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COMMUNITY ANNOYANCE AND SLEEP DISTURBANCE FROM RAILWAY NOISE IN KOREA

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ABSTRACT

Field study on adverse effects from railway noise was surveyed using questionnaire in 18 areas around railway. Questionnaire contains demographic factors, noise annoyance and sleep disturbance, self-rated noise sensitivity, interference with daily activities and health-related symptoms. Community annoyance and sleep disturbance scale is divided into 11 from 0 to 10 with equal interval. In this paper, highly annoyed and sleep disturbed people is defined as people rating over 8 (upper 28%) among 11 numerical scales. The relationship between highly annoyed and sleep disturbed population and their corresponding noise level is introduced in Korea. From Korea Railroad Corporation, time table of railway services could be acquired. Environmental noises are controlled using measured data in surveyed areas and information of railway services. In this paper, the relation between percent highly annoyed (and sleep disturbed) population and day-night average sound level L_{dn} (and nighttime equivalent sound level L_{night}) is introduced.

KEYWORDS: Railway noise, Annoyance, Sleep disturbance

INTRODUCTION

Environmental noise is issued with development of industry because noise pollution as a side effect of industrialization is opposed to quality of life. For this reason, human response to noise has assessed through field and laboratory study in many countries since 1960s. Researches on public health induced by environmental noises have conducted for last few decades and first study on adverse effects from transportation noise was investigated in Korea [1~5].

Most of all, annoyance and sleep disturbance are the most important health effects of environmental noise exposure and World Health Organization (WHO) has recommended population annoyance and sleep disturbance as environmental health indicators to support the effects of environmental noise on health [6]. There are many results of researches on community annoyance and sleep disturbance.

For example, Schultz (1978) synthesized the results of social surveys conducted in several countries with different number of steps in annoyance scale. Highly annoyed (upper 27~29%) population was surveyed [2]. Kryter (1982) and Miedema et al. (1998) proposed different annoyance model according to noise sources [7~8]. Fine gold et al. (1994) have updated adding new data to data used in 1978 Schultz curve [2] and the relationship between percentage of awakening and noise level based on meta-analysis about eight field studies [3]. Miedema et al. (2002, 2003) investigated %HSD (percent highly sleep disturbed) from 3 different noise sources (aircraft noise, railway noise and road traffic noise) and aircraft noise induced probability of awakening and motility model was proposed through analysis of actimeter (with event marker) data [9~10].

In this paper, percent highly annoyed and sleep disturbed population was investigated by questionnaire. The result of this research was compared with other countries.

METHOD OF FIELD STUDY

Site Selection. Field survey was performed in 18 sites around Gyungbu and Honam railway lines in Korea. The two lines cover more than a half of whole railway services. Therefore, residents in the sites have mainly suffered from railway noise.

Table 1 shows distances from railways to houses in this survey. The average distance was 90m, but about 80% of sites were situated within 100m from railway. Table 2 is the information of railway service acquired from Korea Railroad Corporation. Time table for train operation could be also acquired and it is used to control railway noise data. As shown in table 2, the average number of train operation in Gyungbu line is 250/day and 51/day in Honam line. All of the trains are operated by diesel engine.

Table 1 Distance from railway to houses

Distance (m)	d<20	20<d<40	40<d<100	100<d<200	d>200
Number of sites	3	4	7	2	2
Percentile (%)	16.7	22.2	38.9	11.1	11.1

Table 2 Information on railroad vehicle service

Railway	Type of trains (Diesel)		Number of trains per day	
	Passenger	Freight	Day-time	Night-time
Gyungbu line	152	98	178	72
Honam line	32	19	41	10

Noise Measurements. Noise measurement was carried out in each survey areas and free field type SPL meter (B&K Co. type 2238 and Larson & Davis Co. type 812) was used. Frequency weighting was set to be ‘A’ and time integration filter ‘fast’ was applied in SPL meter and time history of noise level was logged in every 5 sec.

