

Wind Turbines: Do they affect our health?

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Wind Turbines:

- Operation of a wind turbine: major exposure concern: Noise
- Noise is both
 - (1) mechanical-from gear box and control mechanisms and
 - (2) aerodynamic-operation of the blades

Noise Levels in decibels (dBA**)

■ Jet Engines	140
■ 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
■ Area near wind turbine (300 meters)	_____ 35-45*

* See Environmental Impacts of Wind Energy Projects, NRC (2007)

- ***Risk of hearing impairment: exposure > 80 dB (A) for many years***

Wind Turbines and sound

- According to the National Research Council, sound power from a single wind turbine "is usually around 90-105 dB (A); such a turbine creates a sound pressure of 50-60 dB (A) at a distance of 40 meters (this is about the same level as quiet conversational speech).
- "Noise (sound pressure) levels from an onshore wind project are typically in the 35-45 dB (A) range at a distance of about 300 meters." (NRC)

Sound Frequencies and Hearing

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

Three kinds of sound emitted by wind turbines that have received some attention are:

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 (dB) 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 well below the audible threshold for infrasound.

Wind Turbines: Are there health effects?

- Due to the long wave lengths of low frequency noise, it can travel long distances and pass through walls and windows with little attenuation.
- 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

Literature Review

Point: address peer reviewed studies of
“wind turbines and health’ via Pub MED
search

Wind Turbines and health:

3 Cross sectional studies of people living in
vicinity of wind turbines in the Netherlands
and Sweden.

Pedersen et al, 2009

- A sample of 1948 people (among > 70,000 adults) living within 2.5 km of a wind turbine in the Netherlands
- Sound level measurements available
- Questionnaire completed

Pedersen et al, 2009

Sound level; dB(A)	30-35	35-40	40-45	>45
Number of people	213	159	93	65
Very annoyed	1 (0.5%)	4 (2.5%)	10 (11%)	2 (3%)

Pedersen et al, 2009

- Authors noted that the % of people who reported annoyance from wind turbine sound appeared to lie between aircraft noise and shunting yards
- Correlation noted- as in other studies- of a link between attitude towards wind turbines and reporting annoyance

Pedersen, 2007

- Evaluation of 754 (among 3471 eligible) people in Sweden

Methods:

1. Questionnaire
2. Sound measurement calculations
3. Distances: 605-1014 meters between homes and turbines

Pedersen, 2007

Results

@ 35-37 db < 5% very annoyed

@ > 40 dB, ~ 15% very annoyed

Strongest associations reported:

Odds ratio (OR) 13.4 (95% CI: 6-30) based on attitude towards wind turbines

OR 14.4 (95% CI: 6-32) attitude RE: Visual impact of turbines

Thus, those who had unfavorable attitude towards WT were over 13 times more likely to be “annoyed”.

Pedersen, 2004

- 351 people in Sweden in 5 domestic areas
- Wind turbines: 600-660 kW
- Frequency analysis: @ Hz < 200 (ie low frequency sound) sound levels ranged from the mid 30s dB to mid 40s dB with a spike of 48 dB at ~ 26 Hz.
- Distances from homes to wind turbines: 150-1199 meters

Pedersen, 2004

- Among 132 people in the 32.5-35 dB range, at a distance of 550-599 meters, 6% reported being very annoyed
- Attitude towards wind turbines was the strongest factor associated with annoyance

Summary of wind turbine environmental studies

Based on the similarity of results of the studies of residents in the vicinity of wind turbines in Sweden and the Netherlands, a number of conclusions can be drawn:

- A small percentage of people report being very annoyed by the sound from wind turbines at levels < 35 dB
- As the noise levels increase, more people report being annoyed
- The perception of "annoyance" from the sound of wind turbines is strongly related to attitudes toward wind turbines. The people who are most likely to be "annoyed" are those who do not like wind turbines

Infrasound & Low Frequency Noise

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

Low frequency sound

Danish Study 2008

- Wind turbines do not emit audible infra sound.
- Other noise sources, such as road traffic, emit low frequencies of higher levels.
- There is an approximate 5-15 dB (A) attenuation of noise from outdoors to indoors with the windows shut.
- The percentage of people annoyed by wind turbine noise at < 40dB (A) is about 5%.

