Understanding the Social Determinants of Older Adults' Sleep: Integrating Actigraphy Into Survey Data Collection and Analysis

Abstract

Poor sleep can lead to increased risk of chronic diseases and excessive mortality of older adults. Few studies have reported on the relationship between social participation and sleep. The purpose of this case study is to discuss the challenges and methodological solutions for examining the relationship between social participation and sleep in older adults. A strategy for incorporating and using actigraphy to measure sleep in a national representative sample of older adults is provided. The semi-longitudinal feature of the data is used to gain insights into the causal relationship between social participation and older adults. Students of social epidemiology, medical sociology, and health disparities can benefit from the methods discussed in this case study.

Learning Outcomes

By the end of this case, students should be able to

- Understand extant methods for collecting sleep data
- Understand the actigraphic method for collecting sleep data
- Understand the difficulty in making causal inference in survey analysis
- Understand the basic rationale for using longitudinal data for causal inference

Understanding Social Determinants of Sleep at Old Age

Everyone would agree that sleep is essential for health. A good night's sleep provides energy for brain functioning and physical activity during the day. Good sleep is even more important for the elderly. Scientific research has demonstrated that poor sleep among older adults can have negative health consequences, including increased risk of chronic diseases and higher mortality. Recent national data from the United States show that approximately half of older adults report difficulty in sleeping (Lauderdale et al., 2014). Unlike other health behaviors and health outcomes, little is understood about the social processes that cause older adults to have trouble sleeping. Previous research has focused on examining the physiological and neurological aspects of sleep. More information is needed on how everyday experiences and social interactions affect the sleep of older adults.

Sociology has a long history in linking social structures and social processes to health behaviors and outcomes, dating back to Emile Durkheim. His classic text, *Suicide*, was published in 1897 and showed how social integration can affect suicide. Since then, sociologists have studied how social structures and processes shape various health behaviors and health outcomes. These efforts fundamentally change the way people think about human health. Although earlier perspectives of human health focus on biological processes, more recent perspectives acknowledge the equal importance of social factors.

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Among various social factors, social participation and engagement are key determinants of health and well-being. Participation and engagement in the community or social groups provide individuals a sense of belonging and companionship and offer opportunities to establish friendship. Community involvement provides important social, emotional support for individuals in the face of negative events. This social and emotional support is even more important for the health and well-being of the elderly. This project seeks to understand whether participation in community and social groups promotes older adults' sleep. In other words, if prior sociological studies show that social participation has health benefits, can social participation also provide benefits for the sleep of older adults?

Methodological Challenges

Two methodological challenges must be addressed when answering this question:

- How can researchers measure sleep in a nationally representative sample of older adults?
- How can researchers ensure that social participation benefits sleep?

Traditionally, sleep researchers recruit volunteer participants and ask them to sleep in the laboratory for one or more nights. Researchers can then observe and monitor participants' sleep. Measuring sleep in the laboratory, however, has several limitations. One of the biggest issues is that participants do not sleep in their natural settings. Researchers are unable to use the information collected in the laboratory to make inferences on how people sleep in their own home. Only participants who live nearby the laboratory can be recruited for these studies, eliminating the possibility of generalizing to the broader population of older adults. A nationally representative survey is needed to generalize results to the elderly population in the United States. Traditional surveys rely on questionnaires to collect information. People often do not remember their sleep accurately. For example, ask yourself the following questions:

- What time did I fall asleep last night?
- How long (exactly) did I sleep last night?
- Between the times I fell asleep last night and woke up this morning, what is my total awake time?

These are difficult questions for nearly all people. Most people have some ideas about how well they sleep, but they are not able to quantify their sleep outcomes. Although traditional survey questionnaires are effective in measuring level of education, income, and frequency of social participation, they are not so useful for measuring sleep. Instruments other than questionnaires are required to collect better sleep data.

Even if the problem of measuring sleep in a nationally representative sample of older adults is resolved, researchers still face the challenge of determining whether social participation benefits older adults' sleep. Although statistics can help researchers understand the correlation between the two variables, a correlation does not mean there is a causal relationship.

