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Voice amplifier: effects on dose and vocal intensity of teachers without dysphonia

Amplificador de voz: efeitos na dose e na intensidade vocal de professoras sem disfonia

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Keywords

Voice
Faculty
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ABSTRACT

Purpose: Analyze the interference of using the voice amplifier in vocal dose of non-dysphonic teachers. **Methods:** This is an experimental study comparing people from the same ambience compound for 20 teachers from municipal elementary school in Belo Horizonte/MG. After consent, the participants were requested to answer the vocal symptom scale questionnaire (ESV) and later participated in two different moments of the study, for which they randomly selected. In the first moment, the participants used only the vocal dosimeter and in the second, they used the vocal dosimeter and the voice amplifier. The measurements were recorded by the device for 1h40m, in the classroom that the teachers taught. The time between the two measurements was one week, with the same room, the same time and the same discipline being taught, at both times. **Results:** The intensity parameter was the only one that showed difference with the use of the voice amplifier. **Conclusion:** Use voice amplification while non-dysphonic teachers are teaching doesn't affect the fundamental frequency and vocal dose measure in the acoustics parameters. The vocal intensity is smaller when teacher uses the vocal amplification.

Descritores

Voz
Docentes
Disfonia
Dosimetria
Fonoaudiologia

RESUMO

Objetivo: Analisar a interferência do uso do amplificador de voz na dose vocal de professoras não disfônicas. **Método:** Trata-se de um estudo experimental, comparativo intrassujeitos, composto por 20 professoras do ensino fundamental da Rede Municipal de Ensino de Belo Horizonte/MG. Após o consentimento as participantes, foram solicitadas a responder o questionário de Escala de Sintomas Vocais – ESV e posteriormente participaram de dois momentos do estudo, selecionados aleatoriamente. No primeiro momento as participantes utilizaram somente o dosímetro vocal e no segundo momento utilizaram o dosímetro vocal e o amplificador de voz. As medições foram registradas pelo aparelho durante 1h40m, na sala de aula que as professoras lecionavam. O espaço entre as duas medições foi de uma semana, sendo mantidas a mesma sala, mesmo horário e mesma disciplina lecionada, em ambos os momentos. **Resultados:** O parâmetro intensidade foi o único que apresentou diferença com o uso de amplificação de voz. **Conclusão:** O uso da amplificação de voz durante a docência de professoras não disfônicas não interfere nos parâmetros acústicos de frequência fundamental, e nas medidas de dose vocal. A intensidade da voz é menor quando o professor faz uso de amplificação vocal.

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INTRODUCTION

The degree of exposure of vocal folds (VFF) tissues to vibration can be expressed as the value of the vocal dose, which is calculated from three parameters: amplitude, frequency and time[1]. These parameters are the basis for calculating the vocal dose in the monitoring of phonation.

The literature[1,2] defines five types of vocal dose: The dose of time (Dt) that quantifies the total time of VFF vibration during speech and is measured in seconds; the dose of cycle (Dc) that quantifies the total number of oscillation periods completed by VFF over time and is measured in a number of cycles; the dose of distance (Dd) that quantifies the total distance covered by the VFF tissue in the cyclical trajectory during the vibration and is measured in meters; the dose of energy dissipation (De), which takes into account the thermal agitation factor of the tissue inside the VFF and measures the amount of heat produced during the VFF vibration; and the dose of irradiated energy (Dr)[1,2] that relates the consumption of energy in VFF to the acoustic energy irradiated in the mouth. The vocal dose studies have used as main measures: the temporal dose, the dose of cycle and the dose of distance[3].

Research shows that the vocal dose increases in speech situations with greater prosodic variation[1]; in teaching[4], especially in teachers of early childhood education[5]; in rehearsals of the singing voice and in the teaching of singing[6]; in situations of vocal overloads, such as loud speech[7]; in environments with greater noise intensity[8]; and in individuals with dysphonia[9], especially those with a behavioral basis[10]. In contrast, the vocal dose decreases in situations of resting voice[11]; in individuals with presbyphonia[12] and with the use of vocal amplification during teaching activity in elementary school teachers[13], in dysphonic teachers[14] and in singing teachers[15].

Literature review shows a high prevalence of dysphonia in teachers, two to three times more frequent than in the general population[16,17]. In Brazil, research with professors shows a prevalence of dysphonia ranging from 11.6% to 89%[18]. Vocal disorders are not limited to the Brazilian territory, in Europe, the prevalence of dysphonia in teachers is 57% in Spain[19] and 51% in Finland[20], and 11% in the United States[21].

