Chapter 8

Higher rate of low birth-weight infants

It is generally recognized that the mental stress possibly causes through the endocrine and nervous systems various physical impact upon human beings. Noise can be a stresser to cause such stress reactions as many mental stresses might do to human bodies.

Many papers have been published to report the results of animal experiments and epidemiological researches suggesting the effect of noise on pregnancy; that is the noise exposure is a factor reducing birth weight and/or shortening the term of pregnancy. For example, it is reported that the rate of low birth weight of infants was found higher in the vicinity of Osaka International Airport (Ando & Hattori; 1973) than the average rate of non-noise exposed area in Japan and that the aircraft noise exposure could be a factor of raising the rate.

Taking the high level of noise exposure around the U.S. airfields in Okinawa, particularly in the vicinity of Kadena Air Base, into account, there would be a good reason to investigate whether the higher rate of low birth weight infants are observed.

8.1 Materials and methods

Japanese government accumulates for every municipality all over the country the birth records including the information on year of birth, address, sex, birth-weight, mother's age, single or multiple pregnancy, legitimacy of the infant, the period of pregnancy, live birth order, experience of stillbirth, occupation of householder, etc. The number of births in Okinawa Prefecture recorded for 20 years from 1974 to 1993 was 356,549 among which 164,028 records of 15 municipalities around Kadena Air Base and Futenma Air Station filed up for the 20 years are used for the analysis in the present investigation.

