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A Comparison of Dysphonia Severity Index in Female Teachers With and Without Voice Complaints in Elementary Schools of Tehran, Iran

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ABSTRACT

Background: Teachers are the greatest group of professional voice users. Prolonged, continuous speaking in a loud voice at school may entail a bad vocal health. It seems that their occupational circumstances make them more likely to develop voice disorders in comparison with other groups.

Objectives: The purposes of this study are 1) to compare teachers with and without voice complaint on the Dysphonia Severity Index and 2) to compare component measures that establish Dysphonia Severity Index.

Materials and Methods: This study included 40 female teachers with voice complaint and 40 female teachers without voice complaint between the ages of 30 and 50 years who were teaching in elementary schools of Tehran city. Simple non-random sampling was done for selected teachers in two groups. The examinees were asked to produce the vowel /a/ three times for calculating any variables, then measures of maximum phonation time, jitter, highest phonational frequency, and lowest intensity were obtained for each subject with Praat and Phonetogram softwares and incorporated into multivariate Dysphonia Severity Index formula. Kolmogoro- Smirnov one sample test and independent sample T-Test was used, the significance level was set at $P < 0.05$.

Results: Results indicate that female teachers without voice complaint have significantly higher Dysphonia Severity Index scores than female teachers with voice complaint (mean Dysphonia Severity Index: 3.58 vs. 1.05, respectively), also significant differences are observed between groups of with and without complaint for four of components of the DSI (F0 high, I low, jitter and maximum phonation time) (P value = 0.001).

Conclusions: The findings of this study indicate that there is a significant difference in Vocal Quality between teachers with and without voice complaint. This finding may indicate teachers with voice complaint have worse vocal quality that means they are at risk for voice problems. This information may be very important for voice professionals and, speech and language pathology to advice teachers with voice complaint and manage to advocate "good vocal health".

Keywords: Voice; Muscle Weakness; Severity of Illness Index; Dysphonia

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► Implication for health policy/practice/research/medical education:

Teachers are the greatest group of professional voice users. Prolonged speaking in a loud voice at work may entail a risk to vocal health. It seems that their occupational circumstances are so that they are more apt to voice disorders in comparison with other groups.

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1. Background

One of the most important tools of communications is voice (1). We express our thoughts and opinions in the form of words and by the sound produced by the larynx (2). Producing this voice will impact the speakers and audiences (3). Voice problems are common among voice professional users (4-6). Teachers are the greatest group of professional voice users that need their voice for daily professional activities routinely (4-8). Thus, they are considered to be at risk for voice problems (8). These problems have been studied in many researches. These studies indicated that 11% to 80% of teachers deal with voice problems while this rate is 1% to 36% in non-teachers (5, 9). Roy et al. reported that the prevalence of voice disorders is higher in teachers (11%) compared with non-teachers (6.2%). These may result in job restrictions and missing work days (5). Dysphonia is the most common pathological process in professional voice users especially teachers (4). Sometimes this problem is so unpleasant that 20% of teachers who have voice-disorder have to miss work days (5). Voice-disorders of teachers lead to inability of listeners (students) to focus on the speaker's words and his/her annoyance (10). Abnormal voice is created by prolonged use of voice then teachers compensate this with empowering their voice and consequently it gets worse (7, 8). Studies show that getting poorer voice lead to increasing of voice complaint and voice handicap (11). This is a general opinion that voice disorders not only have negative effects on the quality of life and professional activities but also impose high costs of therapy and health care (6). There are different definitions of voice disorder. In fact; voice disorder is any disorder in the normal voice. Any deviation in pitch, intensity and quality of voice causes disorder and other people pay more attention to it. Thus, there will be an undesirable effect on both the speaker and the listener (12). Also, the voice of an individual is indicating the physical state of larynx (13). Several factors like talking with the higher sound pressure in the noisy conditions, using of voice for a long time, making effort for talking with a voice louder than others and the bad condition of classrooms will cause various voice disorders in teachers (7, 8). These disorders have destructive impacts not only on the class management but also on the comprehension and learning of students (10) whereas teachers may not be aware of risk factors associated with voice problems. There is an indication that vocal loading and environmental factors are influential in teachers with voice complaints. Morton and Watson mentioned that teachers might view voice problems as an occupational hazard that they must endure as part of the career (14, 15). For evaluating of voice disorders, there are different ways; for example perceptual, acoustic, aerodynamic and physiological assessments by using of computers and laboratory developed equipment (2). In the last decade, voice professionals tried to invert

