The Effect of Surface Hydration on Teachers' Voice Quality: An Intervention Study

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Summary: Purpose. This study aimed to investigate the effects of surface hydration on teachers' voice quality.
Study Design. This is an examiner-blinded, pretest and posttest intervention study with a single group of subjects.
Method. Subjects were 27 teachers from a public-sector state school in Salvador, Bahia, Brazil. Pre- and post-intervention voice recordings were obtained. Voice samples collected underwent computerized acoustic analysis (*VoxMetria*) and perceptual analysis *via* the Consensus Auditory-Perceptual Evaluation of Voice. Intervention was conducted daily before teaching for a 4-week period, consisting of 5 minutes of nebulization with saline solution (NaCl 0.9%), after 10 minutes of dehydration breathing through the mouth.
Results. A reduction in the overall level of voice alteration was observed in the Consensus Auditory-Perceptual Evaluation of Voice, but with no statistical significance. The following were observed: an increase in the mean fundamental frequency of the vowel /a:/ ($P = 0.036$); a statistically significant reduction in the minimum intensity of connected speech ($P = 0.028$), in the median intensity of connected speech ($P = 0.014$), and in the maximum intensity of connected speech ($P = 0.007$). There was also a statistically significant reduction in the minimum ($P = 0.001$) and mean intensities of spontaneous speech ($P = 0.011$).
Conclusion. Surface hydration with saline solution led to an improvement in teachers' voice quality.
Key Words: Occupational health–Teachers–Voice disorders–Hydration of the vocal fold–Teaching.

INTRODUCTION

Teachers are part of a group of professionals who use their voice as their primary working tool.[1,2] These professionals are part of a high-risk category in terms of the development of voice problems and have the highest prevalence of dysphonia among professional voice users.[3–8]

In a study conducted on teachers and nonteachers in the United States, it was found that teachers, who have experienced multiple episodes of dysphonia, consistently attributed their voice symptoms to their occupation, as compared with nonteachers. Results also showed that teachers were significantly more predisposed to limitations in certain tasks (eg, difficulty projecting their voice, trouble speaking or singing softly, loss of singing range), thus reducing their activities or interaction, and changing professions owing to voice issues. Moreover, teachers were the professionals who were absent the most throughout the year during working days, because of dysphonia.[9]

Similar results were noted in a study conducted on teachers and nonteachers in Brazil. A significantly higher occurrence of voice symptoms was observed in teachers. Symptoms include hoarseness, vocal fatigue, difficulty in projecting the voice, discomfort when talking, monotonic voice, effort when speaking, dry throat, sore throat, coughing and vocal instability with tremor, difficulty swallowing, acid taste in the mouth, and difficulty with high-pitched singing, as well as more reports of voice alteration and the association of these symptoms with professional voice users.[10]

Dysphonia in this professional group is associated with common characteristics of this occupation, such as facing an intense and prolonged working day, conducted in noisy surroundings and under adverse vocal conditions.[6,11–15] Hoarseness, vocal fatigue when speaking, and laryngeal desiccation are the symptoms of work-related voice disorders most reported by teachers.[11,13]

A combination of environmental factors, systemic conditions, or illness may lead to laryngeal desiccation.[3,14] Vocal folds without adequate hydration may produce an onset of dysphonia and worsening of voice performance, because a reduction in fluid can create a sheet of viscous mucus that may potentially affect vocal fold vibration.[16–18]

Vocal fold hydration is maintained by fluid in several water compartments.[19] The hydration level may affect the stiffness and the viscosity of the vocal fold lamina propria.[20] Systemic hydration refers to fluid within the body and vocal fold tissue, whereas superficial or surface hydration is the fluid lining the vocal fold surface and laryngeal lumen.[19] Challenges to systemic and superficial vocal fold dehydration may compromise vocal quality and phonatory efficiency in vocally healthy subjects and in subjects with voice disorders.[21]

For this reason, professional voice users are often advised to increase hydration for the purpose of increasing vocal efficiency, reducing respiratory effort, and alleviating the symptoms and discomfort associated with laryngeal desiccation and viscous secretion. Recommendations include increasing water intake and improving environmental humidification or the inhalation of water vapor to prevent or treat excessive desiccation of the vocal folds.[16]

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There are no known studies specific to teachers that examined interventions involving only surface hydration of the larynx. The only studies found were solely on healthy women,[16,22] soprano singers,[23] and individuals with Sjogren syndrome.[24] In all of these intervention studies, the most satisfactory hydration response was observed with saline solution (NaCl 0.9%), despite its statistical insignificance. Therefore, the purpose of this study is to examine the effects of surface hydration using saline solution (NaCl 0.9%) on teachers' voice quality as a voice-protection strategy. The hypothesis is that this intervention will improve auditory-perceptual and acoustic vocal parameters in teachers.