Dysphonia is often associated with inadequate working conditions, and some of the risk factors, including high levels of noise outside and inside the classroom causing the continued use of the voice at high intensity[17,22]. Research[23] shows that the amount of sound energy (Leq) found in empty and furnished classrooms varies from 54.51 to 74.04 dB (A), with a median of 60 dB (A), values considered high for the Brazilian Standard for noise in environments (NBR 10.152)[24].

The prolonged use of voice in the work environment associated with unfavorable environmental conditions, such as high environmental noise, can expose the tissues of the larynx and vocal folds (VFF) to excessive vibrations, which can contribute to the development of dysphonia[9], resulting in a public health concern in the teaching population. For these professionals, dysphonia can interfere with the survival of individuals in the labor market, represent the impossibility of exercising the profession, resulting in absences from work, decreased income, and even the need to change professions[22].

The use of the vocal amplifier by teachers is presented in the literature as a strategy to protect the voice[21-25]. Despite the literature showing the positive impact of the use of this instrument on vocal quality[26-28] on acoustic parameters[26,28], and on the teachers 'self-perception of voice[27,29], studies that analyzed the amplifier's response in the teachers' vocal dose are still incipient, and evaluated elementary school teachers[13], dysphonic teachers[14] and singing teachers[15].

The voice amplifier allows the teacher to speak at a lower intensity when compared to not using the vocal amplifier[25], which reduces laryngeal overload and overexposure of VFF tissues to vibration[26], which can minimize the vocal dose of this professional group.

Teachers use a vocal intensity of 10 to 15 dBSPL during the teaching period above the environmental noise[27]. The damage to the VFF tissue caused by the collision force is reduced when the intensity of the voice is reduced by the use of the vocal amplifier[29]. The literature shows a positive association between the increase in the vocal dose in teachers and the increase in the level of environmental noise[8]. The literature also shows that the presence of dysphonia increases the vocal dose of teachers[9], and that they have twice the phonation time when compared to non-professional use of the voice[30].

Therefore, to development of strategies for prevention and promotion of teachers' voice health, it is important to investigate the impact of vocal amplification on teachers without voice complaints, which can contribute to coping with the vocal illness of this professional group.

This research aimed to analyze whether the use of the voice amplifier interferes with the vocal dose of non-dysphonic teachers.

METHODS

This is an intra-subject comparative experimental study, approved by the Research Ethics Committee of "Universidade Federal de Minas Gerais" (UFMG) under number 47212615.1.0000.5149.

The sample included 20 elementary school teachers, age 27 to 45 years old (average=37.5; SD=6.2) from three schools in the "Rede Municipal de Ensino de Belo Horizonte/MG" (RME-BH), from July to August 2018. The selected schools had an average of 16 classrooms, with classes for children, Elementary School I and II, and operated in the morning and afternoon.

It is a sample for convenience and, to determine the number of teachers participating in the research, the statistical program G.Power 3.1® was used. The sample size was based on the study by Rabelo et al.(2019)[8], with the results of comparing the dose of cycle of women in differentiated acoustic situations, with and without noise. The sample calculation determined the number of 15 teachers in each group, considering the Wilcoxon test for a paired sample with a study power of 95%, alpha equal to 0.05 and effect size of 1.05.

The researchers visited the teachers at their schools and explained the objective of the research and the criteria for participation in the study. Teachers who freely expressed their consent, accepting to participate voluntarily in the research were informed about the data collection procedures, and the purpose of using the collected information, by signing the Informed Consent Term (ICF). All teachers who presented positive self-perception of vocal quality (reported having a good or very good voice) and self-reported absence of vocal symptoms (fatigue and/ or discomfort), were invited to perform speech-language and otorhinolaryngological assessment to participate in the research. All 20 elementary school teachers invited were included in the study and completed the collection.

The speech-language assessment consisted of the perceptual-auditory analysis of the general degree of dysphonia on a Likert scale of four points, in the tasks of vowel /a/ sustained in a habitual way and of connected speech (days of the week). The vocal records were collected using a unidirectional microphone, condenser, of the Shure® brand, model SM86, positioned 10 cm away from the mouth of each participant, connected directly to a notebook (Toshiba Satellite 1800/1850), Sound Blaster sound card, using the Sonic Foundry Soundforge 6.0 program, mono, 16 bits, sampling frequency 44.100Hz, in the school itself, in a quiet environment. The neutral degree of dysphonia graded at zero was considered as neutral vocal quality. The speech-language assessment was carried out by one of the researchers, with five years of experience in auditory-perceptual analysis. For this analysis, the evaluator reproduced the voices as many times as she deemed necessary, using the Multilaser Vibe Headphone stereo supra-earphone.

