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NORAH - field study: The Effects of chronic exposure to traffic noise (aircraft, railway and road) on the self-measured blood pressure

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ABSTRACT

Based on the concept that noise may trigger repeatedly unavoidable autonomous physiological reactions, which each can cause an increase of blood pressure the study examined the effects of chronic traffic noise exposure on self-measured blood pressure (SBPM).

Study region includes areas near Frankfurt airport within the 40 dB(A) equivalent continuous sound level contours of aircraft noise for day and night-time, targeting on voluntary adults residing in the defined region. Telemedical blood pressure devices handed to study participants were issued for SBPM. After successful training, participants performed 2 daily measurements over a 21-day period. Additionally, a questionnaire with reference to current health, medications, lifestyle, individual factors, as well as noise sensitivity was completed.

Data analyses included n=844 (58.4% w; 41.6% m). BP values (mean of morning readings [mmHg]) were systolic/diastolic 118.1/72.3 in women and 125.4/78.8 in men. Multiple linear regression model with main outcome systolic BP including age, gender, socio-economic status, pack years, and physical activity as influencing variables result small positive effect estimators without statistical significance for all investigated noise parameters ($L_{pA,eq,18\text{-}06h}$ aircraft, railway and road traffic).

The results of our study are overall comparable to previously conducted scientific research concerning traffic noise and continuous BP values.

Keywords: NORAH, Transportation Noise, self-measured blood pressure (SBPM), telemedical blood pressure device, health, field study. I-INCE: 62.5, 66.2

1. INTRODUCTION

The module “Blood Pressure Monitoring” is part of the research project NORAH (noise-related annoyance, cognition, and health) and aimed at investigating the effects of chronic noise exposure on blood pressure in adults. It was conducted in the period from 2012 to 2014 in the Rhine-Main- Area near Frankfurt (FRA) airport. Linked references to the detailed reports of the entire project modules are given below (1-7), additional information can be found at

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The study design took into consideration previous studies and meta-analyses on effects of noise on health, and in particular on the cardio-vascular system (8,9,10). It is based on the model that noise on a regular basis acts as a stressor on the body and thus triggers repeatedly unavoidable autonomous physiological reactions, which each can cause an increase of the blood pressure. The present study was designed to examine the effects of chronic noise from different traffic sources as a stressor on blood pressure as a measurable physical response. It did not aim at hypertension as a main outcome, however, this parameter was investigated in secondary analyses and results are presented elsewhere (see INTERNOISE2016/298 (13))

2. METHODS

2.1 Recruitment

Study region included areas near Frankfurt airport within the 40 dB(A) equivalent continuous sound level contours of aircraft noise for day and night-time. Voluntary adults of both genders residing at the time of the investigations (2012-2014) in the defined area were the target group.

Recruitment was done among participants of NORAH module 1, excluding those who reported diagnosed hypertension at this state of the project already (n=1824).

2.2 Exposure

Noise exposure (aircraft, railway and road traffic noise) was assigned to the respective addresses of the participants of the investigation. The equivalent continuous sound pressure level $L_{pA,eq,18\text{-}06h}$, (combined evening night time slice, outside) was primarily set as exposure variable for each investigated traffic noise source. To represent chronic exposure the $L_{pA,eq,18\text{-}06h}$ was calculated over a duration of 12 months ahead of participants' individual start of blood pressure measurements.

2.3 Procedure

Telemedical blood pressure devices handed to study participants were issued for the self-blood-pressure-measurement (SBPM). All participants were trained in the self-blood-pressure-measurement before they were allowed to perform SBPM each morning and evening during the following period of 21 days. Ahead of the SBPM-coaching an additional questionnaire with reference to current health, lifestyle, individual factors, as well as noise sensitivity (NoiSeQ-R) was completed. The measurements were done in two sections: observation period 1 (BP1) from July 2012 to June 2013, observation period 2 (BP2) took place from July 2013 to June 2014.

2.4 Data analyses

Data analyses of the main evaluation presented here included participants from BP1 only due to methodological reasons. For analyses of the resulting study group of n=844 small effects of ß = 0.10 have a test power of 80% respectively 95% for ß=0.13.

We applied analysis models (multiple linear regressions) for the continuous main (systolic BP, mean of morning readings [mmHg]) and secondary targets (diastolic BP, heart rate, amplitude) including fixed factors (age, gender, socio-economic status) in a base model. Additional predictor variables (smoking, physical activity, waist-to-hip ratio) were included based on their statistical effect size on each model separately for each source of exposure.