Day-night average noise level, L_{dn} and nighttime equivalent noise level, L_{night} was calculated as measures of noise exposure for assessing noise annoyance and sleep disturbance by following formula.

$$L_{dn} = 10 \log [15(10^{0.1L_{day}}) + 9(10^{0.1(L_{night}+10)})] / 24 \quad (1)$$

Day-night average noise level is with a nighttime penalty of 10 dB(A) based on A-weighted equivalent noise level during daytime (07:00~22:00) and nighttime (22:00~07:00).

Questionnaire and field survey. Subjective responses to railway noise were investigated within about 50 meters from noise measurement area using a questionnaire. The questionnaire contained questions about demographic factor, degree of noise annoyance and sleep disturbance, self-rated noise sensitive, interferences with daily activities, psychological and physiological health-related symptoms and reaction to a railway noise. Especially, the questions for assessment of noise annoyance and sleep disturbance are ‘how much railway noise has bothered or annoyed you when you have been here at home during the last 12 months’ and ‘How much have you been disturbed your sleep from railway noise in the night time?’ Respondents select rated annoyance and sleep disturbance scale from 0 to 10 by themselves. ‘0’ means ‘not at all’ and ‘10’ means ‘extremely’. Highly annoyed and sleep disturbed were defined as the upper 27~28% among 11 numerical scales.

ANALYSIS AND RESULTS

Data acquired from 613 respondents were analyzed statistically. The relationship between highly annoyed population among 613 respondents and their corresponding noise level (L_{dn}) was founded. Sleep disturbance prediction curve was also founded.

To assess the effects of noise on health, the percentage of respondents who felt highly annoyed (%HA) and highly sleep disturbed (%HSD) are recommended as the indicator of noise annoyance and sleep disturbance. The day-night average sound level (L_{dn}) and nighttime equivalent sound level (L_{night}) are selected as the uniform metric for the description of noise in many countries. Therefore, %HA and L_{dn} have been used to assess the relationship between railway noises and annoyance responses. %HSD and L_{night} have also been used to assess the relationship between railway noises and sleep disturbance responses. The results of this research were compared with those of other countries.

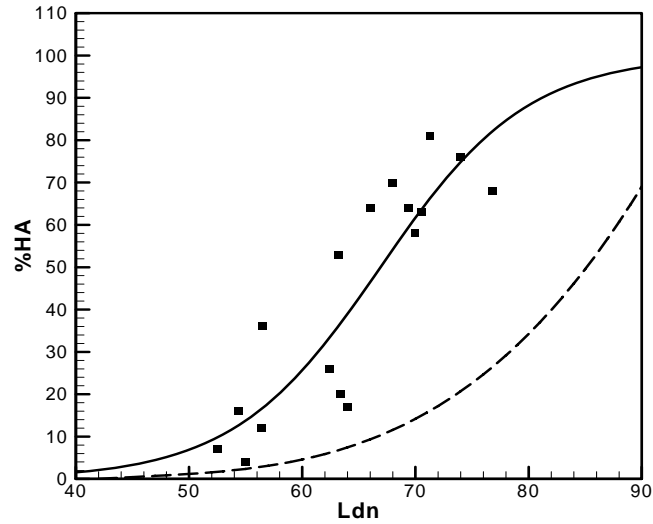


Fig. 1 Comparison between %HA prediction curve of railway noise in this study and that in European country. (■ , field survey data with respect to L_{dn} in this study; — , %HA prediction curve in this study; - - - - , Miedema et al. %HA prediction curve[8])

