Dose-response relationship between hypertension and aircraft noise exposure around Kadena airfield in Okinawa

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INTRODUCTION

Effects of traffic noise on blood pressure have been shown by many epidemiological studies (Babisch 2006, 2008; WHO 1999). Some of the studies obtained dose-response relationships between risk for hypertension and noise exposure level. However, higher prevalence rate of hypertension in the elderly may affect the relative risk for hypertension, and consequently the dose-response relationship could be influenced by age.

In this paper, the dose-response relationships of hypertension due to aircraft noise exposure were investigated for different age subgroups based on the health examination data of the Okinawa study (Okinawa prefectural government 1999; Matsui et al. 2001, 2004).

METHODS

Material

Systolic and diastolic blood pressures were obtained from the records of the health examination conducted by the local governments around the Kadena airfield in Okinawa, Japan (see Figure 1) in the fiscal years of 1994 and 1995. The examination covered the residents who were self-employed persons, part-time workers, house wives and unemployed persons. The data contained information about age, gender, weight, height and address of the residents.

Noise exposure level of the residents was determined from the noise contour in WECPNL designated by DFAA (Defense Facilities Administration Agency) in 1978, and converted into L_{den} by subtracting 13 dB.

Statistical Procedures

The sample was classified into 6 subgroups according to gender and age. Multiple logistic regression analysis was applied to obtain the relationship between aircraft noise level and hypertension defined by WHO with adjustment for age, BMI and their interactions. Trend analysis was also applied to investigate the significance of linear dose-response relationship with L_{den}.

Dose-response relationships were obtained for the different subgroups to investigate the effects of age on the relationship. Relative risk and attributable risk were also calculated for each of the subgroups. All the statistical analyses were done with SPSS 15.0J.

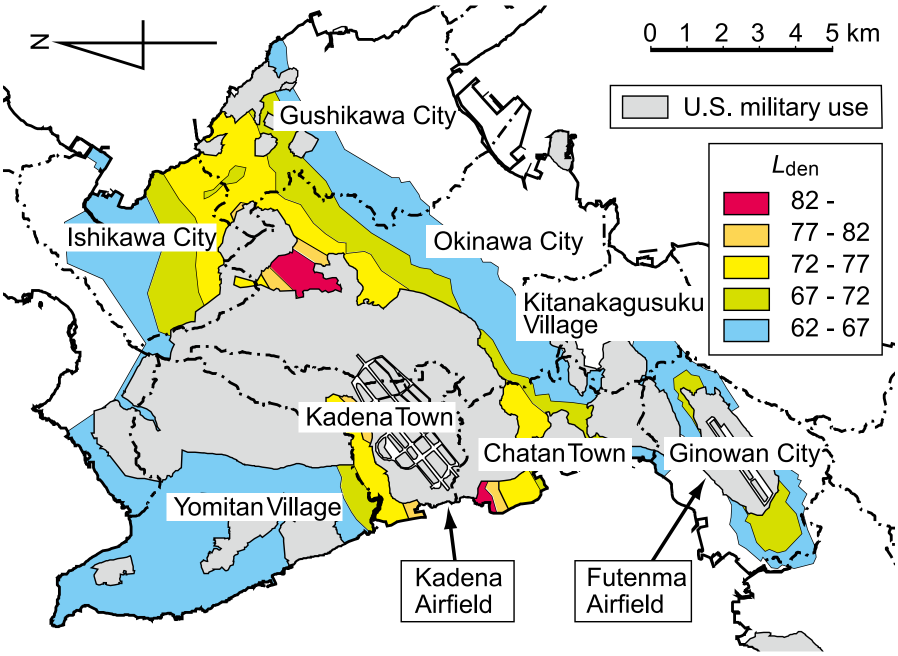

Figure 1: Aircraft noise contour around the Kadena airfield

Table 1: Sample size in the municipalities stratified by Lden

Year	Municipality	L_{den} (dB)						Total
		–62	62–67	67–72	72–77	82–87	87–	
1994	Okinawa City	2,938	4,337	1,006	189	0	0	8,470
	Kadena Town	0	0	0	1,556	155	0	1,711
	Chatan Town	0	441	923	437	15	93	1,909
	Kitanakagusuku Village	1,190	2	0	0	0	0	1,192
1995	Ishikawa City	338	905	642	101			1,986
	Gushikawa City	2,066	1,627	247	213			4,153
	Okinawa City	80	85	1	0			166
	Yomitan Village	0	4,021	222	0			4,243
	Total	6,612	11,418	3,041	2,496	170	93	23,830

RESULTS

Sample

Table 1 shows the valid sample size in each municipality stratified by L_{den}. In the analysis, the noise exposure was classified into 4 levels combining the highest three categories (L_{den}>72 dB) into one category because of the small sample size. The category with the lowest noise exposure (L_{den}<62 dB) was considered as the control group.

