Social Noise Exposure in University Students in Slovakia

Lubica Argalasova, Alexandra Filova, Jana Jurkovicova, Katarina Hirosova, Jana Babjakova, Ludmila Sevcikova
Institute of Hygiene, Faculty of Medicine, Comenius University, Spitalska 24, 813 72 Bratislava, Slovakia

Summary

Background. The social exposure to noise is currently a big issue in adolescents and young adults in Slovakia. Current data on the usage of personal music players (PMP) are missing and the empirical evidence on its association with hearing loss is lacking. Objective. The study is aimed to quantify the effects of social noise exposure and the exposure to the other environmental noise sources in the sample of university students aged 19-23 years. Methods. The validated methodology according to ICBEN and the study Ohrkan was used. The measurement of ambient noise levels was done using hand-held sound level analyzer. There were 315 university students (96 males and 221 females, average age 23.21±1.85) enrolled into the study so far, 119 in the exposed housing facility and 196 in the control area in Bratislava. Results. The monitoring of sound levels in the exposed area showed the levels above the limit also in the afternoon and in the evening time interval. In the composition of the traffic flow the number of passenger cars and trams was predominant. Students in the exposed area were significantly more annoyed by road traffic noise (OR_{MH}=3.32, 95% CI=2.43-4.54), by railways noise (trams), noise from neighbourhood and entertainment facilities (OR_{MH}=3.40, 95% CI=1.20-2.35). There was a significant difference in PMP use between the exposed (83.19 %) and the control group (73.33 %) ($p<0.05$) (77 % of students reported using PMP in the last week). There was not significant difference between the loudness level of PMP, the type of headphones, or in the duration of time spent at events with high noise exposure. Conclusion. The results show the importance of environmental and the social noise as well. In the future we would like to enlarge the sample, to perform audiometric and tympanometric examinations and to formulate the proposals and interventional procedures.

1. Introduction

The harmful effects of noise on human health and development have been underestimated for a relatively long time. This may be due to the fact that noise endangers human health in an indirect manner, as opposed to other harmful substances in the workplace or environment. However, noise is pervasive in everyday life and can cause both auditory and non-auditory health effects [1, 2, 3, 18].
Environmental noise has traditionally been dismissed as an inevitable fact of life and has not been targeted and controlled to the same extent as other health risks. A growing body of research linking noise to adverse health effects coupled with proactive legislation, primarily in the EU, is now driving change [2]. Environmental noise has often been referred to as the 'forgotten pollutant' but is now recognised as an environmental and public health issue which needs to be addressed in modern society [2, 3, 4].
The social exposure to noise is currently a big issue in adolescents and young adults. Various leisure time activities may be responsible for hearing impairment (temporary or permanent hearing threshold shift, hearing loss). Exposure to these noise sources is being compared to the lower action values of noise at work [5, 6]. The limit under the Directive 2003/10/EC - noise level A - 80 dB for 40 hours is reached after less than 30 minutes per week. There are also personal music players (PMP), which at high volume (above 89 dB) reach the noise exposure equivalent to the lower action value after 5 hours per week. We can therefore conclude that personal music players represent a risk to hearing at high sound pressure levels during long-term exposure. At around 2.5 and 10 million citizens use the PMP so often and so loudly that they risk hearing loss after five years of use [7]. Current data on the usage of PMP among adolescents are missing and empirical

evidence on its association with hearing loss is lacking [6].

The study is aimed to quantify the effects of social noise exposure (personal music players, events with high noise exposure) and the exposure to the other environmental noise sources in the sample of university students aged 19-23 years.

2. Methods

The validated methodology according to ICBEN and the study Ohrkan was used [8, 9]. The measurement of ambient noise levels was done using hand-held sound level analyzer.

