Effectiveness of a short voice training program for teachers: changes in acoustics and in self-perception.

Authors: Juana Muñoz [1], Andrés Catena[2], Alicia Montes[3], Mª Elena Castillo[4]

[1] Department of Personality, Evaluation and Psychological Treatment, University of Granada (Spain)

[2] Mind, Brain and Behavior Research Center (CIMCYC), University of Granada (Spain)

[3] Center for Teachers (CEP), Granada (Spain)

[4] Phoniatrics and Speech Medical Center, Granada (Spain)

Correspondence to. Juana Muñoz López.

Facultad de Psicología. Departamento de Personalidad, Evaluación y Tratamiento Psicológico. Campus Universitario de Cartuja s/nº. 18071. Granada, España.

Electronic address: **jmunoz@ugr.es**.

Summary: ***Background***. Using their voices in inappropriate working conditions causes teachers to misuse their voices, because in order to be heard they need to force their voices.

Objetive*:* This paper examines the effects of a short-term voice training program aimed at teachers.

Methods: The pre- and post-training evaluations consisted of acoustic, aerodynamic and subjective measurements (VHI-10).

Results: The findings indicate that the voice performance of teachers improves after 25 hours of training. Specifically, significant changes are observed at the acoustic level, in fundamental frequency (Fo) and in frequency perturbation measures (Jitter, PPQ), as well as in subjective voice assessment using the Voice Handicap Index (VHI-10), in both the physical subscale (VHI P) and the total score (VHI T).

Conclusions: This study confirms the effectiveness of the training program and discusses the most sensitive measures for evaluating the short-term effect of the change.
Key Words: Voice training, teacher, acoustic measurements, aerodynamic measures, Voice Handicap Index.

INTRODUCTION

Various studies have shown that voice problems are more prevalent in teachers (57.7%) than in persons of other occupations (28.8 %)[1-3]. However, the scientific literature contains conflicting data regarding the prevalence of voice abnormalities, possibly because there is no commonly-accepted definition of this term[4,5]. Furthermore, the data on prevalence in teachers varies depending on the number of class hours, the individual's specific characteristics, the type of teaching, the number of students, the acoustic conditions, etc.[6-8]

Using their voices in inappropriate working conditions (high number of students or unsuitable acoustics, for example) causes teachers to misuse their voices, because in order to be heard they need to force their voices. This results in an increase in muscular tension and subglottic pressure during voice production, heightening the collision force of the vocal cords and producing a greater load in the biomechanism of the vocal fold tissue[9]. The result is often a vicious circle that leads to vocal trauma[10]. Furthermore, emotional factors and stress can increase the muscular tension of the larynx, giving rise to or exacerbating voice problems.[11,12]

Generally speaking, the kinds of voice alterations that teachers experience tend to be preceded by long-term non-organic voice disorders that, if left untreated, can lead to larynx lesions such as polyps, nodules, edemas, etc.[13], with the resulting professional and emotional impact[14] in addition to the economic costs associated with teachers who need to take sick leave. Some teachers have relapses and their professional activity is again interrupted as a result of their voice problems, and some are even forced to change profession.[15]

In contrast, the use of a healthy voice is an effective communication tool in the classroom, raising the teacher's self-esteem and improving the individual's perception of his

or her vocal and professional quality. This will lead to better general health and will reduce the personal, social and economic consequences of voice problems[16].

Despite the foregoing data, which points to the existence of a serious problem, official voice training programs (voice hygiene, vocal technique, etc.) are still rarely made available to future teachers during their training[1,2,17-20] and even more rarely are they offered to teachers already exercising their profession. In consequence, some of them turn to voice training courses offered outside of their academic or professional setting, for which there is no data regarding effectiveness (pre- and post-training assessment, follow-up, etc).

Moreover, in the scientific literature few studies look at the application of short-term voice training programs for teachers or future teachers [21-23] and most of the studies that do so primarily seek to determine the effect of different voice therapy programs on various voice pathologies.

A further complication is that in the literature the terms “voice training” and “voice therapy” tend to be used interchangeably, since similar methodologies are used in both cases. However, according to Hazlett, Duffy, and Moorhead[24], the term “voice training” refers to strategies aimed at preventing voice disorders and improving vocal health. The term “voice therapy” is preferred for programs designed to treat various voice pathologies.

Voice training programs for persons who use their voice professionally (teachers, operators, radio/TV commentators, etc.) employ a wide array of methodologies. Some of the programs use exclusively direct training, which is based on vocal technique exercises and focuses on achieving an effective use of the voice. Other programs are based on indirect training, which consists of informing participants of a series of voice hygiene guidelines that

will help them take care of their sound-producing apparatus. Finally, in still other voice training programs, a combination of both direct and indirect techniques is used. [21,25]

The results obtained from studies using these methodologies vary considerably. Some studies have indicated that the most effective method is direct training, [21,25] since it brings improvements in voice parameters and therefore in voice quality. However, other studies find that the opposite is true, i.e. that indirect training has better results following the intervention.[26]

There is also great variability in the length of the programs, generally depending on the objectives of each study [27,28]. In fact, the ideal length of training programs has not yet been studied.

All of this is compounded by the non-existence of standardized evaluation protocols in voice research literature[29] and it is rare to find studies that use the same measurement tools. In short, all of these methodological aspects make it very difficult to compare studies[24].

