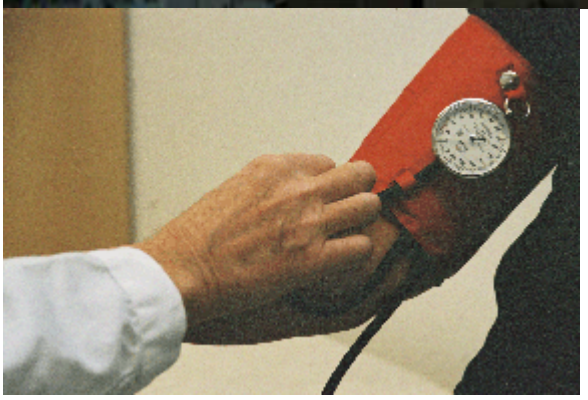
HYENA

HYpertension and Exposure to Noise near Airports

The European Commission
Community Research
Quality of Life
and Management of Living Resources

Information for policy makers



Website: www.hyena.eu.com

Background and objectives

The number of aircraft movements in Europe is increasing at a rapid rate, recent forecasts by International Air Transport Association (IATA) predicting an average annual growth of 4.3% until 2015. As a consequence pollution from noise and aircraft exhaust emissions as well as from the associated road traffic near the airports increases. An increasing number of people live near major airports and are exposed to and disturbed by noise and air pollution from aircraft and airport associated road traffic. Raised BP (hypertension) is one of the most important risk factors for several chronic diseases, ranking alongside tobacco in estimates of the world-wide attributable burden of mortality. It is a major risk factor for coronary heart disease and the major risk factor for stroke. Recent studies have indicated that noise exposure may cause hypertension at noise levels already experienced by a large number of Europeans living near major airports, but existing evidence is far from conclusive.

The overall objective of the HYENA project has been to assess the impacts on cardiovascular health in adults (primarily reflected by high blood pressure) of noise generated by aircraft and road traffic near airports. The project aimed to identify and quantify noise exposure in individuals, relating the exposure to the prevalence of high blood pressure primarily but also myocardial infarction.

The specific objectives were

- To analyse the relationships between long-term exposure to airport related noise and high blood pressure; for aircraft noise, road traffic noise and for combinations of aircraft and road-traffic noise in different populations in six countries across Europe, (Germany, Greece, Italy, the Netherlands, Sweden and the United Kingdom);
- To evaluate the combined effects of traffic related air pollution (NO2, PM) on noise associated cardiovascular risk factors and cardiovascular disease (e.g. high blood pressure, ischemic heart disease (IHD)) at selected major European airports;
- To analyse the difference in blood pressure resulting from different noise exposure patterns (day and night time exposures; in particular, acute effects

related to night time exposure), for aircraft noise at selected major European airports;

- To assess the possible modifying effects by annoyance and sleep disturbances due to road and aircraft noise, on blood pressure;
- To analyse the impact of aircraft and road traffic noise on stress hormone levels;
- To analyse the effect of noise exposure on high blood pressure in subgroups (in particular gender differences) of the population; for aircraft and road traffic noise;
- To provide scientific basis and support for guidelines for a European policy on noise abatement taking advantage of the cross-border environmental diversity of six European countries.

