Chapter 6

General health questionnaire survey: Todai Health Index

Health management is the basis of public health. Collecting precise and minute information on the individuals' health conditions and conducting health management of the individuals might be considered most desirable, but in the realistic conditions it is virtually impossible to carry out health examinations of all the population. It is for this reason that surveys on perceived wellness or subjective health of groups of individuals are widely undertaken by means of personal interview and/or questionnaire survey for the sake of health management.

The basic survey on public health conducted by the Ministry of Health and Welfare of Japan includes the survey of subjective health over the country. It is now recognised that the score of subjective health decreases with age and the average life expectancy is longer in the group of individuals showing higher score of subjective health. It can be said that the correlation between subjective health and objective health is high.

The Todai Health Index, THI, is one of the self-administered questionnaires developed by Suzuki *et al.* in 1974 with the purpose of supplementing the Cornell Medical Index (CMI) — Health Questionnaire(Suzuki *et al.*; 1991). A survey on health effects of aircraft noise on residents living around Kadena Air Base was conducted using the Todai Health Index. This is a report of the analysis of the 12 scale scores concerning perceived physical and mental health in relation to the level of aircraft noise exposure expressed by WECPNL.

6.1 Materials and methods

The THI questionnaire consists of 130 questions regarding vague complaints, mental health, personality, health habits, and so forth. The questions are listed in Appendix B. Based on the answers to 130 questions, twelve scale

Table 6.1 Twelve scale scores of THI

Scale	Abbr.	Content or meaning
Vague complaints	VCOM	Dullness or heaviness in the legs, desire to lie down, head feels heavy or dull, headaches, stiffness or pain in the shoulders, pains in various parts of the body, feel flushed or feverish, etc.
Respiratory	RESP	Cough up phlegm, sneeze, have a runny nose, cough, have mucus in the throat, irritation or pain in the throat, etc.
Eye and skin	EYSK	Sensitive skin, itchy skin, skin eruptions or rashes, pain or itching in the eyes, inflamed or red eyes, etc.
Mouth and anal	MOUT	Rough or raspy tongue, swelling or inflammation in the mouth, bleeding hemorrhoids, bleeding gums, constipation, etc.
Digestive	DIGE	Stomach problems, stomach pain, discomfort in the stomach, diarrhea, indigestion, etc.
Irritability	IMPU	Easily irritated, lose temper, act without considering the consequences, get upset, etc.
Lie scale	LISC	Like to make people think that one is a better person, social desirability, acquiescence tendency, etc.
Mental instability	MENT	Worry about small things, feel uneasy when work is observed by others, nervous and shaky, tremble or feel weak, worry about the past, cold sweats, become mentally tired, mania and depression, etc.
Depression	DEPR	Hopeless, lonely, unhappy and depressed, less confidence, etc.
Aggression	AGGR	Never become ill, not timid, overweight, no orthostatic dizziness, drink a lot, not sensitive to cold, etc.
Nervousness	NERV	Nervous, sensitive, worry about soil and dirt, worry about everything, etc.
Irregularity of life	LIFE	Do not go to bed early, do not get up early, difficulty in awaking early, often skip breakfast, meals are irregular, poor appetite, low energy, etc.

scores are calculated to reveal the pattern of complaints. In Table 6.1 is tabulated the 12 scales as well as their contents. In Table 6.2 are presented the question numbers listed in Appendix for the 12 scales.

The survey was undertaken in six municipalities around Kadena Air Base and three around Futenma Air Station from October 1995 to September 1996. As the control three municipalities are selected in the south part of the island where aircraft noise exposure is scarce.

The questionnaire was distributed to 4,840 residents over 15 years of age around Kadena Air Base, 2,213 around Futenma Air Station and 1,031 in Shimajiri district for the control. The total sample size is 8,084. Figure 6.1 illustrates the communities, as indicated by solid small circles, where ques-

Table 6.2 Question numbers for the 12 scale scores

Scale	Num. of questions	Question numbers
VCOM	20	4, 13, 17, 24, 35, 39, 50, 52, 55, 65, 67, 69, 76, 82, 85, 89, 93, 103, 106, 120
RESP	10	5, 18, 30, 48, 62, 84, 89, 97, 106, 117
EYSK	10	6, 19, 31, 49, 63, 85, 88, 99, 108, 118
MOUT	10	3, 16, 27, 42, 56, 70, 80, 94, 104, 114
DIGE	9	7, 20, 33, 51, 64, 86, 101, 111, 127
IMPU	9	8, 21, 29, 44, 58, 72, 96, 115, 125
LISC	10	12, 36, 38, 44, 47, 61, 68, 102, 110, 126
MENT	14	9, 22, 25, 40, 53, 66, 77, 79, 81, 83, 87, 92, 105, 121
DEPR	10	11, 32, 37, 46, 60, 74, 90, 100, 109, 119
AGGR	7	1, 14, 34, 45, 73, 78, 116
NERV	8	10, 23, 41, 54, 75, 107, 112, 124
LIFE	11	2, 15, 28, 43, 57, 71, 82, 91, 95, 113, 122

tionnaires were distributed in the map of middle and south parts of Okinawa Island.

