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Sound pressure levels in classrooms of a University and its effects on students and professors

Níveis de pressão sonora em salas de aula de uma Universidade e seus efeitos em alunos e professores

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Keywords

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ABSTRACT

Purpose: Measure the sound pressure levels in classrooms of a university as well to verify the self-perception of noise in the educational environment and its influence on the activities carried out by students and professors. **Methods:** The study was carried out with students and professors who answered a questionnaire regarding self-perception of noise in the classroom, as well as the presence of auditory and non-auditory complaints. Measurement of sound pressure levels was performed in ten classrooms of Pontifical Catholic University of Minas Gerais. The points for measuring the sound pressure level inside the classrooms were selected according to the literature and legislation: three distinct points, totaling nine measurements in each room. **Results:** Participated in this study students and professors from the Institute of Biological and Health Sciences. The classrooms of the morning shift had the highest noise measurement. Classrooms at lunch time had the lowest average noise. The first floor has the highest average noise, being classified as the noisiest floor. Noise is perceived by both students and professors as an interfering factor in the activities performed inside the classrooms, however, professors have a greater perception of noise interference in their activities than students. **Conclusion:** Noise is present in all classrooms with values higher than those recommended by national legislation. This noise is perceived by students and professors and negatively interferes in the teaching-learning activities.

Descritores

Ruído
Efeitos do Ruído
Universidades
Fonoaudiologia
Audiologia
Docentes
Estudantes

RESUMO

Objetivo: Mensurar os níveis de pressão sonora em salas de aula de uma Universidade, bem como verificar a autopercepção do ruído e sua influência nas atividades desempenhadas por alunos e professores universitários. **Método:** Trata-se de um estudo realizado em dez salas de aula do Instituto de Ciências Biológicas e da Saúde da Pontifícia Universidade Católica de Minas Gerais. Participaram do estudo 279 alunos e 20 professores. Alunos e professores responderam a um questionário destinado ao levantamento de informações sobre a autopercepção do ruído nas salas de aula, seus impactos nas atividades acadêmicas e presença de sintomas associados à exposição ao ruído. Foi realizada também medição dos níveis de pressão sonora nas salas de aula, em pontos selecionados de acordo com o recomendado pela literatura e conforme consta na legislação. **Resultados:** As salas de aula do turno da manhã apresentaram o maior nível de ruído. O primeiro andar apresenta maior nível de ruído mensurado, sendo classificado como o andar mais ruidoso. O ruído é percebido tanto por alunos quanto pelos professores como fator interferente nas atividades desempenhadas dentro das salas de aula, entretanto professores apresentam maior percepção da interferência do ruído em suas atividades que os alunos. Não foi observada ocorrência significativa de sintomas associados à exposição ao ruído. **Conclusão:** O ruído está presente em todas as salas de aula com valores superiores ao preconizado pela legislação nacional. Este ruído é percebido por alunos e professores e interfere negativamente nas atividades de ensino-aprendizagem.

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INTRODUCTION

Noise is considered a risk factor for the well-being and health of the population, besides making the environments unpleasant[1,2]. Considering that most of the universities are built in places that have access roads and are highly populated, they are environments that inevitably suffer interference from external noise in the neighborhood (big avenues, heavy traffic, horns, among others). In addition to these sources of sound pollution, the teaching-learning activity itself is also related to the production of noise[3]. The presence of noise in classrooms is an important distractor[3,4] and may interfere negatively in the academic activities, which demand great concentration and attentive listening to the professor's speech[1,2,4,5].

If on one hand the students need to be attentive to the professor, the professor needs to be heard by his students[5,6]. Studies have stated that professors often have to raise the intensity of their voice by 10dB above the noise so that their speech is intelligible[6,7]. Therefore, the harms that this vocal effort can provoke are myriad, even promoting an extremely deficient communicative process, generating negative impacts on the teaching-learning process[8-16].

