Relationship between Voice Complaints and Subjective and Objective Measures of Vocal Function in Iranian Female Teachers

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Summary: Objectives. Teachers are at high risk of developing voice problems because of the excessive vocal demands necessitated by their profession. Teachers' self-assessment of vocal complaints, combined with subjective and objective measures of voice, may enable better therapeutic decision-making. This investigation compared audio-perceptual assessment and acoustic variables in teachers with and without voice complaints.

Methods. Ninety-nine teachers completed this cross-sectional study and were assigned to one of two groups: those "with voice complaint (VC)" and those "without voice complaint (W-VC)." Voice samples were collected during reading, counting, and vowel prolongation tasks. Teachers were also asked to document any voice symptoms they experienced. Voice samples were analyzed using Dr. Speech program (4th version; Tiger Ltd., USA), and labeled "normal" or "abnormal" according to the "grade" dimension "G" from GRBAS scale.

Results. Twenty-one teachers were assigned to the VC group based on self-assessment data. There were statistically significant differences between the two groups with regard to self-reported voice symptoms of hoarseness, breathiness, pitch breaks, and vocal fatigue ($P < 0.05$). Fourteen participants in the VC group and 40 from the W-VC group were determined to demonstrate "abnormal" vocal quality on perceptual assessment. Only harmonic-to-noise ratio was significantly higher for the W-VC group (ES = 0.55).

Conclusion. Teachers with and without voice complaints differed in the incidence, but not type of voice symptoms. Teachers' voice complaints did not correspond to perceptual and acoustic measures. This suggests a potential unmet need for teachers to receive further education on voice disorders.

Key Words: Teachers–Voice problem–Voice complaints–Audio-perceptual assessment–Acoustic measure.

INTRODUCTION

Teachers are professional voice users at exceptionally high risk of developing voice problems; as many as 39% of teachers report voicing problems because of the high vocal demands of their vocation.[1,2] Teachers also demonstrate higher incidence and prevalence of voice complaints compared to members of other professions whose jobs do not involve similarly high vocal demand.[3–6] Teachers with a greater number of voice complaints are at higher risk for developing a voice disorder,[2,7–10] in part due to profession-specific risk factors such as loud background noise, dryness,[11] poor posture, limited knowledge of factors that contribute to voice complaints,[12] and high day-to-day professional voice demands.[13,14]

Excessive vocal demands have the potential to cause small to large-scale changes in both vocal fold structure and function.[1,11,15] Confirming the presence of these changes is an essential step toward achieving an accurate and holistic diagnosis, therefore multiple assessment tools are often necessary. These frequently include aerodynamic, acoustic, perceptual and quality of life measures, in addition to various endoscopic means of visualizing the vocal apparatus at rest, and during various voicing tasks. Information gleaned from each of these is considered within the context of patient-specific voice complaints[4] to guide the therapeutic decision-making process. In particular, this project sought to reveal the most common vocal complaints in teachers as well as perceptual and acoustic changes associated with these complaints.

Teachers' vocal complaints and self-reported voice symptoms

Sliwinska-Kowalska et al[16] found that self-reported voice symptoms in Polish teachers were 2–3 times more than nonteachers. Seifpanahi et al[17] revealed that 54.6% of Iranian teachers demonstrated voice complaints compared to 21.1% of nonteachers. These numbers are close to those reported by other similar studies,[3,4,18,19] including hoarseness, breathiness,[3,20] and vocal fatigue. The available data show that aside from the presence of an established laryngeal pathology, dissatisfaction about voice quality prompts many teachers to take action to undergo comprehensive voice evaluation procedures.

Audio-perceptual assessment and vocal complaints

Abnormal voices are perceived and interpreted in a manner that reveals important information about voice function.[11] For a voice therapist, this is an important initial step of the comprehensive voice evaluation. Many patients with voice disorders seek treatment when they perceive something abnormal with their voice.[21] Audio-perceptual voice assessments quantify the severity of

