

Vocal Effort and Voice Handicap Among Teachers

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Summary: The relationship between voice handicap and professional vocal effort was investigated among teachers in a cross-sectional study of census nature on 4496 teachers within the public elementary education network in Salvador, Bahia, Brazil. Voice handicap (the outcome of interest) was evaluated using the Voice Handicap Index 10. The main exposure, the lifetime vocal effort index, was obtained as the product of the number of years working as a teacher multiplied by the mean weekly working hours. The prevalence of voice handicap was 28.8% among teachers with high professional vocal effort and 21.3% among those with acceptable vocal effort, thus yielding a crude prevalence ratio (PR) of 1.36 (95% confidence interval [CI] = 1.14–1.61). In the final logistic model, the prevalence of voice handicap was statistically associated with the professional vocal effort index (PR = 1.47; 95% CI = 1.19–1.82), adjusted according to sex, microphone availability in the classroom, excessive noise, pressure from the school management, heartburn, and rhinitis.

Key Words: Voice disorders—Teachers—Occupational health.

INTRODUCTION

Teachers form a professional group of great social and cultural importance that presents a high proportion of complaints of health problems, especially regarding voice abnormalities.^{1–3}

Many factors may contribute toward generating voice abnormalities, such as infections of the upper respiratory tract, gastroesophageal reflux, and smoking. Other risk factors include the conditions of the working environment (acoustics, level of ambient sound competition, humidity, dust, and temperature), lack of preparation or training for adequate use of the voice, work characteristics (multiple jobs, long workday, and length of exposure as a teacher),² cleaning products, and air conditioning.⁴

The vocal load is considered to be an important risk factor for the development of voice abnormalities.⁴ A significant association was found between voice abnormalities and the lifetime vocal effort index (LVEI), which is the product from years of work as a teacher multiplied by the weekly average number of hours of professional activity.⁵ LVEI is based on variables that are strictly related to demand rather than to vocal effort. However, in the occupational context, like that of the teachers, vocal demand is closely related to vocal effort. Furthermore, LVEI showed significant positive relationships with the prevalence of hyperfunctional dysphonia and strained phonation, neck muscle hypertension, instability of voice, and self-assessed hyperarousal, among Polish teachers.⁵

Traditionally, voice abnormalities are evaluated by methods that investigate the physical dimension, such as acoustic analysis and videolaryngostroboscopy. However, these methods are not able to evaluate the handicap caused by a voice abnormality, notably in its functional and emotional aspects. To broadly evaluate voice limitations and problems, the Voice Handicap Index

(VHI) was created. This is a questionnaire composed of 30 items that evaluate functional, physical, and emotional aspects of voice abnormalities.⁶ Subsequently, an abbreviated form of the VHI was created, the VHI-10, which consists of 10 questions to evaluate the patient's voice handicap. VHI-10 is considered to be a reliable representation of VHI.⁷ The VHI-10 is shorter, and less time is required to answer it. Thus, it can be used to replace the VHI for quantifying the subject's own perception of his/her voice deficiencies.

Cronbach's alpha for the VHI-10 (.89) indicates that this index has good internal consistency.⁸ Compared with the perceptive-auditory analysis, the VHI-10 Portuguese version presented sensitivity of 48%, specificity of 78%, and proportion of correct classification of 70%.⁹ The aim of the present study was to investigate the association between voice disability (evaluated using VHI-10) and professional vocal effort (indexed by LVEI) among teachers.

METHODOLOGY

A cross-sectional epidemiologic study with census coverage was carried out in 2006, among teachers within the municipal educational system in Salvador, Bahia, Brazil. The municipal educational system covers preschool and elementary school (between the first and eighth school years).

All teachers within the municipal educational system were included, that is, teachers at all the educational levels that were the municipality's responsibility. The evaluation included all the teachers within the permanent staff along with those with a temporary contract in the municipal educational system of Salvador. According to the data from the Municipal Education Department of Salvador, the municipal educational system comprises 365 schools and 4697 teachers.

