Road traffic noise, air pollution and blood pressure in Oslo, Norway

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INTRODUCTION

Epidemiological studies have reported an association between traffic noise and hypertension. Especially with respect to aircraft noise there is increasing evidence for an association with hypertension (Babisch 2006; Eriksson et al. 2007; Jarup et al. 2008). There are indications that also road traffic noise may contribute to hypertension (Babisch 2006; Barregard et al. 2009; Bluhm et al. 2007; Bodin et al. 2009; de Kluizenaar et al. 2007), but these findings are more inconsistent, bearing in mind the possible confounding by traffic-related air pollution. In addition, most of these studies are cross-sectional with self-reported hypertension.

Special attention has been drawn to the possible harmful effect of night-time noise exposure on cardiovascular risk (Griefahn et al. 2008; Jarup et al. 2008), and acute effect of night-time aircraft noise on blood pressure has been observed (Haralabidis et al. 2008). However, very few epidemiological studies have included night-time noise exposure in their analyses.

The aim of the present study was to examine the relationship of road traffic noise with blood pressure and hypertension in an adult population, adjusting for several possible confounders including traffic-related air pollution. Of particular interest was the association between night-time road traffic noise and hypertension.

METHODS

Study population and design

The participants (N=21,363) in the population-based "Oslo Health Study" HUBRO (2000-2001) underwent a physical examination including blood pressure measurements. We identified hypertension as measured systolic blood pressure above 140 mmHg, measured diastolic blood pressure above 90 mmHg or self-reported use of antihypertensive medication. The study was approved by the Regional Ethics Committee and the Norwegian Data Inspectorate.

Environmental exposure assessment

Noise from road traffic was calculated according to the EU directive for noise (European Commision 2002). The noise indicators L_{den} and L_{night} were calculated on 5 x 5 m^2 grid, using The Nordic Prediction Method for road traffic noise (Nordic Council of Ministers 1996). The noise levels were calculated for the year 2006, and only those who lived at the same home address in 2000 and 2006 were included in the analyses (N=13,174). The input data on Road traffic (traffic counts, % heavy vehicles, speed limits, diurnal distribution) was obtained from the Norwegian Public Roads Administration and the City of Oslo. Using the geographical coordinates for

each participant's home address, all participants were assigned residential road traffic noise at the most exposed façade.

The Nordic prediction method for road traffic noise calculates noise exposure at the most exposed facade with a deviation of ± 3-5 dB depending on the distance from the noise source. "Deviation" denotes the difference between the calculated value and the measured long-term average using standard procedure for noise measurements. Combining the prediction method with a geographical information system is considered the best available method to assess residential noise exposure.

Nitrogen dioxide (NO_2) was calculated by the EPISODE dispersion model on 1 km^2 grid. Based on historical data on emissions (especially from road traffic), meteorology and background air pollution concentrations, The Norwegian Institute for Air Research has developed a dispersion model which calculates outdoor levels of NO_2 (Oftedal et al. 2009). Using geographical coordinates for the home addresses, all participants were assigned NO_2 levels. Modeling of long-term averages has recently been evaluated by comparing modeled levels versus measurements from monitoring stations in Oslo, and this model may represent long-term levels of local outdoor air pollution reasonably well (Oftedal et al. 2009).

RESULTS

The distributions of road traffic noise are presented in Figure 1.

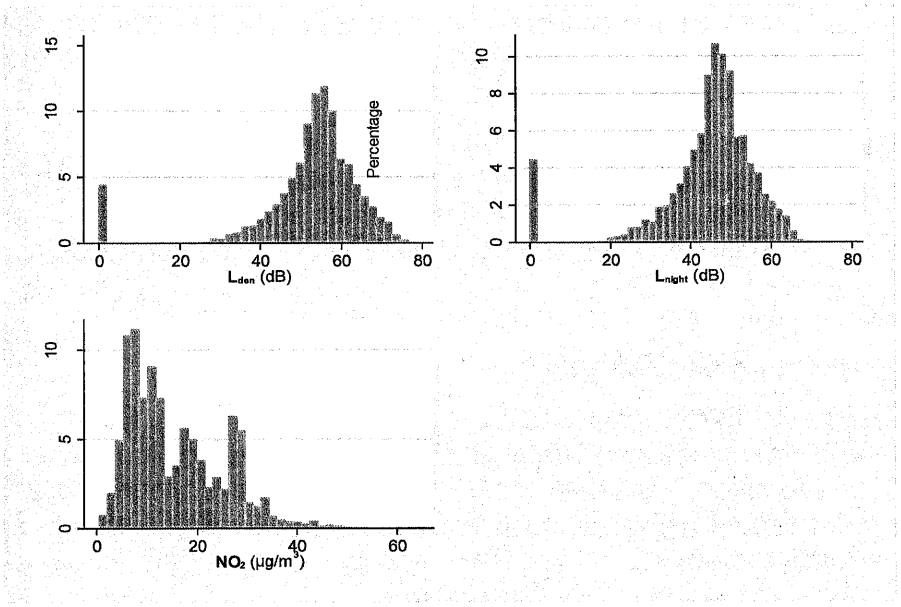

Figure 1: Distribution of residential exposure to road traffic noise (L_{den} and L_{night}) and to NO_2.