The 15 municipalities are shown in the map of Figure 8.1. In the map

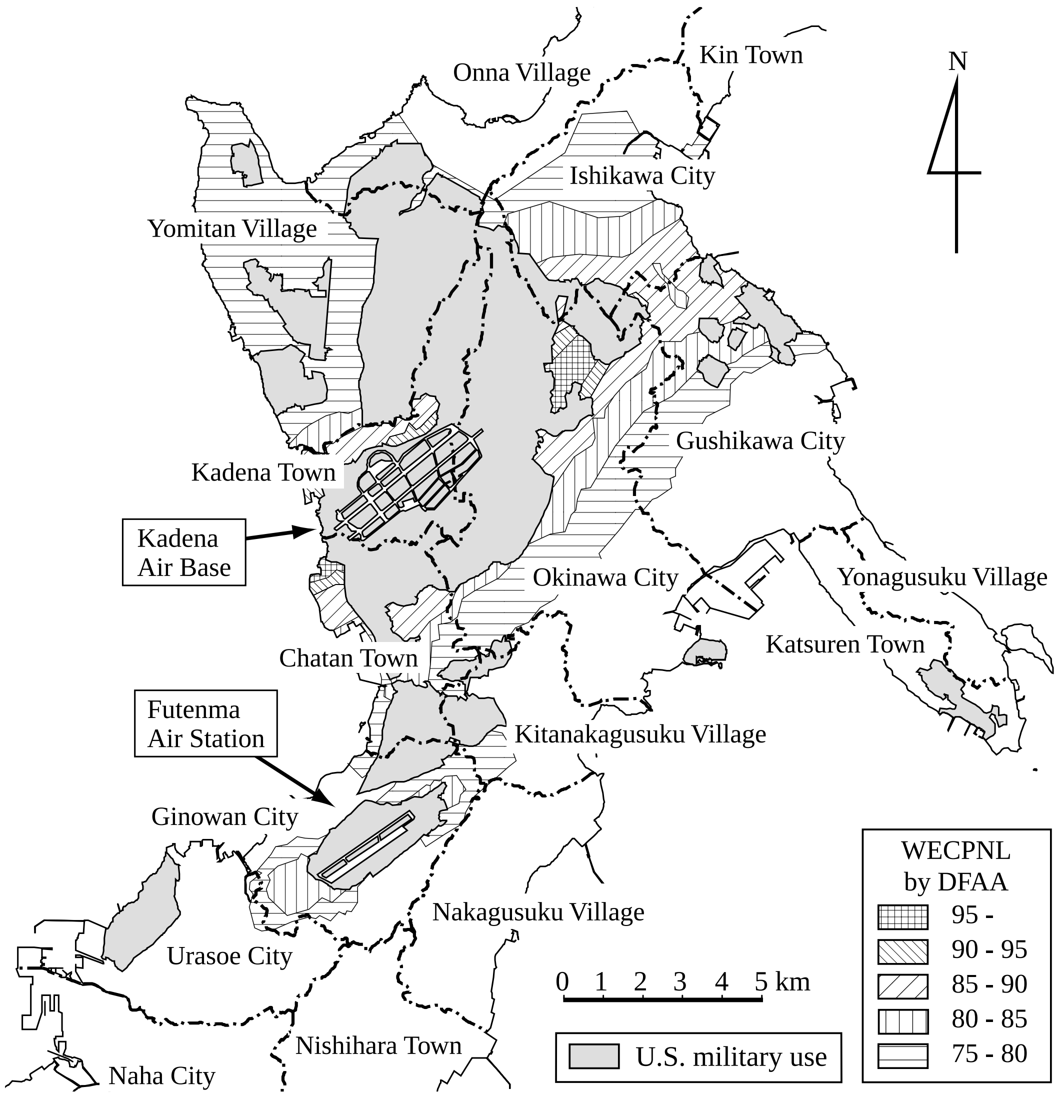

Figure 8.1 Municipalities around Kadena Air Base and Futenma Air Station.

Ishikawa City, Gushikawa City, Okinawa City, Kadena Town, Chatan Town, Yomitan Village and Ginowan City are the nearest municipalities surrounding the bases and have over 30% of the population within the noise contour of WECPNL of 75 designated by the DFAA. Onna Village, Kin Village, Yonagusuku Village, Katsuren Town, Kitanakagusuku Village, Nakagusuku Village, Urasoe City and Nishihara Town are the outer surrounding municipalities of the above ones.

The birthplace is recorded as the name of the municipality only and no direct information is available such as the postal address of birthplace on which one could estimate the noise exposure the mother would have been exposed to during pregnancy. In order to make a rule of thumb estimation of the

Table 8.1 Population stratified in the ranks of WECPNL

Municipality	WECPNL							Average†
	–75	75–80	80–85	85–90	90–95	95–	Total	WECPNL
Kadena Town				12,777	1,265		14,042	88.0
Chatan Town		6,884	6,064	10,229	317	237	23,731	83.5
Okinawa City	47,612	50,070	14,974	2,412			115,068	76.3
Gushikawa City	37,618	14,309	3,256	2,926			58,109	75.0
Ishikawa City	5,398	10,596	4,727	1,254			21,975	77.9
Ginowan City	39,561	24,997	17,258				81,816	76.1
Yomitan Village		31,791	2,263				34,054	77.8
Onna village	8,422	672					9,094	72.9
Kin Town	10,040						10,040	72.5
Katsuren Town	14,112						14,112	72.5
Yonagusuku Village	13,629						13,629	72.5
Kitanakagusuku Village	11,697	2,519					14,216	73.4
Nakagusuku Village	13,497						13,497	72.5
Urasoe City	94,014	2,434					96,448	72.6
Nishihara Town	28,710						28,710	72.5
Total	324,310	144,272	48,542	29,598	1,582	237	548,541	75.6

†'Average WECPNL' is calculated as population weighted average of WECPNL.

noise exposure, population weighted WECPNL is calculated in such a way as follows; firstly, populations in the ranks of WECPNL in every municipality are estimated based on the community population available as of June 1, 1995, and secondly, the average of noise exposure weighted for the population is calculated for the municipalities. In Table 8.1 are tabulated the population stratified in the ranks of WECPNL. In the following analysis the 8 municipalities with average WECPNL under 75 are treated as the control, the 5 municipalities with average WECPNL from 75 to 80 are treated as "lower noise exposed group." Chatan Town and Kadena Town are independent groups.

The weight of the new infant under 2,500g is categorized as low birth-weight. Birth rate of low birth-weight infants are analysed in relation to noise exposure. The data of multiple pregnancy and/or the records of the mothers having experience of stillbirth are excluded from the analysis.

8.2 Results

8.2.1 Birth rate of low birth-weight infants

In Table 8.2 are presented the numbers of births and the birth rates of low birth-weight infants for different ranks of noise exposure. Clearly the higher birth rates of low birth-weight infants are found in the municipalities with higher noise exposure. The birth rate of low birth-weight infants of

Table 8.2 Rate of low birth weight infants

Municipalities	Num. of births	<2,500g
Kadena Town	4,425	366 (8.3%)
Chatan Town	6,066	423 (7.0%)
Okinawa City, etc.	92,332	6,439 (7.0%)
Control	57,637	3,667 (6.4%)

† The samples with multiple pregnancy and/or stillbirth experience are excluded from the analysis.