METHOD

Design and population

This is an examiner-blinded, pretest and posttest intervention study with a single group of subjects. Twenty-seven teachers (15 women and 12 men; with average age of 44.9 years) from a public-sector education system school of Salvador, in Bahia State, Brazil, participated in this study between the months of September and November 2014.

The sample of subjects was randomly selected. All teachers employed at the school were invited to take part in the study. Teachers with or without self-reference of self-assessed dysphonia, who used their voice professionally solely within the professional context of teaching activities, were eligible for the study. The goal was to investigate the effect of surface hydration with saline solution (NaCl 0.9%) on teachers' vocal quality, regardless of the presence or absence of any vocal pathology.

Teachers with an upper respiratory infection on the days of the recordings were excluded from the study. Teachers older than 65 years of age, or currently undergoing speech therapy, or who did not take part in all the stages of the research were also excluded.

Thirty-six subjects accepted the invitation to take part in the study. However, only 27 subjects were used because of the following exclusion criteria: retirement or change of institution (two cases), health issues (two subjects), current enrollment in speech therapy (one subject), and failure to take part in all phases of the study (four subjects) (Figure 1).

This study was approved by the Research Ethics Committee of the State University of Feira de Santana (Portuguese: Universidade Estadual de Feira de Santana) as part of the Project "Teacher's Working Conditions and Health: Interventions to Construct Healthy Working Environments" under report No. 423.012 and compliant with ethical aspects in accordance with Resolution No. 466/12 of the National Council of Health (Conselho Nacional de Saúde).

Study phases

Informed consent form presentation

After the school board approved the consent form, the members of the team presented the project and invited the teachers during extracurricular activity time slots. Teachers' participation was voluntary. Those who agreed to participate received an envelope the following week containing two copies of the informed consent form and the self-reported questionnaire "Teacher's Working Conditions," which was developed by the authors for the present study.

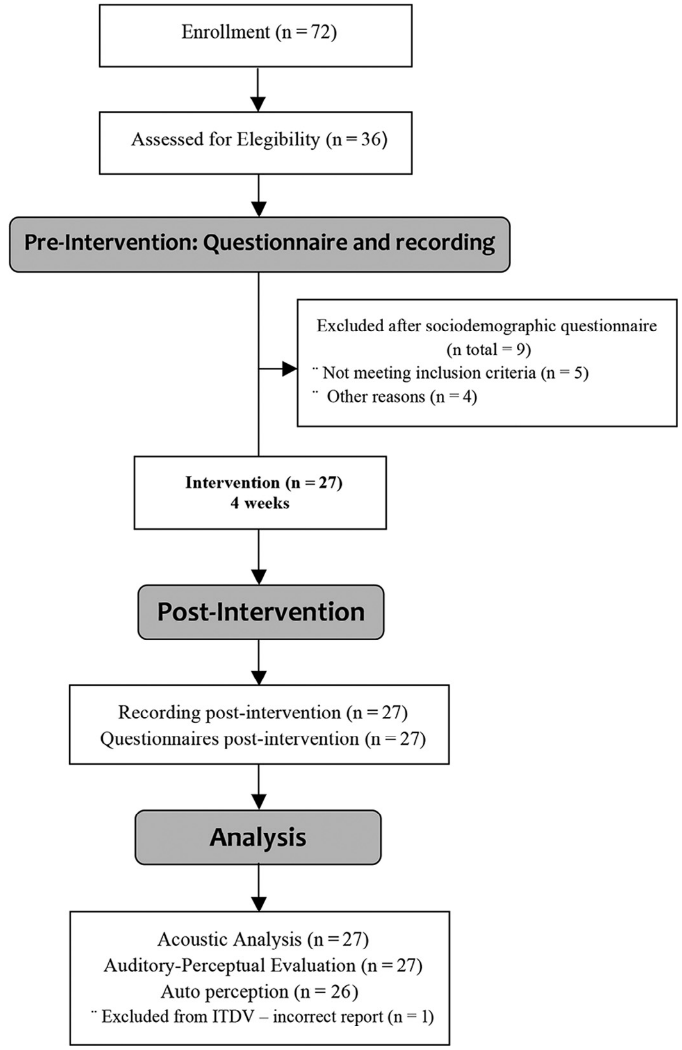

FIGURE 1. Flow diagram of the direct hydration intervention (NaCl 0.9%) in 27 teachers of a public-sector state school (Salvador, State of Bahia, 2014).

