Road traffic noise exposure and myocardial infarction – a novel approach

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Abstract

An increased risk for myocardial infarction related to exposure to road traffic noise has been reported in some studies but the evidence is still conflicting. Our objective is to perform a longitudinal study on noise exposure and myocardial infarction, including high quality medical data, extensive control of potential confounders and refined exposure assessments on an individual basis. The study will be based on a case-control study in Stockholm between 1992-1994, comprising 2,246 first time myocardial infarction cases in the ages 45-70 and 3,206 population controls matched on age, gender and hospital catchment. A postal questionnaire provided information on a large set of potential risk factors for myocardial infarction. The present investigation will be focussed on 3695 subjects, with information gap of residences in Stockholm County of not more than 5 years since 1970. These subjects will be classified according to the historical levels of traffic noise at their residences. Road traffic noise exposure will be calculated for a total of about 7,700 addresses from 1970 and onwards, using retrospective data on traffic statistics and different noise level surveys. A Nordic model, where all determinants affecting noise levels are included, is used for the estimation. Beside road traffic noise, also other transportation noise sources will be assessed. To better characterise the individual noise exposure and to estimate the potential influence of subjective reactions to noise, additional information about room orientation, window opening habits and the degree of annoyance due to noise will be collected using a new questionnaire. In conclusion, this study will include a novel approach to assess individual noise exposure in residential settings during several decades, which will be used to study the relation between longitudinal traffic noise exposure and myocardial infarction.
Introduction

Noise is an environmental factor of rising importance for human health. In urban areas traffic noise is often the dominating source of exposure and steadily increasing [1]. In Sweden more than 2 million inhabitants are exposed to traffic noise levels exceeding 55 dB L.Aeq, 24h, which is the present national guideline value presented by the National Board of Health and Welfare [2]. According to Swedish Environmental Protection Agency [3] approximately one third of these are annoyed by noise outside or near their homes at least once a week. Disturbances due to noise exposure are commonly described. Traffic noise has been linked to various psychological and physiological effects. Common psychosocial responses are sleep disturbances, interference with daily activities and general annoyance. Decreased mood or wellbeing are also well-known effects. Reported physiological reactions include hearing impairments and increase in blood pressure. Some epidemiological studies of long term traffic noise exposure have indicated an increased risk for ischemic heart disease and hypertension (Babisch [4], Bluhm [5], Herbold [6], Reccegovà [7]). However, the evidence is still conflicting.

In a review Babisch [8] reports that there is at present little epidemiological support for an increased risk for hypertension in traffic noise exposed subjects. Regarding ischemic heart disease there is some evidence of an increased risk [8]). In total, there are approximately 20 epidemiological investigations published regarding long-term cardiovascular effects of traffic noise. Most of these studies have a cross-sectional design without data on the duration of exposure. In addition comprehensive studies of health effects due to combined noise sources in the three large areas of transport; road, rail and aircraft, are missing. Other common weaknesses are rough exposure assessments, especially on individual levels as well as incomplete control of potential confounders and non-standardised measurements of blood pressure. There is also a lack of homogeneity in diagnosis of myocardial infarction. Further epidemiological studies are needed.

When designing such studies validated noise exposure assessment models and control for important lifestyle related risk factors as smoking, overweight, high blood pressure and elevated blood lipids have to be taken into account. Information about type of noise exposure as well as residential time and positioning of bedroom and living room are important factors. Knowledge about noise exposure at work is a factor of special interest.

Our objective is to study the risk for myocardial infarction associated with long term residential road traffic noise exposure using refined epidemiological methods, (The ROM study). To control for potential risk factors a large Swedish population based case-control study (SHEEP- Stockholm Heart Epidemiology Program) of first time myocardial infarction is used for the investigation. A tool for exposure assessment on an individual basis is to be refined. In addition we want to study the risk with exposure to rail and/or aircraft noise also taken into account.
Subject and methods