With these considerations in mind, this study examines the effect of a 25-hour voice training program for teaching professionals. The study's main objective is to help teachers to use their voice functionally and comfortably, which entails:

a) A change in acoustic and aerodynamic parameters and also in their physiological correlates.
b) A change in the self-perception of vocal capacity resulting from improved use of the voice, as evaluated with VHI-10. A topic that is increasingly being considered important when assessing the effectiveness of voice training programs is the self-perception of vocal well-being by the participant.[30,31]

c) The evaluation tools used in this course will help determine whether they are sensitive in assessing the effectiveness of short-term voice training programs.

METHODS

Subjects

Participating in the study were 116 teachers (85 women) aged between 25 and 55 years (average age 40.6 and standard deviation 7.8). All of the participants work as teachers at the pre-school, elementary or secondary school level, in various public schools in Granada, Spain and they have an average teaching experience of 14.7 years (SD = 7.9 years). They teach 5 hours of class every day (25 hours/week) in classes with 25 students. The participants signed up as volunteers for our course, which was called "vocal training for teachers" and was offered by the Center for Teachers in Granada, a division of the Andalusian Ministry of Education, Culture and Sports. The purpose of the center is to provide teachers with complementary training on a variety of topics, including the occupational health of teachers. The center's activities are free of charge and participation is voluntary. Given the potential benefits of the program used in this study, a restricted random assignment process was used to create groups in such a way that the experimental group included as many participants as possible without reducing its statistical power, while maintaining the proportionality of the sexes in the total sample. This criterion led to an experimental group of 94 teachers and a control group of 22.

Experimental group: comprised of 94 teachers (69 women) who take the full 25-hour course over a period of 8 weeks. The hours dedicated to each activity were as follows: lecture

(1 hour), posture education workshop based on the Alexander Technique (6 hours), mindfulness/stress-control workshop (6 hours), voice training and vocal hygiene education (12 hours).

Control group: comprised of 22 teachers (16 women) who do not participate in the "vocal training for teachers" course. However, when our study ended they were invited to take the course the next time it was offered.

Vocal training program

The activities programmed in the "vocal training for teachers" course were taught by professionals with expertise in the different subjects covered. The specific content was as follows:

a) Lecture on the mechanisms involved in phonation, vocal parameters (tone, intensity, timbre) and their physiological correlates, the genesis of voice pathologies, vocal hygiene education. Different methods were used to illustrate the content (videos, animations, software, etc.).

   At the end of the lecture all participants received a handout containing a vocal hygiene program that synthesized the guidelines appearing in most programs proposed in the literature.[32-40] All participants were encouraged to follow these guidelines in their everyday activity.

b) The Alexander Technique for posture education. This part of the program works with the body to obtain maximum naturalness and ease in voice production.[41] The basis of the Alexander Technique is the postural relationship between the head, the neck and the shoulders, an aspect that has immediate repercussions on the state of the larynx and the

breathing apparatus and is also the essential factor in the coordination of the entire body.[42,43] Two sessions are held, the first in groups of 30 participants and the second in groups of 15 participants.

c) Mindfulness. This part of the program uses guided meditation. The idea is to help teachers become familiar with the physical and psychological effects of stress[44] and to help them pay closer attention, minute by minute, to the thoughts, emotions, body sensations and the surroundings that play a role in their voice being functional or not. The workshop is comprised of two sessions, with groups of 30 participants.

d) Vocal training and voice hygiene. This part of the program takes place in smaller groups, with 15 participants. The sessions are taught jointly by a speech-language pathologist and a singing instructor, both experts in the field of voice, who are fully trained and qualified to conduct the training sessions. These professionals do not participate in the pre- or post-training assessments. The training takes place in four sessions, each lasting 3 hours. After each session, the participants are given activities to be practiced at home during the week and they are reminded of the importance of following the voice hygiene guidelines discussed at the beginning of the course.

Vocal training exercises*:* To design the vocal training part of the program we turned to the techniques traditionally used in clinical practice. [32, 34, 36, 45-48] Attention was given to vocal technique in the spoken voice and in the singing voice, focusing on the following aspects: specific laryngeal relaxation, yawn-sigh method, chewing technique, voiced tongue vibration technique, diaphragmatic breathing, coordination of breathing with phonation, establishing and maintaining appropriate laryngeal tone, pitch variation and control, reducing vocal loudness, eliminating glottal attack, establishing optimal pitch, voice placement, developing

optimal resonance, maintenance and the generalization of optimal phonatory control to real-life situations.

Pre- and post-training assessment

The assessments were performed by a voice professional who did not participate in any of the voice training activities.

To measure the effect of the training, both groups were evaluated before beginning the course (pre-training evaluation) and at the end of the course (post-training evaluation). The control group did not take the course. The evaluation sessions of both groups took place in the afternoon, after a normal workday (5 hours of class), with the vocal overload that this brings with it.

a) Acoustic evaluation.

All recordings were made using a Sony ICD-SX35 (Tokyo) digital recorder with sampling frequency of 44.100 Hz and an AKG D 222 ED flat-response microphone in a quiet room. The microphone was situated at a standard distance of 12–15 cm from the lips and was directed towards the mouth at an angle of approximately 30–45 degrees. Participants were instructed to sustain the vowel /a/ at its usual pitch and comfortable loudness, for approximately 5 seconds.

A mid-3-second segment of each vowel prolongation was subjected to acoustic analysis using the *Praat* software ver. 5.4.04.[49] The acoustic measurements evaluated were: a) fundamental frequency (F0 Hz); b) frequency perturbation: local jitter (Jitter %), RAP jitter (RAP %), ppq5 Jitter (PPQ %); c) amplitude perturbation: local shimmer (Shimmer %); d) noise measurement: mean noise-to-harmonics ratio (NHR)

b) Aerodynamic evaluation.

