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COMMUNITY REACTIONS TO NOISE AND VIBRATIONS FROM RAILWAY TRAFFIC

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1. INTRODUCTION

Effects on annoyance, sleep, well-being and activity disturbance were evaluated in fifteen different sites located near railway lines in Sweden. The study covered areas with different number of trains per 24 hours in areas with strong vibration caused by the railway traffic exceeding 2 mm/s as well as areas without vibration. In this paper only the results from two areas with and without vibration and a high number of trains per 24 hours are presented. The results show that railway noise is more annoying in areas where there is simultaneous exposure to vibration. To ensure an acceptable environmental quality where less than 5 % of the exposed population is rather or very annoyed by railway noise, these noise levels must be below 80 LAmax and below 55 LAeq respectively in areas without vibration. In areas with simultaneous exposure to strong vibration, action against vibration or a longer distance between houses and the railway line is needed, corresponding to a 10 dBA lower noise level than in areas without vibration.
[Key words: railway noise, vibration, annoyance, sleep, speech]

2. BACKGROUND AND AIM

A majority of the studies reported in the literature show that railway noise causes less annoyance (4-15 dB) than road traffic noise (1). In Sweden railway noise is a minor problem as compared to road traffic noise (2, 3). About 350 000 people are exposed to noise levels from railway traffic exceeding 55 dBA LAeq. There is an urgent need for guideline values for railway noise in Sweden since new railway lines are planned and the railway traffic is increasing.

In order to elucidate effects of noise and vibration from railway traffic as a basis for Swedish guideline values, a study involving a number of investigations in areas with and without vibration was designed.

3. METHOD AND MATERIALS

Design of the study

In the first phase and as a basis for the design of the study an inventory of the Swedish railway lines was performed. Parameters of interest were the extent of vibration in buildings caused by railway traffic, total number of trains per 24 hours and proportion of freight trains. The following parameters were included in the design of the study: vibration level (<1 mm/s, >2 mm/s) and number of trains (less than 25 trains to more than 150 trains per 24 hours). In total 15 cities or urban areas were selected for the investigation. The sites were located between 10 and about 300 meters from the railway line.

Exposure

Noise levels were calculated according to the Nordic calculation model for noise. The levels were calculated in 5 dBA intervals for LAmax and LAeq, respectively. In some of the areas control measurements were made at different distances from the railway line.

The aim was not to study vibration in detail, but vibration levels in the buildings had previously been measured in some of the areas classified as areas with strong vibration. Vibration level [mm/s mean maximum level, not frequency weighted] varies with type of house, distance from the railway line and with speed and weight of the trains. The distance between each house and the railway line was therefore measured on the map and questions about the construction of the dwelling were included in the questionnaire.

Evaluation of effects

The effects were evaluated by postal questionnaires which were sent together with an introductory letter to one person in each household between 18 and 75 years of age. The main questionnaire contained questions about the dwelling, annoyance to different sources in the neighbourhood, sleep and sleep disturbances and health and general well-being. General annoyance was evaluated by a five-point verbal category scale; 0 ="do not observe", 1= "observe, but is not annoyed", 2= "not very annoyed", 3= "rather annoyed" and 4= "very annoyed".

Those who responded that they were "rather" or "very" annoyed by noise or vibration from railway traffic received a second questionnaire on disturbance of different activities.

4. RESULTS

The results from the two areas with the highest number of trains (143-160 trains/24 hours), Partille with vibration and Lund without vibration are presented here.

The response rate for the main questionnaire in the two areas was 72 and 77 % percent respectively or 390 (Partille) and 553 (Lund) respondents.

General annoyance to railway noise

Table 1 illustrates annoyance to railway noise at different LAmax- and LAeq-levels.

Table 1. Annoyance different LAmax- and LAeq levels.
(I = average annoyance, II= % rather + very annoyed.)

L_{Amax}	70-75 Annoyance		76-80 Annoyance		81-85 Annoyance		86-90 Annoyance		91-95 Annoyance	
	I	II	I	II	I	II	I	II	I	II
PARTILLE	1.10	8.1	1.35	10.7	1.77	29.6	2.58	53.3	2.88	60.6
LUND	0.83	0	1.01	2.7	1.23	7.2	1.71	18.0	2.03	34.3

L_{Aeq}	46-50 Annoyance		51-55 Annoyance		56-60 Annoyance		61-65 Annoyance		66-70 Annoyance	
	I	II	I	II	I	II	I	II	I	II
PARTILLE	0.93	0	1.26	12.4	1.26	9.6	1.99	34.7	2.71	61.3
LUND	0.81	0	1.03	3.2	1.18	6.7	1.80	19.1	1.94	32.3

The table shows that at similar noise levels the average mean annoyance reaction as well as the percentage of rather + very annoyed respondents was much higher in Partille, the area with strong vibration.