The otorhinolaryngological evaluation was carried out by otorhinolaryngologists, using videolaryngoscopy. Laryngeal exams were considered normal when presenting with absence of lesions in the vocal folds and complete glottic coaptation. The presence of posterior triangular cleft in women was considered physiological[31]. We analyzed videolaryngoscopy exams performed in the periodic evaluations of the professors of RME-BH, at least four months from the date of the research collection.

For the analysis of vocal symptoms, the teachers answered a voice self-assessment instrument (VoiSS), which includes information on functionality, emotional and physical impact due to the presence of vocal symptoms. The VoiSS is considered a simple and easy to apply and interpret protocol, composed of 30 questions and with a cut-off point equal to or greater than 16 points, to define the presence of vocal complaints[32]. The participants scored from 0 to 15, indicating the absence of vocal complaints (average=10.6; SD=3.2).

Female teachers were included in the study; who taught only inside the classroom; aged between 18 and 45 years old, as this is the period of greatest vocal stability; Voice Symptom Scale (VoiSS)[32] protocol less than 16 points and self-assessment of the absence of vocal symptoms; normal laryngeal examination verified in the otolaryngological evaluation of videolaryngoscopy; and neutral vocal quality observed in the Speech-Language Pathology evaluation. The exclusion criteria adopted were to present a self-reported complaint of auditory or pulmonary disorder, smokers, pregnant women or in the premenstrual or menstrual period.

The instrument used to measure the vocal dose of the teachers was a VoxLog® brand dosimeter from Sonvox model 3.1, consisting of a microphone, a portable unit that stores the vocal data and an accelerometer (Figure 1), positioned in the neck region, close to the thyroid cartilage (Figure 2).

For voice amplification, the BOAS® portable voice amplifier was used, with a range of up to 200 meters, output power of 5w and frequency response from 100Hz to 13000Hz (Figure 3).

The participants were monitored on two different days, defining two moments of recording. At moment 1 (M1) the teachers used the vocal dosimeter in the classroom where they taught, lasting two class hours (1h40min). At moment 2 (M2) the participants used the vocal dosimeter in the same classroom, having the same duration of two class hours (1h40min), making use of the BOAS® brand voice amplifier at the same time.

The teachers did not receive specific vocal training to use the vocal amplifier. They were instructed on how to manipulate the equipment, how to use it during classes, and about the

Source: http://www.sonvox.com/VoxLog_technical_document.pdf
Figure 1. VoxLog® brand dosimeter from Sonvox model 3.1

Source: http://www.sonvox.com/VoxLog_technical_document.pdf
Figure 2. equipment placement

Source: https://www.xfort.com.br/2018/07/amplificadordevoz-ap50.html
Figure 3. BOAS® brand voice amplifier

purpose of using the voice amplifier. Each teacher tested and used the equipment with one of the researchers and was asked any questions related to the handling and use of the equipment.

The environmental noise was measured by the sound pressure level meter with data-logger brand Instrutherm® model DEC-490 with microphone type 2. Measurements were made in the octave bands that cover the frequencies from 63 Hz to 8 kHz, with the furnished classrooms and with school activities occurring normally, including in the adjacent classrooms. The sound pressure level meter was positioned in the center of the room, 1.2 m from the floor, 0.5 m from moving objects and 1 m from walls and fixed objects, and approximately 1.0 m away from the teacher (ANSI S12. 60, 2010).

Using the values measured in the classroom, we calculated the Equivalent Continuous Sound Level (Leq), which is defined as the level of continuous sound that has the same acoustic energy as the floating sound being measured in a given location. The calculation is done by integrating the pressure variation over time. The average environmental noise was 72.5 dBSPL (DP=5.2) at the moment without the voice amplifier (M1), and 72.8 dBSPL (DP=5.2) at the moment with the voice amplifier (M2), with no difference in noise level between the two moments (p=0.06).

Moments M1 and M2 were randomized and defined for each teacher by means of a draw. The distance interval between the two moments of the study was one week. In order to homogenize the sample, the recordings of M1 and M2 took place on the same day of the week, class schedule, class of students, and discipline taught.

Data were collected at the school where the participants teach, always in the morning shift, in the first classes of the day. The average time of the first recording of the voices (M1) with the vocal dosimeter was 105.4 minutes (SD 4.5), and of the second recording (M2) was 106.3 minutes (SD 5.0), which demonstrates the stability of recording time in both moments (p=0.51).