The respondents were sampled from the pole book by means of the stratified random sampling method with respect to WECPNL. As a noise-exposed group, residents living around the airfields were stratified into five groups according to the level of noise exposure expressed in WECPNL from 75 to 80, 80 to 85, 85 to 90, 90 to 95 and over 95. The number of residents living in the area of the highest noise exposure with WECPNL over 95 is so limited that the questionnaire was distributed to all the residents over 15 years. The distribution was done by means of the leave-and-pick-up method.

The number of answers collected is 6,695 to make the response rate 82.8%. The valid answers are selected on the following condition where in the individual answer respondent's age and sex are written as well as his or her address so as to identify the noise exposure in WECPNL and the respondent's age is 15 to 74 years. Valid answers thus obtained is 6,480. In Table 6.3 is shown the number of distribution, answers, and valid answers. The 615 answers of the previous survey conducted in Chatan Town in 1992 (Hiramatsu *et al.*; 1997) are added to the valid answers. The number of valid answers stratified by WECPNL are listed in Table 6.4. As a result 7,095 answers are used for analysis. However, since not all the respondents answered all the questions, the number of valid answers varies one scale after another within the range from 6,301 to 6,966.

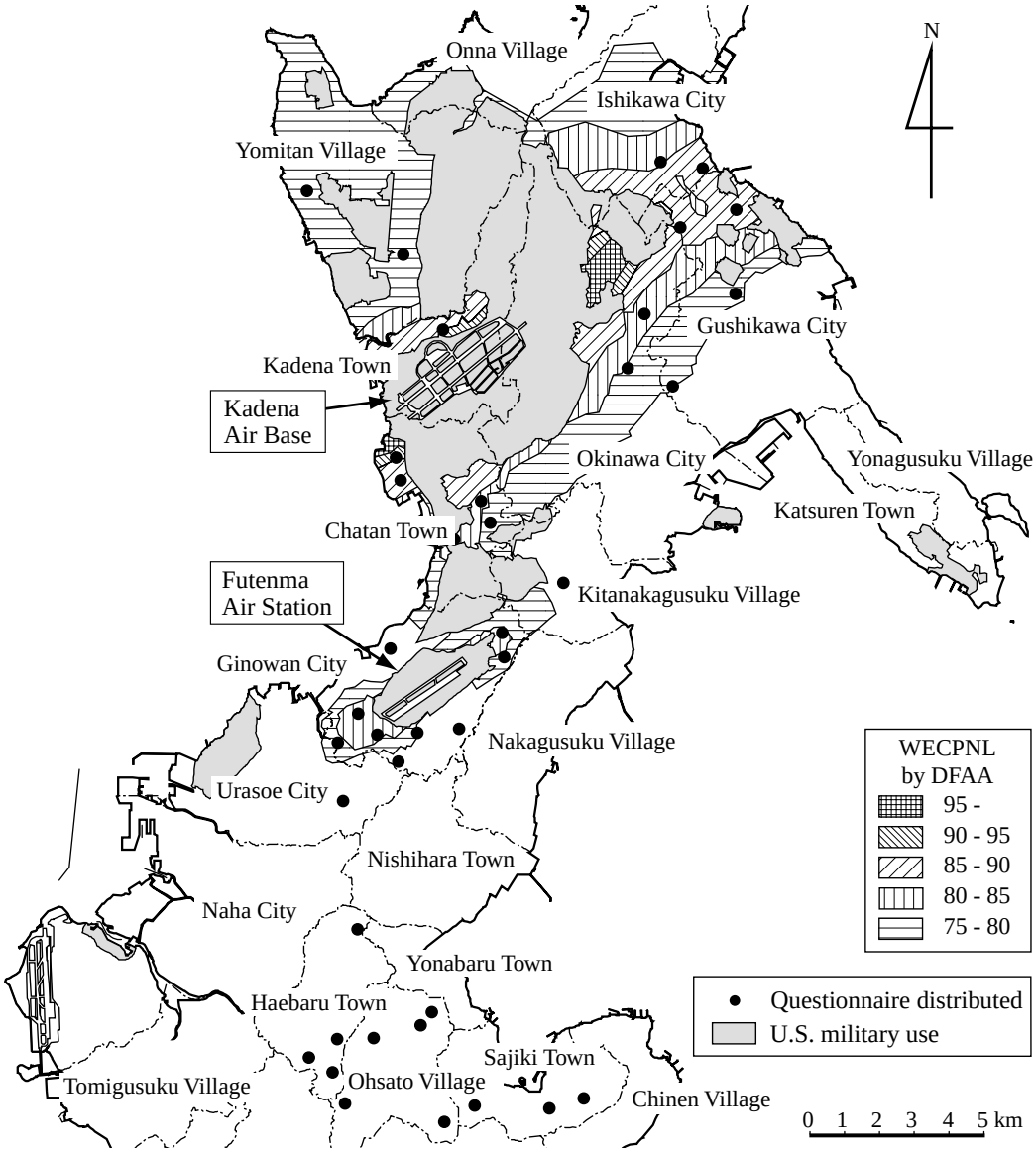


Figure 6.1 Investigated area around Kadena Air Base and Futenma Air Station.

Table 6.3 The number of distribution and valid answers

Address		Present investigation					Previous investigation	Total
		Sample size	Distribution	Collection	Recovery rate (%)	Valid answer		
Ishikawa	Mihara	76	63	38	60.3	36		36
City	Maehara	293	244	192	78.7	190		190
	Chuou	180	150	98	65.3	96		96
Gushikawa	Konbu	138	115	84	73.0	83		83
City	Enobi	166	139	138	99.3	133		133
	Nishihara	209	174	174	100.0	170		170
	Esu	127	106	102	96.2	101		101
Okinawa	Ikehara	150	124	75	60.5	73		73
City	Noborikawa	500	415	372	89.6	362		362