Maximum phonation time (MPT) /a/: the participant was situated standing with his or her arms hanging at the sides. He or she was instructed to maintain the vowel /a/ as long as possible with a comfortable and spontaneous pitch and loudness, after a deep breath.

c) Voice Handicap Index-10 (VHI-10).

This questionnaire was used to evaluate the self-perception that teachers have of their voice problems, in the emotional, functional and physical dimensions. The Functional subscale (VHI F) refers to a voice disorder, the Emotional subscale (VHI E) refers to the person's affective responses to a voice disorder, and the Physical subscale (VHI P) refers to laryngeal discomfort and voice output. The VHI T reflects the Total score. The VHI-10 questionnaire[50] has been adapted for the Spanish population by Nuñez-Batalla.[51] It is comprised of 10 items with five possible answers (0 = never, 1 = almost never, 2 = sometimes, 3 = almost always, and 4 = always). The responses to each item are graded from zero to four. At the end, the results are added up and the final score can range from 0 to 40 (VHI- 10 Total).

RESULTS

All statistical procedures were conducted using IBM SPSS for Windows v 21.0 (Armonk, NY: IBM Corp.). The analysis was performed as follows. First we computed the normalized change of measures as (POST-PRE)/PRE, so that positive values indicated that the parameter was higher at the POST than at the PRE measure and 0 meant that the parameter value was the same at both measurement times. Second, we submitted the change ratios for F0, Jitter, RAP, PPQ, Shimmer, NHR and MPT to a between groups single-factor MANCOVA, gender being the covariate. Third, we computed separate ANCOVAs, gender being the covariate, for

each measure to test for group differences in each measure. We also performed separate ANCOVA with the same factor and covariate for the different VHI measures.

Acoustic and aerodynamic measurements

Descriptive statistics for each measure are displayed in Table 1.

INSERT TABLE 1.

The MANCOVA for the F0, Jitter, RAP, PPQ, Shimmer, NHR, MPT yielded only significant effects of Group, Wilks' Λ=.774, p=.001, η^2_p=0.226. The ANCOVAS showed that normalized POST-PRE changes (Table 2) were larger for the Experimental group than for the Control group for F0 (p<.02), more negative for the Experimental group than for the Control group for Jitter (p<.03), and PPQ (p=.05). The effect of gender did not reach the significant threshold, Wilks' Λ=.958, p=.905, η^2_p=0.042.

INSERT TABLE 2.

Voice Handicap Index-10 (VHI-10)

Some 14 participants did not adequately fulfill the subjective measures and were therefore excluded from the following analysis.

The descriptive statistics for the pre- and post-evaluation of the VHI-T and of the functional (VHI F), physical (VHI P) and emotional (VHI E) dimensions by group are shown in Table 3.

INSERT TABLE 3.

The ANCOVA for the dimensions and the overall VHI score, as well as the descriptive stats by group, appear in Table 4.

INSERT TABLE 4.

DISCUSSION

The effectiveness of a 25-hour vocal training program for teachers was studied. Post-training evaluations revealed significant improvement in acoustic measures (Fo, Jitter, PPQ) and also in the subjective assessment of the voice using the VHI-10 (VHI T and VHI P).

Effect of the training on acoustic measures

The change in the acoustic measures following the vocal training program indicates improvement in the quality of the teachers' voices. In fact, an increase is found in the fundamental frequency (Fo), a parameter that tends to be low in persons with voice impairments.[52-54] Fo has even been considered a measure of treatment effectiveness[55] since it usually improves significantly in treatment programs, regardless of the methodology used.[56-58]

This change in acoustic measures detected in our study has major repercussions on the vocal mechanism, since it may be related to a reduction in the fatigue accumulated in the vocal cord tissue, in spite of the intense vocal activity that our participants engage in every day. In fact, some authors have found that the perturbation measures increase after a day of work, as shown by comparing the measures taken early in the day to the measures taken at the end of the day.[59,60] It has also been shown that vocal loading in teachers causes alterations in the Fo and in different acoustic and spectral measures.[7, 61, 62] Other studies indicate that the increase is mainly in shimmer and jitter.[63,64] However, the type of parameter that undergoes

change varies from study to study because of the different methodologies used, such as the amount of vocal load and vocal fatigue.[65]

Effect of the training on the aerodynamic measures

Most studies evaluating the effectiveness of voice training programs for future teachers, journalists, actors[56, 21, 66, 23] find that the intervention has a positive effect on acoustic and aerodynamic measures. However, given the methodological variability and the different aims of each program (training versus treatment, length, type of evaluation, characteristics and number of participants, etc.), it is not possible to compare or agree on the sensitivity of one type of measure over another, whether acoustic or aerodynamic.

So, with respect to aerodynamic measures, in the literature we find that MPT following treatment or training shows a high degree of variability in the results. For example, in the study by Treole and Trudeaur[67] the MPT does not change after voice therapy in women with nodules on their vocal cords. Similarly, the study by Chen, Hsiao, Hisiao, Chung and Chiang[68] finds that the MPT does not improve after resonant voice therapy applied to female teachers.

In our study we do not see significant changes in the MPT following the voice training program. There are several possible reasons for this:

In the first place, since the primary aim of our vocal training program was for teachers to learn to use their voice comfortably and effortlessly, it may be that they did not perform the task with their maximum potential, so as not to force their vocal mechanism (thereby fulfilling the course objective). This was also found by Awan and Ensslen[69] in their 2010

study with singers. They did not find significant differences in MPT between trained and untrained singers. These authors believe that the trained singers did not use their maximum potential while performing the task because they were reluctant to generate tension in their vocal mechanism[69]. In this respect, there are studies in which the MPT actually falls after training, because while the task is being performed there is less glottic resistance and a more relaxed posture of the vocal cords.[70]

In the second place, in our course, the vocal training lasts just 12 hours and it may be that more training sessions are necessary to significantly increase the MPT following the intervention, as Timmermans, De Bodt, Wuyts and Van de Heyning[71]conclude after finding that the MPT improves significantly after 18 months of training, not before.

