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## Adverse health effects of industrial wind turbines

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Canadian family physicians can expect to see increasing numbers of rural patients reporting adverse effects from exposure to industrial wind turbines (IWTs). People who live or work in close proximity to IWTs have experienced symptoms that include decreased quality of life, annoyance, stress, sleep disturbance, headache, anxiety, depression, and cognitive dysfunction. Some have also felt anger, grief, or a sense of injustice. Suggested causes of symptoms include a combination of wind turbine noise, infrasound, dirty electricity, ground current, and shadow flicker.<sup>1</sup> Family physicians should be aware that patients reporting adverse effects from IWTs might experience symptoms that are intense and pervasive and might feel further victimized by a lack of caregiver understanding.

### Background

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There is increasing concern that energy generation from fossil fuels contributes to climate change and air pollution. In response to these concerns, governments around the world are encouraging the installation of renewable energy projects including IWTs. In Ontario, the Green Energy Act was designed, in part, to remove barriers to the installation of IWTs.<sup>2</sup> Noise regulations can be a considerable barrier to IWT development, as they can have a substantial effect on wind turbine spacing, and therefore the cost of wind-generated electricity.<sup>3</sup> Industrial wind turbines are being placed in close proximity to family homes in order to have access to transmission infrastructure.<sup>4</sup>

In Ontario and elsewhere,<sup>5</sup> some individuals have reported experiencing adverse health effects resulting from living near IWTs. Reports of IWT-induced adverse health effects have been

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missed by some commentators including government authorities and other organizations. Physicians have been exposed to efforts to convince the public of the benefits of IWTs while minimizing the health risks. Those concerned about adverse effects of IWTs have been stereotyped as “NIMBYs” (not in my backyard).<sup>6,7</sup>

## Global reports of effects

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During the past few years there have been case reports of adverse effects. A 2006 Académie Nationale de Médecine working group report notes that noise is the most frequent complaint. The noise is described as piercing, preoccupying, and continually surprising, as it is irregular in intensity. The noise includes grating and incongruous sounds that distract the attention or disturb rest. The spontaneous recurrence of these noises disturbs the sleep, suddenly awakening the subject when the wind rises and preventing the subject from going back to sleep. Wind turbines have been blamed for other problems experienced by people living nearby. These are less precise and less well described, and consist of subjective (headaches, fatigue, temporary feelings of dizziness, nausea) and sometimes objective (vomiting, insomnia, palpitations) manifestations.<sup>8</sup>

A 2009 literature review prepared by the Minnesota Department of Health<sup>9</sup> summarized case reports by Harry (2007),<sup>10</sup> Phipps et al (2007),<sup>11</sup> the Large Wind Turbine Citizens Committee for the Town of Union (2008),<sup>12</sup> and Pierpont (2009).<sup>13</sup> These case studies catalogued complaints of annoyance, reduced quality of life, and health effects associated with IWTs, such as sleeplessness and headaches.<sup>9</sup>

In 2010, Nissenbaum et al used validated questionnaires in a controlled study of 2 Maine wind energy projects. They 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.”<sup>14</sup>

Reports of adverse health effects<sup>15</sup> and reduced quality of life<sup>16</sup> are also documented in IWT projects in Australia and New Zealand.

A 2012 board of health resolution in Brown County in Wisconsin formally requested financial relocation assistance for “families that are suffering adverse health effects and undue hardships caused by the irresponsible placement of industrial wind turbines around their homes and property.”<sup>17</sup>

An Ontario community-based self-reporting health survey, WindVOiCe, identified the most commonly reported IWT-induced symptoms as altered quality of life, sleep disturbance, excessive tiredness, headache, stress, and distress. Other reported effects include migraines, hearing problems, tinnitus, heart palpitations, anxiety, and depression.<sup>18</sup> In addition, degraded living conditions and adverse socioeconomic effects have been reported. In some cases the effects were enough that individuals in Ontario abandoned their homes or reached financial agreements with wind energy developers.<sup>19</sup>

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After considering the evidence and testimony presented by 26 witnesses, a 2011 Ontario environmental review tribunal decision acknowledged IWTs can harm human health:

*This case has successfully shown that the debate should not be simplified to one about whether wind turbines can cause harm to humans. The evidence presented to the Tribunal demonstrates that they can, if facilities are placed too close to residents. The debate has now evolved to one of degree.*<sup>20</sup>

## Indirect effects and annoyance

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When assessing the adverse effects of IWTs it is important to consider what constitutes human health. The World Health Organization (WHO) defines health as “a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity.”<sup>21</sup>