Study subjects

The SHEEP-study has been described in detail elsewhere by Reuterwall [9]. In brief, the study comprised all nonfatal and fatal first events of myocardial infarction (MI) among Swedish citizens age 45-70 years, who were resided in Stockholm county during 1992-1993 (1992-1994 for women) and population controls from the corresponding study base. The upper age limit was set at 65 years during the first 10 months of subject recruitment and 70 years for the rest of the enrolment period. Cases were identified from the coronary and intensive care units at the department of internal medicine at all of the emergency hospitals in Stockholm County, the Hospital Discharge Register for the county, or death certificates from the National Cause of Death Register at Statistics Sweden. The diagnostic criteria for MI used to determine case inclusion where those applied by the Swedish Association of Cardiologists (Stockholm County Council [10]). In addition, patients with myocardial necrosis detected at autopsy that could be related to the time of disease onset were also included. One control per case matched on gender, age and hospital catchment area, was randomly selected from the study base within 2 days of the inclusion of a case. All controls were initially checked for previous MI and were alive when recruited, regardless of the vital status of the corresponding case.

In total, the SHEEP-study included 2,246 cases and 3,206 controls. Extensive information on a large set of potential risk factors for MI was collected in a questionnaire and in a complementary telephone interview. Hospitalised cases and their referents were also invited to a brief health examination. The questionnaire response rate among cases was 72% for women and 81% for men, and the corresponding figures in the control group were 70% and 75%. The subjects responded to the same extent in different age groups and were equally inclined to participate from the different catchment areas.

In the present study on road traffic noise and myocardial infarction, the ROM study, exclusion criteria were residential time more than five years outside Stockholm County since 1970 or information gap regarding home addresses of altogether more than 5 years during 1970-1992/1994. Thus the ROM study finally comprised 3,695 subject.

Risk information

Data available from the questionnaire and the supplementary telephone interview in the SHEEP study provided information about a large set of potential risk factors for MI. These include physical and psychosocial environment at work and home, exposure to environmental tobacco smoke, different life style factors as smoking, physical activity, drinking habits and dietary preferences. Biological data, like occurrence of diabetes, hypertension, overweight, abdominal adiposity and hypercholesterolemia, were mainly based on data from the health examination. Criteria for categorisation of different risk factors are described in detail by Rosenlund [11].
Noise exposure assessment

In total 3,695 subjects are included in the present investigation. There are 1,590 cases and 2,105 controls. Historical levels of traffic noise exposure at their home addresses from 1970 to their inclusion in the SHEEP-study are to be calculated. Altogether approximately 7,700 addresses from 1970-1992/1994 shall be analysed. Half of these addresses are situated in the City of Stockholm and the rest are evenly distributed in the other 25 municipalities in the County of Stockholm. A simplification of a Nordic prediction models for road traffic noise is used for calculation of noise exposure [12]. A similar model is used to estimate noise exposure due to railway traffic [13]. Aircraft noise is assessed for individual addresses using a computer program based on aircraft statistics and expressed either as time weighted equal energy levels (FBN: the Swedish abbreviation for energy averaged aircraft noise level) [14], or maximum noise levels (MNL) [15].

Exposure assessments are performed manually for all addresses. Most of this work has to be done at the different municipalities as information about traffic flow and main traffic changes usually is gathered locally.

Noise exposure assessments for road traffic noise at individual addresses could in the simplified model be calculated using information about number of vehicles/24 h and speed. Also information about distance from roads and angles between the dominating noise exposed façade of the residence and main roads are needed. Occurring noise barriers are also accounted for in the calculations. Local maps, scale 1:4000, make it possible to detect separate houses and measure angles and distance to relevant roads (figure 1).

Figure 1: A typical example of exposure assessment. The residents in the grey house are exposed to two main roads for which angles (solid lines) and distances (dashed lines) are calculated.
Distances and angles from the residence to the roads in question as well as the number of vehicles and estimated speed are registered first. Traffic count has to be matched to the period of residence. Validation of this simplified model is to be performed by comparison with two other noise studies in the county of Stockholm, which have the complete Nordic prediction model as a base.