In total, 4496 teachers were studied, representing a high response rate of 95.7%. To gather data, a standardized questionnaire was used, which was answered by the teachers themselves at their workplace. The questionnaire contained the following groups of questions: (1) general identification of the interviewee; (2) questions about the environmental conditions of the workplace; and (3) health issues, with questions about voice use and voice problems.

To measure voice handicap, the VHI-10 was used. VHI-10 is a questionnaire that consists of 10 items, with five possible

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answers: never, almost never, sometimes, almost always, and always. The responses to each item are graded from zero to four. At the end, the index is summed, and the final score can range from 0 to 40. The greater the index is, the greater the handicap relating to voice problems will be. An index between 0 and 10 represents *minimal* handicap relating to voice problems. An index between 11 and 20 indicates *moderate* handicap due to voice abnormalities, which is generally seen among people with lesions on the vocal folds, such as nodules, polyps, or cysts. An index of 21–40 represents a *severe* voice handicap, generally seen among patients with recent vocal fold paralysis or extensive scars.⁶ This study used 11 as the cutoff point to define the prevalence of voice handicap, thereby dichotomizing the classification as minimal or moderate/severe.

The LVEI, which was taken to be the main independent variable, was measured as the product of the number of years of work as a teacher multiplied by the weekly workload. The sum of the weekly workloads of all jobs was taken into account, in cases in which teachers worked at more than one school. The 90th percentile was taken as the cutoff point to dichotomize LVEI values as acceptable, or as excessive, if equal or greater than that.

The covariables analyzed in this study were sociodemographic characteristics (age, sex, and marital status), work environment characteristics (humidity, chalk dust, microphone availability in the classroom, excessive noise, and dust), general work characteristics (excessive number of students and pressure from the school management), and clinical conditions (rhinitis and heartburn). Vocal demand/effort from other nonoccupational natures was not evaluated in this study.

First, the frequencies of the variables of interest were described, with the aim of characterizing the study population. To evaluate the factors associated with voice handicap in bivariate analysis, the prevalence ratios (PRs) and their respective confidence intervals (CIs) were calculated. The criterion for statistical association was taken to be a significance level of 5%.

The data were processed using the *Statistical Package for the Social Sciences* statistical software (SPSS: applications guide, version 9.0; SPSS, Inc., Chicago, IL, 1991).

Multiple logistic regression¹⁰ was applied to identify factors that were significantly associated with the outcome variable, with concomitant adjustment for the effect of one variable on the other variables of interest included in the analysis. To preselect the covariables, the likelihood ratio test was used to ascertain which of them presented a *P* value of less than or equal to 0.25, in the bivariate logistic regression analyses. From this, a significance level of 0.20 was used as the inclusion criteria for variables. A logistic regression model consisting of the independent variable of interest and all the preselected covariables was used. In the analysis to identify the interaction (change in the main association of interest), the interaction product terms were added, one at a time, to the model containing all the main effects, and their significance was evaluated by means of the likelihood ratio test, at a statistical significance level of 10%.

PRs were estimated by logistic regression according to the method of Rothman et al,¹¹ and the Delta method was used to estimate their respective 95% CIs.^{12,13} Because of the issues

addressed in this study, and with the aim of diminishing the possible resistance as much as possible, anonymity among the respondent teachers was maintained. The questionnaires were identified by numerical codes. The present study followed the recommendations of Resolution No. 196/1996 of the National Health Council, thereby guaranteeing that the data supplied would remain confidential and the information would be used exclusively to meet the objectives of the study. The research project was approved by the Ethics Committee for Research Involving Human Beings of the Clímério de Oliveira Maternity Hospital, Federal University of Bahia, through Report/Additive Resolution No. 159/2007.

RESULTS

The ages of the teachers studied ranged from 18 to 69 years, with a mean age of 40 years (standard deviation [SD] = 9.4). Female teachers predominated (92.0%). The length of time for which they had been working as teachers ranged from 1 to 45 years, with a mean of 14.5 years (SD = 8.4). The mean number of students per class was 31.3. The workload presented bimodal distribution, with peaks at 20 and 40 hours per week, resulting in a mean of 30.4 hours per week (SD = 10.2).

