The Influence of Environmental Noise on the Living and Working Conditions of the Population - Slovak Case Study

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Abstract **– Physical stressors like noise can have a significant impact on both the environment and the health of people who are exposed to it. In particular, the excessive noise produced by road traffic is a highly topical issue. The study aimed to investigate the traffic noise values on a busy road in the town of Turzovka. In addition to comparing the measured results with the limit values, we conducted a questionnaire survey with fifty residents. The questionnaire surveyed the attitudes of fifty town residents towards traffic noise concerning their quality of life and health. Subsequently, we compared the questionnaire survey results with the measured noise values at a measured site on a busy road in Turzovka. The respondents' answers from the questionnaire survey confirmed that 68% of the respondents felt the impact of noise exposure on their health, which corresponded with the results of the accurate measurements. According to the measurements, the critical time zones were from 5:00 to 6:00 and from 16:00 to 17:00. The final part of the thesis consists of the proposed measures, whose implementation can decrease the potential high noise exposure and thus reduce the health risks associated with the noise issue.**

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1. Introduction

Noise is a physical factor that is responsible for several other damages to health in addition to damage to the hearing organ. Among the most important manifestations are a decrease in quality, disorders of psychosocial well-being [1], [2].

Unlike other physical factors, people perceive noise by a specific auditory system. Thus, it is a phenomenon everyone perceives and evaluates, which is why noise exposure is one of the most common, if not the most frequent, complaints of residents living in large cities [3], [4]. Traffic is the most frequently cited noise source in these cities and their surroundings [5].

Many studies have focused on the generation of road traffic noise [6], addressing the effect of roadway type on annoyance to residents [7], [8]. Other authors have addressed annoyance when considering traffic characteristics [9], [10], motorised two-wheelers, and heavy vehicles [11], [12], but have also taken into account the influence of road surface type.

A noise risk assessment system is based on the relationship between noise exposure levels and the likelihood of adverse health effects. [13], [14].

In 2011, the WHO published research on the burden of disease from environmental noise. The survey resulted in data on the loss of healthy years in people due to environmental noise [15], [16].

Based on the research, information was obtained to quantify the noise burden for cardiovascular diseases, cognitive disorders in children, sleep disorders, tinnitus, and crankiness [17], [18].

According to research, after air pollution, environmental noise is the second most important factor contributing to the morbidity of society [19], [20], [22].

The European survey on quality of life in 2016-2017 on a sample of 37,000 respondents from all EU member states and five candidate countries confirmed that one third of respondents (32%) have problems with environmental noise [23], [21].

Countries, regions, and cities are taking various measures to tackle noise-related problems. In order to reduce and limit noise, roads are paved with anti-noise asphalt, cities are building more infrastructure for electric vehicles, quiet tyres are preferred for road transport, streets are transformed into pedestrian zones, and parks and nature reserves are created [24].

In Slovak legislation, the permissible noise levels for road transport ($L_{aeq,p}$) are set by Decree No 549/2007 Z. z. (Table 1).

Table 1. Page layout description [25]

Permissible sound levels for road traffic (Laeq,p)				
Territory category	Territory - description of the protected	Permissible values in dB		
		day	evening	night
I.	• special protection against noise (spa places, medical and spa areas)	45	45	40
II.	• under the windows of family houses and residential living rooms, the space under the windows of protected rooms of school buildings, medical facilities, exterior space in recreational and residential areas	50	50	45
III.	• category II, which includes the surroundings of motorways, class I and II roads, local roads with public transport, railways, airports and town centres	60	60	50
IV.	• without residential function, without protected exterior spaces, factory premises, industrial parks and production zones	70	70	70

The study's main objective was to determine the level of noise pollution from traffic in the town of Turzovka by accurate measurements (screening) and to compare the results of the measurements with the maximum permissible values. By asking the inhabitants of Turzovka, we obtained their opinions on the noise burden and their subjective perception of environmental noise and its harmful effects on their health and well-being.

Turzovka is a small town in the northwest of Slovakia with 7121 inhabitants. It is located near the border with the Czech Republic, and the road from Čadca to the Czech border village of Makov runs around it. It is a Class II road number 487, a crucial traffic junction with high traffic frequency and with an assumption of an increased level of noise pollution (Figure 1).

