics*, 30, 1: 323-348. https://doi.org/10.1891/0198-8794.30.323

Cappuccio, F. P., D'Elia, L., Strazzullo, P., & Miller, M. A. (2010). Sleep duration and all-cause mortality: A systematic review and meta-analysis of prospective studies. *Sleep*, *33,* 5: 585-592. https://doi.org/10.1093/sleep/33.5.585

Carpiano, R. M. (2006). Toward a neighborhood resource-based theory of social capital for health: Can Bourdieu and sociology help? *Social Science & Medicine*, 62, 1: 165-175. https://doi.org/10.1016/j.socscimed.2005.05.020

Chen-Edinboro, L. P., Kaufmann, C. N., Augustinavicius, J. L., Mojtabai, R., Parisi, J. M., Wennberg, A. M., et al. (2015). Neighborhood physical disorder, social cohesion, and insomnia: Results from participants over age 50 in the health and retirement study. *International Psychogeriatrics*, 27, 2: 289-296. https://doi.org/10.1017/S1041610214001823

Chen, J. H., Lauderdale, D. S., & Waite, L. J. (2016). Social participation and older adults' sleep. *Social Science & Medicine*, 149: 164-173. https://doi.org/10.1016/j.socscimed.2015.11.045

Chen, J. H., Waite, L. J., & Lauderdale, D. S. (2015). Marriage, relationship quality, and sleep among US older adults.

Journal of Health and Social Behavior, *56,* 3: 356-377. https://doi.org/10.1177/0022146515594631

Chung, J. (2017). Social support, social strain, sleep quality, and actigraphic sleep characteristics: Evidence from a national survey of US adults. *Sleep Health*, 3, 1: 22-27. https://doi.org/10.1016/j.sleh.2016.10.003

Clarke, P. (2008). When can group level clustering be ignored? Multilevel models versus single-level models with sparse data. *Journal of Epidemiology and Community Health,* 62, 8: 752-758. https://doi.org/10.1136/jech.2007.060798

Clarke, P., & Wheaton, B. (2007). Addressing data sparseness in contextual population research using cluster analysis to create synthetic neighborhoods. *Sociological Methods & Research,* 35, 3: 311-351. https://doi.org/10.1177/0049124106292362

Cornwell, E. Y., & Cagney, K. A. (2014). Assessment of neighborhood context in a nationally representative study. *The Journals of Gerontology, Series B: Psychological Sciences and Social Sciences*, 69 (Suppl. 2): S51-S63. https://doi.org/10.1093/geronb/gbu052

Cramm, J. M., Van Dijk, H. M., & Nieboer, A. P. (2013). The importance of neighborhood social cohesion and social capital for the well being of older adults in the community. *The Gerontologist*, 53, 1: 142-152. https://doi.org/10.1093/geront/gns052

Dahl, R. E. (1996). The regulation of sleep and arousal: Development and psychopathology. *Development and Psychopathology*, 8, 1: 3-27. https://doi.org/10.1017/S0954579400006945

Durkheim, É. (1951). *Suicide: A study in sociology* (JA Spaulding & G. Simpson, Trans.). Glencoe, IL: Free Press. (Original work published 1897)

Foley, D. J., Monjan, A. A., Brown, S. L., & Simonsick, E. M. (1995). Sleep complaints among elderly persons: An

epidemiologic study of three communities. *Sleep,* 18, 6: 425-432. https://doi.org/10.1093/sleep/18.6.425

Frank, R., Cerdá, M., & Rendón, M. (2007). Barrios and burbs: Residential context and health-risk behaviors among Angeleno adolescents. *Journal of Health and Social Behavior*, 48, 3: 283-300. https://doi.org/10.1177/002214650704800306

Gangwisch, J. E., Heymsfield, S. B., Boden-Albala, B., Buijs, R. M., Kreier, F., Pickering, T. G., et al. (2007). Sleep duration as a risk factor for diabetes incidence in a large US sample. *Sleep*, 30, 12: 1667-1673. https://doi.org/10.1093/sleep/30.12.1667

Grigsby-Toussaint, D. S., Turi, K. N., Krupa, M., Williams, N. J., Pandi-Perumal, S. R., & Jean-Louis, G. (2015). Sleep insufficiency and the natural environment: Results from the US behavioral risk factor surveillance system survey. *Preventive Medicine*, 78: 78-84. https://doi.org/10.1016/j.ypmed.2015.07.011

Hale, L. (2005). Who has time to sleep? *Journal of Public Health*, 27, 2: 205-211. https://doi.org/10.1093/pubmed/fdi004

Hale, L., Hill, T. D., Friedman, E., Nieto, F. J., Galvao, L. W., Engelman, C. D., et. al. (2013). Perceived neighborhood quality, sleep quality, and health status: Evidence from the Survey of the Health of Wisconsin. *Social Science & Medicine*, 79*:* 16-22. https://doi.org/10.1016/j.socscimed.2012.07.021