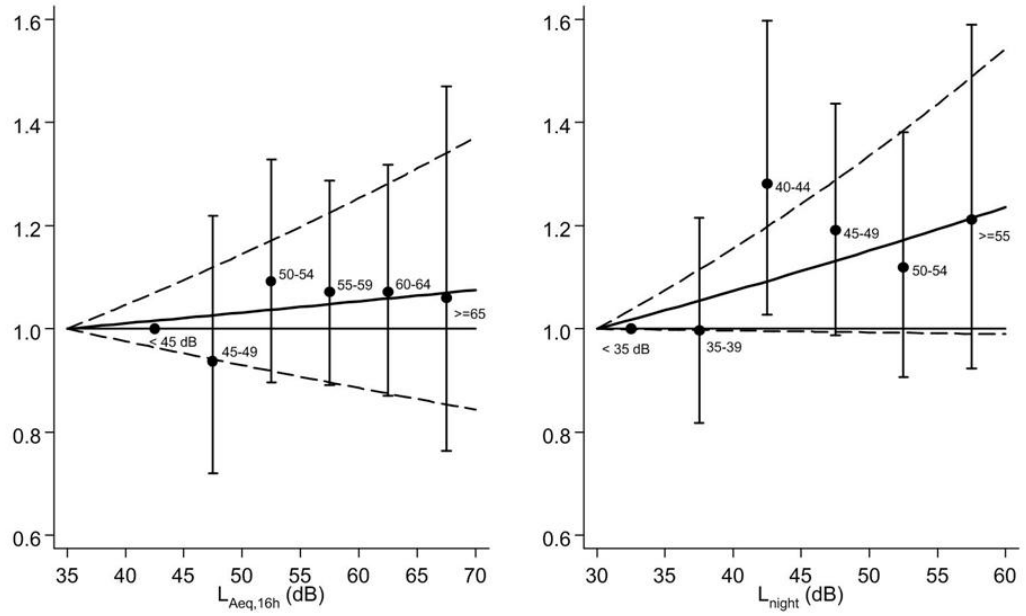
Study methods

We included men and women between 45 and 70 years of age, who had lived at least five years near any of the study airports (London Heathrow, Berlin Tegel, Amsterdam Schiphol, Stockholm Arlanda and Bromma, Athens International Airport Eleftherios Venizelos and Milano Malpensa). The final study population consisted of 5,111 persons (2,535 men and 2,576 women) distributed over a wide range of exposure to aircraft and road traffic noise. Data on health (history of hypertension and cardiovascular disease in particular), life-style factors (diet, smoking, alcohol intake and exercise), work, exposure modifying factors (such as sound insulation and window opening habits) and annoyance were collected via questionnaire at home visits. Blood pressure, height and weight were measured, and 519 participants delivered saliva samples for stress hormone analyses (cortisol). Ambulatory blood pressure was measured in 148 subjects in four participating centres (Greece, Italy, Sweden and the UK) in conjunction with continuous measurements of night-time indoor noise levels.

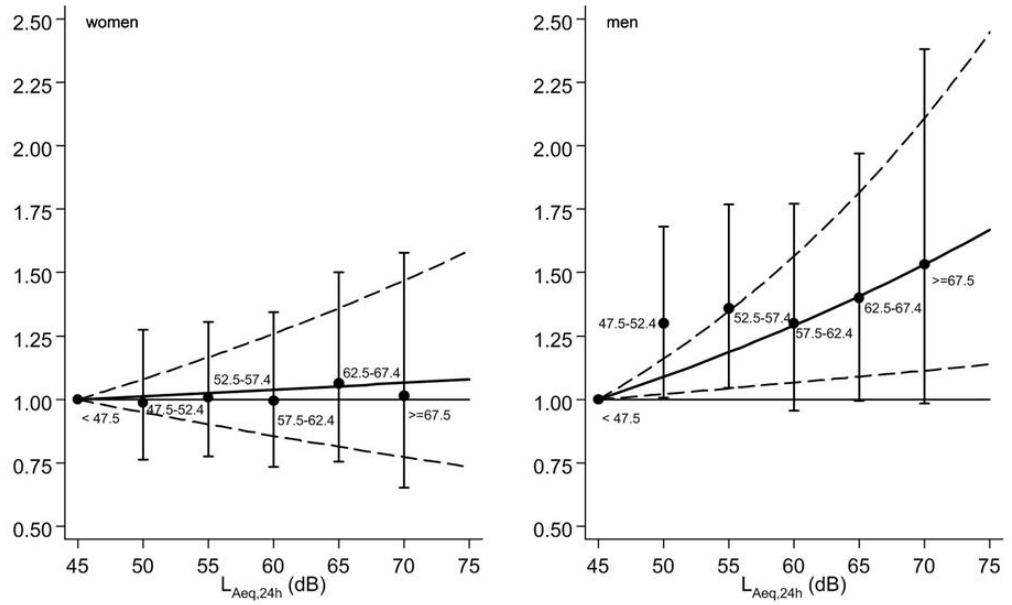
Results

There were statistically significant relationships between exposure to road traffic noise and risk of hypertension in men (but not in women), and a significant relationship for night time aircraft noise exposure regardless of gender.