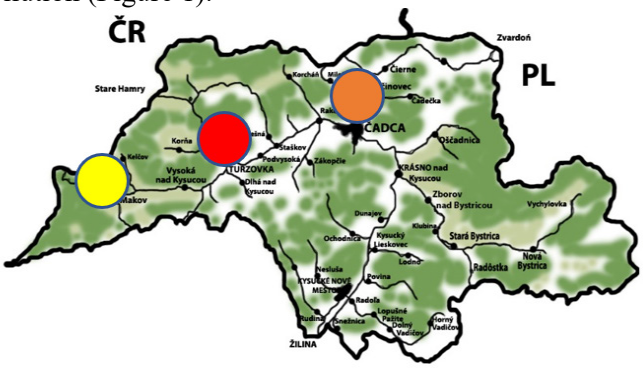

Figure 1. Geographical location of Turzovka (https://www.enviroportal.sk/indicator/detail?id=521)

2. Methods

The study was conducted in two stages. In the first stage, real measurements were taken in the village of Turzovka. In the second stage, a questionnaire survey of residents was carried out, in which they expressed their opinion, how they perceive environmental noise and its impact on their health.

2.1. Design of Experimental Measurement

The determination of the noise measurement sites preceded the actual experimental measurement. Therefore, by observing the number of cars during the day, we determined the location and the time periods for measuring. We took into account the following aspects:

- the crossroads of the main road Makov - Čadca and the contact with the main road to the Czech Republic;
- a specific place – the boundary of the first inhabited house;
- measurement time at the highest noise load (highest number of passing cars).

A graphical view of the measurement site is in Figure 2.

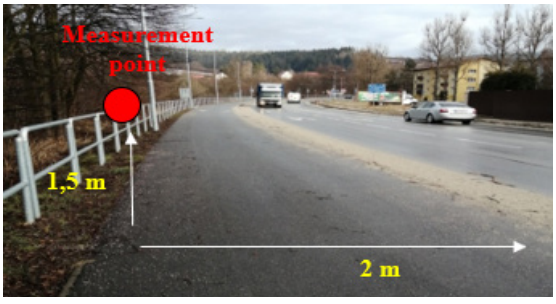

Figure 2. Identification of the measurement point

We made the measurements using a compact noise meter type UNI – T UT353 (UNI-TREND TECHNOLOGY, CO., LTD., China), designed to measure and control the noise level in buildings, outdoor areas, in the vicinity of residences, near highways, railway lines, or even performs loudness measurements of various equipment. The specific measuring instrument is shown in Figure 3, and Table 2 presents its technical parameters.

Figure 3. Measuring instrument UNI – T UT353 (https://www.tipa.sk/sk/hlukomer-uni-t-ut353/d-174949/?gclid=EAIaIQobChMIssqR7dGw9gIVh7LVCh0NmQCUEAQYASABEgLVzPD_BwE)

Table 2. Parameters of noise meter type UNI – T UT353

Sound pressure level measurement range	30 – 130 dB
Measurement deviation	± 1.5 dB
Microphone range (measurement frequency range)	3.5 – 8 000 Hz
Measurement response speed	125 ms/1s

We carried out the measurements over two days (29 November 2022 and 30 November 2022), during which the temperature ranged between 8 and 10 °C during the day and between 3 and 4 °C in the morning and evening hours. The hours of the measurements taken are in Table 3.

Table 3. Measurement timetable (marked with red colour)

date	05:00 - 06:00	06:00 - 07:00	07:00 - 08:00	08:00 - 09:00	09:00 - 10:00	10:00 - 11:00	11:00 - 12:00	12:00 - 13:00	13:00 - 14:00	14:00 - 15:00	15:00 - 16:00	16:00 - 17:00	17:00 - 18:00	18:00 - 19:00	19:00 - 20:00
29.11	1st measurement										2nd measurement				
30.11.						3rd measurement									

The noise level meter was placed 2m from the road boundary and at a height of 1.5m from the ground (Figure 2). We recorded measurement values every 5 minutes. The measurements also included road traffic intensity.