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audible voice parameters and are used to characterize specific features of voice,[21] including pitch, loudness, and quality. Information gleaned from audio-perceptual assessments is ideally examined alongside information obtained during other, more objective assessments including acoustic analysis. Here, information pertaining to vocal frequency, intensity, and perturbation measures, obtained from the client, is compared with age- and gender-matched norms.[22] Examples of commonly used audio-perceptual assessment scales include the GRBAS scale, the Roughness, Breathiness, and Hoarseness (RBH) scale, the Consensus Auditory Perceptual Evaluation of Voice (CAPE-V), and the Grade, Roughness, and Breathiness (GRB) scale. Each of these evaluates vocal quality during conversational speech or speech produced while reading.[23] There is evidence that relates the findings of perceptual, visual (endoscopic or stroboscopic), and acoustic assessments to the presence of voice pathology.[22] However, little information exists detailing the relationship between perceptual assessment of voicing and patient-specific voice complaints. Whereas Tavares and Martins[9] showed that voice disorders were more prevalent in individuals displaying perceptual voice symptoms, Åhlander et al[8] and Gotaas and Starr[24] found no significant differences in perceptual variables relating to voice status between two groups, one with and one without vocal complaints.

Acoustic measures with vocal complaints

Acoustic analysis procedures are noninvasive and relatively simple to obtain,[25,26] and help the therapist to differentiate between normal and abnormal voices as well as quantify patient response to intervention.[26] Mixed findings exist as to the nature of acoustic measures of voice function in teachers with voice complaints. Rantala and Vilkman[27] found a positive relationship between voice complaints and increases in fundamental frequency (F_0); however, frequency perturbation (jitter) and amplitude perturbation (shimmer) were decreased in teachers with a greater number of voice complaints compared to those with few complaints. Ma and Yiu[28] and Laukkanen et al[29] found no relationship between the presence of vocal complaints and aberrant acoustic measures of vocal function.[30]

Little is known about these issues as they relate to voice complaints, particularly among Iranian teachers; however, due to concerns related to health affairs in teachers and comparisons across cultures in voice topics,[31] it seems necessary to do a survey. We sought to delineate differences between teachers with and without voice complaints, and also if there is any relation between teachers' voice complaints and other assessment results; so, the central aim of this study was to distinguish differences in: (1) reported vocal symptoms, (2) audio-perceptual assessment of voice quality, and (3) acoustic variables relating to voice function in two cohorts: teachers with and without voice complaints. We also compare these two groups based on age and years of teaching.

METHOD

Subjects

The study was approved by the ethics committee of the Iran University of Medical Sciences and all of the participants provided informed consent prior to data collection. Cluster sampling was used to select 99 female elementary school teachers from all public elementary schools in Tehran, Iran. We included only female teachers as it was shown that the prevalence of voice problems is higher in female than in male teachers[32,33] (see Table 1).

Following informed consent and baseline data collection, the teachers were assigned to one of two groups according to their responses to the following question: "Do you feel you have a voice problem?" Teachers who responded "yes" were assigned to the "with voice complaint" (VC) group. Teachers who responded "no" were assigned to the "without voice complaint" (W-VC) group.

PROCEDURES

Voice samples

Voice samples were collected from each participant using a head-mounted microphone (type: ECM-717 electret condenser microphone, Sony Corporation, Tokyo, Japan) placed at a 45 degree angle, 10 cm distance from the mouth. A sound recording program, native to the study laptop (LG company; Model: LS70, Korea), was used to record the voice signals for later analysis. After the microphone was placed, each participant was instructed to read a standard passage in Persian, count from 1 to 20, and sustain the vowel /a/ for at least 5 seconds, three times. During each task, the participant was instructed to speak in a comfortable, conversational style using typical pitch and loudness levels. The third repetition of /a/ was selected for acoustic analysis.[23] A sound level meter (Model: CEL-450, product of CASELLACELL, Casella Measurement, Buckinghamshire, UK) was used to measure the noise level of room to be Min LA: 28.00 dB and Min LC: 40.8 dB.

TABLE 1.
Inclusion and Exclusion Criteria

Inclusionary Criteria	Exclusionary Criteria
• Female	• Current or former smoker
• Aged at least 50 years (so as to avoid voice effects attributable to menopause or premenopause)	• History of heart, pulmonary, or neurologic disease
• Employed as a teacher full time (defined as an average of 36 working hours per week over 5 days)	• History of allergies
• Normal hearing	• History of head and neck surgery
• Native Persian speaker	• History of gastroesophageal reflux
	• Respiratory infection within 3 weeks of participation

