

NOISE ANALYSIS AND INTERVENTION IN SPEECH SCHOOL ENVIRONMENT: REGULAR PRIVATE AND PUBLIC SCHOOLS

Análise do ruído e intervenção fonoaudiológica em ambiente escolar: rede privada e pública de ensino regular

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ABSTRACT

Purpose: the aim of this study is to measure noise levels during the school year in two classrooms in a grade of elementary school, a private schools one and a public school another, in both case frequented by deaf students cochlear implant users, to analyze whether noise levels are consistent with the standard Brazilian NBR 10152 of ABNT (1990) and school staff to discuss strategies to minimize the impact of noise on learning of deaf students. **Methods:** we performed eight measurements of noise level, using a dosimeter, model 1444, in each classroom, in a private and public schools. At the same time the measurements were conducted with monthly meetings with teachers from both schools. **Results:** we found that levels of noise present in the public ranged from 74.3 to 79 dB (A) and in the private noise levels ranged between 76.1 and 80.9 dB (A). In each of these schools were made 8 meetings. **Conclusion:** after observations we found high levels of noise in the school environment, and there were no statistical differences between both networks. Referring to monthly meetings it was clear that educators have adopted strategies to help communication within the school environment. It's clearly the need to acquire technological resource accessibility for deaf students who use oral communication, the system of modulated frequency.

KEYWORDS: Education; Noise; Cochlear Implant; Hearing Loss; Audiology

■ INTRODUCTION

The individual hearing aid (HA) and cochlear implant (CI) are technological devices that enable deaf children have access to speech sounds as well as develop oral communication. To help auditory and language development, it is essential to include these children in mainstream schools since the school environment enables interactive communication and allows the student to experience pragmatic language situations¹.

The National Education Guidelines and Framework Law (1996) advocates that school

education for special needs learners be offered preferably in the mainstream education system, having, when needed, the specialized support to meet the peculiarities of the students who need special education².

In order for this inclusion process to be appropriate, it is important that mainstream schools promote accessibility for such students. Thus, in order for there to be the inclusion of deaf students that can communicate orally, it is necessary to ensure access to the perception of speech sounds and pedagogical content.

According to the Brazilian standard, NBR 10152 of ABNT (1990), the noise levels in schools should be between 40-50 dB (A)³. However, studies have demonstrated high levels of noise into classrooms aula ⁴⁻¹³.

The difficulty to perceive the sounds of speech in noisy environments may be more evident in deaf children. Thus, the attenuation of noise in the school environment is a factor that deserves

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attention. Although the technological advancement of electronic devices such as cochlear implants and hearing aids have allowed a better perception of the sounds, studies have shown that in unfavorable situations, such as in the presence of noise and simultaneous multiple speakers, adult cochlear implant users presented difficulties in encoding speech¹⁴.

The acoustic quality in school settings is also another aspect that deserves continued attention. However, studies show that the acoustics in school buildings, despite being extremely important in providing favorable conditions for teaching, is not considered by designers^{8,15}.

Thus, noise above the recommended level is one element that will hinder the accessibility of the deaf student with cochlear implant in the school context. This research justifies the need for a joint effort between school staff and audiologist, providing acoustically favorable conditions for the learning process, especially for the inclusion of deaf students who communicate orally.

The aims of the present study were to measure the noise levels during the elementary school year in two 1st grade classrooms, one from a private and the other from a public school, attended by deaf students with cochlear implant; consider whether the noise levels are in agreement with the Brazilian standard, NBR 10152 of ABNT (1990), and discuss with school staff strategies to minimize the impact of noise on learning of deaf students.

■ METHODS

This study was conducted after approval by the Research Ethics Committee at the School of Philosophy and Science at the Universidade Estadual Paulista – FFC / UNESP / Marília – SP (Opinion No. 019/2009).

Investigation of the noise level in the school environment was performed by a cross-sectional study. The study was conducted in two mainstream classrooms, a private and a public one, attended by deaf cochlear implant users enrolled in the 1st year of elementary school.

To measure the noise level in the classroom, each deaf student used a portable digital dosimeter, model 4445 (Brüel / Kjaer). The equipment was calibrated before use by a Brüel / Kjaer calibrator, model 4231.

The equipment was placed on the deaf student's desk 60 cm from the floor and 2.5 m away from walls and / or windows. The measurement was made during the time in which the deaf student remained in the classroom. There were 16 measurements made during the school year; eight in each

classroom. There was a month interval between measurements, except during the school break.