The self-reported questionnaire contained socio-demographic, functional status, working environment, work organization, habits and lifestyle questions, and a list of voice complaints. The results of the sample characterization were calculated and presented below as simple absolute frequencies.

Evaluation instruments and procedures

Voice recording. A voice recording was performed pre- and post intervention to compare the two voice samples obtained. A written form designed by the research team was used for the purpose of investigating the presence of any upper respiratory infections, in accordance with the respective exclusion and inclusion criteria.

Afterward, participants included in the study had voice samples recorded and saved on file using the CTS Informática (Pato

Branco, Paraná Brazil) *VoxMetria* program with sampling rate of 11.025 Hz, 16 bits, installed on a Dell (Dell Brasil, Eldorado do Sul, Brazil) Inspiron 14R 5437-A10 laptop computer, 64-bit MaxxAudio 4 sound card, in a properly calibrated compact OTOBEL, BEL-BABY2 audiometric cabin (Cruzeiro, Sao Paulo, Brazil).

Voices were captured using a Shure SM10A unidirectional headset microphone (Shure Incorporated, Niles, IL, USA), connected to a Shure X2u XLR preamplifier, set at a distance of 4 cm and an angle of 45° from the speaker's mouth. CTS Informática *VoxMetria* software recommended the use of a unidirectional microphone for the acoustic voice analysis.

For pre- and post-intervention voice recordings, the Consensus Auditory-Perceptual Evaluation of Voice (CAPE-V)[25] was used, consisting of the sustained phonation of the vowels /a:/ and /i:/; reading of five phonetically balanced phrases; response to the question "How is your voice today?"; and two sustained phonations of the vowel /Ɛ:/, one for the acoustic analysis and another for the maximum phonation time.

Teacher's voice quality evaluation parameters

Auditory-perceptual evaluation. The CAPE-V was used as an auditory-perceptual evaluation tool. This instrument was developed as a voice evaluation tool by speech-language pathologists of the American Speech-Language-Hearing Association,[25] with the primary objective to describe the severity of the auditory-perceptual attributes of voice deviation. Six preset parameters were evaluated: overall severity degree, roughness, breathiness, tension, pitch, and loudness, with the possibility of including two additional aspects, including an evaluation of resonance. The degree of deviation from the parameters is obtained using a visual analog scale, 100 mm in length (0–100 mm). The scale presents references to determine the degree of voice alteration: mild, moderate, and severe. A marking toward the left (0) indicates no vocal deviation and toward the right end (100), a severe vocal deviation. For the present study, only the overall severity degree parameter of the CAPE-V was analyzed[25] to investigate the general vocal alteration and not any specific vocal parameter.

Three voice-specialized speech-language pathologists, with clinical experience working with teachers, analyzed the voice samples. Voice samples were recorded on digital versatile disc. The evaluators were instructed to read the provided instructions and to listen immediately to the voice samples before the beginning of their evaluation. Subsequently, they were instructed to analyze each voice file, saved as individual computerized folders, and to complete the encoded protocol with the corresponding evaluation. The voice samples were randomized using the Research Randomizer program for blinded examiners in relation to pre- and posttest periods.

Intra- and inter-rater agreements were measured using the intraclass correlation coefficient (ICC), which is an estimate of the total variability fraction of readings, due to variations between the individuals, being set on a scale ranging from poor to excellent (ICC < 0.4 = poor; 0.4 ≤ ICC < 0.75 = satisfactory; ICC ≥ 0.75 = excellent). For the present study, 20% repetition was used. The most consistent examiner obtained the following result: ICC = 0.82; $P = 0.004$.

Acoustic analysis. The following acoustic vocal parameters were extracted during pre- and post-intervention from the voice samples generated during recording: fundamental frequency (F0), short-term disturbance measurements (jitter and shimmer), noise, glottal-to-noise excitation ratio (GNE), irregularity, and intensity of connected and spontaneous speech.

