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Revision articles

Vocal dose: an integrative literature review

Dose vocal: uma revisão integrativa da literatura

Joana Perpétuo Assad[(1)]
Max de Castro Magalhães[(2)]
Juliana Nunes Santos[(3)]
Ana Cristina Côrtes Gama[(1)]

[(1)] Departamento de Fonoaudiologia da Faculdade de Medicina, Universidade Federal de Minas Gerais - UFMG / Belo Horizonte (MG), Brasil.

[(2)] Departamento de Engenharia de Estruturas - Universidade Federal de Minas Gerais - UFMG / Belo Horizonte (MG), Brasil.

[(3)] Departamento de Fisioterapia da Universidade Federal dos Vales do Jequitinhonha e Mucuri - UFVJM/ Diamantina (MG), Brasil.

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Mailing address:
Joana Perpétuo Assad
Av. Alfredo Balena, 190 – sala 249,
Santa Efigênia, Belo Horizonte (MG), Brasil
CEP: 30130-100
E-mail: joanapassad@gmail.com

ABSTRACT

This study aimed to perform a literature review about the vocal doses and the behavior of these measurements in different communicative situations. A review on MEDLINE, LILACS, IBECS and ISI Web of Science databases of the literature written in English, Spanish and Portuguese, within the past twenty-one years, of articles which were fully available, was performed. Fifteen studies met the set criteria. The majority of the articles studied teachers, since they belong to a vulnerable group for dysphonia. The doses found were phonation percentage, time dose, cycle dose, distance dose, energy dissipation dose and radiated energy dose. The vocal dose increase is associated with an excessive and prolonged voice use in teaching activity, especially when teaching young children and teaching music. The high vocal doses are also associated with the presence of dysphonia, the background noise, the large prosodic variation in speech and the self-perception of vocal fatigue. Patients with behavioral dysphonia (nodes and polyps) present higher vocal doses than patients with other types of dysphonia. Factors such as voice rest and use of voice amplifiers indicate a decrease of vocal dose.

Keywords: Dosage; Voice; Dysphonia; Voice Disorders; Vocal Cords

RESUMO

O objetivo da pesquisa foi realizar uma revisão da literatura referente aos tipos de dose vocal e aos resultados destas medidas em diferentes situações comunicativas. Houve levantamento da literatura nacional e internacional, publicada nos idiomas Inglês, Espanhol ou Português, utilizando-se as bases de dados MEDLINE, LILACS, IBECS e ISI (Web of Science), dos últimos 21 anos, cujos artigos estavam disponíveis na íntegra. Quinze estudos contemplaram os critérios propostos. A maioria dos artigos estudou professores, visto que são mais vulneráveis para a ocorrência de disfonia. Os tipos de dose encontrados foram porcentagem de fonação, dose temporal, dose cíclica, dose de distância, dose de energia radiada e dose de energia dissipada. O aumento da dose vocal está associado ao uso excessivo e prolongado da voz na atividade docente, principalmente entre os professores da educação infantil e os de canto. As altas doses vocais correlacionam-se também à presença de disfonia, ao maior nível de ruído ambiental, à grande variação prosódica na fala e à autopercepção de fadiga vocal. Pacientes com disfonia comportamental (nódulos e pólipos) apresentam maiores doses vocais que pacientes com outros quadros disfônicos. Fatores como repouso de voz e uso do amplificador vocal indicam a diminuição da dose da voz.

Descritores: Dosagem; Voz; Disfonia; Distúrbios da Voz; Pregas Vocais

INTRODUCTION

The term 'vocal dose' is used to define the exposure of the vocal fold tissue to vibration. The same way the dose is used to quantify the exposure of other human body tissues to factors such as solar radiation or chemicals, it was seen that there was a necessity to quantify the exposure of the vocal fold to vibration in order to investigate the effects of the prolonged or excessive use of the voice amongst professionals that use it as a working tool[1].