new methods for thorough evaluation of the voice. For objective evaluation of voice quality, several methods are used and one of them is dysphonia severity index (DSI). Therapeutics know that evaluation of multi parameters is more suitable than evaluating only one parameter like fundamental frequency, shimmer, jitter, frequency (16, 17). The major and fundamental advantage of the DSI is that speech and language pathologists in daily clinical practice can obtain the parameters relatively quick and easy. It is a valuable clinical tool for the quantitative description of voice disorders (16, 17). Duffy and Hazlett's have used DSI to investigate the vocal quality among trainee teachers. A DSI value of + 4 (indicating a normal voice quality) was found (18). Van Lierde et al. investigated the vocal quality in female trainee teachers. Results show that DSI scores increased during the study from + 2.0 in the first year of study to + 2.7 in the second and +3.1 in the third year of study (19). In spite of the importance of the teachers' general and voice related health and its impact on the students' learning and achievement, there is a lack of study in this field in Iran.

2. Objectives

The main purpose of this study was to determine the objective vocal quality (DSI: Dysphonia Severity Index) and the acoustic characteristics that arrange it, in female teachers of elementary schools in Tehran city. Female teachers with and without voice complaint were investigated using DSI as an objective multi-parameter approach for measuring the voice quality.

3. Materials and Methods

This study is a case-control study. The sample size used in the study is determined based on the need to have sufficient statistical power and according to standard deviation of Hakkesteegt and et al, report. Eighty female teachers in elementary schools who had the inclusion criteria placed in two groups with voice disorder ($n = 40$) and without voice complaints ($n = 40$). The two groups were matched in terms of age and teaching experience (with a range of ± 5 years) and in term of average hours of working per week. The study was performed in 17 elementary schools of Tehran city that these schools were selected randomly between elementary schools of Tehran city from April to June 2012. The inclusion criteria in two groups were: no history of voice therapy, no allergic history, no addiction to any of narcotics or smoking, no Catching colds and upper respiratory tract infection three weeks prior recording audio samples or in assessment day and no placing in a menopause or menstrual period at the time of study. Exclusion criteria were, Unwillingness to continue the evaluation and sound recording.

3.1. Procedures

Initially, according to the answer of participants to our question, they were placed in either the group of with or without voice complaint: a subjective evaluation of experienced voice complaints at the moment of assessment or during the past year was used as a measure for placing the subjects in the study groups (20). The answers were rated as “no” or “yes”. Then, two groups completed demographic questioner (including age, teaching experience, education background, level of teaching, number of student, working hours in week) and then acoustic assessment was performed.

3.2. Acoustic Assessment (for DSI)

Recordings were made on an external sound card (TASCAM US-122mkII, Montebello, California, USA, TEAC AMERICA, INC) that was attached to laptop with a microphone AKG (AKG C410, A Harman international company, Vienna/ Austria) that had frequency response Hz50 to kHz20. Then for the transfer of recorded sounds, a digital recorder was connected to the laptop. Each subject was asked to complete the following tasks:

1) Frequency and intensity. Participants were tested individually. Dynamic microphone was used for recording. The microphone was placed at a distance of 10 cm with 30 degree' angle from the mouth of the participants. This instruction was accompanied by a demonstration by the speech pathologist. Frequency was measured in Hertz, intensity in dB SPL. Participants were instructed to phonate vowel /a/ as gently as possible at a comfortable pitch. After this, they were instructed to phonate vowel /a/, starting at a comfortable pitch going up to the highest and down to the lowest pitch. The clinician prompted and modeled the subject to achieve the highest possible pitch. This was recorded three times directly into the Phonetogram software (lingcomphonetogram (version 1.x). The voice range profile of Phonetogram was used to extract the highest F0 and lowest intensity (16, 17, 21).

