Wind Turbines: Do they affect our health?

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Wind Turbines: Are there health effects?

- Purpose of presentation: address review conducted by expert panel convened by AWEA
- Panel members represent disciplines of occupational medicine, audiology, acoustics, otolaryngology, and public health
- Charge of panel: review scientific literature and prepare a report

Sound Panel Members

- **David Colby**

Chatham-Kent Medical Officer of Health

- **Robert Dobie, MD**

Otolaryngologist, UC Davis Health System

- **Geoff Leventhall**

Consultant in Noise Vibration and Acoustics

- **Dave Lipscomb, Ph.D.**

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Research Scientist, MIT Dept of Biological Engineering

- Staff Physician, Mass General Hospital Pulmonary Division

Mike Seilo, Ph.D.

- Professor of Audiology, Western Washington University

Bo Søndergaard

- Danish Electronics Light and Acoustics (DELTA)

Wind Turbines: Are there health effects?

Outline of presentation

1. Methodology-review peer reviewed scientific literature
2. Focus:

a. noise (infra sound and low frequency sound)
b. vibration

III. Results

IV. Discussion

V. Conclusions

Wind Turbines: Are there health effects?

- Operation of a wind turbine
- Noise is both mechanical-from gear box and control mechanisms
- aerodynamic-operation of the blades

Health Effects of Noise

- Sound: mechanical energy
- Sound intensity: measured in decibels
- Decibel scale: logarithmic: an increase of 10 dB represents a 10 fold increase in sound levels; dBA- Adjusted
- Speech frequency: 500-4000 Hz
- Noise: unwanted sound

Noise Levels in decibels dBA**

- Riveting: 75-125
- Saws: 70-100
- Grinders: 70-105
- Furnaces: 70-100
- Industries and Noise
- Food: 72-95 dB
- Textiles: 82-104
- Aircraft: 78-94

Noise Levels in decibels dBA**

- Jet Engines 140
- Jet take off 135

<u>Other activities</u>

- Rock Band 110
- Tractor/power saw 100
- Lawn mower at 3 feet 95
- Vacuum cleaner at 3 feet 85
- Busy restaurant 78
- Speech range: 50-70
- Whisper 30

<u>Wind Turbines</u>

Frequencies and Hearing

- Speech frequency 500 Hz -20,000 Hz
- Low frequency: 20-250 Hz
- Infra sound < 20 Hz

Three kinds of sound are emitted by wind turbines:

1. Infrasound
2. Low frequency sound of approximately 10-200 Hz
3. Fluctuating aerodynamic “swish” from the turbine blades which is in the mid-frequency range, approximately 500-1000 Hz.

Infra Sound and Hearing Perception

Freq Hz	4	8	10	16	20
Noise Level (dB SPL)	107	100	97	88	79

Infra Sound and Hearing Perception

- The noise level (dBA) refers to the loudness of the sound necessary for it to be heard at the respective frequency of the sound.
- Wind turbines: ~ infrasound emitted from wind turbines is at a level of 50 to 70 dB, sometimes higher, but also well below the audible threshold.

Wind Turbines: Are there health effects?

Infra sound

- Due to the long wave lengths of low frequency noise, it can travel long distances and pass through walls and windows with little attenuation. (Waye, 2004)
- There is no evidence for physiological effects from infrasound or low frequency sound at the levels generated from Wind Turbines.
- There can, however, be effects from the sounds becoming audible, but these are similar to effects from other audible sounds

Vibration

- Vibration at inaudible low frequency noise levels has been postulated as having a potential adverse effect on health
- Vibration refers to the way in which energy travels through solid material, whether steel, concrete in a bridge, the earth, the wall of a house or the human body.

Vestibular system

- The vestibular organs are specialized for stimulation by head position and movement, not by airborne sound.
- Each vestibular organ is firmly attached to the skull, to enable them to respond to the slightest head movement.
- In contrast, the hair cells in the cochlea are not directly attached to the skull; they do not normally respond to head movement, but to movements of the inner ear fluids.

Adverse effects of noise

- Speech interference: > 80-85 dBA people need to shout
- Noise-induced hearing loss: > 80 dBA for prolonged periods
- Task interference: < 70 dBA not adverse
- Annoyance-varies
- Sleep Disturbance-varies
- Other adverse health effects of noise

SPEECH COMMUNICATION AT 1 METER (CONVERSATIONAL DISTANCE)

- Speaker's voice: 50-55 db
- Loud Voice: 65-70 dB
- Shout: 80-85 dB

Results

Wind Turbines and health:

3 Cross sectional studies of people living in vicinity of wind turbines

Netherlands and Sweden primarily

Annoyance-major concern raised in relation to noise from wind turbines

Annoyance related to personal factors and attitudes towards wind turbines

Results

- ~5% reported annoyance at 35-40 dBA
- 18% at 40-45 dBA
- Similar results to earlier Swedish studies