This measurement of exposure is obtained through a vocal dosimeter, which is a device that captures the vibration of the vocal fold tissue through an accelerometer attached to the neck[2]. In order for only the phonation to be analyzed in the recording neither any background noises nor the content of the speech are captured thus keeping the speakers anonymity[3].

Research defined five parameters of vocal dose measurement, considering several factors that can contribute to vocal problems which are: time dose, cycle dose, distance dose, dissipated energy dose and radiated energy dose[1].

The time dose, which is defined as the total duration of the vocal fold vibration in time, is obtained considering the total time of the recording and the phonation time. The cycle dose quantifies the total number of oscillatory periods performed by the vocal folds in time and is measured in thousands of cycles per second[1]. It was previously described as Vocal Loading Index – VLI[4] and was measured in hundreds of cycles per second. In order to calculate this dose it is considered the fundamental frequency as well as the calculation parameters of time dose.

The distance dose, which measures the total distance travelled by the vocal fold during the vibration, considers the amplitude of such distance, which changes the intensity of the voice, besides using the calculation parameters of the cycle dose. Theoretically the vocal folds go through the distance of four times the amplitude of a cycle, and that is why there is a factor four in the formula. This type of dose presents, as a limitation, the difficulty in measuring the amplitude of vibration in the vocal folds. For that reason the value of the amplitude can be approximated considering the reference of vocal fold length (0.016 m for men and 0.01 m for women), the pulmonary pressure (considering the intensity measured 50 cm from the mouth) and the subglottic air pressure (considering the fundamental frequency during speech of 120 Hz and for men 190 Hz for women)[1].

The dissipated energy dose takes into account the thermal agitation of the tissue inside the vocal folds and measures the quantity of heat produced in the vocal folds during the vibration. For calculation purposes the following parameters are used: viscosity of the tissue and vertical thickness of the vocal folds (derived from the fundamental frequency) and the angular frequency of the vocal fold vibration[1].

The radiated energy dose quantifies the total energy radiated in the mouth in time. It is not a measurement of the vocal folds exposure, but a potential sound exposure to the listener. In order to obtain the value of this kind of dose it is taken into account the distance between the mouth and the place where the intensity of the voice is registered[1].

All kinds of vocal dose can be obtained from these three parameters: phonation time, fundamental frequency and vocal intensity. The time, cycle and radiated energy doses are measured from the acoustic data of the evaluated person's voice, whereas the distance and dissipated energy doses are estimated from typical vibration amplitude data, thickness and viscosity of female and male vocal folds[1].

The vocal dose, which can be obtained during working hours through a dosimeter, contributes to the understanding of voice use limitations, defining how much voice someone produced in a given time interval. Thus, the voice professionals can self protect from the risk of causing larger vocal damage[5], from the comprehension of how much was utilized of the phonatory musculature to perform their professional duties.

The first device that measured the time of vibration of the vocal folds through a small contact microphone attached to the neck was created in 1983[6]. The vocal dose was first described in literature in 1999 with the name of Vocal Loading Index[4] and new measurements of vocal dose were introduced in 2003[7]. Since then few scientific studies have been developed. However, this measurement can vastly contribute to vocal clinical treatment. In order to better understand vocal dose it is necessary to collect and analyze studies that approach the theme and consequently verify the results of these measurements in different communication situations.

Therefore, the objective of this study was to perform and integrative review of the literature referring to the types of vocal dose and the results of these measurements in different communication situations.

METHODS

It was performed an integrative review of the literature encompassing the following steps: identification of the theme and selection of research question; establishment of the key words and the criteria for inclusion and exclusion of studies; definition of the information to be extracted from the selected studies; categorization of the studies; evaluation of the studies included in the literature review; interpretation of the results; presentation of the review and summary of acquired knwoledge[8].

The question that guided the present study was: 'What are the types of vocal dose and what are the results of these measurements in different communication situations?'. For the selection of the articles there was a search in national and international literature, published in various languages, using the databases MEDLINE, LILACS, IBECS and ISI (Web of Science), due to the fact that these databases have scientific credibility and use search mechanisms to locate bibliographic material. Articles published in the last twenty-one years (1995 to 2016) and that were available in full were included.