The collected vocal data were analyzed on the computer using specific software of the VoxLog® equipment and constitute the analysis of the following parameters:

1. Vocal intensity: represents the amount of energy of the sound produced, measured in dBSPL[1].
2. Fundamental frequency (f_0): the number of sound waves per unit of time and is measured in Hz[2].
3. Percentage of phonation: indicates the time in which phonation is produced, compared to the elapsed time of the monitored period, measured in percentage[2,13]:

$$\frac{\text{Phonation time X 100}}{\text{Recording time}} = \%$$

4. Dose of cycle: quantifies the number of vocal fold oscillations during the recorded period. It is calculated from the phonation time and the f0 average. The value, in thousands of cycles, is defined by[2]:

$$D_c = \int_0^{tp} \mathrm{k_v} FO \mathrm{dt}$$

where t_p is the performance time, that is, the time the individual uses his voice, speaking or singing, *F0* is the fundamental frequency of the vocal folds in Hertz (Hz) and kv is the function defined by[2]:

$$\mathrm{k_v} = \begin{cases} 1(\textit{for voice emitting sound}) \\ 0(\textit{for voice not being used}) \end{cases}$$

5. Dose of distance: the total distance covered by the tissue of the vocal folds in the cyclic trajectory during the vibration and depends not only on the total phonation time and fundamental frequency, but also on the amplitude of the vocal fold vibration and, therefore, on the vocal intensity (dB SPL). The value of this dose, in meters, is defined by[2]:

$$D_d = 4\int_0^{tp} \mathrm{k_v} AFO \mathrm{dt}$$

where F0 is the fundamental frequency of the vocal folds (Hz) and A is the amplitude of vibration of the vocal folds at the top and bottom.

For the calculation of the dose of distance, researchers developed an algorithm, as this dose is not calculated by the manufacturer's software, like the other parameters. The value of A can be determined based on the rules of thumb derived[2]:

$$A = 0{,}05\, L_o \left[\left(P_L - P_{th} \right) / P_{th} \right]^{1/2} m,$$

where L_o represents the length of the vocal folds (0.016 m for men and 0.01 m for women), P_L is pulmonary pressure and P_{th} is the limit of speech pressure. For P_{th} is determined[2]:

$$P_{th} = 0{,}14 + 0{,}06 \left(F_O / F_{ON} \right)^2 kPa,$$

where F0 is the fundamental frequency and F_{ON} is the nominal fundamental frequency (120 Hz for men and 190 Hz for women). To determine pulmonary pressure, it was derived from the measurement of SPL at 50 cm from the mouth and is described as[2]:

$$P_L = P_{th} + 10^{(NPS - 78{,}5)/27{,}3} kPa$$

The statistical analysis was performed using the statistical program MINITAB version 17. First, a descriptive analysis of the data was performed with measures of central tendency and dispersion. Subsequently, the Anderson-Darling test was used to verify the normality of the sample. To compare the intensity measurements with and without the use of voice amplification, the Wilcoxon nonparametric test was used because this variable has an asymmetric distribution. The paired Student's t-test was performed to compare the other variables with normal distribution in situations with and without the use of voice amplification. The 95% confidence level was considered.

RESULTS

The use of the voice amplifier decreased the values of the vocal intensity parameter (Table 1).

Table 1. Analysis of vocal parameters without and with the use of the voice amplifier in teachers without dysphonia.

Parameter	Without Voice Amplifier					With Voice Amplifier					
	Average	SD	Minimum	Median	Maximum	Average	SD	Minimum	Median	Maximum	P-Value
Fundamental Frequency (f0)	281.9	32.9	216.7	280.7	368.6	270.7	30.8	210.14	265.9	353.4	0.188
Intensity	94.2	2.7	90.8	93.4	99.1	93.2	2.7	89.3	92.3	98.8	0.042*
Phonation Percentage (%)	21.2	6.0	10.3	19.5	35.0	19.6	5.2	10.1	19.0	29.1	0.264
Dose of cycle	306.9	107.8	118.0	320.0	488.0	284.9	97.7	103.0	273.5	457.0	0.417
Dose of distance	1.8	0.7	0.7	1.8	3.6	1.8	0.8	0.5	1.8	3.3	0.810

* P-Value <0.05. Wilcoxon test Paired Student's t-test

DISCUSSION

This study consisted of analyzing whether the use of the voice amplifier interferes with the vocal dose of 20 non-dysphonic teachers from schools in the Municipal Education Network. The data found demonstrate that the vocal intensity of the non-dysphonic teachers, suffered a significant reduction with the use of the voice amplifier. The phonatory data of f_0, percentage of phonation, dose of cycle, and dose of distance did not present any differences when comparing the moments without amplification and with amplification.

Teachers' voices are an essential tool for the development of teaching, and the impairment of vocal capacity is one of the most common reasons for the increase in the rate of absenteeism related to the disease(33). Therefore, it is of great importance for the Speech-Language Pathologist to evaluate the vocal function in relation to the real teaching situation of the teacher. In this study, the focus was on comparing the vocal dose with and without the use of the voice amplifier in a real teaching situation.