Additionally, sensitivity analyses were conducted for gender, period of residence, the noise sensitivity and the occurrence of hypertension (with and without antihypertensive medication).

3. RESULTS

3.1 Descriptive Data

Data analyses included n=844 (58.4% w; 41.6% m) in total. Blood pressure values (mean of morning readings [mmHg]) were systolic/ diastolic 118.1/72.3 in women and 125.4/78.8 in men. Descriptive analyses show, that reliable blood pressure measurements as well as the questionnaire and exposure data is overall completed at a very high level. The evaluated study group was a comparatively healthy sample of the population, thus can be used to answer the scientific issue, including the extensive collected confounder variables into the analysis.

Figure 1 shows boxplots of systolic blood pressure values over categories for aircraft sound level in

5dB-level classes. Largest group were those exposed to $L_{pA,eq,18\text{-}06h\ (aircraft)}$ = 50.1-55.0 dB (n=232). Sound pressure levels for railway and road traffic were lower, most participants were exposed to $L_{pA,eq,18\text{-}06h\ (railway)}$ = 45.1-50.0 dB (n=227) and $L_{pA,eq,18\text{-}06h\ (road\ traffic)}$ = 40.1-45.0 dB (n=231). These first explorative approaches did not indicate elevation of blood pressure due to higher sound pressure levels due to equal distributions over the sound level classes.

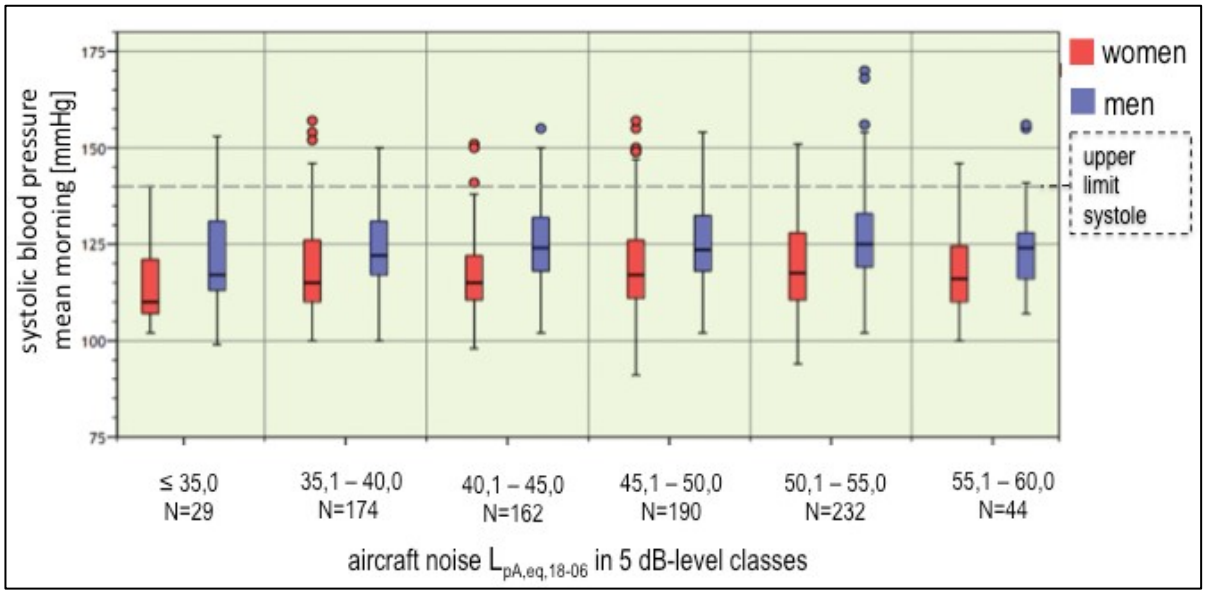

Figure 1 – boxplots for systolic blood pressure (mean of morning readings) over 5 dB level categories of aircraft sound level $L_{pA,eq,18\text{-}06}$ (© Justus-Liebig-Universität Gießen)

3.2 Results of Multiple Linear Regression

Figure 2 shows the main results of our study: risk estimates *b* with 95%-confidence intervals of the enhanced multiple linear regression models for the main (systolic blood pressure) and secondary endpoint variables (diastolic blood pressure, hear rate and amplitude).

