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Residential road traffic noise exposure and survival after breast cancer – A cohort study

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ABSTRACT

Background: It is generally acknowledged that patients with already existing clinical conditions are especially vulnerable to the effects of traffic noise exposure. The aim of the present study was to investigate the association between residential road traffic noise and breast cancer survival.
Methods: Road traffic noise was calculated for all residential addresses from 1987 to February 2012 for incident breast cancer cases (n=1,759) in a cohort of 57,053 Danes. We used Cox Proportional Hazard Models to investigate the association between residential road traffic noise at different time-windows, and overall and breast cancer-specific mortality. Furthermore, we investigated interaction with prognostic and socioeconomic factors. Mortality Rate Ratios (MRR) were calculated in both unadjusted models, and adjusted for residential railway noise, lifestyle factors and socioeconomic variables.
Results: During a median of 7.3 years of follow-up, 402 patients died; 274 from breast cancer. We found no association between time-weighted averages of residential road traffic noise 1-, 3- or 5-years before death, or over the entire follow-up period, and overall or breast cancer-specific mortality. A 10 dB higher road traffic noise from diagnosis until censoring was associated with an adjusted MRR of 0.94 (0.81–1.08) for all-cause mortality. The association was modified by lymph node involvement, with a MRR of 1.20 (0.97–1.48) for those with tumor-positive lymph nodes and 0.76 (0.59–0.98) for those without.
Conclusion: The present study suggests no association between residential road traffic noise and concurrent mortality. As it is the first study of its kind, with relatively limited power, further studies are warranted.

1. Background

Traffic is the most important source of community noise (Ouis, 2002), and residential exposure to traffic noise has increasingly been suggested related to a number of health outcomes, including e.g. cardiovascular disease (Sorensen et al., 2011, 2012; Selander et al., 2009; Babisch et al., 2005; Babisch, 2014), obesity (Pyko et al., 2015, Christensen et al., 2016), and diabetes (Sorensen et al., 2013). Recently, a study suggested that road traffic and railway noise could also increase the risk of breast cancer (Sorensen et al., 2014a). It is generally acknowledged that patients with already existing clinical conditions are especially vulnerable in relation to the effects of noise exposure (Basner et al., 2014; Goines and Hagler, 2007). However, existing studies on traffic noise and disease prognosis are few, and have primarily focused on cardiovascular diseases (Hart et al., 2013; Beelen et al., 2009; Gan et al., 2012; Huss et al., 2010; Tobias et al., 2015).

Breast cancer is the most common cancer in women worldwide, and the number of women surviving breast cancer has increased steadily over the last decades (World Cancer Research Fund, 2014). This is caused by an increasing incidence and improved treatment, which prolongs survival after a diagnosis (World Cancer Research Fund, 2014, 2007). It has spawned a growing interest in lifestyle and environmental factors affecting not only breast cancer incidence, but also survival.

A mechanism by which traffic noise may affect breast cancer survival is through sleep disruption, as traffic noise has consistently been found to adversely affect sleep quality and quantity (Basner et al., 2014; World Health Organization, 2009; Miedema and Vos, 2007). Sleep disruption and duration have been found associated with higher mortality among breast cancer patients (Palesh et al., 2014; Phipps et al., 2015). Sleeping is a recovery process which is essential for the human body to function properly (Passchier-Vermeer and Passchier,

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2000), and it is often compromised in cancer patients: The proportion of cancer patients reporting insomnia is higher than in the general population. Among breast cancer patients, studies have found frequencies ranging from 30% to 88% (Clark et al., 2004; Fiorentino and Ancoli-Israel, 2006). Furthermore, these women often report fatigue as a late complication (Bodtcher et al., 2015). Sleep disruption is the most frequent side-effect of chemotherapy (Palesh et al., 2010, 2012), but breast cancer patients often report sleep disruption also before initiation of chemotherapy (Ancoli-Israel et al., 2006), as well as several years after cancer treatment is finished (Palesh et al., 2012); suggesting that cancer survivors could be especially vulnerable to traffic noise - not only around time of diagnosis and treatment, but also for an extended period of time afterwards.

Another pathway through which traffic noise may affect breast cancer survival is its role as a systemic stressor. Exposure to noise has been associated with release of stress hormones, entailing both emotional and physiological stress (Babisch, 2011). It has been suggested that the effects of noise may interact with other concomitant stressors, including both physical, chemical, biological, and social stressors, and hereby lead to a constant systemic arousal, with a greater than additive effect of each individual stressor (Stansfeld and Matheson, 2003). It therefore seems plausible, that breast cancer patients, who are exposed to both existential stress by facing a life-threatening disease, which for some may result in psychological reactions of anxiety and depression, as well as chemical stress through radiation and chemotherapy, may experience such interaction effects. A large meta-analysis of stress-related factors and cancer incidence and survival found no association with breast cancer incidence, but a significant association with survival (Chida et al., 2008). The quality of the study has, however, been questioned (Coyne et al., 2010).

