

Sound and Health

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Sound

- ▶ The auditory perception of wave energy transmitted through air or fluid
- ▶ Sound intensity (wave amplitude) is measured in decibels (dB), $20 \times \log_{10}$ of the ratio between the measured pressure and the reference pressure (20 micropascals)
- ▶ Usually A-weighted (dBA) to de-emphasize very low and very high frequencies to correspond to the way sounds are perceived by humans

Sound

- ▶ Wave frequency (Hz) is perceived as pitch
- ▶ Hearing range approximately 20–20,000 Hz
- ▶ Sound is described in terms of loudness, frequency and characteristics
- ▶ Very complex: music
- ▶ Unwanted sounds → **noise**
- ▶ Attenuates with distance (inverse square law)

Typical Sound Levels dBA

- ▶ Just audible 10
- ▶ Soft whisper at 5 feet 30 “very quiet”
- ▶ Wind turbine at 1000–2000 feet 40–50
- ▶ Light auto traffic at 50 feet 50 “quiet”
- ▶ Air conditioning unit 20 feet 60
- ▶ Busy restaurant 78
- ▶ Pneumatic drill 50 feet 80 “annoying”

Typical Sound Levels dBA

- ▶ NY Subway station 90 “very annoying”, damages hearing at 8 hr continuous exposure
- ▶ Rock concert, auto horn at 3 feet 110
- ▶ Jet take off at 1000 feet 135
- ▶ Jet take off at 200 feet 120
- ▶ 130 “pain threshold”
- ▶ Aircraft carrier deck jet operation 140

Adverse Effects of Noise

- ▶ Speech interference > 80–90 dBA: people need to shout
- ▶ Noise induced hearing loss: >80 dB for prolonged periods especially sharp transients
- ▶ Hearing loss most pronounced in 4000 Hz range, necessary for perception of consonants
- ▶ Sleep disturbance US EPA > 45 dBA, WHO > 30 dBA (not designed for wind turbine sound)

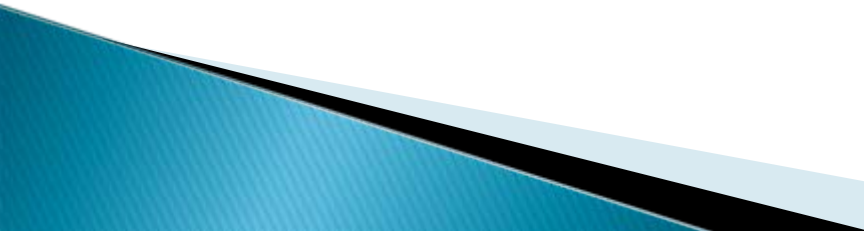
Adverse Effects of Noise

- ▶ Systolic but not diastolic BP elevation (cohort study *Am J Ind Med* 52: 509–517, 2009)
- ▶ Noise annoyance was independent variable for elevated BP (cross-sectional study *Int Arch Occup Environ Health* 65: 23–28, 1993)
- ▶ Association with cardiovascular risk not clear
- ▶ Stress is confounding variable


Annoyance

- ▶ Is annoyance a disease, a health effect or an emotion?
- ▶ Dripping tap, light in room
- ▶ Kalveram: Annoyance following noise exposure can be considered to convey a “possible loss of fitness signal” indicating that the individual’s Darwinian fitness decreases if she or he continues to stay in that situation.


Infrasound

- ▶ IEC 1994: Acoustic oscillation whose frequency is below the low frequency limit of audible sound, ~16 Hz
 - ▶ But, some people can hear sounds at below this frequency
 - ▶ A weighting does not work well with “sounds” in this range, as low frequencies are much more difficult to hear
 - ▶ At 16 Hz the threshold of perception is 88 dB, 107 dB at 4 Hz
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Infrasound

- ▶ Several studies show wind turbines not audible at 50 Hz or less, corresponds to a dB threshold of 44
 - ▶ Infrasound from wind turbines is not perceptible nor above levels produced by the natural environment
 - ▶ No evidence of harm or health effects at these levels, we are immersed all the time
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Wind Turbine Sound

- ▶ Audible aerodynamic “swish” sound is mid frequency, 500–1000 Hz, not low frequency (defined as 10–200 Hz)
 - ▶ Confusion in lay accounts
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Evidence of Harm