For example, if researchers find a significant association between two variables, A and B, in the regression

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analysis, there are two possible explanations:

- *Scenario 1*: As A increases, B also increases, that is, A causes B.
- *Scenario 2*: As B increases, A also increases, that is, B causes A.

The two scenarios tell different causal stories. Simple regression coefficients cannot tell researchers about the directionality between the two variables. Even if they find a significant association in their regression analysis, it can mean that social participation benefits sleep, or however, better sleep leads to more social participation.

Incorporating Actigraphy Into a Nationally Representative Survey to Collect Sleep Data

The advancement of technology offers a new way of collecting sleep data in a nationally representative sample of older adults. This study incorporated actigraphy into a nationally representative survey to collect information about older adults' sleep for a sample of 780.

Actigraphy is the data of an individual's activity level. The actigraphy is collected through a device called an actiwatch. An actiwatch is a watch-like device that a participant can wear on his or her nondominant hand. When the participant wears the device, the actiwatch records the participant's activity level every 15 s. Researchers can obtain the participant's sleep patterns using a complex algorithm to analyze actigraphy.

Actigraphy has two key advantages. First, the device measures sleep in the normal setting. The only requirement for participants is to wear the actiwatch. Second, actiwatches can be distributed to survey participants with instructions on how to use the antiwatch, making actigraphy easier to incorporate into a traditional survey.

This study was based on an innovative survey that incorporated actigraphy into a large-scale, nationally representative, and longitudinal survey of older adults—the National Social Life, Health, and Aging Project (NSHAP). The NSHAP is a nationally representative survey of approximately 3,000 older adults. The first wave of the survey was conducted in 2005-2006 with participants aged 56 to 86 years, and the second wave of survey was conducted in 2010-2011.

Actigraphy was added during the second wave of data collection. After older adults completed the main interview of NSHAP, about one-third of randomly selected participants were invited to participate in the actigraphy study. Participants were randomly selected to make sure the actigraphy sample remained nationally representative. If a participant agreed to join the actigraphy study, an actiwatch and instructions were mailed to the participant. The study used the Actiwatch Spectrum Model (Philips Respironics, Bend, OR) as previously described in greater detail (Lauderdale et al., 2014). This model includes a light meter and an event marker that records a time stamp when pushed but does not start or stop activity recording. Individuals were asked to push the event marker when they began to try to sleep each night and when they woke up each

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day. All participants were instructed to wear the watch for three full days (72 hr). Data collection was limited to three nights of actigraphy, so participation did not become too burdensome. With respect to the couples who agreed to participate, actigraphy was not collected for the same three nights to avoid the possibility of inadvertently switching designated actiwatches.

Respondents were provided with a prepaid envelope and asked to mail the actiwatch back after 3 days of the study. Slightly more than 800 participants completed the study and returned their actiwatches. The survey team at NSHAP, as well as myself, downloaded and cleaned the data. After the raw actigraphy data were cleaned, information was available on 780 older adults.

We analyzed the data using the manufacturer-developed and tested software programs (Actiware 5.5). Actiware 5.5 calculated sleep parameters, for each individual, for each night based on a complex algorithm. We focused on the following three important sleep outcomes:

- *Total sleep time*: total number of minutes scored as sleep during the whole sleep period;
- *Minutes spent awake after sleep onset*: total number of minutes scored as awake between the time that a participant fell asleep and the time that a participant woke up;
- *Sleep fragmentation*: an index of sleep disruption, ranging from 0 to 100, with higher scores indicating higher levels of sleep disruption.

Incorporating actigraphy into a nationally representative survey provides detailed information about older adults' sleep that would not be available using traditional survey questionnaires.

Understanding the Causal Direction

As a regression coefficient does not provide information on the causal direction of the two variables, we relied on the longitudinal feature of the data to better understand the causal relationship between social participation and sleep. Although older adults' sleep was measured during 2010-2011, older adults' social participation was measured twice. Information on participation in community and social groups were available in both 2005-2006 and 2010-2011. Changes in levels of social participation could be identified by comparing frequencies of social participation in two waves of the survey. We used this information to examine whether there is any association between changes in older adults' social participation and sleep. More specifically, if social participation benefits older adults' sleep, we are likely to observe the following patterns:

- For older adults who increased their level of social participation, we expected a positive association with sleep outcomes.
- For older adults who decreased their level of social participation, we expected a negative association with sleep outcomes.