2) Jitter: To obtain a measure of jitter, the subject sustained the vowel /a / for 3 seconds at that similar pitch level. This elicitation method was used to obtain a vowel sample that closely approximates the subjects' habitual speaking pitch (16). Three trials were elicited. Each production was digitally recorded at 44.1 kHz, 16 bit s of resolution. The central 1-second of each sustained vowel was later analyzed for jitter percentage (%) using the Praat software (Paul Boersma and David Weenink, Amsterdam, the Netherlands).

3) MPT (maximum phonation time): When measuring MPT, the subject was asked to hold out a sustained vowel /a / for as long as possible after a maximum inhalation. Three trials were elicited. Each trial was timetabled with a digital stopwatch to calculate the duration (in seconds) (16, 17, 21).

3.3. Dysphonia Severity Index Formula

The DSI formula is derived from a weighted combination of the following vocal parameters: Highest frequency (Hz), lowest intensity (dB), MPT (seconds), and jitter percentage. For each subject, the DSI was calculated using the maximum performances for F0-high and MPT, the lowest intensity, and jitter (17). The results were entered into the following formula:

$$DSI = 0.13 \times MPT + (0.0053 \times F0\text{-High}) - (0.26 \times I\text{-Low}) - (1.18 \times \text{Jitter } \%) + 12.4.$$

For each subject, Final score of DSI, placed between +5 to -5. Normal voice corresponds with a DSI of +5 and a severely dysphonic voice corresponds with a DSI of -5 (16, 17, 21).

3.4. Data Analysis

The distribution of the measurement data was tested for normality with the Kolmogorov Smirnov one-sample test. When the distribution of the measurements was normal, the data was analyzed using the statistical program SPSS 16.0 (SPSS Inc, Chicago, IL). Independent Sample T-Test was used and Odds ratio was calculated, the significance level was set at $P < 0.05$.

3.5. Ethical Considerations

This research was part of an MS thesis and supported by Department of Speech Therapy affiliated to Tehran University of Medical Sciences in Iran. In this study the participants received information concerning the study, and all participants signed the informed consent before participation. They were assured that their information would remain confidential. Also we tried to prevent disruption in the schools, and it was also noted that teachers who were at the risk of voice problems, if they like, would be treated. The researchers observed all ethical issues in accordance with the Helsinki Convention.

4. Results

The mean age of the teachers with voice complaint was 44.5 ± 3.55 years, and in teachers without voice complaint, it was 43.5 ± 4.32 years in a range of 32-50 years. Demographic characteristics of teachers with and without voice complaint were not significantly different (Table 1). The results of Independent Sample T-Test for acoustic characteristics indicated a significant difference in MPT, F0-High, L-low, and jitter and DSI values when compared between the two groups of with and without voice complaint. MPT in teachers with voice complaint (12.21 seconds) was significantly lower than teachers without voice complaint (17.16 seconds). Jitters in teachers with voice complaint (380 Hz) were significantly higher than teachers without voice complaints (264 Hz). L-low in teachers with voice complaint (54.89 dB) was significantly higher than teachers without voice complaint (48.48 dB). F0-

high in teachers with voice complaint (343.2 Hz) was significantly lower than teachers without voice complaint (416.8 Hz) and DSI in teachers with voice complaint (1.70) was significantly lower than teachers without voice complaint (3.58). Mean, SD, and range of DSI and parameters are presented in the Table 2. Also, according to scores

of DSI, the results show that all subjects in the group of teachers without voice complaint had normal voice quality. The scores in DSI were higher than + 5 for them but 15 subjects (37.5%) in the group of teachers with voice complaint had lower score in DSI (score lower than -5) that indicates abnormal voice quality.

