ScienceDirect

Environmental Research

Volume 167, November 2018, Pages 770-775

Pregnancy exposure to wind turbine noise and adverse birth outcomes: a nationwide cohort study

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 d]

https://doi.org/10.1016/j.envres.2018.09.011

Get rights and content

Highlights

- We identified all Danes exposed to wind turbine noise (WTN) from 1982 to 2013.
- We then identified all live born singletons from mothers in this population.
- We investigated preterm birth, low birth weight and small for gestational age.
- We found no associations between WTN and the adverse birth outcomes.
- Few women had high levels of WTN and independent replication is called for.

Abstract

Noise from wind turbines (WTs) is reported as more annoying than traffic noise at similar levels, raising concerns as to whether WT noise (WTN) may negatively affect health, as reported for traffic noise. We aimed to investigate whether residential WTN is associated with adverse birth outcomes. Based on national registries, we identified all Danish dwellings situated within ≤20 wt heights radius and a random selection of 25% of dwellings situated within 20–40 wt heights radius of a WT. We identified 135,795 pregnant women living in the dwellings from 1982 to 2013, and collected information on gestational age and birth weight from a national birth registry. Using data on WT type and simulated hourly wind at each WT, we estimated hourly outdoor and low frequency (LF) indoor WTN at the dwellings of the pregnant women and aggregated as mean nighttime WTN during pregnancy. We used logistic regression with adjustment for individual and area-level covariates for the analyses. We did not find evidence suggesting that mean pregnancy or trimester-specific exposure to outdoor or indoor LF WTN were associated with any of the three adverse birth outcomes investigated: preterm birth (n = 13,003), term small for gestational age (n = 12,220) or term low birth weight (n = 1127). However, the number of cases in the highest exposure categories of ≥ 42 dB outdoor WTN or ≥ 15 dB indoor LF WTN were low for all outcomes (n between 0 and 31). The present study does not support an association between nighttime WTN and adverse birth outcomes. However, there were few cases in the high exposure groups and the results call for reproduction.

Introduction

Wind power deployment has increased markedly over the last decades, with a rise in the global cumulative wind capacity from 23 GW in 2001 to 487 GW in 2016 (GWEC, 2017). In Denmark, wind power covers more than 40% of the national electricity consumption. This has led to a growing number of people exposed to noise from WT. WT noise (WTN) has consistently been associated with annoyance among people living near WTs (Janssen et al., 2011, Michaud et al., 2016a, Schmidt and Klokker, 2014). Moreover, some studies have indicated that WTN disturbs sleep, although results are inconsistent (Basner and McGuire, 2018, Jalali et al., 2016, Michaud et al., 2016b, Schmidt and Klokker, 2014). Although different conclusions have been obtained by recent reviews on WTN and health, concern of whether WTN may negatively affect health has been raised (Basner and McGuire, 2018, Jeffery et al., 2014, Schmidt and Klokker, 2014).

Exposure to transportation noise has been associated with a number of diseases and conditions (Clark et al., 2017, Kempen et al., 2018, Pyko et al., 2017, Sorensen et al., 2014). Recent studies have suggested that transportation noise may be associated with adverse

birth outcomes (Arroyo et al., 2016, Gehring et al., 2014), although other studies found no associations (Hjortebjerg et al., 2016, Smith et al., 2017). In 2017, a systematic evaluation on environmental noise and adverse birth outcomes was published as part of the World Health Organizations (WHO) noise guidelines (Nieuwenhuijsen et al., 2017). Based on 12 research papers, the authors concluded that there was some evidence of an association between noise from aircrafts and road traffic and risk for low birth weight (LBW), small for gestational age (SGA) and preterm birth. They however, rated the evidence as being of low or very low quality, and concluded that there was an urgent need for further studies on noise from different sources and pregnancy outcomes (Nieuwenhuijsen et al., 2017). We are not aware of papers on WTN and pregnancy outcomes.

WTN differs from transportation noise at several points. First, levels of WTN are generally considerably lower than traffic noise in urban settings. Second, at comparable noise levels, WTN has been associated with a higher proportion of annoyed residents than traffic noise (Janssen et al., 2011). Third, amplitude modulation gives WTN a rhythmic quality different from e.g. road traffic noise. Last, WTs are mainly located in rural areas, where noise from WTs may be more audible than in more densely populated areas.

Potential biological mechanisms behind an effect of noise on pregnancy outcomes include a general stress response with stimulation of the hypothalamus-pituitary-adrenal (HPA) axis and the sympathetic-adrenal axis, leading to a rise in maternal stress hormones (Nieuwenhuijsen et al., 2017). This rise in stress hormones may lead to fetal hypoxia followed by growth restriction, by decreasing placental function or by negatively affect the HPA axis of the fetus after passing the placental barrier (reviewed in Nieuwenhuijsen et al. (2017)). Furthermore, disturbance of maternal sleep has been proposed as a risk factor for adverse pregnancy outcomes (Okun et al., 2009).

We aimed to investigate the hypotheses that exposure to nighttime WTN during pregnancy was associated with higher odds of preterm birth, SGA and LBW, in a nationwide register-based study, combining data on WT position and type, simulated meteorological conditions and WTN, residential addresses, birth registry information and socioeconomic indicators.