In addition, although in our study the MPT is evaluated at the end of the course (25 hours), this activity is not specifically trained in our voice training program. It may be that the MPT must be trained specifically in order to produce a significant change, as suggested by Neiman and Edeson,[72] who believe that the MPT increases in accordance with the number of trials.

These conclusions suggest that future research is needed to determine whether it is worthwhile to use this aerodynamic measure routinely to evaluate the results of voice therapy, as some studies have suggested.[73,67]

Vocal Self-Evaluation

While the course was taking place, the teachers continued their normal teaching activity, meaning that a great deal of effort and vocal loading were experienced daily. However, in the post-training evaluation the teachers reported perceiving improvements in the Voice Handicap

Index, in both the total score (VHI T) and the physical subscale (VHI P), which means that the training improved their vocal well-being.

Also, item P5 (" *I feel as though I have to strain to produce voice*") of the physical subscale obtains the highest percentage of points in the group that receives training, with respect to the control group (P5: 49% vs. 27%, p=.04). This means that most teachers, after completing the course, perceive that the voice is produced with less effort, despite the high demands of their professional activity. This overall improvement in the VHI-10 assessments might be related to a reduction in perceived vocal fatigue, which is also supported by the acoustic changes detected in our study.

In addition, in our study it can be seen that the VHI-10 is sensitive to the change perceived in the voice following short periods of vocal training. Along these lines, Roy et al.[38] achieve a significant reduction in VHI scores after 6 weeks of direct training with teachers. In addition, Chen et al.[68] find a significant improvement in the VHI-P after 8 weeks (90 minutes/week) of voice therapy aimed at teachers. In contrast, in the study conducted by Timmermans et al.[71] it was found that the E scale of the VHI improved only after 18 months of training, suggesting that this measurement improves with time and not with training.[28, 74] The reasons behind the differences found in the studies cannot be specified because the two use different methodologies, making comparison difficult.

Certainly, a voice problem is not just a set of clinically-observable physical symptoms, it also includes self-reported symptoms that may have physical, social, emotional and professional repercussions.[6, 75] All of these aspects are reflected in the International Classification of Impairments, Disabilities and Handicaps, proposed by the World Health Organization,[76] which suggests that when a person reports having voice difficulties, he or she

must not be doubted or refuted. In consequence, as the evaluation and treatment are planned, it is important to keep in mind not just what is seen and what is heard in the voice, but also the information that the individual perceives about his or her own voice.[77,78]

CONCLUSIONS

This study has demonstrated that vocal training has helped to protect the organs of the larynx from the fatigue and vocal loading often experienced by teachers,[58] as seen in the positive changes occurring in the self-perception of the voice and also at the acoustic level.

The changes in the acoustic measures are associated with changes of a physical nature, characterized by an improvement in the micro-instability in vocal cord vibrations in the short-term,[49,79-82] and also a better balance of the length, mass and tension of the vocal cords, which contributes to a reduction in vocal fatigue. All of these aspects have had clear repercussions on the self-perception of the participants, who find that their voice difficulties have improved (VHI T) and that their voice is produced with less effort, as shown by the physical subscale (VHI P), especially with the greater weight of item P5.

The tools used in our study to evaluate the effectiveness of the training have been shown to be very sensitive to short-term changes (after 8 weeks). Furthermore, the methodology (protocol) followed has been very effective, inasmuch as the objectives sought have been met in a short period of time and at little economic cost.

In future research it would be valuable to do some follow-up on this study, to determine whether the changes resulting from the vocal training program last over time. Finally, to make the prevention and treatment of voice disorders in teachers more effective, in addition to influencing and improving aspects specific to vocal health it would be important to

act on variables in the area of occupational safety that have repercussions on the vocal health of teachers, such as the acoustics of the classrooms, the degree of environmental humidity, the number of students in the class, etc.[83]

Acknowledgements

Our thanks to the rest of the team participating in this voice training program: Irene Pereira, Carmen Verdejo and Belén Cobos

Thanks also to Alexia Weninger for the English version of the manuscript.

REFERENCES

1. Roy N, Merrill RM, Thibeault S, Parsa RA, Gray SD, Smith EM. Prevalence of voice disorders in teachers and the general population. *J Speech Lang Hear Res*. 2004;*47*(2): 281-93. doi:10.1044/1092-4388(2004/023)

2. Simberg S, Laine A, Sala E, Rönnemaa A. Prevalence of voice disorders among future teachers. *J Voice.* 2000;14 (2):231-235**. doi:10.1016/S0892-1997(00)80030-2**

3. Van Houtte E, Claeys S, Wuyts F, Van Lierde K. The impact of voice disorders among teachers: vocal complaints, treatment-seeking behavior, knowledge of vocal care, and voice-related absenteeism. *J Voice*. 2011; 25(5): 570-575. **doi:10.1016/j.jvoice.2010.04.008**

4. Jardim R, Barreto SM, Assunçao AA. Voice disorder: case definition and prevalence in teachers. *Rev Bras Epidemiol*. 2007; 10(4): 625–636. doi.org/10.1590/S1415-790X2007000400020

5. Sampaio MC, dos Reis EJ, Carvalho FM, Porto LA, Araújo TM. Vocal Effort and Voice Handicap Among Teachers. *J Voice.* 2012; 26(6): 820.e15-820.e18. doi:10.1016/j.jvoice.2012.06.003