	Matsumoto	150	127	103	81.1	101		101
Yomitan	Iramina	337	281	232	82.6	226		226
Village	Namihei	424	380	372	97.9	357		357
Kadena	Higashi	1,014	986	810	82.2	760		760
Town	Nishihama	382	334	271	81.1	264		264
Chatan	Sunabe	297	297	224	75.4	217	237	454
Town	Miyagi	340	283	190	67.1	186	56	242
	Eiguchi	301	251	220	87.6	203	55	258
	Ujihara	227	189	169	89.4	157	31	188
	Jagaru	218	182	172	94.5	172	69	241
	Other						167	167
Subtotal		5,529	4,840	4,036	83.4	3,887	615	4,502
Kitanakagusuku								
Village	Chunjun	70	60	60	100.0	59		59
Ginowan	Nodake-1	294	245	203	82.9	197		197
City	Futenma-2	54	45	36	80.0	35		35
	Kakazu	166	150	147	98.0	146		146
	Maehara	457	381	213	55.9	209		209
	Ueohjana	113	94	82	87.2	80		80
	Ohyama	376	313	235	75.1	225		225
	Ganeko	443	369	350	94.9	337		337
	Ginowan	275	229	190	83.0	182		182
	19-Ku	170	142	127	89.4	123		123
Urasoe City	Nakama	230	185	156	84.3	152		152
Subtotal		2,648	2,213	1,799	81.3	1,745		1,745
Sajiki	Niisato	117	100	99	99.0	99		99
Town	Sajiki	103	90	88	97.8	87		87
	Tetone	108	90	89	98.9	88		88
Ohsato	Haebaru	43	41	41	100.0	41		41
Village	Hirara	53	50	39	78.0	38		38
	Touma	77	65	60	92.3	58		58
	Inamine	106	90	51	56.7	51		51
	Ohshiro	103	90	87	96.7	86		86
Haebaru	Miyagi	125	105	81	77.1	78		78
Town	Kyamu	141	120	86	71.7	85		85
	Yamakawa	105	90	70	77.8	68		68
	Kamisato	118	100	69	69.0	69		69
Subtotal		1,199	1,031	860	83.4	848		848
Total		9,376	8,084	6,695	82.8	6,480	615	7,095

Table 6.4 Number of valid answers stratified by WECPNL

WECPNL	Control	Kadena Air Base	Futenma Air Station	Total
Control	848			848
70–75			1,020	1,020
75–80		1,268	417	1,685
80–85		1,129	308	1,437
85–90		936		936
90–95		969		969
95–		200		200
Total	848	4,502	801	7,095

6.2 Results and discussion

6.2.1 An analysis of the 12 scale scores

Twelve scale scores are converted to dichotomous variables based on scale scores of 90 percentile value or 10 percentile value in the control group. Multiple logistic regression analysis taking twelve scores converted as the dependent variable and WECPNL, age, sex, occupation and the interaction of age and sex as the independent variables is conducted.

