



INSIGHT IN PERSONAL NOISE EXPOSURE FOR PHYSICAL EDUCATION TEACHERS IN PRIMARY SCHOOLS

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ABSTRACT

Physical Education (PE) teachers are exposed to high sound pressure levels in the gym. As a result, they may risk noise-induced hearing loss and stress related health problems. To create healthier working environments, it is necessary to provide the PE teachers with knowledge and tools to identify the influence factors of high noise levels such that they can assess and reduce its impact on their health and well-being. This paper presents research goals and method for a comprehensive, multidisciplinary research project in the Netherlands on noise exposure in sports halls focusing on specialist PE teachers in primary schools. The research will take place in sports halls with various sizes and acoustic qualities. Omnidirectional transducers will be used to establish reverberation time, sound strength and speech intelligibility.

Acoustic cameras will be used to visualize the location of different sound sources in the gym and their contribution to the total noise exposure. Noise-induced hearing loss will be quantified by audiograms, and teachers' experience of their daily teaching activities will be investigated through questionnaires and semi-structured interviews. Results will be used to provide accessible tools to PE teachers for more insight in their personal noise exposure and improve their working environment.

Keywords: *physical education teacher, sports halls, noise levels, acoustic measurements*

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1. INTRODUCTION

Occupational hearing loss is among the top five most common occupational diseases in the Netherlands [1]. It represents a challenging occupational hazard, as excessive noise exposure is difficult to quantify and the resulting damage occurs gradually. Noise-induced hearing loss is a sensorineural hearing deficit that begins at the higher frequencies and is irreversible once it has occurred. According to the Centre for Occupational Diseases, physical education teachers and swimming instructors are a high-risk group for developing hearing loss [1]. Exposure to high sound levels has a negative effect on well-being, communication, the onset of stress, concentration, speech intelligibility, and vocal use [2-7]. In the long term, it can cause irreversible hearing impairment, such as tinnitus, sound distortion, and hearing loss [8-10]. Even children experience stress due to noise exposure [11]. Above this, employees with a hearing impairment are more likely to be absent from work, show more fatigue and stress symptoms, have a greater chance of a workplace accident and tend to stop working at a younger age on average. As a result, hearing impairment reduces people's sustainable employability [12,13].

Research into noise exposure in swimming pools and primary schools has shown that exposure values often exceed the limits, with $L_{A,peak}$ up to 124 dB (A), as a result from children's voices, bouncing balls, squeaking shoes, and whistles [2,3].

The exposure limit values and exposure action values in respect of the daily noise exposure levels and peak sound pressure are fixed at [17]:

1. Exposure limit values:
 $L_{EX,8h} = 87$ dB(A) and $p_{peak} = 200$ Pa.
2. Upper exposure action values:
 $L_{EX,8h} = 85$ dB(A) and $p_{peak} = 140$ Pa.
3. Lower exposure action values:
 $L_{EX,8h} = 80$ dB(A) and $p_{peak} = 112$ Pa.

The daily dose can be measured in relation to tasks, jobs and over a full day. Tasks related measurements will be helpful to determine which activities relate to a high-, or low exposure level.

Sound maps will be used within this research to visualize these activities and the reflections, in relation to the noise exposure. Sound maps will make insightful which areas provide a healthier workspace or a hazard and will show the relation with the room acoustic parameters.

The reverberation time (RT), sound strength (G) and speech transmission index (STI) describe the room acoustics related to the perception of reverb and the amount of sound absorption in the room. Typically, a low reverberation time and a large room lead to a low sound strength [15]. STI is an essential parameter to establish working conditions for PE teachers, where communication is key. Poor speech intelligibility leads to the perceived need to use loud whistling and a shouting voice, which affects the teacher's noise exposure and voice load [16].

In the Netherlands all sports halls must meet the acoustical standards towards reverberation time, presented in de Norm for building acoustics since 2005 [14]. However many are built before 2000 and do not meet the criteria. Moreover, it is unclear whether a low reverberation time actually leads to a low noise exposure during physical education class.

Physical education teachers may be at risk due to exposure of the high daily noise and peak sounds. Therefore, it is crucial to investigate the actual noise exposure of PE teachers, the relation between reverberation time and actual noise exposure, and the impact of this exposure on their health.

The multidisciplinary approach helps to mitigate the noise exposure and find solutions by making adjustments to the source, the environment, with personal hearing protection and behaviour change.

