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Comparative analysis of performance in reading and writing of children exposed and not exposed to high sound pressure levels

Análise comparativa do desempenho em leitura e escrita de crianças expostas e não expostas a níveis elevados de pressão sonora

Keywords

Sound pressure level
Auditory processing
Neuropsychology
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Descritores

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ABSTRACT

Purpose: To analyze the possible relationships between high sound pressure levels in the classroom and performance in the use of lexical and phonological routes in reading and writing. **Methods:** This consisted on a quantitative and exploratory study. The following measures were carried out: acoustic measurement, using the dosimeter, visual inspection of the external auditory canal, tonal audiometry thresholds, speech recognition tests and acoustic immittance; instrument for evaluation of reading and writing of isolated words. The non-parametric χ^2 test and Fisher's exact test were used for data analysis. The results of acoustic measurements in 4 schools in Santa Maria divided the sample of 87 children of third and fourth years of primary school, aged 8 to 10 years, in 2 groups. The 1st group was exposed to sound levels higher than 80 dB(A) (Study group) and the 2nd group at levels lower than 80 dB(A) (Control group). **Results:** Higher prevalence of correct answers in reading and writing of nonwords, reading irregular words and frequency effect were observed. Predominance of correct answers in the writing of irregular words was observed in the Control group. For the Study group, a higher number of type errors neologism in reading and writing were observed, especially regarding the writing of nonwords and the extension effect; fewer errors of lexicalization type and verbal paragraphy in writing were observed. **Conclusion:** In assessing the reading and writing skills, children in the Study group exposed to high noise levels had poorer performance in the use of lexical and phonological routes, both in reading and in writing.

RESUMO

Objetivo: analisar as possíveis relações entre níveis de pressão sonora elevados em sala de aula e o desempenho no uso das rotas lexical e fonológica na leitura e escrita. **Métodos:** estudo quantitativo e exploratório. Medições acústicas por meio de dosímetro; inspeção visual do conduto auditivo externo; audiometria tonal e vocal; imitancimetria; instrumento de leitura e escrita de palavras isoladas. Foram utilizados o teste não paramétrico do χ^2 e teste exato de Fisher para análise de dados. Com base nos resultados das mensurações acústicas em quatro escolas de Santa Maria, foi possível dividir a amostra de 87 crianças do 3º e 4º anos do ensino fundamental, na faixa etária de 8 a 10 anos, em 2 grupos. O 1º grupo foi composto de crianças expostas a intensidades de som superior a níveis de 80 dB(A) (Grupo estudo) e o 2º grupo, com crianças expostas a níveis menores que 80 dB(A) (Grupo controle). **Resultados:** maior prevalência de acertos nas pseudopalavras na leitura e escrita; na leitura de palavras irregulares e efeito de frequência; predomínio de acertos nas palavras irregulares na escrita para o Grupo controle. Para o Grupo estudo, maior número de erros de tipo neologismo na leitura e escrita, principalmente na escrita de pseudopalavras e efeito de extensão; menor número de erros de tipo lexicalização e paragrafias verbais na escrita. **Conclusão:** na avaliação das habilidades de leitura e escrita, considerando-se as rotas fonológica e lexical, as crianças do Grupo estudo, expostas a altos níveis de ruído, obtiveram pior desempenho no uso das rotas, tanto na leitura quanto na escrita.

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INTRODUCTION

In our culture, high sound pressure levels may be present in the classroom and generate difficult listening conditions, causing negative results on cognition⁽¹⁾. Thus, it is possible that children who are acquiring reading and writing skills have their literacy impaired for not having information adequately processed. Although reading and writing disorders may have genetic and environmental components that are not related to exposure to high sound pressure levels^(2,3), this can be considered a complicating factor in the evolutionary process of the child regarding the written language.

A study based on the hypothesis of noise exclusion deficit⁽²⁾ advocates that poor readers with impaired speech perception in noise exhibit reduction of neural synchrony because noise, by leading to degraded representations of expression in cortical and subcortical levels, causes difficulty in extracting the desired signal from the background noise⁽³⁾. This combination of neural indices of brainstem auditory function suggests that further explanations need to be better described by the scientific community⁽⁴⁾. The deficit in speech perception in the presence of high sound pressure levels and its relationship with reading may be related to a delay in spectral and temporal resolution, as well as weak phonological representations⁽⁵⁾. These assumptions are not mutually exclusive and open space for discussion on auditory processing and language and are related to the impact of individual phonological skills on the ability to read and their relationship with orthographic representations⁽⁶⁾.

