Road traffic noise and register-based use of sleep medication

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ABSTRACT

Background

Road traffic noise has been found to influence sleep quality. Use of sleep medications may be an indicator of severe sleep disturbances. However, studies of the association between road traffic noise and use of sleep medication remain scarce.

Aims

The aim was to investigate the association between night-time road traffic noise and register-based use of sleep medication.

Methods

The study population is from Health and Environment in Oslo (HELMILO) (2009-10) (N = 13,019). We obtained individual data on sleep medications from the Norwegian Prescription Database (NorPD). Noise levels (L_{night}) were modeled for the most exposed façade of the building at each participant's home address. Noise exposure was categorized into <45 dB, 45-50 dB, 50-55 dB, and ≥55 dB. Logistic regression models were used to analyze the associations in the total study population as well as among individuals having bedroom located towards a road.

Results

After adjusting for potential confounders, we found positive, however not statistically significant, effect estimates from the noise category L_{night} 50-55 dB and upwards in the total study population. In a sub-population, with more accurately assigned noise exposure for the bedroom (bedroom facing a road), we observed a similar tendency; however, the effect estimates were positive from the category L_{night} 45-50 dB. The results were still not statistically significant. A spline estimated for this association indicated a linear relationship between noise exposure and register-based use of sleep medications.

Conclusions

We did not observe any statistically significant associations between road traffic noise and register-based sleep medication use. However, the magnitude of the effect estimates and the shape of the spline indicated an exposure-response relationship.

INTRODUCTION

Traffic noise is an increasing environmental factor that causes concern for public health (e.g. WHO, 2011). Findings both from field and laboratory studies show that nocturnal noise impact on sleep such as delayed sleep onset, awakenings, arousals and self-reported sleep disturbances (Öhrström et al. 2006; Miedema & Vos 2007; Aasvang et al. 2011; Basner et al. 2011). Besides the direct impact on sleep, night-time traffic noise has also been associated with day after effects such as mood changes (Skånberg & Öhrström 2006), decreased cognitive performance (Elmenhorst et al. 2010), and fatigue (Griefahn et al. 2006). The World Health Organization (WHO) has estimated that more than one million healthy life years are lost annually because of environmental noise exposure and most of them can be related to noise-induced sleep disturbances and noise annoyance. Road traffic noise is the main burden (WHO 2011).

In large scale epidemiologic studies, a common way to assess sleep disturbances is to have participants subjectively evaluate their sleep in questionnaires. Subjective evaluation of sleep is prone to information bias and questions might be interpreted differently among the participants. Objective measurements of sleep with polysomnography are not feasible for larger population-based studies as this will be too costly and time consuming. By using data on sleep medications from a register, we can obtain an objective measure of sleep medication use feasible for use as an outcome in a large population based study.

Only a few previous studies have examined the association between road traffic noise and sleep medication use. Two studies that used self-reported use of sleep medications did not reveal any significant association with road traffic noise (de Kluizenaar et al. 2009; Floud et al. 2011). Self-reports of medication use may suffer from information bias as patients might misunderstand how a drug is classified (Barregard & Stansfeld 2014). Such misunderstandings are avoided by using register data. To our knowledge, there are only two previous studies that have used register data on sleep medications for studying the association with road traffic noise (Bocquier et al. 2013; Halonen et al. 2014). These studies revealed some evidence that road traffic noise is associated with register-based use of sleep medication. Thus, more knowledge is needed on the possible effect of night-time noise on sleep medication use.

The aim of the present study was to investigate the association between night-time road traffic noise and register-based use of sleep medications. Separate analysis was conducted for individuals having bedroom facing a road.

METHODS

Study Population

The study population is from the Health and Environment in Oslo study (HELMILO), conducted in 2009-10. A questionnaire was sent out to 27,097 Oslo inhabitants born in 1924-25, 1940-41, 1955, 1960 and 1970, whereof 13,019 responded. The response rate was 48 %. Written informed consent was obtained and the Regional Committee for Medical Research Ethics and the Norwegian Data Inspectorate approved the study. The study was funded by The Research Council of Norway.