During noise measurements, the researcher was positioned in fixed locations within the classroom and descriptively recorded the activities performed in the school environment, such as deaf student participation, their interaction with the teacher and the strategies adopted by that student during noisy situations.

The physical conditions of the classroom, such as furniture, materials, wall and floor coverings, room size, number of windows, the number of students present and placement of deaf students were also transcribed by the researcher.

Throughout the school year, 16 meetings (8 in each school) were held with teachers and administrators, in which the data collected during the measurements, were discussed with each teacher. These meetings aimed at discussing the noise level present in the school, as well as its interference in the communication and learning process of the deaf students.

To collect the data, the equivalent noise level (Leq) was considered in each classroom. The equivalent noise is the continuous level resulting from the integration of a sequence of events observed over a given period. Due to situations of great fluctuations, the A weighted curve was used for readability since it presents the closest response to the human ear and slow reading.

Data from the dosimeter 4445 were archived in the Noise Explorertm 7815 and Protectormtm 7825 on the Windows[®] platform, in order to obtain numerical answers for a quantitative analysis. The determination of noise levels in the classrooms, followed the National Standards NBR 10151 (2000)¹⁶ and NBR 10152 (1990)³, of the ABNT, which define measurement procedures and tables indicating levels of acoustic comfort and determine the conditions required for assessing the acceptability of noise in communities, establishing the maximum noise levels for different environments.

For statistical analysis of collected data, the nonparametric Wald-Wolfowitz test was employed by using the Statistica software (version 7.0), where the mean levels of Leq for the minute/minute measurement were adopted as dependent variables, and the types of school, public or private, as independent variables. A level of $p < 0.05$ with a confidence interval of 95% was considered significant.

■ RESULTS

The results are presented according to the data found in the noise measurements and in the meetings between researcher and teachers.

Results of Measurements

It was found that there were 24 students enrolled in the public school classroom, and 17 students enrolled in the private school. The results of the measurements in both schools are shown in Table 1.

Table 1 – Threshold equivalent (Leq) in dB (A) noise measurements found in public schools and private schools

Days measured	Private School	Public School
First measurement	78.8	80.9
Second measurement	77.4	78.5
Third measurement	74.3	80.7
Fourth measurement	79.0	78.5
Fifth measurement	76.3	78.9
Sixth measuring	76.3	78.9
Seventh measurement	74.4	76.1
Eighth measurement	76.9	79.5

Key: The figures show the equivalent noise level (Leq) of each classroom

Regarding the physical conditions of the classrooms, it was observed that in the public school, the furniture did not allow the absorption of noise, in other words, the floor was covered with tile, the chairs and / or desks did not have felt to reduce friction with the ground, and the room was located near the playground of this school. In the private classroom, it was noted that the chairs and desks had rubber feet to minimize friction and rubber coated floor, however, the classroom was also near the playground of this school.

The outcome of the meetings

The monthly meetings were held with public and private classroom teachers, with a total of eight individual meetings with each educator.

The main issues discussed at the speech therapy meetings related to the perception of speech sounds and noise, as well as the position of teachers regarding the topics addressed are shown in Figure 1.

It may be noted, as far as the results are concerned, that the purpose of the meetings was to minimize the effect of noise in the communication with the deaf student inside the classroom, considering that these students use a cochlear implant and have no Frequency Modulation System. However, during the meetings issues relating to the development of language and learning of these students were also addressed. Thus, it was discussed with

the teachers on how to assist deaf students within the school context, since these students have difficulties in following the school curriculum and are in the literacy process. A meeting to plan activities with the proposed curricular adaptations was held, taking into account the linguistic and auditory development of each student, as for example, the development of more specific and individualized activities, so as to assist them in the literacy process.

■ DISCUSSION

The discussions will be presented according to the results found in the noise measurements and meetings between researcher and educator.

Measurement Discussions

The data show differences between the values found in both schools during each measurement. However, such difference did not exceed the value of 4.8 dB (A) at the same school. This finding may be explained by the variables present in the school routine, such as type of activity performed and the number of students in the classroom.

The results of the statistical analysis using the nonparametric Wald-Wolfowitz test, setting a significance level of $p < 0.05$ with a confidence interval of 95%, showed no statistically significant difference between the measurements performed in both schools ($p > 0.05$).