The literature presents few studies that analyze the association between the decrease in the vocal dose of teachers and the amplification of voice. One can mention research in situations of singing lessons15, a case study with two teachers(13) and finally a research with 15 dysphonic teachers(14). However, it does not describe studies with non-dysphonic teachers and voice amplification, and their correlations with the vocal dose.

A survey of vocally healthy teachers, in a real teaching situation, found f_0 values of 298.6, and when performing a vocal loading test, she found values of 269.4 Hz7. The observed f0 results are close to the findings of the present study.

Research shows that f0 correlates with the intensity of the spoken voice8. The f0 tends to increase with increasing intensity, which confirms the findings of this study without the use of a voice amplifier(27,34). Researchers observed that f_0 and intensity increase with the presence of environmental noise(13,14,) which may be related to the increase in muscle activity, due to the vocal load imposed during the workday. Teachers complain about the need to speak loudly in order to be heard/understood in noisy environments and inadequate acoustic conditions in classrooms(17).

The results of the present study also revealed that the decrease in voice intensity with the use of the amplifier was not enough to statistically decrease the participants' f_0.

As expected, the decreased intensity observed in the research was due to the use of the voice amplifier. The equipment has the function of modifying the vocal intensity since the individual uses speech more comfortably(25). In addition, the vocal amplifier is a device that can contribute to the phonological comfort and vocal longevity of the voice professional, providing a decrease in symptoms of vocal discomfort, and consequently improving the clinical condition of the teacher(29).

The use of the voice amplifier promoted a slight reduction in the teachers' voice intensity from 94.2 dBSPL to 93.2 dBSPL. Safe limits of voice intensity, in situations of professional and/or social use, have not yet been established by the literature, considering the idiosyncratic aspects of dysphonia. Literature(35) defines that in a woman with an average f_0 value of 300 Hz, an increase of 6 dB in the usual intensity of the voice, will modify her self-reported vocal effort from nothing at all to a sensation of extreme effort, suggesting that small increases in the intensity of voice have a negative impact on vocal self-perception.

Future studies are needed to understand whether the small increase in intensity, observed in this research, is clinically relevant to impact the vocal health of teachers without voice complaints.

The percentage of phonation is related to the time of vibration of the vocal folds over the recording period(1). Research shows that their values are not only dependent on the time the voice was recorded, but factors such as the presence of dysphonia in teachers(9), and in women with behavioral dysphonia(10), increase the percentage of phonation. The results of this research demonstrated that the use of the voice amplifier did not decrease the teachers' phonation time. Such results corroborate the findings of two studies that observed that vocal amplification does not alter the percentage of teachers' phonation during teaching activities13,14. Therefore, vocal amplification does not seem to be an important factor to change the amount of speech of the teacher during the teaching activity.

In contrast, a study with music teachers showed that the use of the voice amplifier decreased the percentage of phonation(15). Such results suggest that the use of the vocal amplifier in teaching the singing voice tends to work differently in terms of phonation time. For music teachers, this reduction is probably associated with positive auditory feedback, allowing better control of the singing voice(15).

Just as the percentage of phonation was not influenced by the voice amplifier, the dose of cycle and the dose of distance did not change. As these parameters are dependent on the f_0 values and the percentage of phonation, such results were already expected, and suggest that vocal amplification does not interfere with the number of vocal fold vibrations of non-dysphonic teachers.

The literature shows that the use of the voice amplifier in dysphonic teachers decreases the dose of cycle and the dose of distance, which indicates a reduction in the collision force and the risk of damage to the vocal folds of these teachers[14]. Such data suggest that this resource works differently for the population of dysphonic teachers.

A survey of five teachers with dysphonia and five teachers without voice alteration during the teaching activity showed that dysphonic teachers have longer phonation time and dose of cycle when compared to teachers without vocal alteration[9], suggesting that teachers without voice alteration have a lower demand during the teaching activity. It is reasonable to assume that the vocal amplifier has a more specific influence on the intensity of the voice in teachers without vocal changes and does not cause important changes in the parameters of the vocal dose.

This assumption is reinforced by a case study that evaluated one dysphonic teacher and one without voice alteration[13] and observed that the dysphonic teacher benefited more from the voice amplifier than the non-dysphonic teacher. Such results suggest a therapeutic effect of the use of the vocal amplifier for the group of dysphonic teachers, while for the group of non-dysphonic ones, the vocal amplifier seems to be an instrument for the prevention of vocal alterations in the face of the decrease in vocal intensity used during teaching.

