Night-time aircraft noise leads to increased prescription volumes of anti-hypertensive and cardiovascular drugs – the Cologne-Bonn Airport Study*, **

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Introduction

Environmental noise has been implicated as risk factor for arterial hypertension since many years. One of the first studies to draw attention to environmental noise at the workplace was that of Graff and co-authors (1968), who demonstrated in a cohort of workers exposed to a high noise load an increased incidence of hypertension. Traffic noise is an established risk factor for the development of arterial hypertension, as the authors of several meta-analyses and scientific reviews have demonstrated (Babisch 2006; van Kempen et al. 2002; Stansfeld and Matheson 2003). Rather few studies have shown that aircraft noise might have a similar impact on risk of hypertension (Franssen et al. 2004; Knipschild 1977a, b; Rosenlund et al. 2001). In these studies hypertension in population survey samples was ascertained by self-reported hypertension, questions on recent intake of antihypertensive drugs or analyses of prescriptions in pharmacies. The use of cardiovascular drugs has been investigated in some of these studies (Franssen et al. 2004; Knipschild 1977b). The investigators of the RANCH Study analyzed the impact of day-time aircraft noise on blood pressure in children in the United Kingdom and in the Netherlands and found a quantitative correlation between intensity of noise and both systolic and diastolic blood pressure (Franssen et al. 2004). The most recent research project – the HYENA Study - investigated the prevalence of arterial hypertension in populations around six major European airports by standardized direct measurement of blood pressure in over 5.000 adults (Jarup et al. 2008). An increase of night-time aircraft noise of 10 dB(A) above 30 dB(A) increased the prevalence of hypertension by 14.1%, whereas day-time aircraft noise had no effect on hypertension. An identical increase of 24-hour road traffic noise led to an increase of hypertension of 9.7%.

The Cologne-Bonn Airport is a major German airport with unlimited night-time flights. In 2004 there were more than 150.000 aircraft movements. Night-time air traffic consisted mainly of air cargo traffic, which was in-bound mostly between 11 p.m. and 1 a.m. and outbound between 3 and 5 a.m., whereas charter flights comprised only a minor part of night-time flights. Frequent complaints from aircraft noise-affected communities in immediate vicinity of the airport initiated the design of an epidemiologic study which was conducted between October 2005 and November 2006. The design implemented both individualized traffic noise data and individual data from eight major statutory sickness funds.

Material and methods

Study region and study population: The city of Cologne and two counties, adjacent to the Cologne-Bonn Airport (Rhein-Sieg-Kreis, Rheinisch-Bergischer Kreis) with a population of 1.860 million were defined as study region. 8 statutory sickness funds contributed data on 1.032 million persons with residence within the study region (= 55.5% of the total population). Data provided on each insured person comprised age, gender, time period of insurance, data on all outpatient prescriptions.

Noise exposure data: From all individual flight data of 2004 six months with highest flight density were extracted. Leq (Q=3) were calculated, using AzB99 algorithms, for night-time aircraft noise data (22 p.m. – 6 a.m.) and for the time period of 3-5 a.m. (Leq_{3-5}), where air cargo traffic was most pronounced at Cologne-Bonn airport. Data on road and rail traffic noise were provided by the Northrhine-Westfalian State Environment Office. All noise data were linked to all 376.223 residency addresses within the study region. All sickness funds linked individual noise data to current addresses of the respective insured persons.

Data on therapeutic drugs: Using a commonly German applied brand- and package-specific identifier (PZN) prescribed drugs were allocated to one of the groups of the WHO provided ATC system and defined daily doses (DDD) were calculated for any insured person as amount prescribed per person year of insurance (DDD/py). In this publication analyses are restricted to antihypertensive drugs (ATC codes C02, C03, C04, C07) and to cardiovascular drugs without antihypertensive action (ATC codes C01, C08, C09, C10).

Statistical analyses: Multiple linear regressions were conducted for both genders and for 10-year age groups using DDD/py as dependent variable and Leq_{night} and Leq_{3-5} resp. as independent variables. Confounders comprised prevalence of social security recipients of the resident’s community quarter (SSR), density of nursing home beds, nigh-time road traffic and rail traffic noise, interaction term of Leq_{night}* SSR and of Leq_{3-5} resp..

Results

The exposure of the study population to night-time aircraft noise (Leq_{night}) is displayed in table 1, indicating that about 20% of the population is exposed to aircraft noise above 40 dB(A). For the time period of 3-5 a.m. the proportion of population exposed is nearly the same, but according to isophones (data not shown) the geographical spread is much larger.

Table 1. Population exposed to night-time aircraft noise (22 p.m. – 6 a.m.)