Table 1. Demographic Characteristics of Teachers With and Without Voice Complaint

Demographic Characteristics	Teachers without voice complaint, (n = 40)	Teachers with voice complaint (n = 40)	P value
Age, y, Mean \pm SD	43.5 \pm 4.32	44.5 \pm 3.55	0.158
Teaching experience, y, Mean \pm SD	22.08 \pm 3.28	21.62 \pm 3.79	0.592
Average hours of work, weekly, Mean \pm SD	24.41 \pm 2.53	24.47 \pm 1.89	0.96
Level of Education, No. (%)			0.821
Diploma	4 (10)	4 (10)	
Associate degree	16 (40)	15 (37.5)	
Bachelor's Degree	17 (42.5)	20 (50)	
Master's Degree	3 (7.5)	1 (4)	
Level of Teaching, No. (%)			0.265
First year	6 (15)	11 (27.5)	
Second year	12 (30)	14 (35)	
Third year	9 (22.5)	3 (7.5)	
Four year	8 (20)	8 (20)	
Five year	5 (12.5)	4 (10)	

Table 2. Mean, Standard Deviation of Dysphonia Severity Index, Maximum Phonation Time, Jitter, L-Low, and F0-High in Teachers With and Without Voice Complaint

Variables	Teachers without voice complaint (n = 40)			Teachers with voice complaint (n = 40)			95% Confidence Interval of the Difference	P value
	Mean \pm SD	Minimum	Maximum	Mean \pm SD	Minimum	Maximum		
Dysphonia severity index	3.58 \pm 0.92	1.68	4.78	1.17 \pm 1.04	-0.99	2.97	1.98, 2.85	0.001
Maximum phonation time, second	17.16 \pm 4.08	11.50	27.10	12.21 \pm 2.98	5.20	17.60	3.36, 6.53	0.001
Jitter, Hz	264 \pm 0.09	0.127	0.527	0.380 \pm 0.09	0.238	0.722	-0.153, -0.073	0.001
L-low, dB	48.48 \pm 7.99	47.13	53.80	54.89 \pm 2.93	50.90	60.40	-9.08, -3.72	0.001
F0-high, Hz	416.8 \pm 55	294.90	554	343.2 \pm 43	222.20	403.70	51.75, 95.46	0.001

5. Discussion

The results of current study indicate that teachers without voice complaint have higher scores in DSI, MPT and F0-high; and lower scores in I-low and jitter than teachers with voice complaint. The DSI is a relatively simple and easy technique to obtain objective evaluation for dysphonia, which can be used in daily clinical practice.

First of all; MPT was significantly lower in teachers with voice complaint compared to teachers without voice complaint. This variation may be because of the difference in the vital capacity or larynx dysfunction (2). Solomon et al reported no relationship between vital capacity and MPT (22), but most of the studies support the link between them. Larger lung volume and better air flow will help in getting voice for larger duration (23, 24). Ad-

ditionally, they suggested that longer phonation time is generally related to longer phonation volume (25). Lewis et al found a significant and dominant relation between vital capacity and length of phonation of vowel /a/ (26). Therefore, it seems that in teachers with voice complaint breath support and vital capacity tends to be decreased, that lead to lower phonation time. Secondly, F0-High was significantly higher in teachers without voice complaint than teachers with voice complaint. Reduce in F0-High in teacher with voice complaint seem to reflect increased muscle tonus as an adaptation to loading and also reduced phonatory control (11). Thirdly, the I-Low was significantly higher in teachers with voice complaint when compared to teachers without voice complaint. This can be attributed to the habitual style of speaking. This finding is consistent with similar studies that have indicated increased phonatory control and a lowering of the minimum intensity ability for subjects who are without voice complaint. Also in teachers without voice complaint, breath support and controlled phonatory tend to be conducive to lower minimum intensity productions. Fourth, the jitter was significantly higher in teachers with voice complaint when compared to teachers without voice complaint. Jitter shows the degree of irregularity of the vocal fold vibration, within certain limits. Increase in jitter correlated with tiredness of throat, possibly reflecting muscle fatigue (25), so this information indicates in teachers with voice complaint; may be exist irregularities of the vocal fold vibration. Finally, the difference in the DSI score was because of greater difference in the MPT, I-Low, jitter and F0-high values between teachers with and without voice complaint. As a result, DSI differentiates between groups of individuals with and without voice complaints. Hence, the results indicate that there are links between voice complaint and dysphonia severity index. Rantala et al reported lack of correlation between the subjective complaints and the objective measurements (27). This difference with our study, can explain by the use of different approach to assessment voice complaint and differences in methods for acoustic assessment (use of single parameter measurements vs. multi-parametric measurement (DSI)). Duffy and Hazlett reported a DSI value of +4.0 indicating a good vocal quality in 55 trainee teachers (18). It is not clear how the difference in DSI values should be explained. This difference with the DSI values of our study (with complaint = +1.17 vs. without complaint = +3.58) cannot be explained by the use of different equipment (digital audio tape vs. a direct acoustic analysis), but can explained in numbers and ages of the participants and in group that Duffy and Hazlett study (teacher in general). This finding indicates teachers with voice complaint are at risk for voice problems. Because teaching is a high-risk profession for the development of voice problems. The incorporation of a direct vocal training technique to increase vocal endurance during teaching together with a vocal hygiene

