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Canadian Wind Energy Association
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Re: Intrinsik Review of Nissenbaum MA, Aramini JJ, Hanning CD. Effects of industrial wind turbine noise on sleep and health. Noise Health 2012; 12: 237-243

The October 29, 2012 edition of the journal Noise & Health includes the following paper:

> Nissenbaum MA, Aramini JJ, Hanning CD. Effects of industrial wind turbine noise on sleep and health. Noise Health 2012; 12: 237-243

The purpose of the Nissenbaum et al. work was to undertake an epidemiology study to investigate the relationship between reported adverse health effects and wind turbines among residents of two rural communities: Mars Hill and Vinalhaven, Maine, USA. Participants living 375 to 1400 m and 3.3 to 6.6 km were given questionnaires to obtain data about sleep quality (using the Pittsburgh Sleep Quality Index- PSQI), daytime sleepiness (using the Epworth Sleepiness Score- ESS) and general physical and mental health (using the SF36v2 health survey). Overall the authors reported that when compared to people living further away than 1.4 km from wind turbines, those people living within 1.4 km of wind turbines had worse sleep, were sleepier during the day and had worse mental health scores. Based on these findings the author's concluded that:

> *"…the noise emissions of IWTs disturbed the sleep and caused daytime sleepiness and impaired mental health in residents living within 1.4 km of the two IWT installations studied".*

This work and its findings are not new; earlier works by Nissenbaum about this investigation have been available on the internet since 2009. The work and findings of this publication have been reviewed in the Queen's Bench of Saskatchewan case McKinnon v. Martin (2010 – also referred to as the Red Lily case) and during the Ontario Environmental Review Tribunal (ERT) Erickson v. MOE (2011 – also referred to as the Kent Breeze case). Indeed, Nissenbaum and his coauthors provided a manuscript (Nissenbaum et al. 2011a) to the ERT in the Erickson v. MOE proceedings. At that time the manuscript was confidential in nature; however, in keeping with the rulings of the ERT order dated February 25, 2011, the manuscript was made part of the public record on February 27, 2012. This work was also presented as a conference proceeding in 2011 (Nissenbaum et al., 2011b) and subsequently reviewed and critically evaluated by an expert panel convened by the Massachusetts Department of Environmental Protection and Massachusetts Department of Public Health (MassDEP/MDPH, 2012).

The work in all three manuscripts is fundamentally the same: the study design, methodology, study population and statistical methods are all similarly reported. There are some variations in text but the fundamental conclusions reached by the authors remain consistent across the manuscripts. The primary change comes in the published version (Nissenbaum et al. 2012) with the inclusion of a limited amount of post-hoc noise data. As such we assert that the previous evaluations of this work remain valid.

For instance, the ERT (2011) wrote this of Nissenbaum et al. (2011a):

> *"Looking at the Appellants' evidence, the Tribunal found that strong statements about harm that will be caused were preceded by evidence that largely showed that harm "may" be caused. For example, with respect to the Nissenbaum Study and Dr. Aramini's application of it, there are enough uncertainties to lead the Tribunal to conclude that no proof of harm is present"*.

As well, the expert review panel convened for the MassDEP/MDPH (2012) stated this of Nissenbaum et al. (2011b):

> *"This study is somewhat limited by its size — much smaller than the Swedish or Dutch studies described above — but nonetheless suggests relevant potential health impacts of living near wind turbines. There are, however, critical details left out of the report that make it difficult to fully assess the strength of this evidence. In particular, critical details of the group living 3–7 km from wind turbines is left out. It is stated that the area is of similar socioeconomic makeup, and while this may be the case, no data to back this up are presented—either on an area level or on an individual participant level. In addition, while the selection process for these participants is described as random, the process of recruiting these participants by going home to home until a certain number of participants are reached is not random. Given this, details of how homes were identified, how many homes/people were approached, and differences between those who did and did not participate are important to know. Without this, attributing any of the observed associations to the wind turbines (either noise from them or the sight of them) is premature."*

Intrinsik also has concerns related to study design, methodology, sample size and administration of questionnaires to participants. These concerns were all raised in detail during the aforementioned legal proceedings and won't be repeated fully herein. With these points in mind, we urge readers of this scientific review to revisit findings of both the legal proceedings in Saskatchewan and Ontario, as well as other panel reviews, for complete details on their suppositions.