Kadena Town is 8.3% which is by about 2% higher than the rate 6.4% of the control and the ratio of the rate of Kadena to that of the control is about 1.3. Chatan Town and the 5 municipalities of lower noise exposure have nearly the same birth rates of low birth-weight infants as each other.

In order to adjust various confounding factors possibly influencing the birth rate of low birth-weight infants, multiple logistic regression analysis is applied with the birth rate as the dependent variable and sex, mother's age, live birth order, occupation of householder, legitimacy of the infant, year of birth and the interaction of mother's age and live birth order as the independent variables. Table 8.3 is the results of the analysis where p-value indicates the significance probability of odds ratio. In the table 'factor' indicates independent variable for the logistic regression model. Here odds ratio is nearly equal to relative risk. They are plotted in Figure 8.2 as a function of WECPNL. Vertical bars in the figure indicate 95% confidence intervals of odds ratios and the asterisks do the odds ratios are significantly higher to the control. The result of the trend test tells that the trend of increase of odds ratio with the increase of WECPNL is significant with the significance probability p less than 0.0001 as shown in the figure, which suggests that significant dose-response relation exists between the birth rate of low birth-weight infants and the noise exposure.

8.2.2 Rate of preterm infants

Birth weight and period of pregnancy are highly correlated with each other. In this section the rate of preterm births is analysed as done for the birth rate of low birth-weight infants in the previous section.

In Table 8.4 are shown the rates of preterm births for different ranks of noise exposure. In the table, preterm, term and postterm mean the period of pregnancy to be less than 37 weeks, from 37 to 41 weeks inclusive and over 41 weeks, respectively. The classification of the term of pregnancy in this

Table 8.3 Results of the logistic regression analysis (<2,500 g)

Factor	Category	N	Odds ratio	95% CI	p-value
Noise exposure	Kadena Town	4,425	1.32	1.18–1.48	<0.0001
	Chatan Town	6,066	1.09	0.98–1.21	0.1232
	Okinawa City, etc.	92,332	1.09	1.04–1.13	0.0001
	Control	57,637	1.00		
Sex	Male	82,777	1.00		
	Female	77,683	1.16	1.11–1.20	<0.0001
Mother's age	$\leq$ 19	5,584	2.14	1.70–2.69	<0.0001
	20–24	36,634	1.39	1.29–1.51	<0.0001
	25–29	59,942	1.00		
	30–34	39,879	0.95	0.89–1.02	0.1376
	35 $\leq$	18,421	1.19	1.10–1.28	<0.0001
Live birth order	1st	58,773	1.42	1.33–1.52	<0.0001
	2nd or after	101,687	1.00		
Interaction of mother's age and live birth order	$\leq$ 19 and 1st	4,840	0.71	0.56–0.92	0.0082
	20–24 and 1st	22,522	0.73	0.66–0.81	<0.0001
	25–29 and 1st	21,478	1.00		
	30–34 and 1st	7,315	1.16	1.03–1.31	0.0118
	35 $\leq$ and 1st	2,618	1.13	0.97–1.32	0.1253
Legitimacy	Legitimate infants	155,421	1.00		
	Illegitimate infants	5,039	1.67	1.52–1.82	<0.0001
Occupation of householder	White-collar worker	51,843	1.00		
	Blue-collar worker	60,005	1.18	1.12–1.24	<0.0001
	Full-time farmer	2,179	1.12	0.94–1.33	0.2050
	Farmar with a side Job	4,727	1.13	1.00–1.27	0.0569
	Self-employed	18,349	1.11	1.03–1.19	0.0041
	Other	22,970	1.24	1.17–1.32	<0.0001
	Unknown	387	1.18	0.80–1.74	0.3983
Period	1974–1978	43,732	1.00		
	1979–1983	38,501	0.96	0.90–1.01	0.1156
	1984–1988	40,422	1.10	1.04–1.16	0.0011
	1989–1993	37,805	1.27	1.21–1.34	<0.0001

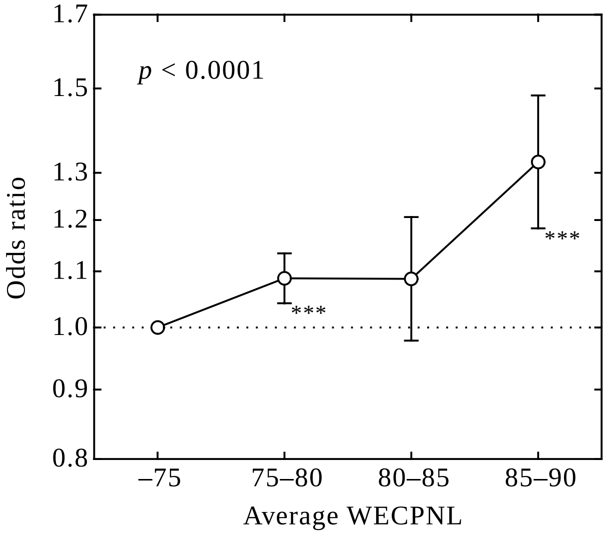

Figure 8.2 Odds ratio *vs.* WECPNL ($< 2,500$ g).

