

Listing of key wind turbine and human health impacts studies available at:

<http://ses.library.usyd.edu.au/handle/2123/10559>

https://ses.library.usyd.edu.au/bitstream/2123/10559/7/WindHealthReviews_3.pdf

Health Canada/Statistics Canada (2014)

Available at: <https://www.canada.ca/en/health-canada/services/environmental-workplace-health/noise/wind-turbine-noise/wind-turbine-noise-health-study-summary-results.html>.

Peer reviewed journal version available at: Feder, K., Michaud, D. S., Keith, S. E., Voicescu, S. a., Marro, L., Than, J. van den Berg, F. (2015). An assessment of quality of life using the WHOQOL-BREF among participants living in the vicinity of wind turbines. *Environmental Research*, 142, 227–238. <http://doi.org/10.1016/j.envres.2015.06.043>

In December 2014, Health Canada (the Canadian equivalent of the U.S. Department of Health and Human Services) and Statistics Canada published the most comprehensive multi-disciplinary field study to date (including surveys and objective health measurements), which found that self-reported sleep issues, illnesses and stress were “not found to be associated with WTN [wind turbine noise] exposure.”

With respect to objective health measurements, Health Canada and Statistics Canada found:

- “WTN was not observed to be related to hair cortisol concentrations, blood pressure, resting heart rate or measured sleep (e.g., sleep latency, awakenings, sleep efficiency) following the application of multiple regression models.”
- “Results of self-reported measures of sleep, that relate to aspects including, but not limited to general disturbance, use of sleep medication, diagnosed sleep disorders and scores on the PSQI, did not support an association between sleep quality and WTN levels.”
- “Self-reports of having been diagnosed with a number of health conditions were not found to be associated with exposure to WTN levels. These conditions included, but were not limited to chronic pain, high blood pressure, diabetes, heart disease, dizziness, migraines, ringing, buzzing or whistling sounds in the ear (i.e., tinnitus).”
- “Exposure to WTN was not found to be associated with any significant changes in reported quality of life for any of the four domains, nor with overall quality of life and satisfaction with health.”
- “The results from multiple linear regression analysis reveal consistency between hair cortisol concentrations and scores on the Perceived Stress Scale (i.e., higher scores on this scale were associated with higher concentrations of hair cortisol) with neither measure found to be significantly affected by exposure to WTN. Similarly, while self-reported high blood pressure (hypertension) was associated with higher measured blood pressure, no statistically significant association was observed between measured blood pressure, or resting heart rate, and WTN exposure.”
- “...calculated outdoor WTN levels near the participants' home was not found to be associated with sleep efficiency, the rate of awakenings, duration of awakenings, total sleep time, or how long it took to fall asleep.”

National Health and Medical Research Council (Australian Government, 2015)

The NHMRC, a part of the Australian government that, among other things, establishes public health related standards issued a statement on wind farms and human health along with a full report in February 2015. Key findings in the statement are below. The statement is available

here:

https://www.nhmrc.gov.au/files/nhmrc/publications/attachments/eh57_nhmrc_statement_wind_farms_human_health_0.pdf. The full report is available here:

https://www.nhmrc.gov.au/files/nhmrc/publications/attachments/eh57a_information_paper.pdf

- “After careful consideration and deliberation of the body of evidence, NHMRC concludes that there is currently no consistent evidence that wind farms cause adverse health effects in humans.”
- “There is no direct evidence that exposure to wind farm noise affects physical or mental health. While exposure to environmental noise is associated with health effects, these effects occur at much higher levels of noise than are likely to be perceived by people living in close proximity to wind farms in Australia.”
- “There is consistent but poor quality direct evidence that wind farm noise is associated with annoyance. While the parallel evidence suggests that prolonged noise-related annoyance may result in stress, which may be a risk factor for cardiovascular disease, annoyance was not consistently defined in the studies and a range of other factors are possible explanations for the association observed.”
- “There is less consistent, poor quality direct evidence of an association between sleep disturbance and wind farm noise. However, sleep disturbance was not objectively measured in the studies and a range of other factors are possible explanations for the association observed. While chronic sleep disturbance is known to affect health, the parallel evidence suggests that wind farm noise is unlikely to disturb sleep at distances of more than 1,500 m from wind farms.”
- “There is no direct evidence that considered the possible effects on health of infrasound or low frequency noise from wind farms. Exposure to infrasound and low-frequency noise in a laboratory setting has few, if any, effects on body functions. However, this exposure did not replicate all of the characteristics of wind farm noise as it has generally been at much higher levels and of short duration.”
- “Although individuals may perceive aspects of wind farm noise at greater distances, it is unlikely that it will be disturbing at distances of more than 1,500 m. Noise from wind farms, including its content of low-frequency noise and infrasound, is similar to noise from many other natural and human-made sources.”

