

Geographic distribution of insufficient sleep across the United States: a county-level hotspot analysis[☆]

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ABSTRACT

Introduction: Insufficient sleep is associated with cardiometabolic risk and neurocognitive impairment. Determinants of insufficient sleep include many social and environmental factors. Assessment of geographic hot/coldspots may uncover novel risk groups and/or targets for public health intervention. The aim of this study was to discern geographic patterns in the first data set to include county-level sleep data.

Methods: The 2009 Behavioral Risk Factor Surveillance System was used. Insufficient sleep was assessed with a survey item and dichotomized. Data from $n = 2231$ counties were available. Tests for significant spatial concentrations of high/low levels of insufficient sleep (hotspots/coldspots) used the Getis-Ord G^* statistic of local spatial concentration, chosen due to the nature of missing data.

Results: Eighty-four counties were hotspots, with high levels of insufficient sleep ($P < .01$), and 45 were coldspots, with low insufficient sleep ($P < .01$). Hotspots were found in Alabama (1 county), Arkansas (1), Georgia (1), Illinois (1), Kentucky (25), Louisiana (1), Missouri (4), Ohio (7), Tennessee (12), Texas (9), Virginia (6), and West Virginia (16). Coldspots were found in Alabama (1 county), Georgia (2), Illinois (6), Iowa (6), Michigan (2), Minnesota (1), North Carolina (1), Texas (7), Virginia (12), and Wisconsin (6). Several contiguous hotspots and coldspots were evident. Notably, the 17 counties with the highest levels of insufficient sleep were found in a contiguous set at the intersection of Kentucky, Tennessee, Virginia, and West Virginia (all $P < .0002$).

Conclusions: Geographic distribution of insufficient sleep in the United States is uneven. Some areas (most notably parts of Appalachia) experience disproportionately high amounts of insufficient sleep and may be targets of intervention. Further investigation of determinants of geographic variability needs to be explored, which would enhance the utility of these data for development of public health campaigns.

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Introduction

Insufficient sleep is increasingly recognized as an important public health issue.¹ Population-based studies have shown that short sleep duration, which may represent insufficient sleep for many individuals, is associated with elevated risk of obesity, cardiovascular

disease, diabetes, and a number of other significant health outcomes.^{2–6} Self-reported insufficient rest or sleep, the outcome studied in this article, has been linked with obesity, hypertension, hyperlipidemia, heart attack, and stroke.⁷ To address this public health issue, the social and environmental determinants of insufficient sleep need further examination.^{2,3,8,9} One possible determinant that has received little attention is geographic location.

Several recent studies have examined social environmental influences on sleep at the national level,^{6,10–12} but these generally did not address geographic patterning insufficient sleep. Hale et al,^{13,14} Bird et al,¹⁵ and Hale and Do^{16,17} have examined whether unhealthy neighborhoods influence the relationship between sleep and physical and mental health,

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but those studies focused on the characteristics of neighborhoods, not on the geographic region in which they were located. However, 1 recent study used the 2006 Behavioral Risk Factor Surveillance System (BRFSS) data for 36 US states to show that those in southern states were more likely to report difficulty sleeping over the past 2 weeks. The states with the highest rates of sleep disturbance included West Virginia, Oklahoma, Missouri, Arkansas, Mississippi, and Alabama; but, notably, data on some nearby states (eg, Kentucky or Ohio) were unavailable, making it difficult to observe clustering of insufficient sleep across states.

One issue with the limited existing research that examines geographic patterning of insufficient sleep is that the state may be too broad a level of geographic aggregation. There may be particular regions within a state that are particularly susceptible to sleep problems and also regions that are relatively free of problems. Studies of the links between neighborhood characteristics and sleep suggest that geographic patterning operates at a more local level than the state. Until recently, no data have been available to address the question of whether insufficient sleep is geographically patterned at the local level, using data that represent the entire United States. These findings would be relevant to many stakeholders, including members of the public and health authorities at the national, regional, and state levels, who could use these data to discern the public health burden of sleep disturbance relative to geography.

Accordingly, the present study leveraged a large, national sample of US adults to assess whether insufficient sleep is differentially reported across counties. Specifically, county-level data from the 48 mainland US states were examined to discern hotspots and coldspots of insufficient sleep. Hypotheses included that (1) regional differences in the percentage of adults reporting insufficient sleep would be evident and most prominent in those states previously identified as having high levels of sleep disturbance; and (2) these regional patterns would elucidate a number of hotspots of abnormally high insufficient sleep and coldspots of abnormally low insufficient sleep.