Comparisons between annoyance to noise and vibration.

The average annoyance reaction was higher for vibration than for noise up to about 200 meters from the railway line (figure 1).

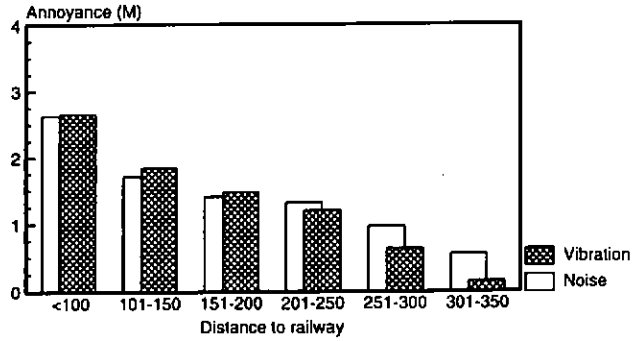

Figure 1. Annoyance to noise and vibration at different distance from the railway line (Partille).

Respondents who lived in apartments with bedroom windows facing the railway line were more annoyed by noise than those having bedroom windows not facing the railway. This is shown in table 2.

Table 2. Annoyance to noise in relation to outside noise level and location of bedroom windows.

	PARTILLE (vibration > 2 mm/s) Annoyance (mean value)				LUND (vibration < 1 mm/s) Annoyance (mean value)			
	n	Facing railway	n	Not facing railway	n	Facing railway	n	Not facing railway
> 80 L_{Amax}	28	3.0***	131	2.06	84	1.89***	168	1.29
< 80 L_{Amax}	24	2.0***	207	1.10	23	1.30***	276	0.84

About 40 % of those who were exposed to outside noise levels above 80 LAmax and had bedroom windows facing the railway, seldom or never slept with open windows as opposed to 20 % among in the group with windows **not** facing the railway.

Activity disturbance

Disturbance of different activities was evaluated by the second questionnaire which was send to respondents, who on the main questionnaire, had reported that they were rather or very annoyed by noise or vibration from railway traffic.

The results showed that 98 % in the vibration area and 89% in the area without vibration were annoyed by railway traffic every day or sometimes a week. Annoyance reactions were more frequent during evenings and night-time.

The response pattern for general annoyance and activity disturbances outdoors and indoors due to noise and vibration from railway traffic is shown in figure 2 for the area with vibration. The result is calculated as percentage of the total number of respondents on the main questionnaire. (The result was similar in the area without vibration but the frequency of disturbance was about 3 - 4 times lower.)

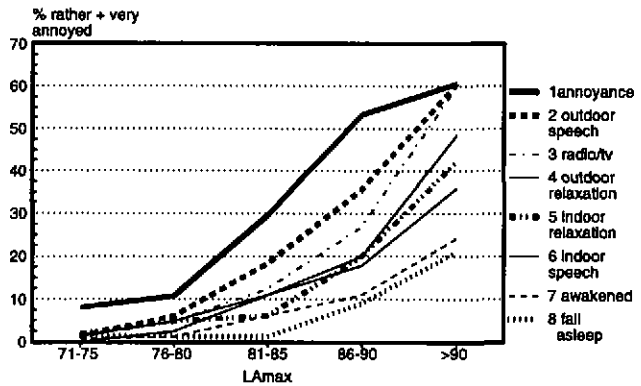

Figure 2. Percentage of respondents who reported that they were rather or very annoyed by the railway traffic during different activities in Partille - the area with vibration.

The figure shows that disturbance during communication outdoors was most frequent, followed by radio/TV, relaxation outdoors and relaxation indoors. Sleep disturbance effects were less frequently mentioned. There was a strong increase in disturbance at noise levels higher than 81 to 85 LAmax. This was also the case in areas without vibration.

5. CONCLUSIONS

This study shows that railway noise is experienced as more annoying in areas where there is simultaneous exposure to vibration from trains. Vibration was generally experienced as at least as annoying as noise up to about 200 meters from the railway line in the area with vibration >2mm/s, - This may be due to difficulties the individual has in differentiating between noise and vibration, which leads to exacerbation of annoyance from noise. Vibration may also make habituation to noise more difficult.

To ensure an acceptable environmental quality where less than 5 % of the exposed population is rather or very annoyed by railway noise, these noise levels must be below 80 LAmax and below 55 LAeq respectively in areas without vibration. - In areas with simultaneous exposure to strong vibration, action against vibration or a longer distance between houses and the railway line is needed, corresponding to a 10 dBA lower noise level than in areas without vibration.

The results indicate that annoyance from noise from railways can be prevented/reduced if bedrooms are located at the quieter side of the house.

Interference with speech and communication is the dominating reaction to railway traffic. It is thus important to these effects especially for dwellings and schools.

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