Hawkley, L. C., Kocherginsky, M., Wong, J., Kim, J., & Cagney, K. A. (2014). Missing data in Wave 2 of NSHAP: Prevalence, predictors, and recommended treatment. *Journals of Gerontology, Series B: Psychological Sciences and Social Sciences*, 69 (Suppl. 2): S38-S50. https://doi.org/10.1093/geronb/gbu044

Hays, J. C. (2002). Living arrangements and health status in later life: A review of recent literature. *Public Health Nursing*, 19, 2: 136-151. https://doi.org/10.1046/j.1525-1446.2002.00209.x

Hill, T. D., Burdette, A. M., & Hale, L. (2009). Neighborhood

disorder, sleep quality, and psychological distress: Testing a model of structural amplification. *Health & Place*, 15, 4: 1006-1013. https://doi.org/10.1016/j.healthplace.2009.04.001

Hofman, A., Breteler, M. M., van Duijn, C. M., Krestin, G. P., Pols, H. A., Stricker, B. H. C., et al. (2007). The Rotterdam study: Objectives and design update. *European Journal of Epidemiology*, 22, 11: 819-829. https://doi.org/10.1007/s10654-007-9199-x

Huang, F. L. (2018). Multilevel modeling myths. *School Psychology Quarterly*, 33, 3: 492-499. https://doi.org/10.1037/spq0000272

Hughes, M. E., & Waite, L. J. (2002). Health in household context: Living arrangements and health in late middle age. *Journal of Health and Social Behavior*, 43, 1: 1-21. https://doi.org/10.2307/3090242

Hystad, P., & Carpiano, R. M. (2012). Sense of community-belonging and health-behaviour change in Canada. *Journal of Epidemiology and Community Health*, 66, 3: 277-283. https://doi.org/10.1136/jech.2009.103556

Inoue, S., Yorifuji, T., Takao, S., Doi, H., & Kawachi, I. (2013). Social cohesion and mortality: A survival analysis of older adults in Japan. *American Journal of Public Health*, 103, 12, e60-e66. https://doi.org/10.2105/AJPH.2013.301311

Johnson, D. A., Brown, D. L., Morgenstern, L. B., Meurer, W. J., & Lisabeth, L. D. (2015). The association of neighborhood characteristics with sleep duration and daytime sleepiness. *Sleep Health*, 1, 3: 148-155. https://doi.org/10.1016/j.sleh.2015.06.002

Kent, R. G., Uchino, B. N., Cribbet, M. R., Bowen, K., & Smith, T. W. (2015). Social relationships and sleep quality. *Annals of Behavioral Medicine*, 49, 6: 912-917. https://doi.org/10.1007/s12160-015-9711-6

Kim, J., & Waite, L. J. (2016). Complex households and the distribution of multiple resources in later life: Findings from

a national survey. *Research on Aging*, *38,* 2: 150-177. https://doi.org/10.1177/0164027515581421

Klinenberg, E. (2002). *Heat wave: A social autopsy of disaster in Chicago*. Chicago: University of Chicago Press.

Knutson, K. L., Rathouz, P. J., Yan, L. L., Liu, K., & Lauderdale, D. S. (2007). Intra-individual daily and yearly variability in actigraphically recorded sleep measures: The CARDIA study. *Sleep*, 30, 6: 793-796. https://doi.org/10.1093/sleep/30.6.793

Lauderdale, D. S., Schumm, L. P., Kurina, L. M., McClintock, M., Thisted, R. A., Chen, J. H., et al. (2014). Assessment of sleep in the national social life, health, and aging project. *The Journals of Gerontology, Series B: Psychological Sciences and Social Sciences*, 69 (Suppl. 2): S125-S133. https://doi.org/10.1093/geronb/gbu092

Lemola, S., Ledermann, T., & Friedman, E. M. (2013). Variability of sleep duration is related to subjective sleep quality and subjective well-being: An actigraphy study. *PLoS One*, 8, 8: e71292. https://doi.org/10.1371/journal.pone.0071292

Li, L. W., Zhang, J., & Liang, J. (2009). Health among the oldest-old in China: Which living arrangements make a difference? *Social Science & Medicine*, 68, 2: 220-227. https://doi.org/10.1016/j.socscimed.2008.10.013

Liu, Y., Wheaton, A. G., Chapman, D. P., Cunningham, T. J., Lu, H., & Croft, J. B. (2016). Prevalence of healthy sleep duration among adults—United States, 2014. *Morbidity and Mortality Weekly Report*, *65,* 6: 137-141. https://doi.org/10.15585/mmwr.mm6506a1

Manning, W. D., & Brown, S. L. (2011). The demography of unions among older Americans, 1980–present: A family change approach. In R. A. Settersten & J. L. Angel (Eds.), *Handbook of sociology of aging* (pp. 193-210). New York: Springer.

