Wind Turbines, Noise and Health

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THE EFFECT OF WIND TURBINES ON HEALTH.

I first realised there might be a problem associated with wind turbines when I was introduced to a couple living near a wind farm in Cornwall. The distance from their home to the nearest turbine is about 400 meters. They told me about poor sleep, headaches stress and anxiety symptoms brought on when the wind was blowing in certain directions. At times, they told me that they have been so disturbed by the noise that after several disturbed nights sleep, they have sought refuge in a nearby bed and breakfast establishment (far enough away not to be similarly affected by the noise).

Since that meeting I have spoken to and / or corresponded with 39 people living between 300meters and 2 km from the nearest turbine of a wind farm all of whom were suffering from the consequences of the noise coming from the turbines. This disturbance is by no means always there and is worse in certain wind directions.
The cases mentioned below are from several wind farms in the UK with a variety of turbine sizes from the smaller, older turbines to the taller more modern turbines. However I have had correspondence from people living near wind farms in New Zealand and Australia and have evidence from other sources, (newspapers, journals and papers) of people being similarly affected in France, Germany, Netherlands and the USA.
What this shows is that there is number of people suffering from the consequences of noise from the wind turbines. I'm sure that the cases mentioned here are probably the "tip of the iceberg" and further independent investigation is warranted. The cases are kept anonymous in order to protect the individuals concerned. There is much concern within communities that if one is seen to complain about the noise that if they decide to move away their properties will be difficult to sell and possibly devalued as a result. Therefore they feel that they are in a "Catch 22" situation.

METHOD

All people involved in this survey were contacted either by phone or in writing. Questionnaires were completed for all cases. Questionnaires were sent to people already known to be suffering from problems which they felt was due to their proximity to wind turbines.
The identity of the people questioned has been with held in order to maintain confidentiality. The respondents were from a number of sites in the UK- Wales, Cornwall and the north of England

Example of questionnaire.

1) Name- (preferred but optional)

2) Age 18-30 30-45
45-60 >60

3) Occupation

4) Address and /or postcode

5) Which wind farm is near your property?

6) How far away from your property is the nearest turbine?

7) How long have you been living at this property?

8) Do you feel that your health has in any way been affected since the erection of these turbines?

9) If yes please answer the following:-
Do you feel that since living near a wind turbine/turbines you have experienced excess of the following symptoms (i.e. more than you did prior to living near these structures)?

Headaches	yes	no
Palpitations	yes	no
Excessive tiredness	yes	no
Stress	yes	no
Anxiety	yes	no
Tinnitus (ringing in ears)	yes	no
Hearing problems	yes	no
Sleep disturbance	yes	no
Migraines	yes	no
Depression	yes	no
Other- please specify		

If you have answered yes to any or the above questions, have you approached your doctor regarding these symptoms? If yes please state any tests and/or treatment initiated.

10) Do you feel that your quality of life has in any way altered since living near the wind turbines? Yes no

If yes could you please explain in what way you feel your life has been altered.

RESULTS

	1	2	3	4
Age	45-60	45-60	45-60	45-60
Occupation	Cleaner/ housewife	Retired Ill health	Head chef	farmer
Distance from turbine	400m	300m	350m	400m
Time at property	36 years	3 years	7years	4years
Health altered	Yes	Yes	yes	yes
Headaches	Yes	Yes	yes	yes
Palpitations	No	no	no	no
Excessive tiredness	Yes	No	yes	yes
Stress	Yes	Yes	yes	yes
Anxiety	Yes	Yes	yes	yes
Tinnitus	No	No	no	no
Hearing problems	No	No	no	yes
Sleep disturbances	Yes	Yes	yes	yes
Migraines	Yes	Yes	no	yes
Other				
Approached doctor	No	No	no	no
Altered quality of life	Yes	Yes	yes	yes

	5	6	7	8
Age	45-60	>60	18-30	18-30
Occupation	Housewife	Retired	Electrician	carer
Distance from turbine	300m	300m	300-500m	300-500m
Time at property	2.5 years	2.5 years	6 months	6 months
Health altered	Yes	Yes	Yes	yes
Headaches	Yes	Yes	Yes	yes
Palpitations	No	No	No	no
Excessive tiredness	No	Yes	Yes	yes
Stress	No	No	No	no
Anxiety	No	No	No	no
Tinnitus	No	No	No	no
Hearing problems	No	No	No	no
Sleep disturbance	No	No	Yes	yes
Migraines	No	no	No	no
Depression	No	no	No	no
Other		Thumping in ears		
Approached doctor	No	Yes-Rx with pain Killers-ongoing assessment	No- didn't associate symptoms with the turbines	
Altered quality of life	Yes	yes	Yes	yes

	9	10	11	12
Age	>60	30-45	30-45	30-45
occupation	Retired	candle maker	Retired-nervous Breakdown	Retired-ill health
Distance from turbine	300m	¼ mile	300m	300m
Time at property	4years	10 years	3 years	3years
Health altered	Yes	no	Yes	yes
Headaches	No	no	Yes	yes
Palpitations	No	no	No	no
Excessive tiredness	No	no	Yes	no
Stress	No	no	Yes	yes
Anxiety	No	no	Yes	yes
Tinnitus	Yes	no	No	no
Hearing problems	No	no	No	no
Sleep disturbance	No	no	Yes	yes
Migraines	Yes	no	Yes	no
Depression	No	no	Yes	yes
Other		See comments at end	Stomach upset	
Approached doctor	No	no	Yes-seen psychiatrist-Ongoing review	no
Quality of life affected	Yes	yes	Yes	yes