Table 2 indicates the sample size classified by L_{den}, gender and age. About 70 % of the sample was female and the sample size of the youngest age subgroup (20–39 years) was comparatively small. Dose-response relationships were obtained for male and female respectively, and were also obtained for the six subgroups classified by gender and age in the table.

Table 2: Sample size classified by Lden, gender and age

Gender	Age	L_{den} (dB)				Total
		–62	62–67	67–72	72–77	
Male	20–39y	331	570	150	153	1,204
	40–59y	683	1,194	348	286	2,511
	60–79y	1,077	2,151	552	489	4,269
	Subtotal	2,091	3,915	1,050	928	7,984
Female	20–39y	833	1,156	300	311	2,600
	40–59y	1,772	2,866	831	702	6,171
	60–79y	1,916	3,481	860	818	7,075
	Subtotal	4,521	7,503	1,991	1,831	15,846
Total		6,612	11,418	3,041	2,759	23,830

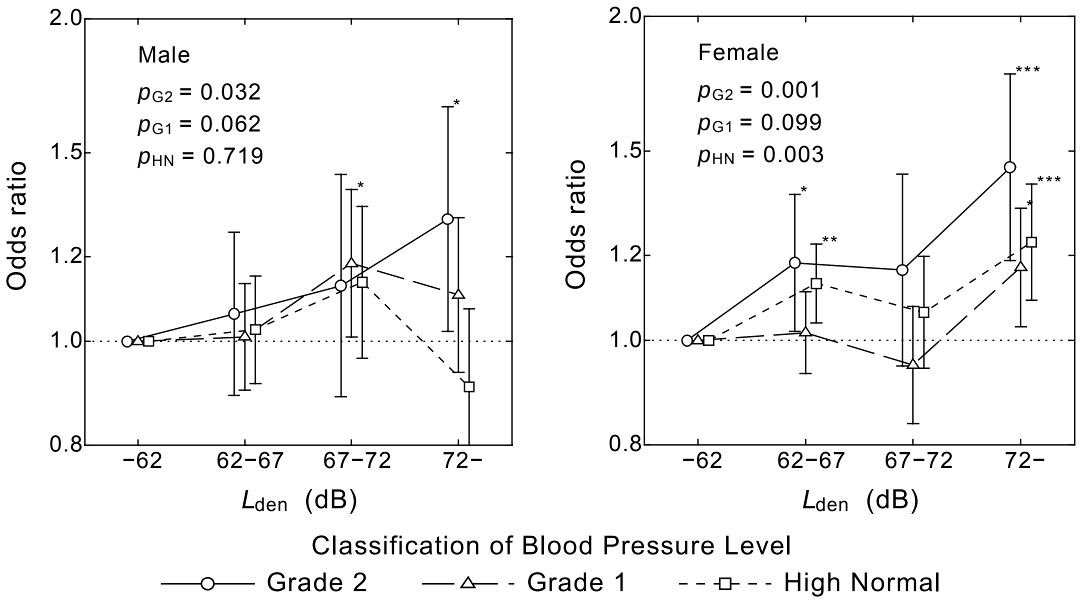

Figure 2: Dose-response relationships between hypertension and L_{den} for male and female. Odds ratios and their 95 % confidence intervals are illustrated as a function of L_{den}. The *p*-values in the figure show the significance probabilities of linear trend of the relationships for three classifications of blood pressure level. Asterisks indicate the significance of odds ratio [*: $p<0.05$, **: $p<0.01$, ***: $p<0.001$].

Dose-response relationship

Based on the classification of blood pressure level defined by WHO, dose-response relationships of ‘Moderate hypertension (Grade 2),’ ‘Mild hypertension (Grade 1)’ and ‘High normal blood pressure’ were obtained with adjustment for age, BMI and their interactions.

Figure 2 indicates the results of the analysis for male and female. The female sample showed more significant *p*-values of the trend test than the male sample, and the linear trend of the dose-response relationship for Grade 2 hypertension was highly significant in female.