*:$p < 0.05$, **:$p < 0.01$, ***:$p < 0.001$

Table 8.4 Rate of preterm infants

Municipalities	Preterm infants	Term infants	Postterm infants	Total
Kadena Town	234 (7.7%)	2,745 (89.9%)	76 (2.5%)	3,055
Chatan Town	308 (6.7%)	4,193 (90.8%)	118 (2.6%)	4,619
Okinawa City, etc.	4,398 (6.6%)	60,438 (91.0%)	1,562 (2.4%)	66,398
Control	2,651 (6.2%)	38,997 (91.3%)	1,065 (2.5%)	42,713

† The samples with multiple pregnancy and/or stillbirth experience are excluded from the analysis.

report is in accordance with the definition proposed by WHO. Since Japan used the classification on month basis before adopting the definition in 1979 for statistics, the records before the year of 1979 are excluded in the following analysis.

Clearly the higher birth rates of preterm births are found in the municipalities with higher noise exposure. The preterm birth rate of Kadena Town is by about 1.5% higher than the rate of the control and the ratio of the rate of Kadena to that of the control is about 1.2. Chatan Town and the 5 municipalities of lower noise exposure have by about 0.5% higher rates of preterm birth than the control.

In order to adjust various confounding factors possibly influencing the birth rate of preterm births, multiple logistic regression analysis is applied with the birth rate as the dependent variable and the same independent variables

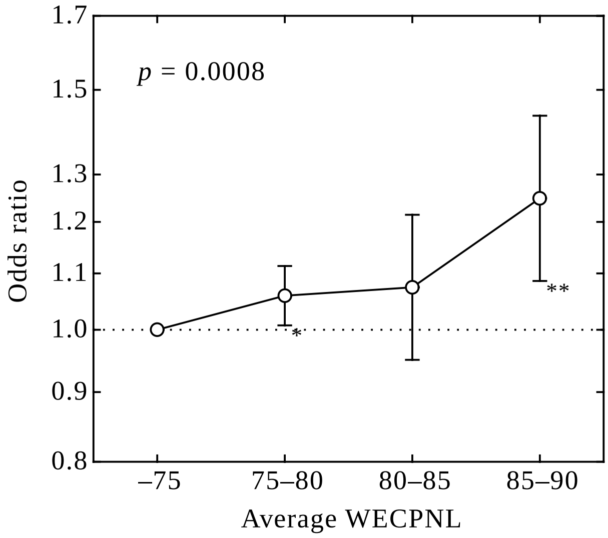

Figure 8.3 Odds ratio *vs.* WECPNL (preterm infants).

*:$p < 0.05$, **:$p < 0.01$, ***:$p < 0.001$

as used in the previous section. The odds ratios of different ranks of noise exposure are shown in Figure 8.3 as a function of WECPNL. As was found in the case of low birth-weight, the trend of increase of odds ratio with the increase of WECPNL is clear and significant according to the trend test.

As have been seen above the dose-response relations between the birth rate of low birth-weight infants and the rate of preterm birth and the noise exposure are significant under the adjustment of confounding factors. But unfortunately strong confounding factors such as smoking habit and some other habits of life style are not used as the independent variables in the present analysis due to the lack of information. In fact, epidemiologists report that smoking habit raises the birth rate of low birth-weight infants by 50 to 100% (Cnattingius *et al.*; 1993, Behrman; 1985, Maruoka *et al.*; 1998). In that sense one cannot draw a firm conclusion based on the present analysis. Suppose, however, the odds ratio of the birth rate due to smoking habit is 2.0 and the higher birth rate of low birth-weight infants in Kadena Town is attributed to the smoking habit solely, then the smoking rate of females in Kadena Town needs to be by 40% higher than the control. That is quite unrealistic.

In conclusion, it would be safe to say that it is fairly likely that the aircraft noise exposure might cause the higher birth rate of low birth-weight infants obsereved in Kadena Town.

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