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Social Participation and Older Adults' Sleep

Jen-Hao Chen, Ph.D.,
Department of Health Sciences and Harry S. Truman School of Public Affairs, University of Missouri

Diane Lauderdale, Ph.D., and
Department of Public Health Sciences, University of Chicago

Linda Waite, Ph.D.
Department of Sociology, University of Chicago

Abstract

Sleep complaints are common among older adults, and poor sleep has been found to predict chronic diseases and mortality. Many studies suggest that social participation benefits healthy aging. We examined the relationships between older adults' social participation and their sleep using two waves (2005–2006–2010–2011) of data from the National Social Life, Health, and Aging Project (NSHAP). The NSHAP recorded older adults' social participation (including religious attendance, volunteer work, and attendance at meetings of organized groups) over five years, and included self-reported sleep duration in both waves and, in the second wave, measures of insomnia symptoms and measures of sleep patterns and rhythms using actigraphy for a subsample. Cross-sectional analysis of the second wave indicates that those reporting higher levels of social participation had better actigraphic sleep but not better self-reported sleep. However, longitudinal analysis suggests that change in social participation was not associated with actigraphic or self-reported sleep characteristics in the second wave data. Further analysis using fixed-effects models showed no association between changes in social participation and changes in self-reported sleep duration. Thus, although older adults with greater social participation slept better, we did not find that increasing social participation improved sleep. These findings imply that a self-selection process may at work; or if social participation does affect sleep, the causal effect may be over a much shorter time frame than five years.

Keywords

Actigraphy; aging; social participation; sleep

The social connectedness of older adults is a salient issue in a rapidly aging society. Close connections to, and participation in, social groups and communities provide material and

Corresponding Author: Jen-Hao Chen, Ph.D. Department of Health Sciences and Harry S. Truman School of Public Affairs, 501 Clark Hall, University of Missouri, Columbia, MO 65211. Phone: 573-882-9129. chenje@health.missouri.edu.

social support, a sense of belonging, and access to information that can be crucial for health and well-being (Berkman, Glass, Brissette, & Seeman, 2000; Kawachi & Berkman, 2000; Uchino, Cacioppo, & Kiecolt-Glaser, 1996). Patterns of social participation change in parallel with life-cycle transitions. Events such as retirement, the decline in physical and mental health in later life, and the loss of a family member or spouse all have considerable effects on the level and configuration of an individual's social participation (Bukow, Maas, & Lampert, 2002; Cornwell, Laumann, & Schumm, 2008; Erlinghagen & Hank, 2006). A large volume of literature has documented the health consequences of social participation at older ages (e.g., de Leon, Glass, & Berkman, 2003; Folland, 2007; Hill, Angel, Ellision, & Angel, 2005; Hummer, Rogers, Nam, & Ellison, 1999). Although the exact mechanisms are not yet fully explored, most studies suggest that social participation is associated with better health outcomes, in particular mental health and mortality, in older adults.

Despite substantial attention to the link between social participation and morbidity/mortality, relatively few studies attempt to link social participation to behavioral risk factors at older ages. This is an oversight because, as many theories suggested (e.g., Berkman, Glass, Brissette, & Seeman, 2000; Kawachi & Berkman, 2000), one of the reasons why social participation benefits older adults' health may be through promotion of healthy behaviors. For example, some studies suggest that participation in religious activities is negatively associated with the likelihood of smoking at older ages (Koenig et al., 1998; Strawbridge, Shema, Cohen, & Kaplan, 2001). Recently, sleep has been increasingly recognized as a crucial behavioral risk factor for cognitive decline, chronic diseases, and mortality in older adults (Cappuccio et al., 2010; Cricco, Simonsick, & Foley, 2002; Gangwisch et al., 2007; Phillips & Mannino, 2007). However, to our knowledge, no study has examined the role of social participation in older adults' sleep. Furthermore, sleep problems are common among older adults (Ancoli-Israel, 2009); large surveys found that nearly half of older adults report at least one insomnia symptom (Foley et al., 1995; Anonymous, 2014). Taken together, these studies suggest that sleep may be an important behavioral risk factor through which social processes affect morbidity and mortality at older ages.

Motivated by this concern, this study aims to examine the relationship between social participation and older adults' sleep. Drawing on theories and research from social epidemiology and medical sociology, we provide one of the first systematic analyses of social participation and older adults' sleep. In addition to social causation processes, we also consider the role of human agency (Thoits & Hewitt, 2001). Many studies of the impact of social relationships on health overlook the necessary role of human agency for social participation. Although an individual's well-being can be enhanced by social participation, personal health conditions also facilitate social participation (Bukow, Maas, & Lampert, 2002; Cornwell, Laumann, & Schumm, 2008; Erlinghagen & Hank, 2006; Kelley-Moore, & Ferraro, 2001). We thus consider both social causation and self-selection processes in explaining the relationship between social participation and sleep. Finally, nationally representative data that include information both on older adults' social participation and on sleep are scarce. Notably, our data include direct actigraphic assessments of sleep characteristics. The richness of our data allow us to examine the influence of social participation on two dimensions of sleep—perceived sleep disorder of older adults and sleep patterns and rhythms..

Social Determinants of Sleep

Sleep is one of the most important restorative behaviors for an individual's health and well-being. All humans require sleep because it provides new energy for the brain and for physical activities. However, relatively few surveys with representative population samples include sleep questions, and most sleep research is clinic based, includes patients or volunteers, and collects data in a clinical sleep laboratory. We thus know more about the role of mental and physical illness in shaping an individual's sleep outcomes than about the effects of social processes.