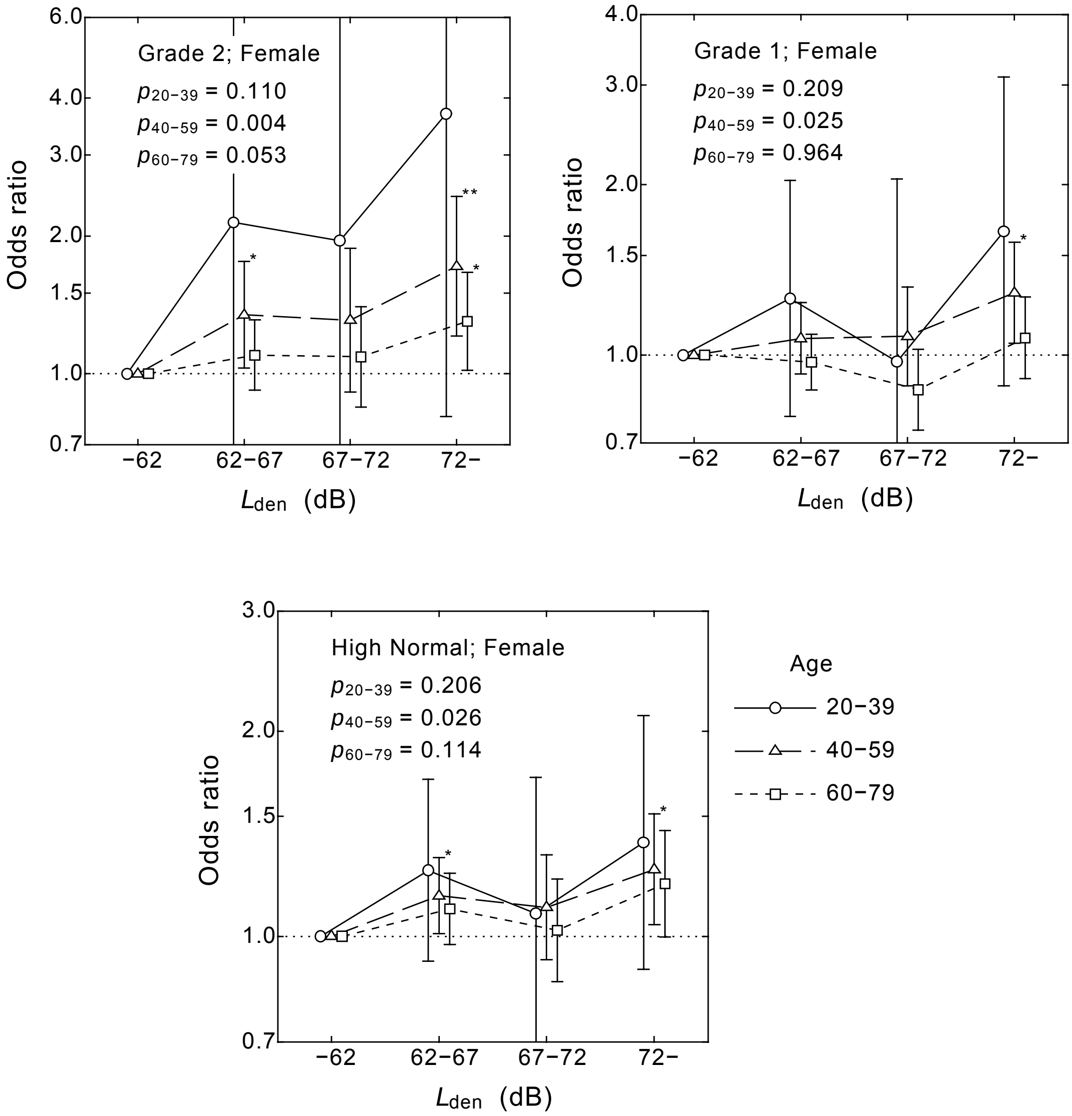

Figure 3: Dose-response relationships between hypertension and L_{den} for different age subgroups in female. Odds ratios and their 95 % confidence intervals are illustrated as a function of L_{den}. The *p*-values in the figure show the significance probabilities of linear trend of the relationships for three generations. Asterisks indicate the significance of odds ratio [*: $p<0.05$, **: $p<0.01$, ***: $p<0.001$].

The dose-response relationships of Grade 2 hypertension, Grade 1 hypertension and High normal blood pressure in female are shown in Figure 3. The relationships were obtained for three generations respectively. The youngest age subgroup (20–39 years) showed relatively higher odds ratios than the elder age subgroups, though the differences were not statistically significant. The confidence intervals of the odds ratios in the youngest age subgroup were wider than those of other age subgroups, because the sample size was small and the prevalence rate of hypertension was also small in the youngest age subgroup.

These results suggest that the dose-response relationship between hypertension and noise exposure may be influenced by age, and that an epidemiological study covering the elderly over 40 years may be efficient to raise the power of statistical analysis.

