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COMMUNITY NOISE ANNOYANCE RISK IN TWO SURVEYS*

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Abstract. Two noise annoyance surveys were performed in Bratislava, the capital of the Slovak Republic, in a ten-year interval (1989–1999). This was a period of political and socioeconomic transformation as well as of changes in traffic management. Equivalent noise levels were assessed at the dormitory (exposed group) and in the residential areas (100 measuring stations) where another group of students (control group) lived. The mean dormitory and the mean control area equivalent noise levels increased significantly after ten years. In comparing current and previous risks of different noise exposures, the current risk was much higher for the group exposed to road traffic noise annoyance (OR = 6.01; 95% CI: 4.97–7.95 vs OR = 2.56; 95% CI: 1.93–3.42), entertainment facilities and neighborhood noise annoyance. Current road traffic noise interference with various activities (reading and mental work, personal communication, telephone communication, sleep) was also higher than previously. The students of the exposed group considered their health status in 1999 worse than ten years earlier (OR = 1.35; 95% CI: 0.99–1.83 vs OR = 0.82; 95% CI7 0.55–1.22) and they were generally taking more drugs. The comparison of two noise annoyance surveys showed that the load of community noise, especially road traffic noise as well as the subjective response to the noise, had increased in Bratislava.

Key words:
Community noise, Road traffic noise, Two surveys, Noise annoyance risks, Bivariate analysis

Community noise (also called environmental noise, residential noise or domestic noise) is defined as the noise emitted from all noise sources except for industrial workplaces. Main sources of community noise include road, railway and air traffic, industry, construction and public works, and neighborhood activity. It has been demonstrated that community noise may have a number of direct adverse effects other than hearing damage. These include adverse effects on communication, performance, and behavior; nonauditory physiological effects; noise-induced disturbance of sleep; and community annoyance [1–7]. Noise annoyance may be defined as a feeling of discomfort evoked by noise [2].

The extent of the noise problem is large. In the countries of the European Union (EU) about 40% of the population is exposed to road traffic noise with an equivalent sound pressure level exceeding 55 dB/A during daytime and 20% is exposed to levels exceeding 65 dB/A. More than 30% of people is exposed at night to equivalent sound pressure levels exceeding 55 dB/A that are sleep disturbing [2].

The major aim of our study was to compare two noise annoyance surveys conducted in a ten-year interval (1989-1999). This was a period of political and socioeconomic transformation, as well as of the changes in traffic management. Specific aims of these surveys were to quantify

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noise exposure affecting a university student cohort; to evaluate the cohort's subjective response to road traffic noise in their residential areas in terms of sleep quality, annoyance, activity disturbances and psycho-social well-being; and to calculate urban noise annoyance risks.

MATERIALS AND METHODS

Equivalent noise levels were assessed in Bratislava (451,395 inhabitants), capital of the Slovak Republic, at the dormitory (exposed group) and in the residential areas where another group of students (control group) lived. The Brűel-Kjaer measuring technique was used in 1989 and 1999. Measuring stations were situated 2 m from the building facades with a microphone 1.2 m height above the ground. The dormitory is situated at the highway level, the major route to Prague, and the extra-level highway crosses at the height of the fourth floor of the buildings. Residential areas where the other group of students lived were situated in relatively quiet surroundings.

Subjective response of students was assessed by a validated noise annoyance questionnaire developed by the Institute of Hygiene, Faculty of Medicine, Comenius University, and the Institute of Preventive and Clinical Medicine, Bratislava [1,5,6]. In addition to questions concerning personal and dwelling characteristics, it contained questions on possible psychosocial effects of noise (annoyance affecting verbal scale, interference with various activities). The questionnaire was administered in person; students were interviewed by trained personnel.

Our samples consisted of the fourth-year medical students ($n_1 = 511$; $n_2 = 857$); 40% of males and 60% of females, mean age 22.34 ± 1.32 years. In 1989, 166 students lived in the exposed area (dormitory) and 345 lived in the control area (the first sample). In 1999, 374 students and 483 students, respectively (the second sample).

The assessment of noise annoyance risks was obtained by bivariate and stratified analysis (odds ratio, Mantel-Haenszel weighted odds ratio, 95% confidence interval). A major tool in our statistical analysis was EPI Info 6.04, Statcalc.

RESULTS

During a ten-year period, the dormitory equivalent noise levels increased from 64.7 ± 2 dB/A to 67 ± 2 dB/A in the 6:00–12:00 interval. The mean equivalent noise level from 100 monitoring stations in other residential areas was significantly lower than the mean dormitory equivalent noise level in 1989 (64.7 ± 2 vs. 56.4 ± 2 dB/A) and in 1999 (67 ± 2 vs. 58.7 ± 6 dB/A) ($p < 0.001$).

Noise levels next to the dormitory were evaluated in 1999 for their day/night dynamics. Equivalent noise levels (L_{Aeq}), maximal noise levels (L_{max}) and minimal noise levels (L_{min}) were assessed. Equivalent noise levels varied within the zone of absolute noise and the maximum noise levels were as high as 84 ± 6.4 dB/A. Investigations of the noise levels in the course of the day and night indicated the continuous character of noise in day time as well as during the night.