In addition to the aforementioned impacts, exposure to noise can cause non-auditory biological changes such as headache, flutter, anxiety, stomach problems, difficulty concentrating and communicating, aggressiveness and low yield[1,3,6,8-12]. According to the World Health Organization (WHO), exposure to noise can promote cardiovascular disease, cognitive impairment and sleep disorders[13]. Factors that also contribute to the low achievement of both students and professors[6,14-16].

In Brazil, there are regulatory norms for the minimum necessary conditions for safety and acoustic comfort in classrooms, establishing at 40dB(A) the acoustic comfort and 50dB(A) the acceptable sound level for activities in classrooms[17]. However, sound pressure levels above those recommended are often not perceived by people exposed to them, probably because the daily exposure promotes habituation and a posture of passivity in face of the problem[6].

The structure and acoustic of the classrooms are fundamental so all students and professors can have a pleasant teaching-learning experience without compromising their physical and mental health[1,5].

There are several articles published on this topic. However, most of them were carried out in schools not universities, counting on the participation of students or professors, with little studies, in which the perception of both actors in the teaching-learning process is verified, in a university environment, about the noise effect on the academic activities.

In view of the above, the present study aims to measure the sound pressure levels in classrooms of a university, as well as to verify the self-perception of noise and its influence on the activities performed by students and professors.

METHODS

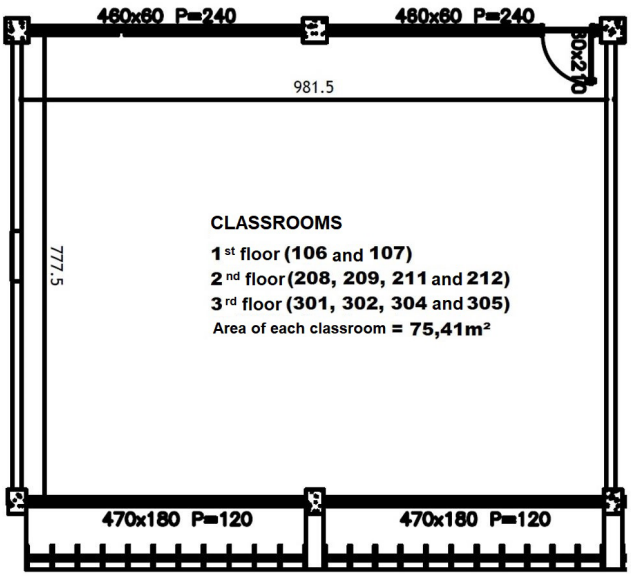
This research was approved by the Research Ethics Committee of the Pontifical Catholic University of Minas Gerais under number 948.301.

This cross-sectional study was carried out in ten classrooms of the Institute of Biological and Health Sciences (Instituto de Ciências Biológicas e da Saúde - ICBS), located in building number 25 of the Pontifical Catholic University of Minas Gerais, Coração Eucarístico campus.

The study involved 279 students and 20 ICBS professors who were invited to participate and signed the Free and Informed Consent Term. The invitation to the participants happened as follows: before the beginning of each class, the researchers explained the purpose of the study and asked if the professor wanted to participate. The professors who accepted allowed the study to be explained to the students, and each student had the choice to participate or not.

The participants answered a questionnaire prepared by the authors for using in the present study, aimed at gathering information on self-perception of noise in classrooms, presence of non-auditory symptoms associated with exposure to noise, noise interference in academic activities and acoustic conditions and location of the classrooms. The first question in the questionnaire was to investigate whether the participant noticed the presence of noise in the classroom. In case of affirmative answer, the participant replied to the subsequent questions. Because students and professors performed different activities in the classroom, the questionnaires applied were different (Annexes A and B). Both the students' and the professors' questionnaires verified the self-perception of the acoustics and location of the classroom, as well as the concentration during the academic activities. In order to evaluate these aspects, they were asked to give them a grade from 0 to 4. For the purposes of statistical analysis, the answers were grouped, being considered as "bad", the grades 0, 1 and 2 and "good" grades 3 and 4.

