



Evaluation and perception of teachers on the effects of sound pressure level in the classroom

Avaliação e percepção docente sobre os efeitos do nível de pressão sonora na sala de aula

Evaluación y percepción de los docentes sobre los efectos del nivel de presión de sonora en el aula

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Abstract

Objective: To evaluate the sound pressure level in classrooms of public schools and perceptions of teachers about its interference with school activities and their health. **Methods:** A descriptive cross-sectional study evaluating the noise of 14 classrooms in eight schools. An assessment of noise was made using the acoustic equivalent sound pressure level parameter. To verify the perceptions of teachers regarding noise in the classroom and its interference in school activities and their health, it applied a questionnaire to 23 teachers with questions about: a) influence of noise in school activities, b) the influence of noise in speech and communication, c) influence of noise in the body, d) influence of internal noise of school, e) influence of external noise of school. The questions obeyed Likert scale with the following answers: none, small, medium, and high. **Results:** The sound pressure level in the classroom ranged from 54,5 dB(A) 70,3 dB(A), with a median of 60 dB(A). Complaints related to noise greater occurrence (medium and high) were student academic performance (95.7%) and understanding of the content in

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Conflito de interesses: *No.*

Contribuição dos autores: ATVR auxílio no delineamento do estudo, coleta de dados, interpretação dos dados coletados, redação do artigo, revisão e aprovação final da versão publicada. ACFG auxílio na coleta de dados, organização dos dados coletados, redação do artigo, revisão e aprovação final da versão publicada. RCO auxílio na organização dos dados coletados, revisão do artigo e aprovação final da versão publicada. LBF auxílio na organização dos dados coletados, revisão do artigo e aprovação final da versão publicada. JNS auxílio no delineamento do estudo, supervisão da coleta de dados, análise e interpretação dos dados coletados, redação do artigo, revisão e aprovação final da versão publicada.

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Recebido: 20/02/2015; **Aprovado:** 14/10/2015



the classroom (95.7%), raising the voice at work (87.0%), vocal fatigue (82.6%), irritability (82.6%) and fatigue (82.6%). The later two were most cited by teachers in the noisiest rooms ($p \leq 0.05$). The conversations in the hall were also a factor related to increased noise in class ($p = 0.03$). **Conclusion:** The measured sound pressure levels are above the recommended by the standards. According to teachers, noise negatively affects the school environment and it is related to the symptoms of tiredness and irritability.

Keywords: School Health; Noise; Noise Effects; Dysphonia.

Resumo

Objetivo: Avaliar o nível de pressão sonora em salas de aula de escolas públicas e a percepção de professores sobre sua interferência nas atividades escolares e em sua saúde. Métodos: Estudo transversal descritivo com avaliação do ruído de 14 salas de aula de oito escolas. Avaliou-se o parâmetro acústico nível de pressão sonora equivalente. Aplicou-se um questionário a 23 professores com perguntas sobre: a) influência do ruído em atividades escolares, b) influência do ruído na voz e comunicação, c) influência do ruído no organismo, d) influência do ruído interno à escola, e) influência do ruído externo à escola. As questões obedeceram à escala Likert com as seguintes respostas: nenhuma, pouca, média e elevada. Resultados: O nível de pressão sonora encontrado nas salas de aula variou de 54,5 dB(A) a 70,3 dB(A), com mediana de 60 dB(A). As queixas de maior ocorrência (média a elevada) relacionadas ao ruído foram: interferência no rendimento escolar do aluno (95,7%) e na compreensão do conteúdo em sala de aula (95,7%), elevação do tom de voz durante o trabalho (87,0%), fadiga vocal (82,6%), irritabilidade (82,6%) e cansaço (82,6%). Esses dois últimos foram mais citados por professores das salas com maior ruído ($p \leq 0,05$). As conversas no corredor também foram um fator relacionado ao maior ruído em sala de aula ($p = 0,03$). Conclusão: Os níveis de pressão sonora mensurados estão acima do preconizado pelas normas. De acordo com os professores, o ruído interfere negativamente no ambiente escolar, além de estar relacionado aos sintomas de cansaço e irritabilidade.