This, however, appears to have changed recently; epidemiologists and social scientists have begun to link a wide array of social factors to sleep outcomes using population-based samples. For example, in a series of papers, Burgard and Ailshire show that those with strained family relationships report more sleep problems (Ailshire & Burgard, 2012), and differences in family responsibilities generate substantial gender gaps in sleep outcomes, including more interrupted sleep and longer self-reported sleep duration in women (Burgard 2011; Burgard & Ailshire, 2013). In a recent article, we (2015b) examined the relationship between marriage and self-report and actigraphic sleep characteristics in older adults. We found that married older adults showed better actigraphic sleep characteristics than single older adults. Among married older adults, positive aspects of the marital relationship were associated with better actigraphic sleep characteristics. The work environment also influences younger adults' sleep. Those who report stressful experiences at work also tend to report poor sleep quality (Burgard & Ailshire 2009). Lastly, as is the case for other health outcomes, scholars have found that markers of socioeconomic status are strong predictors of sleep characteristics. Both education and income were negatively associated with time to fall asleep (Anonymous, 2006; Friedman et al., 2007), higher rates of sleep complaints (Grandner et al., 2010), and short sleep duration (Stamatakis, Kaplan, & Roberts, 2007).

Whereas these studies document the influence of family relationships, the work environment, and socioeconomic status on sleep, the implications of social participation—an influential factor in older adults' health— have received little attention. Furthermore, few prior studies on the social determinants of sleep consider the complex nature of human sleep. Defining what constitutes good sleep is not straightforward. Sleep duration, sleep consolidation, and experience of restfulness are all key aspects for evaluating a person's sleep. These aspects of sleep may be measured by time set aside for sleep, frequency of awakening during the night, or the degree to which one feels rested in the morning. Prior studies have found that individuals' perceptions of their sleep and direct assessments of sleep often diverge (Anonymous, 2015a). As such, the social scientific literature of sleep would be strengthened by considering the influence of social process on both individuals' perceived sleep disorder and sleep patterns and rhythms. With a few exceptions (i.e., Anonymous, 2015b), prior studies in social sciences are unable to examine these two important aspects of sleep. Because of these limitations, we have gaps in our understanding of the influence of social life on sleep at older ages.

Social Participation and Sleep at Old Ages

The literature on older adults' social participation and theories from medical sociology provide substantial theoretical motivation for understanding the relationship between social participation and sleep in older adults. Bukov and colleagues (2002) defined social participation as "the conduct of actions in which individuals share their resources with others." Depending on the resources that individuals shared, social participation can be further distinguished as collective, productive, and political (Bukov, Maas, & Lampert, 2002). Of the three types, collective social participation—"common acting of group members through shared time" (Bukov, Maas, & Lampert, 2002)—appears to be the most consequential for older adults' health. It has been documented that older adults who frequently participate in religion, community, or volunteer activities show better health outcomes than others (Hill, Angel, Ellison, & Angel, 2005; Hummer, Rogers, Nam, & Ellison, 1999; Zhang, 2008). However, studies of other types of social activities (such as giving help to relatives, friends, or neighbors) often find no strong beneficial effect on the elderly person's health (Pynnonen, Tormakangas, Heikkinen, Rantanen, & Lyyra, 2012). Thus, this study focuses on the role of collective social participation in older adults' sleep.

Collective social participation can affect sleep through two mechanisms. First, one key positive feature of collective social participation is the provision of a sense of belonging and social integration through shared time and engagement in joint activities with members of a religious or community group. Companionship and social integration are crucial for older adults' psychological well-being, which in turn promotes sleep at night. Clinical and epidemiological studies find that loneliness undermines sleep quality (Cacioppo et al., 2002; Anonymous, 2011). Companionship with confidants and friends may thus support good sleep quality. Furthermore, the emotional support and resources gained from social participation may help buffer stress, which can damage psychological well-being (Thoits, 2011). Given that insomnia is an important symptom of mental health problems (Harvey, 2001), the resources from social membership may improve sleep outcomes by ameliorating the effects of stress. Accordingly, collective social participation may affect sleep via its influence on psychological well-being and mental health outcomes.

Second, social participation may influence older adults' physical health and health-related behaviors. Older adults who are more involved in religious and community groups have better physical health outcomes, such as lower mortality risk at mid-life (e.g., de Leon, Glass, & Berkman, 2003; Folland, 2007; Hill, Angel, Ellision, & Angel, 2005; Hummer, Rogers, Nam, & Ellison, 1999). Because older adults with medical problems are more likely to report insomnia symptoms (Foley et al., 2004), social participation may promote sleep through an improvement in physical health status or a promotion of positive health behaviors. In addition, social relationships affect risky health behaviors. Clinical and epidemiological studies indicate that alcohol abuse and smoking can impair sleep (Roehrs & Roth, 2001; Zhang et al., 2006). The reduction of risky health behaviors may also lead to better physical outcomes at old ages, which in turn promote better sleep.

Given that prior studies demonstrate strong effects of social participation on older adults' mental health and physiology, we expect that social participation will improve both

dimensions of sleep (i.e., perceived sleep disorder and sleep patterns and rhythms). This, however, does not suggest that we expect the strength of associations between social participation and the two sleep constructs will be the same. As the two dimensions of sleep are conceptually distinct and regulated by different biological and physiological processes, it is possible that one dimension of sleep is more susceptible to the influence of social participation than the other. Current theoretical perspectives offer little guidance on the expected direction of this difference.