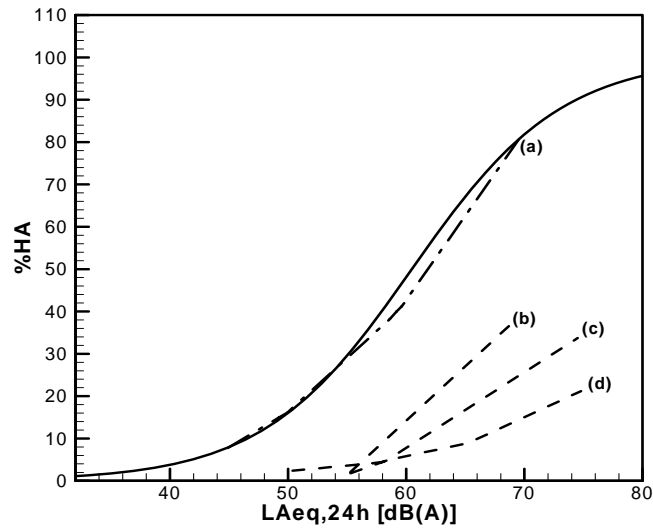


Fig. 2 Comparison between %HA prediction curve of railway noise in this study and those in other countries. (— , %HA prediction curve in this study; (a) Japan 1992[11]; (b) France 1988[12]; (c) Denmark 1988[12], (d) U.K. 1984[12])

Fig. 1 shows field survey data and %HA curve. In this figure, annoyance response from railway noise according to L_{dn} in this research is compared with one in Miedema *et al.*'s research. Fig. 2 is comparison between %HA prediction curve according to $LA_{eq,24h}$ of railway noise in this study and other countries. The results of this study are much more severe than those of European countries. Noise annoyance from railway noise causes less annoyance than other transportation noise in European countries and railways are socially more acceptable than other

types of transportation because of safety, economy and convenience [13]. ‘Railway bonus’ is, therefore, applied to railway noise. There is, however, no scientific evidence why respondents feel that a railway noise is less annoying than other transportation noise. The extent of annoyance from railway noise in Japan is similar to the result of this research [11].

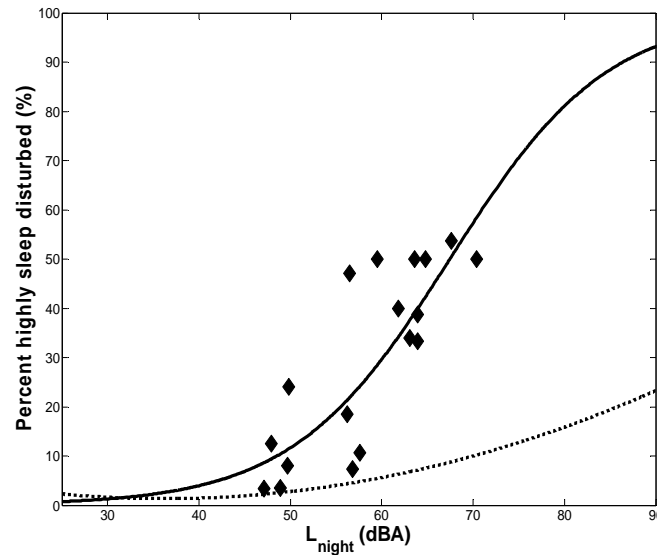


Fig. 3 The result of field survey and comparison with other country (◆, field survey data with respect to L_{night} in this study; —, %HSD prediction curve in this study; ·····, Miedema *et al.* %HSD prediction curve [9])

Fig. 3 also shows quite difference between sleep disturbance response to railway noise in this research and one in Miedema *et al.*'s research. Severe difference between Asian results and European results might come from composite cause such as cultural and environmental differences, relative positions between railway and houses, an attitude to railway noise, a population density and so on.

CONCLUSIONS

Annoyance and sleep disturbance as indicators of environmental health effects were investigated in 18 areas around Gyungbu and Honam lines. Noise measurements were carried out in every survey areas and field survey within 50 meters from points where railway noise was measured. From the statistical analysis, the relationship between not only annoyance but sleep disturbance and noise level was introduced. Also, quite different response to railway noise was found through comparing Korean field survey with others. Annoyance and sleep disturbance from railway noise in Korea is much higher than in European countries. On the other hand, so similar results were shown in Japan which is similar to Korea in environmental and cultural conditions. From these results, it would be difficult to apply railway bonus to the regulation of railway noise in Korea.

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