Palavras-chave: Saúde Escolar; Ruído; Efeitos do Ruído; Disfonia.

Resumen

Objetivo: Evaluar el nivel de presión sonora en las aulas de escuelas públicas y la percepción de maestros sobre su interferencia en las actividades escolares y su salud. Métodos: Estudio descriptivo de corte transversal con la evaluación del ruido en 14 aulas en ocho escuelas. Se evaluó el parámetro acústico nivel de presión sonora equivalente. Se aplicó un cuestionario a 23 maestros con preguntas sobre: a) influencia del ruido en actividades escolares, b) influencia del ruido en voz y comunicación, c) influencia del ruido en el cuerpo, d) influencia del ruido interno a la escuela, e) influencia del ruido externo a la escuela. Las preguntas obedecieron a la escala Likert con las siguientes respuestas: ninguna, poca, media y alta. Resultados: El nivel de presión sonora en las aulas osciló entre 54,5 dB(A) a 70,3 dB(A), con mediana de 60 dB(A). Las quejas de mayor incidencia (media y alta) relacionadas al ruido fueron interferencia en el rendimiento académico del alumno (95,7%) y en la comprensión de los contenidos en el aula (95,7%), elevar la voz durante el trabajo (87,0%), fatiga vocal (82,6%), irritabilidad (82,6%) y cansancio (82,6%). Estos dos últimos fueron los más citados por los docentes en las aulas más ruidosas ($p \leq 0,05$). Las conversaciones en el pasillo fueron también un factor relacionado con el aumento de ruido en el aula ($p = 0,03$). Conclusión: Los niveles de presión de sonido medidos fueron superiores a los recomendados por las normas. De acuerdo con los maestros, el ruido afecta negativamente el ambiente escolar y se relaciona con los síntomas de cansancio y irritabilidad.

Palabras clave: Salud Escolar; Ruido; Efectos de ruido; Disfonia.



Introduction

The noise in classrooms has several negative effects on the school community, with interference on student learning and teachers' occupational health.^{1,2,3,4}

Related to the noise as damaging to health and to the learning process, there are found in the literature changes in hearing thresholds, tinnitus, fatigue, greater effort to concentrate, loss of part of the content taught, vocal effort and unintelligible speech⁵.

Within an empty and furnished classroom are recommended noise levels of 40 to 50 dB (A) for the Brazilian regulation NBR 10152⁶ and 35 dB (A) to international standards^{7,8}, but studies have shown values above these, even in schools during the holiday period^{9,10,11}.

So they can learn, the children should turn their attention to the main stimulus and ignore the competitive stimulus¹. The students' efforts to understand the spoken message in the presence of noise is much higher^{5,11}. Thus, part of the received speech message may be lost and compromise the teaching-learning process.

Regarding the teacher, in the day to day work, many situations lead to inappropriate and abusive use of voice which can cause vocal disorders¹². The literature reports that the factors that can influence the vocal illness can be environmental (noise, dust, chalk dust and smoke) and organizational (over-charging at work and lack of material) associated to stress, lack of vocal preparation in an unfavorable context, little knowledge about the care of the voice and the factors related to the teachers and their health (respiratory problems, hormonal influences, age, medications, smoking, lack of hydration)^{12,13}. All of these conditions, especially the noise⁴, can lead teachers to inappropriate and abusive use of voice compromising their health and may lead to dysphonia¹².

Attention to this topic, seeking reduction of noise and improvement of teaching and learning conditions in classrooms, meets the current policies that have invested in basic education, especially the School Health Program - PSE, which is a intersectoral policy between the Ministries of Health and Education in order to provide comprehensive health care for children and adolescents¹⁴.