The Role of Self-Selection

Although many theories and prior research point out the potential pathways by which social participation may promote sleep, it is also possible that good sleep enables older adults to be active participants in volunteer work, religious activities, and organized groups. Human agency is the antecedent for all behaviors and activities (Thoits, 1994; 2011). Accordingly, better health provides physical resources that older adults can use to engage in social activities. High levels of cognitive functioning and mastery expedite the search for volunteer opportunities, involvement in religious activities, and maintenance of ties with organized groups. Furthermore, many types of social participation require a minimum level of physical functioning. Older adults who do not have a good physical functioning may find it difficult to participate in social activities outside of the home. Not having enough high-quality sleep can increase fatigue and cognitive inefficiency in older adults (Alapin, Fichten, Libman, Creti, Bailes, & Wright, 2000; Shekleton, Rogers, & Rajaratnam, 2010), which may decrease their energy and ability to actively engage in social activities.

It is well documented that older adults in poor health are less likely to participate in various forms of social activities than those in good health (Bukov, Maas, & Lampert, 2002; Cornwell, Laumann, & Schumm, 2008; Erlinghagen & Hank, 2006). This self-selection process can also occur between social participation and sleep. Older adults who have poor sleep may not be energetic enough to engage in various social activities. However, a correlation between social participation and sleep at the same time point provides little information to adjudicate the social causation and self-selection processes. Given this, in addition to cross-sectional analysis, this study also examines changes in social participation in relation to older adults' sleep characteristics in order to better understand the relative importance of social causation and self-selection mechanisms in producing the correlations between social participation and sleep. We expect that if social-causation processes dominate, changes in social participation will be associated with sleep characteristics at a later time. However, if changes in social participation do not predict later sleep characteristics, results suggest that the self-selection process dominates or social participation may not affect sleep over the period of observation.

Data

National Social Life, Health, and Aging Project

This study used data from National Social Life, Health, and Aging Project (NSHAP), a population-based, longitudinal study of health, social life, and well-being among older Americans. A nationally representative probability sample of community-dwelling

individuals aged 57–85 was selected from households across the United States screened in 2004. African-Americans, Latinos, men, and the oldest-old (75–84 years at the time of screening) were over-sampled. Currently, NSHAP has two waves of data: 2005–2006 (first wave) and 2010–2011 (second wave). The second wave of data collection extended the sample to include the spouses and cohabiting partners of Wave 1 respondents. Therefore, there were Wave 2 participants for whom there were no Wave 1 data. Partners were eligible to participate in the NSHAP second wave of data collection if they were at least 18 years of age and resided in the household with the Wave 1 respondent at the time of the second wave interview.

For the second wave of data collection, approximately one-third of the primary respondents were randomly selected to participate in an additional activity and sleep study. Of 1117 selected individuals, 897 agreed (220 refused) to participate. After agreeing to participate, respondents were recontacted to arrange to have a wrist actigraph and a booklet on activity and sleep booklet mailed to them. These collect information about the respondent's activity levels and sleep over three full days (72 hours total). Taken together, data collected from actigraph and sleep booklet provided rich information of sleep characteristics in a representative sample of older adults. In total, 819 individuals were successfully recontacted and completed the activity study. After excluding 39 individuals with no useable actigraph data, the activity study yielded a sample of 780 individuals with complete actigraphy data. Among these 780 individuals, 524 individuals had been included in Wave 1. This yielded a final sample of 780 individuals for cross-sectional analysis and a sample size of 524 for analysis across waves.

Measures

Actigraph-estimated sleep characteristics—The objective sleep measures were derived from the actigraphy data in Wave 2 (Anonymous, 2014). The Actiwatch (Philips/Respironics 2010) records intensity and frequency of movement using a piezoelectric linear accelerometer with 15-second epochs. The Actiwatch continually registers wrist movements, and the sum of all wrist movements during each epoch is saved as an activity score. Data from the Actiwatch were downloaded and analyzed using the manufacturer's Actiware software version 5.59 (Philips/Respironics 2010). This study used the manufacturer's recommended settings for the software. In the present study, we focused on four actigraph-estimated sleep characteristics: (1) actigraphic sleep duration (defined as the total duration of all epochs scored as sleep within the major sleep interval—i.e., the time from the first epoch scored as sleep to the last epoch scored as sleep for the primary sleep interval in each 24-hour period), (2) the number of wakefulness bouts during the sleep interval, (3) a sleep fragmentation index ranging from 0–100 that indicates sleep disruption as the sum of two percentages: 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 (4) wake after sleep onset (WASO, defined as the total minutes awake during the sleep interval). Wakeful bouts, sleep fragmentation, and wake after sleep onset can be considered as actigraph-estimated sleep quality indicators and all relate to the consolidation of sleep during the main sleep period.

Self-reported sleep characteristics—Wave 1 included a survey question on sleep duration. Wave 2 survey measures of sleep characteristics included self-reported hours of sleep and insomnia symptoms. First, each respondent was asked to report his or her usual bedtime and wake up time, separately for weekdays and weekends: "What time do you usually go to bed and start trying to fall asleep?" and "What time do you usually wake up?" Using this information, we calculated each respondent's usual sleep duration for weekdays and weekends separately. Next, we multiplied weekday sleep duration by five and weekend sleep duration by two and divided the sum by seven to obtain an estimate of self-reported average weekly total sleep time. Second, NSHAP also included four questions on insomnia symptoms. These four questions, often used in surveys and specifically included in NSHAP for comparability to the Health and Retirement Study (HRS), were: "How often do you have trouble falling asleep?" "How often do you have trouble with waking up during the night?" "How often do you have trouble with waking up too early and not being able to fall asleep again?" and "How often do you feel really rested when you wake up in the morning?" Response categories for these questions were: most of the time = 2, sometimes = 1, rarely or never = 0. These symptoms are key components of diagnosing insomnia according to the *Diagnostic and Statistical Manual of Mental Disorders (*American Psychiatric Association, 2013*)* and *International Classification of Diseases (*World Health Organization, 2012*)*. We followed the strategy by anonymous (2015a) and created an insomnia symptom scale using the four sleep questions (the feeling rested question was reverse coded). This scale serves as a measure of insomnia-related sleep complaints. The insomnia symptoms scale has an alpha of 0.66.

