Traffic noise and markers of obesity – a population based study

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ABSTRACT

Noise has been found to be associated with endocrine changes and cardiovascular disease. Increased cortisol level and chronic sleep problems due to noise may increase the risk of obesity. The project aims to examine the association between exposure to road traffic noise and markers of obesity.

We used data from a population based study in Oslo conducted in 2000-01 (HUBRO). Only participants of western origin were included in the present analyses (N=15 203). Measurements of weight, height, waist and hip were used to define body mass index (BMI), waist circumference (WC) and waist-hip ratio (WHR). Modelled levels of road traffic noise (L_{den}) at the most exposed façade were assigned to each participant's home address. Regression models including potential confounders were used to analyze the associations between noise and obesity markers. The analyses were done separately for men and women.

We found no associations between road traffic noise and obesity markers, neither in women nor in men. However, in the sub-population of highly noise sensitive women (n=1 108) we found that a 10 dB increase in noise was associated with a slope of 1.014 (95% confidence interval (CI): 1.004, 1.023) for WC, and similar findings for BMI and WHR.

In an adult urban population from Oslo, road traffic noise was positively associated with markers of obesity only among the highly noise sensitive women.

INTRODUCTION

Obesity is a global challenge to health, and one of the main causes of death worldwide (WHO 2013). It is one of the main risk factors for several important non-communicable diseases like diabetes, cardiovascular disease (CVD) and cancer. In a large sample of the European population, both general adiposity, measured by body mass index (BMI), and abdominal adiposity, expressed by waist circumference (WC) and waist-hip ratio (WHR), were found to be associated with increased death rate (Pischon et al. 2008).

Several studies have been undertaken to investigate the association between traffic noise and CVD and positive associations are found (Babisch et al. 2005; Selander et al. 2009; Sørensen et al. 2011; Sørensen et al. 2012). With the exception of hypertension, very few studies have examined the association between noise and *risk factors* for CVD. Perceived stress as well as sleep disturbances due to noise

may affect eating behaviour and metabolism negatively, which in the long run may contribute to weight gain.

In this study we aimed at examining the association between road traffic noise and markers of general and abdominal obesity. Furthermore, we wanted to assess the modifying effects of noise sensitivity.

METHODS

The population-based HUBRO study was conducted in 2000-2001, with 45.9% participation rate (N=18 770) (Søgaard et al. 2004). All participants underwent a physical examination including measurement of anthropometric parameters. Body weight (in kg) and height (in cm) was measured with electronic Height and Weight Scale with the participants wearing light clothing without shoes. WC was measured at the umbilicus to the nearest cm with the subject standing and breathing normally. Hip circumference was measured as the maximum circumference around the buttocks. BMI was calculated by weight (kg) divided by height (m) squared. To represent abdominal obesity we used WC (cm) and WHR assessed by WC (cm) divided by hip circumference (cm).

Using the national identification number, Statistics Norway provided the residential address at inclusion with corresponding geographical coordinates for each participant (N=17 183). Thereby, traffic noise could be linked to each participant's home address (N=16 752). Noise from road and rail traffic (railway, subway and tram) was calculated using the Nordic prediction method for road traffic noise (Bendtsen 1999; Jonasson and Lyse-Nielsen 1996) and for rail noise (Ringheim 1996; Ringheim and Lyse-Nielsen 1996) and the acoustical software program CadnaA, version 3.6 (DataKustik 2004). In addition to digitalized terrain data, ground type, buildings and noise screens in 3D, other input data to CadnaA were road traffic data (traffic counts, percentages of heavy vehicles, speed limits and diurnal distributions) from the Norwegian Public Roads Administration and the City of Oslo, and rail traffic data (frequencies, train types, train lengths and speed limits) from the National Railway Administration and from "Kollektivtransportproduksjon" (Oslo Municipality 2007). Residential traffic noise levels were assessed for all participants as L_{den} outside of the most exposed façade according to the European Environmental Noise Directive (European Commission 2002). L_{den} levels below 40 dB were set to 40 dB.

We included only participants of western origin (N=15 203). The participants reporting to be pregnant were excluded (n=118).

To examine the relationship between long-term exposure to road traffic noise and obesity markers, we used multiple linear regression analysis. The analyses were performed separately for each gender with logarithmic transformation of the outcomes. P-values <0.05 were considered statistically significant. We used Directed Acyclic Graph (DAG) (Shrier and Platt 2008) to determine which covariates to be included in the model of the relationship between road traffic noise and obesity markers. These covariates were age, recommended food score, non- recommended food score, alcohol intake, education, mental health, employment status, physical activity, sleep disturbances and smoking for males. In addition, we adjusted for railway noise. For women we also adjusted for use of hormonal replacement therapy and marital status.