Through noise measurements there are intended propositions of acoustic improvements in

classrooms to improve the learning environment. This is expected to increase the quality of life of students and improve teachers' working conditions in the school.

This research aimed to evaluate the sound pressure level in public school classrooms and teachers' perception of their interference in school activities and in their health.

Materials and Methods

It is a descriptive cross-sectional study, approved by the City Department of Education and the Ethics and Research Committee of the institution under the protocol 352/2012. Teachers invited to participate in the study signed a free and informed consent form (ICF) agreeing to participate.

Noise measurement was performed in public school classrooms and a questionnaire was applied to teachers with questions about the sources of noise pollution, and the influence of noise in school activities and in health and communication of teachers.

In order to obtain data from the current scenario of the classrooms in the city of Belo Horizonte, the aim was to evaluate schools with different design characteristics, located in different areas of the city and in different types of track. In each selected school, two classrooms were drawn to be analyzed acoustically. However, in two schools it was possible to evaluate only one class due to lack of free time for measurements. Thus, eight schools participated in the survey and the sound pressure level of 14 classrooms was scoped out.

The sample consisted of 23 teachers who teach in the rooms where the sound pressure level was measured. It was a sample of convenience, defined from the acceptance of school administrators and teachers to participate. The questionnaire was applied to one or two teachers from each room. As such, the final sample consisted of eight schools, 14 classrooms and 23 teachers.

The noise was evaluated by measuring the acoustic parameter called Equivalent Sound Pressure Level (Leq) consisting in raising the existing noise in a period of time, that is, a temporal noise average in a given environment⁹. The Leq is given in dB (A).



For the measurement of L_{eq} was used a digital sound pressure level meter with data-logger brand Instrutherm DEC-490 model with microphone type two. Measurements were performed at frequencies from 63 Hz to 8 kHz in one-second intervals between measurements, with empty furnished classrooms and with school activities normally occurring in adjacent classrooms. Data were collected for an hour and the sound pressure level meter was positioned 1.2 m from the floor, 0.5 m of moving objects and 1m of walls and fixed objects. The back of the room position was chosen, next to the window, as it was considered the worst situation or noisier location of the room. The measurements were based on the standard ANSI regulatory S12.60⁷ and were performed in empty classrooms to follow recommendations⁷. The standard used is international and has been chosen because it is specific to measuring sound pressure level in classrooms. There is no specific Brazilian norm for this purpose. The Brazilian NBR 10152⁶ provides technical procedures for the implementation of sound pressure level measurements indoors to buildings, but is not specific to classrooms.

The instruments used in the measurement had their calibration certificates within the validity period and were transported to the measurement sites in special boxes.

To verify the perception of teachers in relation to noise in the classroom, and its interference in school activities and health of teachers, it was applied an adapted questionnaire consisting of 11 multiple-choice questions^{2,16}. Of these, nine questions used Likert scale. The questionnaire was answered by 23 teachers with an average age of 47.4 years, 96% female and 4% male. The following variables were assessed:

- Teacher's perception regarding the influence of noise in school activities: test concentration, student reading, group activities, understanding of the proposed content, concentration difficulties and school performance.

- Teacher's perception regarding the influence of noise on voice and communication: Interference in communication, raising voice, vocal fatigue, tiredness to speak, effort to speak, shout, voice failures, hoarseness and pain during voice emission after the work.

- Teacher's perception regarding the influence of noise in the body: difficulty in concentrating, headache, irritability, fatigue and tinnitus.

- Teachers' perception of the influence of the inside school noise: students from other rooms, hallway conversation, talk in the courtyard, movements down the hall, student noise inside the room and adjoining room noise.

- Teachers' perception of the influence of the outside school noise: external noise, horns, alarms, cars, motorcycles, train, plane, industry, buildings and noises from other external sources.

When answering questions, teachers had the following options according to the Likert scale, to qualify their perception of the investigated Question: none, low, medium and high.