	13	14
Age	30-45	>60
Occupation	Veterinary nurse and HGV driver	Retired from farming and Teaching
Post code	TR8	SA38
Wind farm	Bears Down	Blean Bowi
Distance from turbine	Too close	1mile
Time at property	19 months	27years
Health altered	Yes	Yes
Headaches	Yes	Yes
Palpitations	No	Yes
Excessive tiredness	Yes	Yes
Stress	No	Yes
Anxiety	No	Yes
Tinnitus	No	Yes
Hearing problems	No	No
Sleep disturbance	Yes	Yes
Migraines	No	No
Depression	No	Yes
Other	No	Emotional turmoil
Approached doctor	Yes- taking sleepers and Headache tablets	Yes-had heart check up
Quality of life affected	Yes	Yes

	15	16	17	18
Age	45-60	>60	>60	45-60
Occupation	Teacher	Retired	Retired	Charity manager
Distance from turbine	700m	650m	650	½ mile
Time at property	26 years	30+	30+years	Bear Down
Health altered	Yes	Yes	No	No
Headaches	Yes	No	no	No
Palpitations	No	No	No	No
Excessive tiredness	Yes	Yes	No	No
Stress	No	Yes	No	No
Anxiety	Yes	No	No	No
Tinnitus	No	No	No	No
Hearing problems	No	Yes	No	No
Sleep disturbance	Yes	Yes	No	No
Migraines	No	No	No	No
Depression	No	Yes	No	No
Other	No	No	No	No
Approached doctor	No	No	No	No
Quality of life altered	Yes	Yes	Yes	No

	19	20	21	22
Age	>60	>60	>60	>60
Occupation	Retired		Retired	Retired
Distance from turbine			700m	700m
Time at property	20years	20 years	25years	25 years
Adverse health affects	Yes	Yes	Yes	Yes
Headaches			Yes	Yes
Palpitations				
Excessive tiredness	Yes	Yes	Yes	Yes
Stress			Yes	Yes
Anxiety			Yes	Yes
Tinnitus				Yes
Hearing problems				Yes
Sleep disturbance		Yes	Yes	Yes
Migraines				
Depression	Yes		Yes	Yes
Other				
Approached doctor			Yes	Yes- doctor referred me to the hospital. After tests the consultant could find nothing wrong with my ears.
Quality if life affected	Yes	Yes	Yes	Yes

	23	24	25	26
Age	45-60	45-60	>60	57
Occupation	Farmer	Farmer	Retired	Retired police officer
Distance from turbines	430m	430m	1000m	1000m
Time at property	5 ½ years	5 ½	30years	30years
Adverse health affects	No	Yes	Yes	Yes
Headaches			Yes	Yes
Palpitations				
Excessive tiredness			Yes	Yes
Stress			Yes	Yes
Anxiety				Yes
Tinnitus		Yes		
Hearing problems			Yes	
Sleep disturbance				Yes
Migraines			Yes	
Depression				Yes
Other				
Approached doctor		Yes- been under a specialist in Furness General hospital for 1 ½ years	Yes	No
Quality of life affected	Yes	Yes	Yes	Yes

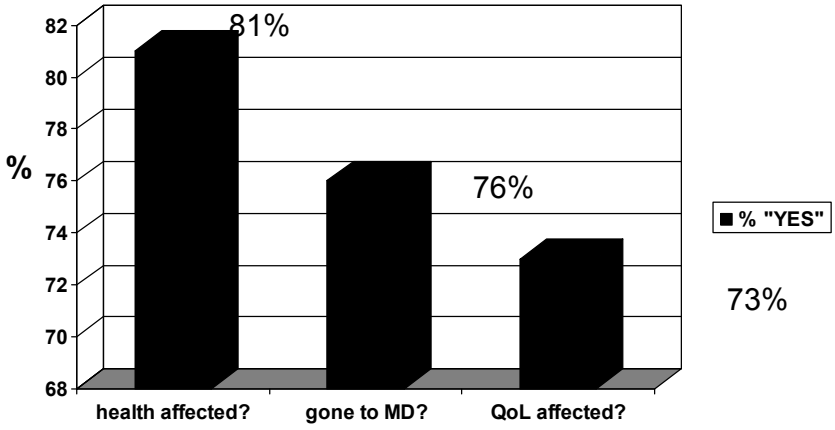
	27	28	29	30
Age	>60	>60	56	79
Occupation	Farmer/ sheep breeder		Pedigree sheep breeder	War veteran
Distance from turbine	½ mile	700m	1/3mile	
Time at property	9 years	33 years	9 years	33 years
Adverse health affect	Yes	Yes	Yes	Yes
Headaches	Yes		Yes	Yes
Palpitations			Yes	
Excessive tiredness	Yes		Yes	Yes
Stress	Yes		Yes	Yes
Anxiety			Yes	Yes
Tinnitus				Yes
Hearing problems				Yes
Sleep disturbance	Yes	Yes	Yes	
Migraines	Yes		Yes	Yes
Depression				
Other			Concentration	
Approached doctor	Yes	No	Yes- have had a 24 hour e.c.g. for investigations of palpitations. Brain haemorrhage 2 years ago.	Yes
Quality of life affected	Yes		Yes	Yes

	31	32	33	34
Age	81	45-60	>60	30-45
Occupation	Retired carpenter	Systems analyst/programmer	Business owner	Retired State registered nurse
Distance from turbine		¾ mile	Less than 1 mile	300m
Time at property	33 years	16 years	16 years	7 years
Health adversely affected	Yes	No	Yes	Yes
Headaches	Yes		No	Yes
Palpitations			No	
Excessive tiredness	Yes	Yes	Yes	Yes
Stress	Yes		Yes	Yes
Anxiety	Yes		No	
Tinnitus	Yes		No	
Hearing problems	Yes		Yes	
Sleep disturbance			Yes	Yes
Migraines	Yes		no	
Depression			No	
Other				
Approached doctor	Yes	Yes	No	No
Quality of life affected	Yes		Yes	Yes