The key words used were: time dose OR vocal dose OR dosimeter OR load vocal OR cycle dose OR distance dose, connected by the Boolean operator AND to the words: frequency OR voice OR voice disorder OR vocal fold OR dysphonia OR phonation. The equivalent words in English and Spanish were also used: *time dose, dosis temporal, vocal dose, dosis vocal, dosimeter, load vocal, cargar vocal, cycle dose, cycle dose, dosis cíclica, distance dose, dosis de distancia, frequency, frecuencia, voice, voice disorders, transtornos de la voz, vocal cords, pliegues vocales, dysphonia, disfonía, phonation e fonación.*

The articles found in the search were analyzed by two researches independently in regards to their pertinence or not to the selection and inclusion in the study. The articles that were excluded were those which did not relate to the theme directly, the literature review articles and the articles about methodology of vocal dose register, analyses of calculation of measurements and forms of dosimeter use. After the analyses of the title, summary and key words and the criteria of inclusion and exclusion the articles for full analysis were selected. There was disagreement between the researchers about three articles which were later included after consensus was reached.

The route performed for the selection and analysis of the texts is represented in Figure 1.

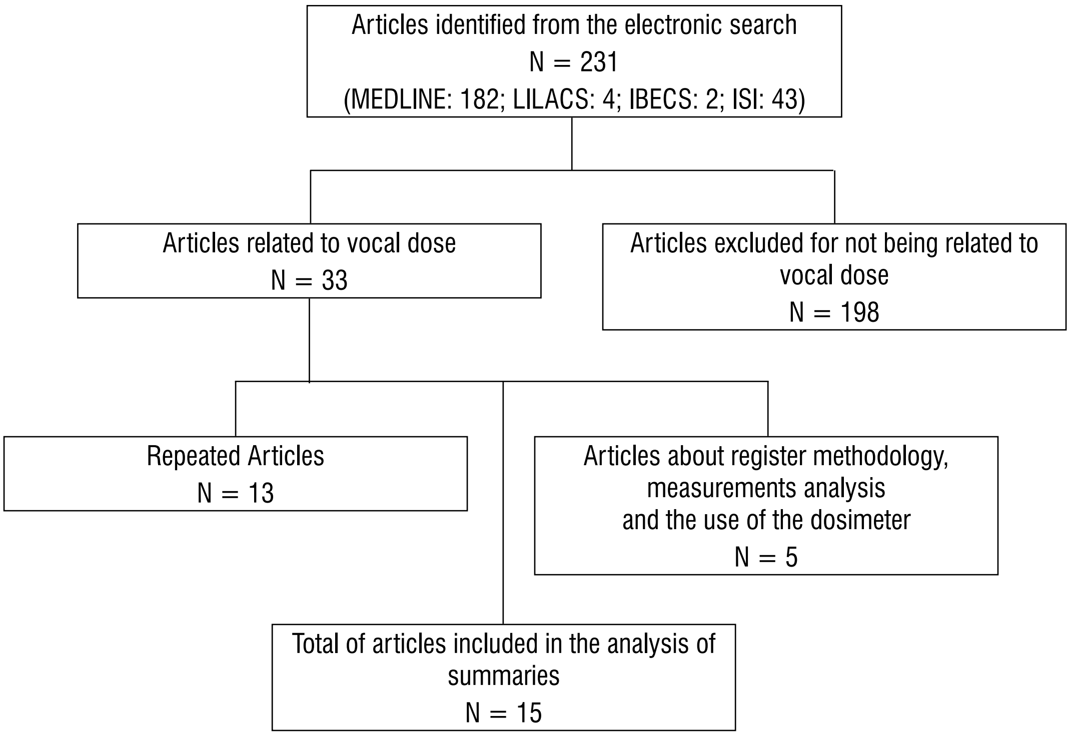

Figure 1. Flowchart of the selection and identification of the studies

In the analyses of the selected studies the following data were considered: year of publication, types of vocal dose analyzed, country in which the research was developed, outline of the study and sample (size and type of professional activity).