Measurement of sound pressure levels in the classrooms was also performed. Two classrooms were selected on the first floor - classrooms 106 and 107; four classrooms on the second floor - classrooms 208, 209, 211 and 212; and four classrooms on the third floor - classrooms 301, 302, 304 and 305. The classrooms on the first floor have four sliding windows facing the parking area and four tilting windows facing the building internal movement corridor . The rooms on the second and third floors have four sliding windows facing the inner courtyard area of the University, where there are academic directories and a canteen, and four tilting windows facing the buildinginternal movement corridor. The ICBS classrooms have 75.41m^2 (Figure 1), are equipped with approximately 50 university desks of plywood and injected foam and a board of medium density fiberboard (MDF), coated on the front face in high pressure melamine laminate. They also have a table and chair for the professor and two ceiling fans. At the time of measuring the sound pressure levels, the fans were turned off, the windows were open, and the professor was teaching.



Source: Dean of Logistics and Infrastructure - Pontifical Catholic University of Minas Gerais.

Figure 1. ICBS classroom's blueprint and dimension

The measurement points were selected according to the indicated in the literature[6] and according to norm 10151 of the Brazilian National Standards Organization (ABNT)[18]. They were within environment normal use condition and in three distinct points selected in the classroom with a minimum distance of 0.5m, totaling nine measurements in each room: a point near the board, another one near the windows and the last one near the door of the room. For each point, minimum and maximum intensities were recorded. The "hold" function of the equipment was used to record the maximum intensity recorded during the measurement period, which was five minutes[9]. The microphone of the sound pressure level gauge was positioned facing the center of the room, at one meter from the floor. For measurement, it was used a sound pressure level gauge of the brand Impac, model IP-410, containing a luxmeter, hygrometer, thermometer and decibelimeter. The sound pressure levels were read in compensation mode A, ranging from 35 to 100 dB(A).

The measurements were taken at five different times: a) in the morning while the classes were taking place; b) in the morning, during the break; c) between 1pm and 2 pm; d) in the afternoon, during the classes; e) in the afternoon, during the break. It was not possible to establish a fixed timetable for measuring in the classrooms during the morning and afternoon classes, since the start times and breaks were diverse. However, the measurements occurred with little variation of schedules.

Data were tabulated and submitted to statistical analysis. A descriptive analysis of the data was performed, separating professors and students, in which frequencies and proportions were calculated for the categorical variables. For the continuous variables, means, medians and standard deviation were calculated. The measured values were determined for the sound pressure level at each measurement site. To compare if there were differences in the mean values of the recorded ones for the sound pressure levels according to floor, turn (shift) and measurement site, Student's t-tests, ANOVA and Fisher's exact test were used. For multiple comparisons, the Bonferroni test was used. In order to compare if there is a difference between the answers of students and professors and if there is a difference between the evaluation of students and professors per floor, we used the chi-square test. The analyses were performed in Stata software (Stata Corporation, College Station, Texas) release 12.0, considering a 5% level of significance.

RESULTS

279 students, of both genders, were part of this study, with an average age of 22 years, being 83.2% female. The classrooms where the study was allowed have an average of 35 students. Thus, we obtained approximately 80.0% participation of the students. In relation to the 20 participating professors, the mean age was 49 years, being 75.0% female. The course that obtained the largest number of participating students was the Speech Therapy course, with 94 students (33.6%), followed by the Biological Sciences course, with 82 students (29.3%). The Nursing course presented the lowest number of students, representing only 10.4% of the sample. The morning shift had the highest number of participating students (56.1%).

Comparing sound pressure levels with environmental variables, we noticed that there is a difference between shifts, with the morning shift presenting higher sound pressure levels (NPS), with a recorded value mean of 63.8 dB(A). Lunch time differs from morning and afternoon shifts, with the lowest recorded values mean (49.9 dB(A)). Due to the fact that during lunchtime teaching-learning activities are not being performed, their records have been removed from the final statistical analysis. When removing them from the analysis model, it was observed that the first floor shows the highest average of recorded values (67.3 dB(A)) (Table 1).