For input, processing and quantitative data analysis, we used the SPSS software, version 16.0. For descriptive analysis purposes it was made frequency distribution of categorical variables and analysis of central tendency and dispersion of continuous variables.

The local noise analysis considers the L_{eq} values. This variable was categorized from its median of 60 dB (A): rooms with medium noise - up to 60 dB (A) - and rooms with high noise - above 60 dB (A). The option for the median was due to the values found, all above the recommended by the legislation, making it difficult to categorize according to appropriate or inappropriate levels. Furthermore, when using the median rather than the mean values, it was possible to form two groups of equal size for comparison in the inferential analysis (7 classrooms each).

The results of the questionnaires answered by teachers in rooms with medium noise were compared with the results of the teachers in high noise rooms. In this situation, the perceptions of teachers were analyzed as numerical variables and the mean value of the answers was considered for inferential analysis using the Student t test.

Results

The Equivalent Sound Pressure Level (L_{eq}) found in the empty and furnished classrooms ranged from 54,5 dB (A) 70,3 dB (A), with a median of 60 dB (A). The distribution of values of equivalent sound pressure level measured in 14 classrooms can be seen in Figure 1.

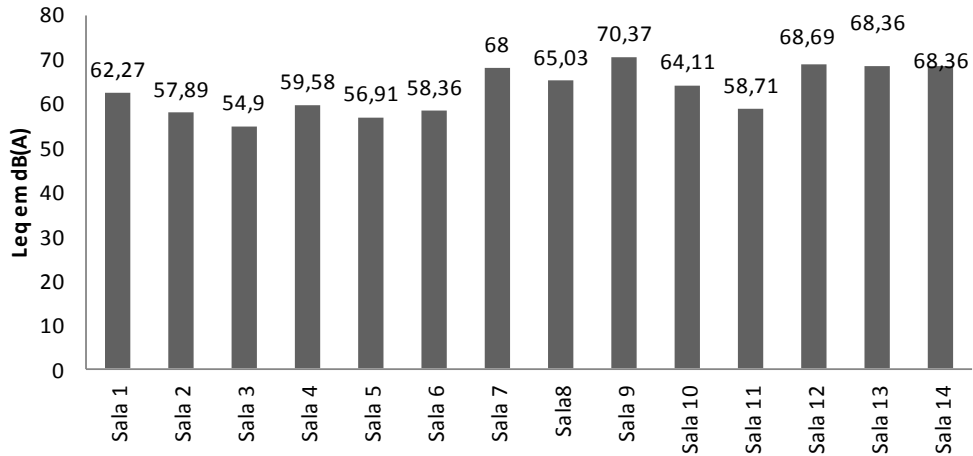


FIGURE 1: Distribution of equivalent sound pressure level (leq) values in 14 classrooms in the city of Belo Horizonte.

Subtitle: dB(A) = Sound pressure level with consideration A.

Leq= Equivalent sound pressure level

The results of the questions are displayed in Tables 1, 2, 3, 4, 5.

TABLE 1 - TEACHER’S PERCEPTIONS REGARDING THE NOISE INFLUENCE ON SCHOOL ACTIVITIES

	Teacher’s perception – answers at Likert scale - descriptive analysis								Teacher’s perception about noise of classrooms - inferential analysis			
	None		Little		Medium		High		Medium noise classroom		High Noise classroom	
	N	%	N	%	N	%	N	%	Mean	Mean	Test t Student	Value p
Test concentration	0	0	3	13	11	47,8	9	39,1	2,09	2,42	1,14	0,26
Student’s reading	0	0	7	30,4	6	26,1	10	43,5	2,09	2,17	0,20	0,84
Group Activities	0	0	3	13	10	43,5	10	43,5	2,09	2,50	1,42	0,16
Classroom Content Comprehension	0	0	1	4,3	12	52,2	10	43,5	2,27	2,50	0,93	0,36
Difficulty in Concentration	2	8,7	6	26,1	8	34,8	7	30,4	1,73	2,00	0,66	0,51