Social participation—In both waves of the NSHAP surveys, respondents were asked questions about their social participation. These questions asked (1) how often they attended religious services in the past 12 months, (2) how often they did volunteer work in the past 12 months, and (3) how often they attended meetings of an organized group in the past 12 months. Answer categories ranged from "never" to "several times a week." In addition to analyzing older adults' participation in each activity separately, we also created a summary score of a respondent's community involvement. Exploratory factor analysis suggests that these three variables loaded into a common factor, and we predicted a factor score based on answers to the three questions. The reliability of the score was 0.71 for the first wave and 0.72 for the second wave.

Confounders—Our theoretical framework suggests that a number of factors may confound the relationship between collective social participation and sleep. These confounders included personal health, cognitive ability, and demographic characteristics. For older adults' heath status, we controlled for self-reported physical health and self-reported mental health, obtained by respondent ratings of each (measured as poor = 1 to excellent = 5). Functional health was assessed by seven questions asking respondents' difficulty with activities of daily living (ADL). An ADL scale was created by summing up points for 7 activities, including walking a block, walking across the room, dressing, bathing, eating, transferring in and out of bed, and toileting (Huisingh-Scheetz et al., 2014). To measure cognitive ability, we used the survey-adapted version of the Montreal Cognitive Assessment (Kotwal et al., 2014; Shega et al., 2014). Two health risk behaviors—(1)

smoking and (2) binge drinking in the last three months—were coded as dummy variables. Social support was measured by the following two questions: “How often can you open up to your friends if you need to talk about your worries?” and “How often can you rely on your friends for help if you have a problem?” Response categories were “never,” “rarely,” “some of the time,” and “often.” In addition, we also controlled for key social and demographic characteristics including education, race and ethnicity, retirement status, marital status, household income, gender and age.

Analytical Strategy

We began with weighted descriptive statistics of older adults in the NSHAP sample with actigraphy. Next, we examined the relationship between social participation and actigraphic and self-reported sleep characteristics using ordinary least squares regressions accounting for NSHAP’s complex survey design. All regressions adjusted for personal health, demographics, health behaviors, and social support variables. Finally, because most sleep variables were available only at Wave 2, to test whether changes in social participation influence sleep in older adults, we examined the associations of changes in older adults’ social participation from Wave 1 to Wave 2 with sleep outcomes at Wave 2, controlling for baseline sleep (i.e., self-reported sleep duration and feeling rested), Wave 1 social participation, time-invariant demographic characteristics in the second wave and changes in marital status, retirement status, household income, health behaviors, ADL scale, social support, and self-reported physical health and mental health. Because the cognitive measure used in Wave 2 was not available in Wave 1, we controlled for cognitive function at Wave 2. Finally, although actigraphic sleep characteristics and insomnia symptoms were only measured at Wave 2, NSHAP had self-reported sleep duration for both waves. As such, a fixed-effects or random-effects analysis of the relationship between social participation and self-reported sleep duration was feasible. Random-effects model provided better evidence on the relationship between social participation and sleep by examining the association between changes of social participation and changes of self-reported sleep duration. A social causation explanation is likely if a significant association is found. However, since unobserved time-invariant confounders might obscure the relationship between social participation and self-reported sleep duration in random-effects model, we also employed a fixed-effects model. Results from a fixed-effects model (in comparison to random-effects model) provided better evidence on the relationship between social participation and self-reported sleep duration. With respect to missing values, we used multiple imputation to account for potential biases resulting from missing data in the control variables. Multiple imputation involves replacing missing values with predictions based on other observed variables using a Monte Carlo technique (Rubin, 1987). 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, creating several complete datasets. The use of multiple imputation data produces better estimates of the missing values that create uncertainty around the missing data (Allison, 2002; Hawkley et al., 2014).

Results

Descriptive Statistics

Table 1 provides weighted descriptive statistics. As the table shows, social participation varies substantially across individuals. On the one hand, for each social participation activity, about one-fourth to one-third of the older adults surveyed had not participated in the activity within the past 12 months. On the other hand, about 10 to 15 percent of older adults were frequent participants in volunteer work, religious activities, or community organizations and participated in these activities several times a week. We created a composite score of social participation using factor analysis with the mean of factor score standardized to zero.

With respect to sleep characteristics, the average duration of actigraphic sleep time was 435 minutes (or 7.25 hours). The mean sleep fragmentation index was 14%, mean WASO was 39 minutes, and the mean number of wake bouts was 46. The average self-reported sleep duration was 493 minutes (or 8.2 hours), and the mean insomnia symptom scale was 2.96 on a scale of 0 to 8.