Notwithstanding these previous criticisms and study limitations, we were encouraged to see that the authors published their work in a peer-reviewed scientific journal. However, we do not believe that their findings support their conclusions. To that end we have prepared this brief scientific review of their published work in Noise & Health.

Findings

Sound Levels

For the first time in publishing this work the authors included sound levels with distance from the turbines. Information on the source of these sound levels is included in the second paragraph of the Study Sites and Participant Selection section of the article. The authors indicate that "*Simultaneous collection of sound levels during the data collection at the participants' residences was not possible, but measured IWT sound levels at various distances, at both sites, were obtained from publically available sources.*"

For Mars Hill the sound levels were reportedly extracted from the "*Sound Level Study, Compilation of Ambient and Quarterly Operations Sound Testing, and the Maine Department of Environmental Protection Order No. L-21635-26-A-N.*" However, Nissenbaum et al. do not provide the figures from which the data were obtained and simply state in the notes of Table 1 that: *"Values read or derived from report figures; accuracy +/- 50 m and +/- 1 Db"*. For Vinalhaven no reference, other than "*R and R, personal communication, 2011*" was provided for the sound measurements that were apparently collected as two-minute measurements over a single day in February 2011.

Given that the relationship between noise from wind turbines and health concerns is the fundamental premise of the study by Nissenbaum et al., it is surprising that the authors gave such little consideration to collection of actual sound data measurements at the study participant homes. The use of post-hoc sound data, visually obtained from figures in reports, is not scientifically defensible and should not have been used to draw conclusions about the findings of the questionnaires with distance from turbine locations. Given the nature of these data we believe that any results or conclusions related to sound levels at these facilities are not supported and the finding that "…*it is apparent that this value will be less than an average hourly LAeq of 40 dBA, which is the typical night time value permitted under the current guidance in most jurisdictions*" is not defensible.

We also believe that the title of the paper "*Effects of industrial wind turbine noise on sleep and health*" is not supported given the nature of the data presented. No evidence with respect to sound level (noise) and its effect on sleep and health has been presented in this paper and the authors could have more appropriately focused the title with respect to the distance, which is the variable that they actually investigated.

Sleep Outcomes

The study team administered two questionnaires related to sleep: the Pittsburgh Sleep Quality Index (PSQI) and the Epworth Sleepiness Scale (ESS).

The PSQI is a self-rated questionnaire meant to assess sleep quality and disturbances over a one month period. A global PSQI score >5 can be used to distinguish “good sleepers” from “poor sleepers”. This is acknowledged within the Nissenbaum et al. (2012) paper in the Questionnaire Development section. Although there was a statistically significant difference between the mean PSQI scores in the near (7.8) and far group (6.0), it is important to remember that both of these average scores are greater than 5, which would qualify both groups as “poor sleepers”. When one examines the reported “% of PSQI score >5” no statistical difference between the near and far groups was found (p=0.0745).

Moreover, the authors attempt to illustrate the relationship between PSQI and distance to the nearest wind turbine in Figure 1 (and ESS scores in Figure 2 and SF36 MCS scores in Figure 3). In all cases the regression lines had p values <0.05. Nissenbaum et al. appear to mistake these significant p values in the regression lines as being related to the relationship of the scores with distance. As with all regressions, the p values in these tests refer to the significance of the slope of the lines being greater than 0, rather than a relationship between variables. In fact in these types of regressions, as important, if not more important, is the r^2 value (coefficient of determination/goodness of fit). This value provides one with the ability to ascertain how well a regression line fits the scatter of data that it attempts to predict. The closer an r^2 is to 1.0, the better the fit of the data and the ability of a regression line to predict a future outcome.

The authors did not provide the r^2 values for any of the three figures nor did they present the slope equations for these lines. If one examines the figures it is revealed that there is considerable scatter of the values, especially in the 375-1400 m near group. For example the scatter of the resulting PSQI scores in the near group is between 1 and 18 and in the far group the range is 1 to 16. Visual examination reveals that one cannot predict the PSQI values from the slope of this line at any given distance. For example, between 600 and 900 m one could just as easily have a score of 19 as they would 1. Based on our experience it is unlikely that the r^2 for any of the three figures would provide reasonable fit to make these regression lines of any use in future predictions or even in predicting scores with distance in this study.