In Tables 6.5 and 6.6 are shown the significance probabilities for twelve scales scores obtained in the multiple logistic regression analysis observed for the residents around Kadena Air Base and Futenma Air Station, respectively. In the column of WECPNL of the table, the significance probabilities of trend test are given in which linear dose-response relationships are assumed between WECPNL and logarithmic values of odds ratio. As can be seen in the table significant dose-response relationships are found around Kadena Air Base in the scale scores of VCOM ($p = 0.0009$), RESP ($p < 0.0001$), DIGE ($p = 0.0004$), MENT ($p = 0.0085$), AGGR ($p = 0.0124$) and NERV ($p = 0.0005$), where p denotes significance probability of trend test. Around Futenma Air Station significant dose-response relationships are found in the scale scores of EYSK ($p = 0.0201$) and NERV ($p = 0.0014$).

The odds ratios of the seven scale scores significant dose-response relationships are found about are plotted against WECPNL in Figure 6.2. As to VCOM, odds ratios of subjects with the scale score of over 39 inclusive were statistically significant in Group 90 and Group 95 as can be seen in the figure. As to RESP and NERV, significant increases of odds ratio are observed even in the groups with lower noise exposure such as Groups 75, 80 and 85 as well as Groups 90 and 95. As to EYSK, the trend of increase of odds ratio is not

Table 6.5 Siginificance probabilities of the independent variables in the logistic regression analysis of 12 scale scores (Kadena Air Base)

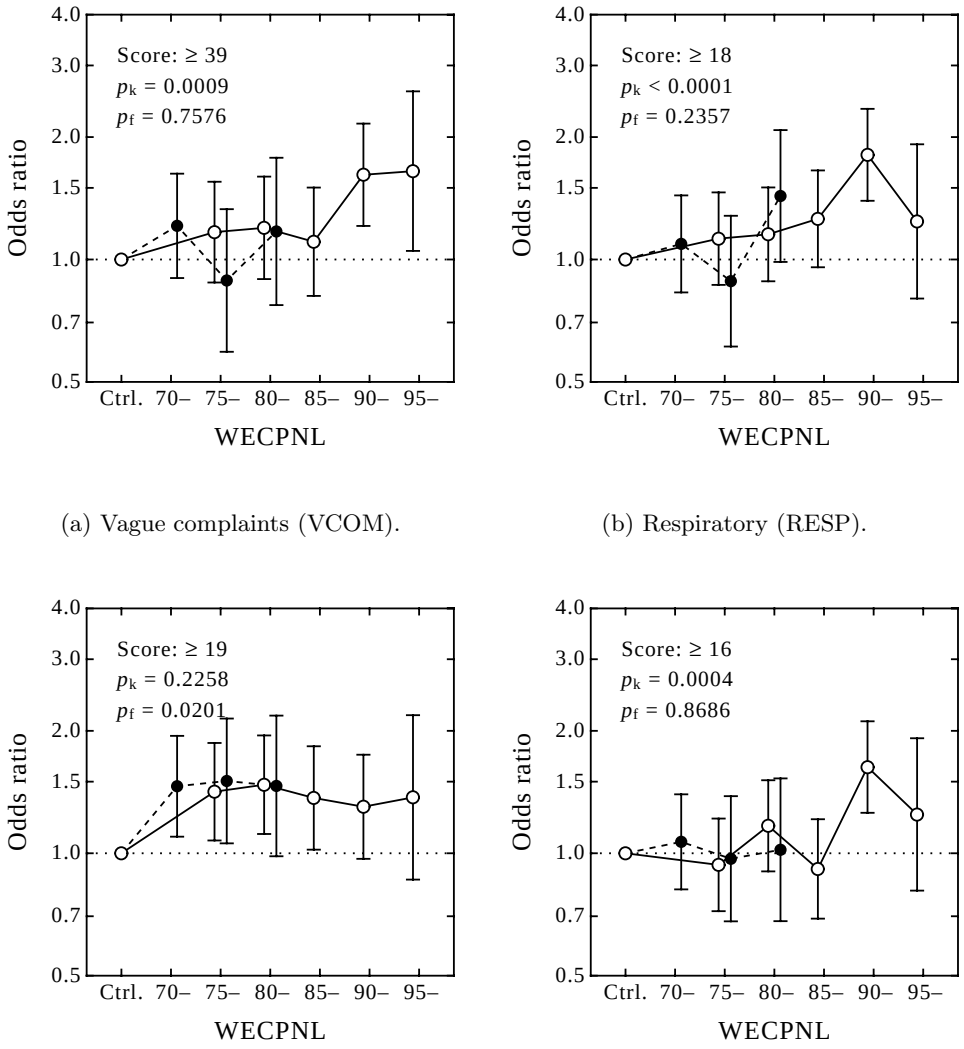
Scale	Threshold	WECPNL	Age	Sex	Age*Sex	Occupation
VCOM	≥ 39	0.0009***	0.0086**	0.8121	0.0904	0.2648
RESP	≥ 18	0.0000***	0.0112*	0.0000***	0.8999	0.2863
EYSK	≥ 19	0.2258	0.5602	0.3721	0.0000***	0.1569
MOUT	≥ 16	0.0666	0.0000***	0.7007	0.0060**	0.3086
DIGE	≥ 16	0.0004***	0.0000***	0.0000***	0.0000***	0.5826
IMPU	≥ 23	0.1356	0.0011**	0.0000***	0.0318*	0.1729
LISC	≤ 14	0.8510	0.0000***	0.0032**	0.9613	0.1111
LISC	≥ 22	0.4461	0.0000***	0.0182*	0.0843	0.3775
MENT	≥ 30	0.0085**	0.0761	0.0000***	0.0462*	0.0509
DEPR	≥ 20	0.0724	0.0015**	0.4475	0.0127*	0.1616
AGGR	≤ 12	0.0124*	0.0666	0.0000***	0.0078**	0.0000***
AGGR	≥ 18	0.4040	0.0024**	0.0000***	0.2431	0.0216*
NERV	≤ 11	0.1487	0.0063**	0.0048**	0.3946	0.0694
NERV	≥ 20	0.0005***	0.0000***	0.4469	0.7192	0.2057
LIFE	≥ 24	0.1094	0.0000***	0.0479*	0.5840	0.0000***

