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Residential exposure to traffic noise and leisure-time sports – A population-based study

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A B S T R A C T

Background: Traffic levels have been found a significant environmental predictor for physical inactivity. A recent study suggested that traffic noise annoyance was associated with lower physical activity.
Objectives: We investigated associations between modelled residential traffic noise and leisure-time sports.
Methods: In the Diet, Cancer and Health cohort, we performed cross-sectional analyses using data from the baseline questionnaire (1993–97), and longitudinal analyses of change between baseline and follow-up (2000–02). People reported participation (yes/no) and hours of leisure-time sport, from which we calculated MET hrs/week. Present and historical addresses from 1987 to 2002 were found in national registries, and traffic noise was modelled 1 and 5 years before enrolment, and from baseline to follow-up. Analyses were performed using logistic and linear regression.
Results: Traffic noise exposure 5 years before baseline was associated with higher prevalence odds ratio of non-participation in leisure-time sports; significantly for road traffic noise (odds ratio (OR): 1.10; 95% confidence interval (CI): 1.07–1.13) and borderline for railway noise (OR: 1.03; 95% CI: 0.99–1.07), per 10 dB. In longitudinal analyses, a 10 dB higher road traffic noise was associated with a higher prevalence odds ratio of ceasing (OR: 1.12; 95% CI: 1.07–1.18) and a lower prevalence odds ratio of initiating (OR: 0.92; 95% CI: 0.87–0.96) leisure-time sports. Exposure to railway noise was negatively associated with baseline MET hrs/week, whereas no association was found in longitudinal analyses, or for road traffic noise.
Conclusion: The study suggests that long-term exposure to residential road traffic noise is negatively associated with leisure-time sports. Results for railway noise were less consistent.

1. Introduction

1.1. Background

Physical inactivity is a threat to public health. It has been estimated to cause between 6 and 10% of the burden of disease from cardiovascular disease, diabetes, breast and colorectal cancer, as well as to account for 9% of the worldwide premature mortality (Lee et al., 2012).

Behavioral research and interventions towards physical inactivity have traditionally focused on individual factors, but with disappointing long-term results (Saelens et al., 2003a). In the last decades, focus has increasingly turned towards multilevel ecological models, suggesting that factors of the built environment also affect individual physical activity levels (Saelens et al., 2003a; Sallis et al., 2012). Several studies have found traffic levels to be a significant environmental predictor for physical inactivity in both children and adults, which has often been explained as a traffic safety issue (Brownson et al., 2009; Committee on Environmental Health and Tester, 2009; Ding et al., 2011; Fraser and Lock 2011). Interestingly, a recent study found that annoyance from traffic noise specifically was associated with subsequent lower levels of physical activity in Swiss adults (Foraster et al., 2016), suggesting a new mode of operation for traffic to affect physical activity levels.

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Apart from a direct pathway between traffic noise and physical inactivity, in which traffic noise renders the outdoor environment unappealing as a venue for physical activity, it could also affect physical activity levels through an indirect pathway by means of sleep deprivation. Traffic noise has consistently been found associated with poor sleep quality and shorter sleep duration (Miedema and Vos 2007; Pirrera et al., 2010; World Health Organization, 2009), and sleep disturbances have been found to negatively affect the capacity for physical activity, impair recovery, and increase the risk of exercise-induced injuries (Chennaoui et al., 2015). Another indirect pathway through which traffic noise could affect physical activity is through its role as a systemic stressor, entailing both emotional and physiological stress (Babisch, 2011). A review of the association between stress and physical activity found that physiological stress generally predicted less physical activity and more sedentary behavior, albeit with some heterogeneity (Stults-Kolehmainen and Sinha, 2014).

In recent years, exposure to traffic noise has been associated with higher risk of a number of illnesses, including cardiovascular disease (Babisch 2014; Basner et al., 2014), diabetes (Sorensen et al., 2013), and breast (Sorensen et al., 2014) and colorectal cancer (Roswall et al., 2017). The pathways explaining these associations are still not clearly elucidated, but given the role of physical inactivity in the etiology of all these diseases (Lee et al., 2012), it could be speculated that part of the explanation is that traffic noise functions through a pathway of physical inactivity.