Males	Females
384.721	444.044
37.520	42.036
40.832	45.295
14.050	15.859
4.041	4.467

As to be expected the prevalence of prescriptions of both antihypertensive as well as of cardiovascular drugs is steadily increasing with age in both genders (table 2). However, in females the prevalences in most age groups are slightly larger. This applies to a greater extent to the amount of prescribed drugs (as defined daily doses per person year), indicating the much observed larger proportion of treated and controlled hypertensive women.

Table 2. Prevalence of prescriptions and defined daily doses per person year of antihypertensive and cardiovas cular drugs

Age group	Population	Males				Population	Females			
		Antihypertensive drugs*		Cardiac drugs**			Antihypertensive drugs*		Cardiac drugs**	
		Prevalence	DDD/ person year	Prevalence	DDD/ person year		Prevalence	DDD/ person year	Prevalence	DDD/ person year
<10	51.760	0.26	0.2	0.34	0.1	48.782	0.19	0.1	0.27	0.1
10-19	55.472	0.65	0.4	0.85	0.3	53.101	0.84	0.4	2.12	0.5
20-29	69.685	2.28	2.3	0.83	0.8	75.987	2.84	2.1	2.22	1.0
30-39	76.508	5.62	9.6	2.54	3.8	81.747	6.27	7.3	3.08	2.5
40-49	73.359	13.71	35.4	8.35	18.5	81.148	14.77	29.0	6.99	11.0
50-59	53.137	31.81	111.5	21.97	65.3	61.927	32.84	91.7	18.51	41.9
60-69	56.083	50.36	209.3	37.99	130.6	65.646	50.48	183.9	34.97	103.8
70-79	31.828	64.54	268.8	50.82	180.6	44.851	68.36	283.8	50.67	164.3
80 +	13.332	68.56	286.7	54.34	201.3	38.512	73.10	329.4	55.06	189.7
Total	481.164	18.97	69.8	13.65	43.5	551.701	23.95	83.9	16.22	45.8

* Antihypertensive drugs: ATC-Codes C02, C03, C04, C07
** Cardiac drugs: ATC-Codes C01, C08, C09, C10

The coefficients of aircraft noise parameters derived from multiple linear regression models were significant at least at the 0.05 level in all but the 40-49 age groups in women and in all age groups of males. Explained variance for the complete model, as derived form R^2, ranged for antihypertensive drugs from 4.5% in 40-49 year old men and women to above 41.0% in the oldest age groups. The respective explained variances for cardiovascular drugs showed a range of 2.5% for the youngest vs. 25.1% in the oldest age group in both genders and in both night-time aircraft noise parameters.

The impact of night-time aircraft noise on amount of prescribed drugs is shown in figures 1-4. For these displays the coefficients derived from multiple linear regression models are applied for a fictious population with fixed confounders (i.e. prevalence of social security recipients of 4.3% [= median of population values]; densitiy of nursing home beds of 9.8 ‰ [=median of population value]; night-time road traffic noise of 40 dB(A); absence of rail traffic noise; interaction of respective air traffic values * median of social security recipients prevalence). The resulting figures indicate an increasing amount of antihypertensive drugs with increasing Leq_{night} for both genders in all age groups, except for the 60-69 year old (figure 1). Regarding the time period of 3-5 a.m. the increases are much larger and are to be seen in all age groups (fig. 2). The same pictures evolves when analysing prescriptions for cardiovascular drugs (figs. 3-4).

Figure 1. Presciption of antihypertensive drugs (as defined daily doses per person year (DDD/py)) by genders and age group and night-time aircraft noise (Leq_{night})