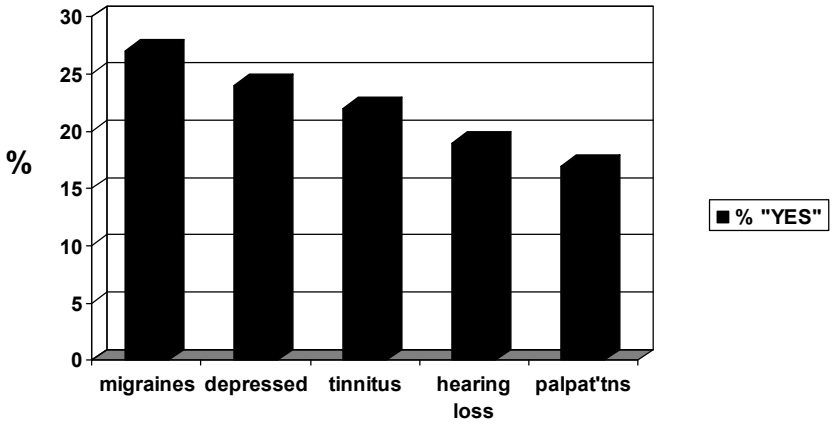
	35	36	37	38
Age	45-60	45-60	45-60	62
Occupation	Retired due to Nervous breakdown	Semi Retired farmer	Semi retired farmer	Retired
Distance from turbine	300m	800m	800m	
Time at property	7 years	11 years	11 years	25 years
Health adversely affected	yes	Yes definitely	Yes	
Headaches	yes	Yes	Yes	
Palpitations		Yes	Yes	
Excessive tiredness		Yes	Yes	Yes
Stress	yes	Yes yes	Yes	
Anxiety	yes	Yes yes yes	Yes	
Tinnitus		Yes	Yes	
Hearing problems		May be		
Sleep disturbance	yes	Yes yes yes	Yes	Yes
Migraines		No	No	
Depression		No	no	
Other	nausea			
Approached doctor	yes	Yes put on antidepressants and anti-hypertensives	Yes	
Quality of life affected	Yes	Absolutely yes	Yes	Yes

	39	40	41	42
Age			45-60	>60
Occupation	Retired phlebotomist	Running own business	Database administrator	Retired farmer
Distance from turbine		600m	3/4mile	1 mile
Time at property	20 years	24 years	7 years	26 years
Adverse affect on health	Yes	Yes	Yes	Yes
Headaches		Yes		Yes
Palpitations				Yes
Excessive tiredness	Yes	Yes		Yes
Stress				Yes
Anxiety		Yes	Yes	Yes
Tinnitus				
Hearing problems				
Sleep disturbance	Yes	Yes		Yes
Migraines				
Depression				Yes
Other	Lack of concentration And irritability		Nausea	
Approached doctor	No	No		Yes
Quality of life affected	Yes	Yes	Yes	Yes

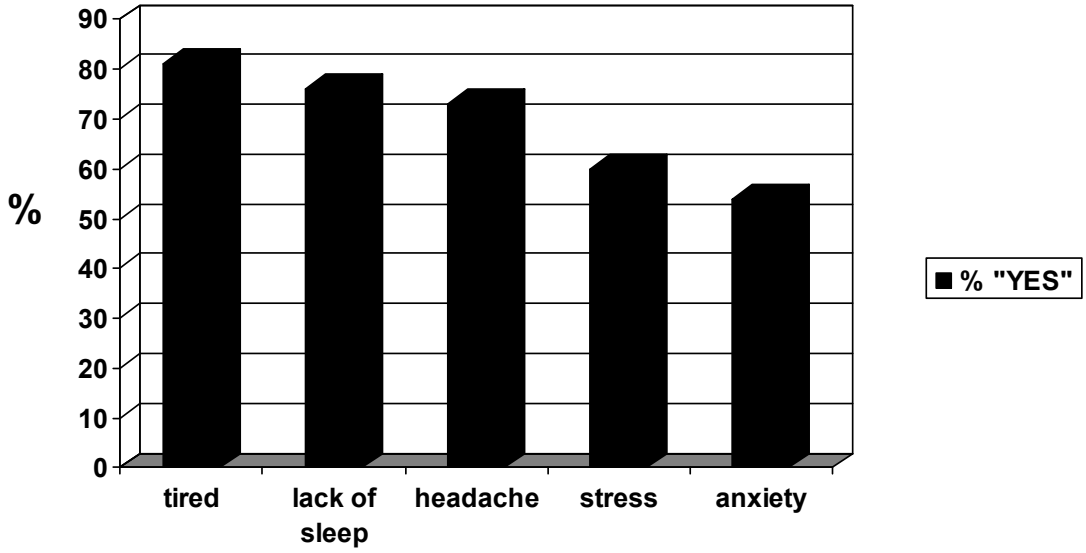
- ***Has your health in any way been affected since the erection of these turbines?***
- ***As a result, have you gone to see your doctor?***
- ***Do you feel that your Quality of Life has in any way been altered since living near the wind turbines?***



Top 5 Self-reported Health Symptoms



Next 5 Self-reported Health Symptoms



ADDITIONAL COMMENTS MADE BY RESPONDANTS

1) I get little sleep when the noise from the turbines is constant in its low frequency noise. I feel so depressed I want to get away and stay away until I know the wind direction has changed.

2) My symptoms are due to lack of sleep when the wind is in the east or northeast

3) I get headaches frequently especially when the turbines are running at a fast rate towards us.

