ScienceDirect

Environment International

Volume 114, May 2018, Pages 160-166

Short-term nighttime wind turbine noise and cardiovascular events: A nationwide case-crossover study from Denmark

Aslak Harbo Poulsen [a], Ole Raaschou-Nielsen [a c], Alfredo Peña [b], Andrea N. Hahmann [b], Rikke Baastrup Nordsborg [a], Matthias Ketzel [c], Jørgen Brandt [c], Mette Sørensen [a]

https://doi.org/10.1016/j.envint.2018.02.030

Get rights and content

Highlights

- We identified all Danes exposed to wind turbine noise from 1982 to 2013.
- Outdoor and indoor low frequency wind turbine noise (WTN) was modelled for each night.
- MI or stroke events were not associated with outdoor WTN in four preceding nights.
- MI and stroke events may be associated with nighttime Indoor low frequency WTN.
- Findings may be due to chance and need replication.

Abstract

Aims

The number of people exposed to wind turbine noise (WTN) is increasing. WTN is reported as more annoying than traffic noise at similar levels. Long-term exposure to traffic noise has consistently been associated with cardiovascular disease, whereas effects of short-term exposure are much less investigated due to little day-to-day variation of e.g. road traffic noise. WTN varies considerably due to changing weather conditions allowing investigation of short-term effects of WTN on cardiovascular events.

Methods and results

We identified all hospitalisations and deaths from stroke (16,913 cases) and myocardial infarction (MI) (17,559 cases) among Danes exposed to WTN between 1982 and 2013. We applied a time-stratified, case-crossover design. Using detailed data on wind turbine type and hourly wind data at each wind turbine, we simulated mean nighttime outdoor (10–10,000 Hz) and nighttime low frequency (LF) indoor WTN (10–160 Hz) over the 4 days preceding diagnosis and reference days. For indoor LF WTN between 10 and 15 dB(A) and above 15 dB(A), odds ratios (ORs) for MI were 1.27 (95% confidence interval (CI): 0.97–1.67; cases = 198) and 1.62 (95% CI: 0.76–3.45; cases = 21), respectively, when compared to indoor LF WTN below 5 dB(A). For stroke, corresponding ORs were 1.17 (95% CI: 0.95–1.69; cases = 166) and 2.30 (95% CI: 0.96–5.50; cases = 15). The elevated ORs above 15 dB(A) persisted across sensitivity analyses. When looking at specific lag times, noise exposure one day before MI events and three days before stroke events were associated with the highest ORs. For outdoor WTN at night, we observed both increased and decreased risk estimates.

Conclusion

This study did not provide conclusive evidence of an association between WTN and MI or stroke. It does however suggest that indoor LF WTN at night may trigger cardiovascular events, whereas these events seemed largely unaffected by nighttime outdoor WTN. These findings need reproduction, as they were based on few cases and may be due to chance.

Introduction

As the number of wind turbines (WT) has increased so has concern about potential health effects, particularly since WT noise (WTN) has been reported to be more annoying than noise from other sources at similar levels (Janssen et al., 2011). Also, some (Schmidt

and Klokker, 2014) but not all (Jalali et al., 2016; Michaud et al., 2016c) studies have found an association with sleep disturbances.

Noise can act as a stressor and provoke a typical stress response, including hyperactivity of the sympathetic autonomic nervous system and activation of the hypothalamus-pituitary-adrenal axis. Nighttime noise exposure is considered particularly hazardous (Babisch et al., 2005; WHO, 2009) and has been associated with disturbance of sleep, from full awakenings to unconscious autonomic perturbations, such as sleep stage changes and body movements (Griefahn et al., 2008; Miedema and Vos, 2007); the latter from outdoor noise levels of down to 30 dB (WHO, 2009). Nighttime noise exposure has been associated with reduced cardiac parasympathetic tone, high blood pressure, endothelial dysfunction, oxidative stress and increased levels of stress hormones shortly after noise exposure or on the morning after (Graham et al., 2009; Schmidt et al., 2013). Evidence from cardiac arousals does not suggest pronounced habituation to nighttime noise (Basner et al., 2011; Muzet, 2007). Long-term residential exposure to transportation noise has consistently been associated with increased risk of cardiovascular diseases (Halonen et al., 2015; Sorensen et al., 2011; Vienneau et al., 2015), whereas it is unknown whether short-term exposure to noise can trigger a cardiovascular event due to lack of studies (Recio et al., 2016). These results are, however, not readily applicable to WTN: WTN levels are typically lower than those reported in relation to health effects of traffic noise. and WTN is reported as more annoying than traffic noise at similar sound levels (Janssen et al., 2011). Also, WTs are typically erected in rural areas and amplitude modulation gives WTN a rhythmic quality different from that generated by car tires. Furthermore, levels of WTN depend on wind speed and direction and hence vary more unpredictably than road traffic noise, permitting investigation of acute effects of noise exposure. Such effects are virtually unexplored, even though factors affected by noise exposure, including increased blood pressure and oxidative stress, are believed to be important triggers of stroke and myocardial infarction (MI) (Biasucci et al., 2008; McColl et al., 2009).