Low frequency sound

British Study 2006

- Low frequency noise associated with road traffic was greater than sound from neighboring wind farms
- Infrasound associated with modern wind turbines will not be injurious to the health of a wind farm neighbor
- Measurements of infrasound of modern wind farms at distances of 200 meters were between 25 and 40 dB below perception thresholds.
- The authors also referred to a World Health Organization report that stated: "**There is no reliable evidence that infra sounds below the hearing threshold produce physiological or psychological effects.**"

Low frequency sound

British Study 2006 (Cont'd)

- The common cause of complaint was not associated with low frequency noise but with occasional audible modulation of aerodynamic noise, mostly at night.
- “Of the 126 wind farms operating in the UK, 5 reported low frequency noise problems. Therefore such complaints are the exception rather than a general problem for wind farms.” (Hayes McKenzie, 2006).

Low frequency sound

USA Study 2010

- 15 wind turbines

The results indicated:

- infrasound is inaudible to even the most sensitive people 305 meters (1,000 feet) from the wind turbines. Low frequency sound above 40 Hz may be audible depending on background sound levels
- At maximum noise at a distance more than 305 meters (1,000 feet) from the nearest residence, wind turbines do not pose a low frequency noise or infrasound problem. "At this distance the wind farms met ANSI/ASA S12.2 indoor levels for low frequency sound for bedrooms, classrooms and hospitals ding on background sound levels

LFN and health effects

- Health related effects of living in the vicinity of wind turbines and corresponding exposure to low frequency sound have been evaluated in the Netherlands (van den Berg, 2008).
- No link between noise levels and risk of diabetes, hypertension, tinnitus and cardiovascular disease was noted. To the contrary, the illnesses assessed were more common at the lower sound levels than the higher sound levels which indicated no link between noise and the illnesses assessed

Infra sound and health

- In Apollo space program experiments, subjects were exposed to between 120 and 140 dB of LFN without harmful effects.
- U.S. space program :studies indicate that 24-hour exposures to 120 to 130 dB are tolerable below 20 Hz, the upper limit of infrasound.
- Modern wind turbines produce sound that is assessed as infrasound at typical levels of 50 to 70 dB, below the hearing threshold at those frequencies (Jakobsen, 2004), who concluded that infrasound from wind turbines does not present a health concern.

Infra sound and health

- Heart tones: 1-2 Hz
- Lung sounds: 5-35 dB at 150-600 Hz
- “A few meters from the device, windmill noise in the infra sound range becomes rapidly inaudible. This infrasound has no effect on human health. Fears regarding windmill-induced infra sound are thus groundless. Infrasound production by windmills has been well studied and the levels are without risk to humans.”
- French National Academy of Medicine, 2006

Low frequency sound

- Research with low frequencies has shown that an audible low frequency sound does not normally become objectionable until it is 10 to 15 dB above hearing threshold (Inukai et al., 2000; Yamada, 1983).

Wind Turbine Syndrome

- **Hypothesis**: low frequency sound and corresponding vibration adversely affects health
- As of 5/2/10 not published in peer reviewed scientific journal (PubMed search)
- 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

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”

“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)

“vibroacoustic disease: 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

“vibroacoustic disease”

- A review of PubMed under the search term "vibroacaoustic disease" indicated 36 references, all but two of which originated with the same Portuguese group noted earlier. It is unclear why the rest of the academic world does not appear to have addressed the vibro-acoustic disease concept introduced by the Portuguese team.

Interpreting scientific literature

- In the case of wind turbine noise and its hypothetical relationships to “wind turbine syndrome” and vibro-acoustic disease, no case-control, cohort or longitudinal studies have been published. In fact, only the weakest type of scientific evidence—case series—is available

Conclusions

- 1. Noise from wind turbines does not pose a risk of hearing loss or any other direct 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 noise. Some 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.