Section snippets

Study base and modeling of wind turbine noise

The procedure for identifying the study base and modeling of WTN for the present study has been described in details elsewhere (Poulsen et al., 2018). Briefly, we identified 7256 WTs eligible for noise modeling in Denmark, and classified each WT into one of 99 noise

spectra classes, with detailed information on the noise spectrum from 10 to 10,000 Hz in thirds of octaves for wind speeds from 4 to 25 m/s. We subsequently estimated the hourly wind speed and direction at hub height for each WT …

Results

We identified 143,684 live born singletons with a mother living in the inclusion dwellings during pregnancy. We excluded deliveries were the mother was retired or living in a hospital or residential institution at conception (n = 949); the gestational age was not between 23 and 42 weeks (n = 1465); there were inconsistencies between gestational age, date of birth or conception (n = 3422); there was implausible birth weight gestational age combinations (n = 529) (Alexander et al., 1996), with …

Discussion

We found no suggestions of associations between residential WTN during pregnancy and preterm birth, LBW or SGA overall, by trimester or in sensitivity analyses. However, despite including all pregnancies in Denmark since 1983 with potential WTN, only very few women were exposed to WTN above 42 dB or 15 dB indoor LF.

Previous studies have found WTN to be associated with annoyance, starting at app. 35 dB (Guski et al., 2017, Janssen et al., 2011). Also, most (Kageyama et al., 2016, Onakpoya et …

Acknowledgements

We thank DELTA, who showed great expertise in all steps of the estimation of wind turbine noise, as well as Geoinfo A/S who made it possible to extract the GIS information for all addresses. 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). …

Recommended articles

References (34)

G.R. Alexander *et al.*

A United States national reference for fetal growth

Obstet. Gynecol. (1996)

V. Arroyo *et al.*
Short term effect of air pollution, noise and heat waves on preterm births in Madrid (Spain)
Environ. Res. (2016)

D. Hjortebjerg *et al.*
Associations between maternal exposure to air pollution and traffic noise and newborn's size at birth: a cohort study
Environ. Int. (2016)

L. McCowan *et al.*
Risk factors for small for gestational age infants
Best. Pract. Res. Clin. Obstet. Gynaecol. (2009)

I.J. Onakpoya *et al.*
The effect of wind turbine noise on sleep and quality of life: a systematic review and meta-analysis of observational studies
Environ. Int. (2015)

M. Pedersen *et al.*
Ambient air pollution and low birthweight: a European cohort study (ESCAPE)
Lancet Respir. Med. (2013)

A.H. Poulsen *et al.*
Short-term nighttime wind turbine noise and cardiovascular events: a nationwide case-crossover study from Denmark
Environ. Int. (2018)

R. a Rogvi *et al.*
Defining smallness for gestational age in the early years of the Danish Medical Birth Registry
PLoS One (2011)

C. Backalarz *et al.*
Big noise data for wind turbines

M. Basner *et al.*
WHO environmental noise guidelines for the european region: a systematic review on environmental noise and effects on sleep
Int. J. Environ. Res. Public Health (2018)

View more references

Cited by (15)

Is it safe to live near wind turbines? Reviewing the impacts of wind turbine noise

2022, Energy for Sustainable Development

> *Citation Excerpt :*
>
> …Conversely, no or even decreased hazard ratios were noted for individuals below the age of 65 in the greatest exposure groups (Poulsen et al., 2018a). Likewise, long-term evening exposure to outdoor wind turbine noise and indoor low-frequency wind turbine noise was not linked either to higher diabetes risk (Poulsen et al., 2018b) or adverse birth outcomes (pre-term birth, small for gestational age and low birth weight) (Poulsen et al., 2018c). However, somewhat higher risk of issues related to sleep and mental health were detected.…

Show abstract

Is setback distance the best criteria for siting wind turbines under crowded conditions? An empirical analysis

2021, Energy Policy

> *Citation Excerpt :*
>
> …Earlier studies have identified a long-term correlation between sleep disruption and exposure to WT noise (Onakpoya et al., 2015; Poulsen et al., 2019). At the same time, there is an absence of significant evidence confirming additional implications for public health (Ellenbogen et al., 2012; Poulsen et al., 2018a, 2018b). It is interesting to note the correlation which exists between noise complaints and residents' attitude toward WTs, along with their satisfaction from the planning process (Pedersen et al., 2009; Firestone et al., 2018; Pohl et al., 2018; Hübner et al., 2019).…

Show abstract

Self-reported health in the vicinity of five wind power production areas in Finland

2021, Environment International

> *Citation Excerpt :*
>
> …In this Canadian study, approximately 60% of the questionnaire respondents lived in areas where modelled wind turbine sound pressure level was at least 35 dB and the maximum was 46 dB. In a large Danish register-based study (n > 500,000), modelled long-term outdoor wind turbine sound

pressure level and indoor low-frequency wind turbine sound pressure level during night-time were not associated with myocardial infarction and stroke (Poulsen et al., 2018d), diabetes (Poulsen et al., 2018c), the use of antihypertensives (Poulsen et al., 2018a), or adverse birth outcomes such as preterm birth, small for gestational age, and low birth weight (Poulsen et al., 2018b). However, night-time outdoor wind turbine sound pressure level was associated with increased use of sleep medication and antidepressants among the elderly (≥ 65 years) (Poulsen et al., 2019b)....

Show abstract

Investigating changes in noise pollution due to the COVID-19 lockdown: The case of Dublin, Ireland

2021, Sustainable Cities and Society

Citation Excerpt :

...Other studies have reported that pregnant women might be at a greater risk of being affected by noise pollution beceause of greater sensitivity to environmental stress factors (He et al., 2019; Murphy & Faulkner, 2018; Poulsen et al., 2018; Sears et al., 2018; Selander et al., 2019)....

Show abstract

Health effects related to wind turbine sound: An update ↗

2021, International Journal of Environmental Research and Public Health

Evidence for environmental noise effects on health for the United Kingdom policy context: A systematic review of the effects of environmental noise on mental health, wellbeing, quality of life, cancer, dementia, birth, reproductive outcomes, and cognition ↗

2020, International Journal of Environmental Research and Public Health

View all citing articles on Scopus ↗

View full text