2.1. Exposure Assessment

Maximal, minimal and equivalent sound levels were assessed for both the control and exposed groups living in the Slovakian capital Bratislava by hand-held analyzer type 2250, with sound level meter software BZ-7222 and frequency analysis software from Brüel&Kjaer. All measurements were recorded according standard STN ISO 1996–1, 2 methods [11] during the time intervals from 17.00-18.00 and from 20.00-21.00 in the exposed and at the same time in the control area. This time interval was chosen to record the afternoon traffic peak and to detect the time most annoying for students and for their activities (studying, watching TV, talking, falling asleep). Measurements were recorded during spring period at working days (Tuesday) two times on each site. Road traffic flow composition was assessed as well.

2.2 Sample

There were 315 university students (96 males and 221 females, average age 23.21±1.85) enrolled into the study so far, 119 in the exposed housing facility at Comenius University and 196 in the control area (relatively quite dormitories and residential areas) surrounding Bratislava proper. Students significantly did not differ by gender, but they differed by age, flat location in relation to noise exposure, position of a flat in the floor height, length of stay in the given area, windows orientation, windows types and satisfaction with flat surrounding.

2.3. Subjective Response, Psychosocial Well-Being and Annoyance

Subjective response was assessed by the authorized "Noise annoyance questionnaire", the different sources of environmental noise were quantified [11]. The validated 5 grade noise annoyance verbal scale (Not at all; Slightly; Moderately; Very; Extremely), was developed and recommended by experts from the noise research ICBEN (The International Commission on the Biological Effects of Noise) team [8].

2.4 Social noise exposure

Based on the authorized methodology of the study Ohrkan (Bavarian Health and Food Safety Authority, Munich) the social noise exposure (personal music players, cellular phones, events with high noise exposure) was quantified and followed [6, 9]. The duration of use of personal music players was assessed subjectively in the period of one week as well as the level of loudness and the type of headphones (headset, earphones, earbuds). The conversion of the subjective assessment of the volume setting and duration of exposure to personal music players were used to estimate the exposure dose (the intensity of noise exposure in dB) [12, 13]. The duration of time spent at events with high noise exposure - entertainment facilities, discotheques, concerts, sport activities, playing the music instrument and noisy household work was assessed subjectively as well.

2.4 Statistical analysis

Statistical evaluation comprises the methods of descriptive statistical analysis, associations among continuous variables by bivariate analysis, t-test, analysis of variance (ANOVA) and correlation coefficients. Partial regression analysis and multivariate analysis (multiple linear regression, multiple logistic regression) will be used to determine mutual associations among life style factors, psychosocial factors, biologic, behavioral and environmental factors. Statistical packages Epi Info™, Version 7.1.1.1, 2013 and S-Plus 6.0 were implemented for the statistical data evaluation.

3. Results and discussion

The monitoring of sound levels in the exposed area showed the levels above the limit also in the afternoon and in the evening time interval. In the composition of the traffic flow the number of passenger cars and trams, which are particularly noisy [14] was predominant (Table I).

Table I. Time dynamics of sound levels in the exposed housing facility, April 2013.

Time intervals	*Sound level L_{Aeq} (dB)*	*Road traffic flow composition*
17.00-18.00	67.6	A 5460, B 36, L 60, T 72
20.00-21.00	64.7	A 4644, B 12, L 12, T 60

Legend: A- automobile, B- bus, L- lorry, T- tram

The sound levels in the control area were significantly lower ($p < 0.05$) (Table II). In the composition of the traffic flow the number of passenger cars was also predominant, however; not such frequently as in the exposed area; there were some buses, but no trams.

Table II. Time dynamics of sound levels in the non-exposed housing facility, April 2013.