We divided the different types of vehicles into trucks over 3.5 tonnes (including suburban public transport), the next group was vans up to 3.5 tonnes and, in the last group were cars.

3. Results

Figure 4 shows the results of the measurements of the equivalent noise level averaged in dB ($L_{aeq,p}$) including the number of personal cars in the distribution of cars over 3.5 tonnes, vans under 3.5 tonnes and cars.

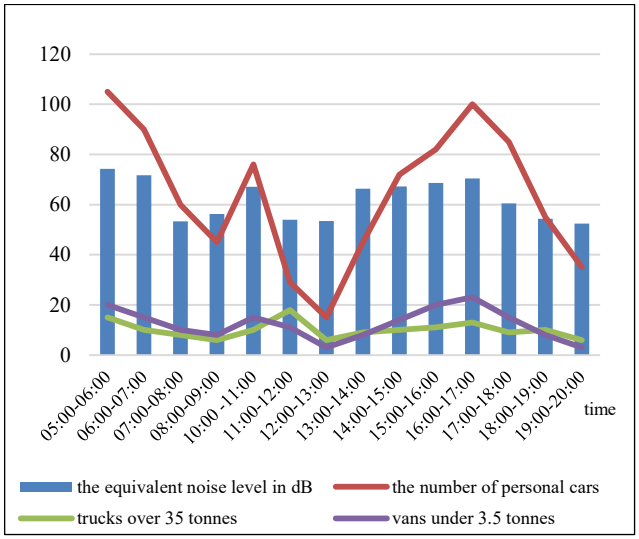

Figure 4. Measured values of noise exposure concerning road traffic frequency and time of measurements

The results show that not only trucks but also cars or several aspects such as vehicle speed, engine type, vehicle speed, road type, and asphalt quality influence the noise level. We found exceeding the permissible noise level for the reference time (day) set at 60 dB, with 74.3 dB and 71.7 dB recorded in the 5:00 - 6:00, 71.7 dB in the 6:00 - 7:00 and 70.4 dB in the afternoon, from 16:00 - 17:00 time periods respectively.

4. Questionnaire Survey

People from the town of Turzovka were contacted at the site of the noise measurements to express their opinion on how they perceive the noise exposure from traffic. The questionnaire consisted of 14 questions, of which one was open-ended, and three questions were 5 Likert-scaled. The scaling was as follows: 1 - noise does not bother me; 2 - noise does not bother me, but I perceive it; 3 - noise bothers me, but I can stand it; 4 - noise bothers me to a considerable extent; 5 - noise bothers me to a great extent, I cannot stand it.

Each digit represents the subjective strength of the respondent's attitude concerning all questions about the noise burden issue.

The sample of respondents consisted of 50 inhabitants of Turzovka, of which 52% were women and 48% were men. The return rate of the questionnaire was 100%, and we preserved the anonymity of the respondents. According to their age, we divided the respondents into the following age groups:

- age up to 26 years – 30% of respondents,
- age from 26 to 62 years – 50% of respondents, and
- over 62 years – 20% of respondents.

In terms of occupation, 26 (52%) were retired, students and mothers on maternity leave, 4 residents (8 %) were not working, 8 (16%) respondents were doing mental work, and 12 (24%) were doing manual work.

Among the questions asked, we also surveyed the type of housing. 31 respondents (62%) reported living in a house on the first floor, 19 respondents (38%) lived in a flat, of which 9 (18%) reported living on the 1st floor, 5 (10%) reported living on the 2nd floor, and 5 (10%) reported living on the 3rd floor. These results also represent the composition of houses and flats in Turzovka, where housing in family houses dominates, especially in the urban districts. One question in the questionnaire asked about the orientation of bedrooms. As many as 48 (96%) respondents indicated that such rooms are oriented in the street with heavy traffic.

The next question focused on the respondents' views on where they felt the most noise disturbance. They answered on a Likert scale from the following options: at work, home, school and outdoors. We present the results of the responses (respondents could also indicate more than one option) in Table 4.