Finally, it is increasingly acknowledged, that the conventional treatments for breast cancer; chemotherapy and radiation, come with considerable cardiac side-effects, as recently reviewed (Zagar et al., 2016). Given the established association between traffic noise and cardiovascular symptoms and disease (Basner et al., 2014; Babisch, 2011), and the general acknowledgement that patients with already existing clinical conditions are especially vulnerable in relation to the effects of noise exposure (Basner et al., 2014; Goines and Hagler, 2007), this may render breast cancer survivors particularly vulnerable to the harmful effects of traffic noise, given their already stressed cardiovascular system.

The objective of the present study was to investigate the association between residential road traffic noise and survival after breast cancer, and to explore potential effect modification by train noise, prognostic and socioeconomic factors.

2. Methods and material

2.1. Study population

The study was based on the prospective Diet, Cancer and Health (DCH) cohort (Tjonneland et al., 2007). 160,725 Danes were invited to participate from 1993 to 1997. Inclusion criteria were 50–64 years of age, residence in the greater Copenhagen or Aarhus area, and no previous cancer diagnosis in the Danish Cancer Registry; 57,053 participants (29,875 women) accepted, and were included into the study; representing 7% of the Danish population in this age-group. The study was approved by the local ethical committees of Copenhagen and Frederiksberg Municipalities. All participants provided written informed consent, and the study was conducted according to the Helsinki Declaration.

Participants have been followed up in Danish registries on cancer and mortality since baseline, and the present study is based on all women with a breast cancer registered as their first cancer in the Danish Cancer Registry (Storm et al., 1997) between baseline and February 10th, 2012.

2.2. Exposure assessment

Assessment of residential road traffic noise exposure for the DCH-cohort has been described in details elsewhere (Sorensen et al., 2013). Briefly, residential address history was collected for each participant between July 1st, 1987 and February 10th, 2012, using the Danish civil registration system (Pedersen, 2011). This allowed calculation of complete exposure history for each participant at an individual level: Residential road traffic noise exposure was calculated using SoundPLAN, implementing the joint Nordic prediction method for road traffic noise (Bendtsen, 1999). Using this method, equivalent noise levels can be calculated for each address, when a series of traffic and topographic parameters are known. Input variables included: points for noise estimation (geographical coordinate and height (floor) for each residential address), road links (information on annual average daily traffic, vehicle distribution (light/heavy), travel speed, and road type), and building polygons for all Danish buildings provided by the Danish Geodata Agency. We obtained traffic counts for all roads with more than 1,000 vehicles/day from a national road and traffic database (Jensen et al., 2009).

The terrain was assumed flat, which is a reasonable assumption in Denmark. Urban areas, roads, and areas with water were assumed to be hard surfaces, whereas all other areas were assumed acoustically porous. No information was available on noise barriers or road surfaces. Residential road traffic noise was calculated as the equivalent continuous A-weighted sound pressure level (L_{Aeq}) at the most exposed facade of the dwelling at each address for the day (L_d; 07:00–19:00 h), evening (L_e; 19:00–22:00 h) and night (L_n; 22:00–07:00 h), and expressed as L_{den} (den=day, evening, night). A 5 and 10 dB penalty was applied to evening and night, respectively.

Values of road traffic noise below 40 dB were set to 40 dB as this was considered a realistic lower limit of ambient noise.

2.3. Outcomes

We investigated overall mortality and breast cancer-specific mortality. Information regarding vital status was collected by linkage to the Danish Civil Registration System (Pedersen, 2011), and cause of death through the Cause of Death Registry (Helweg-Larsen, 2011).

2.4. Covariates

At DCH-study baseline, all participants filled in a food frequency and a lifestyle questionnaire, and anthropometric measures were collected by trained personnel. Furthermore, information on menopausal status and prognostic factors (tumor size, malignancy grade, estrogen receptor (ER) status, lymph node involvement) was available from time of diagnosis through linkage with the database of the Danish Breast Cancer Cooperative Group (DBCG).

Railway traffic noise was calculated individually for each woman, at all present and historical addresses using SoundPLAN, implementing a Nordic calculation method for predicting noise propagation for railway traffic noise (NORD2000). Input variables for the noise model were: point for noise estimation (geographical coordinate and height), railway links (information on annual average daily train lengths, train types, travel speed) and building polygons for all Danish buildings. All noise barriers along the railway are included in the model. Railway traffic noise was expressed as L_{den} at the most exposed facade of the dwelling. As for road noise calculations, the terrain was assumed flat. Urban areas, roads, and areas with water were assumed to be hard surfaces, whereas all other areas were assumed acoustically porous. The minimum train noise level that could realistically be estimated was 20 dB, and hence, all values below 20 dB were set to 0. In the present study, railway noise was included as a covariate and in interaction analyses only, as we did not have the statistical power to investigate this as an independent exposure.