Jitter is defined as a short-term variability of F0. It expresses how a period is different from the previous or its immediate successor. High levels of jitter are typically associated with pathologic voices.[26]

Shimmer is a parameter that measures the short-term variation of waveform amplitude. It expresses how fast the amplitude changes in a sustained vowel. High shimmer levels are usually associated with pathologic voices.[26]

Noise corresponds to the aperiodic component of the signal.[26]

GNE is an acoustic measurement used to calculate the noise in a series of pulses produced by the oscillation of vocal folds. It is an acoustic parameter based on the assumption that pulses that resulted from the collision of the vocal folds generate a synchronous excitation of different frequency bands.[27]

Irregularity refers to the fluctuation of the voice over time, considering the instability frequency and intensity over time.[26]

According to the parameters set by the acoustic analysis program used in the present study—*VoxMetria 4.0* (CTS Informática)—the values considered normal were jitter (<0.60%), shimmer (<6.50%), noise (<2.5 dB), GNE (>0.50 dB), and irregularity (<4.75 dB).

Intervention

The research team received training *via* workshops to ensure procedures were homogeneous, and the teachers were monitored throughout the entire intervention period.

Before the procedure, all teachers had had contact beforehand with the equipment that was to be used, and were advised on the preparatory and sanitization procedures of the intervention.

During the intervention, teachers were subjected to mucous desiccation of the vocal tract *via* oral respiration for a 10-minute period, using a nasal clip to close the nostrils, according to the procedure recommended by Tanner et al.[22–25] This procedure was adopted to ensure that all subjects would have a homogenous base of vocal fold mucosa because we opted for the development of a real-life situation study without modifying any aspects of the subjects' work routine, such as environment and personal habits. Surface hydration consisted of the inhalation of 5 mL of saline solution (NaCl 0.9%) for a 5-minute period. The intervention was conducted every day over a 4-week period, using the NS Evolusonic ultrasonic nebulizer device (NS Indústria de Aparelhos Médicos LTDA, Vila Livieiro, São Paulo, Brazil). This device was provided to the teacher in the classroom, during his or her most vocally demanding shift, and used before the shift commencement. Each participant was provided in advance with his or her own nebulizer with an allotted code. All nebulizations were followed up and monitored by the research team.

Two nebulizations were planned for the teachers in the morning and afternoon shifts, and a single nebulization for those on the night shift. Accordingly, during daytime shifts (4 hours and 10 minutes total), the first inhalation was conducted before the teachers started their first class, and the second nebulization was conducted during their break, i.e. 2 hours after the first class. That's because 2 hours is the average time referred to in short-duration studies using surface hydration, for the prejudicial viscosity to the vibration of the vocal folds to return.[23] The night shift teachers underwent a single nebulization session before the beginning of their first class, because the workload in this shift was lower (2 hours and 20 minutes total with no break).

The subjects' voices were recorded twice: (1) 1 week before starting the nebulization procedures (pre intervention); (2) the week after finalizing the procedures (post intervention).

Data analysis

The differences between the pre- and the post-intervention values of the abovementioned variables were analyzed, observed, and discussed.

The *SPSS Statistics* 19.0 (IBM Corporation, New York, USA) for Windows software package was used for data storage and analysis.

In the analysis, the *t* test for paired samples was used for continuous variables that demonstrated normal distributions. The nonparametric Wilcoxon signed-rank test was used to analyze variables that demonstrated abnormal distributions. A statistical significance level of 5% ($P \leq 0.05$) was adopted for all tests.

RESULTS

Sample and working environment characterization

From the total number of teachers who took part in the study (n = 27), 15 were women and 12 were men, the average age was 44.9 years, and the average time of teaching was around 18 years. Average weekly working hours as a teacher amounted to 33.6 hours, including 28.5 in the school where the intervention was conducted.

In terms of the organizational aspects of the work, 33.3% of the participants reported that the institution at which they taught was a stressful environment, with unfavorable acoustics (70.4%) and noisy rooms (78.8%), with an average of 39.6 students per class.

It was also observed that 55.6% of the teachers reported consuming some form of alcoholic beverage; 18.5% were former smokers; 74.1% stated they had to raise their voice during classes and 32% stated they shouted while teaching; 51.9% reported they normally drank water when teaching, consuming, on average, 6.3 cups of water a day. It was also observed that 70.4% did not report having voice alterations, and 11.1% reported they had already been on work leave because of voice alterations.