The semi-longitudinal data can be used to improve understanding of the causal relationship between social participation and sleep of older adults.

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Advantages and Limitations of the Method

The method of actigraphy, as described in this case study, has several advantages. First, the method can provide a contour of sleep patterns of the general population on the national scope. Because actigraphy can be incorporated into traditional surveys containing nationally representative samples, results can represent a population as a whole, such as the U.S. population. This data collection method allows for a detailed investigation of sleep patterns on a national scale and over time. Second, the method offers detailed information of sleep behaviors and patterns of individuals. Actigraphy directly assessed individuals' sleep outcomes without relying on self-report data, providing more objective measures of sleep. Good measures of sleep should not depend on respondents' perception, emotion, or ability to memorize his or her sleep at the time of the survey. Aside from providing objective data, actigraphy allows for collecting sleep outcomes over several days and is easy for respondents to use.

Although actigraphy offers various advantages, it has some limitations as well. First and foremost, incorporating actigraphy into a nationally representative survey can be costly. As the sample size increases, more research funding will be needed. Overtime, the manufacturer may develop new versions of the actiwatch that are cheaper and more effective. Second, actigraphy requires a higher degree of compliance compared with traditional survey questions. Although it may require only several minutes to fill out survey questions about an individual's sleep experience, actigraphy requires the respondent to wear the actiwatch for several days. Although using Actiwatch requires no specialized knowledge and is easy to use, respondents may not comply with the instructions completely and wear the actiwatch only for 1 or 2 days. The compliance issue may result in fewer data for researchers to analyze.

Conclusion

Sociologists have a long history of studying whether social participation improves individuals' health. Building on this sociological concern, this project sought to answer the question of whether participation in community and social groups improves the sleep outcomes of the elderly.

The survey team and I had to address two methodological challenges when trying to answer the question. The first challenge involves measuring sleep more accurately in a nationally representative sample of older adults. The second challenge involves identifying the causal direction between social participation and sleep. In other words, does social participation make people sleep better? Or, does better sleep make people have the energy to engage in social groups?

This project addressed the first methodological challenge by incorporating actigraphy into the data collection of the NSHAP. The adoption of actigraphy allowed for detailed measures of sleep and, at the same time, collected data on a nationally representative sample of older adults. The second methodological challenge was addressed by relying on the longitudinal data of social participation that were collected in the two waves

of NSHAP core survey, despite the fact that we did not have longitudinal data on older adults' sleep. The semi-longitudinal structure of the data aided our understanding of the relationship between social participation and sleep.

Higher levels of social participation were associated with better sleep outcomes. The longitudinal analysis did not show that changes in social participation predicted older adults' sleep. We concluded that although sociological theories suggested beneficial effects of social participation on sleep, we found no strong evidence that social participation promoted sleep at old age.

Exercises and Discussion Questions

1. From the sociological perspective, why is measuring older adults' sleep in the natural setting important?
2. Discuss the relative advantages and disadvantages of actigraphy and survey questions in collecting information about human sleep.
3. What are the possible explanations if researchers find an association between social participation and sleep? Can we understand causal direction of the two variables? Why or why not?
4. How can additional waves of data collection assist in understanding the causal relationship between social participation and sleep?

Further Reading

Chen, J. H., **Waite, L. J.**, & **Lauderdale, D. S.** (2015). Marriage, relationship quality, and sleep among U.S. older adults. *Journal of Health and Social Behavior*, 56, 356–377.

Chen, J. H., **Lauderdale, D. S.**, & **Waite, L. J.** (2016). Social participation and older adults' sleep. *Social Science & Medicine*, 149, 164–173.

Web Resources

Philips Respironics, Actiware: http://www.actigraphy.com/solutions/actiware/

References

Lauderdale, D. S., **Schumm, L. P.**, **Kurina, L. M.**, **McClintock, M.**, **Thisted, R. A.**, **Chen, J. H.**, & **Waite, L.** (2014). Assessment of sleep in the national social life, health, and aging project. *Journal of Gerontology, Series B: Psychological & Social Sciences*, 69(Suppl. 2), S125–S133.

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