- ▶ ~ 100 reports of wind-turbine associated sickness of varying degrees in Ontario
- ▶ Reported symptoms nonspecific
- ▶ Generated from self-reported open survey, uncontrolled and unverified
- ▶ *Wind Turbine Syndrome* by Nina Pierpont, MD, PhD, 2009
- ▶ Vibro-acoustic disease, Alves Piera and Castelo Branco, many papers and abstracts
- ▶ Victims passionate about etiology despite lack of proof

Wind Turbine Syndrome

- ▶ uncontrolled and unverified reports of nonspecific symptoms in 38 people interviewed by Dr Pierpont
 - ▶ No physical examinations
 - ▶ No diagnostic testing
 - ▶ Subjects were selected by the investigator using interesting criteria: extreme selection bias
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Wind Turbine Syndrome

- ▶ P. 124: “In other families, excluded from the analysis, one spouse was clearly committed to staying in the house and minimized what the other spouse said. I endeavored to protect against exaggeration by including in the study only families who had moved out of their homes or done something else expensive in response to their symptoms, proving their symptom severity in ways other than words.”
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Wind Turbine Syndrome

- ▶ P. 125: “ For this study, I chose a cluster of the most severely affected and most articulate subjects I could find.”
- ▶ “This is an extraordinary book. It is personal and passionate, which makes it compelling reading. But it is much more–authoritative, meticulous and scholarly....It clearly takes its place as the leading work on the topic.”

Dr Robert Y. McMurtry



Wind Turbine Sound and Health Effects

An Expert Panel Review

W. David Colby, MD

Robert Dobie, MD

Geoff Leventhall, PhD

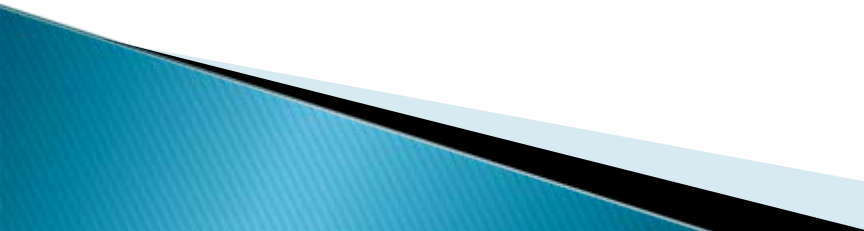
David M. Lipscombe, PhD

Robert J. McCunney, MD


Michael T. Seilo, PhD

Bo Søndergaard, MSc

Expert Panel Review

- ▶ No evidence that audible or sub-audible sounds emitted by wind turbines have any direct adverse physiological effects.
 - ▶ Ground-borne vibrations from wind turbines are too weak to be detected by, or to affect, humans.
 - ▶ Sounds emitted by wind turbines are not unique. There is no reason to believe...that the sounds from wind turbines could plausibly have direct adverse health consequences.
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Expert Panel Review

- ▶ Panel members agree that the number and uncontrolled nature of existing case reports of adverse health effects alleged to be associated with wind turbines are insufficient to advocate for public funding of further studies.
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Precautionary Principle

- ▶ An attempt to shift the burden of proof away from *proof of harm* [the standard used by society] to that of *proof of no harm*.
- ▶ Activists maintain that until there is definite proof that wind turbines are *not* harmful, wind turbines should not be built.
- ▶ No other technologies are expected to meet this impossible standard. [Was proof demanded that antibiotics, automobiles or electrical appliances could not cause harm before they were put into use?]
- ▶ A negative statement, for example, that ghosts do not exist, cannot be logically proved.

The Nocebo Effect

- ▶ An adverse outcome, a worsening of mental or physical health, based on fear or belief in adverse effects.
- ▶ The opposite of placebo effect, where belief in positive effects of an intervention may produce positive results (Spiegel 1997)
- ▶ Canadian experience with urea formaldehyde foam insulation

Power Generation

- ▶ The realistic alternatives to wind energy for temperate regions all have worse health and/or ecologic consequences:
 - ▶ Coal-fired generating stations
 - ▶ Damming more rivers
 - ▶ Nuclear reactors
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