

DO WE HAVE TOO MUCH NOISE IN EDUCATIONAL ESTABLISHMENTS?

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Abstract: Noise is any unwanted sound that has a negative impact on our well-being and health and also damages the environment. In educational settings, noise is a risk factor for both staff and children, but it is often neglected. Excessive noise levels are an occupational hazard for teachers and endanger the health of pupils. The objective was to determine the noise levels to which certain teachers are exposed during their work in a selected elementary school. Noise measurements were conducted in accordance with SIST ISO 9612:2009. We used the Brüel & Kjær 2260 Investigator. Measurements were made in October 2019 in a selected elementary school in some classrooms and other areas of the school. Noise was measured in empty classrooms and during lessons. The results showed that the limit of 87 dB was exceeded in the foyer of the school (88.8 dB) and during the lunch break in the canteen (88.4 dB). The lower alert value of 80 dB was exceeded in the music classroom (82.4 dB) and in the gym (82.6 dB). The use of an electronic ear has significantly reduced noise in the dining hall. Noise exposure has become one of the most important factors in indoor quality of life. Excessive noise exposure during classes, where noise levels are constantly fluctuating, can have a negative impact on both teachers and pupils. Therefore, it is important to face the noise problem and take deliberate measures. We recommend acoustic inspections, regular use of SoundEars to warn of high noise levels, and raising awareness among teachers, pupils, and parents about the harmful effects of noise. Lower noise levels will lead to better health and also better quality education.

Keywords: noise, educational institution, exposure, occupational risk

Introduction

We use the term 'noise' to refer to unwanted sounds. Noise can harm workers if it occurs in high intensity or persists for a long period of time [1]. Noise in the workplace has negative effects on workers' health and work. More serious hearing damage can occur when a person is exposed to noise for long periods of time and frequently, such as in industry, construction, agriculture, education, etc. The harmfulness of noise depends on the level, type and frequency of noise, duration of exposure, distance from the source, activity, characteristics of the environment, and the person [2].

For educational personnel, the voice is the most important work tool. Overuse of the voice can lead to hoarseness, sore throat, damaged vocal cords, and weak voices. As a profession, teachers are highly exposed to the possibility of noise-related health problems [3].

Noise in the school environment can affect productivity and concentration while working, learning, and collaborating [4]. Noise exposure reduces performance on complex mental tasks (reading, arithmetic) and problem solving [5].

Among teaching staff, noise causes restlessness, irritability, fatigue, impaired attention, stress (increased hormonal response and heart rate), and loud speech (colds, hoarseness, vocal cord nodules) [4].

Schools should provide an optimal and healthy environment where teachers and students feel comfortable, since they spend between 70 and 80% of their time indoors [6].

Noise exposure has become an important factor determining indoor quality of life. Excessive noise levels during class, where the volume is constantly fluctuating, can have a negative impact on both teachers and pupils. Noise levels above 65 dB with prolonged exposure, can already lead to hearing impairment; noise levels above 80 dB with exposure over several years, are very likely to cause irreversible hearing impairment [7].

In classrooms, it is recommended that the three most important acoustic parameters be monitored: sound power (how much the characteristics of the room amplify the sound), speech intelligibility, and sound reverberation (how long it takes for the sound to drop to 60 dB once the sound source stops emitting sound) [8].

In elementary schools, teachers are exposed to noise levels as high as 85 dB, which can lead to a variety of health problems with prolonged exposure [9].

Noise management in school buildings must be approached holistically, with an emphasis on appropriate timing and spacing of children. Excessive background noise impairs the efficiency and learning performance of children with sensory hearing loss and those without hearing and speech impairments [10].

The aim was to determine the noise levels to which selected employees of the observed elementary school are exposed during their work.

Material and work methods

In October 2019, noise measurements were conducted in a selected elementary school in Upper Carniola. We focused on internal noise generated by pedagogical activity (noise from children, didactic aids, teaching aids). The measurements were performed using the Brüel & Kjær 2260 Investigator measuring device and in accordance with SIST ISO 9612:2009 - Acoustics - Determination of noise exposure in the working environment - Engineering method [11].

