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Editorial

EDITORIAL

# Wind turbine noise and sleep

Jeffrey M. Ellenbogen[1,2,3,4,*]

[1]Department of Neurology, Uniformed Services University, Bethesda, MD, USA, [2]Department of Military & Emergency Medicine, Uniformed Services University, Bethesda, MD, USA, [3]National Intrepid Center of Excellence, Department of Defense, Bethesda, MD, USA and [4]The Sound Sleep Project, Baltimore, MD, USA

*Corresponding author. Jeffrey M. Ellenbogen, Department of Neurology, School of Medicine, Uniformed Services University, 4301 Jones Bridge Road, Bethesda, MD 20814, USA. Email: jellenbogen2015@gmail.com.

Controversy is the constant companion of modern wind energy development in the United States. Opinions abound. Some love wind turbines to such a degree that they support them at all costs. Others dislike wind turbines so much that they are willing to abandon reason in order to assert far-fetched claims of health concerns. The result is that local counties—and the board members elected by them—have difficulty making decisions concerning whether to approve the development of wind projects in their communities.

Human health concerns are center stage among the variables that opponents raise in order to impede wind development. A wide range of potential problems fall under this umbrella: headaches, vestibulopathy, neuropathy, seizures, hypertension, cardiovascular disease, tinnitus and hearing loss, depression, sleep loss, and so on. In 2009, a collection of anecdotal health concerns was collated into a book written by a pediatrician, who coined the compelling expression for health effects brought about by wind turbines: Wind Turbine Syndrome.

It was in this backdrop of controversy that the Commonwealth of Massachusetts convened a committee of expert scientists, engineers, physicians, and public health experts to evaluate the merits of such concerns for human health by wind energy. Expressing his simple reasoning, the commissioner of the Department of Public Health at the time effectively said to the committee: if we're going to consider permits for wind farms, we need to first know that they're safe.

As a neurologist and sleep specialist with a focus on noise-induced sleep disruption [1], I was a part of that expert committee. We met numerous times over the course of a year. We deliberated a wide range of health topics, solicited public feedback, and ultimately published our work in 2012 [2]. Among the key take-home messages from our report was that modern wind turbines appeared safe for use when placed at reasonable distances from humans. We acknowledged that if turbines were noisy enough (or close enough) that they could disrupt sleep. We provided guidance and acknowledged the gap in certainty.

That gap of knowledge made our Massachusetts report insufficient at resolving controversy on the topic of wind and human health. Fortunately, in 2016, through a series of scientific publications, the Canadian government ("Health Canada") produced the largest and most comprehensive examination of the potential impact of wind turbines on human health. In short, Health Canada examined a wide range of topics, in a cross-sectional epidemiological study of more than 1200 people living near spinning wind turbines. Topics examined included objective measures and self-reported data across a range of issues, including headaches, tinnitus, blood pressure, physiological stress, and sleep [3–5].

Subjective measures of sleep were measured by Health Canada via Pittsburgh Sleep Quality Index, as well as questions concerning sleep disorders and subjective reporting of sleep disturbance over the prior year. Objectively, sleep was measured by Health Canada as well. They used actigraphy in more than 650 participants over the course of seven consecutive nights. By these measures, at the existing noise levels of two large wind farms in operation, there was no demonstrable difference in sleep across a range of sound levels from <25 dBA up to 46 dBA, the maximum noise measured outside the residence among people living in these communities of Canada. Taken together, "beyond annoyance [by some people], results do not support an association between exposure to wind turbine noise up to 46 dBA and the evaluated health-related endpoints."

Health Canada was a cross-sectional study of people living near spinning wind turbines. Sleep appeared undisturbed by the turbines across a range of noise levels. But maybe actigraphy was insensitive. Maybe certain sensitive populations of people