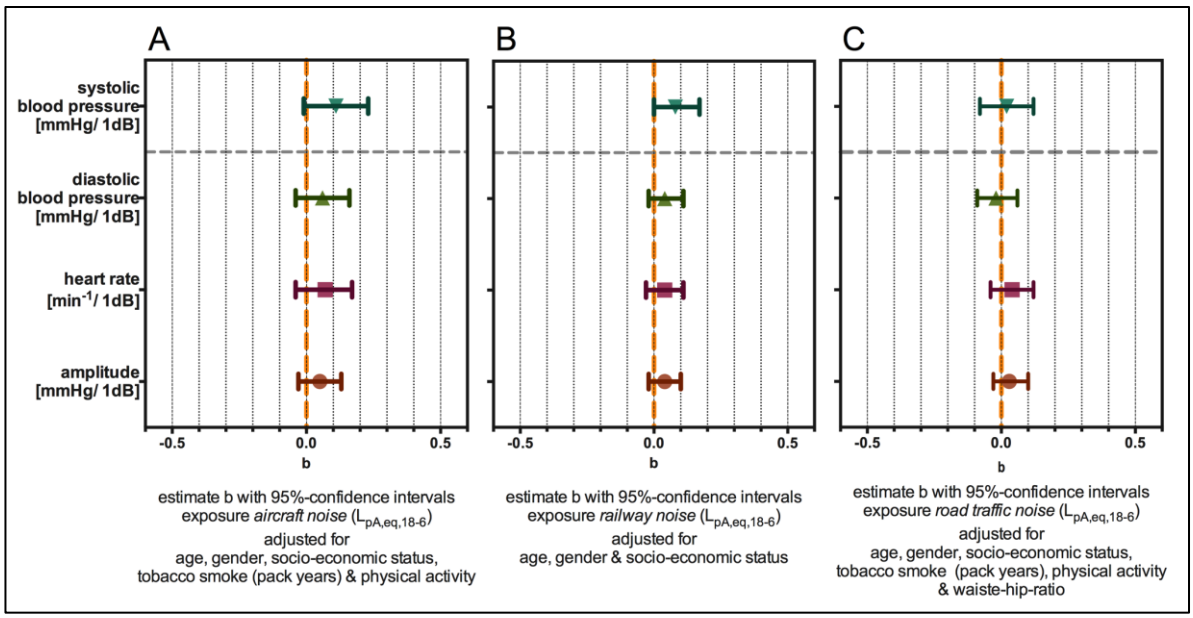

Figure 2 – results of multiple linear regression analyses for the three traffic noise exposures (aircraft (A), railroad (B), road (C)) studied and the outcome variables of the NORAH blood pressure study (© Justus-Liebig-Universität Gießen)

In total, the associations between the studied traffic noise exposure and the blood pressure values have turned out to be weak. The analyses for the association between the extent of noise from air, railway and road traffic in the period 18-06h and the endpoints mean systolic and mean diastolic blood pressure, heart rate, blood pressure and amplitude resulted quantitatively small effect estimators, which do not achieve statistical significance.

4. SUMMARY

Multiple linear regression models with main outcome systolic blood pressure (n=844) including age, gender, socio-economic status, pack years, and physical activity as influencing variables result small positive effect estimators without statistical significance for all investigated noise parameters ($L_{pA,eq,18\text{-}06h}$ aircraft, railway and road traffic).

Information on vulnerable groups is given in sensitivity analyses (data not shown, see Eikmann et al. 2015, NORAH study report, 1). It becomes apparent that in men, in hypertensive (with medication rather than without) or in persons with a period of residence less than 14 years, the associations between noise and blood pressure values tend to be stronger. Also belonging to groups with a medium noise sensitivity (NoiSEQ-R >1 to 2) or aged older than 40 years had an influence on the resulting estimators.

The results of our study – small positive effect estimators without statistical significance – are overall comparable to previously conducted scientific research concerning air traffic noise (e.g., Huang et al. 2015 (11)) and railway noise (e.g. Dratva et al. 2012 (12)).

New scientific questions that have been emerged in the course of the study, suggest a need for further research specifically focused on the evaluation of potential vulnerable groups, as well as analyses, that take into account of the data of other NORAH modules (annoyance & life quality as well as sleep study).

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