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Disentangling the effects of traffic-related noise and air pollution on blood pressure: indoor noise levels and protections

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ABSTRACT

Outdoor road traffic noise levels are associated with hypertension (HT). Studies on blood pressure (BP) are inconsistent and the true indoor traffic noise exposure may differ due to protections against noise. We analysed the effects of long-term exposure to outdoor and indoor traffic noise levels on HT, systolic (SBP) and diastolic BP (DBP, mmHg), adjusting for outdoor annual average concentrations of near-road traffic-related air pollution (nitrogen dioxide, NO_2) among 1926 participants (aged 36-82) from the Catalan REGICOR study. Long-term outdoor residential levels of traffic noise at night (L_{night}, in A-weighted dB) and annual averages of NO_2 (in $\mu g/m^3$) were estimated at the postal addresses' façades with a city-specific noise model and a land-use regression model, respectively. Indoor traffic noise was calculated from outdoor noise levels subtracting the attenuations in dB according to reported noise protections. Median noise levels were 56.7 dB outdoors and 27.1 dB indoors. Spearman correlations between outdoor and indoor noise with NO_2 were 0.75 and 0.23, respectively. Outdoor noise was only associated with HT (OR=1.19, 95%CI: 1.02, 1.40), whereas there was a suggestive association of indoor noise with both HT (OR=1.06, 95%CI: 0.99, 1.13) and SBP (β=0.38, 95%CI: -0.08, 0.83) per 5 dB increase in outdoor noise levels. NO_2 was also associated with both outcomes after adjustment for indoor noise. Findings for indoor traffic noise levels are more plausible than those for outdoor traffic noise. The use of indoor traffic noise estimates help to disentangle the effects from those of traffic-related air pollution.

1. INTRODUCTION

Long-term exposure to road traffic noise has been associated with cardiovascular disease (CVD) [1] and prevalence of hypertension [2]. However, reports are inconsistent for blood pressure (BP).

Moreover, traffic is also the underlying source of traffic-related air pollution, and this environmental factor has been also related to BP [3], [4], [5], [6]. However, evidence is more limited for hypertension [5], [7], [8].

Given that traffic is a relevant common source for both road traffic noise and air pollution and that both environmental factors may affect high blood pressure, the question remains whether their effects are mutually confounded [9], [10].

Current studies investigating the effects of transportation noise rely on outdoor noise levels, whereas the true exposure may be modified by room orientation, noise protection elements, and remedies against noise, as already proposed [11].

Knowing people's road traffic noise exposure indoors might be essential to ascertain the effects of road traffic noise and to disentangle them from those suspected for traffic-related air pollution.

2. OBJECTIVES

We analyzed associations of long-term exposure to indoor traffic noise levels at bedrooms, and hypertension (HT) and systolic (SBP) and diastolic (DBP) BP, considering outdoor annual average levels of nitrogen dioxide (NO_2).

3. METHODS

We evaluated 1926 participants recruited at baseline (years 2003-2006) from a cohort of the REGICOR study, Girona, Spain. All participants had answered a questionnaire on remedies and protections against noise at home at the follow-up visit.

Blood pressure was measured according to the Joint National Committee VII recommendations. Hypertension was defined as having systolic (SBP) or diastolic (DBP) BP levels $\geq$140/90 mmHg, respectively [12], or taking antihypertensive treatment.

We estimated long-term outdoor road traffic noise levels for each individual during the night-time (A-weighted equivalent noise levels, L_{night}, 11pm-7am) [13]. Estimates were derived at the geocoded residential addresses, 2m from façades and at the floor's height of each dwelling. The estimates were derived with a detailed city-specific traffic noise model (year 2005) that complied with the European Noise Directive 2002/49/EC (END), as described elsewhere [10].

Individual indoor traffic L_{night} levels at bedrooms were derived from outdoor L_{night} applying dB

attenuation rates provided by reported noise protections according to the Spanish Building Code and complimentary literature.

We carried out multivariate logistic regression for hypertension and multivariate linear regression for systolic and diastolic blood pressure. We built two-exposure models, i.e. models accounting for the effects of both L_{night} (either outdoor or indoor) and NO_2, and adjusted for relevant confounders.

4. RESULTS

Median levels were 27.1 dB (indoor L_{night}), 56.7 dB (outdoor L_{night}), and 26.8 $\mu g/m^3$ (NO_2). Spearman correlations between outdoor and indoor L_{night} with NO_2 were 0.75 and 0.23, respectively.

In two-exposure models for hypertension, a 5 dB increase of outdoor traffic L_{night} yielded an odds ratio (OR) of 1.19 (95%CI: 1.02, 1.40), whereas no associations were found with blood pressure. On the other hand, there was a suggestive association between indoor traffic L_{night} with both hypertension and SBP in the group not taking blood pressure-lowering medication. Results for SBP in the entire population were stronger. Associations were also observed between NO_2 and all the outcomes when adjusting for indoor traffic noise.

5. DISCUSSION

In this study, we used indoor road traffic noise levels to get an estimate closer to the true relevant personal exposure. Moreover, accounting for road traffic noise indoors at home reduces the correlation observed between outdoor traffic noise and outdoor NO_2 levels, thus helping to identify the independent effects of both road traffic noise and traffic-related air pollution on high blood pressure.

Very few studies accounted for both exposures and none applied indoor traffic noise estimates to disentangle the effects of the two environmental stressors.

6. CONCLUSION

We observed a suggestive association between individual night-time road traffic noise levels at bedrooms and both hypertension and systolic blood pressure, whereas outdoor traffic L_{night} levels were only associated with hypertension. The use of indoor traffic noise estimates help to ascertain the effects of traffic noise and to disentangle them from those of traffic-related air pollution.

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