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POPULATION-BASED QUESTIONNAIRE SURVEY ON HEALTH EFFECTS OF AIRCRAFT NOISE ON RESIDENTS LIVING AROUND U.S. AIRFIELDS IN THE RYUKYUS—PART II: AN ANALYSIS OF THE DISCRIMINANT SCORE AND THE FACTOR SCORE

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Discriminant function values of psychosomatics and neurosis are calculated using the 12 scale scores of the Todai Health Index, a general health questionnaire, obtained in the survey done around the Kadena and Futenma U.S. airfields in Okinawa, Japan. The total number of answers available for the analysis is 6301. Factor analysis is applied to the 12 scale scores by means of the principal factor method, and Oblimin rotation is done because the factors extracted are considered likely to correlate with each other to a greater or lesser extent. The logistic regression analysis is made with the independent variables of discriminant function (DF) values and factor scores and with the dependent variables of L_{dn}, age (six levels), sex, occupation (four categories) and the interaction of age and sex. Results indicate that the odds ratio of the DF values regarding psychosomatic disorder and of the score of somatic factor have clear dose–response relationship. The odds ratios of the DF value of neurosis and of the score of the mental factor increase in the area where noise exposure is very intense.

1. INTRODUCTION

The Todai Health Index (THI), is a self-administered questionnaire developed by Suzuki *et al.* [1] in 1974 to act as a supplement to the Cornell Medical Index (CMI)—Health Questionnaire. A survey on health effects of aircraft noise on residents living around the Kadena and Futenma airfields in Okinawa in the Ryukyus was conducted using the THI. The results and analysis of 12 scale scores are reported in a previous paper [2]. This is the report of the results obtained by the analysis of the discriminant function (DF) values and the factor scores.

2. METHODS

The DF values for psychosomatic disorder and neurosis were calculated by the discriminant function equation as proposed by Suzuki *et al.* [1]. Aoki *et al.* [3] suggested some revised discriminant functions to calculate DF values, among which is a formula requiring all the 12 scale scores for the calculation. This is applied in the present analysis.

Factor analysis was used for the 12 scale sores obtained in the previous paper. After extracting two factors by the principal factor method, Oblimin rotation was carried out since the factors extracted are considered to be likely to correlate with each other to a greater or lesser extent.

The dichotomous variables converted from the DF values and the factor scores were applied as the dependent variables in the logistic regression analysis with the independent variables of L_{dn}, age (six levels), sex, occupation (four categories) and the interaction of age and sex. The conversion of the variables was done with the threshold of null of the DF value. The factor scores of 90 percentile of the control were taken as the thresholds in the conversion of the variables of factor scores.

A total of 6301 respondents answered all the items in the questionnaire necessary to calculate 12 scale scores. These are shown in Table 1 with the breakdown list stratified according to L_{dn}.

3. RESULTS AND DISCUSSION

3.1. ANALYSES OF DF VALUES

Figure 1 presents the response rates in percentage of different DF values of psychosomatic disorder in Figure 1(a) and neurosis in Figure 1(b) for each of the stratified groups according to the noise exposure. The rates are adjusted so that the respondents'

TABLE 1

The number of respondents on DF values and factor scores

		L_{dn} (dB)					
Airfield	Ctrl.	–55	55–	60–	65–	70–	Total
Kadena	—	1667	737	608	793	183	3988
Futenma	—	911	261	381			1553
Ctrl.	760						760
Total	760	2578	998	989	793	183	6301

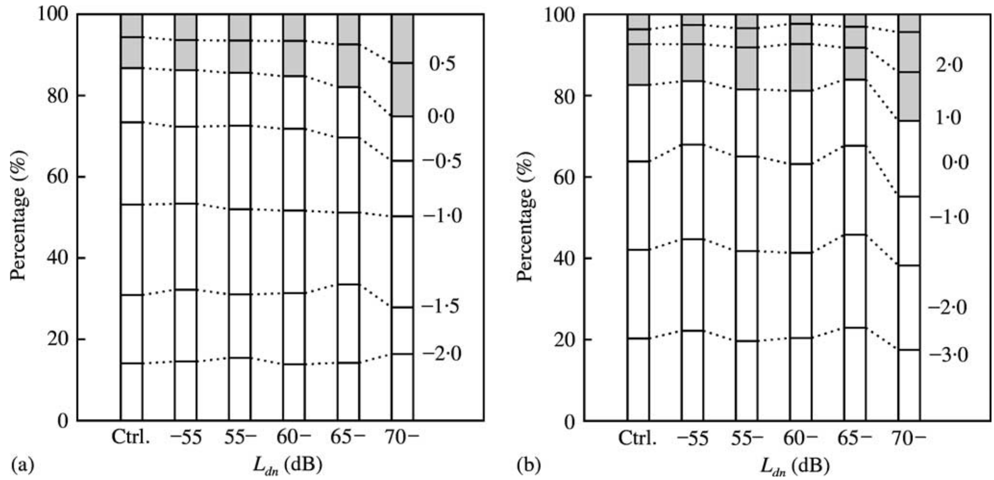

Figure 1. Discriminant function value versus L_{dn}: (a) psychosomatic disorder; (b) neurosis.