**Questionnaire**

To refine exposure assessments and reduce exposure misclassification additional residential data is needed. Because of that a new questionnaire has been constructed. This postal questionnaire shall be distributed to all subjects and controls still alive, approximately 3,000 subjects. About 600 persons in our study population are not alive any longer why adjusted questionnaires will be sent to near relatives. Information will be collected about all addresses from 1970 to 1992/1994 regarding orientation of living rooms, bedrooms and window opening habits. Access to a quiet side at the address is an information of special importance. Other noise sources and annoyance due to noise is also asked for. To estimate the potential influence of noise sensitivity and attitudes towards noise, relevant questions in this respect are included.

To control for work related noise there are some questions regarding noise conditions at all working places between 1970-1992/1994. Some questions regarding problems with noise related to work and strategies for coping are also included.

**Results**

Hitherto about 1,000 addresses have been evaluated and the results are gathered in a database. To validate the method a comparison will be performed with the results from two other recent exposure studies in the county of Stockholm. In both these studies the complete Nordic prediction model has been used for extensive digital noise mapping. In one of these investigations a database regarding noise exposure (L_Aeq, 24 h, > 59 dBA) has been created for the whole city of Stockholm. Altogether 8,000 addresses have been registered and noise exposure has been assessed in detail for each individual façade. These results are soon to be published. The other study is a pilot project of noise exposure in Huddinge, a municipality in Stockholm county with 70,000 inhabitants and a lot of different transportation noise, and in Södermalm, a district in the inner part of the city of Stockholm with nearly 100,000 inhabitants. In this study a tool for digital noise mapping of the total area has been evaluated. Besides road traffic noise, which is the dominating source, also noise from railways, aircraft’s and industrial plants have been analysed. Noise mapping in Huddinge, which recently has been published by the County Administrative Board in Stockholm [16], has been validated by actual measurements.
So far results from our exposure assessments have been evaluated for a random sample of 19 addresses located in the municipality of Huddinge by comparison with the results from the pilot study using paired t-test. The comparison of 19 addresses indicated that the simplified model on average resulted in 3.8 dB(A) Leq, 24h (95% Confidence Interval 2.7-5.5) lower exposure level than in the pilot study in Huddinge. Regarding 5 dB(A) noise intervals the results fit perfectly at thirteen addresses and there are small differences, 1-4 dBA, at two others and only in two cases the results diverge more.

**Discussion**

Community noise studies have traditionally considered only noise from a single specific source such as aircraft or road traffic. In recent years also noise from railway traffic has been estimated as an important source for stress induced effects. Our goal is to integrate all form of transportation noise. In the analyses different concepts of summation can be used for multiple exposure as e.g. sum score, maximum score and factor score. However the interpretation of these results have to be handled with care. It is important to point out that a total integrated estimate of noise is not enough to get a complete picture. There are also other factors to be taken into account contributing to noise induced stress reactions. Subjective attitudes towards noise and activities disturbed may modify the health effects quite considerably. Susceptible population may include people highly annoyed by noise and persons with a family history of cardiovascular disease.

The use of individual residential façade noise assessments by help of available traffic data is a new approach, when estimating health effects due to traffic noise. The comparison of exposure calculation using the simplified model and the Nordic prediction model has hitherto indicated somewhat lower estimates when using the simplified model though the figures usually were in the same 5dBA intervals. The model will be further developed based on experiences from more sophisticated comparisons using a larger sub-set of addresses from our address database.

We have no reason to believe that a potential misclassification of exposure would differentiate between cases and controls in the study. Therefore, the results from the epidemiological analyses would be expected to shift toward the null. Because such nondifferential misclassification of exposure cannot be ruled out even using a more complicated exposure model, a potential increased relative risk for myocardial infarction related to traffic noise exposure would be underestimated.

According to previous epidemiological studies the availability to a quiet side, especially if it is the bedroom, and window opening habits has been considered to be of crucial importance, when calculating noise exposure in relation to risk estimates for cardiovascular effects [8]. This information is also to be controlled for in the present study,
In conclusion the SHEEP database makes extensive confounding control and high accuracy in diagnosis settling possible. The longitudinal design improves exposure assessments. Individual exposure assessments combined with residential positioning information raise the quality of exposure classification. To consider noise exposure from road, railways and aircraft in the analysis is an innovative method, when deciding health effects due to transportation noise.

References