The presence of noise is perceived by 100.0% of professors and 88.9% of students. Noise interferes on concentration inside the classroom for 74.6% of students and 80.0% of professors, and 80.0% of professors report that their performance is affected by the presence of noise (p=0.020). For 85.0% of professors, it is necessary to speak louder than usual due to the presence of noise (p=0.007) (Table 2).

The answers of the students' and professors' questionnaires, whose classrooms are located on the first floor, were compared to the answers of the students and professors whose classrooms are located on the second and third floors. This comparison showed that on the first floor performance is more affected (p=0.045), the professor speaks louder than usual (p=0.036), the room acoustics are considered bad (p=0.001) and the classroom location is considered bad (p<0.001).

Table 1. Measurements of sound pressure levels in relation to room location, class shift and floor

		Average	SD	Minimum	Median	Maximum	p
Local		62.9	8.2	44.7	62.7	77.7	0.727
	Door	62.6	8.3	44.3	62.2	820	
	Blackboard	61.5	9.2	39.7	60.2	83.0	
	Window						
Shift							
	Morning	63.8	7.6	44.7	64.7	77.7	0.069
	Afternoon	60.9	9.2	39.7	60.2	83.0	
Period							
	Class	62.7	76	44.3	61.7	83.0	0.642
	Break	62.0	9.4	39.7	62.7	82.0	
Floor							
	1st floor	67.3	9.3	50.3	67.8	83.0	0.003*
	2nd floor	60.0	8.4	39.7	59.0	77.7	
	3rd floor	62.2	7.3	44.3	62.3	73.7	

*Anova Test significant at 5%. Post Hoc Bonferroni difference between 1st floor and the rest; significant p≤0.05
Caption: SD = Standard deviation

Table 2. Comparison of students' and professors' questionnaire responses

Questions		Professors		Students		p
		n	%	n	%	
Presence of noise in the classroom	Yes	20	100.0	249	88.9	0.243
	No	0	0.0	31	11.1	
Noise interferes with concentration	Yes	16	80.0	209	74.6	0.593
	No	4	20.0	71	25.4	
Performance is affected by noise	Yes	16	80.0	149	53.2	0.020*
	No	4	20.0	131	46.8	
Speaks louder than usual because of noise	Yes	17	85.0	151	53.9	0.007*
	No	3	15.0	129	46.1	
Understanding of class is compromised by noise	Yes	16	80.0	190	67.9	0.258
	No	4	20.0	90	32.1	
Headache	Yes	5	25.0	123	43.9	0.098
	No	15	75.0	157	56.1	
Excessive tiredness	Yes	15	75.0	150	53.6	0.065
	No	5	25.0	129	46.1	
Buzz	Yes	2	10.0	23	8.2	0.677
	No	18	90.0	257	91.8	
Aural fullness	Yes	4	20.0	19	6.8	0.056
	No	16	80.0	261	93.2	
Difficulty in comprehension	Yes	2	10.0	61	21.8	0.267
	No	18	90.0	219	78.2	
Classroom acoustics	Bad	6	30.0	56	20.0	0.268
	Good	14	70.0	223	79.6	
Classroom location	Bad	1	5.0	31	11.1	0.707
	Good	19	95.0	248	88.6	
Concentration during classes	Bad	1	5.0	21	7.5	0.999
	Good	19	95.0	257	91.8	

*Chi-square test significant at 5%; significant p≤0.05
Caption: n = number

DISCUSSION

Prolonged exposure to noise causes a number of adverse health effects[1-3,6,8-12] and, when present in the work environment, negatively interferes with work activities. In view of this, Regulatory Standards (NR) were created in order to guarantee the acoustic comfort and safety in the work environment, regulating the limits of tolerance for exposure to continuous or intermittent noise[19] and the noise levels appropriate to environments where there is peformance of activities that require intellectual solicitation[20].

In the present study, sound pressure levels were analyzed in classrooms, where there is a great demand for attention and intellectual requirement. Therefore, acceptable noise limits should be in accordance with standards NR-17 and NBR-10152, which recommend noise levels for acoustic comfort in a variety of environments, including the classroom, at 40-50 dB(A)[17,20].