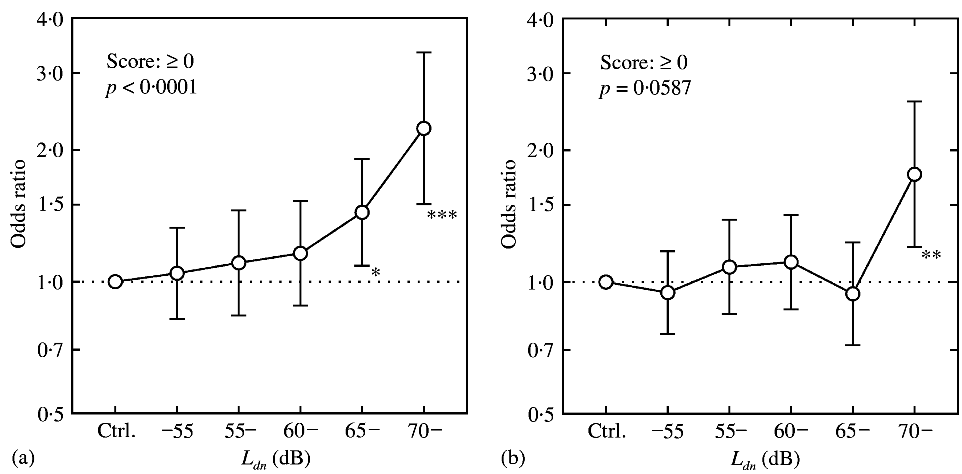

Figure 2. Odds ratio versus L_{dn} on Discriminant function values: (a) psychosomatic disorder, (b) neurosis (*, $p < 0·05$; **, $p < 0·01$; ***, $p < 0·001$).

proportion with respect to age and sex matches that of the control. The figures shown in the right side of the rightmost bar are the DF values. In the figure the shadowed parts of the bars indicate the respondents with positive DF values. Figure 1(a) shows that the rate of respondents with positive DF values for psychosomatic disorder rises as the noise exposure becomes greater. The rate of respondents with positive DF values in the group with the greatest noise exposure is about 26%, which is twice as high as the approximately 13% in the control group.

Figure 1(b) indicates that the rate of respondents that had positive DF values for neurosis remains around that of the control group, 17%, in the groups with L_{dn} below 70 dB and rises to 27% in the highest noise exposure group.

Figure 2(a) shows the result of the analysis of the DF values of psychosomatic disorder, where the odds ratio with the threshold of zero DF value is plotted as a function of the level of noise exposure expressed as L_{dn}. The factors that would be related to the response such as age, sex, occupation, and the interaction of age and sex are applied as the independent

TABLE 2

Pattern matrix of factor analysis with Oblimin rotation

Scale	Somatic factor	Mental factor
Vague complaints	0·876†	0·033
Respiratory	0·706†	– 0·056
Eye and skin	0·699†	0·012
Mouth and anal	0·566†	0·079
Digestive	0·701†	– 0·024
Irritability	0·025	0·698†
Lie scale	0·097	– 0·607†
Mental instability	– 0·016	0·907†
Depression	0·164	0·668†
Aggression	– 0·126	– 0·404
Nervousness	0·047	0·506†
Irregularity of life	0·426	0·260

† > 0·5.

variables in the logistic regression analysis. The vertical bars in the figure indicate 95% confidence limits of the odds ratio and the small p indicates the significance probability (two-tailed) of the trend test.

A clear dose–response relationship is found between the odds ratio of psychosomatic disorder and aircraft noise exposure, and the trend of increase was found to be statistically significant (trend test, $p < 0{\cdot}0001$). The odds ratio of the area of L_{dn} over 70 is over 2·0.

The result of the analysis of the DF value of neurosis is also shown in Figure 2(b). The figure shows that the odds ratio was high and significant ($p = 0{\cdot}0037$) in the area of L_{dn} 70 dB but that the linear dose–response relationship was not as clear in the range of noise exposure observed in the area. The significance probability (two-tailed) of the trend test is 0·0587 in the case of neurosis.

3.2. ANALYSES OF FACTOR SCORES

Table 2 shows the factor pattern matrix of two factors extracted by the principal factor analysis with Oblimin rotation. Figure 3 compares the results of the Oblimin and Varimax rotations. It is seen that Oblimin rotation provided a better fit to the scale scores than Varimax rotation does, which suggests that the two factors are correlated with each other. The factor showing strong relation with somatic symptoms was named as "somatic factor" and the other one related with mental symptoms as "mental factor".

