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Gender Differences in the Reporting of Vocal Fatigue in Teachers as Quantified by the Vocal Fatigue Index

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Abstract

Objectives: Occupational voice users report higher instances of vocal health problems. Women, who are more likely than men to report voice problems, are the largest members of some occupational voice users like teachers. While a common complaint among this population is vocal fatigue, it has been difficult to quantify. Therefore, the goal of this study is to quantify vocal fatigue generally in school teachers, and investigate any related gender differences.

Methods: 640 (518F, 122M) teachers were surveyed using an online questionnaire consisting in part of the Vocal Fatigue Index (VFI), an index specifically designed to quantify vocal fatigue.

Results: Compared to vocally healthy adults, the teachers surveyed were three times as likely to report vocal tiredness or vocal avoidance, and over three times as likely to report physical voice discomfort. Additionally, female teachers were more likely to have scores approaching those with dysphonia.

Conclusions: The VFI quantified elevated levels of vocal fatigue in teachers, with a significant prevalence of symptoms reported among females compared to males. Further, because the VFI indicated elevated complaints (between normal and dysphonic) in a population likely to be elevated, the VFI might be used to identify early indications of voice problems and/or track recovery.

Keywords

vocal fatigue; voice disorders; voice recovery; occupational voice use

INTRODUCTION

Occupational voice users (i.e., those whose professional performance depends on vocal quality, health or endurance) make up a significant part of the patient load at voice clinics¹, often presenting with vocal disorders such as nodules or acute laryngeal injuries (e.g., submucosal hemorrhages, phonotrauma)^{2–4}. Laryngeal injuries can lead to missed workdays or performances, lost revenue, significant rehabilitation periods, and the need to change

professions or retire early^{1,5,6}. Nevertheless, often these voice problems are reversible when treated promptly and effectively⁷.

Often a large portion of occupational voice users report early vocal complaints (e.g., laryngeal discomfort, increased or elevated vocal/respiratory effort, or poor vocal quality) that have been traditionally grouped under the general term vocal fatigue⁸. If ignored or untreated, vocal fatigue complaints may go away on its own but may also eventually lead to the more significant health problems mentioned above. Some risk factors which correspond with such complaints include room acoustics⁹, environmental conditions (e.g. airborne particulates, irritants)¹⁰, extent of vocal loading¹¹, and recovery period¹². Gender also appears to be a factor, with females reporting higher rates of vocal disorders than males^{13,14}; as discussed in a review of the literature¹⁵. These higher rates may stem from gender differences related to both laryngeal e.g.,¹⁶ and non-laryngeal physiology e.g.,¹⁷, as well as the effects of hormones¹⁸, behavior¹⁹, stress/anxiety²⁰, and personality²¹.

Unfortunately, vocal fatigue has been a challenge to consistently identify, diagnose and definitively quantify. One reason is that current standardized assessment tools, such as the Voice Handicap Index (VHI) and the Voice-Related Quality of Life (V-RQOL), were not designed to be sensitive to vocal fatigue^{22,23}. In response, Nanjundeswaran et al²⁴ developed the Vocal Fatigue Index (VFI), a 19-question standardized tool with the aim of differentiating between those individuals suffering from vocal fatigue and those without. The VFI quantifies symptoms related to three likely factors of vocal fatigue: (1) Factor 1, perception of an effortful voice and/or tendency to avoid using her/his voice (*performance*); (2) Factor 2, physical discomfort when using the voice (*pain*); and (3) Factor 3, decrease of symptoms after the individual rests his/her voice (*recovery*). The VFI was verified on 175 patients presenting with dysphonia at vocal health clinics and 70 healthy controls. The results suggested that vocal fatigue is an underlying symptom of many vocal health conditions and demonstrated that the VFI may be effectively used to identify individuals with vocal fatigue.

Nevertheless, the VFI has not been tested specifically on occupational voice users, the population of speakers whose vocal load puts them at high risk for vocal fatigue and other more severe issues. Additionally, while women are at greater risk for voice problems, gender differences in the VFI have not yet been explored. The current study uses schoolteachers, a population of occupational voice users that is predominantly female, to answer the following research question: To what extent will the VFI identify elevated levels of vocal fatigue in teachers generally, and female teachers specifically? It is hypothesized that teachers will present with VFI scores indicative of more severe vocal fatigue than healthy controls. Additionally, it is hypothesized that, per previous research, the VFI will indicate more severe vocal fatigue in female teachers than male teachers.