Table 4. Respondents' response to the question of the location where they experience the effects of noise as disturbing [26]

The environment where respondents experience noise disturbance	Respondents' answers in %				
	1	2	3	4	5
at work	10	16	10	0	4
at home	2	15	22	3	8
at school	0	0	2	3	10
outdoors	2	3	30	10	5

There is a significant impact of noise exposure on residents in both the home and school environments, but most so in the outdoor environment, with up to 45 respondents agreeing. In another response, 40 (80%) of respondents identified traffic as the most significant source of noise, 5 (10%) of respondents identified work-related noise, and 5 (10%) of respondents identified noise from outdoor industrial sources. These results are consistent with noise measurements carried out on a busy road.

Subsequently, we aimed to specify the periods the respondents perceived as significant concerning the impact of noise burden on their organism. These results, subjected to comparative analysis with accurate measurements, result from subjective perceptions with observed noise values. Figure 5 presents these results.

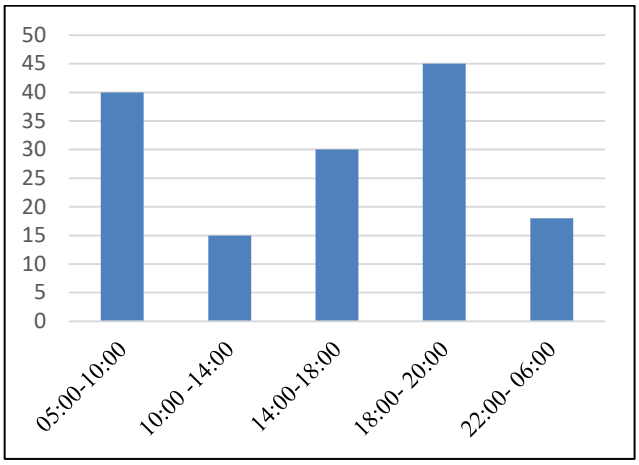

Figure 5. Time of day periods identified by respondents as the most bothersome for environmental noise [26]

Up to 40 (80 %) of respondents said that noise annoyed them between 5:00 and 10:00. The next critical period of the day is between 18:00 and 20:00, which was identified by up to 45 (90%) respondents as the period during which they experience noise disturbance. The results are compatible with the obtained measurements. We measured the highest traffic intensity and noise burden values in these time intervals, namely from 5:00 to 6:00 - up to 74.3 dB, when the equivalent noise level was exceeded until 7:00 when the average noise level reached 71.7 dB. In the afternoon, we also recorded a noise burden as high as 70.4 dB.

The final questions in the questionnaire were devoted to the adverse effects of noise on public health. The most common health problems mentioned by the respondents were sleep disturbance, mentioned by 18 (36%) of the respondents, and hearing impairment by 15 (30 %) of the respondents. We cannot overlook concentration disorders in work performance reported by 9 (18%) respondents, mainly young people under 26 years. Of the sample of respondents who had health problems, 18 residents (i.e. up to 52% of the respondents) had to seek medical attention. Nine respondents need to take medication for sleep disorders in the long term.

According to the questionnaire results, residents would welcome effective measures to reduce noise in the town. Firstly, up to 33 (66%) of respondents would welcome a reduced traffic volume in the town. 25 (50%) respondents favoured the construction of noise barriers, and 22 (44%) respondents demanded a reduction in the maximum speed limit.

15 (30%) would welcome measures such as road reconstruction, soundproof windows, and other construction solutions.

5. Conclusion

The result analysis shows that the classification of urban traffic noise depending on the frequency of vehicles is annoying and disturbing for the inhabitants of Turzovka. In the overall analysis of the results, 25% of the measurements were higher than 60 dB(A), which shows that traffic noise is a significant pollutant even in such a small non-industrial city. The results showed a clear relationship between urban traffic noise and traffic volume.

The questionnaire results indicate that up to 34 (68%) of citizens feel the impact of noise exposure on their health. In selecting the types of health problems to include in the questionnaire, we drew on information on the health problems of Europeans obtained from the EEA European studies mentioned in Chapter 1 and from the 2015 survey by the Slovak Republic's Public Health Office [27]. Of our research sample, up to 34 (52%) respondents also had to see a doctor, and some are also taking medication for noise-related problems such as sleep disturbances and hearing impairment.

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