ICUH 2018, Kampala

Body Mass Index and Insomnia association with exposure to nighttime noise in the state of Geneva

Andrea Salmi[1], Jérôme Chenal[1], Idris Guessous[2,4], Stéphane Joost[1,2,3]

1 Urban and regional planning community (CEAT), School of Architecture, Civil and Environmental Engineering (ENAC), Ecole Polytechnique Fédérale de Lausanne (EPFL), Lausanne, Switzerland
2 Unit of Population Epidemiology, Division of Primary Care Medicine, Department of Community Medicine, Primary Care and Emergency Medicine, Geneva University Hospitals, Geneva, Switzerland
3 Laboratory of Geographic Information Systems (LASIG), School of Architecture, Civil and Environmental Engineering (ENAC), Ecole Polytechnique Fédérale de Lausanne (EPFL), Lausanne, Switzerland
4 Department of Ambulatory Care and Community Medicine, University of Lausanne

AIM: explore obesity and disturbed sleep in the noise exposure space: assess whether spatial dependent cases of Body Mass Index (BMI) and Self-Reported Insomnia (SRI) are associated with higher level of nighttime noise exposure, in the canton of Geneva using a large population-based cohort.

Obesity is an important public health burden and evidence is rising regarding its link with the *built environment*. In the literature, obesity is reported to be associated with higher noise exposure in half of the studies while the other half reports no association. Noise exposure is a major environmental stressor in Europe, second only to air pollution. Since insomnia is usually assessed as covariate in cardiovascular risk factors studies, and it can be caused by noise disturbance; the spatial distribution has been assessed.
Prevention in Public Health can not being confined to Health-care alone: the impact of the (Built) environment rises new interrogatives which may guide urban planning and the management of the territory to a healthier future.

DATASETS

Bus Santé study[2]: geo-referenced participants,N > 15000 in the canton of Geneva, on cardiovascular diseases, ongoing from 1993. Every year, 1000 participants are recruited in order to be representative of the demographic and distribution of the population (for age, gender and postal code).
SonBase: night-noise (7 pm to 7 am) geo-data throughout Switzerland , computed by road and rail traffic, resolution 10 m^2 [5].

PREVALENCE IN SWITZERLAND

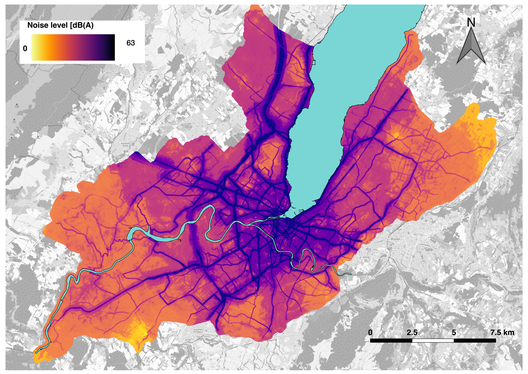
- 10% obese population: percentage doubled from 1992 to 2012[3]
- Obesity and sleep disorders may be spatially dependent[2,8]
- 13% of the population is exposed to noise levels over 50 dB(A) during the night, and 34% to 45 dB(A) (WHO recommendation)[5]
- 31.3% of the population suffers of insomnia symptoms[9]
- 22500 hospital days given by noise exposure (or 6000 years of life lost) per year[9]
- CHF 1174 million: Health cost and loss of rent in 2005 given by the noise[5]

METHODS

The analysis where performed using Python© (3.7.1) and GeoDa© (1.8.16.4) for the spatial analysis. Nighttime noise exposure is calculated from the modelled dates using the following:

$$L_{total} = 10\,log_{10}\left(10^{\frac{L_{road}}{10}} + 10^{\frac{L_{rail}}{10}}\right)\,[dB(A)]$$

Statistics of noise exposure were calculated within 25m around the place of residence of participants, the median noise level has been used in this analysis.
Obesity is easily identified through BMI (weight/hight²) above 30 (overweight above 25). Insomnia is evaluated from SRI of participants that reported “few” or “a lot” cases of insomnia.
BMI and SRI were adjusted using multivariate linear regression using multiple covariates as age, gender, median areal income, education level, smoking habits or physical activity. Normality has been obtained with Box-Cox power transformation. BMI and SRI categories were statistically compared with nighttime noise exposure (Pearson).
Local Indicators of Spatial Association (LISA[6]) where calculated using multiple spatial lags (400m, 600m, 800m), 999 permutation with a significance level p<0.05. Per each LISA class of BMI and SRI; (High-High(HH), Low-High(LH), Low-Low(LL), High-Low(HL), Not Significant(NS)) the mean nighttime noise exposure (dB(A)) has been assessed. We assed whether differences where significant among LISA cluster with ANOVA tests, and single T-test between couples of LISA clusters.



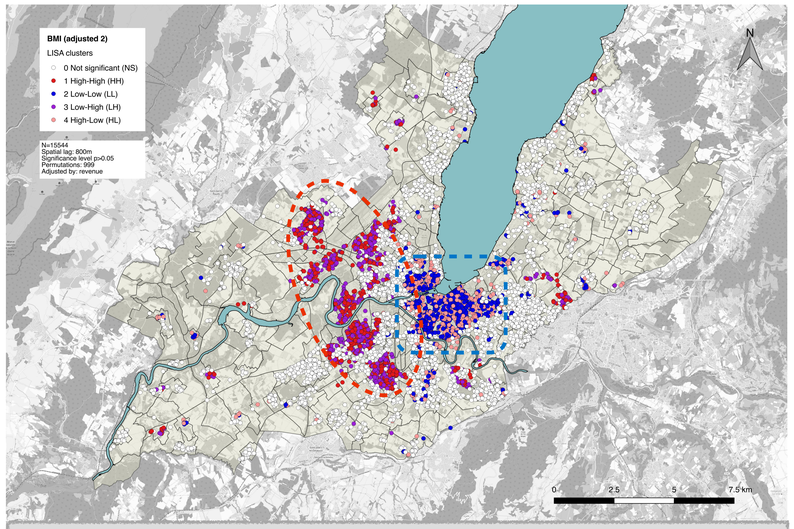
Modelled nighttime (19:00 to 7:00) noise level [dB(A)] from road and rail traffic.