Scholar Performance 0 0 1 4,3 10 43,5 12 52,2 2,27 2,67 1,6 0,11

Subtitle: N = number of participants

TABLE 2 – TEACHER’S PERCEPTION OF NOISE REGARDING INFLUENCE IN VOICE AND COMMUNICATION

	Teacher’s perception – answers at Likert scale - descriptive analysis								Teacher’s perception about noise of classrooms - inferential analysis			
	Nada		Pouca		Média		Muita		Medium noise classroom		High noise classroom	
	N	%	N	%	N	%	N	%	Mean	Mean	Test t Student	Value p
Raising voice	1	4,3	1	4,3	4	17,4	16	69,6	2,64	2,55	0,26	0,79
Vocal fatigue	0	0	3	13	3	13	16	69,6	2,45	2,73	0,86	0,39
Effort to speak	3	13	3	13	7	30,4	8	34,8	2,30	1,64	1,45	0,16
Tiredness to speak	5	21,7	2	8,7	5	21,7	9	39,1	2,10	1,64	0,85	0,40
Shouting	4	17,4	8	34,8	7	30,4	2	8,7	1,50	1,18	0,70	0,43
Voice Failures	5	21,7	1	4,3	9	39,1	6	26,1	1,90	1,64	0,52	0,60
Hoarseness	6	26,1	3	13	5	21,7	5	21,7	1,50	1,44	0,09	0,92
Pain during voice mission after the work	4	17,4	4	17,4	8	34,8	3	13	1,60	1,44	0,32	0,75

Subtitle: N = number of participants

TABLE 3 – TEACHER’S PERCEPTION REGARDING THE INFLUENCE OF NOISE IN THE BODY

	Teacher’s perception – answers at Likert scale - descriptive analysis								Teacher’s perception about noise of classrooms - inferential analysis			
	None		Little		Medium		High		Medium noise classroom		High noise classroom	
	N	%	N	%	N	%	N	%	Mean	Mean	Test t Student	Value p
Difficulty in concentration	2	8,7	6	26,1	8	34,8	7	30,4	1,73	2,00	0,66	0,51
Headache	2	8,7	7	30,4	9	39,1	4	17,4	1,45	1,91	1,20	0,24
Irritability	0	0	4	17,4	8	34,8	11	47,8	1,91	2,67	2,68	0,01*
Tiredness	0	0	1	4,3	8	34,8	47	47,8	2,36	2,83	2,06	0,05*
Tinnitus	8	34,8	5	21,7	7	30,4	2	8,7	1,00	1,27	0,60	0,55

Subtitle: N = number of participants * statistically significant

TABLE 4 – TEACHER’S PERCEPTION ON THE INFLUENCE OF INTERNAL SCHOOL NOISE

	Teacher’s perception – answers at Likert scale - descriptive analysis								Teacher’s perception about noise of classrooms - inferential analysis			
	None		Little		Medium		High		Medium noise classroom		High noise classroom	
	N	%	N	%	N	%	N	%	Mean	Mean	Test t Student	Value p
Students from other classes	1	4,3	5	21,7	10	43,5	7	30,4	1,73	2,25	1,51	0,14
Talking in the hallway	3	13	10	43,5	9	39,1	1	4,3	1,00	1,67	2,24	0,03*
Talking in the courtyard	1	4,3	1	4,3	7	30,4	14	60,9	2,27	2,67	1,21	0,24
Hallway movements	3	13	7	30,4	11	47,8	2	8,7	1,18	1,83	1,96	0,06
Student noise inside classroom	0	0	2	8,7	7	30,4	14	60,9	2,55	2,50	0,16	0,87
Noise next door classroom	2	8,7	6	26,1	10	43,5	5	21,7	1,55	2,00	1,22	0,23

Subtitle: N = number of participants * statistically significant.