Noise Exposure Assessment

Night-time road traffic noise levels (L_{night}, A-weighted night-time equivalent noise level, 2300-0700 hours) were modeled for Oslo in 2011 (The Municipality of Oslo 2012) in accordance with the European Environmental Noise Directive (European Commission 2002). The noise levels were calculated according to The Nordic Prediction Method for road traffic noise (Nordic Council of Ministers 1996) using the software package CadnaA. Grid points for the calculations were 5 x 5 meters and calculation height was 4 meters above terrain. Road traffic data included in the model (traffic counts, % heavy vehicles, speed limits, diurnal distribution) were obtained from the Norwegian Public Roads Administration and the City of Oslo. Residential noise levels modelled for the most exposed façade of the building were assigned to each participant's home address using geographic coordinates.

Sleep medications

Information on sleep medications was obtained from The Norwegian prescription database (NorPD), which includes individual data on all prescription drugs dispensed at Norwegian pharmacies since 2004. The unique personal identification number assigned to all Norwegian citizens, makes it possible to store information on dispensed drugs at an individual level (Furu 2008; Furu et al. 2010). We considered it a proxy for current use of sleep medications if an individual had dispensed a prescription on hypnotics (N05C according to the Anatomical Therapeutic Chemical (ATC) classification system (WHO 2013)) at a pharmacy during a period of 100 days prior to participation in HELMILO.

Statistical analysis

We used logistic regression for analyzing the associations between road traffic noise and register-based sleep medication use. Noise exposure (L_{night}) was included as a categorical variable with the four levels < 45 dB (n=3,500), 45-50 dB (n=2,859), 50-55 dB (n=1,832), and ≥ 55 dB) (n=1,551). We also assessed the relationship between traffic noise and sleep medication use in the total study population by estimating a spline where we included noise exposure as a continuous variable with a cut-off at L_{night} 35 dB. We ran two models for the association between traffic noise and sleep medication use, one model adjusted for age and sex, and one where we in addition adjusted for body mass index (BMI), education level (low, medium, high), marital status (married/cohabiting, unmarried, divorced/separated, widowed), employment status (unemployed, working 1-29 hours/week, working ≥30 hours/week, old age-retired), household income (low, medium, high), physical activity (sedentary, moderately active, very active), alcohol consumption during last year (abstainer/not been drinking last year, ≤ 3 times/month, 1-3 times/week, 4-7 times/week), smoking status (current, previous, never), mental distress (high vs. low degree), chronic respiratory diseases (yes vs. no), and railway noise (≥45 dB vs. <45 dB). Railway noise was modelled according to the Nordic prediction method for rail traffic noise (Nordic Council of Ministers 1996) using the software package CadnaA. Participants who had lived at their current address less than one year at the time of the study were excluded from the analyses (n=367). Medications dispensed at an institution are not registered in NorPD at an individual level. Taking into consideration that individuals in the oldest age group (84-85 year olds) could be living at nursing homes, we excluded this group from the analyses (n=1,341).

In addition to the main model, we performed separate analyses for the individuals who had their bedroom facing a road. Information on bedroom location in the building was collected in the questionnaire.

Statistical analyses were carried out in STATA version 12 (StataCorp, College Station, Texas, USA). The spline was estimated in R statistical software 2.15.1 (R-project, library mgcv, function gam, Vienna, Austria).

RESULTS

In the total study population (n=9,742) 6.0 % had filled at least one prescription on hypnotics during 100 days prior to participation in HELMILO. The corresponding proportion was 7 % among the participants with bedroom facing a road (n=3,170). Table 1 shows distribution of age and sex both for the total study population and among individuals with bedroom facing a road, along with the distribution of the outcome.

Table 1: Characteristics of the study sample in the total study population and among individuals with bedroom facing a road.