Consensus Auditory-Perceptual Evaluation of Voice

A reduction in overall severity (CAPE-V) was noted among subjects (pre: 29.0 and post: 22.0). However, the differences were not statistically significant ($P = 0.171$) (Table 1).

Acoustic evaluation

Pre- and post-intervention comparisons demonstrated a statistically reduction of five parameters of speech intensity and in the mean F0 of the vowel /a:/ during acoustic evaluations ($P \leq 0.05$) (Table 1).

Measurements of jitter, shimmer, noise, GNE, and irregularity were within normal limits pre- and post intervention.

TABLE 1.
Comparison of Auditory-Perceptual Evaluation and Pre- and Post-intervention Acoustic Parameters in 27 Teachers of a Public-sector State School (Salvador, State of Bahia, 2014)§,‖

Variable	Mean/Median		Mean	Std.	
n = 27	Pre	Post	Difference	Deviation	*P* Value*
CAPE-V	29	22	—	—	0,171‡
Mean F0 /a:/ (Hz)	157,38	163,33	–5,95	13,97	0,036†
Mean F0 /Ɛ:/ (Hz)	165,48	172,30	–6,82	20,33	0,093†
Mean F0 /i:/ (Hz)	174,44	181,30	–6,86	18,75	0,068†
Mean intensity /a:/ (dB)	68,61	66,26	2,35	15,18	0,103†
Mean intensity /i:/ (dB)	64,70	62,72	—	—	0,199‡
Minimum intensity of connected speech (dB)	22,09	21,03	—	—	0,028‡
Mean intensity of connected speech (dB)	55,39	52,42	2,97	5,87	0,014†
Maximum intensity of connected speech (dB)	81,52	78,43	3,08	5,43	0,007†
Minimum intensity of spontaneous speech (dB)	23,56	19,60	3,95	5,74	0,001†
Mean intensity of spontaneous speech (dB)	55,32	52,66	2,66	5,02	0,011†
Maximum intensity of spontaneous speech (dB)	79,49	74,43	5,05	13,83	0,069†
Jitter (%)	0,180	0,120	—	—	0,604‡
Shimmer (%)	3,360	3,070	—	—	0,836‡
GNE (dB)	0,910	0,920	—	—	0,616‡
Noise (dB)	0,610	0,570	—	—	0,668‡
Irregularity (dB)	3,74	3,69	0,045	0,908	0,795†

* $P \leq 0,05$.
† *T* test;
‡ Wilcoxon signed-rank test.
§ Negative mean (–), elevation of the value in the post-intervention time; positive average = decreased value in the post-intervention time.
‖ 30% of the variables were double checked statistically.

Nevertheless, a decrease in the abovementioned parameters was observed, with the exception of the GNE.

DISCUSSION

Auditory-perceptual evaluation

The overall level of voice alteration of the subjects, as measured by the overall severity parameter of the CAPE-V scale, was not significantly different pre- and post intervention, despite a reduction of the CAPE-V score.

In a study[28] performed to verify the effects of hydration in individuals with vocal nodules and polyps, blind auditory-perceptual evaluations were conducted, adopting a five-point scale. The pre-hydration group classified their voice as moderately altered based on overall results, increasing only slightly in the post-hydration group. As such, this result demonstrated an improvement in voice quality of the subjects, although with no statistical significance ($P = 0.100$). The results of this study corroborate the study herein, because a reduction in the overall CAPE-V score was observed, despite no statistical significance. From a descriptive classification standpoint, the subjects of this study improved to a mild level of voice alteration.

In interventions with karaoke singers, in which the voice quality of the group of subjects who underwent hydration and vocal rest was evaluated, no statistically significant differences were observed between the groups, despite a decrease in the level of hoarseness occurring in the group that underwent hydration and vocal rest. The examiners measured only the levels of hoarseness and breathiness of the voice samples of the participants, using two separate 10-cm long scroll bars on a 38-cm computer screen. Markings on the right end classify dysphonia as "accentuated," and markings on the left end classify dysphonia as "merely notable." The authors inferred that this procedure of voice evaluation was not sensitive enough to detect the slightest changes in the score of the voice quality of the groups that tested below two points on the 10-point scale throughout the entire intervention.[29]

This situation was similar to that encountered in the study herein. The small number of participants in these interventions likely did not enable a statistically significant result to be observed. In addition to this, the examiners may have encountered problems using the analogic scale, which may have interfered with the results. Despite this, auditory-perceptual voice evaluation through continuous variable is still regarded as more sensitive to subtle voice changes than through discreet variables.