Methods

Data from the 2009 BRFSS were used.¹⁸ The BRFSS is an annual, state-based, random-digit-dialed telephone survey of adults in the

United States. It is conducted by the Centers for Disease Control and Prevention and designed to monitor health-related behaviors in the general population. Data from all 48 contiguous states and Washington, DC, were included in these analyses. Response rates varied by state, with a median of 53.86% (range, 37.90% [Oregon] to 66.85% [Nebraska]).

The outcome of interest was perceived insufficient rest or sleep (insufficient sleep). This was measured using the item, “During the past 30 days, for approximately how many days have you felt you did not get enough rest or sleep?” Responses were dichotomized, with those reporting $\geq 15/30$ days being categorized as reporting insufficient sleep. This dichotomization was chosen for several reasons. First, a dichotomized variable allows for much more interpretable prevalence estimates. Second, the cutoff of 15 days was chosen to mirror the diagnostic criteria for insomnia, which suggests that symptoms should exist for approximately half of nights to be clinically relevant.¹⁹ Second, this dichotomization at 50% of nights is consistent with other BRFSS studies that similarly dichotomized global sleep disturbance.^{20–25} Third, preliminary evaluation of different cut-offs (3, 7, 15, or 30 days) did not result in noticeably different patterns of findings regarding insufficient sleep and outcomes.

To examine the prevalence of insufficient sleep, the BRFSS data were analyzed in 3 ways. First, prevalence of insufficient sleep was estimated for all available counties and mapped at the county level. Second, these county-level prevalence estimates were evaluated using a spatial clustering technique to identify regionally anomalous areas of counties that demonstrate unusually high or low values (ie, “hotspots” and “coldspots”). Third, linear regression analyses aimed to assess characteristics of individuals who live in hotspots and coldspots Vs most counties, which were identified as neither.

Regarding the clustering analysis, tests for significant spatial concentrations of high percentage values (or low percentage values) were conducted. These tests evaluate the percentage of respondents within a specific county that reported insufficient sleep, relative to neighboring counties. Typically, this analysis would involve comparing frequency of insufficient sleep with immediate neighbors. However, there were many missing counties that would make this approach problematic because counties were not missing at random (because these were generally the most sparsely populated counties), and all

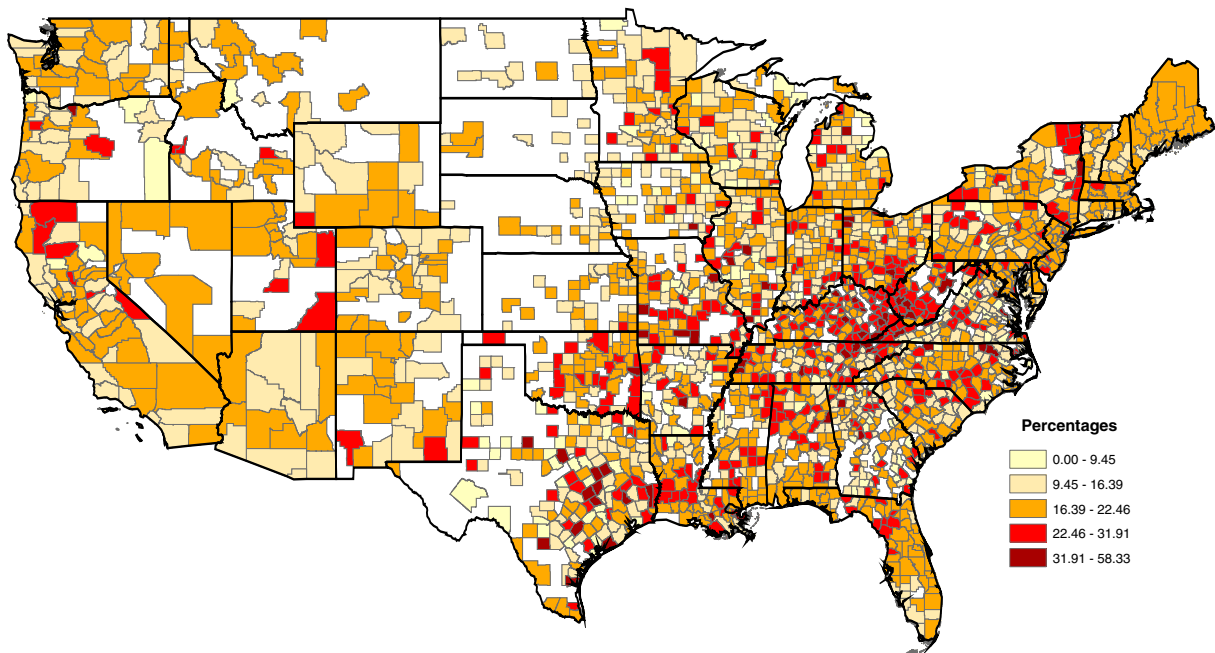


Fig. 1. Percentages of insufficient sleep by county.

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