Massachusetts Department of Environmental Protection (2012)

Available at: <http://www.mass.gov/eea/docs/dep/energy/wind/turbine-impact-study.pdf>

The expert independent panel members who prepared the report for the MA DEP included a neurologist and division chief for sleep medicine, professors of environmental health, a mechanical engineer, an epidemiologist, and a former state health officer.

The study evaluated the potential human health effects related to the exposure to sounds from operating wind turbines. The findings of the study were particularly conclusive, stating:

- “There is no evidence for a set of health effects from exposure to wind turbines that can be characterized as **‘Wind Turbine Syndrome.’**”
- “Claims that infrasound from wind turbines directly impacts the **vestibular system** have not been demonstrated scientifically. Available evidence shows that the infrasound levels near wind turbines cannot impact the vestibular system.”

- “The strongest epidemiological study suggests that there is not an association between noise from wind turbines and measures of **psychological distress** or mental health.”
- “None of the limited epidemiological evidence reviewed suggests an association between noise from wind turbines and **pain and stiffness, diabetes, high blood pressure, tinnitus, hearing impairment, cardiovascular disease, and headache/migraine.**”

Massachusetts Institute of Technology (2014)

McCunney, Mundt, Colby, Dobie, Blais. “Wind turbines and health: a critical review of the scientific literature.” *Journal of Environmental and Occupational Medicine*. Available at:

http://journals.lww.com/joem/Fulltext/2014/11000/Wind_Turbines_and_Health_A_Critical_Review_of_the.9.aspx and referenced in the NIH Library of Medicine here: <https://www.ncbi.nlm.nih.gov/pubmed/25376420>

Massachusetts Institute of Technology (MIT) issued a report that provides a comprehensive review of scientific literature on wind turbines and human health. The peer reviewed report, entitled “*Wind Turbines and Health: A Critical Review of the Scientific Literature*”, has been published online in the *Journal of Environmental and Occupational Medicine*.

While the MIT review was funded by the Canadian Wind Energy Association (CanWEA) through a grant to MIT’s Department of Biological Engineering, CanWEA did not take part in editorial decisions or reviews of the report. The report was prepared by a multidisciplinary team with expertise in environmental medicine, epidemiology, acoustics, otolaryngology, clinical psychology and public health and included a comprehensive literature review of over 160 references. Included within this report was an analysis of epidemiological studies and it addressed symptoms associated with the central nervous system, such as dizziness, vertigo, epilepsy and others that have been raised in the context of living near wind turbines. In addition, the review includes analysis on studies that have evaluated effects related to low frequency sound and infrasound.

The findings of this study are consistent with the findings of other epidemiological studies related to wind and health, including the aforementioned 2014 Health Canada study, concluding:

- “Measurements of low-frequency sound, infrasound, tonal sound emission, and amplitude-modulated sound show that infrasound is emitted by wind turbines. The levels of infrasound at customary distances to homes are typically well below audibility thresholds.”
- “No cohort or case–control studies were located in this updated review of the peer-reviewed literature. Nevertheless, among the cross-sectional studies of better quality, no clear or consistent association is seen between wind turbine noise and any reported disease or other indicator of harm to human health.”
- “Components of wind turbine sound, including infrasound and low frequency sound, have not been shown to present unique health risks to people living near wind turbines.”

- “Annoyance associated with living near wind turbines is a complex phenomenon related to personal factors. Noise from turbines plays a minor role in comparison with other factors in leading people to report annoyance in the context of wind turbines.”

Chief Medical Officer of Health of the Province of Ontario, Canada (2010)

The Potential Health Impact of Wind Turbines. Available at:

http://www.health.gov.on.ca/en/common/ministry/publications/reports/wind_turbine/wind_turbine.pdf

This report was prepared by the Chief Medical Officer of Health (CMOH) of Ontario in response to public health concerns about wind turbines, particularly related to noise. The CMOH was assisted by a technical working group comprised of members from the Ontario Agency for Health Protection and Promotion (OAHP), the Ministry of Health and Long-Term Care (MOHLTC) and several Medical Officers of Health in Ontario with the support of the Council of Ontario Medical Officers of Health (COMOH).

The main conclusions are:

- “While some people living near wind turbines report symptoms such as dizziness, headaches, and sleep disturbance, the scientific evidence available to date does not demonstrate a direct causal link between wind turbine noise and adverse health effects.”
- “The sound level from wind turbines at common residential setbacks is not sufficient to cause hearing impairment or other direct adverse health effects.”
- “... infrasound from current generation upwind model turbines is well below the pressure sound levels at which known health effects occur. Further, there is no scientific evidence to date that vibration from low frequency wind turbine noise causes adverse health effects.”

Knopper, Ollson. “Health effects and wind turbines: a review of the literature.”

