Protective Strategies Against Dysphonia in Teachers: Preliminary Results Comparing Voice Amplification and 0.9% NaCl Nebulization

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Summary: Objective. This study aimed to compare the effects of two protective strategies, voice amplification (VA) and 0.9% NaCl nebulization (NEB), on teachers' voice in the work setting.

Methods. An interventional evaluator-blind study was conducted, assigning 53 teachers from two public high schools to one of the two protective strategy groups (VA or NEB). Vocal function was assessed in a sound-treated booth before and after a 4-week period. Assessment included the severity of voice impairment (Consensus Auditory-Perceptual Evaluation of Voice [CAPE-V]), acoustic analysis of fundamental frequency (f0), sound pressure level (SPL), jitter, shimmer, glottal-to-noise excitation ratio (GNE), noise (*VoxMetria*), and the self-rated Screening Index for Voice Disorder (SIVD). Data were statistically analyzed using *SPSS Statistics* (version 22) with a significance level of $P \leq 0.05$. Effect size was calculated using Cohen's d coefficient.

Results. There were no statistical differences between groups at baseline in terms of age, sex, time of teaching, teaching workload, and voice outcomes, except for SPL. During postintervention between groups, NEB displayed lower SIVD scores (VA = 3; NEB = 0; $P = 0.018$) and VA had lower acoustic irregularity (VA = 3.19; NEB = 3.69; $P = 0.027$), with moderate to large effect size. Postintervention within-groups decreased CAPE-V for VA (pretest = 31.97; posttest = 28.24; $P = 0.021$) and SIVD for NEB (pretest = 3; posttest = 0; $P = 0.001$). SPL decreased in both groups, NEB decreased in men only, and VA decreased in both men and women. NEB increased f0 for female participants ($P \leq 0.001$).

Conclusion. Both VA and NEB may help mitigate dysphonia in different pathways, being potential interventions for protecting teachers' voices in the work setting. An ongoing study with a control group will further support these preliminary results.

Key Words: Occupational health–Voice quality–Voice training–Vocal loading–Faculty.

INTRODUCTION

Teachers exhibit a high prevalence of voice disorders,[1–4] two to three times more than the general population,[5] with an incidence rate of 3.87 new cases out of 1000 teachers per year.[6] Voice disorders are often associated with unfavorable work conditions[5,7–16] as well as individual factors such as sex, age, and family history of dysphonia.[1] The most significant work-related risk factors include high levels of noise in classrooms, habitual use of a loud speaking voice, and being a physical education instructor.[16] Prolonged voice use combined with unfavorable work conditions is defined by Vilkman[17] as "vocal loading." This combination can affect the voice by increasing fundamental frequency (f0)[17–19] and sound pressure level (SPL),[17–19] especially in noisy classrooms,[19] causing potential "impairment of vocal function."[17] The intensive and continuous use of voice in the work setting associated with unfavorable environmental conditions is responsible for a vicious vocal cycle that may further worsen vocal quality and may result in hyperfunctional phonotraumatic lesions such as nodules and polyps,[20] which are the most prevalent laryngeal lesions in teachers.[5]

Teachers require protective strategies for their voices because of their exposure to vocal loading. Interventions like voice amplification (VA)[21–27] and nebulized agents[28–30] have already demonstrated positive effects on voice quality and can also be used for protecting teachers' voice in the work setting.

The main goal of VA is to decrease vocal loading.[21] Increasing the output signal of the amplifier may reduce laryngeal overload because vocal effort is reduced when speaking at a comfortable pitch and loudness.[22] Bovo et al[27] described two most used VA systems: sound-field frequency modulation and portable personal voice amplifiers. Portable voice amplifiers were used in this study because of their ease of acquisition and use, as well as their low cost.

Hydration[31,32] is one of the most widely used techniques for preventive and therapeutic application. "Moisturizing" the vocal folds may reduce effort during phonation, protect vocal folds from harm, and contribute to reversing a voice disorder.[31] Dehydration of the vocal folds might produce harmful effects on voice because of dryness, increased viscosity, and vocal effort. In opposition, hydration can improve laryngeal biomechanical properties.[32] Verdolini[31] has defined three approaches to hydration: (1) large amount of water intake (also called "systemic hydration"[32–35]); (2) moistening the vocal fold surface by direct steam inhalation or hot water vaporization (also called "superficial hydration"[32] or "vocal fold surface hydration"[36]) through

Accepted for publication April 19, 2017.

This article was presented as a poster at the joint meeting of the Voice Foundation's 45th Annual Symposium: Care of the Professional Voice, Philadelphia, PA, June 2, 2016.