Time intervals	*Sound level L_{Aeq} (dB)*	*Road traffic flow composition*
17.00-18.00	53.4	A 108, B 12, L 0, T 0
20.00-21.00	54.3	A 60, B 12, L 0, T 0

Legend: A- automobile, B- bus, L- lorry, T- tram

Students in the exposed housing facility were significantly more annoyed by road traffic noise (OR_{MH}=3.32, 95% CI=2.43-4.54), by railways noise (trams) (OR_{MH}=2.54, 95% CI=1.80-3.58), noise from industry (OR_{MH}=2.25, 95% CI=1.68-3.02), noise from neighbourhood (OR_{MH}=1.78, 95% CI=1.35-2.34) and entertainment facilities (OR_{MH}=3.40, 95% CI=1.20-2.35); there was not significant difference concerning noise annoyance from the house construction and aircraft noise (Table III)

From the total sample of 315 responding students 245 (77 %) reported using of personal music players (PMP) in the last week. There was a significant difference in PMP use between the exposed (83.19 %) and the control group (73.33 %) ($p<0.05$), but there was not significant difference between males and females ($p=0.20$). More than 10 % of students listen to the music on the loudness level 4 (they cannot hear the speech or even the traffic) and more than 80 % (84.68 %) use earbuds. There was not significant difference between the loudness level of PMP, the type of headphones, or in the duration of time spent at most events with high noise exposure. The only significant difference was in the duration of time spent in the cinema for the exposed group ($p<0.05$). Students from the exposed group spent about 194.69 minutes a months in the cinema in comparison to 153.97 minutes for the control group (Table IV)

Table III Annoyance risks from community noise (years 2014)

Noise annoyance (type of noise)	*Risks in 2014*
	OR (95 % CI)
Road traffic	$^{+}$ 3.32 (2.43-4.54)***
Neighbourhood	$^{+}$ 1.78 (1.35-2.34)***
Entertainment facilities	$^{+}$ 3.40 (1.20-2.35)***
House construction	$^{+}$1.27 (0.89-1.82)
Railways	$^{+}$2.54 (1.80-3.58)***
Aircraft	1.05 (0.70-1.58)
Industry	$^{+}$ 2.25 (1.68-3.02)***

Legend:
*** *$p < 0.001$,*
$^{+}$ *Mantel-Haenszel weighted odds ratio*
CI = confidence interval; OR = odds ratio

The self-reported usual volume setting was used to derive the mean sound pressure level [12, 13]. The mean sound pressure level associated with the reported duration of use was transformed into an energy equivalent sound pressure level associated with a duration of 40 hours per week. The equivalent sound pressure level, derived as described above, was compared to work noise limits (lower action value LAV = 80 dB) [6].

Table IV. The use of PMP and the noisy leisure events in the sample of university students

Variable	*Exposed group* (n=119)*		*Control group* (n=196)*		*p-value*
	N	*%*	*N*	*%*	
Gender					
Male	41	34.5	54	27.5	0.21
Female	78	65.5	141	72.5	
Age**					
Male	22.73 ± 1.42		24.40 ± 2.87		0.63
Female	22.63 ± 0.95		23.22 ± 1.65		< 0.001
The use of PMP in the last week (subjectively)					
No	20	16.8	52	26.7	< 0.05
Yes	99	83.2	143	73.4	
Loudness of PMP music					
1 Not louder than speech	17	17.2	30	20.7	0.14
2 Could hear the talk	50	50.5	52	35.9	
3 Could hear the traffic	23	23.2	48	33.1	
4 Could not hear either talk or traffic	9	9.1	15	10.3	
Type of headphones					
Earbuds	90	90.9	119	81.5	0.31
Headset	9	9.1	27	18.5	
Other noisy events and activities (min/month)***					
Playing music instrument	597.14 ± 683.24		601.43 ± 939.30		0.99
Visit to the cinema	194.69 ± 117.65		153.97 ± 80.18		< 0.05
Visit of classical concerts	142.50 ± 84.47		146.25 ± 159.45		0.95
Visit of rock, pop, jazz concerts	366.96 ± 731.29		248.05 ± 221.07		0.34
Visit of discotheques	370.97 ± 331.00		565.08 ± 852.35		0.09
Visit of sport events	376.15 ± 345.16		767.50 ± 1266.72		0.14
Household/garden work	461.82 ± 987.76		515.15 ± 962.58		0.73

* *There are missing values for each variable category*
** *Average age in the sample (arithmetic mean ± standard deviation)*
*** *Average number of minutes per month (arithmetic mean ± standard deviation)*

Among PMP users 28.7 % exceeded the LAV, 26 % in the community noise exposed area and 30.4 % in the control area (p=0.81), 35.8 % males and 25.83 % females exceeded the LAV (p=0.69) (Figure I and II).