The Brüel & Kjær 2260 Investigator metre was placed on a tripod at a height of 150 cm at a distance of 0.5 m to 3 m from the workers (who were moving around the room during the work) during the measurements. All windows and doors in the rooms were closed during the measurements as long as the activity continued.

Noise measurements were performed in two parts, in empty and in fully selected rooms of the school. The noise measurements were performed in the music room, the gym, the canteen, and the foyer of the school. Each measurement in an empty room lasted between 2 and 5 minutes. In the rooms where classes were held (music room and gym), measurements were taken for 30 minutes. During breaks, noise measurements in the canteen and foyer were shortened due to time constraints and were conducted for 10 minutes during break time and 15 minutes during recess. At lunchtime, one-hour measurements were taken in the canteen area between 1 and 2 p.m., as this is when most of the children eat their lunch. The measurements were taken at the same measurement points as the previous measurements in the empty room.

We measured the equivalent noise level (L_{Aeq}), the peak noise level ($L_{C, peak}$), and the difference between the equivalent and impulse noise levels ($L_{AIm} - L_{Aeq}$). We calculated the estimated impulse-corrected noise level ($L_{AI, Te}$). This provided information about the noise level, both in an empty room and during activities (teaching, eating).

We installed the SoundEar in the canteen of the selected school for one month. Based on the results obtained with the Brüel & Kjær 2260 Investigator metre, we set the noise level on the SoundEar at 85 dB. If the noise level is higher than the set value, a red light illuminates to warn the children of the excessive noise level in the room. Otherwise, the green light illuminates. The goal of installing the SoundEar was to make the children aware of excessive noise in the room, to get their attention (visual representation, since numbers and words do not mean much to children), and to encourage them to participate in reducing the noise.

Results and discussion

Results of noise level measurements in four areas (canteen, school foyer, music classroom, and the gym) when they were empty and during activities (Table 1). We found that some of the employees of the observed elementary school are exposed to noise levels above 85 dB in the foyer and canteen, while Eysel-Gosepath and colleagues [9] found that employees in their elementary schools are exposed to noise levels up to 85 dB. At the same time, they conclude that prolonged exposure to noise levels up to 85 dB can lead to health problems.

In the study by Jeram et al., Noise and health in elementary schools, participants indicated that, in their opinion, the highest noise levels in the school were in the canteen, followed by the hallways, school foyer, the gym, and the classrooms [4]. Our measurements showed that the foyer of the school generates the most noise, followed by the canteen and the gym. These are the areas where many children spend time, but also the areas where children relax.

During the noise measurements in the empty rooms, we found that the noise is caused by the buzzing of the lamps that are turned on. We recommend that the lighting be

replaced when the school is renovated, as this would reduce or eliminate the background noise that is present but unnoticed in full classrooms.

Table 1: Noise levels in four areas (canteen, school foyer, music classroom and the gym) when they were empty and when activities were taking place.

Area	L_{Aeq} [dB]	$L_{AIm} - L_{Aeq}$ [dB]	$L_{C, peak}$ [dBC]	$L_{AI, Te}$ [dB]
Canteen (empty)	31.5	1.8	64.7	31.5
Canteen (at snack-time)	83.7	3.1	110.3	86.8
Canteen (at lunch-time)	85.3	3.1	114.6	88.4
School foyer (empty)	29.2	3.2	72.3	32.4
School foyer (during break)	85.9	2.9	112.0	88.8
Music classroom (empty)	26.1	2.5	57.3	28.6
Music classroom (during the class)	79.1	3.3	107.0	82.4
Gym (empty)	31.1	1.0	61.1	31.1
Gym (during the class)	78.5	4.1	122.5	82.6

Legend:

- L_{Aeq} is the equivalent noise level,
- $L_{AIm} - L_{Aeq}$ is the difference between the equivalent and impulse noise levels,
- $L_{C, peak}$ is the peak noise level,
- $L_{AI, Te}$ is the estimated impulse-corrected noise level.

