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# Noise exposure at the place of residence is associated with atherothrombotic risk, in men but not in women. Findings from ENVI-MI (Environment and Myocardial Infarction) study

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**Abstract**
This study analysed the relationships between environmental noise and atherothrombotic risk (AtR). Patients were identified from the Côte d'Or infarction observatory. From 2004 to 2008, 867 consecutive myocardial infarction (MI) patients were included. The AtR was quantified by the TRS- 2P score. Environmental models were used for quantifying residential noise exposure. Odds ratios (OR) were expressed for a 10-dB(A) increase. The mean age was 68 y, 66% were male. Main CV factors were smoking, hypertension and hypercholesterolemia. The OR of road-related noise and railway-related noise were 1.16 (1.02-1.32) and 1.03 (1.00-1.06), respectively. When stratified on sex, OR related to transportation $L_{Aeq,24h}$ and $L_{Aeq,night}$ were 1.24 (1.04-1.47) and 1.26 (1.08-1.47) for men and 1.01 (0.80-1.30) and 0.96 (0.76-1.20) for women, respectively. If confirmed, the identification only in men of an association between the environmental noise and the AtR could have major consequences in terms of public health.

**Keywords:** acute myocardal infarct, environmental noise, atherothrombotic risk, sex, hypertension.

# 1 Introduction

The World Health Organization (WHO) has estimated that exposure to noise in Western Europe is responsible for a million years of healthy life lost [1]. Recent epidemiological studies suggest that noise exposure may be associated with an increase in cardiovascular disease including myocardial infarction (MI) [2]. In 2018, a meta-analysis commissioned by the WHO concluded that, above 50 dB, road traffic noise increased the incidence of coronary heart disease by 8% per 10 dB (A) ($L_{DEN}$) [3]. However, only a few studies have investigated the specific weight of exposure to ambient noise on atherothrombotic risk. In addition, the question of whether home noise exposure might influence the risk of cardiovascular events after MI remains unclear. The aim of this study is to analyse the relationships between environmental noise and atherothrombotic risk (AtR) and to assess a possible difference between men and women in this relationship.

# 2 Method

Study population
Patients having presented a MI between January 2004 and December 2008 were identified from the Côte d'Or infarction observatory (RICO). Only patients living in the Dijon urban unit (France, Burgundy, 237,000 inhabitants in 2006) at the time of their MI were included in this study.

Medical data
Demographical, clinical and biological data were collected by the RICO in the medical records, including risk factors, comorbidities, chronic medications, heart failure (HF) and hemodynamic parameters. The Thrombolysis in Myocardial Infarction Risk Score for Secondary Prevention (TRS-2P) was calculated to quantify atherothrombotic risk [4], in order to assess long-term risk after recent acute MI [5,6]. TRS-2P is the arithmetic sum of 9 parameters associated with atherothrombotic risk: age ≥75 years, diabetes mellitus, hypertension, current smoking, peripheral artery disease (PAD), prior stroke, prior coronary artery bypass grafting (CABG), history of HF, and renal failure (estimated glomerular filtration rate <60 $mL.min^{-1}$). Four atherothrombotic risk classes were defined: low-risk (TRS-2P = 0/1), medium-low-risk (TRS-2P = 2), medium-high-risk (TRS-2P = 3) and high-risk (TRS-2P ≥ 4).

Environmental noise exposure
Outdoor noise levels were calculated in accordance with the European directive 2002/49/EC [7] using the environmental noise prediction Mithra-SIG software (version 3.7, https://www.geomod.fr/fr/geomatique-modelisation-3d/mithrasig/)[8]. Noise levels were calculated in front of the residential building of each patient (average noise level in front of each façade and floor), using the address at the time of the MI.
Three noises sources were considered: rail traffic, road traffic, and pedestrian streets. Equivalent continuous A-weighted sound levels were calculated considering two time periods: daily equivalent A-weighted noise level ($L_{Aeq,24h}$) and night equivalent A-weighted noise level ($L_{Aeq,night}$) from 22:00 to 6:00.

Socio-economic level
The neighbourhood socio-economic level was estimated at the IRIS scale (geographical scale of the French sub-municipal census block groups defined by the National Institute of Statistic and Economics Studies (INSEE)) using the deprivation index developed by Lalloué et al. [9,10]. The index was discretized into 3 classes: advantaged, mixed and disadvantaged IRIS.

Statistical analyses
Ordinal regressions with adjacent category models with constant coefficients were used to assess the relationship between atherothrombotic risk and noise levels. The odds ratios associated with noise exposure

were expressed for an increase of 10 dB (A). Statistical analysis was performed using R version 4.0.2 statistical software [11].

## 3 Results

Of the 1350 eligible patients, 879 patients were included in the study. The majority of patients (n = 567, 64.5%) were men. Main CV factors were smoking, hypertension and hypercholesterolemia. In the univariable analysis, the acoustical indices were positively associated with atherothrombotic risk. The OR of road-related noise and railway-related noise were 1.16 (1.02-1.32) and 1.03 (1.00-1.06), respectively. The association was only slightly changed after adjustment.

When stratified on sex, the association remained significant in men, but was no longer found in women. The OR related to transportation L24h and Ln were 1.24 (1.04-1.47) and 1.26 (1.08-1.47) for men and 1.01 (0.80-1.30) and 0.96 (0.76-1.20) for women, respectively.

## 4 Conclusions

Our results suggest for the first time an association between exposure to transport noise and atherothrombotic risk, and support the hypothesis of a specific sensitivity of men to the CV effects of chronic environmental noise exposure. Further studies, conducted on a prospective population basis, are therefore necessary to better understand this interaction of gender on the CV effects of environmental noise on health, and to adapt, if necessary, the prevention messages.

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