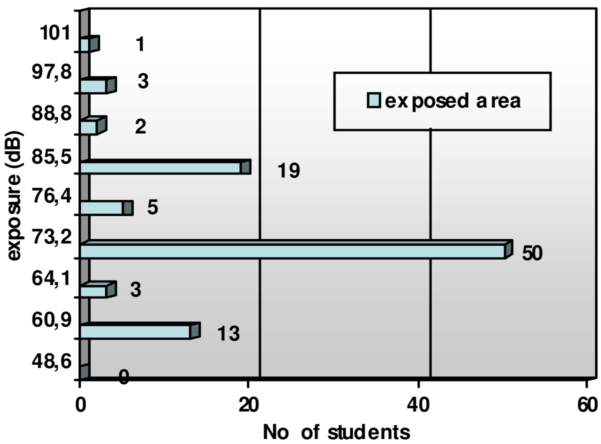

Fig. I Estimation of exposure dose from PMP use in the exposed area

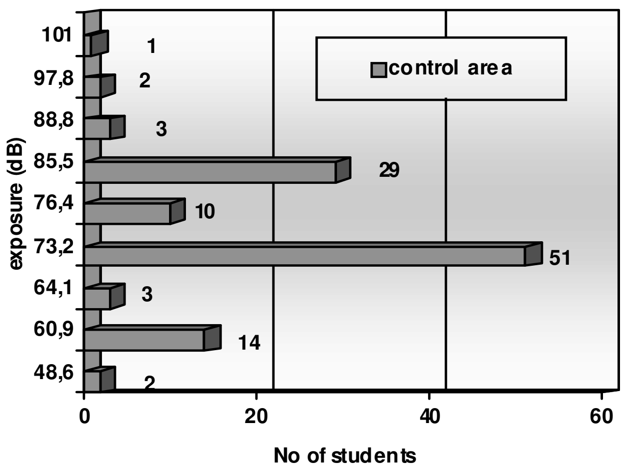

Fig. II Estimation of exposure dose from PMP use in the control area

Our results are comparable with the other studies comparing "annoyance", distortion of psycho-social-well-being and sleep disturbances in the exposed (noisy) and control areas [3, 15]. Noise annoyance showed strong correlation with noise levels, personal characteristics and housing conditions according to authors in Belgrade, Serbia [3]. The most annoying noise sources were construction, road traffic and leisure/entertainment activities in Skopje, Macedonia [15]. Students from our community noise exposed group were listening to PMP more often than students from the control group (maybe trying to mask the effect of other community noise sources). However; the loudness level was not significant between groups. We could not find the studies with such finding and we would like to follow this topic further, because university students represent a vulnerable group concerning their life style and noise sensitivity.

In the future we would like to enlarge the study sample to 1000 university students and to add a population group of 500 adolescents in the age of 15-17 years. In cooperation with the experts on Pediatric Otorhinolaryngology we plan to arrange audiometric and tympanometric examinations, to objectify the effects of social noise exposure on the hearing organ.

There are not so many data on the usage of PMP among adolescents and young adults [5, 9, 16, 17]. Studies like Ohrkan are needed to conclude whether widespread exposure to loud music in the young age increases the prevalence of hearing loss in the future.

4. Conclusion

The results show the importance of environmental and the social noise as well. In the future we would like to formulate the proposals and interventional procedures in the prevention of auditory and non-auditory noise effects of environmental noise.