LITERATURE REVIEW

After applying the criteria for inclusion and exclusion 15 studies were found, being 14 in English and one in Portuguese, from 2003 to 2016. From those, 86.7% are from the last five years.

Figure 2 presents the types of vocal dose found in the studies, their definitions and formulas.

Type of vocal dose	Definition	Formula
Percentage of Phonation	Relative time spent in phonation, compared to the time passed in the monitored period [9].	$\frac{\text{Time of phonation x 100}}{\text{Time of recording}} = \%$
Time dose (Dt)	Quantifies the total time of vocal folds vibration during the speech [1].	$D_t = \int_0^{t_p} k_v\, dt$ seconds
Cycle dose (D_c)	Quantifies the number of oscillations of the vocal folds during the period recorded. It is calculated from the time of phonation and the median of the fundamental frequency [1].	$D_c = \int_0^{t_p} k_v\, Fodt$ thousands of cycles\second
Distance Dose (D_d)	Total distance travelled by the vocal folds tissue in the cyclical trajectory during the vibration. It depends on the time of phonation, the F0 and the amplitude of the vocal fold vibration (vocal intensity- dB NPS)[1].	$D_d = 4 \int_0^{t_p} k_v AFodt$ meters
Dissipated energy Dose (D_e)	Takes into account the thermal agitation of the tissue inside the vocal folds and measures the quantity of heat produced in the vocal folds during the vibration [1].	$D_e = \int_0^{t_p} k_v P_d dt = \frac{1}{2}\int_0^{tp} k_v\, \eta (A/T)^2 \omega^2 dt$ joules/m^3
Dissipated energy Dose (D_r)	Quantifies the total energy radiated from the mouth in time [1].	$D_r = 4\pi R^2 \int_0^{t_p} k_v 10^{(SPL-120)/10}\, dt$ joules

t_p: time in which the subject uses his voice, speaking or singing;
$k_v = \begin{cases} 1 \text{ (for voice emitting sound)} \\ 0 \text{ (for voice not being used);} \end{cases}$
F_o: fundamental frequency of the vocal folds;
A: amplitude of the vocal fold vibrations at the top and the base;
η: viscosity of the vocal fold tissue;
T: vertical thickness of the vocal folds;
$\omega = 2\pi Fo$: angle frequency of the vocal fold vibration;
R: distance from the mouth in which the level of sound pressure of the voice is registered [1].

Figure 2. Types of vocal dose

Most of these studies were developed in the United States (73%), one study was developed in Belgium (6.7%), one in Germany (6.7%), one in Italy (6.7%) and one in Brazil (6.7%).

In the analysis of the methodological characteristics of the selected articles five were identified as cross-sectional studies (53%), six as case studies (40%) and one as a longitudinal study (6.7%).

The number of participants in the studies varied from two to a hundred and three, with a median of 12 subjects. From the total number of articles analyzed, nine studied vocal dose in teachers (60%), two in singers (13%), two in dysphonic women with various professions (13%), one in employees of the *National Center for Voice and Speech* – NCVS (6.7%) and one did not identify the profession of the participants (6.7%). The teachers studied were from kindergarten, elementary school and music school.

Figure 3 presents the studies categorized by 1) Author of the study and year of publication; 2) Type of research outline and country where it was developed; 3) Characteristics of the sample (size and profession); 4) Objective of study; 5) Type of vocal dose analyzed; 6) Conclusion drawn by the research.