Table 3: Relative risk and attributable risk in the highly noise-exposed area (Lden>72 dB)

Gender	Hypertension	Relative risk			Attributable risk (/1,000)		
		20–39 y	40–59 y	60–79 y	20–39 y	40–59 y	60–79 y
Male	Grade 1	1.01	1.07	1.06	1.2	21.7	29.6
	Grade 2	1.08	1.19	1.30	3.0	17.0	40.1
Female	Grade 1	1.57	1.24	1.03	19.8	57.0	12.3
	Grade 2	3.57	1.72	1.24	9.3	34.7	26.8

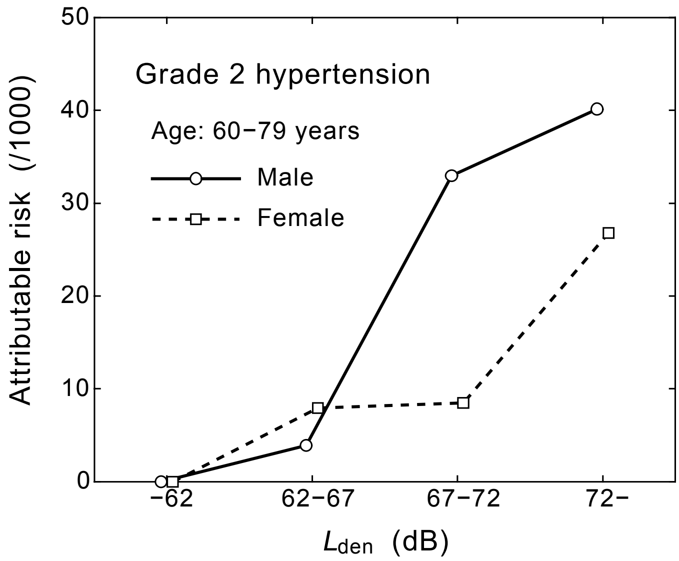

Figure 4: Dose-response relationships between L_{den} and attributable risk for hypertension in the eldest age subgroup

Many evidences have been reported on cardiovascular effects of traffic noise. Most of the studies showed relative risk or odds ratio for the health effects. From the viewpoint of public health, attributable risk is considered to be useful for evaluation of lifetime risk and for comparison with other risks. The values of relative risk and attributable risk in the highly noise-exposed area (L_{den}>72 dB) are tabulated in Table 3 for the six subgroups classified by gender and age.

In female, the relative risks decreased with age, though the increasing trend was found in male. This difference, however, was not statistically significant. Further investigation may be necessary to detect the difference between genders.

The attributable risk showed higher values in the elder age subgroups than the youngest age subgroup, which was considered to be reasonable because the health effects of noise should be chronic and cumulative. Figure 4 shows the dose-response relationships between L_{den} and the attributable risk for Grade 2 hypertension in the eldest age subgroup (60–79 years). The attributable risk in the highly noise-exposed area was 30–40 per mil.

To evaluate lifetime risk due to noise exposure, the attributable risk in the eldest age subgroup seemed to be a better risk measure than the relative risk, because the relative risk did not show the number of affected residents by noise exposure. If the relative risk in younger age subgroup was applied with a high prevalence rate in the elderly for the evaluation of lifetime risk, the calculated result could be an overestimate.

CONCLUSIONS

The dose-response relationships of hypertension were obtained for different age subgroups. In female, the gradients of the dose-response relationships decreased with age, which might be caused by the high prevalence rate in the elderly. However, the same result was not found in the male sample. Further study with an enough sample size may be necessary to obtain more precise dose-response relationships for different age subgroups.

Attributable risks for hypertension were also calculated for the subgroups classified by gender and age. The attributable risk increased with age, and the risk of 30–40 per mil was detected in the highly noise-exposed area for the eldest age subgroup. From the viewpoint of public health, it was suggested that the attributable risk in the elderly was a better risk measure than the relative risk because it indicated the number of affected residents by noise exposure.

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REFERENCES

Babisch W (2006). Transportation noise and cardiovascular risk: Updated review and synthesis of epidemiological studies indicate that the evidence has increased. Noise & Health 8(30): 1-29.

Babisch W (2008). Road traffic noise and cardiovascular risk. Noise & Health 10(38): 27-33.

Matsui T, Uehara T, Miyakita T, Hiramatsu K, Osada Y, Yamamoto T (2001). Association between blood pressure and aircraft noise exposure around Kadena airfield in Okinawa. In: Proceedings Internoise 2001.

Matsui T, Uehara T, Miyakita T, Hiramatsu K, Osada Y, Yamamoto T (2004). The Okinawa study: effects of chronic aircraft noise on blood pressure and some other physiological indices. J Sound Vibr 277: 469-470.

Okinawa prefectural government (1999). A report on the aircraft noise as a public health problem in Okinawa. http://www.asahikawa-med.ac.jp/dept/mc/hygiene/okinawa/report-e.html.

WHO (1999). Guidelines for community noise (eds.: by Berglund B, Lindvall T, Schwela DH). Geneva: WHO.