Acknowledgement

This project has been partially supported by the ESF-OPV project „MPH study programme development at Comenius University in Bratislava in English language (Master of Public Health).“ ITMS code of the project: 261402300093.

References

[1] M. Basner, W. Babisch, A. Davis, M. Brink, C. Clark, S. Janssen, S. Stansfeld. Auditory and non-auditory effects of noise on health. Lancet 383 (2014) 154-168.

[2] L. Fritschi, L.A. Brown, R. Kim, D. Schwela, S. Kephalopoulos. Burden of disease from environmental noise. Quantification of healthy life years lost in Europe. World Health Organization, Geneva, 2011.

[3] K. Paunovič, B. Jakovljevič, G. Belojevič. Predictors of noise annoyance in noisy and quiet urban streets. Sci Total Environ 1 (2009) 3707–3711.

[4] E. Murphy, E.A. King. Environmental Noise Pollution. Noise Mapping, Public Health, and Policy. Elsevier 2014.

[5] D. Twardella, A. Wellhoefer, J. Brix, H. Fromme. High sound pressure levels in Bavarian discotheques remain after introduction of voluntary agreements. Noise Health 10 (2008) 99–104.

[6] D. Twardella, C. Perez-Alvarez, T. Steffens, G. Bolte, H. Fromme, U. Verdugo-Raab. The prevalence of audiometric notches in adolescents in Germany: The Ohrkan-study. Noise Health 15 (2013) 412–419.

[7] SCENIHR, Potential health risks of exposure to noise from personal music players and mobile phones including a music playing function: Scientific Committee on Emerging and Newly Identified Health Risks, European Commission; 2008.

[8] J. Fields, R.G. De Jong, T. Gjestland et al.. Standardized general-purpose noise reaction questions for community noise surveys: Research and recommendation. J Sound Vib 242 (2001) 641–679.

[9] D. Twardella, C. Perez Alvarez, T. Steffens, H. Fromme U. Raab. Hearing loss in adolescents due to leisure noise. The OHRKAN study (in German). Bundesgesundheitsbl 54 (2011) 965–997.

[10] STN ISO 1996–1, 2. Acoustics. Description, measurement and assessment of environmental noise. Part 2: Determination of environmental noise levels. SSTN 2008.

[11] Ľ. Sobotová, J. Jurkovičová, J. Voleková, Ľ. Ághová. Community noise annoyance risk in two surveys. International Journal Occupational Medicine and Environmental Health 14 (2001) 197–200.

[12] C.D.F Portnuff, B.J. Fligor, K.H. Arehart. Teenage Use of Portable Listening Devices: A Hazard to Hearing? J Am Acad Audiol, 22 (2011) 663-677.

[13] C.D.F Portnuff, B.J. Fligor, K.H. Arehart. Self-report and long-term field measures of MP3 player use: How accurate is self-report? International Journal of Audiology 52 (2013) S33–S40.

[14] E. Panulinová, S. Harabinová. Monitoring of Tram Traffic Noise in the Small Curve Radius. Applied Mechanics and Materials 617 (2014) 120-123.

[15] G. Ristovska, D. Gjorgjev, A. Polozhani, M. Kocubovski, V. Kendrovski. Environmental noise and annoyance in adult population of Skopje: a cross-sectional study. Arh. Hig. Rada Toksikol, 60 (2009) 349-355.

[16] I. Vogel, H. Verschuure, C.P.B. van der Ploeg, J. Brug, H. Raat. Estimating adolescent risk for hearing loss based on data from a large school-based survey. Am J. Public Health 100 (2010) 1095-1100.

[17] S. Jeram, N. Delfar. Preliminary results of the study on usage of portable music players and future plans for public policy in Slovenia. 11th International Congress on Noise as a Public Health Problem (ICBEN) 2014, Nara, JAPAN.

[18] S. Žiaran. Potential health effects of standing waves generated by low frequency noise. Noise Health 15 (2013) 237-245