Annoyance

- Many environmental causes
- Increases with “noise sensitivity” 12 dBA
- Swedish study: 84 of 1095 people “fairly or very annoyed” by wind turbines
- Personal characteristics affect development of “annoyance”

Low frequency noise

- No link between LFN from wind turbines and health effects
- FDA approves infra sound for therapeutic massage at 70 dBA

Flicker and Epilepsy

- Photosensitive epilepsy
- Family predominant
- 1/4000 people
- Sunlight a precipitant
- Unclear if related to wind turbines-no published reports
- the epilepsy website (http://www.epilepsyfoundation.org/about/photosensitivity/) says “Generally, flashing lights most likely to trigger seizures are between the frequency of 5 to 30 flashes per second (Hertz)”
- No risk if < 5 Hz or speed of

wind turbine < 60 rpm (Harding, 2008)

Discussion

1. Noise and Health no risk of hearing loss

- No risk from infra sound

2. Annoyance-affected by personal factors and noise sensitivity at low frequencies (~12 dB)

Discussion

3. Vibroacoustic disease -dubious due to

a. Case reports-2 families
b. Exposure intensity (~ 55-60 dBA),
c. Lack of control group
d. Lack of control of confounders
e. Low frequency noise in body

- heart (27-35 dB @ 20-40 Hz)
- lung sounds (5-35 dB @150-600 Hz)

Discussion

4. Wind Turbine Syndrome appears based on two hypotheses

- Low levels of airborne infrasound from Wind Turbines, at 1 – 2Hz, directly affect the vestibular system, and
- Low levels of airborne infrasound from Wind Turbines at 4-8Hz enter the lungs via the mouth and then vibrate the diaphragm, which transmits vibration to the viscera. (Internal organs of the body)

Wind Turbine Syndrome

- Low-level sounds from outside the body **do not** cause a high enough excitation within the body to exceed the internal body sounds
- The similarity between symptoms of noise annoyance and those of the "Wind Turbine Syndrome" indicates that this "diagnosis" is not a pathophysiological effect, but an example of the well-known stress effects of exposure to noise-virtually any type- displayed by a small proportion of the population.

Wind Turbine Syndrome

- not a recognized diagnosis in the medical community.
- no unique symptoms or combination thereof that would lead to a specific “disease”.
- Symptoms in some people in the context of exposure to wind turbines are likely associated with annoyance to low noise levels

Visceral vibratory vestibular disturbance (VVVD)

Pierpont proposes that wind turbine sound in the 4 – 8 Hz spectral region causes

- vibrations in abdominal viscera (e.g., intestines, liver, and kidneys)
- that in turn send neural signals to the part of the brain that receives information from vestibular labyrinth.

Visceral vibratory vestibular disturbance (VVVD

- Visceral receptors proposed as a mechanism for VVVD respond to **static gravitational position** changes, but not to vibration (that is why they are called graviceptors).
- If vibration-sensitive receptors were in the abdominal viscera, they would be constantly barraged by low-frequency body sounds such as pulsatile blood flow and bowel sounds, and
- external sounds would be attenuated by overlying tissues.
- Finally, wind turbine sound at realistic distances possesses little, if any, acoustic energy, at 4 – 8 Hz above ambient noise levels.

Interpreting studies

How to evaluate the quality of scientific information?

- Types of studies
- Control groups
- Avoid biases

Interpreting scientific literature

- In the case of wind turbine noise and its hypothetical relationships to “wind turbine syndrome” and “vibroacoustic disease” (VAD), we have only the weakest type of evidence – **case series**, from only a single investigator. These reports can suggest hypotheses – for further research but do not demonstrate causal connections

Guidelines for siting wind turbines

- Like other sources of noise, a uniform regulatory approach for wind turbine noise has not been established- domestically or internationally.

Guidelines for siting wind turbines

WHO guidelines

- represent a consensus view of international expert opinion on the lowest noise levels below which the occurrence rates of particular effects can be assumed to be negligible.
- Exceedances of the WHO guideline values do not indicate significant noise impact;
- The guidelines form a starting point for policy development. However, costs and benefits of reducing noise levels need to be addressed.

Conclusions

- 1. Noise from wind turbines does not pose a risk of hearing loss or any other adverse health effect.
- 2. Some people may become annoyed from the sound from wind turbines but this is not a disease.
- 3. The major cause of concern from wind turbine noise is the fluctuating nature of it. Some may find this noise annoying, a reaction that depends primarily on personal characteristics as apposed to the intensity of the noise level.
- 4. Sub audible low frequency noise and infra sound from wind turbines do not present a risk to health.
- 5. Wind Turbine Syndrome is neither a new disease or accepted medical diagnosis. Symptoms reflect noise annoyance.