4) I get headaches and thumping in the ears. I also find its continual noise very distressing.

5) Suffer with headaches more and feel tired more so find daily tasks difficult to do.

6) I also find that the sound we get from the farm affects my metal heart valve.

7) I couldn't say whether or not the storbing effect wakes me up but it is impossible to go back to sleep with it there.

8) Constant worry about noise. I feel sick when the turbines are running fast and towards the property. I came here to a rural area for peace after a busy city life. I feel this has been ruined by the turbines.

9) Stressed and extremely anxious as I am constantly disturbed by them when they are turning fast and facing towards me. We are having to live our lives around them due to the constant noise when they are working causing wind pressure throbbing.

10) The strobing even when curtains are closed is "HELL". The noise is a pain. TV blocks it, night and day. Can't sit and read a book or write letters.

11) My plan was to stay here- in my newly converted barn (7 years old) (we farmed here) until I died. We have our own private water supply, a good supply of fire wood, my own painting studio- VERY IMPORTANT TO ME! And a good workshop for my husband; friends nearby, brother and sister nearby. I was born 2 miles away- Now WE HAVE TO MOVE. This move has been forced upon us. We planted 7,000 trees here. Etc.etc.etc……..

12) We will probably have to move, I can see no future for me here.

13) I dare not sleep at home.

14)
Noise disturbance at night –when wind in certain direction, interferes with sleep patterns, causing restlessness. During the day- makes it difficult to stay out of doors for any length of time through excessive thumping sound. Both can cause headaches, anxiety and irritability.

15) Certain wind directions mean excessive noise, like a thrashing machine constantly pounding, making it unpleasant to be in the garden or to have windows open. With strong wind conditions, double glazed windows vibrate and cause an intrusive, almost sub audible interference in some rooms.

16) Tired, disturbed by noise. Feel it as much as hear it. Developers deny there are any problems unless we can prove, but how can we do that?

17) Irritating noise from wind farm in easterly winds. You can almost feel it as well as hear it. It drives you mad over extended periods because of the nature of the noise, not the level per se. Unable to have front doors/windows open when winds are easterly, or use front bedroom if all 7 turbines are in operation.

18) Our quality of life we had before the wind farm came has gone. We no longer control the way we live our lives e.g. if we can work or sit in the garden, or at times, even where we can sit in our own home or get a full nights sleep.

19) I never suffered from any problems before the turbines. I am convinced that living in a continual state of anxiety over the past four and a half years since the noise nuisance started has contributed to my present problems (hypertension and stress). Prior to 1999 I always enjoyed excellent health and rarely visited the doctor's surgery. As my husband and I have been retired since 1994 and our family grown up and living in different areas of the country we do not have any other problems that are likely to cause stress or anxiety.

20) Not being able to choose when I work or sit in my own garden. Not getting full nights sleep. Waking with headaches when the noise is bad and feeling sick. Ears feel like I experience when travelling by plane- feel as if they are swollen inside. I cannot work more than 2-3 hours in the garden when the wind direction if from the east. We cannot see the wind farm from our property but at times the noise is horrendous.

21) My quality of life has been affected by the shadow flicker and the noise

22) I am bothered by the shadow flicker, and the noise while working behind the building.

23) I feel generally off colour

24) As we leave the house, the turbines are always there, menacing, always drawing your attention, depressing, in a beautiful area. Normally I sleep with the bedroom windows closed, if in summer we have a heat wave and the windows are open, I find I am wheezing in time with the turbine noise, it seems to come inside my body. This is an old stone gatehouse south of the site.

25) Quality of life has almost disappeared. No longer able to relax in the garden (when wind speed/ direction cause noise). Glinting and reflection also cause disturbance. Visual dominance is oppressive- extremely angry.

26) Constant sleep disturbance. Unable to work within certain areas, for noise levels, when wind is in certain directions, very stressful.

27) Disturbed sleeping. View blades whishing in the wind. Drawn to blades going round. Little concentration. Ugly to look at. Dominant. Not able to work in yard for long periods of time.

28) Our lives and home have been trashed and must be seen to be believed. We seem to be short tempered, unable to concentrate. Every thing we have such as mattress, duvets, cushions 4" thick, 3 rolls of sound deadening quilt, 3 sheets of corrugated asbestos, blankets, curtains, pillows even floor carpet stacked against the walls to try and keep out the sound. Not the peace I volunteered to fight for.

29) constant noise

30) Constant noise when turbine is facing us and away from us. Sleepless nights which make me irritable. Stress due to husbands anxiety about the turbines.

31) Noise from turbines effects my sleep patterns, I sleep less. I get nausea when the turbines face our home and causes a drumming at low noise frequency. I worry about the turbine blades coming off and killing me

32) Alienation from mainstream community that have the erroneous impression that wind power is a good alternative. Forced to sell property at a reduced rate- that was meant to be our retirement home. Health improved since moving from the property

33) As soon as the wind farm was operating I experienced horrendous continuous noise when the wind was from the east. This was both inside and outside my home. There were many times I had to leave the garden because of the noise. It was like a Chinese water torture, it was a constant pulsating noise. It was almost a feeling of compression as much as noise. I had to move bedrooms at times in order to escape the noise. It imprints on you, if you have had it all day in the garden, it stays with you,

once it's in your head it's hard to get rid of. It's weird. It's a feeling as much as a noise. It's torture.

34) It's an irritating and tiring noise, especially when you have not had any sleep because of it.

35) Even if you shut the window, the noise is still there, but not as much. The problem is, once you get the noise in your head, it's always there, it does annoy you and it is difficult to disregard.

36) The noise is like a whooshing noise. It is intrusive. It keeps me awake- it doesn't affect my husband as much as me but my being awake keeps him awake.