From the neuropsychology and cognitive psychology perspectives, the processing of written language for both reading and writing should cover the relations of visual and auditory information in the different linguistic levels⁽⁷⁾. The Dual Route (phonological and lexical) hypothesis is still a topic of several studies. From such model, it is possible to analyze the performance on both routes through the reading and writing of isolated words, considering stimuli that satisfy the frequency, length and regularity criteria of real words and nonwords⁽⁸⁾.

Therefore, the purpose of this study involves the integration of knowledge from cognitive psychology of reading, audiology and acoustics to establish possible relationships between performance on the reading and writing routes, exposure to high sound pressure levels and auditory processing. The central hypothesis of this study is that auditory processing disorders, especially in the presence of high sound pressure levels, may be associated with inappropriate use of the phonological route, with possible indirect effects on the lexical route.

Thus, the main purpose of this study was to analyze the possible relationship between levels of sound pressure in the classroom and performance in the use of lexical and phonological routes in reading and writing.

METHODS

The procedures were initiated after approval by the Ethics Committee (CAAE 0371.0.243.000-10) under the criteria of Resolution 196/96 on research involving humans.

This consisted on a quantitative study with direct documentation technique and use of questionnaire and tests. According to the objectives it consists on a combined exploratory-descriptive study.

The following inclusion criteria were applied: age range between eight and 10 years, students of the third and fourth grades of elementary education who were in the process of literacy completion, of both genders, with good or poor academic performance as assessed the teacher.

With regard to the exclusion criteria, the following were applied: unavailability of parents and educators to collaborate with the research; presence of learning disabilities and speech disorders; neurological alterations; proven or reported hearing loss. These aspects were assessed by behavioral observation of children and health history provided by the school and parents.

The following were considered for analyzing the above mentioned aspects:

- Anamnesis (criterious investigation in order to analyze the audiologic, educational, and health history of the child).
- Visual inspection of the external acoustic meatus.
- Conventional audiologic evaluation consisting of pure tone audiometry (PTA), speech recognition threshold (SRT) and the speech recognition index (SRI). The examination was conducted in a sound-treated booth with two channel digital audiometer, Madsen – GN Otometrics, Itera model, type II, with TDH – 39 earphones calibrated according to ISO 11957-1986, and immittance measures performed with a impedanciometer Interacoustics model AZ-26, with supra-aural earphones, model TDH-39P, Telephonics and cushion HB-7 with tone-probe of 256 Hz calibrated according to IEC 60645-5-1992. Children with airway auditory thresholds up to 25dBHL at frequencies 250–8000 Hz in both ears, SRT compatible with audiometry and SRI above 88% were selected. Regarding the results of the acoustic impedance, the groups were subdivided according to the variable impedance alterations as follows: no impedance alteration — type A tympanogram and acoustic reflexes in both ears; impedance alteration — children with other types of curve⁽⁹⁾ and/or no acoustic reflexes.

Children were recruited at four municipal schools. The schools were selected by convenience, considering the location related to a noisy environment and/or silent environment for performing acoustical measurements in situ.

The criteria adopted by CONAMA Number 001 were employed according to the resolution NBR 10.152/2000, which establishes as maximum acoustic level for classroom comfort values between 35–45 dB (A) and acceptable sound levels from 40–50 dB (A)⁽¹⁰⁾. The groups were divided into: children exposed (study group) and unexposed (control group) to high sound pressure levels above the permitted according to NR 15 of Ordinance Number 3.214/1978 – which considers the limit tolerance for sound pressure levels of 85 dB as harmful to hearing. However, considering the level of action — the preventive measure that determines the minimum likelihood that exposure to high levels cause damage to hearing — the sound levels at 80 dB (A) were adopted as cutoff criteria. Therefore, the

study group corresponded to children exposed to noise levels detrimental to the auditory integrity.

The dosimeter used for the measurement of sound pressure levels was the Model 4445 (Lavg, average level), which is defined as the average of the sound levels measured during an elapsed time measurement. The equipment was adjusted to compensation scale “A”, slow speed response (slow), placed on the collar of a calm student who was positioned at the center of the room. The factor Q=5 dB was used for the exposure time according to international values established by OSHA.