6. Kooijman PG, de Jong FI, Thomas G, Huinck W, Donders R, Graamans K, Schutte HK. Risk factors for voice problems in teachers. *Folia Phoniatr Logop.* 2006;58(3):159–174. doi: 10.1159/000091730

7. Sala E, Laine A, Simberg S, Pentti J, Suonpää J. The prevalence of voice disorders among day care center teachers compared with nurses: a questionnaire and clinical study. *J Voice.* 2001;15(3): 413-423. **doi:10.1016/S0892-1997(01)00042-X**

8. Thibeault SL, Merrill RM, Roy N, Gray S, Smith E. Occupational risk factors associated with voice disorders among teachers. *Ann Epidemiol*. 2004;14(10): 786-792. **doi:10.1016/j.annepidem.2004.03.004**

9. Jiang JJ, Titze IR. Measurement of vocal fold intraglottal pressure and impact stress. *J Voice.* 1994; 8(2): 132–144. **doi:10.1016/S0892-1997(05)80305-4**

10. Hillman RE, Holmberg EB, Perkell JS, Walsh M, Vaughan C. Objective assessment of vocal hyperfunction: an experimental framework and initial results. *J Speech Hear Res.* 1998; 32(2):373–392. doi:10.1044/jshr.3202.373

11. de Jong FICR. An introduction to the teacher's voice in a biopsychosocial perspective. *Folia Phoniatr Logop.* 2010;62(1-2): 5-8. doi: 10.1159/000239058

12. Wellens WAR, Van Opstal MJMC. A comprehensive model of how the stress chain affects voice. In K. Izdebski (Ed.), Emotion in the Human Voice. San Diego: Plural Publishing; 2008: (Vol. 2) 253-271

13. Rubin JS, Sataloff RT, Korovin GS. (Eds) *Diagnosis and treatment of voice disorders* (4th Ed.). San Diego: Plural Publishing; 2014

14. Ilomäki I, Laukkanen AM, Leppänen K, Vilkman E. Effects of voice training and voice hygiene education on acoustic and perceptual speech parameters and self-reported vocal well-being in female teachers. *Logop Phoniatr Vocology.* 2008 33(2): 83-92. doi: 10.1080/14015430701864822

15. Verdolini K, Ramig LO. Occupational risks for voice problems. *Logop Phoniatr Vocology.* 2002; 26(1): 37–46. doi:10.1080/1401543011996

16. Halpern A E, Spielman J L, Hunter E J, Titze IR. The inability to produce soft voice (IPSV): A tool to detect vocalchange in school-teachers. *Logop Phoniatr Vocology.* 2009; 34(3):117-127. doi: 10.1080/14015430903062712

17. Russell A, Oates J, Greenwood KM. Prevalence of voice problems in teachers. *J Voice.* 1998;12(4): 467-479.

18. Smith E, Gray SD, Dove H, Kirchner L, Heras H. Frequency and effects of teachers' voice problems. *J Voice*. 1997; 11(1): 81-87. **doi:10.1016/S0892-1997(97)80027-6**

19. Smith E, Kirchner HL, Taylor M, Hoffman H, Lemke JH. Voice problems among teachers: Differences by gender and teaching characteristics. *J Voice.* 1998;12(3):328-334. **doi:10.1016/S0892-1997(98)80022-2**

20. Yiu EML. Impact and prevention of voice problems in the teaching profession: Embracing the consumer's view. *J Voice.*2002:16(2): 215-229. **doi:10.1016/S0892-1997(02)00091-7**

21. Duffy, OM, Hazlett DE. The impact of preventive voice care programs for training teachers: a longitudinal study. *J Voice.* 2004;18(1):63–70. **doi:10.1016/S0892-1997(03)00088-2**

22. Schneider B, Bigenzahn W. Vocal risk factors for occupational voice disorders in female teaching students. *Eur Arch Oto-Rhino-Laryn.*2005;262(4):272-276. doi: 10.1007/s00405-004-0768-2

23. Simberg S, Sala E, Rönnemaa AM. A comparison of the prevalence of vocal symptoms among teacher students and other university students. *J Voice.*2004;18(3):363-368. **doi:10.1016/j.jvoice.2003.12.005**

24. Hazlett DE, Duffy OM, Moorhead SA. Review of the impact of voice training on the vocal quality of professional voice users: implications for vocal health and recommendations for further research. *J Voice.*2011: 25(2):181-191. **doi:10.1016/j.jvoice.2009.08.005**

25. Ilomäki I, Laukkanen AM, Leppänen K, Vilkman E. Effects of voice training and voice hygiene education on acoustic and perceptual speech parameters and self-reported vocal well-being in female teachers. *Logop Phoniatr Vocology.*2008; 33(2):83-92. doi: 10.1080/14015430701864822

26. Pasa G, Oates J, Dacakis G. The relative effectiveness of vocal hygiene training and vocal function exercises in preventing voice disorders in primary school teachers. *Logop Phoniatr Vocology.* 2007; 32(3):128-140. doi: 10.1080/14015430701207774

27. Lehto L, Rantala L, Vilkman E, Alku P, Bäckström T. Experiences of a short vocal training course for call-centre customer service advisors. *Folia Phoniatr Logop. 2003;55*(4):163-176. doi: 10.1159/000071016

28. Timmermans, B., De Bodt, M.S., Wuyts, F.L., & Van de Heyning, P.H. (2004a) Training outcome in future professional voice users after 18 months voice training. *Folia Phoniatr Logop.*, *56*(2), 120-129. doi:10.1159/000076063

29. Ruotsalainen J, Sellman J, Lic P, Lehto L, Verbeek J. Systematic review of the treatment of functional dysphonia and prevention of voice disorders. *Otolaryngol Head Neck Surg.* 2008;138 (5):557-565. doi: 10.1016/j.otohns.2008.01.014.