Author / year	Outlining/ Local	Sample	Objective	Vocal Dose	Conclusion
Titze et al (2003)[7]	Case Study / The United States	Three men and three women without vocal problems (workers from the NCVS)	Compare vocal dose in normal, monotonous and with higher prosodic variation speech.	Time (D_t), cycle (D_c), distance (D_d), dissipated energy (D_e) and radiated energy (D_r) doses.	All kinds of doses, except the D_t, had higher values in the speech with higher prosodic variation.
Carroll et al (2006)[2]	Case Study/ The United States	Seven singers: Five men and two women.	Compare the measurements of vocal dose in singing with the self-perception of vocal fatigue.	Time (D_t), cycle (D_c) and distance (D_d) doses.	The symptom of vocal fatigue appeared after the vocal use in higher doses. When the use of the voice in higher doses was preceded by vocal rest the fatigue was reduced.
Schloneger MJ (2011)[12]	Case Study/ The United States	Two singing students and two singing assistant teachers.	Measure the vocal dose in periods of opera rehearsal, individual rehearsal and singing teaching.	Time (D_t) and distance (D_d) doses.	The D_t and D_d were higher during the individual rehearsal and the teaching.
Morrow SL; Connor NP (2011)[13]	Case Study/ The United States	Seven Music teachers.	Measure the dose in music teaching with and without voice amplification.	Cycle (D_c) and distance (D_d) doses.	Significant decrease in the D_c and D_d, in the period of vocal amplifier use.
Morrow SL; Connor NP (2011)[14]	Cross - Sectional/ The United States	Twelve teachers: seven music teachers and five from elementary school teachers.	Compare the dose of the voice in teaching music and teaching elementary school.	Cycle (D_c) and distance (D_d) doses.	Music teachers presented higher values of phonation time, D_c and D_d.
Gaskill et al (2012)[9]	Case Study/ The United States	Elementary School Teachers: one with and one without a history of vocal problems.	Measure the professional vocal dose with and without a vocal amplifier.	Percentage of phonation, cycle (D_c) and distance (D_d) doses.	The use of the voice amplifier reduced the D_d of both teachers. The D_c and the percentage of phonation were not affected.
Nacci et al (2013)[5]	Cross-Sectional/ Italy	Ten teachers from Elementary School: Five without dysphonia and laryngeal lesions and five with nodes in their vocal folds.	Measure the dose of the professional use in dysphonic women and women without vocal complaints.	Percentage of phonation and distance (D_d) doses.	Teachers with vocal nodes presented a slight reduction in the D_d, but without statistical significance. There was no significant change in the percentage of phonation between groups.
Echternach et al (2014)[10]	Cross-Sectional/ Germany	One hundred and one young teachers without vocal complaints.	Analyze the vocal dose in 10 minutes of vocal overload and 45 minutes of teaching tests.	Time (D_t), cycle (D_c), distance (D_d), dissipated energy (D_e) and radiated energy (D_r) doses.	The D_d (in women) and the D_e were higher in the vocal overload test. The D_t was higher in teaching (in men). There was no difference in the D_c. The D_t, D_d, D_e e D_r were higher in men and the D_c in women. There is a strong connection between the intensity of the voice and the background noise.
Remacle et al (2014)[11]	Cross-Sectional/ Belgium	Thirty-two teachers without vocal problems: twelve from kindergarten and twenty from elementary school.	Compare the vocal dose in kindergarten and elementary school teachers for both social and professional environments.	Time (D_t), cycle (D_c) and distance (D_d) doses.	D_c and D_d were higher in the kindergarten teachers in both environments. D_t, D_c and D_d were higher in the professional environment in both groups.
Misono et al (2015)[25]	Cross-Sectional/ The United States	Eleven healthy subjects and eleven subjects in vocal rest after vocal fold surgery.	Measure, through the vocal dosimeter, the adherence to the vocal rest recommendations.	Percentage of phonation	Diminishing of the percentage of phonation after vocal rest. In the healthy individuals, the percentage of phonation was associated to a self-perception of vocal use.

