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Original Article

Sound pressure level at the workplace: the case of physical education teachers

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Abstract:
Measure the sound pressure levels to which physical education teachers are exposed in gyms. In addition, evaluate the self-reported effects on physical education teachers. The sound pressure levels of ten gymnasiums were evaluated and a subjective questionnaire containing eight questions was applied to 12 teachers. The equivalent sound pressure level varied from 57 to 78 dB(A), the maximum sound pressure level ranged from 69 to 105 dB(A), and the minimum sound pressure level varied from 40 to 61 dB(A). The mean maximum sound pressure level was 70 dB(A), the minimum was 51 dB(A) and the average maximum sound pressure level was 84 dB(A). Demographic data were obtained from a questionnaire that was applied to 12 physical education teachers. Male physical education teachers accounted for 80% of the sample. The average age of the teachers was 34 years, and their teaching experience was approximately 12 years. The weekly workload was 37 classes and the daily workload was 8.92 classes. The sound levels in the work environment of physical education teachers were not high. However, the self-reported discomfort of the teachers was significant, since an average of 49% reported feeling discomfort. Actions aimed at preventing and reducing noise in the work environment are needed to improve the quality of life of physical education teachers.
Key words*:* sound pressure level, physical education teachers, gymnasiums, noise effects.

Introduction

Acoustic pollution is one of the problems that most affect people today (Zannin et al., 2007, Zannin et al., 2013;(Zannin & Bunn, 2014). Noise is the third most significant type of pollutant that has harmful effects on people. Therefore, the implementation of preventive actions in the work environment is important (Calixto et al., 2008; Fiorini et al., 2009; Ogido et al., 2009). Gymnasiums have multiple functions: they are used for musical performances, cultural and theatrical activities, and competitive games. All these different activities that can be performed in a gym require very specific acoustic characteristics and precise architectural planning to ensure that this structure provides its users with sound quality and acoustic comfort and that it does not become an unhealthy environment (Jardim et al., 2007; Samelli et al., 2011). Excessive exposure to noise in the work environment causes a variety of symptoms, including insomnia, behavioral disorders, decreased concentration, headaches, loss of balance, hormonal changes, stress, sleep disorders, gait changes, tinnitus, communication disorders, vestibular changes, digestive alterations, neurological problems, cardiovascular disorders and changes in work performance (Jardim et al., 2007; Samelli et al., 2011). The objective of this research was to measure the equivalent sound level (LA_{eq}), maximum sound level (LA_{max}) and minimum sound level (LA_{min}) to which physical education teachers are exposed in gymnasiums and to determine the deleterious effects of workplace noise self-reported by teachers.

Material & methods

The purpose of this study was to measure the sound levels to which teachers are exposed in gyms. In compliance with ethical principles, all the participants were informed in writing about the procedures and intent of the research before they signed an informed consent form (ICF), according to the Guidelines and Regulatory Standards for Research Involving Human Beings (Resolution: 466/2012) established by the National Health Commission. The procedures were evaluated and approved by the Research and Ethics Committee of the Federal University of Parana, under CAAE number 23385313.0.0000.0102.

The individuals that participated this study were selected randomly. The inclusion criteria were as follows: teachers with a degree in Physical Education, from 18 to 60 years old, female or male, teaching in gyms (at schools or universities). On the other hand, the exclusion criterion was individuals with hearing problems, who refused to sign the ICF, who used medications on a continuous basis, and those who declined participating in the research.

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Five high schools and five universities agreed to participate in this study. Sound pressure levels were measured in the gyms and a questionnaire was applied to the physical education teachers. Sound pressure levels were measured according to Regulatory Standard NR-15 for Unhealthy Activities and Operations, established by Brazil's Ministry of Labor and Employment, which deals with noise assessment in the work environment and in unhealthy operations.[10] The sound pressure levels were measured using a Bruel & Kjaer type 2250 class 1 sound level meter. The measurements were taken for 20 consecutive minutes, after which the following data were obtained: equivalent continuous noise level (L_{eq}), minimum sound pressure level (L_{min}) and maximum sound pressure level (L_{max}), all measured in dB(A).