30. Stuut R, Tjon Pian Gi RE, Dikkers FG. Change of Voice Handicap Index after treatment of benign laryngeal disorders. *Eur Arch Oto-Rhino-Laryn.*2014; 271(5):1157-1162. doi: 10.1007/s00405-013-2773-9

31. Watts CR, Hamilton A, Toles L, Childs L, Mau T. A randomized controlled trial of stretch-and-flow voice therapy for muscle tension Dysphonia. *Laryngoscope.*2015;25 (6):1420-1425. doi: 10.1002/lary.25155

32. Boone DR, McFarlane SC, Von Berg SL, Zraick RI. *The voice and voice-therapy* (9th ed.). Boston: Pearson; 2013.

33. Case JL. *Clinical management of voice disorders* (3th ed.). Austin, TX: Pro-Ed; 2002

34. Colton RH, Casper JK, Leonard R. *Understanding voice problems: A physiological perspective for diagnosis and treatment* (3rd ed.). Baltimore, MD: Williams & Wilkins; 2006

35. Koschkee DL, Rammage L. *Voice care in the medical setting*. San Diego, C.A: Singular; 1997.

36. Morrison MD, Rammage LA. *Tratamiento de los trastornos de la voz*. Barcelona: Masson; 1996.

37. Prater, R.J., & Swift, R.W. (1984). *Manual of voice therapy*. Boston, Mass: Little, Brown Book Group Limited.

38. Roy N, Gray SD, Simon M, Dove H, Corbin-Lewin K, Stemple JC. An evaluation of the effects of two treatment approaches for teachers with voice disorders: A prospective randomized clinical trial. *J Speech Lang Hear Res.*2001; 44(2):286-297. doi: 1092-4388/01/4402-0286

39. Stemple JC, Roy N, Klaben B. *Clinical voice pathology: Theory and management* (5th ed.). San Diego, CA: Plural Publishing; 2014.

40. Verdolini, K., **Titze** I.R., & Fennell, A. (1994). Dependence of phonatory effort on hydration level. *J Speech Lang Hear Res.*1994; 37(5):1001-1007. doi:10.1044/jshr.3705.1001

41. Elgström E, Cantero FJ. *Adequació del camp vocal dels mestres de música*. Barcelona: Universitat de Barcelona; 2011.

42. Delacretaz S. (2003). La técnica Alexander y su interés para los músicos. *Música y Educación. 2003; 55:* 174-175.

43. Gelb M. *El cuerpo recobrado. Introducción a la técnica Alexander*. Barcelona: Juan Luppi Editor; 2010.

44. Khoury, B., Sharma, M., Rush, S.E., & Fournier. C. (2015). Mindfulness-based stress reduction for healthy individuals: A meta-analysis. ***J Psychosom Res.*** 2015;78(6):519-28. doi: 10.1016/j.jpsychores.2015.03.009.

45. Andrews ML, Summers AC. *Voice treatment for children and adolescents*. San Diego, CA: Singular, Thompson Learning; 2002.

46. Casper JK. Treatment outcomes in occupational voice disorders. In P. H. Dejonckere (Ed.), *Occupational voice: Care* and *cure*. The Hague The Netherlands: Kugler Publications; 2001:187–199

47. Carding PN, Horsley IA, Docherty GJ. A Study of the Effectiveness of Voice Therapy in the Treatment of 45 Patients With Nonorganic Dysphonia. *J Voice.* 1999;13(1):72-104. doi:10.1016/S0892-1997(99)80063-0Timmermans B, Coveliers Y, Meeus W, Vandenabeele F, Van Looy L, Wuyts F.(2011). The Effect of a Short Voice Training Program in Future Teachers. *J Voice*. 2011; 25,(4): e191–e198. doi: 10.1016/j.jvoice.2010.04.005.

48. Boersma P, Weenink D. Praat: doing phonetics by computer [Computer program]. Version 5.4.04, retrieved 28 December 2014 from http://www.fon.hum.uva.nl/praat/download_win.html

49. Rosen C, Lee AS, Osborne J, Zullo T Murry T. Development and validation of the Voice Handicap Index-10. *Laryngoscope.* 2004;114(9):1549-1556. doi: 10.1097/00005537-200409000-00009.

50. Nuñez-Batalla F. Adaptación y validación del índice de incapacidad vocal (VHI-30) y su versión abreviada (VHI-10) al español. *Acta Otorrinolaringol Esp.* 2007; 58(1):386-392. doi:10.1016/S0001-6519(07)74954-3

51. Domeracka-Kołodziej A, Maniecka-Aleksandrowicz B, Grzanka A. Voice quality in teachers with occupational voice disorders. *Otolarynolaryngol Clin Rev.* 2002; 1(2):105–12.