37) Once the noise gets into your head, it also seems to beat at the same frequency as my heart and I find it annoying and am unable to get any sleep- this can go on for nights on end. It's not always the level of the noise, it's the intermittent nature. You think "Oh it's stopped" then it starts up again.

38) If the wind is from the East or the South the noise is horrendous- you can't get away from it. It's inside and outside the house. It's worse at night- I have to bed hop. It's a whooshing, drumming, constant drumming noise. It's annoying. It's frustrating. It wears you down. You can't sleep at night or concentrate during the day. Once it gets inside your head you can't get rid of it. You get up in the morning, tired, agitated and depressed and it makes you short- tempered.

39) Our lives are hell, they have been ruined and it's all due to those turbines.

40) The noise from the wind farm is different and I can't explain why, it just is. All you ever want to do is to get out of the way of it, by whatever means you can.

CONCLUSIONS

I think it is clearly evident from these cases that there are people living near turbines who are genuinely suffering from health effects from the noise produced by wind turbines. These neighbours of turbines clearly state that at times the noise from turbines is unbearable. The developers are usually heard to say that noise is not a problem. Clearly this cannot be the case.
A discussion follows which clearly explains why the characteristic noise from these turbines can be producing the symptoms that are being described above. On searching through the current literature I can find no papers written showing that turbines are harmless, only statements from acousticians giving their personal thoughts. In addition to this some of these acoustic experts have made statements categorically saying that the low frequency noise from turbines does not have an effect on health. I feel that these comments are made outside their area of expertise and should be ignored until proper medical, epidemiological studies are carried out by independent medical researchers.

DISCUSSION

As shown in the case studies, people living near wind farms in the United Kingdom have been complaining of health problems since the construction of the wind farms near their homes. Inquiries reveal that some wind farms located close to peoples residences in Europe, Australia and North America have reported similar problems

The range of symptoms mentioned by complainants includes headaches, sleep disturbance, anxiety, depression, stress, vertigo and tinnitus. People complain of the noise, vibration and shadow flicker (caused by rotation of the blades and the reflection of the sun).

The following seeks to explain why these symptoms and problems could be caused by the wind turbines.

The evidence supplied has been made by a prolonged study of research available worldwide. Some acousticians have expressed the opinion that the level of low frequency noise (in dB (A)) emitted by a wind turbine will not produce health problems. However during my extensive search of the published literature, I have been unable to find any medical evidence to support this opinion.

Although the papers researched are generally not specific to wind turbines they are specific to the type and intensity of noise produced by wind turbines. The noise produced by wind turbines is quite complex therefore our response is likely to be complex also. In addition wind turbines produce a repetitive visual stimulus which goes to reinforce annoyance.

SOUND AND NOISE

Recently the European Union Noise Committee stated that noise is the biggest pollutant and the fastest growing pollutant in Europe.

Noise can be defined as unwanted sound and is commonly associated with annoyance reactions. It is commonly perceived as an environmental stressor and nuisance. Environmental noise is ubiquitous and annoyance is one of the most widely studied adverse reactions to noise. Noise interferes with task performance; cognitive performance modifies social behaviour and causes stress and irritation.

According to the World Health Organisation (WHO), health should be regarded as "a state of complete physical, mental and social wellbeing and not merely the absence of disease or infirmity"- WHO 2001. Under this broad definition, noise induced annoyance is an adverse health effect. As with any psychological reaction, annoyance has a wide range of individual variability, which is influenced by multiple personal and situational factors.

WHO also defines noise annoyance as "a feeling of resentment displeasure, discomfort, dissatisfaction or offence which occurs when noise interferes with someone's thoughts, feelings or daily activities- (WHO paper on Environmental noise- Passchier and Verneer 1993.

Noise annoyance is always assessed at the level of populations, using questionnaires. There is consistent evidence for annoyance in populations, exposed for more than one year to sound levels of 37dBA and severe annoyance at 42dBA.

There is no doubt that annoyance from noise adversely affects human wellbeing.

The level of annoyance can only be described by listeners themselves. These descriptions are often fuzzy and not quantified most of the time. In addition to this different people have different subjective responses on the grade of annoyance. There are many theories regarding noise nuisance and many factors are thought to have an influence e.g. the types of noise source, noise energy, frequency, age , previous noise exposure, types of building structures and weather conditions. Subjective annoyance relates not only to the sound level and frequency but also to the physiological and mental factors of the sound recipients.

Field studies performed among people living in the vicinity of wind turbines showed that there is a correlation between sound pressure levels and annoyance but that annoyance is also influenced by other factors such as attitude to wind turbines an the landscape. However noise annoyance from wind turbines was found at lower sound pressure levels than in studies of annoyance from road traffic noise.
This is because the absolute noise level is less important than the character of the noise produced.

Non-auditory effects of noise, can be defined as all those effects on health and well being which are caused by noise exposure with the exclusion of effects on the hearing organ. Non auditory effects include stress, related physiological and behavioural effects and safety concerns. There have been studies showing that aircraft noise can decrease cognitive function resulting in decreased scholastic achievement.

It is obvious that the health issues relating to wind turbines are caused by these non-auditory effects as the sound pressure levels are not high enough to cause an auditory effect (e.g. hearing impairment resulting from excessive noise exposure).

How does noise affect health?

It is generally considered that noise can be an intrusion into daily activities and tasks, causing annoyance. In certain circumstances in certain susceptible individuals this annoyance may lead to a stress response which in turn may lead to symptoms and subsequently illness.
The response to noise probably depends upon the characteristics of the sound, including intensity, frequency, and complexity of
sound, duration and meaning of the noise i.e. whether the noise is perceived as threatening or not.