TABLE 5 – TEACHER’S PERCEPTION ON THE INFLUENCE OF EXTERNAL NOISE TO SCHOOL

	Teacher’s perception – answers at Likert scale - descriptive analysis								Teacher’s perception about noise of classrooms - inferential analysis			
	None		Little		Medium		High		Medium noise classroom		High noise classroom	
	N	%	N	%	N	%	N	%	Mean	Mean	Test t Student	Value p
Horns/alarms	1	4,3	12	52,2	7	30,4	3	13	1,64	1,42	0,65	0,51
Vehicles/motocycles	1	4,3	8	34,8	11	47,8	3	13	1,73	1,67	0,18	0,85
Train	21	91,3	2	8,7	0	0	0	0	0,09	0,08	0,06	0,95
Airplane	20	87,0	3	13	0	0	0	0	0,09	0,17	0,51	0,61
Industry	21	91,3	1	4,3	0	0	1	4,3	0,00	0,33	1,24	0,22
Constructions	15	65,2	3	13	2	8,7	3	13	1,09	0,33	1,71	0,10
External noise	3	13	9	39,1	8	34,8	3	13	0,36	0,33	0,14	0,88

Subtitle: N = number of participants.

When comparing the responses of teachers' questionnaires of more or less noisy rooms there was difference from the perception of the teacher about the symptoms of irritability and fatigue, over-represented in noisy rooms (Table 3)..

Na percepção dos professores, as conversas de outros no corredor também foram um fator relacionado ao maior ruído em sala de aula ($p=0,03$) (Tabela 4).

Discussion

The noise values in furnished and empty classes were higher than the maximum recommended by NBR 10152 ⁶, ANSI S12.60 ⁷ and at Building Bulletin 93 ⁸ that is 40 to 50 dB (A) to NBR 10152, and 35 dB (A) to the other rules. However, other studies evaluating the sound pressure level equivalent in classrooms found similar results ^{9,10,11}. These data indicate that the classrooms in the evaluated schools do not provide ideal conditions for the best performance of students and teachers in school activities.

According to the perception of the teacher, the noise impacts negatively (medium and too much interference) in school activities carried out by the students, and the two most affected activities are the academic performance of students (95.7%) and the understanding of the room content class (95.7%) (Table 1). Other studies also report the noise impact on school activities carried out by the student and by the teacher, demonstrating that the noise is a negative agent in the teaching-learning process ^{1,5,17}.

Among the vocal symptoms, expressed as the biggest annoyance for teachers (moderate to high), were raising the voice at work (87%) and vocal fatigue (82.6%) (Table 2). Were also cited effort to speak, tiredness to speak, voice failures, shouting and hoarseness. All these symptoms are constantly highlighted by teachers ^{17,18,19}. Other studies also showed that all respondents reported raising voice during the lesson ^{17,18}.

Of the 36 teachers interviewed in Piracicaba (SP), 95% had complaints about the voice, among those 47% of teachers make effort to speak, 22% have voice failures, 39% tire when they speak, 33% yell too much, 30% have pain or burning after work and 39% have hoarseness ¹⁷. In another survey with 126 teachers, 87.3% reported occurrence of dysphonia in teaching ²⁰. From the 1651 teachers interviewed in 27 Brazilian states, 63% reported

being affected by a voice problem at some point in their lives ²¹. International studies also report high rates of teachers with voice disorders and even describe the stress, work pressure and composition of the class as negative influencing factors on the voice ²². The data indicate a high occurrence of teacher vocal complaints, which are caused by the inappropriate use of voice, often caused by noise present in the classroom. It emphasizes the need for preventive measures to improve the quality of life in the teaching work and avoid the high incidence of dysphonia in teachers.