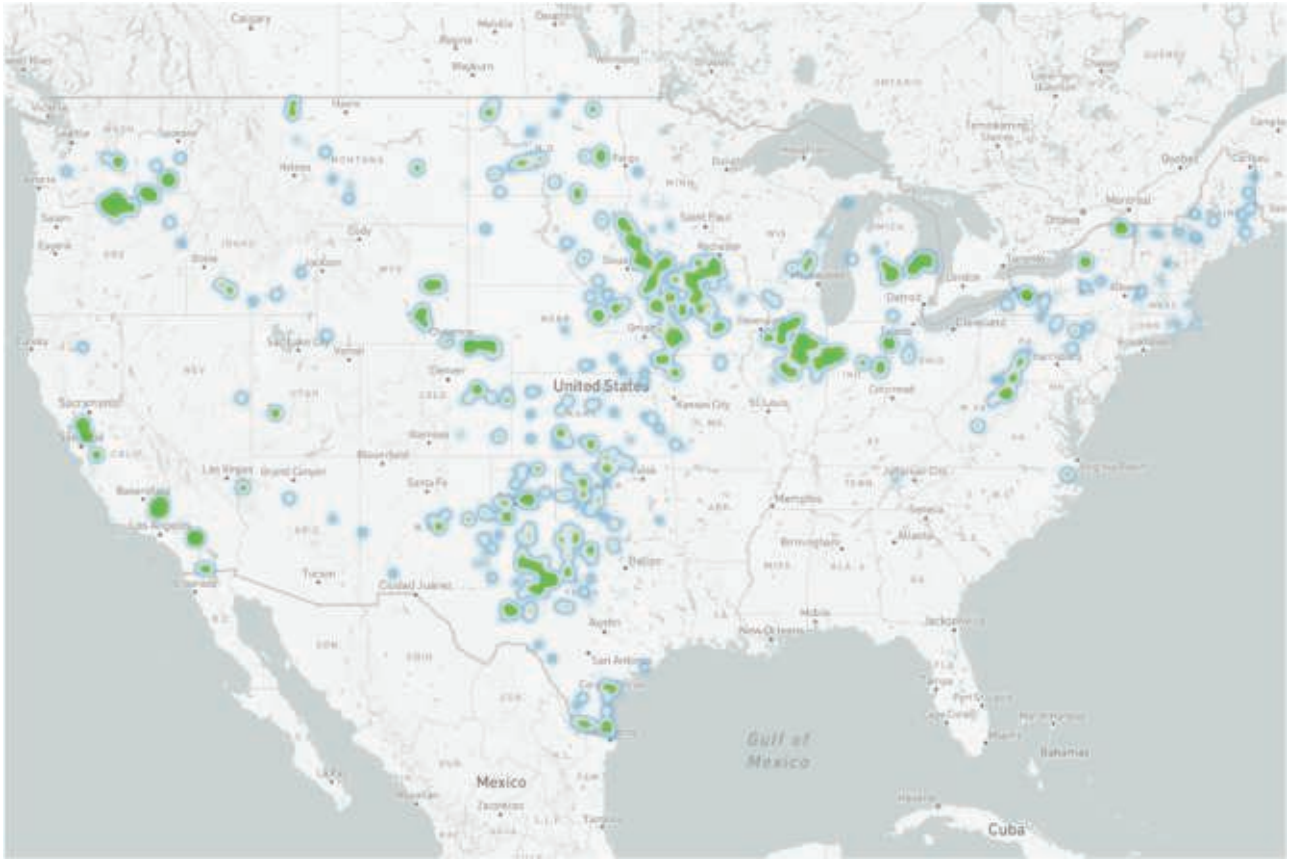


**Figure 1.** A heat map demonstrating the relative density of wind turbines across the continental United States. Data are from the publicly available "U.S. Wind Turbine Database," and they demonstrate more than 71 000 turbines with a total capacity of over 134 000 megawatts. Source: https://eerscmap.usgs.gov/uswtdb/viewer/#4/37.77/-94.71 [7].

exist. Such is the context by which the study by Liebich et al. provides further insights into the possibility of noise-induced sleep disturbance from wind turbines [6].

Liebich et al. produced the largest polysomnographic study of the potential interaction between wind turbine noise (WTN) and sleep. Their controlled, repeated-measures, laboratory study of 68 adults was conducted in a pin-drop quiet laboratory of 19 dBA background noise; with WTN exposures of 25 dBA, depending on the condition. This was a meticulously conducted laboratory study measuring the primary outcome of sleep efficiency among those exposed to WTN.

My only criticism of Liebich et al. is that the investigators appear to try to accomplish too much in a single study. They recruited participants from four separate groups (e.g. those living near turbines who had concerns of sleep disruption, and those who did not), and then examined six different noise exposure conditions. By trying to achieve so much in a relatively small study, they may have underpowered their study and exposed themselves to a type 2 error. Nonetheless, the findings did not demonstrate differences in their primary outcome of sleep efficiency, an impressive finding given the WTN noise exposure in the otherwise quiet laboratory. The authors themselves acknowledge that they did not discover the upper limit of sound pressure level which would carry this null effect. The importance of their study is that the WTN level was substantially higher than the background noise, and yet their primary outcome of sleep efficiency was undisrupted.

At present, there are more than 71 000 wind turbines spinning across the United States (Figure 1) [7]. To my knowledge, there has never been a single case of a community resident injured by blade failure or ice throw. There is no known uptick in human diseases among those near wind turbines. And there have been a substantial number of scientific papers supporting the healthy use of wind turbines when placed at reasonable distances from human dwellings. Between Health Canada and this paper by Liebich et al., it appears that the reasonable placement of wind turbines does not pose a risk to human sleep. Do we understand the upper limit of that phenomena? We don't. If the turbines made more noise, or if placed closer to dwellings, then eventually there will be a tipping point where noise-induced sleep disturbance will commonly occur. If companies wish to remain in the reasonable window of protection against noise-induced sleep loss, they would do well to limit themselves to using the data demonstrated by Health Canada—allowing noises to not exceed 46 dBA measured outside the residence [8]. The actual, population-based threshold may be higher, but existing data support this number.

## Disclosure Statement

The author has served as a consultant to Invenergy Renewables, LLC and to Apex Clean Energy Management, LLC.

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