Source-specific transportation noise mortality from heart failure and myocardial infarction in Switzerland

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ABSTRACT

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1. INTRODUCTION

Recent research has shown that, transportation noise affects health at different levels in various ways. In particular, transportation noise affects the cardiovascular system via release of stress hormones in the blood stream triggering mechanisms, which are risk factors for hypertension, arteriosclerosis and myocardial infarction.

The bulk of the literature on health effect of noise reports time-averaged noise levels as exposure variable. Within the framework of the SiRENE project, we have developed a novel noise metrics termed “Intermittency Ratio” (IR) to describe the variability of the noise source (1).

To date, most studies consider a single noise source as exposure variable. In the present study, we investigate on the link between mortality from heart failure and myocardial infarction and the three major transportation noise sources in Switzerland -aircraft, railway and road traffic noise- along with the combined nighttime IR of those sources in multipollutant models.

2. METHODS

2.1 Study Population

The Swiss National Cohort (SNC) links national census data with mortality and emigration records (2). Coverage of the census is estimated at 98.6%. The data used in our study is based on the 4 December 2000 census data and on mortality and emigration data for the period 5 December 2000 to 31 December 2008.

The SNC dataset contains information on age, sex, marital status, education, floor and geocoded place of residence. It also contains a composite indicator of socio-economic status (3).

The SNC was approved by the cantonal ethics boards of Bern and Zurich.

2.2 Outcomes

The outcomes under investigation are primary causes of death from heart failure (ICD-10 code:

I50) and myocardial infarction (ICD-10 code: I21-I22).

2.3 Noise data

Within the framework of the SiRENE project (Short and Long Term Effects of Transportation Noise Exposure), a Swiss-wide noise database has been built for the years 1991, 2001 and 2011 for the three major transportation noise sources: aircraft, railway and road traffic noise. Since 2001 matches the SNC time window best, we use only the 2001 data in the current study. The noise database is described in detail in the publication of Karipidis et al. (4).

In brief, for aircraft noise, we consider the three major civils airports; Zürich, Geneva and Basel, and a military airport located in Payerne. Noise estimates for Zürich airport are generated via FLULA2, which uses radar data as input. Noise estimates for the airports of Geneva and Basel are calculated on the basis of traffic statistics from the Federal Office of Civil Aviation (FOCA) along with available acoustic footprints from year 2000 and 1999 respectively. For the military airport of Payerne, aircraft operation data is poor and the calculation is based on idealized flight paths, number of flights and approximate operation times.

Noise emissions from railway noise are calculated using sonRAIL and noise attenuation is computed using the Swiss railway noise model SEMIBEL. Input variables for sonRAIL are geometry of the railway tracks, location of switch points, location and height of the noise barriers, train types, driving speed, and traffic statistics.

Noise emissions from road traffic noise are calculated using sonROAD which considers the followings input data: road geometry, slope, type and width, speed limit, bridge construction height, traffic statistics (through sonBASE which is based on census data about population and enterprises), and noise barriers location and height. Noise propagation is calculated via StL-86.

Nighttime IR combined from all sources was derived from the modeled noise. The IR quantifies the contribution of individual events in the total noise level from all sources above a certain threshold (1).

For participant of the SNC, noise exposure to each source was determined at the maximal exposed façade of the building of residence. Lden for each noise source was calculated applying a 5-dB penalty for the evening and a 10-dB penalty for the night. Lden were censored at 35dB for road traffic and at 30dB for railway and aircraft noise.

2.4 Statistical Analysis

We analyze the data by Cox proportional hazards model with age as underlying time variable. Cohort participants are followed until emigration or death or end of follow-up. Hazard ratios for the outcomes of interest were computed using multivariable linear regression models for road traffic, railway, and aircraft noise exposure (Lden) and nighttime IR in multiexposure models. All models were adjusted for sex, socio-economic status, civil status, education level, mother tongue, nationality and NO2 exposure. Analysis was run using the package "survival" of the R software.

3. RESULTS

After exclusion of imputed death records, subjects below 30 at beginning of follow up, and observations without geocodes in the 2000 census, the study population amounts to 4.5 mio observations for the period 5th December 2000 to 31st December 2008.

The cohort contains about 172 thousands death records from cardiovascular diseases, from which 9.4% and 12% are deaths from heart failure and myocardial infarction.

Heart failure and myocardial infarction are associated with all three noise sources, whereas the association is stronger for road traffic noise with both outcomes. Nighttime IR is significantly associated with myocardial infarction. The hazard ratio for heart failure and myocardial infarction, and the three noise sources and nighttime IR are displayed in table 2.

Table 1: Hazard ratio per 10dB(A) increase of noise exposure and 10% increase of nighttime IR for Heart Failure and Myocardial Infarction in multiexposure models adjusted for sex, socio-economic status, civil status, education level, mother tongue, nationality and NO2 exposure.

	Heart Failure n=16’234	Myocardial Infarction n=21’198
Lden Aircraft	1.06 (1.03-1.08)	1.02 (1.00-1.04)
Lden Railway	1.02 (1.01-1.04)	1.01 (0.99-1.02)
Lden Road traffic	1.06 (1.04-1.08)	1.04 (1.02-1.06)
Nighttime IR	0.99 (0.98-1.00)	1.01 (1.00-1.02)

4. CONCLUSIONS

Our study demonstrates the impact of all major transportation noise sources on CVD mortality. For MI degree of IR was found to be relevant in addition to Lden, suggesting nighttime IR is relevant for protection policy of various noise sources with different characteristics.

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