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

Table 6.6 Siginificance probabilities of the independent variables in the logistic regression analysis of 12 scale scores (Futenma Air Station)

Scale	Threshold	WECPNL	Age	Sex	Age*Sex	Occupation
VCOM	≥ 39	0.7576	0.8704	0.2322	0.2929	0.9373
RESP	≥ 18	0.2357	0.0269*	0.0174*	0.9005	0.5148
EYSK	≥ 19	0.0201*	0.0081**	0.0383*	0.3320	0.1569
MOUT	≥ 16	0.1209	0.0054**	0.7798	0.6860	0.3171
DIGE	≥ 16	0.8686	0.0000***	0.0081**	0.0179*	0.0202*
IMPU	≥ 23	0.8736	0.1564	0.3842	0.0709	0.3394
LISC	≤ 14	0.0576	0.0000***	0.0234*	0.6434	0.8180
LISC	≥ 22	0.0927	0.0000***	0.0426*	0.6563	0.4979
MENT	≥ 30	0.7803	0.1996	0.0000***	0.7758	0.1281
DEPR	≥ 20	0.9907	0.3792	0.5326	0.4365	0.9167
AGGR	≤ 12	0.9292	0.2210	0.0007***	0.4577	0.0815
AGGR	≥ 18	0.1711	0.0034**	0.0000***	0.0535	0.1421
NERV	≤ 11	0.2323	0.3333	0.9680	0.5019	0.2501
NERV	≥ 20	0.0014**	0.0013**	0.1400	0.1594	0.0749
LIFE	≥ 24	0.8190	0.0000***	0.1983	0.8960	0.3844

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



(a) Vague complaints (VCOM).

(b) Respiratory (RESP).

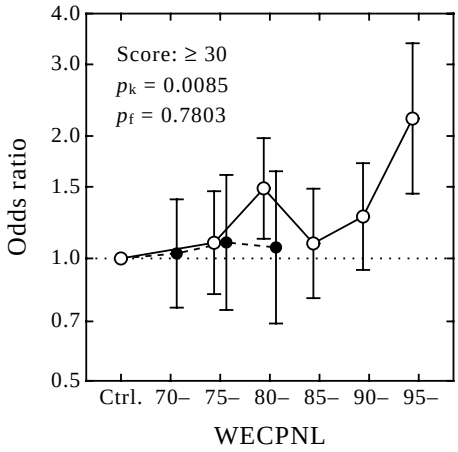
(c) Eye and skin (EYSK).