Author / year	Outlining/ Local	Sample	Objective	Vocal Dose	Conclusion
Gama et al (2015)(21)	Case Study/ Brazil	Five dysphonic teachers and five without vocal complaints.	Compare the vocal dose in teachers with dysphonia and teachers without alterations of the voice.	Percentage of phonation and cycle dose. (D_c)	Dysphonic teachers presented a higher time of phonation and cycle dose when compared to teachers without vocal alteration.
Schloneger, Hunter (2015)(23)	Cross-Sectional/ The United States	19 singing students.	Compare the values of vocal dose and acoustic measurements in different uses of the voice: choir singing, solo singing and singing voice.	Percentage of phonation and time (D_t), cycle (D_c) and distance (D_d) doses.	Higher values of vocal doses are related to higher vocal intensity, more vocal clarity and lower acoustic measurements of disturbance (jitter, shimmer e Harmonic Noise Ratio).
Mehta et al (2015)(15)	Longitudinal/ The United States	61 women with dysphonia were evaluated before and after vocal treatment (phonotherapy and/ or surgery) and compared to a group of 42 women without vocal alterations (control group)	Compare the values of vocal dose in women with dysphonia of behavioral origin with women with non behavioral dysphonia and women without voice alterations.	Percentage of phonation, cycle (D_c) and distance (D_d) doses.	Women with behavioral dysphonia (nodes and polyps) present higher values of vocal dose when compared to women with dysphonia without behavioral etiology. The measurements of the dose of the voice are more useful to analyze the vocal behavior than to aid in the clinical diagnosis.
Titze, Hunter (2015)(16)	Cross-Sectional/ The United States	57 teachers (45 women 12 men) were evaluated for two weeks.	Analyze the measurements of vocal dose in teachers and develop acoustic markers of vocal damage.	Time (D_t), cycle (D_c), distance (D_d), dissipated energy (D_e) doses.	The measurements of the cyclical (D_c), distance (D_d), dissipated energy (D_e) and radiated energy (D_r) doses have a correlation to the time of speech, the intensity of the voice and the variation of fundamental frequency. The authors propose a new acoustic measurement to identify risk of vocal damage (*equal-energy-dissipation*).
Van Stan et al (2015)(26)	Cross-Sectional/ The United States	35 women with behavioral dysphonia (nodes and polyps) were compared to a group of 35 women without vocal alterations. (control group)	Compare the values of vocal dose in women with behavioral dysphonia with those of women without alterations in the voice.	Percentage of phonation, cycle (D_c) and distance (D_d) doses.	Women with behavioral dysphonia do not present higher values of vocal dose when compared to women without dysphonia.

Figure 3. Categorization of the selected studies

The type of vocal dose most utilized in the studies was distance dose (86.7%), followed by cycle dose (80%) and time dose (46.7%).

The higher use of distance dose, described as the total distance travelled by the vocal folds in the cyclical path during vibration, in these studies[2,5,7,9-14] can be justified by the fact that it is derived from the vocal intensity, phonation time and fundamental frequency, that is, from the three vocal parameters measured by the dosimeter. The change caused in the glottis by the use of a more intense voice can contribute in a more effective way to the alteration in vocal quality than that caused only by a longer period of phonation. The clinical experience shows that patients with vocal nodes usually speak a lot and in a strong intensity, which can contribute to high doses of distance[9,15], percentage of phonation[15] and cycle dose[15].

The United States is the country which most published about vocal dose probably because the studies that developed and implemented the calculations of vocal doses[1,7,16] were performed by American research centers.

In the literature analyzed it was observed a major concern of the research with teachers vocal health, since most of them favored these professionals, probably due to the fact that they belong to the group that is most vulnerable to the occurrence of dysphonia[16-21]. Teachers have a great need of their phonatory function and one of the most common reasons of the fall in teaching quality and absenteeism is the compromising of their vocal capacity[10,17,22]. The second group of most studied voice professionals regarding vocal dose was the singers, which are also dependent of a good vocal production for professional practice[13,23].

Studies of prevalence reveal that the presence of dysphonia in teachers is two to three times more frequent than in the general population[19,24]. Dysphonia in this professional group presents itself associated with inadequate acoustics of the classroom, excessive background noise, individual health conditions, inadequate vocal habits and voice abuse[24].