The acoustic measurements performed with the dosimeter according to the record of the sound pressure levels scaled by Lavg per classroom ranged from 51.9 to 114 dB (A), demonstrating that the 12 classrooms analyzed exceeded the acceptable sound pressure levels according to CONAMA 001, NBR 10.152⁽¹⁰⁾. Regarding the values set for sound levels with cutoff at 80 dB (A) (action level), 17 children in the study group (19.54%) and 70 in the control group (80.46%) were found.

The sample consisted of 87 children, 40 boys and 47 girls. Regarding the educational level, 43 children were enrolled on the third grade and 44 on fourth grade of elementary education. These children underwent the assessment of reading and writing according the Dual Route model:

- Instrument for the Assessment of Isolated Word Reading⁽¹¹⁾, composed of 60 stimuli, divided into 20 stimuli for the following categories: regular words, irregular words and nonwords (string of characters that composes a whole pronounceable, but devoid of meaning word). The reading stimuli were randomly presented on individual cards. The responses were recorded on paper and via digital recorder MP3/4 player for later transcription.

The interpretation of the responses regarding the linguistic effects was computed as percentage accuracy⁽¹¹⁾ as below:

- Frequency effect (percentage accuracy in reading frequent words minus the infrequent words); regularity effect (percentage accuracy in reading regular words minus irregular words);
- Length effect (percentage accuracy in reading short words minus long words). This effect was calculated separately for real words and nonwords.
- Lexical effect (percentage accuracy in reading real words (frequent and infrequent) minus nonwords).

The words read incorrectly were classified into the following categories:

- 1) Regularization: irregular grapheme-phoneme correspondence is replaced by a regular and more frequent in certain circumstances correspondence (e.g. boxing read as /bɔ̃ʒe/).
- 2) Lexicalization: when a nonword is read as a real word, with formal similarity between them.
- 3) Neologism: when the word read generates a nonword in the task of real word reading, or the reverse, when the nonword generates a nonword that is different than the target stimulus. In this study, this category was adapted and subdivided into: Neologism I - when changes that modifies the word for one of the above situations; however, it is possible to

recover the target word such as the word atmosphere read as /atsmosefera/; Neologism II – when the changes that modify the word and it is impossible to associate it to the target word (e.g. letter read as /lateri/).

- 4) Lack of knowledge of contextual rule: corresponds to the erroneous emission due to the lack of knowledge of contextual rules of the Portuguese language (e.g. raposa read as /ra'poza/).
 - 5) Errors of lowest occurrence: verbal paralexia; formal verbal paralexia (e.g. parágrafo read as /parabês/); lack of accentuation rule (e.g. parágrafo read as /para'grafo/); no response (stimulus presented is not read); naming letters and syllables (spelling that does not result in a word); replacement of voiced and voiceless phonemes (e.g., the word erva read as /'erfa /).
- Assessment Instrument of Writing Isolated Words⁽¹¹⁾: the child was asked to write a total of 38 words, 28 real words and 10 nonwords. Of these words, 16 are irregular, 5 are regular and 7 are of the rule type — 27 long and 11 short. The examiner spoke the word, then the word in a sentence and, finally, the isolated word again, and the word should be written (e.g. ninho (*nest*). Os pássaros alimentam seus filhotes no ninho (*Birds feed their young in the nest*). Write “ninho”). The total number of real words and nonwords spelled correctly⁽¹¹⁾ were analyzed according to the effects of regularity, length and lexical.

The misspelled words were classified into the following categories:

- 1) Regularization: the child replaces an irregular letter-sound correspondence by a regular correspondence, i.e., when the child omits, replaces or adds a grapheme in the word that reflects in the writing as spoken (e.g. campeonato written as “campionato”).
- 2) Replacement of graphemes representing voiced and voiceless phonemes: when a target grapheme is replaced by another representative of an identical phoneme, considering the place and manner of articulation; however, only the voice trace is distinguished. It consists on a neologism, however, with the occurrence of voiceless-voiced replacement or vice versa (ex.: zangado written as “sangado”).
- 3) Lack of contextual rules: grapheme substitutions or omissions of letters that are applied in dependence on contextual rules (e.g. pato written as “patu”).
- 4) Neologism: when the written word generates a nonword on the dictation task of real words or nonwords, and this generates a nonword different from the target stimulus. It covers omissions, substitutions, inversions, additions of grapheme and/or syllables (neologism I). When the production was distant from the target stimulus, making it unrecognizable, it characterized neologism II. For example, minhoca written as “mioca” and medalha written as “medulea”, respectively.
- 5) No answer: the child does not write the dictated real word or nonword, leaving a blank space.
- 6) Lowest occurrence errors: verbal paraphasy (e.g. casa written as “filho”); semantic verbal paraphasy (e.g.