Teachers who work with limitations in carrying out their activities due to voice issues do not satisfactorily perform their function of teaching. The meaning for the teacher in this scenario can be demotivation, absenteeism, or abandonment of the profession[36]. The main reason in Brazil for absenteeism in the category is vocal disorder, followed by respiratory and emotional problems[33].

The elaboration of surveillance actions in work environments and processes must aim at early intervention to avoid worsening the voice problem and consequent recurrent absences in teaching work[32]. In this sense, the present work suggests that the voice amplifier, by reducing the vocal intensity of the teacher, can be an available tool for the prevention of dysphonia in teachers. Research[35] observed that, in the elaboration of a multivariate model to determine a vocal fatigue index, the increase in voice intensity explained 66% of the model. Therefore, the increase in voice intensity has a high correlation with the presence of vocal fatigue.

Using a single tool to reach workers with different demands is of great value to public health. The vocal amplifier when used by different groups (without dysphonia and with dysphonia) had specific repercussions for each group. For non-dysphonic teachers, evaluated in this research, vocal intensity decreased, a result that suggests the possibility of maintaining voice quality throughout teaching. While the literature[14] demonstrates that the group of dysphonic teachers shows a reduction in the vocal dose parameters, which may indicate a therapeutic effect for the voice alteration.

In Brazil, public policies have been established to deal with noise pollution (NBR 10,152) 24. However, it is necessary to expand knowledge about the relationship between noise in schools, sociodemographic characteristics, and the working conditions of teachers, in order to assist in the intervention proposals.

The noise levels measured in the classrooms of the participants in this research were around 72 dBSPL, values close to those indicated in the literature[23], and considered high for the Brazilian Standard for noise in environments (NBR 10.152) [24]. Assessing the acoustics of classrooms to establish adequate indications of voice amplification equipment[37], in addition to guidance on the importance of noise reduction in the school environment, aiming at the vocal health of teachers, and the learning process of students, are important aspects of school health. Positive actions and public policies aimed at teachers' vocal health must emphasize the ergonomic and organizational aspects of the work of this professional class.

It is necessary to go beyond individual and behavioral training and create spaces for discussions to seek solutions to reduce the vocal burden linked to the demands and challenges encountered by teachers, mainly related to the conditions of the work environment.

The limitations of our study include aspects related to the recording time; absence of a structured training program for the use of voice amplifiers; the type of research design with intra-subject comparison; and the use of perceptual-auditory analysis of vocal quality performed by only one of the researchers. The teachers were evaluated during two consecutive classes (1h40min), at two different times (with and without vocal amplification). Studies with collections in longer periods, and more days of the week are important, mainly because the values of the parameters of the fundamental frequency, percentage of phonation and dose of cycle present a reduction of the average value when comparing the moments without amplification and with amplification, however without statistical significance.

Future research that analyzes the effect of a training program for the use of the voice amplifier on teachers is important to assess the impact of these guidelines on the results of this equipment on the teachers' voice health.

Future studies, with greater strength of scientific evidence, such as controlled and randomized clinical trials, are important for a better understanding of sound amplification in non-dysphonic teachers, for the elaboration of protocols for the promotion and prevention of vocal health.

CONCLUSION

The use of the voice amplifier during teaching in non-dysphonic teachers reduces the intensity of the voice and does not interfere with the acoustic parameters of fundamental frequency and measures of vocal dose.

Our results suggest that non-dysphonic teachers can benefit from the use of sound amplification, due to the decrease in vocal intensity, which probably can be a protective factor of the vocal health of this professional group.