Alternatively, noise may affect health directly and not through annoyance. E.g. studies show elevated cortisol levels in individuals subjected to; vibroacoustic disease caused by excessive exposure to low frequency noise resulting in abnormal proliferation of extra cellular matrices.

Any severe extreme imposed on the sonic environment has a profoundly destabilizing effect on the individual.
This is evident in both the areas of high intensity acoustic energy and also its complete absence.
Anechoic chambers, which create an environment void of sound, have the ability to produce similar feelings of disorientation and disturbance that are evident with high intensity sound. The silence envelops the individual in a suffocating manner causing both psychological trauma and also physiological disturbance in the form of balance problems and other related body functions. It is clearly apparent that the human organism is in an extremely delicate state of equilibrium with the sonic environment and any profound disturbance of this system will have profound ramifications to the individual

The auditory system is an extremely complex system .Because of the complexity of the auditory and cerebral systems it becomes easy to understand why the issues surrounding noise annoyance/ disturbance and associated health effects is not a simple one.

Studies in USA have shown a relationship between anxiety and vestibular disorders such as dizziness and migraines vertigo. Anatomical and electrophysiological evidence suggests that serotonin modulates processing in the vestibular nuclei in the brain. Therefore a disturbance in the serotonin balance which occurs in anxiety and depression syndromes can cause vestibular problems.

Low frequency noise is also produced from wind turbines. Low frequency sound is predominately the result off the displacement of air by a blade and of turbulence at the blade surface. The low frequencies contribute to the overall audible noise but also produce a seismic characteristic which is one of the common complaints from neighbours when they say that not only can they hear the noise but they can also feel it.
The various parts of the body have a specific natural frequency or a resonance frequency. The human body is a strongly damped system, therefore, when a part of it is excited at its natural frequency, it will resonate over a range of frequencies instead of at a single frequency.
(fig. 1).

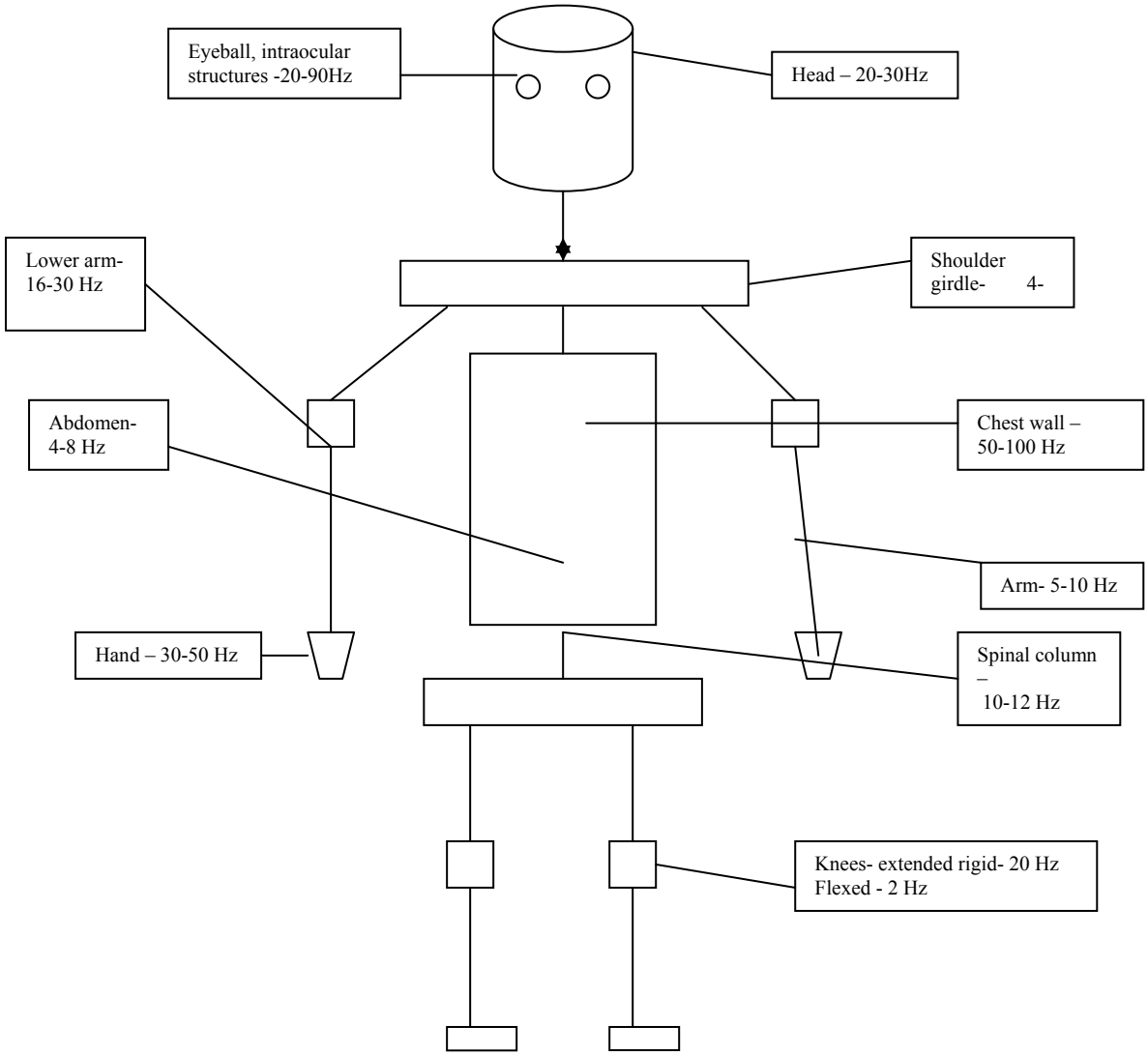
A research paper by G Rasmussen looked at body vibration exposure at frequencies of 1-20 Hz. Part of a table shows:-