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Journal of Voice, Vol. ■■, No. ■■, pp. ■■-■■

0892-1997

http://dx.doi.org/10.1016/j.jvoice.2017.04.013

nebulized agents (water or saline solutions[28,29,37]) and (3) taking medicines that fluidify bodily secretions. Combined approaches are another method to simulate, for instance, a dry and wet hydration condition, using a dehumidifier or vaporizer combined with decongestant or mucolytic.[38] Nebulization (NEB) with isotonic saline solution (NaCl 0.9%) was used in this research as previous studies have demonstrated optimal outcome.[28–30]

The current study aims to compare the effects of two strategies in protecting teachers' voices in the work setting: VA and NaCl 0.9% NEB. In addition, the estimation of effect size was performed to verify whether one intervention was superior to another. The hypothesis is that both strategies are likely to protect the voice in the work setting. Measurements to demonstrate this hypothesis include improvements in the following vocal parameters: auditory-perceptual scores of Consensus Auditory-Perceptual Evaluation of Voice (CAPE-V), Screening Index for Voice Disorder (SIVD) self-perception scores, f0, SPL, jitter, shimmer, irregularity, noise, and glottal-to-noise excitation ratio (GNE). As this is a preliminary study, the authors would like to understand the potential they have for being a testable intervention in a future investigation.

METHODS

Design and participants

This is an interventional evaluator-blind design study with two groups of teachers assigned to one of the two protective strategy groups: VA or NEB. The interventions took place during 4 weeks, based on the research by Stemple et al.[39]

All teachers from one of two Brazilian public high schools in Salvador, Bahia, were invited to participate in the research. Ninety-five teachers filled out the questionnaire and a total of 53 teachers (20 men, 33 women) agreed to join the interventions. VA (n = 26, eight men, 18 women) took place at one school from July 2014 to October 2014, and NEB (n = 27, 12 men, 15 women) was performed at another school between September 2014 and November 2014. It is important to highlight that Salvador, Bahia, Brazil, is a tropical city with a high level of humidity at 80% all year long (±1.7).[40] Thus, humidity is a stable variable that does not require control in this case.

Inclusion and exclusion criteria

The inclusion criteria were to have professional voice use solely for teaching and lecturing at least 20 hours per week. Exclusion criteria were experiencing a cold or upper respiratory infection on the days of the recordings, voice therapy simultaneous with the intervention, age over 65 years old, and not taking part in all the stages of the research. The criteria were broad enough to include most of the teachers in the working setting.

Ethical aspects

This study received authorization from the school board and was approved by the Research Ethics Committee of the State University of Feira de Santana (Universidade Estadual de Feira de Santana) as part of the project "Teachers' Working Conditions and Health: Interventions to Build Healthy Working Environments" under report No. 423.012. It is in accordance with ethical principles established on the Resolution no. 466/12 of the National Council of Health (Conselho Nacional de Saúde), Belmont Report, and Helsinki Declaration.

Instruments and procedures

Questionnaire

After signing the informed consent, teachers received a self-assessment, semi-structured questionnaire, which has been applied for investigating teachers' work conditions. The questionnaire consisted of questions related to socioeconomic status, teachers' working conditions, functional status, working environment, work organization, habits, lifestyle, and health status (presence of voice, musculoskeletal, or mental disorders). Age, gender, time of teaching (years), and teaching workload (hours per week) were included in this analysis.

SIVD self-assessment protocol

The SIVD served for self-assessment analysis. The SIVD[41] is a validated Likert scale based on the most common vocal symptoms in teachers. The scale has a good correlation with the Voice Handicap Index,[42] especially in terms of sensitivity. Moreover, it is easy, quick to manage, and very useful in the occupational context. The SIVD covers 12 symptoms: hoarseness, voice loss, voice breaks, low-pitched voice, phlegm, dry cough, cough with secretion, pain when speaking, pain when swallowing, secretion or phlegm in the throat, dry throat, and strained speech. The participants filled out how often they experience each symptom: "never," "sometimes," "almost always," or "always," before and after the 4-week intervention. Each "almost always" or "always" answer was given a score of 1 point. The total score was calculated by summing the points obtained. Values ≥5 suggest likelihood of a voice disorder.[41]

Audio recording

Participants' voice samples were recorded on a Dell Inspiron 14R 5437-A10 laptop (Dell Inc., Round Rock, TX) with an Intel Core i5 1.60 GHz processor and a 64-bit MAXXAudio4 sound card. They were seated in an approved-calibration certificate compact (0.90 m × 0.90 m × 1.70 m) sound-treated booth (OTOBEL, model BEL-BABY2, Cruzeiro, São Paulo, Brazil). The average internal noise measured was 22.74 dB for the 50–8000 Hz frequency range. As the signal-to-noise ratio was higher than 30 dB (32.03 dB), it was possible to get valid results for acoustic analysis, especially perturbation measures and relative SPL.[43] Voice samples were captured by a Shure (Niles, IL) unidirectional head-mounted microphone (model SM10A) connected to a Shure X2U XLR preamplifier, and set at 4 cm from the speaker's mouth at an angle of 45°, according to instructions provided by the manufacturer of *VoxMetria* software (Pato Branco, Paraná, Brazil) with a 11,025 Hz sampling rate for connected and running speech and 44,100 Hz for vowel analysis. Teachers were instructed to use a comfortable loudness and pitch during the recorded vocal tasks, following the CAPE-V protocol. Teachers were recorded in the beginning of their shift (morning or evening). Posttest recordings were made at about the same time and day of the week as the pretest recordings.