REFERENCES

1. Titze IR, Svec JG, Popolo PS. Vocal dose measures: quantifying accumulated vibration exposure in vocal fold tissues. J Speech Lang Hear Res. 2003;46(4):919-32. http://dx.doi.org/10.1044/1092-4388(2003/072). PMid:12959470.
2. Švec JG, Popolo PS, Titze IR. Measurement of vocal doses in speech: experimental procedure and signal processing. Logoped Phoniatr Vocol. 2003;28(4):181-92. http://dx.doi.org/10.1080/14015430310018892. PMid:14686546.
3. Assad JP, Magalhães MC, Santos JN, Gama ACC. Vocal dose: an integrative literature review. Rev CEFAC. 2017;19(3):429-38. http://dx.doi.org/10.1590/1982-021620171932617.
4. Titze IR, Hunter EJ, Svec JG. Voicing and silence periods in daily and weekly vocalizations of teachers. J Acoust Soc Am. 2007;121(1):469-78. http://dx.doi.org/10.1121/1.2390676. PMid:17297801.
5. Remacle A, Morsomme D, Finck C. Comparison of vocal loading parameters in kindergarten and elementary school teachers. J Speech Lang Hear Res. 2014;57(2):406-15. http://dx.doi.org/10.1044/2013_JSLHR-S-12-0351. PMid:24129011.
6. Schloneger MJ. Graduate student voice use and vocal efficiency in an opera rehearsal week: a case study. J Voice. 2011;25(6):265-73. http://dx.doi.org/10.1016/j.jvoice.2010.09.010. PMid:21429708.
7. Echternach M, Nusseck M, Dippold S, Spahn C, Richter B. Fundamental frequency, sound pressure level and vocal dose of a vocal loading test in comparison to a real teaching situation. Eur Arch Otorhinolaryngol. 2014;271(12):3263-8. http://dx.doi.org/10.1007/s00405-014-3200-6. PMid:25012705.
8. Rabelo ATV, Santos JN, Souza BO, Gama ACC, Castro Magalhães M. The Influence of Noise on the Vocal Dose in Women. J Voice. 2019;33(2):214-9. http://dx.doi.org/10.1016/j.jvoice.2017.10.025. PMid:29290547.
9. Gama ACC, Santos JN, Pedra EFP, Rabelo AT, Magalhães MC, Casas EB. Vocal dose in teachers: correlation with dysphonia. CoDAS. 2016;28(2):190-2. http://dx.doi.org/10.1590/2317-1782/20162015156. PMid:27191884.
10. Mehta DD, Van Stan JH, Zañartu M, Ghassemi M, Guttag JV, Espinoza VM, et al. Using Ambulatory Voice Monitoring to Investigate Common Voice Disorders: research Update. Front Bioeng Biotechnol. 2015;3(155):1-14. http://dx.doi.org/10.3389/fbioe.2015.00155. PMid:26528472.
11. Misono S, Banks K, Gaillard P, Goding GS Jr, Yueh B. The clinical utility of vocal dosimetry for assessing voice rest. Laryngoscope. 2015;125(1):171-6. http://dx.doi.org/10.1002/lary.24887. PMid:25137621.
12. Ziegler A, Hapner ER. Vocal dose in older adults with Presbyphonia: An analytic, cross-sectional study. J Voice. 2018;97(18):30320-5. PMid:30322822.
13. Gaskill CS, O'Brien SG, Tinter SR. The effect of voice amplification on occupational vocal dose in elementary school teachers. J Voice. 2012;26(5):667.e19-27. http://dx.doi.org/10.1016/j.jvoice.2011.10.010. PMid:22521533.
14. Assad JP, Gama ACC, Santos JN, Castro Magalhães M. The effects of amplification on vocal dose in teachers with Dysphonia. J Voice. 2019;33(1):73-9. http://dx.doi.org/10.1016/j.jvoice.2017.09.011. PMid:29122417.
15. Morrow SL, Connor NP. Voice amplification as a means of reducing vocal load for elementary music teachers. J Voice. 2011;25(4):441-6. http://dx.doi.org/10.1016/j.jvoice.2010.04.003. PMid:20655172.
16. Martins RHG, Pereira ERBN, Hidalgo CB, Tavares ELM. Voice Disorders in Teachers. A Review. J Voice. 2014;28(6):716-24. http://dx.doi.org/10.1016/j.jvoice.2014.02.008. PMid:24929935.
17. Limoeiro FMH, Ferreira AEM, Zambon F, Behlau M. Comparação da ocorrência de sinais e sintomas de alteração vocal e de desconforto no trato vocal em professores de diferentes níveis de ensino. CoDAS. 2019;31(2):e20180115. http://dx.doi.org/10.1590/2317-1782/20182018115. PMid:30892420.
18. Behlau M, Zambon F, Guerrieri AC, Roy N. Epidemiology of voice disorders in teachers and nonteachers in Brazil: prevalence and adverse effects. J Voice. 2012;26(5):665.e9-18. http://dx.doi.org/10.1016/j.jvoice.2011.09.010. PMid:22516316.
19. Preciado-López J, Perez-Fernandez C, Calzada-Uriondo M, Preciado-Ruiz P. Epidemiological study of voice disorders among teaching professionals of La Rioja, Spain. J Voice. 2008;22(4):489-508. http://dx.doi.org/10.1016/j.jvoice.2006.11.008. PMid:17574808.