METHODS

Survey

This study was conducted in accordance with policies of Michigan State University's Human Research Protection Program (determined exempt)²⁵. Data were collected through

an electronically presented survey (Qualtrics Survey Software, <https://www.qualtrics.com/>), which was composed of the 19-question Vocal Fatigue Index (VFI), along with additional questions that will be explored in future studies. In the original VFI, Factors 1 and 2 statements were written such that higher scores reflected a greater severity of issues (e.g. “It feels like work to use my voice”), while items in Factor 3 were worded so that lower scores reflected a greater severity. In the current study design, all three factors had comparable directions for scores (e.g., more severe symptom reporting resulted in larger scores). Factors 1 and 2 (*performance* and *pain*) were left unchanged, but questions in Factor 3 (*recovery*) were modified so that higher scores would also reflect a greater severity of issues. Therefore, while our Factor 3 statements elicited the same information from mostly the same wording, they may not be directly comparable to the inverse of Factor 3 scores from Nanjundeswaran et al²⁴.

The survey was distributed directly to several thousand teachers (K-12) in school districts throughout the United States, primarily in Michigan, Utah, Tennessee, Alabama, Florida, Georgia, New Hampshire, and South Carolina. These states were chosen for convenience because of collaborators who could assist with reaching out to teachers and administrators in local school districts, but teachers outside of these states were given the opportunity to respond to the survey. After completing the survey, teachers were given the opportunity to forward a link to the survey to other teachers, and links to the survey were also made available on educational listservs. To facilitate the identification of unreliable participants, survey responses were excluded from analysis for the following reasons: (1) begun but not completed; (2) completed in a very short timeframe suggesting invalid data; and (3) incorrect response to a question that asked the participant to choose a specific answer from a list of options.

Participants

Overall, 640 respondents (518F, 122M) were included in the analysis (per the exclusion criteria discussed above). The gender distribution of respondents was similar to the national average in which 76% of school teachers are female²⁶. The average age of the respondents was 43.5, s.d. 12.2 years (F 43.0 s.d. 12.2, M 48.4 s.d. 11.5).

Analysis

Statistical analysis (using Excel and SPSS 21) was conducted on the 640 study population data with complete information on all variables. The dependent variables were the three factors from the VFI: (1) voice avoidance and tiredness of voice (*performance*), (2) physical discomfort when using the voice (*pain*), and (3) decrease of symptoms after vocal rest (*recovery*). For this study, the dependent variables (results of the three factors) were assumed to be continuous variables based on two reasons: 1) the scores of the three VFI factors may be between 0 – 55, 0 – 25, and 0 – 15 respectively; and 2) the sample size of the present study was larger than 200²⁷. The Shapiro-Wilk test was used to evaluate whether variables were normally distributed. With these assumptions, descriptive statistics were used to quantify the scores for the three VFI factors, and linear regression analysis was conducted to investigate the association between age and gender with the three scores. The magnitude of the association was expressed by the Beta () and its standard error (SE).

RESULTS

Full descriptive statistics from the teacher respondents were presented in Table I. Overall, female teachers responded with higher values (indicating more pronounced symptoms) for all three factors (performance, pain, and recovery), with similar standard deviations for both genders; this was reflected also in the median and interquartile range (IRQ). The averages for Factors 1, 2 and 3 (combined male and female, not listed in the table) were 16.4 (s.d. 8.2), 5.9 (s.d. 4.2), and 1.8 (s.d. 2.0) respectively. The skewness of the factors indicates that the distributions were between *fairly symmetrical* (between -0.5 and 0.5) for the female teachers and *moderately skewed* (between 0.5 and 1.0) for the male teachers (excluding Factor 3, recovery). The primary reason for the skewness value was that several of the participants responded with no reported symptoms (zero values), creating a large number of zero responses without distributed tails as would be seen in a normal distribution. The kurtosis (e.g., combined weight of tails relative to the rest of the distribution) was less than 0 for all but the males' Factor 3 responses, indicating light tails of the distribution for Factors 1 (performance) and 2 (pain), with kurtosis greater than 0 indicating a heavy tailed distribution²⁸. The last row in Table I lists the coefficient of determination (r^2), which is nearly zero for all factors when compared to participant age indicating that there is essentially no fit between participant age and the three VFI factors.