The values of sound pressure levels found at each measurement point inside the classrooms did not present statistically significant differences. However, we can observe that the average of registered values is above the levels of comfort recommended

by the legislation. Regarding the shifts, statistically significant differences were found, with the morning shift rooms being the noisiest, which may be justified by the greater number of courses offered at the ICBS in this shift. The measurements during lunch hours - empty classrooms - were performed in order to verify the noise generated by the classroom itself, as this is a notorious factor quite reported by professors and strongly interferes with academic activities[4]. The mean values of NPS recorded were 49.9 dB(A) and we can see that this value is inadequate, since the international legislation recommends a noise level of 35 dB(A)[21]. After the lunch break, we noticed that the difference in the sound pressure level - in the classrooms - between the floors, presents statistically significant values, where the first floor presented higher averages of recorded values, and can be classified as the floor that has the noisiest classrooms. This factor is mainly due to the location of two entrances on this floor, a parking lot and external side corridors with large flow of people. All values found are in disagreement with the legislation, which recommends values of 40 dB(A) for acoustic comfort and 50 dB(A), the acceptable sound level for classroom activities[17].

The difference of values presented in relation to the number of students participating in each course is due to the greater acceptance of the professors and students of the Speech Therapy course in participating in the research. The number of students participating between the shifts is related to the number of courses that have most of the curriculum in these shifts (morning and afternoon). At the ICBS, in the morning shift, there are classes of Speech Therapy, Physiotherapy, Odontology and Nursing courses. And, in the afternoon, only Biological Sciences, Physical Education and Odontology.

By means of the sound pressure levels registered and observation performed by the researchers it was concluded that there are several sound sources of noise that interfere in classrooms, such as conversations among the students, fans, people movement in the corridors and inside the classrooms, car sounds and parking alarms. All these factors contribute to a noisy and uncomfortable classroom environment, exposing students and professors to stimuli beyond those resulting from the teaching-learning activity[7].

The presence of noise in classrooms is perceived by both professors and students. It is pointed out as one of the factors that interferes in the concentration inside the classroom, in the academic performance and in the intelligibility of the classes. Studies have confirmed that noise is a contributing factor for the communicative process not occurring effectively, also interfering in the listening skills, making it difficult to transmit and receive information and directly interfering in the teaching-learning process[1-7,14-16,22].

Another important factor linked to the presence of high sound pressure levels inside the classroom is the impact on the professor's voice. The data obtained from the questionnaires indicate that 85% of the interviewed professors reported speaking higher than usual due to the presence of noise in classrooms and 75% reported feeling vocal fatigue after the classes. These findings match with the literature, which demonstrates an association between classroom internal noise and speech effort, leading to the manifestation of vocal changes[9-11,16,23]. These changes, especially in professors, negatively interfere in their professional performance, generating an unfavorable impact on professor's quality of life[9,10,16]. Considering that the habitual level of speech is 60 dB, and for classrooms, 65 dB[5,10,24], the ideal is that speech is 10 dB above the noise level, a healthy environment would be a classroom presenting sound pressure level of at most 55dB(A).

The most non-auditory symptoms reported by both professors and students were excessive tiredness and headache. These findings corroborate those of the literature[11,23,25], which presents them as symptoms mentioned by participants of other studies, although they are not the most frequent ones. It is not possible to affirm that there is a direct relation between the occurrence of symptoms and the level of sound pressure in classrooms only, since other auditory habits were not investigated in the population of the present study. However, the numerous non-auditory effects caused by noise are already known[1,3,6,8-12] and we can therefore infer that there is a contribution of this added to other environmental, psychological and physical factors[9,11-13]. Noise is among the agents responsible for stress, headache, difficulty concentrating and low performance[1,3,6,8-12], compromising physical and mental health conditions.

Professors and students have different perceptions about the classroom environment. This fact can be explained due to: position they occupy inside the room, being the professor most of the times in front of the class, next to the blackboard; number, being only one professor in front of a class of several students - (the students being the main responsible for the noise coming from the conversations); performed activities. In this study, most professors stated that their performance is affected by the presence of noise in the classroom in contrast with only a little more than half of the students. These differences in the responses of students and professors lead us to conclude that students do not perceive the noise they produce, agreeing with the literature that it is possible for us to become accustomed to everyday noises and, in this case, to the noises we produce[6].