The logistic regression analysis was carried out using the factor scores with the threshold of the score given to 90 percentile of the respondents in the control group. The independent variables applied in the logistic regression analysis were L_{dn}, age, sex, occupation and the interaction of age and sex.

Figure 4 shows the odds ratios of somatic factor and mental factor plotted as a function of L_{dn}. A dose–response relationship was found with the trend of increase of odds ratio regarding somatic factor starting from the comparatively low level of L_{dn} of 55 dB. Although in the case of mental factor, the dose-response relationship shown in the figure is not as clear as in the case of somatic factor, high odds ratios were observed in the high noise exposed area ($p = 0{\cdot}0028$). Odds ratios were over 2·0 in the area where L_{dn} is over 70.

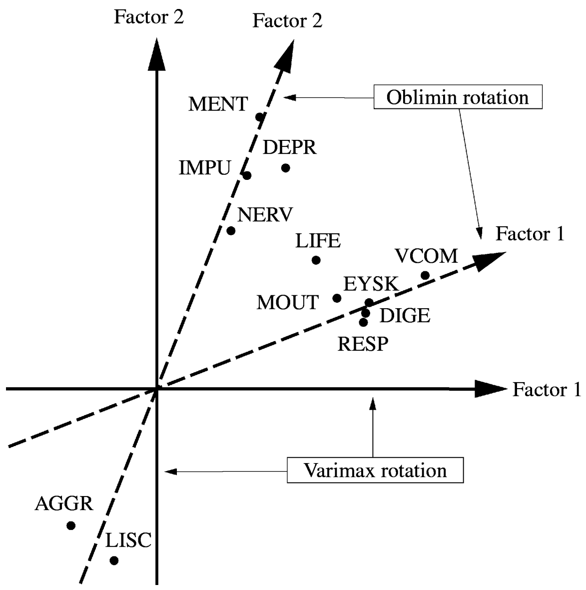

Figure 3. Comparison of Oblimin rotation and Varimax rotation.

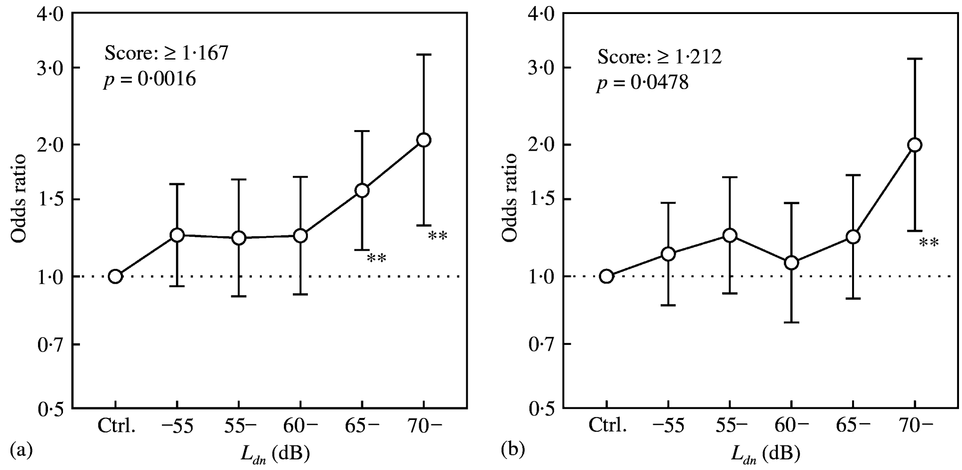

Figure 4. Odds ratio versus L_{dn} on factor scores (a) somatic factor; (b) mental factor. (*, $p < 0{\cdot}05$; **, $p < 0{\cdot}01$; ***, $p < 0{\cdot}001$).

4. COMMENTS

On the medical significance of DF values, Aoki *et al.* [4] state "The larger the DF value, the greater the probability of disease." The zero point of DF value is considered to be the threshold of identification of disease from normal, and positive DF value indicates that the individual has the tendency of psychosomatic disorder or neurosis. It is reported that the sensitivity of identification by the DF value is 82·0% in the group of psychosomatic disorder and 80·8% in the group of neurosis judged as such by doctors [3]. Although an individual whose DF value exceeds zero does not necessarily mean he or she is judged to have psychosomatic disorder or neurosis by diagnosis and vice versa, the probability of identification is sufficiently high.

The results indicate that the odds ratio of DF values regarding psychosomatic disorder and that of the score of somatic factor show dose–response relationship. The odds ratios of DF value of neurosis and that of the score of mental factor increased in the area where noise exposure was very intense. Judging from the results obtained in the present study as well as the previous paper [2], it would not be very unsafe to say that some portion of the residents living around the two airfields might manifest some kind of mental and somatic symptoms. At the same time, it should always be borne in mind that physical health effects of noise may manifest in a susceptible subgroup within a population and the sites where various symptoms appear are different among individuals even in the same condition of noise exposure.

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