(d) Digestive (DIGE).

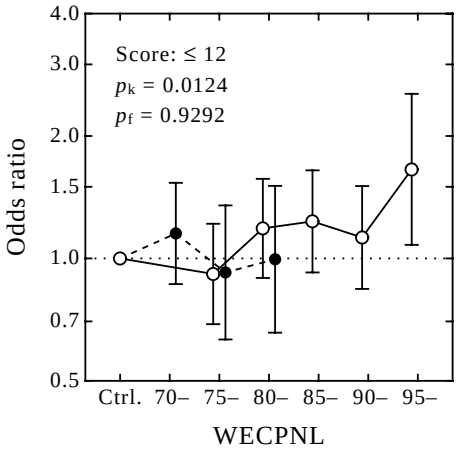
Figure 6.2 Odds ratio *vs.* WECPNL on 12 scale scores.

Open circles and solid circles show the odds ratios with the 95% confidence interval around Kadena Air Base and Futenma Air Station, respectively.

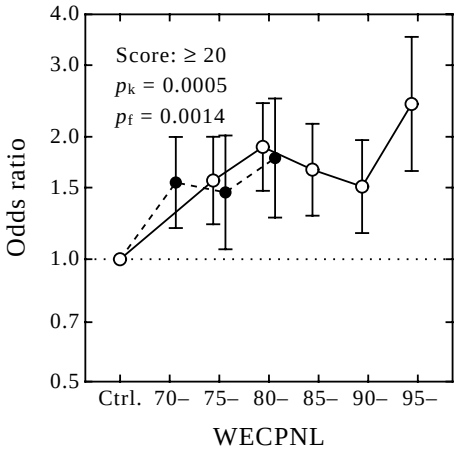
significant. However, the odds ratios of the respondents in the noise-exposed groups are more or less around 1.5. As to DIGE, odds ratio of subjects with the scale score of over 16 is elevated for the Groups of WECPNL of 90 and 95. Odds ratio regarding MENT increases as WECPNL is higher and that with scale score of over 30 inclusive exceeds 2.0 in Group 95. As to AGGR, odds ratio with scale score of less than 13 inclusive was significant in Groups 85, 90 and 95.



(e) Mental instability (MENT).



(f) Aggression (AGGR) (low score).



(g) Nervousness (NERV) (high score).

Figure 6.2 Odds ratio *vs.* WECPNL on 12 scale scores (cont.)

Open circles and solid circles show the odds ratios with the 95% confidence interval around Kadena Air Base and Futenma Air Station, respectively.

Table 6.7 Siginificance probabilities of the independent variables in the logistic regression analysis of DF values (Kadena Air Base)

DF value	WECPNL	Age	Sex	Age*Sex	Occupation
Psychosomatic	0.0000***	0.4329	0.0000***	0.4501	0.0080**
Neurosis	0.2159	0.0064**	0.0177*	0.0333*	0.0593

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

6.2.2 Analysis of DF values

The discriminant function (DF) values for psychosomatics and neurosis are calculated as is proposed by Suzuki *et al.* (1991). The dichotomous variables converted from the DF values are applied as the dependent variables in the logistic regression analysis with the independent variables of WECPNL, age, sex, occupation and the interaction of age and sex. The conversion of the variables is done with the threshold of null of the DF value.

Tables 6.7 and 6.8 are the lists of significance probabilities obtained in the trend test of odds ratio of DF values of the residents around Kadena Air Base and Futenma Air Station regarding the different variables used in the logistic regression analysis. The probability of psychosomatics for WECPNL around Kadena Air Base is very low indicating that the trend of increase of odds ratio with the increase of the level of noise exposure is highly significant. In Figure 6.3 is shown the results of the analysis of the DF values of psychosomatics, where the odds ratio is plotted as a function of the level of noise exposure expressed by WECPNL. The vertical bars indicate 95% confidence limits of the odds ratio and p_{k} and p_{f} indicate confidence probabilities of trend test for Kadena Air Base and Futenma Air Station. The clear dose-response relationship is found and the trend of increase is statistically significant for Kadena Air Base. The odds ratio of the area of WECPNL over 95 is over 2.0. The result of the analysis of DF value of neurosis is also shown in Figure 6.3. From the figure it can be seen that the odds ratio is significantly high in the area of WECPNL 95.