All voice samples were analyzed using the *Dr. Speech program* (4th version; Tiger Ltd., USA) and its *Real Analysis software* for F_0, mean F_0, F_0 range, harmonic to noise ratio (HNR), jitter, and shimmer. The sample rate was set as 48 000 Hz, and no peak clipping was noted. The initial and final 200 ms were removed from the vowel production to avoid known potential variability of onset and offset phases.[34]

Self-report of vocal symptoms

The study clinician reviewed the 9 primary symptoms[35] of voice disorders with the participants, then asked them to note any vocal symptom that they were experiencing at that moment or in the last 2 weeks. These symptoms were presented as *hoarseness, vocal fatigue, breathy voice, reduced pitch range, aphonia, pitch breaks* (including transient inappropriately high pitch), *strain/struggle voice, tremor*, and *pain* or *other abnormal physical sensations*. These symptoms were selected because they are among the most common symptoms reported by voice patients.[35]

Audio-perceptual analysis

Three expert voice pathologists completed audio-perceptual evaluation of collected voice samples, including recordings of the reading passage. We asked the raters to evaluate the voice quality based on "G" from the GRBAS scale; 0 and 1 were evaluated as *Normal* and 2 and 3 were evaluated as *Abnormal*. The samples were assigned a binary rating of *normal* or *abnormal* in the final analysis. There was no need to evaluate the severity and type of the voice problem to match and compare experts' opinion versus teachers' opinion about voice quality. Hence, based on experts' opinion, each voice sample was labeled as *normal* or *abnormal* if at least two out of 3 experts agreed to the assignment.

Statistical procedures

SPSS 18 was used for statistical analysis of all data obtained during this investigation. Normal distribution of data was confirmed and mean values of ages, years of teaching, and acoustic measures were compared between participants in the VC and W-VC groups via independent *t* test. The self-reported voice symptoms and auditory-perceptual assessment results were also compared between both groups via chi-square by Fisher's exact test. Binary logistic regression was used to evaluate the odds ratio and 95% confidential intervals with respect to self-reported voice symptoms; theW-VC group was considered as the reference group.

RESULTS

Demographic data

Ninety-nine full-time female teachers agreed to participate in this study. Of these, 21 (21.21%) teachers indicated that they believed they had a voice problem and were assigned to the VC group. The remaining 78 (78.78%) teachers reported no voice problem and were assigned to the W-VC group (Table 2).

TABLE 2.
Demographic Information (VC: Self-Reported Voice Problem)

	Groups		
Mean (SD)	*VC*	*W-VC*	*P* Value
Age	42.05 (7.55)	42.33 (7.89)	0.88
Years of teaching	19.55 (7.69)	20.76 (5.29)	0.40

Abbreviations: SD, standard deviation; VC, with voice complaint; W-VC, without voice complaint.

Vocal symptoms

Hoarseness and vocal fatigue were the most reported symptoms in both groups (Table 3). There were statistically significant differences between the two groups with regard to self-reported voice symptoms of *hoarseness*, *breathiness*, *pitch breaks*, and *vocal fatigue* ($P < 0.05$). None of the teachers reported reduced phonation range. Based on logistic regression results, the instance of *hoarseness* was about 11 times higher in teachers in the VC group. There were no association between risk of voice complaints and instance of breathiness, pitch breaks, and vocal fatigue.

Auditory-perceptual assessment

Expert evaluation of voice quality based on the "G" scores of GRBAS resulted in 54 diagnosed as having *abnormal* voice quality—14 from the VC group and 40 from the W-VC group. The other 45 teachers were determined to display *normal* voice quality. The results based on Fisher's exact test showed that there was no relationship between perceptual assessment and vocal complaint results ($P = 0.22$). The mean age and years of teaching differed significantly between teachers with normal voice and teachers with abnormal voice ($P = 0.01$). The results are presented in Tables 4 and 5.

Acoustic analysis

The mean values of F_0, jitter, and shimmer, obtained from both groups, are provided in Table 5. The only parameter that varied significantly between the two groups was *HNR*. The effect size of HNR was interpreted as moderate (ES = 0.55) (Table 6).

DISCUSSION

This study is the first of its kind to focus on voice complaints exibited by Iranian teachers.[17,31,36,37] The central objective of this investigation was to determine if teachers' feelings regarding their voice quality corresponded to expert perceptual and acoustic measures of voice quality. An additional objective was to identify factors that could distinguish teachers with voice complaints from those without voice complaints relative to (1) vocal symptoms, (2) audio-perceptual assessment of voice quality, and (3) acoustic analysis.