Using the univariate analysis to compare each VFI factor individually with age, only Factor 2 had any significant relationship ($p < 0.5$). However, this association did not remain significant after adjustment (multivariate analysis). In the univariate analysis, there was a significant difference between female and male teachers for Factors 1 and 2 (Table II). Factor 3 was approaching significance for the univariate case. Multivariate analysis demonstrated that, after adjustment for age, female teachers still scored higher than males on Factors 1 and 2 ($=2.44$ and 1.40 , respectively). The magnitude of these differences was 2.4 – 2.5 for Factor 1 and 1.4 – 1.5 for Factor 2.

DISCUSSION

Overall, the teachers in the current study had VFI scores indicating elevated levels of vocal fatigue in comparison with the healthy control group from Nanjundeswaran et al²⁴. The teachers were three times as likely to report tiredness and voice avoidance symptoms (Factor 1) and more than three times as likely to report physical discomfort symptoms in the voice (Factor 2), while patients with dysphonia from Nanjundeswaran et al²⁴ reported nearly 5 times higher scores for both of these scores. Thus, while teachers had higher prominent vocal fatigue indicators than the vocally healthy individuals, these indicators were still lower than that of the dysphonic population. This difference may suggest that the VFI is capable of indicating elevated fatigue indicators, thereby identifying potentially at-risk individuals at an earlier stage. Therefore, it may be useful for healthcare professionals in identifying symptoms before they have progressed to a significant, more costly (financially as well as physically) vocal injury. Finally, the standard deviations of the teacher scores for these two factors were also between the normal and the dysphonic individuals. The score with Factor 3 was not compared due to the change in question structure.

The results from the teachers surveyed in this study suggest gender differences for vocal fatigue indicators associated with Factor 1 (perception of effortful voice and/or voice avoidance). Underlying responses to Factor 1 could be social awareness and awareness of effort. In a pair of studies^{9,29} examining the changes in voice production due to vocalization style (soft, comfortable, loud) and different acoustic environments, female subjects adjusted their voices more dynamically (e.g., intensity, F0) to the conditions. Further, when participants were asked to rate their vocal effort in the different conditions, female subjects reported a wider and higher range of values on the vocal effort response scale than males. Therefore, gender differences in Factor 1 scores could stem from not only female teachers using their voice in more dynamic (effortful) ways than males (thus higher vocal fatigue), as well as possibly having greater awareness of their vocal effort levels.

Indicators for Factor 2 (physical discomfort when using the voice) also showed a gender difference, with female teachers scoring about 1.3 times higher than male teachers and nearly as high as those for the dysphonic individuals in Nanjundeswaran et al.²⁴. This gender difference is in line with findings of Smith et al.¹⁴, who reported that female teachers were about 1.6 times more likely to report symptoms of physical discomfort than males. This difference could simply stem from the fact that female teachers use their voices more than male teachers. For example, in a study of teachers' voice use over several weeks of observation¹⁹, female teachers vocalized 10% more than males at work and 7% more outside of work. Further analysis of the same teachers showed that female teachers were more likely than their male counterparts to adjust their voice use due to situational need³⁰. Higher vocal load would indicate more extensive vocal damage and, thus, more physical discomfort. However, Factor 2 could also be sensitive to differences in how discomfort presents in males and females. For example, previous studies^{31–33} suggest that women may generally report painful stimuli as more painful than men, with men appearing to have a greater pain threshold (i.e. the point at which a person becomes aware of pain) and tolerance for pain. Thus, it is possible that some of the elevated Factor 2 scores among females are due to a potentially heightened awareness of discomfort. However, this difference in pain recognition cannot be the only explanation or male teachers would have a greater incidence of voice disorders because they would not notice the signals that damage is being done before real damage was done.

Factor 3 (recovery) showed only trending differences. While previous literature suggests that there may be a difference in wound healing between the genders³⁴, future studies are necessary to explore gender-based differences in recovery. However, it is possible that this trending difference in vocal recovery could be affected by underlying gender-based physiological differences of the laryngeal system generally and vocal folds specifically. For example, women have less hyaluronic acid in the superficial layer³⁵, which may predispose females to increased vocal fold injury and increased scarring^{36,37}.