Subjects covered	Public School	Private school
<p>Hearing loss, the use of cochlear implants and possibilities of speech perception: We discussed the possibility of perceiving speech sounds for the hearing-impaired student with a profound sensorineural hearing loss. Access to speech sounds using cochlear implants demonstrated, in detail, the electronic device as well as the hearing ability and oral communication aspects of the student.</p>	<p>The teacher was sensitized and informed that he/she had no knowledge about this kind of hearing loss presented or the cochlear implant. He/she also mentioned having trouble working with the deaf student, because of limited previous experience.</p>	<p>The teacher reported having little knowledge about electronic devices that permit deaf or hard of hearing have access to the sounds of spoken language as well as doubts concerning cochlear implant.</p>
<p>The impact of the distance between teacher, noise and reverberation to the perception of speech sounds: Adverse effects on the learning process present in the classroom were presented to teachers, such as noise, reverberation and distance between speaker and listener. The difficulty of speech sound perception in the "noisy" environment, especially when it comes to deaf students using technological resources to ensure access to sounds was discussed. The need to approach at the moment of communication between teacher and cochlear implant user in order to help learning process was also emphasized. The benefits of the Frequency Modulation System to mitigate the impact of distance during speech perception were discussed with the teachers; however, the difficulty of access to this device due to its high cost has been mentioned.</p>	<p>The teacher reported that his/her classroom is very noisy because the students talk a lot and he/she had noticed that the hearing impaired student has difficulty understanding the activities. It was reported that the student needs to stay close, so as to understand and perform the activities in the classroom, a fact that requires a lot of attention from the teacher in a school setting.</p>	<p>The teacher reported seeking to avoid parallel conversations during class, but the room still has a lot of noise and thus, it is necessary to speak loudly for students to hear his/her voice. He/she also reported that the student can carry out the activities, but often loses the information covered in class.</p> <p>Also the students start the activity after the general explanation, however, the hearing impaired student performs the activity after the observation of other fellow classmates</p>
<p>Values observed in noise measurements: The values found were presented to the teachers. It was shown that, according to ABNT NBR 10 152 (1990), the noise levels of schools should be between 40-50 dB (A), however, all measured values were found above the indicated levels. The noise impact on the perception of speech sounds and understanding of the activities in the school environment was discussed.</p>	<p>The teacher reported of being aware that the classroom had high levels of noise, though was not aware that the data would be found above the recommended level, thereby causing injury to the perception of speech sounds.</p>	<p>The teacher was surprised with the values found, and also said that he/she did not realize that the noises were so intense and was not aware of the negative effects of noise on communication.</p>
<p>Positioning the hearing impaired student in the classroom: Teachers were advised to stay close to the hearing impaired student during the explanations, preferably on the same side in that he/she uses a cochlear implant to assist the speech perception. Students were asked to position themselves close to the teachers and stay away from walls, doors and windows, due to background noise and reverberation.</p>	<p>The teacher changed the student placement in the classroom, as well as start to approach the student during the explanation of activities. According to the professor, these measures helped student understanding and, consequently, become more participative.</p>	<p>The teacher placed the student away from windows, doors and walls, putting him in first row and offered to approach him for explanations. The educator said the shorter distance between student and teacher has facilitated the learning for the hearing impaired student</p>
<p>Action to reduce the noise impact in the classroom: It was discussed with educators that in regard to the values obtained, some actions, such as use of felt on the feet of chairs and tables, as well as using curtains and carpets can assist in the absorption of noise present in the classroom.</p> <p>Teachers also were instructed that in the following years, classrooms farther from playground could be selected for these students.</p> <p>The importance of having all students aware of the difficulties the hearing impaired students have in understanding speech in noisy environments and the need of closeness during conversation with this student was discussed with teachers.</p>	<p>The teacher discussed this proposal with the educational coordinator and said he/she believes there are possibilities to achieve the placement of felt not only in their school, but throughout all the public school system.</p> <p>The educator also said that students are aware of the difficulties of hearing impaired student and that this has made them more careful in making less noise in the classroom and moving closer to them during conversation.</p>	<p>The educator mentioned that the chairs and desks are already with felt on de bases to minimize friction as well as the room is made of a rubber floor, a material that helps to absorb noise.</p> <p>According to the professor, students are aware of the difficulties the hearing impaired students have in understanding speech in noisy places and, thus, they should stay closer to talk to them.</p>

Figure 1 – Results of the main issues discussed related to the perception of speech sounds and noise in the classroom and the teachers reactions on each discussed topic

The values presented in both schools exceed the recommended values for the perception of speech in the school environment. These findings corroborate the literature which indicates high levels of noise in the school environment⁴⁻¹³.