Only 15.1% of the teachers reported that a microphone was available in the classroom. Excessive number of students in the classroom was a complaint of 40.4% of the teachers. Nineteen percent reported that they suffered pressure from the school management. Regarding the physical characteristics of the working environment, the presence of dust was the greatest complaint (61.9%), followed by chalk dust (50.2%), excessive noise (48.7%), and humidity (28.4%). Symptoms of rhinitis and heartburn were reported by 31.8% and 16.7% of the teachers, respectively.

The LVEI presented a mean of 616.4 units, with a minimum of 4 and a maximum of 2880. The SD was 436. The median was 520, and the 90th percentile was 1200. The scores from the VHI-10 ranged from 0 to 40, resulting in a mean of 6.2 (SD = 6.6).

The prevalence of voice handicap was 28.8% among the 379 teachers who reported high professional vocal effort and 21.3% among the 3263 who reported acceptable vocal effort, resulting in a (crude) PR of 1.36 (95% CI = 1.14–1.61).

Bivariate analyses revealed that voice handicap was significantly associated with the following factors: professional vocal effort (PR = 1.32), female sex, unavailability of a microphone in the classroom, excessive noise, pressure from the school management, heartburn, rhinitis, humidity, chalk dust, dust, and excessive number of students (Table 1).

In the final logistic model, a statistically significant association (PR = 1.47; 95% CI = 1.19–1.82) was found between voice handicap and the LVEI, adjusted for the following covariables: sex, unavailability of microphone in the classroom, excessive noise, pressure from the school management, heartburn, and rhinitis (Table 2). None of the interaction tests was below the significance level of 10%, and thus, occurrence of effect modification of the main association was ruled out.

TABLE 1.
PRs for Voice Handicap and the Respective 95% CIs,
According to the Professional Vocal Effort and
Covariables of Interest Among Teachers Within the
Municipal Educational System of Salvador, Bahia, Brazil,
2006 (Bivariate Analysis)

Variables	PR	95% CI
Professional vocal effort (LVEI)	1.32	1.09–1.60
Heartburn	1.87	1.65–2.11
Female sex	1.56	1.19–2.05
Excessive noise	1.54	1.37–1.74
No microphone in the classroom	1.47	1.21–1.78
Rhinitis	1.44	1.29–1.62
Dust	1.36	1.19–1.54
Pressure from the school management	1.32	1.15–1.50
Excessive number of students	1.20	1.07–1.35
Humidity	1.16	1.02–1.31
Chalk dust	1.16	1.04–1.31

DISCUSSION

The prevalence of voice handicap found in the present study ranged from 21.3% to 28.8%, according to the stratum of the professional vocal effort index. The prevalence of voice abnormalities usually varies widely because there are various definitions for this condition.¹⁴ The lack of a consensual criterion for defining voice abnormalities or dysphonia may partly explain the variations in voice abnormality prevalence reported in the scientific literature.¹⁵ VHI-10 has been used in an attempt to standardize and increase the reproducibility of this measurement because it is a simple and easily applied method that reflects the presence or absence of dysphonia, as the sole denominator of voice handicap.

The present study identified an important association between voice handicap and vocal effort among teachers. The LVEI evaluates not only the number of working hours but also the professional vocal effort.⁵ This result shows the importance of factors associated with the duration and intensity with which

the work is carried out by the teacher, thus indicating the need for revision of some aspects of their professional use of their voices. It has been suggested that voice abnormalities among voice-using professionals occur after 10–20 years of work.¹⁶

A study among teachers in Vitória da Conquista, Bahia, Brazil identified a significant association between hoarseness and weekly teaching workload greater than 24 hours and also between the presence of vocal fold nodules and working as a teacher for more than 5 years.²

Persistent poor voice adaptation, resulting from the vocal load over many years in the profession, may lead to reduction in the amplitude of mucous wave vibrations in the vocal folds and incomplete glottic closure.⁵

Because voice disorders are multifactorial, other factors have also been implicated in voice handicap among teachers, such as female gender, unavailability of a microphone in the classroom, excessive noise, pressure from the school management, heartburn, and rhinitis.