The results in literature show that the growth of the vocal dose is connected to the excessive and prolonged use of the voice that occurs in teaching[5,9-14], the background noise[11], singing[14,23], increase in voice intensity[15], and the large frequency variation[15] and intensity in speech (speech with large prosodic variation)[7], and that factors such as vocal rest and the use of a vocal amplifier diminish the dose of the voice[9,14,25]. Literature also highlights that the increase in vocal dose is associated with a self-perception of vocal tiredness, mechanism that can be understood as a process of muscular fatigue due to the intense use of the voice[2].

Literature also suggests that the values of vocal dose are higher in dysphonic teachers when compared to teachers without vocal complaints[21]. A study reported that women with behavioral dysphonia do not present higher values of vocal dose when compared to women without dysphonia[26]. In dysphonic clinical conditions those of behavioral etiology (nodes and polyps) present higher vocal doses than other dysphonic conditions[15]. Future research is necessary to understand the real interference of professional and vocal behavioral aspects in the values of vocal dose.

The increase of vocal dose due to excessive and prolonged use of the voice in teaching was highlighted in the study that compared 10 minutes of vocal overload tests (reading of a text in an intensity above 80 dBNPS, measured 30cm far from the mouth) with 45 minutes of teaching, with no significant differences found between them, that is, the vocal dose of 10 minutes of test corresponds to the dose of approximately 45 minutes of class[10]. The distance dose in women in the vocal overload test was 771 meters and in teaching was 658 meters[10]. Such results suggest that teaching, even having more moments of rest that can be associated with muscular recovery, cause vocal overload.

Besides these, another research that showed higher vocal dose in teaching was the case study of two singing students and singing assistant teachers[12]. It was observed higher doses in the period of individual rehearsal (D_t= 44.84 and 28.30%) and music teaching (D_t= 25.35 and 29.45%), if compared to the period of rehearsal for the opera (D_t= 9.71 and 13.71%) and the period without rehearsal (D_t= 5.9 and 7.49%), even with the awareness of those professionals of the need for voice care. These results confirm the high risk for teachers of developing dysphonia, especially if it is associated with another type of voice use such as singing. In the case of dysphonic teachers, these present higher cycle doses and phonation percentages (D_c= 238.1 and 30.7%) than those of non dysphonic teachers (D_c= 188.8 e 23.9%)[21]. The accumulation of intense vocal activities (teaching and singing) generates an increase in vocal dose. In the comparison between music teachers and regular school teachers[14], the former presented higher values in the vocal parameters measured (D_d= 7001 and 3688 meters, respectively), which corroborates with the literature, which claims that music teachers can develop vocal problems more frequently than other teachers. Besides teaching long hours with few breaks for vocal rest, music teachers usually participate in extra rehearsals and singing performances[14]. Singing students present higher values of vocal dose in singing voice activities than in speaking voice activities[23]. Chronic vocal problems were found more frequently in music teachers, which suggests that singing regularly can increase the chance of developing a lesion of the vocal fold tissue[27].

In relation to the segments that the teacher teaches, kindergarten teachers presented higher vocal dose than those of elementary school ones, which suggests that there are more oscillatory cycles and longer distance travelled by the vocal folds in teachers that work with younger children[11]. This difference can be related to the need of a more constant speech to keep students attention. It is worth pointing out that kindergarten teachers use more didactic strategies of storytelling which require speech with higher prosodic variation for the interpreting of characters and theme songs. Literature shows that vocal strategies with higher prosodic variation[7] and singing[14] propitiate an increase in vocal dose.

The large variation in frequency and intensity of speech results in an increase of vocal dose. Participants were asked to read a text in three melodic variations: monotonous, normal and exaggerated (as if they were reading to capture the attention of small children) and the $D_{c,}$ D_d, D_r and D_e had higher values in the presence of larger prosodic variation[7]. Such result suggests that different prosodic variations modify the vocal dose, with higher values for emissions with larger melodic contour and intensity.