colher written as “garfo”); formal verbal paragraphy (e.g. admissão written as “adição”); morphemic paragraphy (e.g. pedreiro written as “pedraria”); difficulty marking nasalization (e.g. gigantesco written as “gigãotesco”); lexicalization (e.g. vaxa written as “faixa”); mirroring letters (e.g. casa written as “caza”); lack of knowledge of syllabic rule (e.g. gafivro written as “gfifo”).

The analysis of the phonological route in reading and writing words was developed according to four types of information: 1) the performance in reading/writing of nonwords, 2) the regularity effect, 3) the length effect and 4) regularization and neologisms. In turn, the lexical route analysis in reading and writing words has been developed using four types of information: 1) performance with irregular words, 2) frequency effect, and 3) lexical effect and 4) errors of word type (lexicalizations, paragraphy or paralexia).

Statistical analysis

The results of evaluations were organized in Microsoft Office Excel 2003 spreadsheets and statistically analyzed with the use of the Statistical Analysis System (SAS) 9.0. Descriptive statistics were calculated and nonparametric χ^2 and Fisher’s exact tests were used for comparison between variables, with statistical significance of $p \leq 0.05$.

RESULTS

The data of the study group regarding the phonological route and sound pressure levels are displayed in Table 1.

Performance on each reading and writing route was compared between the study group and the control group.

Accuracy levels were higher for nonwords in the control group of children exposed to noise levels below 80 dB (A), both in reading and in writing. In turn, the study group showed a higher number of neologisms, both in reading and in writing, with a difference in writing nonwords, where there was a high

frequency of neologisms in the study group. The length effect was also more significant in the study group. The results show that in tests of phonological route, children exposed no high noise levels had poorer performance than children of the control group in both reading and writing.

Differences in reading irregular words were found; however, the difference was higher in the control group. The frequency effect was also significant for this group, showing, therefore, more effective use of the lexical route (Table 2).

Similarly, in writing, there was a predominance of correct responses on irregular words for the control group. The study group had fewer lexicalization and verbal paragraphy errors, demonstrating a poorer use of the lexical route in writing on these two tests.

The results suggest that children exposed to noise levels above 80 dB(A) presented poorer performance when compared to the control group since the use of phonological and lexical routes were impaired in both reading and writing (Tables 1 and 2).

The results also expose the difference in reading and writing for the phonological route between third and fourth grades (Table 3).

Difference between the third and fourth grades in neologisms of real words in reading was found. In the fourth grade, this type of error decreased, demonstrating that children do not accept that the final production of reading is not a word (neologism). In writing, there was a statistically significant decrease in errors involving the voice distinction domain and the different nasality spellings. It is observed, therefore, that fourth graders outperformed third graders in the use of the phonological route.

The comparative results of the two grades on the use the lexical route are presented next.

Regarding reading, there was a percentage predominance of the effects of frequency and lexicality for the children of the fourth grade. Concerning writing, the children of the fourth grade showed more morphemic paragraphy errors, which may suggest an increased attention to the written morphological rules in a reorganizational process (Table 4).

Table 1. Phonological route performance and sound pressure levels exposure

Reading	Study Group		p-value	Writing	Control Group		p-value	
	n=87				n=87			
	(% accuracy/effect)			(% accuracy/effect)				
Nonwords	49.12	75.29	0.004*	Nonwords	27.65	47.57	0.004*	
Regularity effect	11.47	14.0	0.543	Regularity effect	36.50	30.25	0.191	
Length effect	Real	11.47	8.21	0.256	Length effect	34.32	23.14	0.004*
	Nonword	13.82	15.43	0.724				
Reading	Study Group		p-value	Writing	Control Group		p-value	
	n=87				n=87			
	(% errors)			(% errors)				
Regularization errors	7.21	5.96	0.37	Regularization errors	25.63	23.47	0.281	
Neologism errors	Real	18.97	9.46	0.064	Neologism errors	Real	13.16	0.010
	Nonword	19.85	15.25	0.283				