Preliminary results showed that road traffic noise (L_{den}) ≥ 60 dB was associated with an increase of 0.9 mmHg (95% confidence interval (CI): 0.0, 1.8) in systolic blood pressure compared to noise levels <50 dB, while no associations were found with diastolic blood pressure. The results were similar for L_{night}, except for a minor change by adjusting for NO_2. Figure 2 shows the estimates for systolic blood pressure in different L_{night} categories adjusted for several potential confounders, of which one of the models includes NO_2.

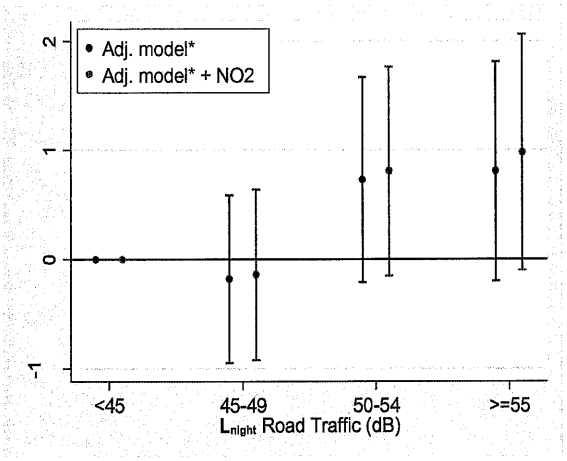

Figure 2: Estimates of coefficients with 95% CI for systolic blood pressure for different noise exposure categories, *adjusted for age, sex, smoking habits, intake of fruit, cod liver oil intake, waist-hip ratio, seasons, marital status, education and western country of birth, with L_{night} <45 dB as the reference category.

We found no associations between NO_2 and blood pressure. The correlation between road traffic noise and NO_2 was moderate (r=0.4). Preliminary results regarding hypertension showed that road traffic noise (L_{night}) ≥ 55 dB was associated with an odds ratio (OR) of 1.06 for hypertension (95% CI: 0.92-1.22) with noise levels <45 dB as reference adjusted for age, gender, body mass index and education. However, we found no exposure-response relationship. We found no associations between NO_2 and hypertension. Adjusting for NO_2 did not change the OR of traffic noise. The results stratified by gender are presented in Figure 3. As can be seen in men the estimated ORs increased with increasing noise levels, but were not statistically significant.

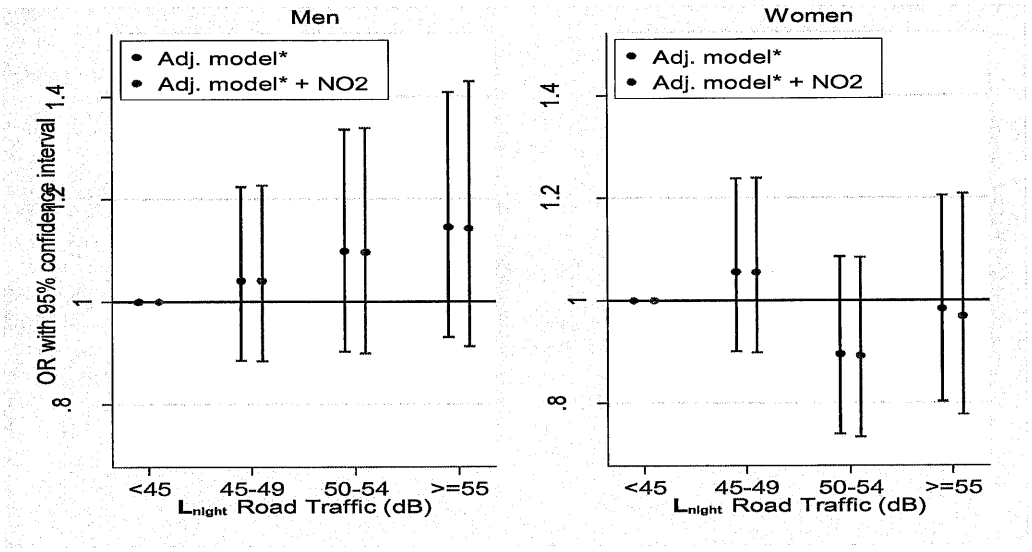

Figure 3: Odds ratio with 95% CI for hypertension in men (left) and women (right) for different noise exposure categories, *adjusted for age, body mass index and education, with L_{night} <45 dB as the reference category.

CONCLUSIONS

Exposure to road traffic noise may be related to a slight increase in systolic blood pressure, and this relationship seemed to be minimally affected by traffic-related air pollution. However, residential road traffic noise was poorly related to hypertension. The association was somewhat stronger in men than women, but did not reach statistical significance. These associations are probably not affected by traffic-related air pollution in Oslo. Further analyses using historic information of changes in buildings, noise screens and traffic data, road traffic noise levels will be calculated backwards to 2000-2001, when the blood pressure measurements were conducted, and will increase the power of the statistical analyses.

In the future, a longitudinal design, including more contextual variables will provide more reliable results on the effect of traffic-related exposures and cardiovascular health outcomes.

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