52. Muñoz J, Mendoza E, Fresneda MD, Carballo G, López P. Acoustic and Perceptual indicators of normal and pathological voice. *Folia Phoniatr Logop.*2003; 55 (2):102-114. doi: 10.1159/000070092

53. Awan S N, Roy N. Acoustic Prediction of Voice Type in Women with Functional Dysphonia. *J Voice.*2005;19(2):268-282. **doi:10.1016/j.jvoice.2004.03.005**

54. Roy N, Hendarto H. Revisiting the pitch controversy: changes in speaking fundamental frequency (SFF) after management of functional dysphonia. *J Voice.* 2005;19(4): 582-591. doi: 10.1016/j.jvoice.2004.08.005

55. Bele I, **Laukkanen AM,** Sipila L. Effects of a three-week vocal exercise program using the Finnish Kuukka exercises on the speaking voice of Norwegian broadcast journalism students. *Logop Phoniatr Vocology.*2010; 35(4):150-165. doi: 10.3109/14015430903578779

56. Fex B, Fex S, Shiromoto O, Hirano M. Acoustic Analysis of Functional Dysphonia: Before and After Voice Therapy (Accent Method). *J Voice.*1994; 8(2):163-167. **doi:10.1016/S0892-1997(05)80308-X**

57. Niebudek-Bogusz E, Kotyło P, Politańsk, P, Śliwińska-Kowalska M. Acoustic analysis with vocal loading test in occupational voice disorders: outcomes before and after voice therapy. *International Journal of Occupational Medicine and Environmental Health,* 2008;21(4):301-308. doi: **10.2478/v10001-008-0033-9**

58. Fant G. *Acoustic theory of speech production* (2nd ed.). The Hague, The Netherlands: Mouton; 1970

59. Titze IR. *Principles of Voice Production*. Englewood Cliffs, Prentice-Hall; 1994.

60. Laukkanen AM, Ilomäki I, Leppänen K, Vilkman E. Acoustic measures and self-reports of vocal fatigue by female teachers. *J Voice.*2008;22(3): 283-289. **doi:10.1016/j.jvoice.2006.10.001**

61. Laukkanen AM, Järvinen K, Artkoski M, et al. Changes in voice subjective sensations during a 45-min vocal- loading test in female subjects with vocal training. *Folia Phoniatr Logop.* 2004; 56(6): 335-346. doi: 10.1159/000081081

62. Dehqan A, Scherer RC. Acoustic Analysis of Voice: Iranian Teachers. *J Voice.*2013;27(5),: 655.e17–655.e21. doi: 10.1016/j.jvoice.2013.03.003

63. Eustace CS, Stemple JC, Lee L. Objective measures of voice production in patients complaining of laryngeal. *J Voice.*1996;10(2):146-154. **doi:10.1016/S0892-1997(96)80041-5**

64. Rantala L, Vilkman E, Bloigu R. Voice Changes During Work: Subjective Complaints and Objective Measurements for Female Primary and Secondary Schoolteachers. *J Voice.* 2002;16(3): 344-35. **doi:10.1016/S0892-1997(02)00106-6**

65. McHenry M, Johnson J, **Foshea B. (2009).** The effect of specific versus combined warm-up strategies on the voice. *J Voice.2009; 23*(5):572-576. **doi:10.1016/j.jvoice.2008.01.003**

66. Treole K, Trudeau MD. Changes in sustained production tasks among women with bilateral vocal nodules before and after voice therapy. *J Voice.*1997;11(4):462-469. **doi:10.1016/S0892-1997(97)80043-4.**

67. Chen SH, Hsiao TY, Hsiao LC, Chung YM, Chiang SC. Outcome of resonant voice therapy for female teachers with voice disorders: perceptual, physiological, acoustic, aerodynamic, and functional measurements. *J Voice.*2007; 21(4):415–425. doi: 10.1016/j.jvoice.2006.02.001

68. Awan SN, Ensslen AJ. A comparison of trained and untrained vocalists on the dysphonia severity index. *J Voice.*2010; 24(6), 661-666. doi: 10.1016/j.jvoice.2009.04.001

69. Sulter AM, Meijer JM. Effects of voice training on phonetograms and maximum phonation times in female speech therapy students. In: A.M. Sulter, (Ed.),*Variations of Voice Quality Features and Aspects of Voice Training in Males and Females*. Groningen: Rijkuniversiteit Groningen. 1996: 133-147.

70. Timmermans B, De Bodt MS, Wuyts FL, Van de Heyning PH. Analysis and Evaluation of a voice training Program in future professional voice users. *J Voice.*2005;19(2):202-210. **doi:10.1016/j.jvoice.2004.04.009**

71. Neiman, GS, Edeson B. Procedural aspects of eliciting maximum phonation time source. *Folia Phoniatr Logop.*1981;33 (5):285-293.

72. Baken RJ, Orlikoff RF. *Clinical measurement of speech and voice* (2nd ed.). San Diego, CA: Singular Publishing Group; 2000.

73. Timmermans B, De Bodt MS, Wuyts FL,Van de Heyning PH. Voice quality change in future professional voice users after nine months voice training. *Eur Arch Oto-Rhino-Laryn.* 2004b; 261(1): 1-5. doi: 10.1007/s00405-003-0652-5

74. Verdolini K, Ramig LO. Occupational risks for voice problems. *Logop Phoniatr Vocology.*2002;26(1):37–46. doi:10.1080/1401543011996

75. World Health Organization. *International classification of impairments, disabilities and handicaps*. *A manual of classification relating to the consequences of disease.* Geneva, Switzerland: World Health Organization; 2001.

76. Carding PN, Wilson JA, MacKenzie K, Deary IJ. Measuring voice outcomes: state of the science review. *J Laryngol Otol.* 2009;123(8):823-829. doi: 10.1017/S0022215109005398

77. Rodrigues G, Zambon F, Mathieson L, Behlau M.Vocal tract discomfort in teachers: its relationship to self-reported voice disorders. *J Voice.* 2013;27(4): 473-480. **doi:10.1016/j.jvoice.2013.01.005**

78. Heiberger VL, Horii Y. Jitter and shimmer in sustained phonation. In N.J. Lass., (Ed.), *Speech and Language: advances in basic research and practice.* New York: Academic Press; 1982:299-331.