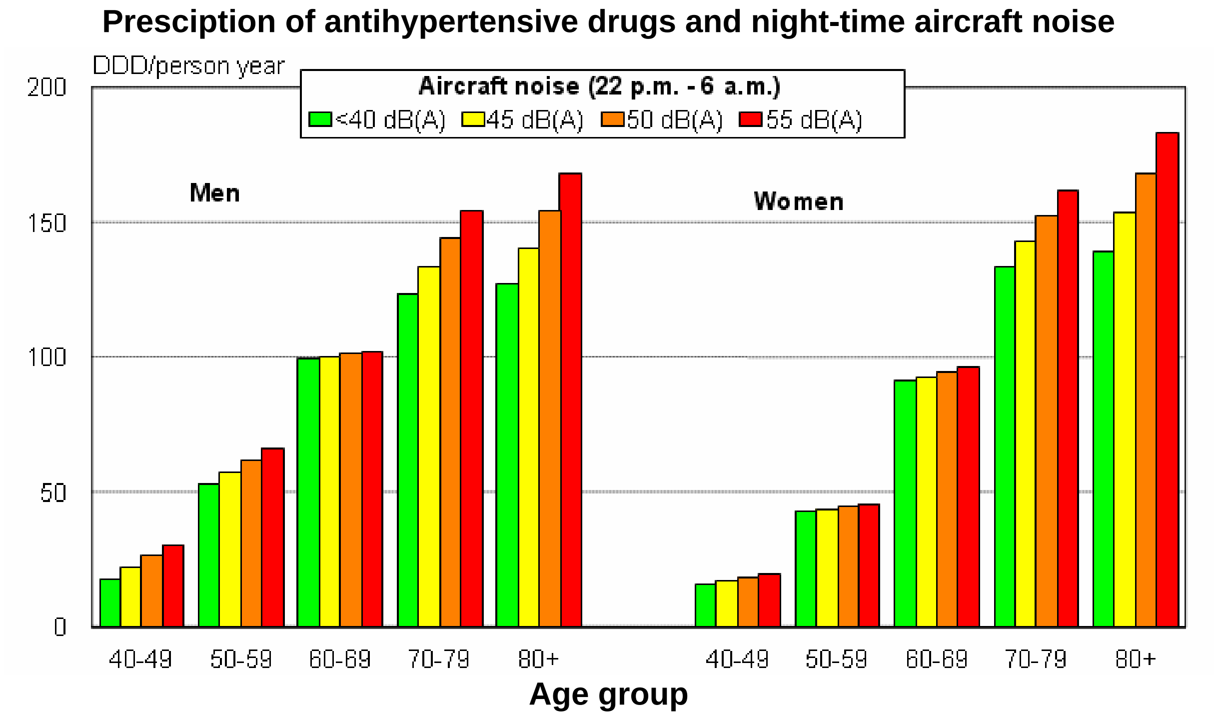


Figure 2. Prescription of antihypertensive drugs (as defined daily doses per person year (DDD/py)) by genders and age group and night-time aircraft noise during 3-5 a.m.

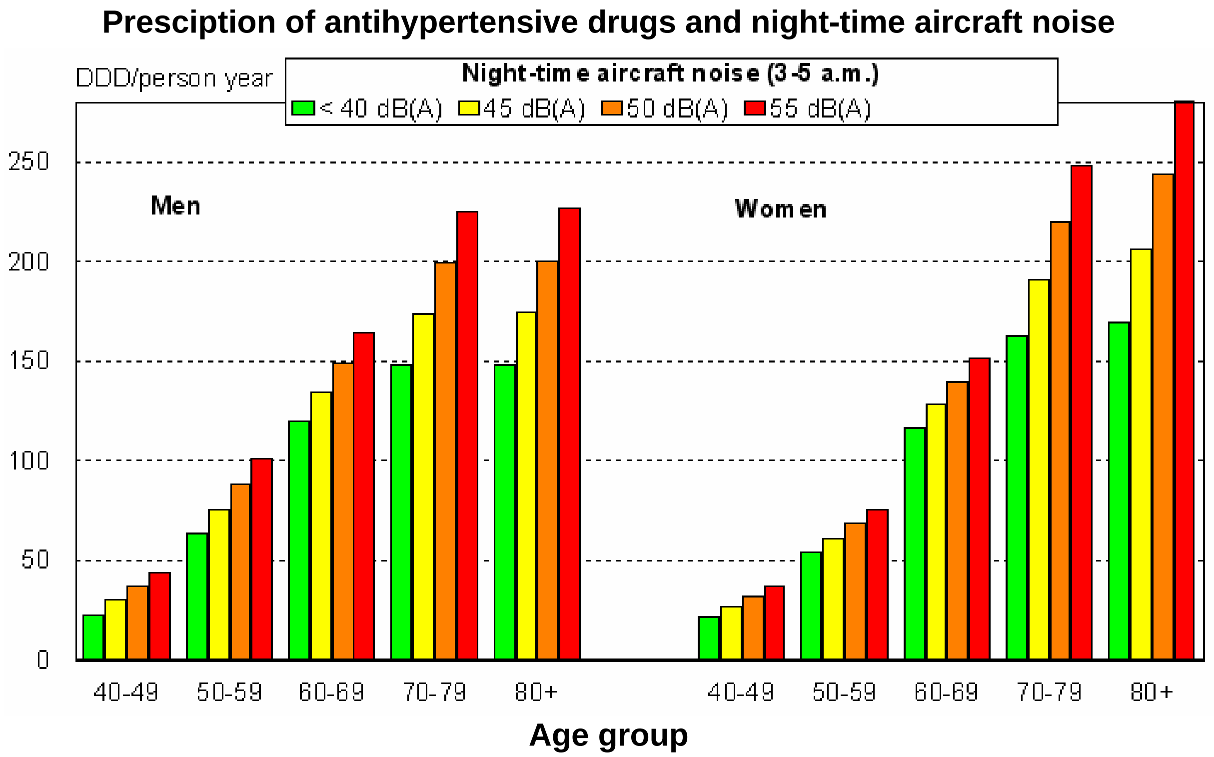


Figure 3. Presciption of cardiovascular drugs (as defined daily doses per person year (DDD/py)) by genders and age group and night-time aircraft noise (Leq_{night})