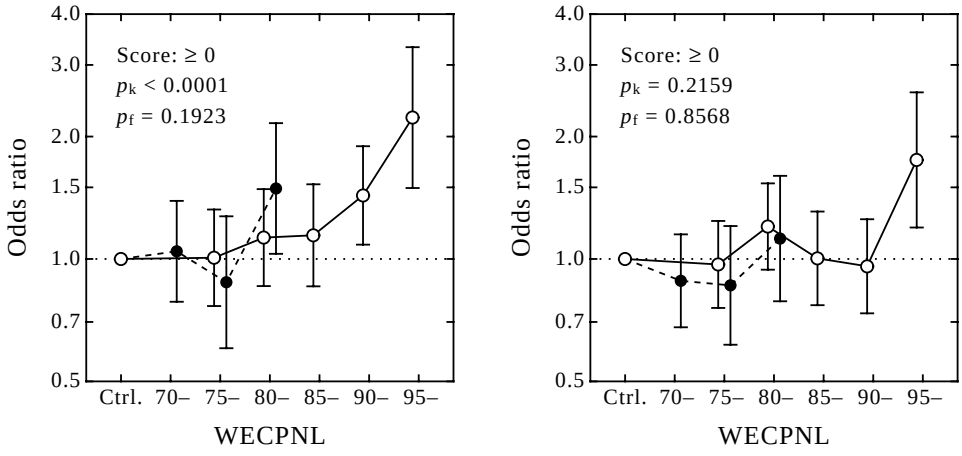
6.2.3 Analysis of factor scores

In this section principal factor analysis is applied and then Oblimin rotation is carried out using the 12 scale scores.

Table 6.9 is the factor pattern matrix of two factors extracted by the factor analysis by means of principal factor method with Oblimin rotation.

Table 6.8 Siginificance probabilities of the independent variables in the logistic regression analysis of DF values (Futenma Air Station)

DF value	WECPNL	Age	Sex	Age*Sex	Occupation
Psychosomatic	0.1923	0.8130	0.0662	0.2828	0.2207
Neurosis	0.8568	0.6624	0.0803	0.1872	0.4425



(a) Psychosomatic.

(b) Neurosis.

Figure 6.3 Odds ratio *vs.* WECPNL on DF value.

Open circles and solid circles show the odds ratios with the 95% confidence interval around Kadena Air Base and Futenma Air Station, respectively.

Table 6.9 Patern matrix of factor analysis with Oblimin rotation

Scale	Abbr.	Somatic factor	Mental factor
Vague complaints	VCOM	0.871*	0.034
Respiratory	RESP	0.730*	−0.066
Eye and skin	EYSK	0.700*	−0.001
Mouth and anal	MOUT	0.587*	0.072
Digestive	DIGE	0.689*	−0.003
Irritability	IMPU	0.003	0.718*
Lie scale	LISC	0.084	−0.601*
Mental instability	MENT	−0.018	0.908*
Depression	DEPR	0.178	0.655*
Aggression	AGGR	−0.144	−0.384
Nervousness	NERV	0.034	0.506*
Irregularity of life	LIFE	0.425	0.265

* : ≥ 0.5

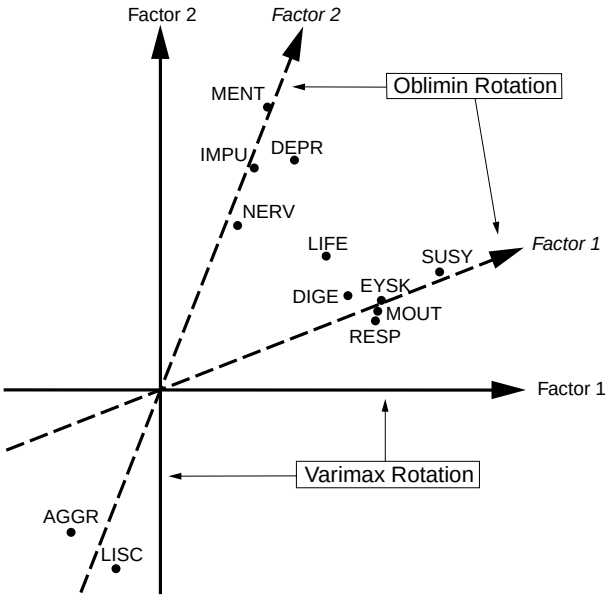
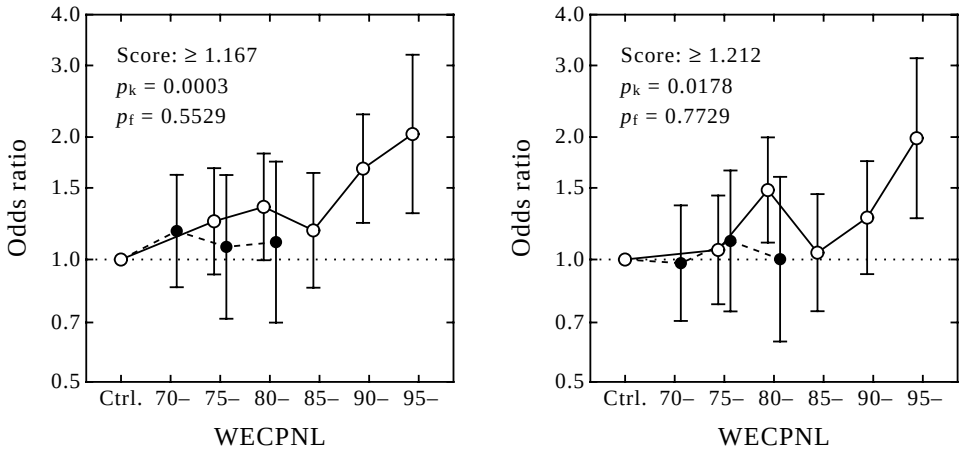