20. Ilomäki I, Leppanen K, Kleemola L, Tyrmi J, Laukkanen AM, Vilkman E. Relationships between self-evaluations of voice and working conditions, background factors, and phoniatric findings in female teachers. Logoped Phoniatr Vocol. 2009;34(1):20-31. http://dx.doi.org/10.1080/14015430802042013. PMid:19283550.
21. Roy N, Merrill RM, Thibeault S, Parsa RA, Gray SD, Smith EM. Voice disorders in teachers and the general population. J Speech Lang Hear Res. 2004;47(2):281-93. http://dx.doi.org/10.1044/1092-4388(2004/023). PMid:15157130.
22. Jardim R, Barreto SM, Assunção AA. Condições de trabalho, qualidade de vida e disfonia entre docentes. Cad Saude Publica. 2007;33(10):2439-61. http://dx.doi.org/10.1590/S0102-311X2007001000019. PMid:17891304.
23. Rabelo ATV, Santos JN, Oliveira RC, Magalhães MC. Efeito das características acústicas de salas de aula na inteligibilidade de fala dos estudantes. CoDAS. 2014;26(5):360-6. http://dx.doi.org/10.1590/2317-1782/20142014026. PMid:25388068.
24. Associação Brasileira de Normas Técnicas. NBR 10.152: Níveis de ruído para conforto acústico. Rio de Janeiro: ABNT; 2017.
25. McCormick CA, Roy N. The ChatterVox portable voice amplifier: a means to vibration dose reduction? J Voice. 2002;16(4):502-8. http://dx.doi.org/10.1016/S0892-1997(02)00126-1. PMid:12512638.
26. Jónsdottir V, Laukkanen AM, Siikki I. Changes in teachers' voice quality during a working day with and without electric sound amplification. Folia Phoniatr Logop. 2003;55(5):267-80. http://dx.doi.org/10.1159/000072157. PMid:12931060.
27. Bovo R, Trevisi P, Emanuelli E, Martini A. Voice amplification for primary school teachers with voice disorders: a randomized clinical trial. Int J Occup Med Environ Health. 2013;26(3):363-72. http://dx.doi.org/10.2478/s13382-013-0115-1. PMid:23817868.
28. Masson MLV, Araújo TM. Protective Strategies Against Dysphonia in Teachers: Preliminary Results Comparing Voice Amplification and 0.9% NaCl Nebulization. J Voice. 2018;32(2):257.e1-10. http://dx.doi.org/10.1016/j.jvoice.2017.04.013. PMid:28579158.
29. Teixeira LC, Behlau M. Comparison between vocal function exercises and voice amplification. J Voice. 2015;29(6):718-26. http://dx.doi.org/10.1016/j.jvoice.2014.12.012. PMid:26296853.
30. Hunter EJ, Titze IR. Variations in intensity, fundamental frequency, and voicing for teachers in occupational versus non-occupational settings. J Speech Lang Hear Res. 2010;53(4):862-75. http://dx.doi.org/10.1044/1092-4388(2009/09-0040). PMid:20689046.
31. Dedivitis RA, Tsuji DH. Manual Prático de Laringologia. 1ª ed. Rio de Janeiro: DI LIVROS; 2011.
32. Moreti F, Zambon F, Oliveira G, Behlau M. Cross-cultural adaptation, validation, and cutoff values of the Brazilian version of the Voice Symptom Scale. VoiSS. J Voice. 2014;28(4):458-68. http://dx.doi.org/10.1016/j.jvoice.2013.11.009. PMid:24560004.
33. Medeiros AM, Vieira MT. Ausência ao trabalho por distúrbio vocal de professores da Educação Básica no Brasil. Cad Saude Publica. 2019;35(1, Suppl. 1):e00171717. http://dx.doi.org/10.1590/0102-311x00171717. PMid:30994819.
34. Rantala LM, Hakala S, Holmqvist S, Sala E. Holmgvist, Sala E. Classroom Noise and Teachers' Voice Production. J Speech Lang Hear Res. 2015;58(5):1397-406. http://dx.doi.org/10.1044/2015_JSLHR-S-14-0248. PMid:26089145.
35. Bottalico P. Speech Adjustments for Room Acoustics and Their Effects on Vocal Effort. J Voice. 2017;31(3):392.e1-12. http://dx.doi.org/10.1016/j.jvoice.2016.10.001. PMid:28029555.
36. Ferreira LL. Lições de professores sobre suas alegrias e dores no trabalho. Cad Saude Publica. 2019;35(1, Suppl 1):e00049018. http://dx.doi.org/10.1590/0102-311x00049018. PMid:30994815.
37. Cutiva LCC, Puglisi GE, Astolfi A, Carullo A. Four-day Follow-up Study on the Self-reported voice condition and noise condition of teachers:

relationship between vocal parameters and classroom acoustics. J Voice. 2017;31(1):120.e1-8. http://dx.doi.org/10.1016/j.jvoice.2016.02.017. PMid:27427163.

Authors' contribution

EVSS collected and analyzed the data and organized the text; IBB and ACCG have critically reviewed the content of the manuscript.