	Population No. (%)	
Variable	Total study population (n= 9,742)	Bedroom facing road (n= 3,170)
Age		
39	2,233 (22.9)	745 (23.5)
49	2,401 (24.65)	771 (24.3)
55	2,224 (22.8)	705 (22.2)
68-69	2,884 (29.6)	949 (29.9)
Sex		
Female	5,239 (53.8)	1,744 (55.0)
Male	4,503 (46.2)	1,426 (45.0)
Sleep medications		
Yes	583 (6.0)	221 (7.0)
No	9,159 (94.0)	2,949 (93.0)

Associations between road traffic noise and sleep medications for the total study population are shown in Table 2.

Table 2: ORs and 95 % CIs for register-based sleep medication use by night-time traffic noise for the total study population.

Noise level (dB)	Total study population (n = 8,843)
Model 1[a]	
<45	1 [Reference]
45-50	1.01 (0.79, 1.26)
50-55	1.43 (1.11, 1.84)
≥55	1.50 (1.15, 1.95)
Model 2[b]	
<45	1 [Reference]
45-50	0.96 (0.75, 1.23)
50-55	1.23 (0.95, 1.60)
≥55	1.30 (0.98, 1.71)

[a]Model adjusted for age and sex.
[b]Model adjusted for age, sex, railway noise, education, marital status, employment status, household income, physical activity, body mass index, smoking, alcohol use, mental distress, and chronic respiratory diseases.

After adjusting for potential confounders, we observed positive, however, non-significant, effect estimates in the two highest noise categories, L_{night} 50-55 dB and L_{night} ≥ 55 dB in the total study population. Among individuals with bedroom facing a road we observed positive effect estimates for the noise category L_{night} 45-50 dB and higher levels, although non-significant. A statistically significant trend across the four noise categories was observed (p=0.02). Among the individuals with a bedroom facing a road the trend test was non-significant (p=0.1). The spline was assessed visually and we found a linear relationship between road traffic noise and sleep medication use (Figure 1).

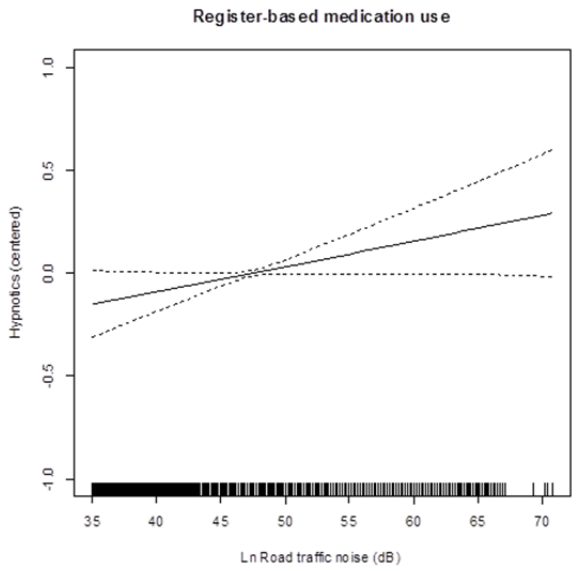

Figure 1: Function of night-time road traffic noise and sleep medication use for the total study population adjusted for age, sex, railway noise, education, marital status, employment status, household income, physical activity, body mass index, smoking, alcohol use, mental distress, and chronic respiratory diseases. Solid line: odds ratio, dashed lines: 95% confidence interval. The vertical lines on the x-axis show the distribution of road traffic noise levels.

CONCLUSIONS

We did not find any statistically significant associations between road traffic noise at night-time and register-based sleep medication use. However, the magnitude of the effect estimates and assessment of the spline suggest an exposure-response relationship. Furthermore, we observed a stronger relationship between road traffic noise and sleep medication use in the sub-population of individuals with bedroom facing a road compared with the total study population. Since noise calculations are performed at the most exposed facade of the building, it is likely that noise exposure is more precisely estimated for individuals with bedroom facing a road. In order to better assess the causal mechanisms of this relationship, a study with longitudinal design should be performed.

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