The first floor, as previously mentioned, is the floor that has the noisiest classrooms, and the results regarding the answers of the students' and professors' questionnaires and their relationship with the floors, show us that the first-floor classrooms presented the highest number of affirmative responses, indicating that participants report that their academic performance is affected by noise. This result is related to the findings of question eight of the questionnaire, regarding the evaluation of classroom acoustics, being smaller the number of positive evaluations attributed to the first floor. The second floor was the best evaluated for its location and acoustics, and was considered adequate by almost all participants.

The noise present in classrooms is a worrisome factor and produces undesirable effects on both professors and students[1-7,14-16,23-25]. Since the university is the place to prepare for entry into the labor market, attention must be paid to this factor so that the teaching-learning process is not impaired. This is an action of co-responsibility between students, professors, employees and technical-administrative staff. A good acoustic architectural design should be chosen so that the coefficients of

refraction and absorption of the materials used in the construction are well observed and contribute to an acoustically comfortable and adequate environment.

In addition to structural change actions, investment in health promotion measures in the educational environment is an important catalyst for significant and effective change.

One of the limitations of the present study is the absence of measures related to the equivalent dose of noise exposure of the participants, since the sound pressure levels may present variable values throughout the class period. The inclusion of dosimetry could allow a better investigation of the effects of noise in the studied population. However, it is important to emphasize that the present study did not aim to investigate the equivalent dose of exposure to noise of professors and students throughout their academic activities, but to correlate the self-perception of noise with measurements of sound pressure levels in the classrooms that participated in the study, at the time of application of the questionnaires.

CONCLUSION

From the results of the present study, we can conclude that the sound pressure levels measured in the classrooms evaluated surpass the levels recommended by the national legislation, having been reported by students and professors as a factor that interferes negatively in the activities carried out in classrooms.

The improvement of the acoustic conditions of the classrooms, associated with actions to raise awareness about the effects of noise on health and the promotion of hearing health, can contribute significantly to the reduction of sound pressure levels in the educational environment.