Hadzi - Nikolova et al [12] performed noise measurements in kindergartens, elementary and secondary schools. They found that the most noisy activities in elementary and secondary schools occurred during breaks. They measured noise levels between 83.3 and 84.7 dB during these times. During school hours, noise levels were measured between 50.4 and 64.3 dB. They also found that the gyms were very noisy areas of the school, with noise levels between 79.2 and 81.7 dB. In our study, the measured noise level during breaks in the school lobby was 88.8 dB, an increase of 4.1 dB compared to the above study. During school hours in music classes, the noise level in the observed elementary school was 82.4 dB and in the gym 82.6 dB. According to the study by Hadzi-Nikolova et al [12], the noise levels at the observed elementary school are higher.

The Rules on the protection of workers from risks related to exposure to noise at work establishes the alert value and the limit value for an eight-hour working day [13]. Based on the measurements performed, it is difficult to say whether the noise has a negative impact on the health of workers or not, because the measurements were not performed during the whole day and not during the preparation of the teaching sessions. According to the regulation, the employer is obliged to provide workers with personal protective equipment if the noise exposure exceeds the lower alert value. Workers must wear personal protective equipment when noise exposure reaches or

exceeds the upper warning level [13]. The upper alert value of 85 dB is exceeded in the canteen and in the foyer of the school. The maximum noise exposure is 1.5 to 2 hours per day. The warning levels are specified in the regulations for an eight-hour workday. Let us take the example of a physical education teacher who teaches 6 school hours per day. This teacher is exposed to noise levels of approximately 82 dB for 4.5 hours, which exceeds the lower warning level of 80 dB under the regulations. In addition to teaching, the teacher is also in the foyer of the school for 15 minutes (noise level 88.8 dB) and in the canteen for one hour at lunchtime (noise level 88.4 dB). However, in both areas, the noise level is above the limit of 87 dB. Physical education teachers should not be exposed to noise during breaks, at least not as often as others. They should also be provided with personal protective equipment if requested (e.g., earplugs).

Noise can be reduced by installing absorbent materials (felt, cork, styrofoam). For greater efficiency, we recommend the installation of pyramid-shaped absorber panels made of polyurethane foam. In addition to sound absorption, the foam also provides thermal insulation [14]. The pyramid shape increases the absorption area. The foam is very durable and resistant to vibrations [15]. When renovating a school, we recommend covering the ceiling and walls of the gym, the ceiling of the foyer and the canteen with polyurethane foam. This would reduce noise pollution in these areas and improve thermal insulation. We also recommend lining the walls of the music room with polyurethane foam to prevent sound from being transmitted through the building structure to adjacent areas.

Noise from chairs (impact noise) could also be reduced by installing a floating floor or a floating screed on the canteen floor [16].

The results of noise level measurements in the canteen after one month following the installation of SoundEar are shown in Table 2.

Table 2: Noise levels in the canteen during snack time and lunch time after one month of SoundEar installation.

Area	L_{Aeq} [dB]	$L_{AIm} - L_{Aeq}$ [dB]	$L_{C, peak}$ [dBC]	$L_{AI, Te}$ [dB]
Canteen (at snack-time)	83.5	3.2	112.2	86.7
Canteen (at lunch-time)	81.7	3.3	112.5	85.0

Legend:

- L_{Aeq} is the equivalent noise level,
- $L_{AIm} - L_{Aeq}$ is the difference between the equivalent and impulse noise levels,
- $L_{C, peak}$ is the peak noise level,
- $L_{AI, Te}$ is the estimated impulse-corrected noise level.

After the SoundEar had been installed in the canteen for a month, we measured the noise levels again. The estimated impulse-corrected noise level ($L_{AI, Te}$) did not improve significantly during the snack period, it was 0.1 dB lower. The upper exposure alert value of 85 dB is still exceeded. During the lunchtime, the measurements showed an improvement of 3.4 dB. However, this was also the time

when the pupils were scheduled to arrive for lunch. The estimated impulse-corrected noise level exceeded the lower exposure alert value of 80 dB and remained at the upper exposure limit of 85 dB.

Noise mitigation approaches vary depending on the noise source. Indoor noise can be reduced through sound insulation or behavioural measures, while background noise can be reduced through the use of quieter heating and cooling systems. Excessive noise exposure can have a negative effects on learning, especially on children's language and literacy skills [17].

Jiménez-Tejada et al [18] suggest that involving parents in awareness activities would eventually lead to the introduction of prevention programmes as part of the school curriculum.