Figure 6.4 Comparison of Oblimin rotation and Varimax rotation.

The factor showing strong relation with somatic symptoms is named as somatic factor and the other related with mental symptoms as mental factor. Oblimin rotation is applied in the present analysis since the factors extracted are considered to correlate with each other. In Figure 6.4 is illustrated the comparison of Oblimin rotation and Varimax rotation.

The dichotomous variables converted from the factor scores are applied as the dependent variables in the logistic regression analysis with the independent variables of WECPNL, age, sex, occupation and the interaction of age



(a) Somatic factor.

(b) Mental factor.

Figure 6.5 Odds ratio *vs.* WECPNL on factor scores.

Open circles and solid circles show the odds ratios with the 95% confidence interval around Kadena Air Base and Futenma Air Station, respectively.

and sex. The factor scores of 90 percentile of the control are taken as the thresholds in the conversion of the variables of factor scores.

Figure 6.5 show the odds ratios of somatic factor and mental factor plotted as a function of WECPNL, respectively. Clear dose-response relationship is found for Kadena Air Base in Figure 6.5 where the trend of increase of odds ratio regarding somatic factor starts from comparatively lower level of WECPNL of 75. Although in the case of mental factor the dose-response relationship shown in Figure 6.5 is not as clear as in the case of somatic factor, higher odds ratio is observed in the area of highest noise exposure. Odds ratio is over 2.0 in the area where WECPNL is over 95.

In Tables 6.10 and 6.11 is listed the significance probabilities obtained in the trend test of odds ratio of factor scores of the residents around Kadena Air Base and Futenma Air Station regarding the different variables used in the logistic regression analysis.

6.3 Conclusions

As a non-specific biological stressor, noise can influence the entire body system via both autonomic nervous system and neuroendocrine system (Morrell *et al.*; 1997). In this sense, it would be reasonable to consider that pro-

Table 6.10 Siginificance probabilities of the independent variables in the logistic regression analysis of factor scores (Kadena Air Base)

Factor score	Threshold	WECPNL	Age	Sex	Age*Sex	Occupation
Somatic factor	≥ 1.167	0.0003***	0.1771	0.0864	0.0108*	0.0460*
Mental factor	≥ 1.212	0.0178*	0.0018**	0.2380	0.0055**	0.1802

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

Table 6.11 Siginificance probabilities of the independent variables in the logistic regression analysis of factor scores (Futenma Air Station)

Factor score	Threshold	WECPNL	Age	Sex	Age*Sex	Occupation
Somatic factor	≥ 1.167	0.5529	0.1040	0.3567	0.7865	0.7222
Mental factor	≥ 1.212	0.7729	0.2028	0.0010***	0.1276	0.9476

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

longed and repeated exposure of aircraft noise may adversely affect health and well-being of individuals around Kadena Air Base, making allowance for the serious noise exposure level in the residential area (Chapter 2) and the high community responses (Chapter 3) regarding sleep disturbance, disturbance of rest, fear of possible danger as well as annoyance. In addition, it was denied that sound insulation as a measure against aircraft noise and air conditioning which reduces ventilation might cause the spread of air borne infections and thus increase the complaints regarding respiratory organs (RESP). Finally, it should always be borne in mind that physical health effects of noise may manifest in susceptible subgroup within a population and the sites where various symptoms appear are different among individuals even in the same conditions of noise exposure.

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