The figure below shows the odds ratios (relative risks) for hypertension in relation to aircraft noise during the day ($L_{Aeq,16h}$) and during the night (L_{night}). As can be seen in the figure, a rise in odds ratio with increasing exposure is indicated primarily for night-time noise. There were no differences in risk between men and women.



The figure below shows the odds ratios (relative risks) for hypertension in men and women in relation to daily average road traffic noise exposure ($L_{Aeq,24h}$). There was an increase in risk for men related to increasing exposure, but no such trend was found for women. The difference in trend between genders is statistically significant.



The table below shows the odds ratios (relative risks) for hypertension related to aircraft and road traffic noise using continuous variables after adjustment for the other noise exposure indicators, odds ratios showing the risk per 10 dB increase in noise exposure. The trends for night-time exposure to aircraft and average 24h exposure to road traffic were both statistically significant whereas 16h day-time average aircraft noise exposure was not.

Variable	*OR*	*95% CI*	
L_{Aeq16h} aircraft	0.928	0.829	1.038
L_{night} aircraft	1.141	1.012	1.286
$L_{aeq,24h}$ road traffic	1.097	1.003	1.201

There were no significant differences in effect between exposure to noise from aircraft and road traffic, although the odds ratio for night-time aircraft noise was somewhat higher than the odds ratio for road traffic noise. It should be noted that all airports but two (Bromma in Sweden and Berlin-Tegel) allow night-flights, although some restrictions are in place. However, given the national definitions of L_{night} (which are in accordance with the European Environmental Noise Directive), it is clear that there is substantial night-time exposure in all participating countries, particularly, in the "shoulder hours" in the late evening and early morning. The risk of hypertension related to night-time noise exposure tended to be more pronounced than for daytime aircraft noise exposure.

There were no differences between countries in risks related to aircraft noise, but there were some differences in relation to road traffic noise, Germany and Sweden having higher risks and Greece a lower risk than the other countries.

A second study objective was to analyse risk of myocardial infarction in relation to noise exposure, aiming to account for traffic related air pollution. We found no statistically significant excess risks for any of the noise indicators.

A third aim was to assess the effects of noise exposure on stress hormone levels. The main finding was a significant increase in cortisol levels in the morning for women exposed to aircraft noise. No comparable association was found in men. We did not find any consistent effect by road traffic noise on morning saliva cortisol levels. This may suggest that the effect on blood pressure by road traffic noise is mediated by pathways other than those manifested in increased saliva cortisol levels. However, a less powerful design in terms of exposure contrast for assessment of road traffic effects than for aircraft noise effects on saliva cortisol could also contribute.

We also aimed to assess annoyance due to aircraft related noise exposure. The highest mean annoyance scores due to aircraft noise were found in Greece and the UK, whereas most highly annoyed subjects due to road traffic noise were found in Italy, Germany and the UK. Annoyance ratings due to aircraft noise were much higher in Greece and Italy than in the other countries. This may be due to the fact