A greater PR for voice handicap among women is in agreement with other published articles.^{17–19} This finding can be explained by some particular female biological characteristics, such as a glottic configuration favoring arching of the vocal folds,²⁰ the hormonal influence,²¹ and lower levels of hyaluronic acid in the superficial layers of the lamina propria.²² Women present greater predisposition to dysphonia because of the smaller dimensions of their larynx and the small difference between their vocal frequency and that of the children, thus obliging them to increase their vocal intensity for them to be heard.²³

The number of students per class is a factor associated with voice handicap because teachers need to exert more effort to make themselves heard: the number of students in the classroom contributes toward increasing the noise level, which in turn can increase the effort required to speak, thus overloading the vocal apparatus. This relationship has been shown in other studies.^{4,24} Teachers have to speak louder because of the noise and inadequate acoustic conditions.²⁵ Pressure from the school management is a stress factor for teachers. Stress associated with the work is also a factor that contributes toward the prevalence of voice problems among teachers.^{26,27}

An association with heartburn symptoms was detected in the present study. The laryngeal mucosa is constantly exposed to acid reflux (chloridic acid, pepsin, and bile), which may lead to laryngeal lesions¹⁹ and/or to contribute to vocal alterations.

An important association between rhinitis and voice handicap was observed in the present study. Exposure of the laryngeal mucosa to irritants such as dust or mold may alter the vocal mechanism.²⁸ This may be related to the presence of mold in schools.²⁹

Cross-sectional studies present advantages and disadvantages. One of the limitations of this type of study is that there is no secure differentiation between cause and effect conditions for each variable involved in a given association (reverse causality and *temporal directionality*).

There are three general categories of bias in studies: selection, measurement, and intervention. Selection bias needs to be taken into consideration, especially the bias resulting from the so-called healthy worker effect. Thus, it is important to

TABLE 2.
PRs for Voice Handicap and the Respective 95% CIs,
Among Teachers Within the Municipal Educational
System of Salvador, Bahia, Brazil, 2006 (Final Logistic
Regression Model)

Variables	PR	95% CI
Professional vocal effort (LVEI)	1.47	1.19–1.82
Heartburn	1.74	1.50–2.02
Female sex	1.72	1.20–2.48
No microphone in the classroom	1.69	1.32–2.17
Excessive noise	1.47	1.28–1.70
Rhinitis	1.35	1.17–1.55
Pressure from the school management	1.22	1.04–1.44

consider the possibility of information loss from teachers who (1) left the profession because of illness or work-related exhaustion or (2) could not be contacted by the researchers at the time of data gathering for some health-related reason, with severe voice handicap among these. Because this study was a census with high participation among the population (95.7%), this bias was greatly reduced.

Measurement bias can occur when the measurement methods used to differ between the groups of patients. The questionnaire applied was the same for all participants. There might have been a difference in the time taken to fill out the questionnaires, but this factor was not controlled in this investigation. The older teachers might have affirmed with more conviction that they had voice abnormalities, whereas the younger ones might have wanted to demonstrate that they were fitter, thus concealing their symptoms. Increasing age can lead to degeneration of the vocal folds, thus accentuating the symptoms reported by the teachers. Confounding bias occurs when two factors are associated and the effect of one is confounded or distorted by the effect of a third factor. To control for this bias, multiple logistic regression was used.

In conclusion, this study revealed that professional vocal effort was associated with voice handicap among teachers, after adjustment for the effects of the following relevant covariables: sex, unavailability of microphones in classrooms, excessive noise, pressure from the school management, heartburn, and rhinitis. This result indicates that there is a need to revise the aspects of how teachers' work is organized that determine the extent of professional voice use.

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