***Environmental Health Journal*. September 2011. Available at:**

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3179699/>

Key conclusions:

- “Conclusions of the peer reviewed literature differ in some ways from those in the popular literature. In peer reviewed studies, wind turbine annoyance has been statistically associated with wind turbine noise, but found to be more strongly related to visual impact, attitude to wind turbines and sensitivity to noise.”
- “To date, no peer reviewed articles demonstrate a direct causal link between people living in proximity to modern wind turbines, the noise they emit and resulting physiological health effects.”
- “Given that annoyance appears to be more strongly related to visual cues and attitude than to noise itself, self-reported health effects of people living near wind turbines are more likely attributed to physical manifestation from an annoyed state than from wind turbines themselves. In other words, it appears that it is the change in the environment that is associated with reported health effects and not a turbine-specific variable like audible noise or infrasound. Regardless of its cause, a certain level of annoyance in a population can be expected (as with any number of projects that change the local environment) and the acceptable level is a policy decision to be made by elected officials

and their government representatives where the benefits of wind power are weighted against their cons.”

Infrasound and low frequency noise

Leventhall, Geoff. “Infrasound from Wind Turbines: Fact, Fiction or Deception.” *Canadian Acoustics*. June 2006. Available at: <https://jcaa.caa-aca.ca/index.php/jcaa/article/view/1794/1541>

- “The perception of infrasound occurs at levels higher than the levels produced by wind turbines and there is now agreement amongst acousticians that infrasound from wind turbines is not a problem.”
- “It has been shown above that there is insignificant infrasound from wind turbines and that there is normally little low frequency noise.”
- “Infrasound from wind turbines is below the audible threshold and of no consequence.”
- “Low frequency noise is normally not a problem, except under conditions of unusually turbulent inflow air.”

Leventhall, Geoff. “Concerns about infrasound from wind turbines.” *Acoustics Today*. July 2013. Available at: http://acousticstoday.org/wp-content/uploads/2017/10/Article_3of4_from_ATCODK_9_3.pdf

- “Internally generated infrasound from heartbeat and breathing, which enters the inner ear via the cochlear aqueduct, is greater than that received externally from wind turbines at similar frequencies, perhaps by 20dB or more.”
- “Levels of infrasound received from wind turbines at typical residential distances are well below hearing threshold and also mainly below the outer hair cell threshold, proposed by Salt and Hullar as a possible onset level of adverse effects.”
- “There is no evidence that this wind turbine infrasound is harmful, whilst there is evidence from atmospheric infrasound that it is not.”

Berger et.al. “Health-Based Audible Noise Guidelines Account for Infrasound and Low-Frequency Noise Produced by Wind Turbines.” *Frontiers in Public Health*. February 2015. Available at: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4338604/pdf/fpubh-03-00031.pdf>

- “Over-all, the available data from this and other studies suggest that health-based audible noise wind turbine siting guidelines provide an effective means to evaluate, monitor, and protect potential receptors from audible noise as well as IS and LFN.”
- “Based on the data presented here, the indoor IS component of wind turbine noise measured as dB(G) at distances of 450 and 900m, was well below the levels of human perception, providing further support to previous reports.”
- “IS is produced at levels comparable or greater than those shown here by natural and engineered sources. There is no scientific evidence to indicate that exposure at these G-weighted levels of IS can directly impact human health.”
- “Results from the current investigation indicate that increases in LFN associated with wind turbine operation are correlated with increases in overall sound levels. These results, in conjunction with those of previous reports, suggest that controlling for overall sound levels produced by normally operating wind turbines will inherently control for LFN.”

Bolin, Bluhm, Eriksson, Nilsson. "Infrasound and low frequency noise from wind turbines: exposure and health effects." *Environmental Research Letters*. September 22, 2011.

Available at: <http://iopscience.iop.org/article/10.1088/1748-9326/6/3/035103/pdf>

- "Infrasound (1–20 Hz) from wind turbines is not audible at close range and even less so at distances where residents are living. There is no evidence that infrasound at these levels contributes to perceived annoyance or other health effects."
- "Low frequency noise (LFN) from modern wind turbines are audible at typical levels in residential settings, but the levels do not exceed levels from other common noise sources, such as road traffic noise."
- "Except for noise annoyance, no consistent effects on health due to wind turbine noise have been reported."
- "It has been argued that infrasound and low frequency noise from wind turbines may cause serious health effects in the form of 'vibroacoustic disease', 'wind turbine syndrome' or harmful infrasound effects on the inner ear. However, empirical supports for these claims are lacking. "

Sonus Consulting. Infrasound Measurements from Wind Farms and Other Sources. November 2010. Available at:

http://www.qoyder.sa.gov.au/webdata/resources/files/Attachment_5.pdf. Also reported in

Acoustics Australia, April 2012, available at:

https://www.acoustics.asn.au/journal/2012/2012_40_1_Turnbull.pdf

- "This study goes beyond the international studies by providing comparative measurements of natural and other human made sources. These sources, including waves on a beach and motor vehicles, have been found to generate infrasound of a similar order to that measured in close proximity to wind farms."