Self-assessment of voice status

Just under a quarter of teachers participating in this study reported experiencing voice complaints at any time in the 2 weeks

TABLE 3.
Vocal Symptoms Reported by Iranian Teachers

	Logistic Regression				Chi-square		
		95% CI			VC (n = 78)	W-VC (n = 21)	
Symptoms	OR	Lower	Upper	*P* Value	N (%)	N (%)	*P* Value
Hoarseness	11.17	1.25	99.70	**0.03***	20 (95.23)	39 (50)	0.001*
Breathiness	5.09	1.36	18.94	0.15	12 (57.14)	12 (15.38)	0.001*
Pitch break	1.73	0.50	0.5.92	0.37	11 (52.38)	21 (26.92)	0.027*
Pain	0.15	0.01	1.99	0.15	6 (28.57)	1 (1.28)	0.54
Reduced phonation range	—	—	—	—	0 (0.0)	0 (0.0)	—†
Tremor	0.89	0.09	8.27	0.92	3 (14.28)	4 (5.12)	0.162
Strain voice	1.50	0.34	6.65	0.58	7 (33.33)	12 (15.38)	0.66
Vocal fatigue	1.94	0.42	8.94	0.39	18 (85.71)	38 (48.71)	0.002*
Aphonia	2.09	0.61	7.14	0.23	12 (57.14)	27 (34.61)	0.53

* $P < 0.05$.
† None of the teachers reported reduced phonation range.
Abbreviations: CI, confidence interval; OR, odds ratio; VC, with voice complaint; W-VC, without voice complaint.

TABLE 4.
Perceptual Assessment of Voice Quality

	Chi-square	
Perceptual Assessment	VC (N = 21) n (%)	W-VC (N = 78) n (%)
Normal voice (n = 45)	7 (33.3)	38 (48.7)
Abnormal voice (n = 54)	14 (66.7)	40 (51.3)
P	**0.22**	

Abbreviations: VC, with voice complaint; W-VC, without voice complaint.

TABLE 5.
Differences in Age and Years of Teaching Based on Perceptual Assessment of Voice Quality

	t Test	
Perceptual Assessment	Age Mean (SD)	Years of Teaching Mean (SD)
Normal voice (n = 45)	40.11 (8.40)	17.80 (7.93)
Abnormal voice (n = 54)	44.07 (6.79)	21.48 (6.20)
P	**0.01***	**0.01***

* $P < 0.05$.

TABLE 6.
Acoustic Analysis Results

		Group			
Acoustic Parameters		VC	W-VC	*P*	ES
F_0 –V	Mean	199.08	199.61	0.99	–0.02
	SD	30.68	22.38		
Jitter (%)	Mean	0.54	0.41	0.05	0.45
	SD	0.313	0.262		
Shimmer (%)	Mean	4.46	3.77	0.13	0.37
	SD	1.91	1.83		
HNR	Mean	15.12	17.3	***0.03****	**–0.55**
	SD	3.44	4.38		
F0 –C	Mean	188.81	189.14	0.95	–0.01
	SD	27.04	19.39		
F0 –R	Mean	187.22	187.91	0.89	–0.03
	SD	26.59	19.58		

* $P < 0.05$.
Abbreviations: C, counting; ES, effect size; HNR, harmonic-to-noise ratio; R, reading; SD, standard deviation; V, vowel; VC, with voice complaint; W-VC, without voice complaint.

preceding their participation in this study. This estimate can be considered alongside rates previously reported by Leão et al,[38] Behlau et al,[4] Thomas et al,[10] Van Houtte et al,[3] and Meulenbroek and de Jong.[7] Varying estimates of the prevalence of voice complaints in teachers seem to be the product of varying methodologies.

The majority of teachers participating in this investigation did not report any voice complaints.

The incidence of all vocal symptoms was higher in the VC group when compared to the W-VC group. This finding is in accordance with Behlau et al,[39] Rodrigues et al,[2] Martins et al[1] and Tavares and Martins.[9]

Participants assigned to the W-VC and VC groups differed in the incidence, but not type of self-reported voice symptoms. In both groups, vocal fatigue and hoarseness were the most commonly reported symptoms, followed by breathiness, pitch breaks, and aphonia. Previous studies have attempted to quantify the prevalence of hoarseness,[9,40] throat dryness,[2,41] sore throat,[2] loss of singing range,[2,40] globus ("lump in the throat"), tickling,[41] aphonia, weakness in speaking,[40] vocal fatigue,[9,29] decreased loudness and ability to produce projected voicing.[9] Teachers who reported voice complaints were more likely to suffer from hoarseness in comparison with teachers in the W-VC group.