The figures indicate the need for strategies to minimize the noise impact on the school environment, in order to assist the learning process for students with normal hearing and, especially, deaf students with cochlear implant or a hearing aid.

Research conducted with children with normal hearing patterns found that the younger the child, the lower the ability to understand speech among noise¹⁷. Therefore, the concern regarding the minimization of noise in the school environment rises, when considering the age and the difficulty children with cochlear implants or hearing aids have in perceiving speech sounds in places with background noise.

Considering the findings, it is extremely important that immediate and future measures be taken to ensure the appropriate inclusion of deaf children.

With regard to immediate action, it is suggested that administration and teachers be aware of the negative consequences that noise provides in a school environment. It is also appropriate that these professionals be aware of strategies to minimize the noise present in the classroom. For this reason, there is an urgent need for interventions and measurements of noise in schools.

According to the physical conditions observed at the schools, it is possible to adopt low-cost actions that can help reduce noise. Among the proposals to be made are: covering the desks feet or chairs with felt, or using noise absorbing materials, such as curtains, carpets or rubber flooring and wall covering¹⁸.

For the next few years, it is also recommended that the classrooms with deaf students be placed more distant from the playground, aiming to reduce the noise interference. Furthermore, it is advisable to reduce the number of students in the classroom, since the inclusion of a special needs student requires more attention from the teacher.

The most efficient electronic device that ensures accessibility to speech sounds is the Frequency Modulation System, which aims to improve speech perception in noisy places such as the classroom¹⁹⁻²¹. This is an important device that could contribute significantly to the development process of communication and learning of deaf students.

A study with 9 student hearing aid users, in order to evaluate the advantages of the Frequency Modulation System within the school environment, demonstrated that the performance of these students in the perception of speech sounds was

significantly worse in the presence of background noise²². This study also found that the performance of these students was significantly improved when the Frequency Modulation System was coupled in noise situations.

Among the future steps that may be taken is the implementation of proper acoustics in the classroom. However, as mentioned above, investigations indicate that the acoustics in school buildings is not considered important by the architects^{8,15}.

Internal sources in the school were the main causes of noise pollution, and the study found that the transmission loss of sound energy between the walls of this school was not enough to isolate noise⁸. This work emphasized the importance of future school proposals aiming to reduce noise and improve acoustics in order to improve education.

The construction market has noise-isolation materials (glass, partitions, ventilation system, etc.) that may confer adequate acoustics to the classroom according to the standards²³.

The noise present in the classroom could be minimized with some adjustments, such as replacing highly reverberant flooring material (tile, ceramic) with more absorbent materials such as carpet, mats and rubberized coating; separate classrooms by employing walls that absorb sound energy. If the noise is not reduced, coating material like cork and movable panels is suggested. The use of curtains is indicated for the windows. And if the classroom is equipped with fans and/or air conditioners, it is advisable to monitor the noise generated by these devices²⁴.

The Meeting Discussions

In the discussion regarding hearing loss, the use of cochlear implants and possibilities of perception of speech sounds, it was observed that both teachers, since they had limited experience with deaf students, demonstrated lack of preparation and difficulties in working with deaf students that used devices to provide access to sounds.

These findings confirm a study implemented with 45 elementary school teachers, which found that the vast majority of the participants had minimal knowledge and common sense about hearing loss²⁵.

Research conducted has shown that teachers with or without experience, at all levels of elementary school, did not have knowledge about different aspects of hearing loss²⁶. This point emphasizes the importance of systematic and integrated working between speech therapists and school staff.

Therefore, the meetings had an extremely important effect because it addressed information regarding cochlear implants, as well as aspects

of perception of speech sounds and noise, which allowed the teacher to interact appropriately with deaf students, giving the teacher an opportunity to get to know each student better.

Regarding the values found in measurements, there were high levels of noise in the classrooms. This factor, along with the distance between teacher and student, as well as the reverb effect present in the classroom, hinders the perception of speech sounds, especially for the deaf cochlear implant user.

Research with teenage cochlear implant users showed a significant worsening in speech perception in the presence of background noise²⁷.

Therefore, in the absence of a Frequency Modulation System, the proper placement of this student inside the classroom, aimed to bridge the gap between the student and teacher, as well as help understand the content worked in the classroom, becomes extremely important.