Studies from Canada (1238 participants) and Sweden and the Netherlands (1755 participants) investigated associations between long-term outdoor WTN and self-reported cardiovascular diseases (high blood pressure and heart disease) (Michaud et al., 2016b; E Pedersen 2011). The study from Canada additionally investigated hair cortisol levels, resting heart rate and blood pressure collected at the time of interview (Michaud et al., 2016a). Neither study found any association. However, as most scientific literature on WTN (Schmidt and Klokker, 2014), the studies were cross-sectional, relied on self-reported data and had few participants potentially exposed to WTN levels above 40–45 dB. Also, their exposure metrics did not reflect day-to-day variations in WTN, making the results relevant mainly for long-term health effects.

Denmark is a densely-populated country with a high number of residents living close to WTs. This provides a unique opportunity to investigate acute effects of WTN on stroke and MI.

Section snippets

Study base and noise exposure assessment

The study was based on the Danish population, where all citizens since 1968 have been assigned a personal identification number by the Central Population Register, allowing residents to be tracked in and across all Danish health and administrative registers (CB Pedersen 2011).

We identified all WTs (7860) in operation in Denmark any time between 1980 and 2013, from the administrative Master Data Register of Wind Turbines maintained by the Danish Energy Agency. The register, to which reporting is …

Results

We identified 17,559 events of MI and 16,913 events of stroke in the study population and excluded case events where the address (816 MI and 857 strokes) or nearest WT (1651 MI and 1433 strokes) had changed in the 18 months preceding diagnosis, yielding for analysis 15,092 MI events and 14,623 stroke events, corresponding to 13,343 and 13,026 persons, respectively.

Compared to all events, persons with high levels of nighttime WTN prior to their event were more likely to be male, younger, live in …

Discussion

This study found high levels of indoor nighttime LF WTN over the preceding days to be associated with increased risk estimates for both MI and stroke, whereas for outdoor nighttime WTN we observed higher risk estimates for stroke and lower risk estimates for MI. The number of cases exposed to >15 dB(A) indoor LF WTN was, however, small, and the CIs generally spanned one.

While two studies have investigated long-term exposure to WTN and cardiovascular disease (Michaud et al., 2016b; E Pedersen …

Acknowledgements

We wish to express our gratitude to DELTA, who even in the face of enormous datasets, has shown great expertise, diligence and ingenuity in all steps of the process towards estimating detailed wind turbine noise data useable for the epidemiological analyses. We are also indebted to Geoinfo A/S who made it possible to extract the GIS information relating to all address point covered in our study. …

Funding

This study was supported by a grant [J.nr. 1401329] from the Danish Ministry of Health (the grant was co-funded by the Danish Ministry of Food and Environment and the Danish Ministry of Energy, Utilities and Climate). The funding source had no role in the study design, in the collection, analysis or interpretation of data, in the writing the paper or in the decision to submit the paper for publication. …

Conflict of interests

All authors received a grant from Danish Ministry of Health for conducting the present study (J.nr. 1401329). All authors report no conflicts of interest. …

Authors' contributions

MS conceived the study. AHP and ORN contributed to study conception and design. AHP analysed the data and drafted the manuscript. AP and AH provided wind and climate data. MK and JB provided road traffic and air pollution data. RBN provided GIS data. All authors participated in interpreting results, revising the manuscript and approved the final submitted version of the paper. …

Recommended articles

References (36)

Habitual traffic noise at home reduces cardiac parasympathetic tone during sleep
Int. J. Psychophysiol. (2009)

B.W. McColl *et al.*
Systemic infection, inflammation and acute ischemic stroke
Neuroscience (2009)

A. Muzet
Environmental noise, sleep and health
Sleep Med. Rev. (2007)

A. Recio *et al.*
The short-term association of road traffic noise with cardiovascular, respiratory, and diabetes-related mortality
Environ. Res. (2016)

D. Vienneau *et al.*
The relationship between transportation noise exposure and ischemic heart disease: a meta-analysis
Environ. Res. (2015)

Z.J. Andersen *et al.*
Association between short-term exposure to ultrafine particles and hospital admissions for stroke in Copenhagen, Denmark
Eur. Heart J. (2010)

W. Babisch *et al.*
Traffic noise and risk of myocardial infarction
Epidemiology (2005)

C. Backalarz *et al.*
Big Noise Data for wind turbines

M. Basner *et al.*
Single and combined effects of air, road, and rail traffic noise on sleep and recuperation
Sleep (2011)

L.M. Biasucci *et al.*
Local and systemic mechanisms of plaque rupture
Angiology (2008)

View more references

Cited by (0)

View full text