REFERENCES

1. Servilha A, Delatti M. College students' perception of classroom noise and its consequences on learning quality. Audiol Commun Res. 2014;19(2)
2. Jerônimo CEM, Silva JA, Silva RRT. Mathematical modeling of impacts extramural noise produced by a university in Mossoró-RN. Holos. 2015;31(2):142-54. http://dx.doi.org/10.15628/holos.2015.2197.
3. Gonçalves V, Silva L, Coutinho A. Ruído como agente comprometedor da inteligibilidade de fala dos professores. Produção. 2009;19(3):466-76. http://dx.doi.org/10.1590/S0103-65132009000300005.
4. Guimarães ACF, Santos JN, Rabelo ATV, Magalhães MC. The influence of noise on verbal auditory temporal ordering ability. Rev CEFAC. 2015;17(1):209-215.
5. Santos JF, Seligman L, Tochetto TM. Acoustical comfort in the perception of literate school children. Rev Soc Bras Fonoaudiol. 2012;17(3):254-9. http://dx.doi.org/10.1590/S1516-80342012000300004.
6. Cielo CA, Portalete CR, Ribeiro VV, Bastilha GR. Occupational, general health and vocal profile of teachers of Santa Maria city. Rev CEFAC. 2016;18(3):635-48. http://dx.doi.org/10.1590/1982-021620161838515.
7. Guidini RF, Bertoncello F, Zanchetta S, Dragone MLS. Correlations between classroom environmental noise and teachers' voice. Rev Soc Bras Fonoaudiol. 2012;17(4):398-404.
8. Almeida N Fo, Filetti F, Guillaumon HR, Serafini F. Intensity of noise in the classroom and analysis of acoustic emissions in schoolchildren. Arq Int Otorrinolaringol. 2012;6(1):91-5.
9. Jiménez-Tejada MP, Hodar JÁ, González-García F. Noise, what noise? Raising awereness of auditory health among future primary-school teachers. Teach Teach Educ. 2012;28(8):1083-90. http://dx.doi.org/10.1016/j.tate.2012.06.002.
10. Costa DB, Lopes LW, Silva EG, Cunha GMS, Almeida LNA, Almeida AAF. The risk factors and emotional on the voice of teachers with and without vocal complaints. Rev CEFAC. 2013;15(4):1001-10. http://dx.doi.org/10.1590/S1516-18462013000400030.
11. Ribeiro MER, Oliveira RLS, Santos TMM, Scharlach RC. A percepção dos professores de uma escola particular de Viçosa sobre o ruído nas salas de aula. Rev. Equilíbrio Corporal e Saúde. 2010;2(1):27-45.
12. Gannouni N, Mhamdi A, Tebourbi O, El May M, Sakly M, Rhouma KB. Qualitative and quantitative assessment of noise at moderate intensities on extraauditory system in adult rats. Noise Health. 2013;15(67):406-11. http://dx.doi.org/10.4103/1463-1741.121236. PMid:24231419.
13. WHO: World Health Organization. Burden of disease from environmental noise: quantification of healthy life years lost in Europe [Internet]. Copenhagen: WHO Regional Office for Europe; 2011. [citado em 2018 Maio 4]. Disponível em: http://www.euro.who.int/__data/assets/pdf_file/0008/136466/e94888.pdf
14. Gomes NR, Medeiros AM, Teixeira LC. Self-perception of working conditions by primary school teachers. Rev CEFAC. 2016;18(1):167-73. http://dx.doi.org/10.1590/1982-021620161819515.
15. Servilha EAM, Roccon PF. Relation between voice and life quality for university teachers. Rev CEFAC. 2009;11(3):440-8. http://dx.doi.org/10.1590/S1516-18462009005000029.
16. Rabelo ATV, Guimarães ACF, Oliveira RC, Fragoso LB, Santos JN. Evaluation and perception of teachers on the effects of sound pressure level in the classroom. Distúrbios Comum. 2015;27(4):715-24.
17. Brasil. Ministério do Trabalho e Emprego. Normas Brasileiras Regulamentadoras: NBR 10152-2000: níveis de ruído para conforto acústico [Internet]. Brasília; 2000 [citado em 2018 Maio 4]. Disponível em: http://www.scribd.com/doc/4035856/NBR-10152-2000-Nivel-de-Ruido-para-Conforto-Acustico
18. Brasil. Ministério do Trabalho e Emprego. Normas Brasileiras Regulamentadoras: NBR 10151-2000: avaliação de ruídos em áreas habitadas visando o conforto da comunidade [Internet]. Brasília; 2000 [citado em 2018 Maio 4]. Disponível em: http://www.scribd.com/doc/14126784/NBR-10151-Procedimento-Avalicao-Ruido-Habit
19. Brasil. Ministério do Trabalho e Emprego. Normas Regulamentadoras: NR 15-1978: atividades e operações insalubres [Internet]. Brasília; 1978 [citado em 2018 Maio 4]. Disponível em: http://www.guiatrabalhista.com.br/legislacao/nr/nr15.htm
20. Brasil. Ministério do Trabalho e Emprego. Normas Regulamentadoras: NR 17-1978: ergonomia [Internet]. Brasília; 1978 [citado em 2018 Maio 4]. Disponível em: http://trabalho.gov.br/images/Documentos/SST/NR/NR17.pdf
21. Acoustical Society of America. ANSI S12.60-2010: acoustical performance criteria, design requirements, and guidelines for schools, part 1: permanent schools [Internet]. New York: American National Standard; 2010 [citado em 2018 Maio 4]. Disponível em: https://successforkidswithhearingloss.com/wp-content/uploads/2012/01/ANSI-ASA_S12.60-2010_PART_1_with_2011_sponsor_page.pdf
22. Nascimento LS, Lemos SMA. Environmental noise influence on student performance in the Frequency Pattern Tests and Duration Pattern Tests. Rev CEFAC. 2012;14(3):390-402. http://dx.doi.org/10.1590/S1516-18462011005000093.
23. Servilha EAM, Delatti MA. Noise perception in the workplace and auditory and extra-auditory symptoms referred by university professors. J Soc Bras Fonoaudiol. 2012;24(3):233-8. http://dx.doi.org/10.1590/S2179-64912012000300008. PMid:23128171.
24. Rabelo ATV, Santos JN, Oliveira RC, Magalhães MC. Effect of classroom acoustics on the speech intelligibility of students. CoDAS. 2014;26(5):360-6. http://dx.doi.org/10.1590/2317-1782/20142014026. PMid:25388068.
25. Gonçalves CL, Dias FAM. Audiological findings in young users of headphones. Rev CEFAC. 2014;16(4):1097-108.