Conclusion

The goal of our survey was to raise awareness of excessive noise levels in specific areas of elementary schools. The goal of the survey was to suggest to the observed elementary school simple and cost-effective measures to reduce noise on school grounds and to improve the working environment of teaching staff. We also want to encourage staff to take action at an individual level to manage excessive noise. The first step is to be aware of being exposed to noise, and then to take simple and inexpensive measures. Regular visits by a sanitary engineer should be scheduled in elementary schools, as their expertise is an important link in assessing and controlling noise. Noise issues should be discussed and addressed in schools among both pupils and teaching staff. We propose several workshops and educational sessions on noise for teachers and parents of children to raise awareness of the importance of noise to our health.

We have taken organisational, pedagogical, educational and building measures to reduce the noise level in the school.

As an organisational measure, we have proposed that pupils who have finished their recess meal wait in the canteen until the end of recess. This would reduce noise in the school's foyer, as previous measurements have shown that most noise in the school's foyer occurs during breaks. The timing of when pupils arrive for lunch is also important. We have also suggested introducing active breaks once or twice a week. The physical education teachers would prepare quick stretching and breathing exercises. They would also incorporate ball games (football, volleyball, between two fires). The American Heart Association (2019) gives 135 suggestions for introducing active breaks in schools.

Among pedagogical measures, we suggested greater staff involvement to reassure children during meals, to monitor them, and to expel children without lunch from the canteen. We recommended developing rules of conduct for the canteen, during the warmer months, classes could be held outside. We also recommended playing quiet music during breaks and installing a SoundEar in the school canteen as it encourages children and teachers to self-regulate the noise level in the room (Skovmand, 2017).

In the canteen, we proposed to cover the legs of the wooden chairs with felt and the walls with cork. By placing absorbent materials on the walls, ceiling, and floor, we can reduce the reverberation time in the room [16].

Noisy classrooms (music, art, home economics) should be separated from Slovenian, math, and English classrooms. If physical separation is not possible, we recommend sound insulation on the walls of the room.

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IMAMO LI PREVIŠE BUKE U OBRAZOVNIM USTANOVAMA?

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Sažetak: Buka je svaki neželjeni zvuk koji negativno utječe na naše blagostanje i zdravlje, kao i štetno djeluje na okoliš. U obrazovnim ustanovama buka je faktor rizika i za osoblje i za djecu, ali se često zanemaruje. Prekomjerni nivoi buke predstavljaju profesionalni rizik za nastavnike i ugrožavaju zdravlje učenika. Cilj je bio utvrditi nivoe buke kojoj su određeni nastavnici izloženi tokom rada u odabranoj osnovnoj školi. Mjerenja buke vršena su u skladu sa standardom SIST ISO 9612:2009. Koristili smo mjerni instrument Brüel & Kjær 2260 Investigator. Mjerenja su obavljena u oktobru 2019. godine u odabranoj osnovnoj školi u pojedinim učionicama i drugim prostorijama škole. Buka je mjerena u praznim učionicama i u vrijeme održavanja nastave. Rezultati su pokazali, da je prekoračena granična vrijednost od 87 dB u holu škole (88,8 dB) i u menzi za vrijeme ručka (88,4 dB). Donja vrijednost upozorenja od 80 dB premašena je u muzičkoj učionici (82,4 dB) i teretani (82,6 dB). Upotreba elektronskog uha značajno je smanjila buku u trpezariji. Izloženost buci postala je jedan od najvažnijih faktora u određivanju kvaliteta života u zatvorenom prostoru. Prekomjerni nivoi buke tokom nastave, gdje nivoi buke konstantno variraju, mogu negativno uticati i na nastavnike i na učenike. Zato je važno suočiti se s problemom buke i svjesno djelovati. Predlažemo pregled prostorija sa stanovišta akustike, redovnu upotrebu elektronskih ušiju za upozoravanje na visok nivo buke i podizanje svijesti nastavnika, učenika i roditelja o štetnosti buke. Niži nivoi će dovesti do boljeg zdravlja i kvalitetnijeg obrazovanja.

Ključne riječi: buka, obrazovna ustanova, izloženost, profesionalni rizik