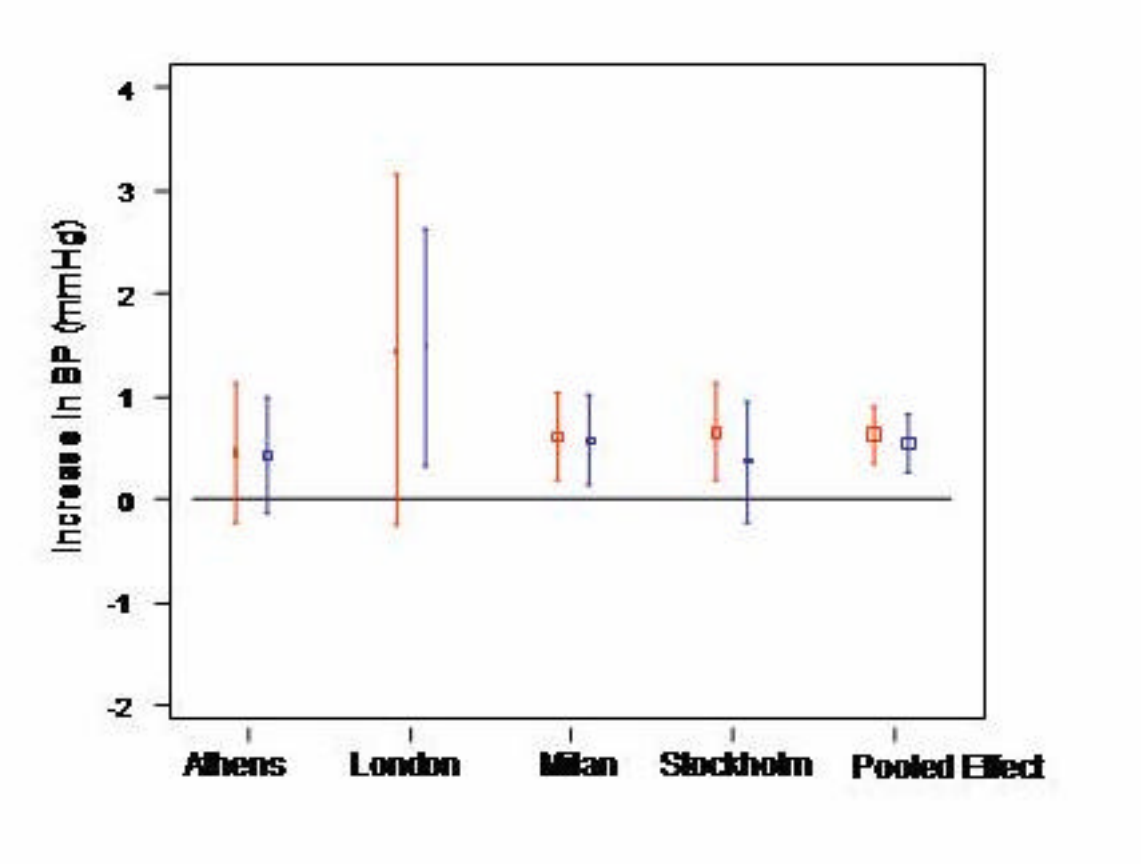
that both airports were only a few years in operation and steady-state conditions may not yet have been reached.

When associations between noise level and annoyance were calculated excluding these countries, the results for road traffic noise were very similar, but for aircraft noise the HYENA annoyance curves were closer to the relationship for annoyance recommended by the Commission expert group on health and socio-economic aspects (WG HSEA)[1]. Our data confirm the results of other studies that have suggested that people's perception towards aircraft noise has changed over the years (subjects are more annoyed).

For aircraft noise as well as annoyance due to aircraft noise, we found associations for self-reported doctor diagnosed hypertension and anti-hypertensive medication suggesting that both objective noise exposure (sound level) and subjective noise exposure (annoyance) are associated with prevalence of high blood pressure. However, we cannot exclude that subjects with doctor diagnosed and treated high blood pressure may be more annoyed by noise.

One further aim of our study was to assess acute effects on blood pressure in relation to night-time noise events. The measured noise during the study night (15 and one minutes before the BP measurement) was associated with higher blood pressure in all countries. The figure below shows the country-specific and pooled effect estimates of a 5dB(A) increment in the equivalent noise level of 15 minutes (red) and 1 minute (blue) before BP measurement on diastolic BP.

[1] See *http://ec.europa.eu/environment/noise/pdf/noise_expert_network.pdf*



In summary, effects of noise exposure on elevated subsequent blood pressure measurements were clearly shown. The effect size of the noise level appeared to be independent of the noise source.

Conclusions

In conclusion, the HYENA study supports previous studies that have suggested an effect of long term road traffic noise on blood pressure. In particular, the prevalence of hypertension increases with increasing noise exposure. Our findings also indicate an effect of night-time aircraft noise on hypertension. We found acute effects on blood pressure related to night time noise. The effects of aircraft noise on blood pressure were partly supported by findings of increased morning cortisol levels in women, whereas no such effects were found in men or for road traffic noise. Our study indicates that greater proportions of highly annoyed people are found at aircraft noise levels than previously assumed in European Communities. Also, the percentage of highly annoyed people can be up to 15% at levels below 55 dB Lden. As a consequence, EC member states that strictly apply the EC Noise Directive recommendations for noise mapping, will underestimate the number of people highly annoyed by aircraft noise near airports.