Regression Results

Table 2 presents results of the regression of older adults' actigraphic sleep characteristics on concurrent collective social participation. Results showed that older adults with greater levels of social participation had better sleep outcomes measured by actigraph. Specifically, after controlling for all confounders, those who participated more often in religious services, volunteer work, and/or meetings of organized groups showed lower levels of wake after sleep onset (WASO), fewer wake bouts, and less sleep fragmentation. Social participation was not related to actigraphic sleep duration. Nor was social participation significantly associated with self-reported sleep duration or insomnia symptoms.

In Table 3, we examined the associations between social participation and actigraphic and self-reported sleep characteristics for each type of social participation separately. We treated participation level for each social activity as an ordinal variable. A sensitivity analysis treating these variables as categorical showed similar patterns. Thus, for ease of interpretation, we report the ordinal results. All regressions controlled for full sets of confounders. As Table 3 suggests, frequent participation in volunteer work and in religious services was associated with better actigraphic sleep characteristics as indicated by less WASO, fewer wake bouts, and less sleep fragmentation. The associations between participation in meetings of organized groups and sleep characteristics were in the same direction, but not statistically significant. Thus, it appears that the associations between the social participation scale and actigraphic sleep characteristics were mostly driven by participation in volunteer work and religious services.

Next, we consider how changes in older adults' social participation related to their sleep outcomes. These analyses only include the 524 respondents who participated in both Wave 1 and Wave 2. Table 4 summarizes the coefficients from models regressing changes in older adults' social participation on Wave 2 sleep characteristics. All regressions controlled for social participation at Wave 1, age, gender, race and ethnicity, education, MoCA-SA at

Wave 2, changes in household income, changes in marital status, changes in retirement status, changes in self-rated physical health and mental health, changes in health behaviors, change in ADL scale, and changes in social support. As Table 4 suggests, after taking baseline social participation and confounders into account, there is little evidence of associations between changes in the social participation scale and sleep characteristics, with the exception of self-reported sleep duration. Increased social participation is associated with shorter self-reported sleep duration. When examining each social participation activity separately, we found that increased participation in religious services was associated with fewer wake bouts, less sleep fragmentation, and shorter self-reported sleep duration at Wave 2. Increased participation in volunteer work and meetings of organized groups showed little impact on either actigraphic or self-reported sleep characteristics.

Finally, Table 5 presents results of the relationship between social participation and self-reported sleep duration (i.e., the only sleep measure that was available in both waves) from both random-effects and fixed-effects models. We found no evidence of strong associations between social participation and self-reported sleep duration. Taken together, Table 4 and Table 5 suggest that changes in social participation over five years has limited effects on older adults' sleep characteristics except perhaps for religious participation and actigraphic measures of sleep quality.

Discussion & Conclusion

This study provides a first assessment of the link between social participation and two important dimensions of sleep—perceived sleep disorder and sleep patterns and rhythms—in a nationally representative sample of older adults. Although sleep is a universal health behavior, the effect of the social world on the quantity and quality of sleep has received little attention. The present study considers the role of social participation, a key modifiable health determinant and an intervention goal of health professionals. We consider both social causation and self-selection processes that can lead to a correlation between social participation and sleep. The innovative design of NSHAP allows for an in-depth investigation of the association between social participation and different dimensions of sleep at older ages. This adds to the prior literature on the social epidemiology of sleep that has focused mostly on subjective aspects of sleep among younger adults.

We found that social participation was strongly associated with actigraphic measures of sleep quality in cross-sectional analysis. When examining each social participation activity separately, we found that religious attendance and volunteer work showed the strongest effects. However, in longitudinal analysis, we found weaker evidence that changes in social participation over a five-year period had an effect on current sleep, with statistically significant associations limited to changes in religious participation and actigraphic measures of sleep quality. We found no significant association between social participation and self-reported sleep duration in regressions using both fixed-effects and random-effects models. Taken together, although our results suggest that older adults who frequently participated in social activities slept better as measured by actigraphy, changes in social participation did not predict sleep outcomes. Results from longitudinal analysis imply that,

self-selection may at work or, if social participation promotes sleep, the beneficial effects may only be observable over a shorter time frame than five years.

There are several possible interpretations of these findings and patterns. First, from the methodological standpoint, we may not have enough power to detect a small effect in longitudinal analysis given the smaller longitudinal sample. Additionally, the study design of NSHAP prevented us from applying more advanced statistical models (such as fixed-effects and random-effects models) for longitudinal analysis with the exception of self-reported sleep duration. It is therefore possible that changes in social participation may relate to changes in sleep outcomes. Hence, comparisons between the cross-sectional and longitudinal results should be done with care. Second, the cross-sectional and longitudinal results may reflect causal associations in the opposite direction, to the extent that older adults who sleep better do more volunteer work, attend community meetings more regularly, and actively participate in religious services. There may be a selection process that leads to the observed correlation between social participation and sleep in cross-sectional analysis but no association in longitudinal analysis. Finally, it is also possible that social participation promotes sleep but the effect does not extend over five years. Even though two-thirds of older adults in our sample changed their levels of social participation, we might not fully capture the dynamics of older adults' social participation during the five years period. More frequent data collection may show relationships hidden over extended periods. Nevertheless, given the limitations of our data, we were unable to further adjudicate these potential explanations. More studies and better data are needed to estimate the causal direction between social participation and sleep among older adults.