This paper reports the method of a comprehensive, multidisciplinary research project in the Netherlands that investigates noise exposure in sports halls and its effect on specialist PE teachers in primary schools. The study aims to measure the following:

1. Room acoustical properties of sports halls.
2. Noise exposure levels of PE teachers.
3. Noise-induced hearing loss and tinnitus.
4. Wellbeing, health and communication.
5. Sound distribution in sports hall.

2. METHOD

2.1 Room acoustical properties of sports halls

The study will include a minimum of 10 sports halls that are representative of the most commonly used sports halls in the Netherlands for PE teachers. The NOC*NSF standard categorizes sports halls into three common sizes: small (approximately the size of one volleyball field), medium (two volleyball fields), and large (three volleyball fields) [14]. For each size of sports hall, at least one must be built before 2000 without any acoustical adjustments, and at least one must be recent (built after 2015) with acoustical adjustments [17].

The acoustic parameters of reverberation time (T_{20}), background noise ($L_{A,eq}$), sound strength (G), and speech intelligibility (STI) will be measured according to the method described in IEC 60268-161 in the unoccupied situation.

Impulse responses (IRs) will be obtained using a deconvolution technique with an exponential sine sweep as the measurement signal, using DIRAC 6 Software. The reverberation time and background noise levels will be measured both at source and receiving positions, following the NOC*NSF standard for sound strength.

2.2 Noise exposure levels of PE teachers.

The physical exercise teacher's daily noise exposure will be evaluated through dosimetry in accordance with ISO standards [18]. The daily dose will be compared to the daily dose that is allowed according to health and safety regulations within work environments [17].

2.3 Noise-induced hearing loss and tinnitus.

A hearing test will be conducted on 100 PE teachers following the guidelines for prevention of occupational hearing loss in the Netherlands. Inclusion criteria require a minimum of 2 years of work experience for at least 2 days per week. Occupational hearing loss typically starts with high tones between 4000 and 6000 Hz. Therefore, a pure-tone audiogram will be conducted at frequencies of 500, 1000, 2000, 3000, 4000, 6000, and 8000 Hz. Prior to the audiogram, an otoscopy will be performed to identify any possible abnormalities in the middle ear. The audiogram will be conducted in a controlled soundproof booth.

All subjects will fill in a questionnaire regarding, age, sex, working experience, exposure to other sounds sources, effect on stress, headache, fatigue, voice and

tinnitus. Tinnitus will be assessed using the Tinnitus Handicap Inventory [19].

2.4 Wellbeing, health and communication.

The experiences of physical education teachers of noise exposure on well-being, health and communication will be investigated through qualitative, semi structured interviews and focus groups. Teachers are eligible when they have a minimum of 2 years work experience for at least 2 days a week. The main topics will be effects on well-being, stress, and communication of the PE teachers and the effect on children's behaviour. Furthermore, the use of hearing protections, perceived exposure of sound levels, and knowledge of limit values will be included in the research.

2.5 Sound distribution in sports halls

Sound maps will be made for different lesson activities to gain insight in the sound distribution within the hall. The sound maps will be created by the use of acoustic cameras, known as the L642 and CAMiV64.

An example of a sound map that is related to an activity, is shown in figure 1. This sound map visualizes a running and throwing game; "Maze runner", where 2 teams play against each other to see who can score the most points. The students have a starting position and 2 'home' positions. These three areas of interest are visualized by the sound distribution shown by the sound map. The red areas show a high sound pressure level and the blue areas a lower sound pressure level.



Figure 1. Sound map recording over time (a) that is representative for the "maze runner" activity (b).

3. RESULTS

All measurements will be conducted during spring and summer 2023. Preliminary results indicated that the noise exposure levels exceed the exposure limit levels, even in sports halls with low reverberation time that meet the standards for building acoustics. Results from the qualitative interviews shown that all PE teachers

included suffer from headache and loss of focus as a result from the noise exposure.

4. DISCUSSION & CONCLUSION

Not all data have been collected yet; therefore it is too early to draw any conclusions. However, the assessed results are in line with results from literature.

PE teachers teach children to enjoy sports and have faith in their physical abilities. They play an important role in developing healthy children. However, their working environment should be healthy as well. This study contributes to the development of a sustainable and healthy work environment for PE teachers.

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