

ASSOCIATION BETWEEN TRANSPORTATION NOISE EXPOSURE AND HYPERTENSION RISK IN THE FRENCH E3N COHORT

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ABSTRACT

Background: Exposure to transportation noise seems to be associated with a hypertension (HTA) risk. Few studies have explored this association in Europe and even less in France in a prospective cohort. This is therefore the objective of the present study.

Methods: Transportation noise exposure was estimated from two periodic strategic noise maps at the residence of 21,515 women from the French E3N cohort, residing in the Île-de-France or Auvergne-Rhône-Alpes regions between 2000 and 2014. Lden (day-evening-night level) indicator was used for three noise sources: road, railway and aircraft. Incident HTA cases were identified using follow-up questionnaires and validated using drug reimbursement insurance databases.

Results: Over the period 2000 to 2014, 85% of women were exposed to at least one transportation noise source and at least 82% of these women were exposed to noise

levels that exceed one of the World Health Organization (WHO) guidelines.

Conclusions: A large proportion of the women from the E3N cohort who lived in Île-de-France or Auvergne-Rhône-Alpes during the period 2000-2014 were exposed to noise levels that exceeded WHO guidelines for transportation noise. Results of the study for the association between transportation noise exposure and HTA risk will be presented at the conference.

Keywords: Transportation noise, hypertension, women, epidemiology, France

1. INTRODUCTION

The World Health Organization (WHO) has recently updated guidelines for the management of environmental noise [1]. These guidelines are based on the results of epidemiological studies which have shown associations between exposure to transportation noise and cardiovascular diseases [2] including hypertension (HTA) [3].

Exposure to noise generates stress. Stress can cause an excessive release of stress hormones such as cortisol [4] or catecholamines (adrenaline, dopamine) [5]. This

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excessive release of stress hormones then leads to an increase in blood pressure and heart rate [6]. These in turn promote the development of cerebrovascular risk factors such as HTA.

Few studies in Europe and even fewer in France study the effects on health of environmental noise and several limitations have been identified in existing studies such as for example: short follow-up time, small numbers of participants.

In this context, a research project called BROUHAHA (Association between noise exposure and risk of cardio-metabolic diseases (type 2 diabetes, hypertension or cardiovascular diseases)) was set up to deepen the knowledge on the consequences of transportation noise on the health of populations residing in Île-de-France and Auvergne-Rhône-Alpes.

The present article specifically addresses the exposure of the BROUHAHA population to transportation noise and its association with the risk of HTA.

2. MATERIALS AND METHODS

2.1 Study Population

The BROUHAHA study population includes women of the E3N (Epidemiological study in women subscribed to the MGEN, a national health insurance covering mainly teachers) prospective cohort [7] who resided in Île-de-France (IdF) or Auvergne-Rhône-Alpes (AuRa) regions over the whole period from 2000 to 2014. E3N cohort involved 98,995 French women aged 40 to 65 at the time of their inclusion in 1990, who were affiliated with the MGEN. Follow-up questionnaires are sent approximately every 2 to 3 years. Since January 1, 2004, for each cohort member, the health insurance plan provided data that included all outpatient reimbursements for health expenditure.

In total, the BROUHAHA study population includes 21,515 women.

2.2 Noise exposure assessment

The noise exposure of participants was estimated in three steps:

Step 1: Addresses of the participants from the E3N follow-up questionnaires were geocoded with the BD Address[®] geocoder for ArcGIS [8].

Step 2: The exposure of participants to transportation noise was estimated at each address using the Strategic Noise Maps (SNM) elaborated by two French noise observatories (BruitParif for the IdF region and Acoucity

for the AuRA region). The SNM represents estimates of transportation noise levels obtained by modeling with average traffic and topographic data and they provide average annual noise levels [9]. The European harmonized indicator L_{den} (day-evening-night level) was used for each of the three sources of transportation noise (road, railway noise and aircraft noise). The WHO guidelines are 53, 54 and 45 dB(A) for road traffic, railway and aircraft noise respectively [1].

Step 3: The average noise exposure values accumulated over different periods for 15 years were obtained by calculating the noise level average of the annual values.

2.3 Incidence of HTA

The questionnaires sent to the women included in the E3N cohort collected information on the diagnosis of HTA. A woman was considered as a validated case of HTA if she self-reported and had at least one reimbursement of antihypertensive medication within one year, according to the MGEN medical-administrative database.

2.4 Statistical analyses

Exposition to each noise source (road, railway noise and aircraft noise) were expressed as means \pm standard-deviations (SD) for continuous variables, and as frequency and percentages for categorical variables. All analyses were performed using the SAS system, version 9.4 (SAS Institute, Cary, NC).

3. RESULTS

Table 1 shows number and percentage of women exposed to at least one noise source (road, railway noise or aircraft noise) and to each noise source in the study population in 2000, 2005, 2010 and 2014.

