Long-term exposure to road, railway, and aircraft noise levels and their association with incidence of obesity and obesity parameters

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ABSTRACT

The contribution of different transportation noise sources to obesity and its subphenotypes remains understudied. We evaluated the associations of long-term exposure to road, railway and aircraft noise with measures of general, central obesity and incidence of overweight and obesity in an adult Swiss cohort using cross-sectional and longitudinal designs.

We assessed 4678 SAPALDIA cohort participants visited in 2001 and 2010/2011. We measured body mass index (BMI, kilograms/metre^2), waist circumference (WC, centimetres), and Kyle body Fat Index (BF, %) and derived incidence by severity: overweight only (iOW, BMI: 25-29.9) or obesity (iOB, BMI: ≥ 30). We assigned annual average aircraft, railway, and road traffic noise levels at the most exposed dwelling façade ($Lden_{source}$, dB) using Swiss noise models for 2001 and 2011. Associations were evaluated with multivariable linear and multinomial regression models.

We observed positive associations between $Lden_{road}$ and BMI, WC, %BF and iOB. $Lden_{rail}$ and $Lden_{air}$ were related to iOW. Associations were independent of the other noise sources and air pollution.

Long-term exposure to road traffic noise may be more obesogenic than railway or aircraft noise.

INTRODUCTION

Long-term exposure to transportation noise has been associated with cardiovascular disease and hypertension [1–3]. It is suggested that noise may impact health through stress-related reactions, sleep impairment, among others, which may lead to chronic homeostatic dysregulations, cardiovascular disease but also other metabolic disorders [4]. However, very little is known about the contribution of different transportation noise sources on metabolic endpoints such as obesity and its subphenotypes.

We evaluated the associations of residential outdoor levels of road, railway and aircraft noise with measures of general, central obesity and incidence of overweight and obesity in an adult Swiss cohort using cross-sectional and longitudinal designs.

METHODOLOGY

We assessed a total of 4678 adults from the SAPALDIA cohort (Study on Air Pollution and Lung and Heart Diseases) who attended both the second (S2, year 2001) and third examinations (S3, year 2010/2011). Participants lived in environmentally diverse areas in Switzerland. Personal interview-administered questionnaires were performed to collect information on age, sex, socio-economic status, and lifestyle.

We measured body mass index (BMI, kilograms/metre^2) at both examinations. At S3 we also measured waist circumference (WC, centimetres) and Kyle Body Fat Index (BF, %). Furthermore, between the two examinations, we derived a combined 3-category incidence outcome to assess the degree of obesity and its clinical relevance: reference (BMI at S2 and S3 < 25), incidence of overweight (BMI at S3 between 25 and 29.9) or obesity (BMI at S3 ≥ 30).

We geocoded participants' addresses, assigned A-weighted day-, evening-, and night-time noise levels at the most exposed dwelling façade and used them to calculate the day-evening-night noise indicator ($Lden_{source}$, in dB) for this study. Noise estimates were derived from current source-specific Swiss noise models for years 2001 and 2011 [5], improved for the SiRENE (Short and Long Term Effects of Transportation Noise Exposure) project. Nitrogen dioxide levels (µg/m^3) for years 2001 and 2010/2011 were derived by land-use regression models and also assigned at residential level.

We performed cross-sectional analyses at S3 because of the availability of additional obesity markers. At S3 we assessed associations between transportation noise levels and BMI, WC and BF using multivariable linear mixed regression models, adjusting for several covariates including age, sex, education, smoking, diet, alcohol intake, physical activity, nitrogen dioxide and a random intercept by study area. In longitudinal analyses between S2 and S3, we assessed the association between transportation noise levels and incidence of overweight or obesity and restricted the analyses to non-movers, to control for mobility between visits. We used multinomial logistic regression for the 3-category outcome and adjusted for several covariates at S2, similarly to cross-sectional analyses.

RESULTS

Participants had an average age of 59 years, 50% were women, and the incidence of obesity was 7%. The median (IQR, interquartile range) of BMI at S3 was 26 (6) kg/m^2 and medians (IQR) of $Lden_{road}$, $Lden_{rail}$, and $Lden_{air}$ were respectively: 54 (11), 30 (8), 33 (8) dB.

In longitudinal analyses in non-movers, we observed statistically non-significant associations of $Lden_{rail}$ and $Lden_{air}$ with incidence of overweight (BMI 25-29.9), but not with obesity (See Figure 1). $Lden_{road}$ was significantly associated with incidence of obesity. In cross-sectional analyses, we also observed positive significant associations between $Lden_{road}$ and BMI, WC, %BF (data not shown).

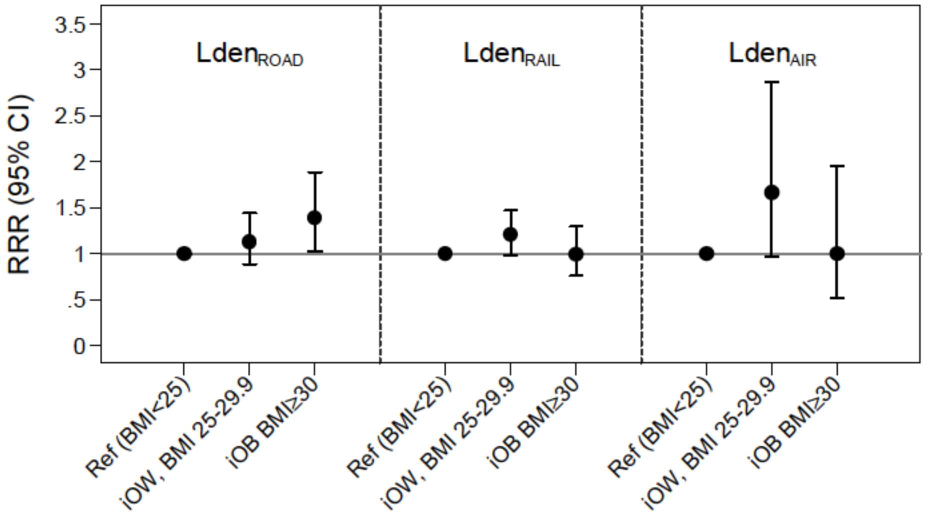

Figure 1: Adjusted relative risk ratios (RRR) and 95% confidence intervals (95%CI) for the association between transportation noise levels and incidence of overweight only (iOW) or obesity (iOB), (reference: BMI < 25) per 10 dB, including all source-specific noise sources in the same adjusted model.

DISCUSSION AND CONCLUSIONS

In this study, we evaluated the association between road, railway, and aircraft transportation noise levels, the most prevalent environmental noise sources, and markers of general, central obesity and incidence of obesity. This comprehensive evaluation adds to the scant evidence available on the association between noise and obesity, which is mostly cross-sectional, focussed on one or two of the noise sources or sometimes based on self-reported measurements [6–10].

This preliminary results suggest that long-term exposure to road traffic noise might be more obesogenic than railway or aircraft noise levels. However, this finding might be also influenced by the greater exposure to road than railway or aircraft noise in this sample. Road traffic noise may also contribute to central obesity and to higher percentage of body fat.

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