Nevertheless, our results expand the literature on social participation and healthy aging in several significant ways. First, epidemiologists have increasingly come to recognize poor sleep as a behavioral risk factors for healthy aging (Hill, Angel, Ellision, & Angel, 2005; Hummer, Rogers, Nam, & Ellison, 1999; Zhang, 2008). There is a large volume of literature on the long-term benefits of social participation, in particular religious participation, on older adults' morbidity and mortality (e.g., Hill, Angel, Ellision, & Angel, 2005; Hummer, Rogers, Nam, & Ellison, 1999; Zhang, 2008). However, the mechanisms through which social participation lowers morbidity or mortality are not well understood. The relationship between good sleep and healthy aging suggests that sleep is one of the potential pathways through which social participation affects morbidity and mortality in older adults. In this vein, our study provides the very first evidence on this hypothesis. Since we found no strong evidence of a long-term benefit of social participation on older adults' sleep, our findings imply that the beneficial effects of social participation on health and mortality may not operate through the promotion of sleep outcomes. Nevertheless, since we did not test this mechanism directly, future studies with longitudinal data on social participation, sleep, and morbidity/mortality may provide additional empirical evidence on this issue.

Second, the enhancement of older adults' social participation has been a key policy framework in response to concerns of healthy aging (WHO, 2002). As neuropsychological studies suggest, even among the healthy elderly, sleep architecture—the episodic pattern of deep sleep, light sleep, and REM sleep throughout the night—becomes more and more fragile as people age (Pace-Schott & Spencer, 2011; Espiritu, 2008; Vitiello, 2006). It is thus

imperative to know if a program or intervention that promotes older adults' social participation can lead to better sleep. Results from this study suggest that increasing social activity may not help ameliorate the impact of aging on sleeplessness in older adults in the long run. However, since we did not rule out the causal effect of social participation on sleep, it is possible that active social participation may promote sleep over a shorter time frame.

Finally, this study contributes to the emerging field of the social epidemiology of sleep. Most of the prior studies in this field focus on the social causation process (e.g., Anonymous, 2015b; Burgard, 2011; Burgard & Ailshire, 2009; 2013; Venn et al., 2008). Although it is important to consider various social factors in affecting sleep outcomes, these studies often overlook the self-selection process as a potential explanation of the correlation between social factors and sleep. In this study, we theorize that both social causation and self-selection processes account for the correlation between social participation and sleep outcomes: we consider not only the causal effects of social participation but also good sleep as an antecedent of social participation. As the determination of causality remains an ongoing issue in the field of social relationships and health (Kawachi, 2006), it is essential for studies on the social determinants of sleep to carefully consider all of the processes that may produce a correlation. In this way, our study contributes also to the future development of a social epidemiological theory of sleep.

Despite the strength and novelty of these findings, we acknowledge several limitations of the study. To the extent that poor sleepers may be less likely to participate in community activities because they are tired, it is possible that better sleep outcomes lead to higher levels of social participation. However, after controlling for all variables, we found that the social participation was significantly associated with actigraphic estimated sleep characteristics but not with self-reported sleep. This does not support the argument that poor sleep characteristics lead to less social participation because respondents were not reporting worse sleep characteristics. Finally, it is possible the non-effect may be due to our limited measure of social participation. Although our questions captured the essence of the concept of social participation (Levasseur, Richard, Gauvin, & Raymond, 2010), they focused on frequency of participation. Other dimensions of social participation, such as intensity, may matter for sleep outcomes. Also, the self-reported sleep questions might not measure insomnia symptoms well, which could attenuate the association between social participation and the scale. However, while such measurement error might reduce the strength of association, we believe it is not the primary reason why we found no association between social participation and the insomnia symptom scale. First, these questions have been used in prior studies that yielded valuable insights about insomnia in the general population (e.g., Kaufmann et al., 2013). Second, while the reliability of the scale is not high, it is within the acceptable range for an additive scale. Nevertheless, future studies using surveys with more refined social participation and self-reported sleep measures may illuminate these issues.

In sum, in this study, we brought together theoretical and empirical research on social participation and health and innovative measures of sleep outcomes to highlight the importance of the context of social participation for older adults' sleep. This study makes important contributions to research on social participation and health at old ages by

extending the ideas to sleep outcomes. We found that an increase or decrease of social participation over the five years period did not predict current sleep outcomes, suggesting that self-selection process may at work or that the influence of social participation on sleep may operate on a shorter timeframe. Nevertheless, future studies and data collection are warranted to fully understand the relationship between social participation 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 obtain a greater understanding of these relationships.

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Highlights

- We examined the relationships between older adults' social participation and their sleep
- We focused on two sleep dimensions: perceived sleep disorder and sleep patterns and rhythms
- Social participation predicted better sleep in cross-sectional analysis
- Longitudinal analysis showed no association between social participation and sleep
- We found no strong evidence of a long-term benefit of social participation on older adults' sleep

Table 1

Weighted Description of Variables Used in the Analysis (N=780)

Variable	Description	Mean (SD)
Participation in volunteer work		
Several times a week		.08
Every week		.15
About once a month		.08
Several times a year		.10
About once or twice a year		.14
Less than once a year		.12
Never		.34
Participation in religious services		
Several times a week		.12
Every week		.30
About once a month		.07
Several times a year		.10
About once or twice a year		.15
Never		.26
Participation in organized group		
Several times a week		.09
Every week		.18
About once a month		.18
Several times a year		.09
About once or twice a year		.10
Less than once a year		.09
Never		.26
Social participation scale (0–21)	Factor score of the frequency of (1) religious services attendance, (2) volunteer work, and (3) involvement in organized group	−.02 (0.81)
Sleep Measures		
Sleep duration (hours)	The total duration of all of the epochs scored as sleep during the sleep interval	7.25 (1.27)
Wake after sleep onset (WASO, minutes)	The minutes awake during the sleep interval	39.07 (22.84)
Number of wake bouts	Number of wake bouts during the sleep interval	46.15 (21.50)