The high prevalence of voice symptoms among all teachers and the reported symptoms, revealed by this investigation, are in agreement with earlier findings and likely occur secondary to increased professional risk factors including speaking to a large number of students, long working hours,[9] longer recovery times brought about by daily heavy vocal use, or as a sequelae of chronic laryngitis.[38]

Perceptual assessment

A sizeable percentage of teachers both with and without voice complaints demonstrated vocal abnormalities on audio-perceptual assessment. There were no significant differences between the two groups on perceptual assessment. This finding was in agreement with earlier works by Gotaas and Starr[24] and Åhlander et al,[8] both of which found no differences in voice quality between two groups of teachers: those with and without voice complaints. However, Tavares and Martins detected voice quality changes in both groups, particularly among those teachers with voice complaints.[9] Meulenbroek and de Jong[7] also showed that 86% of teacher students with voice complaints and 76% of those without voice complaints were ultimately diagnosed with dysphonia.

These results may suggest that self-assessment is not a reliable indicator of voice abnormalities in teachers.

Teachers assigned by expert raters to the abnormal and normal voice groups varied with respect to age and years of teaching; differences not seen between the VC and W-VC groups. These results were in accordance with Roy et al[42] and Smith et al,[43] but not with Chen et al.[44] These differences may emphasize the effects of intensive years of teaching on the voice quality of teachers. As our samples were all under 50, it is not likely that these differences are related to hormonal changes and aging voice.

Acoustic analysis

There was no difference between the two groups in mean F_0 on vowel prolongation, reading, and counting tasks. These findings were in accordance with Aghadoost et al,[37] but not with Laukkanen et al[29] or Rantala and Vilkman[27]. In the latter investigation,[27] teachers with few voice complaints demonstrated a lower mean F_0 compared to teachers with more voice complaints. Some authors have concluded that excessive vocal use could alter mean F_0.[11,15] The fact that no significant between-group differences in mean F_0 were found suggest that F_0 changes may not be a determining factor as to whether or not teachers felt they had a voice problem.

The only acoustic parameter demonstrating significant between-group differences was HNR, which was higher in the W-VC group. HNR represents average ratio of harmonic-to-noise energy within the voice signal.[45] Higher measures of HNR therefore indicate a more "normal" sounding voice where acoustic energy from harmonics contributes more than noise to the overall signal. Higher measures of HNR in the W-VC group suggest that the teachers without voice complaints did, in fact, demonstrate more "normal" (ie, periodic) voicing signals. The effect size of 0.55 showed that the HNR differences could moderately be affected by sample size and distribution.

CONCLUSION

Teachers' self-report of voice complaints does not universally correspond to perceptual and acoustic measures of voice parameters. Perhaps this is suggestive of an unmet need for teachers to receive further education pertaining to voice disorders to increase their ability to accurately detect abnormal voicing. Teachers with no underlying indicators of dysphonia were found among those in the VC group, and vice versa. Although patient self-assessment is a crucial component of the diagnostic process, it is not sufficient as a sole indicator of dysphonia. Increased rates of hoarseness and vocal fatigue were reported by teachers in both groups, although teachers in the VC group reported hoarseness more frequently than those in the W-VC group. HNR was the only acoustic parameter that differed significantly between groups, with teachers assigned to the W-VC group demonstrating larger (ie, more "normal sounding") values of HNR. The other acoustic parameters did not differ between groups, possibly because the teachers' voice problems were relatively new-onset and without associated major structural changes and corresponding changes in acoustic parameters (although we know that symptoms sustained over time may result in small to large-scale changes in both vocal fold structure and function).[1,15] These findings suggest that self-assessment should be used in conjunction with other, subjective and objective assessment tools, to obtain a better image of voice quality.

LIMITATIONS

Visual assessment tools such as videoendoscopy (with or without stroboscopy) were not used in this investigation. Future investigations may wish to include these additional measures to better examine voice symptoms within the context of structural changes to the larynx.

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