Acoustic voice evaluation

Increase in fundamental frequencies was observed, with statistical significance in the means of the vowel /a:/. In pre- and posttest intervention studies, positive differences were detected in vibratory characteristics following surface and indirect hydration of the larynx.[30] These studies were conducted with no control group and on six male voice professionals, for the purpose of evaluating modifications in the vibration of the mucosal wave of the vocal folds through videokymography. A reduction in the open phase-closed phase time coefficient during post-hydration was noted in 83% of the participants, and an increase was observed in the F0 in 60% of the subjects. The latter result was conducive with the results encountered herein.

In *in vitro* interventions with four excised larynges of dogs and *in vivo* with euphonic individuals, a change in the viscosity of the vocal folds that affected the phonation threshold pressure (PTP)—the minimum lung pressure required to start the vibration of the vocal folds—was observed. It was observed that the greater the hydration, the lower the viscosity, the greater the extent of the vocal fold oscillation, and the lower the PTP.[31–33]

An increase in viscosity of the vocal folds slows down the velocity of the vibratory cycles, resulting in a loss of harmonic movements of the mucous membrane.[34] Vibratory irregularities of the mucus, in turn, generate adventitious noises, and predominantly low, aperiodic sounds[35]; this is common in laryngeal desiccation or laryngeal dehydration, in which an increase of the viscous mucus occurs, contributing to a worsening in voice performance.[36]

Thus, it is suggested that the observed increase in the mean of the F0 can be considered a positive finding. Although small (6 Hz), the frequency increase was possibly generated by the reduction of the viscosity of the vocal folds. In turn, the vocal folds might have become lighter, vibrating slightly quicker, resulting accordingly in a slightly higher F0. Randomized clinical trials[22–24] pointed that hydration increased the optimization of the biomechanical characteristics of the vocal folds, increasing the efficiency of their oscillation.

It is known that people typically have lower F0s in the morning because of the physiological swelling of the vocal fold. Therefore, because the subjects did not warm up their voices to not confound the results, the increase of F0 parameters could be attributed to the natural use of the voice throughout the day. However, teachers who worked both morning and evening shifts performed the procedures. As such, this may suggest that the surface hydration might have influenced the increase in F0 more than typical morning vocal fold swelling.

Some reductions in intensity parameters were statistically significant following intervention.

Increased voice intensity is directly proportional to subglottic pressure, glottal resistance, and airflow. As such, the higher the co-optation of the vocal folds and air speed originating from the lungs, the higher the intensity.[32,35]

It is known that the presence of environmental noise in the classroom, frequently mentioned by teachers, is an adverse environmental condition for teaching and a variable that is closely associated with work-related voice disorder. This is because of the fact that teachers often need to speak at a higher vocal intensity in noisy and stressful environments, for long periods of time, with little time for rest and voice recuperation.[12] This condition leads to voice fatigue and may contribute to the onset of laryngeal complications.[10,37]

In studies on laryngeal hydration for the purpose of analyzing its relation on the PTP[32,38] and phonation effort,[32,33,38] it was observed that PTP and phonation effort tend to increase under conditions of little hydration and prolonged phonation with a high intensity, primarily at elevated pitches[32,33,38] (aspects present daily in the work of the teaching profession).

Thus, the lowering of the vocal intensity of the subjects in the present study, whom, in their vast majority (74.1%), had already indicated having the habit of speaking at a high intensity level, was demonstrated to be another positive result of hydration using saline solution (NaCl 0.9%). This result probably occurred because of the reduced viscosity of the mucus of the teachers' vocal folds, which led to a reduction in glottal resistance and phonatory effort. The finding may be relevant primarily because of the fact that the effect was shown to be statistically significant in the vocal parameter (ie, intensity) that influences most the development of vocal nodules—the pathology most commonly found in teachers, especially among women.[3,14,17,18]

Therefore, the study herein ratifies the beneficial properties of the intervention conducted by Verdolini-Marston et al,[28] which concluded that hydration procedures are regarded as important in the prevention and treatment of dysphonia caused by vocal nodules.