Regarding the influence of noise (medium and high interference) on the body of teachers during classes and at its end, the main complaints were irritability (82.6%) and tiredness (82.6%), which were statistically significant related to greater noise in the classroom (Table 3). Other symptoms such as difficulty in concentrating, headaches and tinnitus have also been reported by teachers on a medium to high intensity for more than 40% of respondents. These findings corroborate the literature, which referred as main complaints of São Paulo teachers the tiredness, headache and stress ²³. Another study reports symptoms in teachers' organism like the mental fatigue (71.4%), headache (66.5%), sore throat (61.9%) and irritation (38%) ¹⁹. Teachers also reported that the deterioration of their general physical condition has a negative influence on their voice ²⁴. The symptoms in the body, in general, are indicators of the health status of teachers and are often related to poor working conditions. Noise is one of the agents that contribute to a health unfavorable environment, and may be causing auditory and non-auditory symptoms ²⁵.

By analyzing the school's internal noise it was observed that the conversations in the hallway were significantly related to the noise present in the classroom. Answering the questionnaires, the teachers attribute to the noise too much interference in the activities and report that the main sources are generated by the student in room (91.3%) and conversations on the patio (91.3%), values found by adding the values of medium and high interference (Table 4). In a research conducted with university teachers of Campinas, they also complained about the noise from the courtyard and other rooms, classifying them as high intensity noise sources ²⁶. These findings corroborate the literature ^{17,19}, as activities in the courtyard and the noise generated by the students in the classroom were the most cited

sources among teachers as harmful. It emphasizes the concern about the interior sound levels to schools, as is known about the negative effects of noise in the body, especially in the hearing²⁵.

It was observed that the external noise to school annoy teachers little or nothing, when asked about the train, aircraft, industry, buildings and neighbors noise. And it is observed little and moderate annoyance compared to the noise of horns, alarms, cars and noise from external sources. These data corroborate research with teachers in the literature^{17,19,26}. In the present study, evaluated schools were not close to all noise sources cited, but in other studies that evaluated school environment close to noisy places like airports and industries, noise values were observed above those recommended by the rules, even in the holiday period.⁹

All teachers of this research present complaints about noise, which only varied in intensity. A possible explanation is the fact that all rooms have presented noise levels above the ideal. Even the study rooms considered for analysis as less noisy (Leq up to 60 dB (A)) had levels that annoy teachers in their teaching practice, highlighting the need to order noise control measures to achieve an environment conducive to health and learning.

Studies should seek to practice the effectiveness of health promotion and control of noise in order to point out integrated actions among the sectors of health, education and engineering. A recent study reported changes to objects in the classroom, which contributed to an acoustic favorable to the learning process as well as educational measures which could help to reduce noise levels and improve the health of teachers²⁷.

In this study, the acoustic characteristics of the rooms were very similar, which possibly explains, perceptions of noise often similar among respondents. Recent study conducted in Bogota (Colombia) with 1449 teachers, compared the measured acoustic parameters in the workplace to the voice complaints from participants from different schools, and the researchers also failed to find many associations due to the fact that there is little difference between the rooms, all values found were high. When all values are high and similar the ability to demonstrate associations between variables is limited¹³.

Importantly, the speech therapists inserted in the school environment have the main role act as health promoter. They can contribute to raise

awareness about self-care measures aimed at reducing the impact of noise in the process of teaching and learning, as well as the health of teachers.

Conclusions

The noise in the classrooms was above the recommended by regulatory standards and it was related to the symptoms of tiredness and irritability in teachers.

Results demonstrate the need for efforts to reduce the noise in schools and for promoting better quality of work and teaching in the school environment.

New studies are suggested, focusing on the quality of the school environment and workers' health in different regions and educational institutions in order to obtain a greater knowledge of the acoustic conditions of classrooms and noise interference in teachers and students' health. The study of the impact of actions to improve the acoustic comfort with measurements before and after the changes probably will enhance environmental improvement actions in the school environment, with possible positive impact on teaching health and student learning.

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