The underlying reasons for the gender differences in the teachers' VFI scores is likely multifaceted¹⁵, which is evident in the discussion above. In reality, it is possible that some of these differences may relate to gender-based differences in how men and women respond to surveys regarding life experiences. In a 30-year study conducted by Wilhelm et al.³⁸, there were no gender differences in the number and type of significant life events reported, but

there was a significant difference in how these events were experienced between genders. Thus, how a person perceives or experiences a vocal problem would likely affect the outcome of the VFI or any survey-based tool used in voice.

As with any study and survey, the results are dependent on the responses of the participants. While an attempt was made to improve the reliability and quality of the data (e.g. multiple regions of the country, survey techniques to exclude those not paying attention), it is possible that the teachers sampled were not a representative sample of U.S. school teachers generally because the primary focus for recruitment was on eight states (based on convenience in survey distribution avenues) which may not represent teachers in all states due to differences in such things as climate (e.g. humidity level, temperature), social and economic status of students, and state funding levels. While such differences should be examined in future studies, the results of the current study are of interest given the number of responses.

CONCLUSION

The Vocal Fatigue Index (VFI) has been previously used to effectively identify individuals presenting at a voice clinic with vocal fatigue. The aim of the current study was to determine to what extent the VFI could effectively identify elevated levels of vocal fatigue symptoms in one population of occupational voice users (school teachers), and distinguish if there were gender differences in the VFI scoring.

As hypothesized, the VFI appears to have the ability to quantify vocal fatigue. The current study found that a general population of school teachers were found somewhere between healthy normal adults and those diagnosed with dysphonia. Additionally, the VFI was able to quantify the already known gender differences in vocal fatigue, a key indicator that this tool may be reflecting known prevalence of vocal fatigue issues in the target population.

Previous work has suggested the need for a method to identify vocal fatigue within occupational voice users. Such a tool could be useful to voice users and clinicians. For example, early intervention is key to preventing serious voice disorders. Thus, for occupational voice users who experience an elevated risk for vocal issues, the VFI could indicate early signs of vocal health issues before conditions like dysphonia are present and help them recognize the need to seek professional help from a laryngologist or speech-language pathologist. Clinically, the VFI may be a useful complement to objective measures to justify treatment of pathological voices where fatigue is a component. Further, the VFI may also be useful after therapy or other medical intervention to track improvement, a needed metric in evidence-based medicine.

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Table I.

Vocal Fatigue Index (VFI) three Factors descriptive statistics for female (N=518) and male (N=122) teachers.

	Females			Males		
	Fact 1	Fact 2	Fact 3	Fact 1	Fact 2	Fact 3
Mean	17.1	6.2	1.9	14.6	4.7	1.5
s.d.	8.2	4.2	2.0	8.0	3.9	2.2
Q1	11	3	0	9.25	1	0
Median	17	6	2	14	4	0
Q3	23	9	3	20	8	3
IQR	12.0	6.0	3.0	10.8	7.0	3.0
Skew	0.1	0.4	0.7	0.4	0.7	1.6
Kurtosis	-0.3	-0.3	-0.2	0.0	-0.4	2.6
min	0	0	0	0	0	0
max	42	20	9	37	16	11
r ² w/age	0.004	0.006	0.003	0.002	0.004	0.005

Table II.

Linear regression analysis by gender for three factors of Vocal Fatigue Index (VFI). SE is the Standard Error.

Variable	Factor 1				Factor 2				Factor 3			
	Univariate		Multivariate		Univariate		Multivariate		Univariate		Multivariate	
	β	SE	β	SE	β	SE	β	SE	β	SE	β	SE
Female	2.50 [*]	0.82	2.44 [*]	0.82	1.46 [*]	0.42	1.40 [*]	0.42	0.32 ⁺	0.20	0.30	0.20
Age	-0.03	0.03	-0.03	0.03	-0.03 [*]	0.01	-0.03	0.01	-0.01	0.01	-0.01	0.01

⁺ p<0.20,

^{*} p<0.05

Table III.

Vocal Fatigue Index (VFI) average scores for the three Factors as reported in the original paper by Nanjundeswaran et al (2015). Participants included 70 vocally healthy individuals (mean age, 39, SD 15; 21 males and 49 females) and 105 patients with dysphonia (mean age 50, SD 16; 35 males and 70 females).

	Vocal Health Individuals			Individuals with Dysphonia		
	Fact 1	Fact 2	Fact 3	Fact 1	Fact 2	Fact 3
Mean	5.16	1.44	5.8	24.47	6.39	7.71
s.d.	4.58	1.92	4.05	9.76	5.53	3.05