Table 1: Number of women exposed to noise in the study population according to L_{den} indicator (n=21,515)

Noise sources	2000	2005	2010	2014
At least one noise source	18,441 (85.7%)	18,413 (85.6%)	18,461 (85.8%)	18,431 (85.7%)
Road traffic noise	17,740 (82.5%)	17,703 (82.3%)	17,747 (82.5%)	17,718 (82.4%)
Railway noise	8,363 (38.9%)	8,316 (38.7%)	8,400 (39.0%)	8,348 (38.8%)
Aircraft noise	1,680 (7.8%)	1,639 (7.6%)	1,643 (7.6%)	1,636 (7.6%)

Table 2 shows number and percentage of women exposed to noise levels exceeding WHO thresholds among women exposed to noise.

Table 2: Number of women exposed to noise levels exceeding WHO thresholds

Noise sources	2000	2005	2010	2014
At least one threshold	16121 (87.4%)	15819 (85.9%)	15478 (83.8%)	15144 (82.2%)
Road traffic threshold	15,572 (87.8%)	15,228 (86.0%)	14,844 (83.6%)	14,470 (81.7%)
Railway threshold	2,351 (28.1%)	2,263 (27.2%)	2,182 (26.0%)	2,142 (25.7%)
Aircraft threshold	1,513 (90.1%)	1,480 (90.3%)	1,480 (90.1%)	1,464 (89.5%)

4. DISCUSSION

In total, 85% of the women in this study were exposed to at least one source of noise from 2000 to 2014. Among these women, at least 82% were exposed to a level exceeding the WHO guidelines. The average exceedance of the threshold was 9.3 ± 4.8 dB(A) for road traffic noise, 6.2 ± 4.9 dB(A) for railway noise and 6.2 ± 4.1 dB(A) for aircraft noise over 15 years (2000-2014).

These results improve the current knowledge on women exposure to different transportation noise (road traffic, railway or aircraft) in IdF and AuRA regions. Results of the study for the association between HTA risk and transportation noise exposure will be presented at the conference.

5. CONTRIBUTIONS

Conception and study design: EF, A-SE, LG-A, EC, FM, BV and GS. Project management: AH and EF. Geocoding and assessing participants' noise exposure: KG, AB, MQ, VG, CD, VJ, BV, PJ, AP-M, AG and FM. Statistical analyses: FA, CP, FM and JL.

AH and EF wrote the manuscript with critical input from all other authors who read and approved the final manuscript.

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8. CONFLICTS OF INTEREST

None declared.

9. REFERENCES

- [1] WHO. Environmental noise guidelines for the European Region. 2018. Available from: <http://www.euro.who.int/en/publications/abstracts/environmental-noise-guidelines-for-the-european-region-2018>.
- [2] Skogstad M, Johannessen HA, Tynes T, Mehlum IS, Nordby K-C, Lie A. Systematic review of the cardiovascular effects of occupational noise. OCCMED 2016 Jan;66(1):10–16.
- [3] Kourieh A, Giorgis-Allemand L, Bouaoun L, Lefèvre M, Champelovier P, Lambert J, Laumon B, Evrard A-S. Incident hypertension in relation to aircraft noise exposure: results of the DEBATS longitudinal study in France. Occup Environ Med 2022 Jan 19.
- [4] Wagner J, Cik M, Marth E, Santner BI, Gallasch E, Lackner A, Raggam RB. Feasibility of testing three salivary stress biomarkers in relation to naturalistic traffic noise exposure. International Journal of Hygiene and Environmental Health 2010 Mar;213(2):153–155.
- [5] Hammoudi N, Aoudi S, Tizi M, Larbi K, Bougherbal R. Rôle du bruit dans le développement de l'hypertension artérielle en milieu aéroportuaire. Annales de Cardiologie et d'Angéiologie 2013 Jun;62(3):166–171.
- [6] Hahad O, Prochaska JH, Daiber A, Münzel T. Environmental Noise-Induced Effects on Stress Hormones, Oxidative Stress, and Vascular Dysfunction: Key Factors in the Relationship

between Cerebrocardiovascular and Psychological Disorders. *Oxidative Medicine and Cellular Longevity* 2019 Nov 11;2019:1–13.

- [7] Clavel-Chapelon, F., the E3N Group, Van Liere, M. J., Giubout, C., Niravong, M. Y., Goulard, H., Le Corre, C., Hoang, L. A., Amoyel, J., Auquier, A., Duquesnel, E. E3N, a French cohort study on cancer risk factors. *European Journal of Cancer Prevention* 1997;6(5):473–478.
- [8] Faure E, Danjou AMN, Clavel-Chapelon F, Boutron-Ruault M-C, Dossus L, Fervers B. Accuracy of two geocoding methods for geographic information system-based exposure assessment in epidemiological studies. *Environ Health* 2017 Dec;16(1):15.
- [9] Bruitparif. Les Cartes Stratégiques de Bruit (CSB). Available from: <https://www.bruitparif.fr/les-cartes-strategiques-de-bruit-csb>