The results of bivariate analysis showed higher risk of annoyance from several community noise sources for students living in the dormitory with additional increase of risks after 10 years. In addition to road traffic noise, students also found entertainment facilities, neighborhood noise and industrial noise to be annoying (Table 1).

Current risks of road traffic noise interference with various activities for the exposed group were higher than the previous ones concerning interference with listening to radio and TV, reading and mental work, personal communication and telephone communication. In the current survey, road traffic noise disturbed sleep, rest, falling asleep more often than in the previous survey (Table 2).

DISCUSSION

Equivalent noise level (L_{Aeq}) is now widely used in standards and legislation throughout the world as the basis for developing a dose-response relationship for community noise annoyance. It is particularly useful where the noise is steady and broadband. However, care must be taken when assessing community noise to ensure that significant characteristics associated with the noise are considered. The measurement period must also reflect the noise being assessed to enable the dose-response relationship of the

Table 1. Current and previous risks of different noise exposures in noisy vs control areas, 1989 and 1999

Noise annoyance (type of noise)	Risk in 1989			Risk in 1999		
	OR (95 % CI)	χ^2	p-value	OR (95 % CI)	χ^2	p-value
Industrial	+ 1.62 (1.14–2.35)*	7.23	<0.05	+ 3.49 (2.48–4.21)**	84.13	<0.001
Aircraft	+ 0.46 (0.22–0.92)*	5.55	<0.05	+ 0.87 (0.62–1.22)	0.58	0.45
Road traffic	+ 2.56 (1.93–3.42)**	44.80	<0.001	+ 6.01 (4.97–7.95)**	271.84	<0.001
Neighborhood	+1.71 (1.29–2.27)**	14.51	<0.001	+ 2.43 (1.99–3.03)**	75.05	<0.01
Entertainment facilities	+1.51 (0.90–2.52)	2.34	0.126	+ 3.90 (3.19–5.46)**	124.70	<0.001
Railway	0.56 (0.31–1.98)*	4.62	<0.05	2.06 (1.58–2.71)**	29.30	<0.001
Household equipment	+1.09 (0.40–0.80)*	10.72	<0.05	+1.25 (0.98–1.58)	3.33	0.07

\+ Mantel-Haenszel weighted odds ratio
* statistically highly significant
** statistically very highly significant

Table 2. Current and previous risks of road traffic noise interference with various activities, 1989 and 1999

Interference (type of activity)	Risk in 1989			Risk in 1999		
	OR (95 % CI)	χ^2	p-value	OR (95 % CI)	χ^2	p-value
Listening to radio and TV	+ 1.43 (1.08–1.91)*	6.13	<0.05	+ 2.81 (2.31–3.55)***	98.76	<0.001
Reading and mental work	+ 2.32 (1.76–3.36)***	30.88	<0.001	+ 3.72 (2.93–5.09)***	102.64	<0.001
Personal communication	0.88 (0.48–1.62)	0.18	0.674	2.70 (1.75–4.19)***	23.13	<0.001
Telephone communication	0.56 (0.26–1.17)	2.78	0.096	1.92 (1.20–3.08)**	8.45	<0.01
Rest disturbance	+ 1.59 (1.17–2.18)**	9.14	<0.01	+ 3.98 (3.23–5.46)***	129.18	<0.001
Falling asleep	+ 1.37 (0.99–1.93)	3.53	0.06	+ 4.08 (3.29–6.02)***	107.03	<0.001
Sleep	1.09 (0.70–1.69)	0.15	0.701	+ 3.13 (2.29–4.56)***	50.47	<0.001

noise to be determined. To evaluate a dose-response relationship for road traffic noise some authors suggest to use maximum noise levels (L_{max}) or L_{90}, which means 90% noise level [2]. In our comparative study we concentrated mostly on the equivalent noise levels.

The equivalent noise levels next to the exposed area of the dormitory exceeded 65 dB(A) (healthy risk area, area of absolute noise). Daily noise levels were continual, without the phenomenon of ”traffic peak” on the work day. They exceeded the Slovak limit for urban zone and the guidelines recommended by WHO [2,8,9].

Odds ratios obtained from our bivariate analysis are crude odds ratios (unadjusted). A stratified analysis was made to adjust for gender, but did not substantially change the results. Our results are similar to those of several authors who have compared noise annoyance, disturbances of psychosocial well-being and impaired sleep in noisy and control areas [2,7,10].

CONCLUSION

A comparison between two noise annoyance surveys shows that community noise, especially road traffic noise load, increases in urban agglomerations as does the subjective response to it. The results of the bivariate analysis show higher risk of annoyance from several community noise sources for students living in the dormitory with additional increase in risks after 10 years. Psychosocial effects and annoyance are the consequences that need to be taken into account in our samples of medical students, because they could play an important role as causes of non-communicable disease.

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