In relation to jitter, shimmer, noise, and irregularity, an overall decrease in these parameters was found following surface hydration, with no statistical significance, but with scores within normal limits.

Jitter alteration in normal voices may indicate a minor variation in the distribution of the mucus on the vocal folds[39] and it may be considered a possible predictor of the appropriate level of vocal hydration.[29]

Hence, it is suggested that surface hydration led to a more homogenous distribution over the vocal folds of the individuals, as it promoted a reduction in the viscosity of the mucus of the vocal folds.

In the randomized clinical trial with karaoke singers, a significant increase in jitter was observed in the male group that did not undergo hydration and vocal rest ($P = 0.02$). Thus, the authors suggested that hydration and vocal rest might be useful strategies for preserving voice quality and function, reducing the effects of voice fatigue. They also pointed out that jitter sensitivity might also be useful in revealing the effect of voice fatigue in future studies.[29]

In relation to shimmer and GNE, the same tendency was observed. Once again, this may be attributed to the reduction in the viscosity of the mucus and improvement in vibratory conditions of the vocal folds and increase of the harmonic component of the voice samples of the teachers.

An intervention study conducted on 19 university students with no voice complaints observed that systematic hydration had a statistically significant positive impact on voice performance.[39] There was a statistically significant reduction in shimmer and jitter in comparison with pre- and post-intervention periods.

In a clinical trial[28] that evaluated the effectiveness of hydration treatments in common voice disorders in the clinic, a statistically significant reduction in the mean of jitter and shimmer parameters and an increase in the signal-noise proportion were observed following hydration, in addition to the reduction in the PTP. Thus, such results corroborated the results of the intervention conducted, once again ratifying the presence of vocal benefits arising from laryngeal hydration, whether superficial, indirect, or combined.[22–24,29–33]

The study herein presented some limitations that must be taken into account when analyzing the results obtained. The primary limitation refers to the reduced number of participants, which may contribute toward a type-II error—false negative. This fact may result in two important limitations: (1) the group studied may not represent the characteristics of the group of teachers, limiting the generalization of the study; (2) the small number has an impact on the evaluation of statistical significance, as the sample size interferes with this analysis.

Another limitation arises from the absence of a control group to reduce bias and allow for a series of situations or conditions to be controlled, enabling more in-depth analysis of the effect under investigation. The fact that the study occurred under day-to-day conditions, on one hand, may have reduced the possibility of control over the situation studied, but on the other hand, it may have had benefits associated to it. As the study was conducted under actual conditions, in situations of routine working activities, it may have therefore provided more comprehensive information that reflects more realistically the lives of teachers. Note that evaluating interventions under real-life conditions is a characteristic that differentiates this study from most of other referenced intervention studies, as it includes new aspects for analyzing the procedure under investigation.

In addition, in-depth parameters such as PTP analysis were not used in this study for an evaluation of laryngeal hydration. Rather, the parameters assessed were auditory-perceptual and acoustic analyses. This fact reduced the possibilities of a more in-depth comparison and discussion with other studies that have evaluated hydration and the voice.

Despite the aforementioned limitations, important improvements have been obtained from the outcomes analyzed.

Accordingly, data suggest that surface hydration with saline solution (NaCl, 0.9%) may render positive effects on the voice quality of teachers, as it did in studies conducted with healthy women, singers, and people with chronic laryngeal desiccation. The purpose of these studies was to examine the effects of nebulization treatments using substances with different osmotic properties, and the results indicated that nebulization with an isotonic saline solution (saline solution, NaCl, 0.9%) was shown to be potentially more advantageous than hypotonic and hypertonic solutions.[22–24] Tanner et al suggest that saline solution may facilitate short-term laryngeal hydration without altering the ionic balance maintained by the system and by the hydration mechanism of the surface tissues in healthy individuals.[22] This is to say that it does not unbalance the reserves of electrolytes in the region of the laryngeal lumen.

CONCLUSION

The conclusion is that the findings of this study reinforce the hypothesis of the protective effect of hydration in teachers' voices. Even without observing statistically significant changes in all of the parameters analyzed, a general trend was noted toward the improvement in voice characteristics. Hence, it is suggested that studies on speech-language pathology with surface long-term hydration should be conducted on larger populations of teachers and in other schools, to confirm the results obtained in this study. We also recommend setting up a control group and adopting a randomized criterion for participant selection.

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