Despite being widely accepted, the WHO definition of health is frequently overlooked when assessing the health effects of IWTs. Literature reviews commenting on the health effects of IWTs have been produced with varying degrees of completeness, accuracy, and objectivity.<sup>22</sup> Some of these commentators accept the plausibility of the reported IWT health effects and acknowledge that IWT noise and visual effects might cause annoyance, stress, or sleep disturbance, which can have other consequences. However, these IWT health effects are often discounted because “direct pathological effects” or a “direct causal link” have not been established. In 2010, the Ontario Chief Medical Officer of Health released *The Potential Health Impact of Wind Turbines*, which acknowledged that some people living near wind turbines report symptoms such as dizziness, headaches, and sleep disturbance but concluded “the scientific evidence available to date does not demonstrate a direct causal link between wind turbine noise and adverse health effects.”<sup>23</sup> The lead author of the report,<sup>23</sup> Dr Gloria Rachamin, acknowledged under oath that the literature review looked only at direct links to human health.<sup>24</sup>

Focusing on “direct” causal links limits the discussion to a small slice of the potential health effects of IWTs. The 2011 environmental review tribunal decision found that *serious harm to human health* includes “indirect impacts (e.g., a person being exposed to noise and then exhibiting stress and developing other related symptoms).”<sup>20</sup>

According to the night noise guidelines for Europe:

*Physiological experiments on humans have shown that noise of a moderate level acts via an indirect pathway and has health outcomes similar to those caused by high noise exposures on the direct pathway. The indirect pathway starts with noise-induced disturbances of activities such as communication or sleep.*<sup>25</sup>

Pierpont documented symptoms reported by individuals exposed to wind turbines, which include sleep disturbance, headache, tinnitus, ear pressure, dizziness, vertigo, nausea, visual ring, tachycardia, irritability, problems with concentration and memory, and panic episod

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sociated with sensations of internal pulsation or quivering when awake or asleep.<sup>13</sup> The American Wind Energy Association and the Canadian Wind Energy Association convened a panel literature review that determined these symptoms are the “well-known stress effects of exposure to noise,” or in other words, are “a subset of annoyance reactions.”<sup>26</sup>

Noise-induced annoyance is acknowledged to be an adverse health effect.<sup>27-30</sup> Chronic severe noise annoyance should be classified as a serious health risk.<sup>31</sup> According to the WHO guidelines for community noise, “[t]he capacity of a noise to induce annoyance depends upon many of its physical characteristics, including its sound pressure level and spectral characteristics, as well as the variations of these properties over time.”<sup>32</sup> Industrial wind turbine noise is perceived to be more annoying than transportation noise or industrial noise at comparable sound pressure levels.<sup>33</sup> Industrial wind turbine amplitude modulation,<sup>34</sup> audible low frequency noise,<sup>35</sup> tonal noise, infrasound,<sup>36</sup> and lack of nighttime abatement have been identified as plausible noise characteristics that could cause annoyance and other health effects.

## Health effects in Ontario expected

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Evidence-based health studies were not conducted to determine adequate setbacks and noise levels for the siting of IWTs before the implementation of the Ontario renewable energy policy. In addition, provision for vigilance monitoring was not made. It is now clear that the regulations are not adequate to protect the health of all exposed individuals.

A 2010 report commissioned by the Ontario Ministry of the Environment concludes:

*The audible sound from wind turbines, at the levels experienced at typical receptor distances in Ontario, is nonetheless expected to result in a non-trivial percentage of persons being highly annoyed .... [R]esearch has shown that annoyance associated with sound from wind turbines can be expected to contribute to stress related health impacts in some persons.*<sup>37</sup>

Consequently, physicians will likely be presented with patients reporting health effects.

Family physicians should be aware that patients reporting adverse effects from IWTs might experience symptoms that are intense and pervasive and that they might feel further victimized by a lack of care-giver understanding. Those adversely affected by IWTs might have already pursued other avenues to mitigate the health effects with little or no success. It will be important to identify the possibility of exposure to IWTs in patients presenting with appropriate clinical symptoms.<sup>38</sup>

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## Conclusion

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Industrial wind turbines can harm human health if sited too close to residents. Harm can be avoided if IWTs are situated at an appropriate distance from humans. Owing to the lack of

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quately protective siting guidelines, people exposed to IWTs can be expected to present to their family physicians in increasing numbers. The documented symptoms are usually stress disorder-type diseases acting via indirect pathways and can represent serious harm to human health. Family physicians are in a position to effectively recognize the ailments and provide an empathetic response. In addition, their contributions to clinical studies are urgently needed to clarify the relationship between IWT exposure and human health and to inform regulations that will protect physical, mental, and social well-being.

## Footnotes

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This article has been peer reviewed.

La traduction en français de cet article se trouve à [www.cfp.ca](http://www.cfp.ca) dans la table des matières du numéro de mai 2013 à la page [e218](#).

## Competing interests

**Dr Jeffery, Ms Krogh, and Mr Horner** are on the Board of Directors for the Society for Wind Vigilance, an international federation of physicians, acousticians, engineers, and other professionals who share scientific research on the topic of health and wind turbines.

**The opinions expressed** in commentaries are those of the authors. Publication does not imply endorsement by the College of Family Physicians of Canada.

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