79. Koike Y. (1973). Vowel amplitude modulations in patients with laryngeal diseases. *Journal of The Acoustical Society of America, 1973*45(5), 839. **doi.org/10.1121/1.191155**

80. Lieberman P. Some acoustic measures of the fundamental periodicity of normal and pathologic larynges. *J Acoust Soc Am*. 1963;*35*(3):344-353. **doi.org/10.1121/1.1918465**
81. Ludlow C, Gentges D. The differential sensitivity of measures of fundamental frequency perturbation laryngeal neoplasms and neuropathologies. In: D.Bless and J.H. Abbs, (Eds.), *Vocal fold physiology: contemporary research and clinical issues*. San Diego, Califomia: College-Hill Press; 1983:381-392.
82. Vilkman E. Occupational safety and health aspects of voice and speech professions. Folia Phoniatr Logop. 2004;56(4):220-53.

Table 1. Descriptive stats for measures (acoustic and aerodynamic) and group.

		PRE				POST			
				95% CI				95% CI	
Variable	**Group**	**Mean**	**SEM**	**LL**	**UL**	**Mean**	**SEM**	**LL**	**UL**
F0	Experimental	171.297	4.461	162.442	180.151	187.698	4.690	178.390	197.006
	Control	170.033	8.699	151.943	188.122	170.507	8.879	152.043	188.971
Jitter	Experimental	.510	.041	.428	.592	.358	.016	.326	.389
	Control	.541	.059	.418	.664	.533	.048	.434	.632
RAP	Experimental	.294	.025	.245	.343	.202	.010	.183	.222
	Control	.318	.043	.228	.408	.305	.035	.231	.378
PPQ	Experimental	.311	.026	.259	.362	.214	.009	.196	.233
	Control	.333	.040	.249	.417	.311	.031	.246	.376
Shimmer	Experimental	4.144	.343	3.463	4.825	3.669	.301	3.073	4.266
	Control	4.127	.756	2.554	5.699	3.184	.622	1.889	4.478
NHR	Experimental	3.693	.661	2.382	5.004	4.353	.751	2.862	5.844
	Control	.082	.018	.045	.118	.063	.020	.022	.105
MPT	Experimental	14.031	.517	13.006	15.056	13.320	.520	12.287	14.352
	Control	13.113	1.255	10.502	15.724	13.477	1.198	10.987	15.968

Note. CI= Confidence Inervals; *SEM = Standar Error of the Mean*, LL = 95% CI lower limit, UL = 95% CI upper limit

Table 2. Change rates for each measure (acoustic and aerodynamic) according to group.

				95% IC		
Variable	**Group**	**Mean**	**SD**	**LL**	**UL**	**Significance**
F0	Control	0.003	0.034	-0.064	0.071	0.02
	Experimental	0.111	0.016	0.079	0.143	
Jitter	Control	0.188	0.106	-0.022	0.399	0.03
	Experimental	-0.134	0.05	-0.233	-0.034	
RAP	Control	0.239	0.138	-0.034	0.511	.06
	Experimental	-0.104	0.065	-0.233	0.025	
PPQ	Control	0.154	0.108	-0.06	0.369	0.05
	Experimental	-0.138	0.051	-0.24	-0.036	
Shimmer	Control	-0.124	0.106	-0.333	0.085	
	Experimental	-0.016	0.05	-0.115	0.083	
NHR	Control	0.122	0.32	-0.511	0.755	
	Experimental	0.184	0.151	-0.115	0.484	
MPT	Control	0.043	0.052	-0.061	0.147	
	Experimental	-0.07	0.025	-0.119	-0.021	0.03

Note. 95% confidence intervals are used to determine the significance of each average change rates

Table 3. Descriptive stats for VHI, measurement time and group.

			PRE				POST			
					95% CI				95% CI	
Variable	**Group**	**N**	**Mean**	**SEM**	**LL**	**UL**	**Mean**	**SEM**	**LL**	**UL**
VHI F	Experimental	84	10.92	0.42	10.07	24.07	10.11	0.36	9.38	22.15
	Control	18	9.83	0.82	8.18	19.91	9.94	0.67	8.60	20.10
VHI P	Experimental	84	7.56	0.32	6.93	16.79	6.46	0.26	5.93	14.33
	Control	18	7.22	0.69	5.84	14.64	6.67	0.57	5.53	13.50
VHI E	Experimental	84	4.25	0.24	3.78	9.74	4.01	0.21	3.58	9.15
	Control	18	3.50	0.34	2.83	7.10	3.56	0.40	2.76	7.22
VHI T	Experimental	84	22.73	0.86	21.00	50.02	20.58	0.75	19.08	45.14
	Control	18	20.56	1.68	17.18	41.61	20.17	1.44	17.27	40.78

Note. CI= Confidence Intervals ; *SEM = Standar Error of the Mean*; LL = 95% CI lower limit; UL =95% CI upper limit

Table 4. Change rates for each measure according to group.

VHI-10	Group	Mean	SEM	LL	UL	Significance
VHI F	Experimental	-.031	.029	-.089	.026	
	Control	.057	.049	-.046	.160	
VHI P	Experimental	-.092	.036	-.164	-.020	.05
	Control	-.035	.061	-.164	.093	
VHI E	Experimental	.008	.035	-.061	.077	
	Control	.062	.108	-.166	.291	
VHI T	Experimental	-.063	.024	-.111	-.014	.05
	Control	.011	.039	-.071	.094	

Note. 95% confidence intervals are used to determine the significance of each average change rates.