*Statistically significant values ($p \leq 0.05$) – χ^2 test

Table 4. Lexical route performance of children from third and fourth years

Reading	Third year		p-value	Writing	Third year		p-value
	Fourth year				Fourth year		
	n=87				n=87		
	(% accuracy/effect)				(% accuracy/effect)		
Irregular	58.60	71.70	0.091	Irregular	34.45	73.26	0.061
Frequency effect	5.78	10.81	0.041*	Lexical errors	6.53	6.96	0.878

Writing		Third year		p-value			
		Fourth year					
		n=87					
		(% errors)					
Lexical effect	0.47	3.24	0.049*	Lexical errors	1.63	2.05	0.962
Paragraphy effect	VP			VP	0.25	0.24	0.976
	VPP			VPP	5.56	4.62	0.223
	VMP			VMP	0.08	1.13	0.014*

* Statistically significant values (p≤0.05) – χ^2 test

Legend: VP = verbal paragraphy; VPP = verbal phonemic paragraphy; VPM = verbal morphemic paragraphy

only by sound with the use of the phonological route^(11,12). Thus, if the teacher speaks in a not suitable sound field, the student may receive information with acoustical distortions that will interfere with phonemic-orthographic associations (sound-spelling) exerted by the phonological route, fundamental to the constitution of the lexicon. In this view, in order for the lexical route to consolidate, it is necessary that the word has been previously read via phonological route - even though the latter route is always required before new words/nonwords that arise in everyday life^(13,14).

The aspects that influence the processing of isolated words are investigated by analyzing the types of errors produced on the reading and writing of different classes of stimuli. Therefore, it is expected from the reader/writer a more efficient correction hence faster reading/writing of familiar words than unfamiliar words; irregular compared to regular; shorter in relation to longer words; and, finally, agility with words from the language to which one is exposed than compared to nonsense words. Thus, it is indicative the use of phonological route in reading/writing, word recognition with greater precision and less time-related regularity and extension effect and use of lexical route for the effects of frequency and lexicality^(11,14).

In this study, the poorer use of phonological route in reading by the study group was evidenced by the poor performance in nonwords and amount of neologism errors, in addition to greater effect of word length in writing, i.e., the more extensive the word, the poorer the writing for these subjects.

In the Dual Route model, a familiar word is more easily perceived than an unknown word or a nonword. The explanation for faster reading of real words is due to the lack of internal visual representations of nonwords⁽¹²⁾; therefore, as a child increases the frequency of contact with the written word and learns the spelling rules, the representations stabilize and allow an increasingly automated and fast recovery of that word⁽¹⁵⁾.

In the irregular words, grapheme-phoneme correspondences are arbitrary (not explained by rules); reading by phonological route tends to regularize them, generating an incorrect, slow and contradictory pronunciation with respect to that generated by the lexical route⁽¹⁶⁾. It is observed that the reading of irregular

words and the effect of frequency are better performed by children from the control group (Table 2). This means that in two of the three tasks that measure lexical route processing, the children of the study group showed poorer performance than the control group children. There is, therefore, a most effective use of the lexical route in children from the control group, with improved performance in reading irregular and infrequent words, which demands great knowledge of the orthographic lexicon. It should be noted that the phonological route is one of the evolutionary basis of such knowledge.

During the lexical encoding, the word is not analyzed according to phonetic elements, but recovered in its entirety by letter recognition and semantic associations exercised to identify and match the words with others that are already stored and redeemed to generate its pronunciation⁽¹⁷⁾. The best performance in writing irregular words and less use of errors as lexicalization and verbal paragraphy by children from the control group shows that noise exposure was negatively associated with the use of the lexical route. In cognitive-linguistic terms, word recognition (access to the mental lexicon) and understanding of what is recognized are essential in the process of reading/writing. The lexical access in an interactive perspective involves the combination of contextual, visual, phonological and orthographic information⁽¹⁸⁾. When some of this information is impaired, in the case of children from the study group, this seems to have an effect beyond phonological processing, that is, the deficit in the phonological route construction have consequences in the lexicalization of words already read. If the signal/noise ratio of an environment is compromised, the performance in coding speech is strongly affected, being related to the characteristics of the input stimulus and environmental context in which it occurs⁽¹⁹⁾.

