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NOISE EXPOSURE RISKS IN TWO NOISE ANNOYANCE SURVEYS AFTER TEN YEARS

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ABSTRACT
Two noise annoyance surveys were performed in the city Bratislava in ten year interval. Equivalent noise levels were assessed at the dormitory (exposed group) and in the residential areas where the other students lived (control group). Mean dormitory equivalent noise levels increased from 64,7 dB/A to 67 dB/A after ten years. Current risks of different noise exposure were much higher concerning 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 noise annoyance (OR=3.90; 95% CI=3.19-5.46 vs OR=1.51; 95% CI=0.90-2.52) and neighbourhood noise annoyance (OR=2.43; 95% CI=1.99-3.03 vs OR=1.71; 95% CI=1.29-2.27) for exposed group. Current risks of road traffic noise interference with various activities were also higher than the previous ones.

1 - INTRODUCTION

Road traffic noise represents a frequent, unavoidable and continuously increasing environmental factor in big cities throughout the world. In the European Union countries about 40% of the population are exposed to road traffic noise with the equivalent sound pressure level exceeding 55 dB/A daytime and 20% are exposed to levels exceeding 65 dB/A [1]. The analysis of the noise environment should take into account not only the physical impact of noise and its physiological effects, but also psychosocial consequences, including annoyance.

The global aim of our contribution was to compare two noise annoyance surveys conducted in ten year interval. This ten year period (1989-1999) includes political, socioeconomic and traffic management changes as well. Specific aims of these surveys were to quantify noise exposure affecting university students cohort, to evaluate their subjective response to road traffic noise in their residential areas in terms of sleep quality, annoyance, activity disturbances and psychosocial well-being and to calculate risks of urban noise on students' health.

2 - MATERIAL AND METHODS

Equivalent noise levels were assessed in the city Bratislava (451 000 inhabitants), capital of Slovak Republic, at the dormitory (exposed group) and in the residential areas where the other students lived (control group) by Brüel-Kjaer measuring technique in the years 1989 and 1999. Measuring stations were situated 2 meters from the building facades with the microphone height of 1.2 meters above ground.

The palatine building of dormitory is situated in the level of highway, the major communication route to Prague, and the extra-level highway crossing in the height of a buildings' fourth floor. Residential areas where the other students lived were situated in a relatively quite surrounding.

Subjective response of students was assessed by a validated noise annoyance questionnaire developed by Institute of Hygiene, Faculty of Medicine, Comenius University, Bratislava and Institute of Preventive and Clinical Medicine, Bratislava [2, 3, 4]. Questionnaire was administered personally, students were interviewed during practical training by a trained personnel.

Our samples were represented by medical students in the fourth grade of their study ($n_1 = 511$; $n_2 = 857$). They consisted of about 40% males and 60% females, mean age 22.34 years. In the first sample

from year 1989 166 students lived in the exposed area (dormitory) and 345 lived in the control area. In the second sample from year 1999 374 students lived in the exposed and 483 lived in the control area. Risks of different noise exposures were obtained by bivariate and stratified analysis (odds ratio, Mantel-Haenszel weighted odds ratio, 95% CI). Major tool in our statistical analysis was EPI Info 6.04, Statcalc.

3 - RESULTS AND DISCUSSION

Mean dormitory equivalent noise levels increased from 64.7 dB/A to 67 dB/A after ten years. Mean equivalent noise level from 100 control measuring stations in other residential areas was comparatively lower than mean dormitory equivalent noise level (67 dB/A vs 56.2 dB/A).
Results from bivariate analysis show higher risk of annoyance from several community noise sources for students living in dormitory with additional increase of risks after 10 years. In addition to road traffic noise students consider also entertainment facilities, neighbourhood noise and industrial noise to be annoying (Tables 1 and 2).

Noise annoyance (type of noise)	OR (95 % CI)	chi square	p-value
Industrial noise	$^{+}$.62 (1.14-2.35)**	7.23	<0.05
Aircraft noise	$^{+}$ 0.46 (0.22-0.92)**	5.55	<0.05
Road traffic noise	$^{+}$ 2.56 (1.93-3.42)***	44.80	<0.001
Neighbourhood noise	$^{+}$ 1.71 (1.29-2.27)***	14.51	<0.001
Entertainment facilities noise	$^{+}$.51 (0.90-2.52)	2.34	0.126
Railways noise	0.56 (0.31-0.98) **	4.62	<0.05
House equipment noise	$^{+}$ 0.57 (0.40-0.80) **	10.72	<0.05

Table 1: Previous risks of different noise exposures, year 1989 (noisy (n=166) vs control (n=345) area; *** statistically very highly significant; ** statistically highly significant; * statistically significant; $^{+}$ Mantel-Haenszel weighted odds ratio).