program, dietetics, and a stress management training program is needed to prevent occupational dysphonia. These findings may be crucial for voice professionals and, speech and language pathologists to advice teachers and management to advocate "good voice". On the other hand, results of few studies in the field of voice disorder in nurses indicate that however they are at risk for voice problem (28, 29), they have to communicate with their patients verbally and talk about patients` problems with their families and physicians. Nurses have essential roles in the voice clinics or hospital and they, as a member of multidisciplinary team, provide care for patients with voice disorders both directly and indirectly. Direct responsibilities involve patient care and the coordination of care provided by all members of the voice team. Indirect care includes providing and maintaining a safe physical environment in which the patient receives care and treatment from all members of the team. Nurses educate patients and their families. So they should be familiar with characteristics of patients with voice disorders generally, and professional voice users specially. Although this is a new notion in our country, this study can be helpful in this field and make a start for the Iranian nursing community. Although a few studies have been in this field (voice disorder in nurses) but we can study occupational voice health in nursing community, which suggested for future research. Also we recommend the study of occupational voice health and risk factors in other professional voice users such as actors, singers, and politicians for future research. In this study, we were limited by lack of cooperation from some of the principals and teachers of schools for sampling. Also sampling intervals were interfering with hours of teaching.

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Authors' Contribution

Ozra Aghadoost and Negin Moradi were responsible for study concepts and design, made critical revisions to the paper for important intellectual content, data collection and participated in preparing the first draft. Younes Amiri-shavaki helped with preparing the first draft and supervised the study. Shohreh Jalai performed the data analysis.