Symptoms	Frequency
General feeling of discomfort	4Hz – 9Hz
Head symptoms	13Hz – 20Hz
Influence on speech	13 Hz – 20 Hz
Lump in throat	12 Hz – 16Hz
Chest pains	5Hz – 7Hz
Abdominal pains	4Hz – 10Hz
Urge to urinate	10Hz – 18Hz
Influence on breathing movements	4Hz – 8Hz

Also in the region 60-90 Hz disturbances are felt which suggest eyeball resonances, and a resonance effect in the lower jaw/skull system has been found between 100-200 Hz

Fig. 1

The resonance frequency ranges for various parts of the human body- values taken from the International Standards Organisation –ISO standards 2631



An important contribution to the low frequency part of the sound spectrum may be the result of the sudden variation in air flow the blade encounters when it passes the tower: the angle of attack of the incoming air suddenly deviates from the angle that is optimised for the mean flow. This effect has not been considered important as the blade frequency is of the order of 1Hz where humans' hearing is relatively insensitive. However low frequency modulates well audible, higher frequency sounds and thus creates periodic sound. This effect is stronger at night because in the stable atmosphere there is a greater difference between rotor average and near tower wind speed. In addition to this multiple turbines can interact with each other to further multiply the effect. The effect will be greater for the larger more modern wind turbines.

As wind is variable and not consistent, the nature of the noise produced is also impulsive and unpredictable.

Low frequency noise issues have been researched extensively in Portugal and have been found to cause a complex disease known as vibroacoustic disease. Although this research has been mainly concerned with high levels of low frequency noise, it is felt that over years lower levels of low frequency noise may cause similar problems. It appears that the low frequency noise compromises the mechanotransduction signalling of cells which lead to structural changes of tissues and cells. This damage sustained is dose dependent and it is only in the latter stages that routine medical investigations will become positive. The syndrome can be broken down into various stages:-

Stage 1 - MILD *(1-4 years)* Slight mood swings, indigestion, heartburn, mouth/throat infections, bronchitis
Stage 2 - MODERATE *(4-10 years)* Chest pain, definite mood swings, back pain, fatigue, skin infections (fungal, viral, and parasitic), inflammation of stomach lining, pain and blood in urine, conjunctivitis, allergies.
Stage 3 - SEVERE *(> 10 years)* psychiatric disturbances, haemorrhages (nasal, digestive, conjunctive mucosa) varicose veins, haemorrhoids, duodenal ulcers, spastic colitis, decrease in visual acuity, headaches, severe joint pain, intense muscular pain, neurological disturbances.)

Low frequency noise exposure has also been shown in many studies to interfere with performance and cognitive function in the workplace. The effects are greatest in noise sensitive particularly low frequency noise sensitive individuals. In this group of people salivary cortisol levels are elevated during exposure.

For many years research has been carried out using noise as a non lethal weapon. Recently the Israeli army used such a weapon for crowd dispersal. Witnesses describe d a minute-long blast of sound emanating from a white Israeli military vehicle. Within seconds, protestors began falling to their knees, unable to maintain their balance. The technology is believed to be similar to the LRAD — Long-Range Acoustic Device — used by U.S. forces in Iraq as a means of crowd control.

Professor Pratt a professor of neurobiology specializing in human auditory responses at Israel's Technion Institute explains that by stimulating the inner ear, which houses the auditory and vestibular systems, with high intensity acoustic signals that are below the audible frequencies- below 20 Hz, the vestibular organ can be stimulated and create a discrepancy between inputs from the visual system and somatosensory system and the vestibular organ will erroneously report acceleration (because of the low- frequency inaudible sound). It doesn't have to be a loud sound This will create a sensation similar to motion sickness. Such cases have been reported in relation to air conditioning systems.

Work by Fritz van den Berg shows why the characteristics of the noise produced by wind turbines increases and alters at night . He showed that the noise at night can be 15-18dBs higher at night time than during the day because of atmospheric changes (ref. Fritz van den Berg).
Therefore when we are resting in bed at night, the noise from the wind turbines can be at their loudest and most disturbing.

Those people who are disturbed by the noise are often particularly aware of the problems at night. – this statement can be partially explained by lower background noise levels at night, and also the fact that atmospheric stability increases at night giving a greater differential between rotor averaged and near tower wind speed . This explains why the characteristic of the noise emitted from turbines takes on a "beating" character early evening and night-in agreement with the blade passing frequency.

Noise induced sleep disturbance is well known to have adverse health effects and has been studied extensively although not with particular reference to wind turbines. Due to the indisputable restorative function of sleep, noise induced sleep disturbances are regarded as the most deleterious effects of noise.