The purpose of the questionnaire was to ascertain the teacher's response to eight questions, as follows. (1) Does noise during work disrupt classes? (2) Does it interfere with speech intelligibility? (3) Does it cause changes in sleep patterns? (4) Do you normally have a headache after work? (5) Do you feel irritated after work? (6) Do you suffer from tinnitus after work? (7) Do you suffer from lack of concentration after work? (8) Do you feel a change in hearing after work? To quantify the teacher's response to each question, an intensity scale was used comprising a straight 10-cm line between two extreme expressions such as "no discomfort" and "strong discomfort." [11] In answer to each question, the teacher was asked to mark his response on the line, describing his sensation as closely as possible. In addition, the following data were collected: age (years), working time (years), weekly working hours (hours) and daily working hours (hours). This study involved twelve physical education teachers who work in sports gyms. The teachers were not chosen systematically to participate in this research. In other words, given the small number of schools and universities that agreed to participate in the study, all the teachers who agreed were included in the sample. The teachers were asked to fill out the questionnaire during their working day in the gyms. The researchers gave the participants an explanation of how the research would take place and how to answer the questionnaire.

The questionnaire's response scale was transformed into a scoring system and then grouped in three ordinal scales: "no discomfort – 0 to 10 points," "minor discomfort – 11 to 49 points," and "strong discomfort – 50 to 100 points." The data from the questionnaire were tabulated and organized for statistical analysis in SPSS v.20 (Statistical Package for the Social Sciences).

Results

This study investigated the sound pressure levels in ten sports gyms, as well as the perception of noise of 12 P.S. teachers. The findings indicated that 30% of the gyms were at private schools and 70% at public schools, and that the gyms offered classes at Brazil's three educational levels: elementary school, middle school and higher education. The cities where the gyms are located are Guarapuava (population 167,328 and 2010 human development index (HDI) of 0.731), Ponta Grossa (population 311,611 and 2010 HDI of 0.763), and Curitiba (population 1,751,907 and 2010 HDI of 0.823), all in the state of Paraná. Table 1 describes the activities of the gyms.

Table 1. Characteristics of the evaluated gymnasia.

Gym	City	Type of school	Grade level	Type of activity	Number of students
Gym 1	Curitiba	Private	Elementary school	Dance	15
Gym 2	Curitiba	Private	Elementary school	Volleyball	12
Gym 3	Ponta Grossa	Private	Elementary and middle school	Dance	19
Gym 4	Guarapuava	Public	Elementary and middle school	Volleyball	30
Gym 5	Guarapuava	Public	Elementary and middle school	Futsal	35
Gym 6	Curitiba	Public	Higher education	Futsal	40
Gym 7	Curitiba	Public	Higher education	Volleyball	37
Gym 8	Ponta Grossa	Public	Higher education	Futsal	37
Gym 9	Ponta Grossa	Public	Higher education	Futsal	40
Gym 10	Guarapuava	Public	Higher education	Basketball	36

As can be seen in Table 1 shows, the number of students per class varied, mainly between schools (12 to 35 students) and universities (36 to 40 students) and between types of school (private 12 to 19 students and public 30 to 40 students). The types of activities in the classes differ significantly, ranging from ball sports (e.g., futsal, volleyball and basketball) to dance, which involves the use of loud music. Table 2, lists the sound pressure levels measured in the gyms. In the 20 minutes of measurement, which represents the average duration of a physical education class, the L_{eq} ranged from 60 to 78 dB(A). As for the L_{max}, the peak value reached in a gym was 105 dB(A).

Table 2: Sound pressure levels measured in the gyms.

Site	L_{eq} dB(A)	L_{min} dB(A)	L_{max} dB(A)
Gym 1	71	51	101
Gym 2	76	45	105
Gym 3	67	59	90
Gym 4	75	61	73

Gym 5	74	51	84
Gym 6	78	59	81
Gym 7	72	60	82
Gym 8	70	40	89
Gym 9	75	49	79
Gym 10	60	44	78

The average age of the twelve physical education teachers who participated in this study was 34 years; the youngest was 21 and the oldest 52 years old. The average workload was 37 classes per week; the lowest workload was 9 and the highest was 50. The teachers taught an average of 8.92 hours of classes per day, varying from 12 classes to only one class per day. The average working time was 12 years, ranging from 2 years, to 30 years, which was the longest teaching time. Table 3, describes the findings obtained from the questionnaire about the discomfort reported by the physical education teachers resulting from workplace noise. According to the teachers' responses, the greatest reported discomforts were interference in classes caused by workplace noise and headache after the workday (8 teachers, i.e., 66.7%, reported strong discomfort resulting from these two causes). The discomfort caused by hearing changes and tinnitus after work also showed high scores (5 teachers, 41.7%, reported strong discomfort caused by changes in hearing, and 4 teachers, 33.3%, reported strong discomfort caused by tinnitus after work).