1.2. Objectives

On this background, the objective of the present study was to investigate the association between residential traffic noise exposure and leisure-time sports, both cross-sectionally and longitudinally, in a cohort of middle-aged Danes.

2. Methods

2.1. Study population

The study is conducted in the prospective, Danish Diet, Cancer and Health cohort, which has been described in detail previously (Tjonneland et al., 2007). Briefly, 160,725 persons were invited to participate from 1993 to 97. Inclusion criteria were 50–64 years of age, residence in the greater Copenhagen area or Aarhus area and no previous cancer diagnosis in the Danish Cancer Registry. In total, 57,053 participants accepted the invitation and were included into the study, representing 7% of the Danish population in this age group.

At baseline, participants filled in a lifestyle questionnaire, and anthropometric measures were collected by trained personnel. In 1999–2002, participants received a follow-up questionnaire, and gave self-reported anthropometric data. In total, 45,271 persons (79% of the original cohort) filled in this second questionnaire, and were available for the follow-up part of the present study. Reasons for non-participation (N = 11,782) were death (14.6%), emigration (3.8%), and no reply to the questionnaire (81.7%).

The study was approved by the local ethical committees of Copenhagen and Frederiksberg Municipalities (Approval no.: (KF) 01-345/93). All participants provided written informed consent, and the study was conducted according to the Helsinki Declaration.

2.2. Traffic noise assessment

Assessment of traffic noise exposure for the cohort has been described in details elsewhere (Sorensen et al., 2013). Briefly, residential address history was collected for all participants between July 1st, 1987 and until end of follow-up, using the Danish civil registration system (Pedersen 2011). Road traffic and railway noise exposure was calculated using SoundPLAN, implementing the joint Nordic prediction method (Bendtsen 1999). Using this method, equivalent noise levels can be calculated for each address, when information on a series of traffic and topographic parameters is available. The input variables were: points for noise estimation (geographical coordinate and height (floor) for each address), and building polygons for all buildings, as well as traffic information on road links (data on annual average daily traffic, vehicle distribution (light/heavy), travel speed, and road type) and railway links (annual average daily train lengths and types, travel speed, and noise barriers along the railway). We obtained traffic data for all roads with more than 1000 vehicles/day from a national road and traffic database (Jensen et al., 2009). For road traffic noise, no information was available on noise barriers or road surfaces, and values below 40 dB were set to 40 dB as this was considered a realistic lower limit of ambient noise. For railway noise, persons with an exposure below 20 dB were considered non-exposed. For the assessment of both road traffic and railway noise the terrain was assumed flat, 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. 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. In the present study, we investigated noise exposure in 1 and 5-year time-periods before baseline as well as exposure from baseline to follow-up.

2.3. Physical activity assessment

Baseline physical activity information was based on questions on leisure-time sports during summer and winter separately. Participants reported the average number of hours per week spent over the past year. The number of hours spent over each season was averaged.

Information on leisure-time sports at follow-up was based on questions on low-impact sports, medium-impact sports and high-impact sports during summer and winter separately. Participants reported duration and frequency of the activity, as well as whether they experienced shortness of breath in relation to the activity.

At baseline, sports activities were each assigned a metabolic equivalent task (MET) value, according to the compendium of physical activities (Ainsworth et al., 1993). This was multiplied by the average number of hours/week over summer and winter to get the MET hrs/week for leisure-time sports. At follow-up, again each type of sport was assigned a MET-value, according to the compendium of physical activities (Ainsworth et al., 1993), based on whether they experienced shortness of breath while active. The MET hrs/week for leisure-time sports was calculated as an average number of hours/week over summer and winter. A detailed description of the physical activity questions and the MET-value assignment is available in (Ammitzboll et al., 2016).

The present study investigates physical activity by two measures: a dichotomized variable for participation in leisure-time sports (yes/no), and a continuous measure of MET hrs/week for leisure-time sports. Both measures are calculated at baseline and follow-up. Change in leisure-time sports status between baseline and follow-up was categorized as initiation (inactive-active), continued participation (active-active), continued non-participation (inactive-inactive), and cessation (active-inactive), respectively. Change in MET hrs/week was calculated as MET hrs/week at follow-up minus MET hrs/week at baseline.

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