Another factor that showed association with the increase of vocal dose was the presence of background noise[11], and the increase of voice intensity[15]. The literature refers that the higher is the noise in the classroom with the students, the higher is the intensity of the teacher's voice[28]. This is called Lombard Effect, defined as an involuntary vocal response of the speaker to the presence of background noise. As the background noise increases the intensity of the voice also increases[29]. A study that evaluated the association between levels of background noise in kindergarten schools and vocal alterations in teachers observed that dysphonia was more prevalent in teaching institutions with more intense noise[30].

The increase of the vocal dose is also related to a self-perception of voice tiredness as pointed out in the study with singers, in which the symptom of vocal fatigue appeared after vocal use in higher doses, being that there was an improvement of these symptoms when these higher doses were preceded by 48 hours of vocal rest[2]. Vocal fatigue generally refers to voice tiredness following its prolonged use, which demands a higher effort to continue speaking. It can come together with changes in vocal quality, in the pitch, the loudness and laryngeal discomfort. In general, it occurs right after the abnormal use of vocal frequency, intensity and quality or after continuous speech for more than an hour[31]. Literature points out that, at the end of the working day, teachers refer to higher vocal tiredness[32].

The use of vocal amplification was one of the factors that indicated a decrease in vocal dose[9,13]. A case study, which evaluated music teachers, observed a decrease of the D_c (1.63 and 1.24 million respectively with and without vocal amplification) and of the D_d (7001 and 4053 million respectively with and without vocal amplification)[13]. Another case study with elementary school teachers found out that the use of vocal amplification decreased the D_d from 3058 meters to 2793 meters, with more positive effects on the teacher with dysphonia[9]. Such results support the findings in literature that point out that the use of vocal amplification protects teachers from vocal effort during the long hours of teaching, promoting a better use of the voice in the professional environment[33,34] and produces significant improvement of the perception of the teachers about the impact of their vocal limitations[34]. Besides, it improves the teachers vocal quality and diminishes the level of damage in the vocal fold tissue caused by the force of collision due to decreasing of the vibration dose[33,34].

Another factor associated with the decreasing of the dose of the voice is the vocal rest. A study found out that the vocal rest generated a 12% lowering of the percentage of phonation in the post-operation[25]. The vocal rest, along with hydration, are pointed out in literature as preventive measures of vocal fatigue[31], for they generate a lower subglottic air pressure (minimum pressure of expired air flux necessary to initiate the oscillation of the vocal fold) that can be perceived by the speaker as low respiratory and phonatory effort[32].

Teachers frequently speak in a strong intensity for long periods of time in noisy atmospheres and stressful situations[18,20,24], which makes them the professionals with the highest chance of developing vocal problems. However, there is a necessity to analyze the vocal dose of other professionals that use their voice as a working tool such as actors, telemarketing attendants, priests and pastors etc., so that preventive measures are taken, avoiding damage in their professional development. Studies with larger samples and consequently higher external validity are also important for the advance in the understanding of the results of the vocal dose in different communication situations.

The measurements of vocal dose allow us to quantify the exposure of the vocal fold tissue to vibration[1], and several measurements are currently available in literature[1,7]. Future research that analyzes the differences in the sensibilities and specificities of these measurements of vocal dose are important for a better definition of the value and the clinical application of these voice evaluations.

CONCLUSION

The types of doses found in literature were percentage of phonation, time dose, cycle dose, distance dose, radiated energy dose and dissipated energy dose.

The increase in the vocal dose is associated with the use of the voice in the teaching activity, especially amongst teachers that work with kindergarten and singing teachers. The high vocal doses correlate also to the presence of dysphonia, to a higher level of background noise, to a great prosodic variation in speech and to the self-perception of vocal fatigue. Patients with behavioral dysphonia (nodes and polyps) present higher vocal doses than patients with other dysphonic conditions. Factors such as voice rest and the use of vocal amplifiers indicate a diminishing of the dose of the voice.

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