By analogy, speech perception in noise requires simultaneous integration of different acoustic cues in various time scales, as well as reading requires the recognition of a sequence of graphemes through the mapping of its units in a phonological and semantic code. However, due to noisy conditions, if children do not stably realize the phonemic categories because they cannot ignore the background noise (deficit excluding noise)

or because they have a phonological disorder, the grapheme-phoneme relationship will suffer with consequences over the construction of the orthographic lexicon^(2,5). The fact that there may be environmental limits, related both to the literacy practices of the school and the family, or even some biological limit that has not yet been detected by children should not be excluded from this analysis⁽²⁰⁾.

As for skills in reading and writing related to educational level, fourth grade children made fewer neologism errors in reading, which leads one to suppose that there is an improvement in the performance of the phonological route between third and fourth grades. In writing, children from the third grade also made more errors in phoneme-grapheme conversion regarding voice and representation of nasal sounds, besides making more neologisms. The overall data indicate that there is an improvement in the use of the phonological route between third and fourth grades of elementary education. It is assumed in this model of information processing that the phonological route in early schooling is used with greater emphasis for children to become good readers later⁽²¹⁾. The reader/writer who efficiently uses both routes is considered skilled in reading and writing⁽²²⁾. Even if the phonological route may be the most required at the beginning of the acquisition, the trend is that with time and experience on the grapheme-phoneme, lexical representations become stronger.

In reading, the effects of frequency and lexicality are higher among children of the fourth grade, which suggests a better performance in the lexical route in that group. Fourth grade children only differ from third grade children in writing morphemic verbal paragraphy, with greater use of this resource, which indicates the beginning of the domain of suffix writing and possible erroneous overgeneralization. The data demonstrate that there is an improvement in the tests related to the use of the lexical route in writing, except in the use of suffixes. This fact shows that, pedagogically, there are important gains between one grade and the other in the general area of the lexical route when children write. Comparing the results on both routes, children from the fourth grade have a broader domain of the phonological route possibly forming the basis for the process of lexicalization.

In contrast to this research, a study conducted in order to characterize and compare the reading performance of 262 students from public and private schools of basic education revealed differences among the average of nonword reading from first to fourth grades⁽²³⁾. Furthermore, the study revealed that among children from the first grade, the use of the phonological route is higher compared to students from fourth grade regardless the type of school. This demonstrates that during early literacy the use of the phonological route overlaps the lexical route, while the lexical route is most used in the fourth grade due to increased spelling knowledge⁽²³⁾.

The children of this study were enrolled on the second school semester and should already have completed the literacy process so that they could evolve in advanced textual processing tasks. However, they show advances compatible with children at the end of the first semester of the fourth grade, that is, are beginning to dominate grapheme-phoneme conversion rules

and vice versa, as well as simple contextual rules in writing. This demonstrates that, apart from exposure to high sound pressure levels, there are pedagogical factors to be considered in this population. A study that included one of the schools of the current study revealed insufficient family and school based literacy practices in the areas of the study⁽²⁴⁾.

Assuming that extraneous sounds are automatically processed causing disruptions in information processing⁽²⁵⁾, it becomes necessary to apply control measures to minimize noise exposure risks and avoid losses to attention and concentration of students⁽²⁶⁾.

Under the same rationale previously mentioned, with respect to the approach against high sound pressure levels, there is also a socio-cultural interference that makes evident the responsibility of the school as an agent that can intervene in the environment and promote awareness practices against noise pollution to engage students and the community⁽²⁷⁾.

CONCLUSION

The study found that children exposed to sound pressure levels above 80 dB(A) showed poorer performance in the use of phonological and lexical routes both in reading and in writing.

This data corroborates other publications on the interference of sound pressure levels in learning, demonstrating that there is a need for creating educational and school health policies that encourage preventive actions to minimize exposure to high noise levels — which effects were evident — thus aiming the qualification of literacy practices in school, with the support of the family environment.

Thus, the characterization of reading and writing patterns of children in the literacy process in an acoustically unhealthy environment enables the development of specific strategies for intervention in order to prevent losses along the academic path.

**JFS was in charge of collecting, analyzing and discussing data; APRS and LS collaborated with analysis and discussion of data, as well as general orientation of data*

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