Variable	Description	Mean (SD)
Sleep fragmentation (0–100)	An index of sleep disruption	14.36 (6.03)
Self-reported sleep duration (hours)		8.22 (1.33)
Insomnia symptoms scale		2.96 (2.53)
Confounders		
Age		71.79 (7.25)
Female		.54
Race and ethnicity		
White		.83
Black		.07
Hispanic		.06
Other		.04
Education		
<High school		.14
High school		.30
Some college		.34
Bachelors and more		.22
Retired		.74
Median household income (thousand dollars)		40
Married		.70
MOCA-SA (0–20)		14.15 (3.46)
Self-rated health		
Excellent		.15
Very good		.34
Good		.32
Fair		.15
Poor		.04
Self-rated mental health		
Excellent		.20
Very good		.39
Goood		.32
Fair		.08

Variable	Description	Mean (SD)
Poor	.01	
ADL Scale	.88 (2.05)	
Smoking	.14	
Binge drinking	.11	
Frequency open up to friends to talk		
Never	.12	
Rarely	.19	
Some of the time	.40	
Often	.29	
Frequency rely on friends for help		
Never	.09	
Rarely	.10	
Some of the time	.40	
Often	.41	

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Table 2

Coefficients of Regressing Social Participation on Each Sleep Characteristic (NSHAP 2010–2011, N=780)

	Actigraphic sleep duration (hours)	WASO (minutes)	Wake bouts	Fragmentation	Self-reported sleep duration (hours)	Insomnia Symptoms scale
Social participation scale	−.009 (.077)	−2.386* (.983)	−2.297* (1.099)	−0.718* (.293)	−0.075 (.075)	−0.013 (.124)
Age	.021** (.007)	.101 (.110)	.004 (.114)	.035 (.036)	.004 (.007)	−.001 (.013)
Female	.425** (.122)	−1.931 (2.205)	−7.096** (1.993)	−1.960** (.565)	.155 (.132)	.341† (.179)
Race (White = ref)						
Black	−.248 (.168)	8.480** (3.059)	10.297** (3.262)	2.406** (.677)	−.512** (.188)	−.218 (.242)
Hispanic	−.061 (.172)	1.304 (3.453)	−.018 (2.971)	.115 (.702)	−.403 (.244)	−.731* (.298)
Other	−1.112** (.387)	−4.417 (3.323)	−1.945 (4.711)	1.256 (1.672)	.009 (.296)	−.242 (.533)
Education (No high school = ref)						
High school	−.140 (.166)	−7.505* (3.572)	−4.853 (3.894)	−1.181 (.777)	−.315 (.225)	−.048 (.265)
Some college	−.188 (.171)	−5.608 (3.600)	−5.004† (2.955)	−.500 (.824)	−.473* (.193)	−.244 (.295)
Bachelors or more	−.119 (.170)	−6.955* (3.180)	−6.232* (2.932)	−.842 (.687)	−.557* (.232)	.126 (.304)
Household income	−.000 (.000)	−.000 (.010)	−.003 (.013)	−.003 (.003)	−.000 (.000)	.000 (.001)
Retirement	.176 (.141)	1.140 (2.059)	.109 (2.018)	−.261 (.567)	.215* (.101)	.164 (.204)
Married	.270* (.134)	−7.183** (2.330)	−2.247 (1.780)	−1.716* (.644)	.159 (.148)	−.024 (.172)
Cognitive score	−.017 (.022)	−.694* (.319)	−.197 (.303)	−.099 (.082)	−.038 (.024)	−.015 (.029)
Self-rated health (excellent = ref)						
Very good	−.031 (.150)	−1.994 (2.630)	.811 (2.621)	.431 (.714)	−.003 (.189)	.216 (.266)
Good	.093 (.168)	−3.633 (2.793)	−1.604 (2.438)	−.248 (.768)	.116 (.173)	.504† (.285)
Fair	−.306† (.176)	−.033 (4.323)	.314 (4.447)	.956 (1.142)	−.197 (.250)	.755* (.321)
Poor	−.250 (.289)	2.832 (7.859)	−1.421 (6.173)	.923 (1.785)	−.425 (.380)	.704 (.483)
Self-rated mental health (excellent = ref)						
Very good	.105 (.158)	3.704 (2.715)	.693 (2.602)	.316 (.790)	.050 (.171)	.408* (.196)
Good	.083 (.177)	5.369* (2.621)	2.728 (2.743)	.843 (.888)	.252 (.204)	.888** (.288)
Fair	−.007 (.1944)	1.027 (3.707)	2.998 (3.431)	−.353 (.837)	.301 (.263)	1.034** (.297)
Poor	−.054 (.671)	5.344 (10.202)	8.706 (11.120)	1.734 (1.614)	.341 (.509)	1.871† (.953)