Martin, J. L., & Hakim, A. D. (2011). Wrist actigraphy. *Chest*, 139, 6: 1514-1527. https://doi.org/10.1378/chest.10-1872

Mezick, E. J., Matthews, K. A., Hall, M., Kamarck, T. W., Buysse, D. J., Owens, J. F., et al. (2009). Intra-individual variability in sleep duration and fragmentation: Associations with stress. *Psychoneuroendocrinology*, 34, 9: 1346-1354. https://doi.org/10.1016/j.psyneuen.2009.04.005

Michael, Y. L., Berkman, L. F., Colditz, G. A., & Kawachi, I. (2001). Living arrangements, social integration, and change in functional health status. *American Journal of Epidemiology*, 153, 2: 123-131. https://doi.org/10.1093/aje/153.2.123

Perkins, D. D., Meeks, J. W., & Taylor, R. B. (1992). The physical environment of street blocks and resident perceptions of crime and disorder: Implications for theory and measurement. *Journal of Environmental Psychology*, 12, 1: 21-34. https://doi.org/10.1016/S0272-4944(05)80294-4

Phillips, B., & Mannino, D. M. (2007). Do insomnia complaints cause hypertension or cardiovascular disease? *Journal of Clinical Sleep Medicine*, 3, 5: 489-494.

Piro, F. N., Nœss, Ø., & Claussen, B. (2006). Physical activity among elderly people in a city population: The influence of neighbourhood level violence and self perceived safety. *Journal of Epidemiology & Community Health*, 60, 7: 626-632. https://doi.org/10.1136/jech.2005.042697

Robert, S. A., & Li, L. W. (2001). Age variation in the relationship between community socioeconomic status and adult health. *Research on Aging*, 23, 2: 234-259. https://doi.org/10.1177/0164027501232005

Sadeh, A. (2011). The role and validity of actigraphy in sleep medicine: An update. *Sleep Medicine Reviews*, 15, 4: 259-267. https://doi.org/10.1016/j.smrv.2010.10.001

Sampson, R. J. (2012). *Great American city: Chicago and the enduring neighborhood effect*. Chicago, IL: University of Chicago Press.

Sampson, R. J., Morenoff, J. D., & Gannon-Rowley, T. (2002). Assessing "neighborhood effects": Social processes and new

directions in research. *Annual Review of Sociology*, 28: 443-478. https://doi.org/10.1146/annurev.soc.28.110601.141114

Simonelli, G., Patel, S. R., Rodríguez-Espínola, S., Pérez-Chada, D., Salvia, A., Cardinali, D. P., et al. (2015). The impact of home safety on sleep in a Latin American country. *Sleep Health*, 1, 2: 98-103. https://doi.org/10.1016/j.sleh.2015.02.006

Slater, J. A., Botsis, T., Walsh, J., King, S., Straker, L. M., & Eastwood, P. R. (2015). Assessing sleep using hip and wrist actigraphy. *Sleep and Biological Rhythms*, 13, 2: 172-180. https://doi.org/10.1111/sbr.12103

Troxel, W. M., Buysse, D. J., Monk, T. H., Begley, A., & Hall, M. (2010). Does social support differentially affect sleep in older adults with versus without insomnia? *Journal of Psychosomatic Research*, 69, 5: 459-466. https://doi.org/10.1016/j.jpsychores.2010.04.003

Venn, S., Arber, S., Meadows, R., & Hislop, J. (2008). The fourth shift: Exploring the gendered nature of sleep disruption among couples with children. *British Journal of Sociology*, 59, 1: 79-97. https://doi.org/10.1111/j.1468-4446.2007.00183.x

鄰里社會壓力與社會連結、居住安排對老年人睡眠狀況與變化之影響

陳人豪
國立政治大學社會學系
11605 臺北市指南路二段 64 號
Email: jenhao@nccu.edu.tw

摘 要

美國研究證實，居住社區會影響不同群體之個人健康與福祉。然而有關於社區鄰里與健康的研究中，卻尚未探究其對老人睡眠的影響。本研究整合睡眠醫學和社會學理論觀點，探究老人客觀睡眠品質如何受其所處的社區鄰里社會環境所影響。本研究欲驗證兩項假說：（一）居住在危險或孤立的鄰里會危害老人的睡眠；反之，居住在社區連結強的鄰里則會提升其睡眠狀況。（二）老年人的居住安排能調節鄰里特徵對睡眠的影響。本研究使用美國老年健康社會生活調查資料進行統計分析，探究居住鄰里社會環境對客觀睡眠狀況之影響，包含平均睡眠狀況與睡眠變化情形。結果顯示，老人居住於孤立的鄰里較易睡眠中斷；反之，居住於社會連結強的鄰里則有較穩定的睡眠時間長度。此外，老人的居住安排方式調節社區對睡眠的效果。與子女同住或居住安排較為複雜的老人，其居住於危險鄰里對於睡眠的負面效果會被強化。本研究證實社區鄰里特徵能預測老年客觀睡眠狀況，但此影響效果在不同性別間有差異。並且，社區鄰里特徵的效果受老人居住安排方式所調節。

關鍵詞：老化、鄰里效應、人口健康、居住安排、睡眠