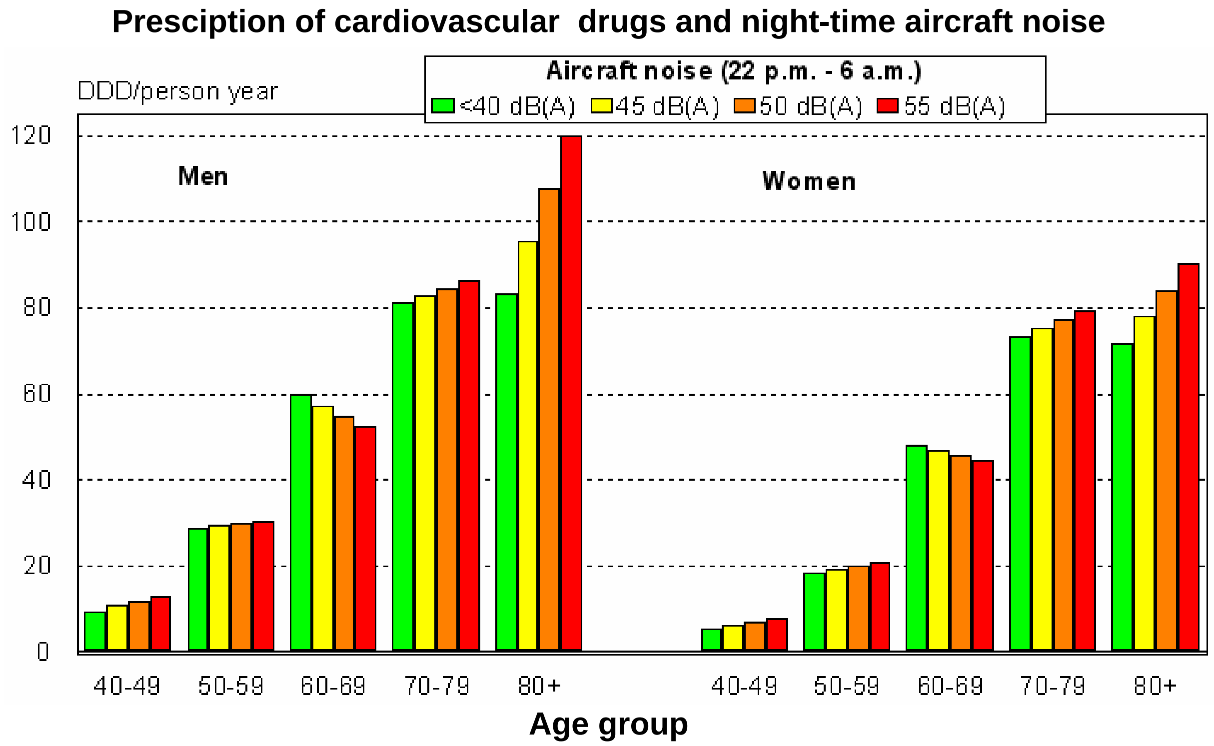
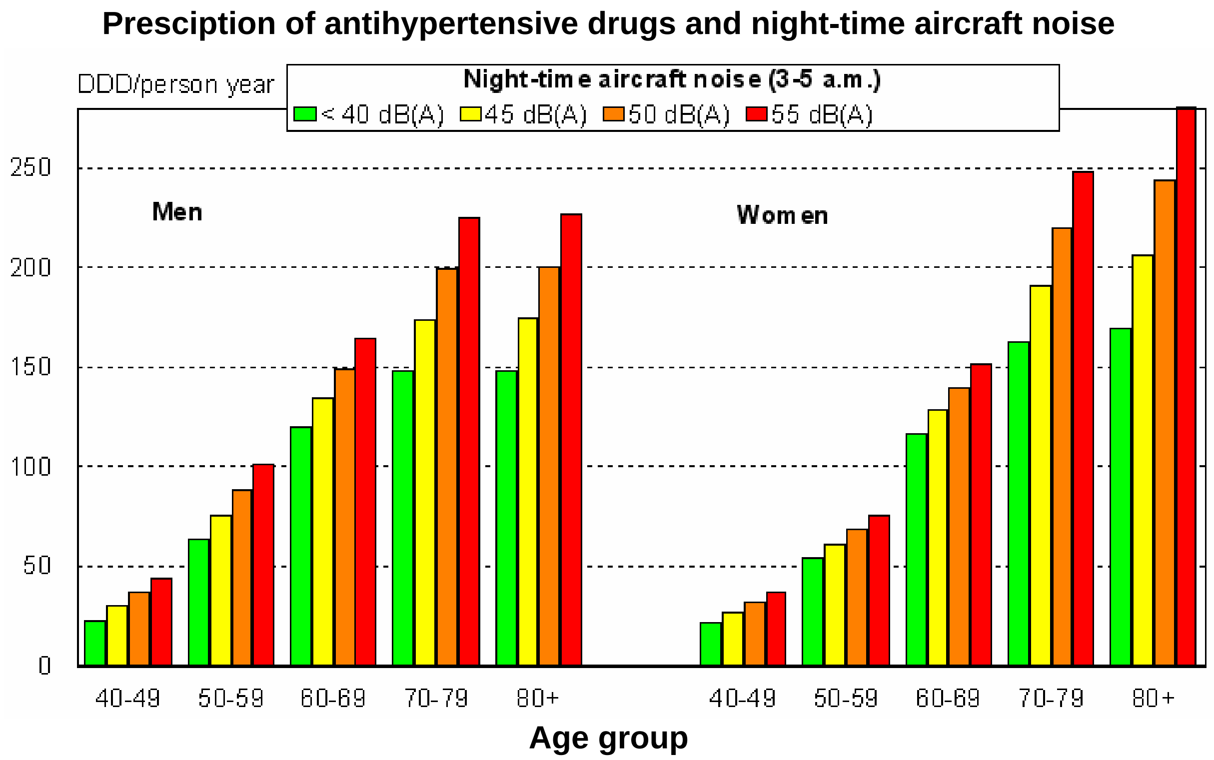