According to the inverse square law, sound spreads in all directions, and the measured noise energy is inversely proportional to the square of the distance from the sound source, so the sound pressure decreases 6 dB every time you double the distance²⁸. Thus, the greater the distance between the speaker and listener, the lower the recognition of the signal of speech.

The authors state that the distance in the school environment becomes a great problem, since the lack of understanding of speech leads to complications in the learning process of students with disabilities¹⁸. In addition, they argue that such students should not sit next to walls, doors and windows, due to the effect of reverberation and background noise present in the classroom.

The study of cochlear implant users revealed the difficulties these users have in understanding speech within the school environment, suggesting that such students should position themselves nearer the speaker (teacher) to help speech understanding²⁹.

It is noteworthy that after intervention the teachers have adapted the placement of deaf students in the classroom and were willing to approach these students, especially during the presentation of new material. Likewise, the classmates were made aware of the difficulties these students have in understanding speech in noisy environments. Considering that these students have no Frequency Modulation System, these attitudes are extremely important in minimizing the effects of background noise, distance and reverberation present in the school environment.

The importance of implementing noise absorbing material in the classroom of the public school was

also discussed during the meeting. Both the public and private school system stressed the need of selecting classrooms farthest from the playground. Such actions were not adopted in the schools during the measurement of noise; however, they did show themselves ready to make the changes in the future.

Finally, the meetings allowed for the use of communication strategies to minimize the impact of noise on the school environment, as well as focus on aspects related to hearing, speech and learning of the hearing impaired student. According to the literature, the inclusion of students with disabilities, those bearers of special educational needs, in mainstream education does not consist of only bringing them together with other students, but involves a reorganization of the educational system, seeking the cognitive, cultural and social development of these students, respecting their differences and meeting their needs³⁰.

Equally important, the interventions were performed in a dynamic and interactive manner, emphasizing dialogue between educator and researcher, aiming to improve knowledge, disseminate information and implement measures to help and minimize the impact of noise on the educational environment.

These meetings were based on the assistance of speech pathologists within the context of school, in order to develop proposals that foster an environment suitable for the learning process³¹. This assistance seeks to expand the capacity of analysis and intervention within the school context. Thus, the meetings held in the school have become a fundamental tool in the development of a more integrated and decisive collaboration.

■ CONCLUSION

Based on these results, it is possible to conclude that there are no significant differences between the level of noise present in the public and private school. It was also concluded that school systems have high levels of noise, and thus impair the learning process, especially for deaf students with cochlear implant.

The meetings helped professionals in education and health develop communication strategies and the necessary adaptations of the school environment attended by deaf students who communicate orally. Educators have adopted strategies to minimize the impact of noise in the school environment and help the learning process. Clearly there is the need for acquiring accessible technology resources, i.e. a Frequency Modulation System, for deaf students who use oral communication.

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RESUMO

Objetivo: mensurar os níveis de ruído, durante o ano letivo, em duas salas de aula do 1º ano do Ensino Fundamental, sendo uma da rede privada de ensino e outra da rede pública, frequentadas por alunos deficientes auditivos usuários de implante coclear; analisar se os níveis de ruídos encontrados estão de acordo com a Norma Brasileira, NBR 10.152 da ABNT (1990), e discutir com a equipe escolar estratégias que minimizem o impacto do ruído, na aprendizagem dos alunos deficientes auditivos.

Métodos: foram realizadas oito mensurações do nível de ruído, empregando um dosímetro, modelo 1444, em cada sala de aula, sendo uma sala da rede privada e outra da rede pública de ensino. Concomitantemente às mensurações de ruído, foram feitas reuniões com os professores e gestores.

Resultados: verificou-se que os níveis de ruído presente na rede pública variaram entre 74,3 e 79 dB (A) e que, na rede privada, os níveis de ruído variaram entre 76,1 e 80,9 dB (A). Também foram realizadas 8 reuniões em cada escola. **Conclusão:** diante dos dados, notaram-se elevados índices de ruído em ambiente escolar, não ocorrendo diferenças estatísticas entre as redes pública e privada de ensino regular. Com relação às reuniões mensais, foi possível observar que os educadores adotaram estratégias que auxiliam a comunicação no ambiente escolar. É evidente a necessidade da aquisição de recurso tecnológico de acessibilidade para alunos deficientes auditivos que utilizam a comunicação oral, o sistema de frequência modulada.

DESCRIPTORIOS: Educação; Ruído; Implante Coclear; Perda Auditiva; Audiologia

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