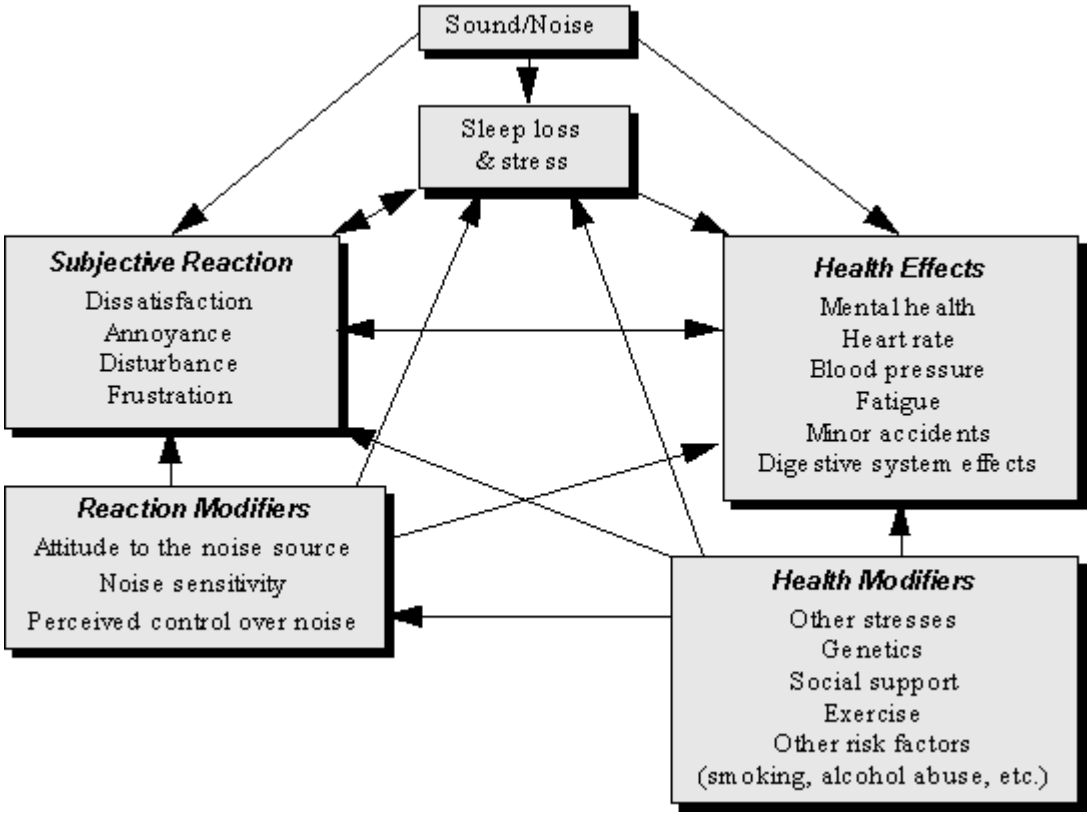
Nocturnal noise disturbance has been shown to disrupt nocturnal cortisol secretion. Nocturnal noise excites areas of the brain such as the amygdyla (functions as the fear centre) and cortical areas (arousal, annoyance and awakening). Noise –even levels below awakening threshold – can induce cortisol secretion. Repeated night time disturbance will result in an accumulation of cortisol levels in the blood. In the long term this can result in long term stress activation.

Several epidemiological studies in patients with primary insomnia found to be at a higher risk of developing major depression in the following years.
It has also been shown that women with increased morning cortisol levels show a higher risk of a major depressive episode within the next 12 months.

Psycho physiological reactions such as effects on heart rate and
respiration rate have been observed during exposure to noise whilst subjects sleep. These have been found to be induced by road traffic noise with levels exceeding 40 dB LA max (both in lab and in field studies). Hardly any habituation occurs during or between nights. Children have higher psycho physiological reactivity than adults. In addition for these types of reactions, the difference between the background noise levels and the maximum sound pressure level is of more importance than the absolute sound level. (Vernet 1983).

The potential adverse health effects are usually classified according to the type of noise. Sudden or impulsive noise appears to create more disturbance than non impulsive noise (Job 1996). Intermittent noise has a greater effect than louder more continuous noise (Westman and Walters 1981). Predictability and controllability are clearly influencing factors in an individual's response to noise and this has been born out by surveys conducted by Eja Pederson in a paper presented in Berlin in Oct 2005.

It has been shown in several studies that depressed people and the elderly have a diminished variability in circadian cortisol levels and a raised morning cortisol in common. (Kern et al in 1996, Van Cauter et al 1998, Deushle et al 1998). It would therefore be likely that the elderly and patients already suffering depression might be more susceptible to noise induced arousals.



However we as humans experience our environment through multi sensory channels e.g. acoustic, visual, proprioceptive, vibrational and psychological and emotional issues.

Therefore all these factors have to be considered when we try to explain why people might be disturbed by wind turbines. When discussing noise with people who are disturbed by turbines, frequent complaints are of vibration leading to an intrusional

and invading noise that they feel they cannot get away from. People say that they can "feel the noise".

I would suggest that several factors are therefore concerned in this annoyance. The "periodic noise" as described previously and the low frequency component. I think that the presence of these two together has an additive effect compounding both. The periodic noise draws the attention to the vibrational component and therefore becomes more annoying than if either were present individually.

In addition to this there is the visual stimulation of the turbine blades rotating- this is particularly disturbing in certain light conditions where strobing occurs, but provide a constant reminder of the presence of the turbines by their movement.

Psychological and social issues must also be considered. E.g. pre-existing psychological problems and also perceptions of having a wind turbine built close to their homes. Most people live in the countryside because they appreciate the quiet and the visual amenity. Therefore reluctance to having a wind farm nearby will exacerbate any problems.

SUMMARY

There are many people living near wind turbines who are suffering from problems with their health.

The noise produced from wind turbines is an extremely complex one and I feel that it is the complexity of the noise and vibration which causes the disturbance.

From my discussions with people suffering from ill health who live near wind farms, it seems that the symptoms suffered can occur up to a mile from the wind farm. Until further independent medical and epidemiological research has been carried out I would suggest that no wind turbines should be sited closer than 1.5 miles away from the nearest wind turbine.

The current UK guidance for establishing a safe distance between turbines and dwellings is the ETSU-R-97. This document was produced when turbines were approximately 20% the size of the currently proposed turbines. The guidelines pay scant reference to low frequency noise and the complexity of the noise profile produced by the turbines.
The continued use of ETSU-R-97 has been publically condemned by Professor FFowcs- Williams and G.P.Van den Berg.

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