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References

- Nicolosi L, Harryman E, Kresheck J. *Terminology of Communication Disorders: Speech-Language-Hearing*. Lippincott Williams & Wilkins; 2004.
- Sataloff RT. *Professional voice: the science and art of clinical care*. Plural Pub., Inc.; 2005.
- Bouwers F, Dijkers FG. A retrospective study concerning the psychosocial impact of voice disorders: Voice Handicap Index change in patients with benign voice disorders after treatment (measured with the Dutch version of the VHI). *J Voice*.2009;**23**(2):218-24.
- de Medeiros AM, Barreto SM, Assuncao AA. Voice disorders (dysphonia) in public school female teachers working in Belo Horizonte: prevalence and associated factors. *J Voice*.2008;**22**(6):676-87.
- Roy N, Merrill RM, Thibeault S, Gray SD, Smith EM. Voice disorders in teachers and the general population: effects on work performance, attendance, and future career choices. *J Speech Lang Hear Res*.2004;**47**(3):542-51.
- 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.
- Åhlander VL, Rydell R, Löfqvist A. How do teachers with self-reported voice problems differ from their peers with self-reported voice health? *J Voice*.2012;**26**(4):e149-e161.
- Morrow SL, Connor NP. Comparison of voice-use profiles between elementary classroom and music teachers. *J Voice*.2011;**25**(3):367-72.
- 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):570-5.
- Rogerson J, Dodd B. Is there an effect of dysphonic teachers' voices on children's processing of spoken language? *J Voice*.2005;**19**(1):47-60.
- Kooijman PG, de Jong FI, Oudes MJ, Huinck W, van Acht H, Graamans K. Muscular tension and body posture in relation to voice handicap and voice quality in teachers with persistent voice complaints. *Folia Phoniatri Logop*.2005;**57**(3):134-47.
- Colton RH, Casper JK, Leonard R. *Understanding Voice Problems: A Physiological Perspective For Diagnosis And Treatment*. Lippincott Williams & Wilkins; 2006.
- Chen SH, Chiang SC, Chung YM, Hsiao LC, Hsiao TY. Risk factors and effects of voice problems for teachers. *J Voice*.2010;**24**(2):183-90.
- Gotaas C, Starr CD. Vocal fatigue among teachers. *Folia Phoniatri (Basel)*.1993;**45**(3):120-9.
- Morton V, Watson DR. The teaching voice: problems and perceptions. *Logopedics Phoniatrics Vocology*.1998;**23**(3):133-139.
- Schindler A, Mozzanica F, Vedrody M, Maruzzi P, Ottaviani F. Correlation between the Voice Handicap Index and voice measurements in four groups of patients with dysphonia. *Otolaryngol Head Neck Surg*.2009;**141**(6):762-9.
- Wuyts FL, De Bodt MS, Molenberghs G, Remacle M, Heylen L, Millet B, et al. The dysphonia severity index: an objective measure of vocal quality based on a multiparameter approach. *J Speech Lang Hear Res*.2000;**43**(3):796-809.
- Duffy OM, Hazlett DE. The impact of preventive voice care programs for training teachers: a longitudinal study. *J Voice*.2004;**18**(1):63-70.
- Van Lierde KM, Claeys S, Dhaeseleer E, Deley S, Derde K, Herregods I, et al. The vocal quality in female student teachers during the 3 years of study. *J Voice*.2010;**24**(5):599-605.
- Meulenbroek LF, de Jong FI. Voice quality in relation to voice complaints and vocal fold condition during the screening of female student teachers. *J Voice*.2011;**25**(4):462-6.
- Hakkesteegt MM, Brocaar MP, Wieringa MH, Feenstra L. The relationship between perceptual evaluation and objective multiparametric evaluation of dysphonia severity. *J Voice*.2008;**22**(2):138-45.
- Pearl Solomon N, Garlitz SJ, Milbrath RL. Respiratory and laryngeal contributions to maximum phonation duration. *J Voice*.2000;**14**(3):331-340.
- Bovo R, Galceran M, Petruccielli J, Hatzopoulos S. Vocal problems among teachers: evaluation of a preventive voice program. *J Voice*.2007;**21**(6):705-22.
- Sliwinska-Kowalska M, Niebudek-Bogusz E, Fiszler M, Los-Spychalska T, Kotylo P, Sznurowska-Przygocka B, et al. The prevalence and risk factors for occupational voice disorders in teachers. *Folia Phoniatri Logop*.2006;**58**(2):85-101.
- Tavares ELM, Martins RHG. Vocal evaluation in teachers with or without symptoms. *J Voice*.2007;**21**(4):407-414.
- Lewis K, Casteel R, McMahon J. Duration of sustained /a/ related to the number of trials. *Folia Phoniatri (Basel)*.1982;**34**(1):41-8.
- Rantala L, Vilkmann E. Relationship between subjective voice complaints and acoustic parameters in female teachers' voices. *J Voice*.1999;**13**(4):484-95.
- Pekkarinen E, Himberg L, Pentti J. Prevalence of vocal symptoms among teachers compared with nurses: a questionnaire study. *Scand J Logop Phoniatri* .1992;**17**:113-117.
- Sala E, Laine A, Simberg S, Pentti J, Suonpaa J. The prevalence of voice disorders among day care center teachers compared with nurses: a questionnaire and clinical study. *J Voice*.2001;**15**(3):413-23.