Figure 4. Prescription of cardiovascular drugs (as defined daily doses per person year (DDD/py)) by genders and age group and night-time aircraft noise during 3-5 a.m.



Discussion

Our study is based on the largest data base so far analyzed for the impact of night-time aircraft noise on out-patient prescriptions for antihypertensive and cardiac drugs. We were thus able to investigate effects of aircraft noise by gender and by 10-year age groups. We did encompass both road and rail traffic noise parameters as confounders and considered likewise social status of our population by including a regional parameter of social deprivation, i.e. the prevalence of social security recipients of the respective community quarter. There is a strong correlation between regional parameters of deprivation with individual social status, as it has been shown e.g. by Kalff and co-authors (2001) or by Spencer and co-authors (1999).

Table 3. Characteristics of confounding factors

Confounder	Median	Range
Prevalence of social security recipients (%) of community quarter	4.3	0 – 66.7
Density of nursing home beds / population, aged 65 +, (‰) of community quarter	9.8	0 – 162.2
Night-time road traffic noise (dB(A))	41	< 35 – 79*
Night-time rail traffic noise (dB(A))	48	< 35 – 81*

* Road and rail traffic noise were calculated from 35 dB(A) uwards.

The increase of prescriptions for antihypertensive drugs can not easily be compared with the increase of prevalence of hypertension, as found in the HYENA Study, as the HYENA investigators provide a global increase for both genders and for all participants of their study, aged 45 – 70. But when calculating the increase of prescriptions due to an increase of aircraft noise from 40 to 50 dB(A) for the age group of 50-59 year old males from our study, the resulting figures are 17.0% for Leq_{night} and 40.4% für $Leq_{3\text{-}5}$. These figures are well be in the range of the HYENA results for a similar increase (14.1%). The respective increases for cardio vascular drugs from our study are 3.2% for Leq_{night} and 22.5% for $Leq_{3\text{-}5}$. As in males the proportion of treated hypertensives is in general smaller than in females these observed increases in prescriptions might reflect an even larger increase in prevalence of all hypertensives.

Regarding cardiovascular drugs Franssen and co-authors (2004) found an aircraft noise dependent increase for OTC drugs only and not for drugs prescribed by a physician. This finding might well be due to the limited sample size of slightly above 12.000 with a accordingly small power to detect smaller increases.

Conclusion

The Cologne-Bonn Airport Study provides further epidemiologic evidence for a causal relationship between aircraft noise and subsequent arterial hypertension.

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