The study was approved by the Regional Committee for Medical and Health Research Ethics in Norway. Written informed consent was obtained from the study participants.

RESULTS

We found no associations between road traffic noise and obesity markers, neither in women nor men. The interaction between noise and noise sensitivity was statistically significant in women (p=0.008 for BMI, p=0.0009 for WC and p=0.081 for WHR), but not in men. Figure 1 shows the associations between road traffic noise (L_{den}) and WC within each category of noise sensitivity, separately for women and men. Road traffic noise was positively associated with WC and BMI in the population of highly noise sensitive women (10 dB increase in noise was associated with a slope of 1.014 (95% confidence interval (CI): 1.004, 1.023) for WC and 1.017 (95% CI: 1.006, 1.029) for BMI). However, in highly noise sensitive men the associations were not statistically significant.

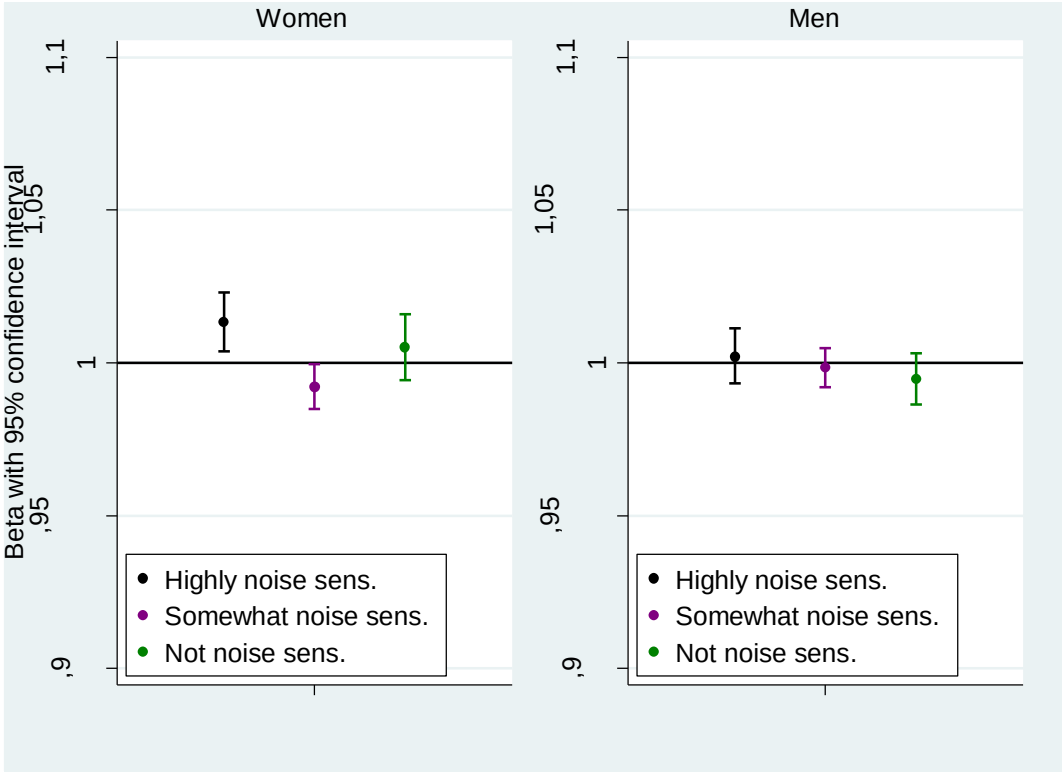

Figure 1: Slope with 95 % CI of the associations between an increase of 10 dB in road traffic noise (L_{den}) and WC within each strata of noise sensitivity in women (left) and men (right). The associations are adjusted for age, recommended food score, non-recommended food score, alcohol intake, education, mental health, employment status, physical activity, sleep disturbances, smoking status and railway noise for males, with adjustment also for use of hormonal replacement therapy and marital status for women.

CONCLUSIONS

In a large study of an urban population in Oslo we found no support for an association of traffic noise with obesity in the total population. However, among women we found a statistically significant interaction between noise exposure and noise sensitivity, suggesting that noise sensitivity has an effect modifying role in the association between noise and risk of obesity in women. Road traffic noise was

statistically significantly associated with both general and abdominal obesity markers among highly noise sensitive women. Very few studies have examined the association between noise and obesity, and further research is needed to increase the knowledge of the metabolic effects of noise.

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