Noise annoyance (type of noise)	OR (95 % CI)	chi square	p-value
Industrial noise	$^{+}$ 3.49 (2.48-4.21)**	84.13	<0.001
Aircraft noise	$^{+}$ 0.87 (0.62-1.22)**	0.58	0.45
Road traffic noise	$^{+}$ 6.01 (4.97-7.95)***	271.84	<0.001
Neighbourhood noise	$^{+}$ 2.43 (1.99-3.03)***	75.05	<0.001
Entertainment facilities noise	$^{+}$ 3.90 (3.19-5.46)	124.7	<0.001
Railways noise	2.06 (1.58-2.71) **	29.3	<0.001
House equipment noise	$^{+}$ 1.25 (0.98-1.58) **	3.33	0.07

Table 2: Current risks of different noise exposures, year 1999 (noisy (n=374) vs control (n=483) area; *** statistically very highly significant; ** statistically highly significant; * statistically significant; $^{+}$ Mantel-Haenszel weighted odds ratio).

Current risks of road traffic noise interference with various activities for exposed group were higher than the previous ones concerning interference with listening to radio and TV, interference with reading and mental work, interference with personal communication and interference with telephone communication. In current survey road traffic noise disturbs rest, falling asleep and causes awakening more than in previous survey (Tables 3 and 4).

Interference (type of activity)	OR (95 % CI)	chi square	p-value
Listening to radio and TV	$^{+}$ 1.43 (1.08-1.91)**	6.13	<0.05
Reading and mental work	$^{+}$ 2.32 (1.76-3.36)***	30.88	<0.001
Personal communication	0.88 (0.48-1.62)	0.18	0.674
Telephone communication	0.56 (0.26-1.17)	2.78	0.096
Rest disturbance	$^{+}$ 1.59 (1.17-2.18)**	9.14	<0.05
Falling asleep	$^{+}$ 1.37 (0.99-1.93)	3.53	0.06
Sleep	1.09 (0.70-1.69)	0.15	0.701

Table 3: Previous risks of road traffic noise interference with various activities, year 1989 (noisy (n=166) vs control (n=345) area; *** statistically very highly significant; ** statistically highly significant; * statistically significant; $^{+}$ Mantel-Haenszel weighted odds ratio).

Interference (type of activity)	OR (95 % CI)	chi square	p-value
Listening to radio and TV	$^{+}$ 2.81 (2.31-3.55)***	98.76	<0.001
Reading and mental work	$^{+}$ 3.72 (2.93-5.09)***	102.64	<0.001
Personal communication	2.70 (1.75-4.19)***	23.13	<0.001
Telephone communication	1.92 (1.20-3.08)**	8.45	<0.01
Rest disturbance	$^{+}$ 3.98 (3.23-5.46)***	129.18	<0.001
Falling asleep	$^{+}$ 4.08 (3.29-6.02)***	107.03	<0.001
Sleep	$^{+}$ 3.13 (2.29-4.56)***	50.47	<0.001

Table 4: Current risks of road traffic noise interference with various activities, year 1999 (noisy (n=374) vs control (n=483) area; *** statistically very highly significant; ** statistically highly significant; * statistically significant; $^{+}$ Mantel-Haenszel weighted odds ratio).

In our homogeneous samples one of several factors that could interfere with effect of noise on various activities and annoyance is gender (our samples consist of 40% males and 60% females). Stratified analysis was made to adjust for gender, but did not change the results substantially.
Our results are similar to results of several authors comparing noise annoyance, disturbances in psychosocial well-being and impaired sleep in noisy and control area [5, 6, 7].

4 - CONCLUSION

Comparison of two noise annoyance surveys shows that road traffic noise load continuously increases as well as subjective response to it. Results from bivariate analysis show higher risk of annoyance from several community noise sources for students living in dormitory with additional increase of risks after 10 years. In addition to road traffic noise students consider also entertainment facilities, neighbourhood noise and industrial noise to be annoying. Current risks of road traffic noise interference with various activities for exposed group were higher than the previous ones. In current survey road traffic noise disturbs rest, falling asleep and causes awakening more than ten years ago.
Psychosocial effects and annoyance are consequences that are needed to be taken into account. Younger age groups (especially students) are important to study because of their life style and noise sensitivity. Noise annoyance, sleep and rest disturbance, nervousness and irritability could be the basis for civilization diseases origin. Further studies are needed to evaluate psychosocial risks of community noise. This problem is interdisciplinary and requires joined effort of several experts (psychologists, medical doctors, epidemiologists, urbanists, traffic engineers, managers, etc.) as well.

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