RESULTS

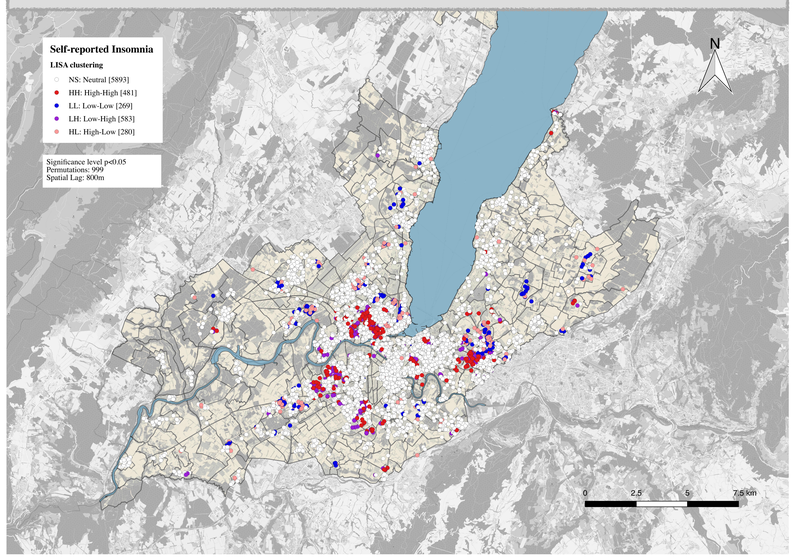
- Heterogeneous distribution: 64% and 22% o participants belong to spatial clusters (BMI and SRI respectively).
- **10.4% are obese** and 43.2% overweight.
- **48.9% reports insomnia** and 10.6% frequent insomnia.
- **28%** are exposed above **50 dB(A)** and 62% above 45 dB(A).
- Adjustments with multiple covariates produces clusters with similar location, exposures and smaller not-significant sizes.
- Obesity and Insomnia, as BMI and SRI classes, are weakly correlated.

Nighttime noise exposure is significantly different among LISA clusters, p<0.001.
Low-Low clusters of BMI cluster are characterised by higher noise level compared to the High-High (e.g. 48.47 vs 45.9 dB(A)) of mean noise level, unadjusted). An reversed association compared to the literature is observed.
Low-Low clusters of SRI are characterised by lower noise level compared to the High-High (e.g. 45.2 vs 47.74 dB(A)).
The bivariate spatial analysis BMI and SRI produces a small cluster representative of the 0.87% of the population (N=7515) characterised by 3.5 dB(A) higher noise level in HH compared to LL.

CONCLUSIONS AND OBSERVATIONS:
BMI is highly clustered and spatially segregated. SRI is weakly clustered but segregated. Association of BMI and noise pollution are weak (and reversed) and major factors may explain the BMI spatial dependency. Town center is characterised by low values of BMI and exposed to high nighttime noise levels. A better housing (and sound proofing) may explain the result, but it is usually associated with higher income: adjustment by median income does not affect the results. Insomnia HH clusters are exposed to higher noise levels (and consistent) compared to the LL clusters. Despite higher exposure to noise, the core of the town center does not show any pattern of insomnia. The SRI measure is not an official measure of Insomnia and has a low variability. Factors as sensibility to noise, habits of sleeping with open windows, location of the bedroom and sleep medicaments consumption are important variables that should complete this analysis. We do not forget that Geneva is a city classed as 8th[7] in world for quality of life: the impact of a single factor may be difficult to detect compared to other cities.



Red clusters show locations where a high BMI (or SRI below) is significantly associated with a high average noise level (**HH**), and **blue** clusters show locations where a low BMI is significantly associated with a low average noise level (**LL**). The pink and purple classes show high-low and low-high relationships respectively. White dots show sampling areas where BMI are randomly distributed and are not significant in term of spatial dependence.



REFERENCES

1. Healthy Urban Development Unit (HUDU), 2015. Healthy Urban Planning Checklist. National Health Service (NHS).
2. Guessous, I., et al., (2014). A comparison of the spatial dependence of body mass index among adults and children in a Swiss general population. Nutritional Diabetes, 4, e111.
3. Office Fédéral de la Statistique (OFS). (2014). Enquête suisse la sante 2012 : Surpoids et Obésité.
4. EEA 2007: Presenting Noise Mapping Information to the Public. A Position Paper from the European Environment Agency Working Group on the Assessment of Exposure to Noise (WG-AEN).
5. Federal Office for the Environment (FOEN), 2014. Noise pollution in Switzerland. SonBase.
6. Anselin, L., (1995). Local indicators of spatial association-Lisa. Geographic Analysis 27, 93-115.
7. Mercer, (2017). Quality of Living Rankings.
8. Joost S, et al. (2018) Spatial clusters of daytime sleepiness and association with nighttime noise levels in a Swiss general population (GeoHypnoLaus). *International Journal of Hygiene and Environmental Health* 221(6): 951–957.

CONTACTS:
Andrea Salmi: andrea.salmi@epfl.com;
Jérôme Chenal:jerome.chenal@epfl.ch;
Idris Guessous: idris.Guessous@hcuge.ch;
Stéphane Joost: stephane.joost@epfl.ch