The Epworth Sleepiness Scale (ESS) is also a widely used self-administered questionnaire that can provide information about a person’s general level of daytime sleepiness or average daily sleep propensity. According to the University of Maryland Medical Centre, Sleep Disorders Centre, an ESS score of 10 or more is considered sleepy and a score of 18 or more is considered very sleepy (http://www.umm.edu/sleep/epworth_sleep.htm).

Similar to the PSQI test, when completing the ESS test those living near turbines had significantly different scores than those in the far group (7.8 vs. 5.7); however, given that the threshold of sleepiness is a value of 10, on average neither group should be considered sleepy. Moreover, the "% with ESS score > 10" was not statistically different between the two groups (p=0.1313). While some individuals from both groups reported scores greater than 10 it needs to be highlighted that 10-20% of the general population report having ESS scores greater than 10 (http://epworthsleepinessscale.com/about-epworth-sleepiness/), similar to those found in the near and far groups in this study.

In their paper Nissenbaum et al. state that noise emitted by IWTs can affect sleep. However, their results do not support this statement. In fact, the authors state that "*The data on measured and estimated noise levels were not adequate to construct a dose-response curve*…" and no statistical analyses were conducted to assess this supposed relationship. Therefore, we do not believe that Nissenbaum et al. (2012) show any statistical difference in overall "poor" sleep quality or sleepiness between the groups.

Physical and Mental Health Outcomes

The SF36 test has been widely used within the quality of life scientific investigation field. The SF 36 is a multi-purpose, short-form health survey made up of 36 questions that yields an 8-scale profile of functional health and well-being scores as well as psychometrically-based physical and mental health summary measures and a preference-based health utility index (http://www.sf-36.org/tools/sf36.shtml).

It is important to note that the authors acknowledge that "*There was no statistically significant difference in PCS (p=0.9881)."* This means that respondents reported no difference in their Physical Component Summary score or physical well-being between the two groups. Nissenbaum et al. did show significantly decreased SF36 Mental Component Summary (MCS) scores between the near (42.0) and far (52.9) groups (p=0.0021). However, the conclusion that the reduced MCS score in some residents living near wind turbines is related to noise emissions is hypothetical and not support by the data. In the paper, neither sleep nor physical effects were related to noise levels, and no attempt was made to relate MCS score to sleep. Moreover, there was no significant difference (p=0.06) between the number of respondents that required psychotropic medications since the start of turbine operations for the two groups. Simply put Nissenbaum et al. show that some people in the vicinity of turbines reported lesser MCS scores than those living further away, but no underlying reason for this was conclusively established.

The authors pointed out that visual cue and attitude towards wind turbines *"are known to affect the psychological response to environmental noise"*. While this may be true, visual cue and attitude by themselves have been shown to be stronger drivers of psychological responses than a wind-turbine specific variable like sound itself (e.g., Pedersen 2004). Therefore, a conclusion that can be drawn from this study is that the self-reported health effects of people living near wind turbines can be likely attributable to physical manifestations from an annoyed state, rather than a wind-turbine specific factor like noise. Indeed, the weight of evidence in the wind turbine and human health literature points to a causal relationship between self-reported health effects and annoyance, which is to say annoyance brought on by the change in the local environment (i.e., a decrease in amenity) that wind turbines represent (Knopper and Ollson 2011).

Overall Conclusion

Overall, in our opinion the authors extend their conclusions and discussion beyond the statistical findings of their study. We believe that they have not demonstrated a statistical link between wind turbines – distance – sleep quality – sleepiness and health. In fact, their own values suggest that although scores may be statistically different between near and far groups for sleep quality and sleepiness, they are no different than those reported in the general population. The claims of causation by the authors (i.e., wind turbine noise) are not supported by their data.

Closure

The opinions in this scientific review are those of the undersigned who are independent scientific professionals and are not influenced by any contractual obligations. Drs. Knopper and Ollson will be submitting these comments as a Letter to the Editor to the journal Noise & Health for consideration for publication. If you have any questions please do not hesitate to contact the undersigned.

Yours sincerely,
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