	Actigraphic sleep duration (hours)	WASO (minutes)	Wake bouts	Fragmentation	Self-reported sleep duration (hours)	Insomnia Symptoms scale
ADL Scale	.050† (.026)	.888† (.450)	.645 (.474)	.384** (.117)	.100** (.027)	.23* (.045)
Smoking	−.303† (.157)	1.678 (2.681)	.737 (3.106)	.307 (.652)	−.438* (.167)	.062 (.306)
Binge drinking	.217† (.122)	3.083 (3.695)	1.923 (3.159)	−.336 (.845)	−.122 (.191)	.235 (.318)
Frequency open up to friends to talk (never = ref)						
Rarely	−.316 (.226)	2.835 (2.975)	−.917 (3.311)	1.268 (.865)	−.162 (.192)	.144 (.337)
Some of the time	−.169 (.182)	4.575† (2.713)	3.018 (3.788)	1.317 (.844)	.103 (.182)	.160 (298)
Often	−.267 (.199)	6.365* (3.159)	2.660 (4.132)	1.815* (.824)	.081 (.214)	−.454 (.336)
Frequency rely on friends for help (never = ref)						
Rarely	.433† (.231)	−5.177 (3.641)	.240 (3.678)	−1.815† (.944)	.456 (.305)	−.246 (.508)
Some of the time	.357† (.194)	−1.226 (3.184)	1.779 (3.729)	−.439 (.899)	.307 (.209)	−.075 (.352)
Often	.348† (.206)	−.871 (3.479)	3.308 (3.927)	−.189 (.920)	.231 (.215)	.061 (.366)

Note.

† $p<.1$;

* $p<.05$;

** $p<.01$;

*** $p<.001$. All regressions were properly weighted to account for complex survey design.

Table 3

Coefficients of Regressing Each Social Participation Activity on Each Sleep Characteristic (NSHAP 2010–2011, N=780)

	Actigraphic sleep duration (hours)	WASO (minutes)	Wake bouts	Fragmentation	Self-reported sleep duration (hours)	Insomnia symptoms scale
Analysis I						
Volunteer work	0.014 (0.039)	−1.033* (0.425)	−0.915† (0.485)	−0.326* (0.148)	−0.019 (0.028)	0.033 (0.067)
Analysis II						
Religious service	−0.040 (0.038)	−1.333* (0.538)	−1.584* (0.587)	−0.429* (0.162)	−0.050 (0.038)	−0.014 (0.054)
Analysis III						
Community meeting	−0.002 (0.038)	−0.525 (0.479)	−0.479 (0.562)	−0.120 (0.162)	−0.016 (0.037)	−0.019 (0.054)

Note.

† $p<.1$;

* $p<.05$;

** $p<.01$;

*** $p<.001$. All regressions included the same control variables as Model 2 in Table 2 and Table 3 which controlled for age, gender, race/ethnicity, education, household income, marital status, retirement status, cognitive score, self-rated physical health, and self-rated mental health, ADL scale, smoking, binge drinking, frequency open up to friends to talk, and frequency rely on friends for help. All regressions were properly weighted to account for complex survey design.

Table 4

Coefficients of Regressing Changes in Social Participation over Five Years on Each Sleep Characteristic (N=524)

	Actigraphic sleep duration (hours)	WASO (minutes)	Wake bouts	Fragmentation	Self-reported sleep duration (hours)	Insomnia symptoms scale
Analysis I						
Change in social participation scale	−.023(.019)	−.274(.354)	−.366(.354)	−.099(.095)	−.042*(.021)	−.015(.041)
Baseline social participation scale	−.001 (.017)	−.479† (.248)	−.216 (.247)	−.126* (.054)	−.026† (.014)	.014 (.028)
Analysis II						
Change in volunteer work	−.012(.042)	−.505 (.569)	−.460(.626)	−.147(.169)	−.033(.047)	−.033(.075)
Baseline volunteer work	.006 (.037)	−1.163* (.048)	−.477 (.544)	−.379** (.134)	−.054† (.031)	−.053 (.064)
Analysis III						
Changes in community meeting	−.027(.040)	−.345(.656)	.018(.615)	−.154(.190)	−.068†(.037)	.014(.078)
Baseline community meeting	.029 (.051)	−.062 (.065)	−.008 (.749)	−.105 (.149)	−.040 (.043)	.006 (.070)
Analysis IV						
Changes in religious service	−.053(.067)	−1.075(.939)	−2.082*(.928)	−.563*(.233)	−.118*(.062)	-.044(.092)
Baseline religious service	−.025 (.043)	−1.232† (.068)	−.889 (.640)	−.319* (.159)	−.085* (.041)	.006 (.071)

Note.

† $p<.1$;

* $p<.05$;

** $p<.01$;

*** $p<.001$. All regressions controlled for Wave 1's subjective sleep measures (feeling rested and self-reported sleep duration) and social participation, Wave 2's age, gender, race/ethnicity, education, cognitive score, and changes in household income, changes in marital status, changes in retirement status, changes in self-rated physical health, changes in self-rated mental health, changes in ADL scale, changes in smoking, changes in binge drinking, changes in frequency open up to friends to talk, and changes in frequency rely on friends for help. All regressions were properly weighted to account for complex survey design.

Table 5

Coefficients of Random Effects-and Fixed-Effects Regressions of Longitudinal Analysis of Social Participation and Sleep-Reported Sleep Duration (N=524)

	Random-effects Model	Fixed-effects Model
Analysis I		
Social participation scale	−.006 (.010)	−.012 (.010)
Analysis II		
Volunteer work	.001 (.022)	−.011 (.023)
Analysis III		
Community meeting	.006 (.024)	−.013 (.026)
Analysis IV		
Religious service	−.036 (.023)	−.044† (.023)

Note.

†$p<.1$;

*$p<.05$;

**$p<.01$;

***$p<.001$. Self-reported sleep duration was measured in hours. Random-effects regressions controlled for time invariant variables including gender, race/ethnicity, education, and time-varying variables including age, household income, marital status, retirement status, self-rated physical health, self-rated mental health, ADL scale, smoking, binge drinking, frequency open up to friends to talk, and frequency rely on friends for help. Fixed-effects regressions controlled for time-varying variables only. All regressions were properly weighted to account for complex survey design.