Table 3. Evaluation of discomfort caused by workplace.

	No discomfort	Minor discomfort	Strong discomfort
Question 1 – Workplace noise disrupts classes.	3	1	8
Question 2 – Interferes with speech intelligibility.	10	2	0
Question 3 – Changes sleep patterns.	7	5	0
Question 4 – Causes headache after work.	3	1	8
Question 5 – Causes irritation after work.	4	6	2
Question 6 – Causes tinnitus after work.	2	6	4
Question 7 – Lack of concentration after work.	5	6	1
Question 8 – Changes in hearing after work.	1	6	5

Dicussion

The purpose of this study was to measure the sound pressure levels in school and university sports gyms and to ascertain the perception of physical education teachers regarding noise in these environments. The equivalent continuous sound pressure level in all the evaluated gymnasiums was lower than 85 dB(A), a reference value recommended by the Brazilian standards NR-15 and NHO 01 for an 8-hour workday (Brasil, 1992; Brasil 1999). This value varied among the gyms under assessment, because the activities performed in each class were different (ball sports and dance). The number of students in the assessed classes also varied, indicating different characteristics of the public in these classes. There are studies demonstrating that sound pressure levels in school and university environments exceed recommended limits (Angelo et al., 2014, Almeida et al., 2012). However, few studies published in the literature have evaluated the work environment in sports gyms. The sports gyms of this study were in compliance with Brazilian legislation, which establishes a maximum of 85 dB(A) for an 8-hour workday, without requiring ear protection. However, according to the Brazilian standard NR-17 (Brasil, 1999), which involves ergonomics in occupational environments, values above 65 dB(A) in the work environment can be considered uncomfortable. Equivalent sound pressure levels ranging from 70 to 87 dB(A) and maximum sound pressure levels of 85 to 135 dB(A) have been found in school gymnasiums, according to Maffei et al. (2009). These authors also point out that sound pressure levels in gyms are influenced by five factors, namely, the number of students (more than 30), exposure time (more than 25 hours per week), ball bouncing during classes, intensive use of whistles, and reverberation time in the gym (longer than 5 seconds). Physical education teachers work in environments that are often characterized by high noise levels, especially in sports gyms. The noise assessment carried out by Jiang (1997) in gymnasiums revealed the exposure of physical education teachers to noise levels ranging from 72 to 119 dB(A), with a L_{eq} of 90.8 dB(A) and peak values of 125 dB(A). The author pointed out that poor gymnasium acoustics interferes in the effectiveness of physical education teachers, and hinders speech intelligibility. Another problem associated with high sound pressure levels is hearing loss caused by excessive noise. In their evaluation of noise-induced discomfort, physical education teachers reported that the greatest discomfort was caused by noise interference in classes (66.7%), followed by headache after the workday (66.7%) and hearing impairment (41.7%). Enmarker and Boman (2004), demonstrated that teachers are more sensitive to noise than students, and that they have worse hearing conditions and higher levels of stress. Martin et al. (2006), stated that there is a connection between noise and headache, and that exposure to noise can undoubtedly be a factor that triggers the onset of headache.

Hearing disorders linked to noise exposure are one of the main complaints raised by teachers. Martins et al. (2007), reported that 65% of a sample of teachers presented auditory symptoms and 25% showed audiometric changes, and that these symptoms were more prevalent in teachers than in volunteers. Therefore, professionals

whose work involves teaching activities, such as physical education teachers, should be the focus of studies aimed not only at identifying factors that may contribute negatively to their professional performance but also at improving their health conditions.

Conclusions

The equivalent sound pressure levels in the gyms evaluated here were lower than those recommended by Brazilian standards, but exceeded the level recommended for comfort in work environments. This assessment revealed that the noise-induced discomfort reported most frequently was caused by noise interference in classes, followed by headache after the workday, and hearing impairment. It is recommended that adjustments be made in the acoustics of the gymnasiums of this study, e.g., installation of sound absorption materials, in order to reduce the sound pressure levels in these environments.

Conflicts of interest

The authors declared no conflict of interests regarding the publication of this manuscript.

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