Author contributions

FAMD was responsible for the study design, literature review, data analysis, article writing, manuscript submission and formalities; BAS was responsible for the study design, literature review, data collection and analysis, article writing; HCM was responsible for the literature review, data collection and analysis, article writing.

Annex A. Students' Questionnaire

Curso de Fonoaudiologia – ICBS
Questionário alunos para Coleta de Dados

Idade: _____ Sexo: □ Feminino □ Masculino Sala:_____ Período: _____ Curso:_____
Turno: □ Manhã □ Tarde

Para as questões abaixo responda sim ou não.

1. Você nota a presença de ruídos na sala de aula?
( )sim ( )não
Em caso afirmativo, responda às questões que se seguem:

2. Esse ruído interfere em sua concentração dentro da sala?
( )sim ( )não

3. Seu desempenho é afetado pela presença do ruído?
( )sim ( )não

4. Você fala mais alto que o habitual devido à presença de ruídos na sala?
( )sim ( )não

5. A inteligibilidade da aula é comprometida devido à presença de ruídos na sala?
( )sim ( )não

6. Você percebe algum desses sintomas após as aulas?
( ) Dor de cabeça
( ) Cansaço excessivo
( ) Zumbido no ouvido
( ) Sensação de ouvido tampado
( ) Dificuldade em compreender o que as pessoas falam

7. Analise as questões abaixo de acordo com sua percepção e atribua notas de 0 a 4 – sendo a nota 0 muito ruim e a nota 4 excelente.

1. Como você avalia a acústica da sala de aula? ____

2. Como você avalia a localização da sala de aula? ____

3. Como você avalia a concentração durante as aulas? ___

Annex B. Professors' Questionnaire

Curso de Fonoaudiologia – ICBS
Questionário professores para Coleta de Dados

Idade: _____ Sexo: □ Feminino □ Masculino Tempo de profissão: _____ horas/aula por dia:_____
Curso:_____ Turno: □ Manhã □ Tarde

Para as questões abaixo responda sim ou não.

1. Você nota a presença de ruídos na sala de aula?
( )sim ( )não
Em caso afirmativo, responda às questões que se seguem:

2. Esse ruído interfere em sua concentração dentro da sala?
( )sim ( )não

3. Seu desempenho é afetado pela presença do ruído?
( )sim ( )não

4. Você fala mais alto que o habitual devido à presença de ruídos na sala?
( )sim ( )não

5. Você sente cansaço vocal após as aulas?
( )sim ( )não

6. A inteligibilidade da aula é comprometida devido à presença de ruídos na sala?
( )sim ( )não

7. Você percebe algum desses sintomas após as aulas?
( ) Dor de cabeça
( ) Cansaço excessivo
( ) Zumbido no ouvido
( ) Sensação de ouvido tampado
( ) Dificuldade em compreender o que as pessoas falam

8. Analise as questões abaixo de acordo com sua percepção e atribua notas de 0 a 4 – sendo a nota 0 muito ruim e a nota 4 excelente.

1. Como você avalia a acústica da sala de aula? ____

2. Como você avalia a localização da sala de aula? ____

3. Como você avalia a concentração durante as aulas? ____