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Original Research Article

Impact of Vocal Loading Test in Primary School Teachers with and without Dysphonia

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ABSTRACT

The present study aimed to evaluate and compare the voice characteristics of Primary School Teachers with and without Dysphonia complaints, pre and post vocal loading test. A total of 28 female primary School teachers divided into two groups i.e. 14 Group I (D) and 14 Group II (N) with a mean teaching experience of 7.71 yrs participated in the study. The Group I (D) consisted of teachers who complained of Dysphonia and had at least one visit to ENT for voice problems in the last six months. The Group II (N) consisted of teachers who did not complain about Dysphonia. Further to confirm the presence of Dysphonia, Voice Handicapped Index was administered. A vocal loading test was performed on all the participants in which they were asked to read a text loudly with 80 dBSPL white noise presented for a duration of 30 minutes. A voice sample of sustained phonation |a| for a duration of 5 seconds was collected and analyzed for Fundamental frequency, Jitter, Shimmer and Harmonic to noise ratio pre and post vocal loading. The results indicated a positive effect of vocal loading on all voice parameters in both the groups of teachers. However, there was a pronounced affect of vocal loading which was also statistically significant in group II (N) teachers. It is hence, concluded that acoustic analysis along with vocal loading test can be a helpful tool in the clinical battery for diagnosis and evaluation of treatment efficacy in occupational dysphonia.

Key words: Dysphonia, Primary teachers, F0, Shimmer, Jitter, HNR

INTRODUCTION

Anyone whose voice is essential to his or her job is considered an occupational or professional voice user. Teachers form a major proportion of professional voice users. This group specifically is encumbered with numerous economic, social and health problems. [1] One of the major health problems reported by teachers is dysphonia. Dysphonia is impairment in the ability to produce voice sounds using the vocal organs. Marcal and peres, [2] reported a high prevalence rate of self-reported voice problems in teachers in their study. Environments with internal and external background noise, classrooms with inadequate acoustics, excessive number of students in a classroom, exposure to dirt and chalk in the classroom are some of the harmful agents that can negatively affect the teacher's vocal health. Age-related changes, gender related differences in human vocal anatomy, allergies, upper respiratory infections, drug use, smoking and dehydration of vocal fold surface have also

been associated with voice disorders. As per the DISE report, India has a total of 7963161 primary school teachers who use their voice as primary tool of employment. [3] Teachers are more susceptible to vocal pathologies like edema, polyps and nodules than non-vocal professionals. Dysphonia leads to a lesser quality of teaching, an increased absenteeism and a major financial burden. A number of studies have focused on the teaching population and showed that the prevalence of dysphonia was significantly higher in teachers i.e. ranging from 11% to 81.0% compared with non teachers i.e. ranging from 1.0% to 36.1%. [4] A study conducted by Mjaavatn, [5] reported intermittent dysphonia in 50% and dysphonia on a regular basis in approximately 4% in 1000 primary school teachers. In India, a survey study conducted by Boominathan et al [6] found 49% of high and higher secondary Indian school teachers experiencing voice problems. Another study conducted by Rajasudhakar and Savithri [7] to investigate the short term effects of teaching i.e. vocal loading on acoustic parameters and effect of vocal rest revealed positive effect of vocal loading on dysphonia.

Vocal loading is defined as a combination of vocal loading time and factors affecting voice production for example the acoustic conditions at work i.e. size of work space, reverberation properties, background noise and the size of the ground etc. Use of voice in teaching profession is highly demanding, and the hazardous factors are teaching often at high voice output level due to the presence of background noise, poor classroom acoustics and poor working posture, long speaking distance, poor quality of air/ventilation, stress, non- availability or poor quality aids, inhalation of chalk powder, inadequate treatment of early symptoms, especially laryngeal infections. Contributing co-factors are gender, living habits, individual endurance, vocal skills/experiences, etc.

Nowadays, many occupations require a high vocal loading capacity. Therefore, it becomes increasingly important to have suitable test procedures for the vocal load, which can be executed with a low personnel and temporal expenditure. Review of literature has indicated a minimum of 15 minutes of vocal loading tasks to be efficient in distinguishing patients with reduced vocal loading capacity to normophonics. [8] Whitling, Rydell & Ahlander, [9] in their study designed a vocal loading task which consisted of ambient speech babble of 85 dB sound pressure level and subjected voice-healthy subjects (six female, five male) to read. The results indicated that all the subjects endured the vocal loading task for 3-30 minutes and their F0 and SPL rose during the task. The authors further concluded that onset and recovery from self perceived vocal loading was traceable through the vocal activity questionnaire.

Echternach and et al, [10] evaluated the changes of voice parameters with respect to different vocal loading tests. Seventeen subjects with healthy vocal function were subjected to 3 vocal loading test conditions i.e. continuous loading of 80 dB(A), loading with changes of intensity between 75 and 80 dB(A) and without loading for 10 min. The study results indicated that vocal loading test with continuous intensity was more stable for healthy subjects and can be fulfilled more easily.

Niebudek-Bogusz, [11] attempted to study the effect of vocal loading test on vocal fatigue and acoustic waveform perturbations in 51 female teachers with functional voice disorders. The results indicated that after vocal loading, some voice acoustic parameters in the teachers with functional dysphonia displayed statistically significant abnormalities, mostly in frequency perturbation parameters and P-I contour of vowel /a:/. Further they concluded that acoustic analysis performed before and after the vocal-loading test can significantly

contribute to objective voice examinations and may also be useful in diagnosis of early stages of dysphonia in teachers or other professional voice users.

In the present scenario to achieve objective evaluation of voice in professional voice users a set of clinical tests include laryngo-videostroboscopy (LVSS), glottography, aerodynamic test and acoustic analysis. Among these methods, voice evaluation via acoustic measurements is particularly promising because it is non-invasive and relatively easy to perform. Since a decade or two vocal loading tests have been incorporated along with acoustic measurements of voice clinically to evaluate vocal function with respect to vocal fatigue. In western countries commonly vocal loading tests with changes of loading intensity between 75 and 80 dB or tests with continuous intensity of 80 dB are used clinically. In India there are very few studies that have utilized vocal loading tasks and tried to report its effects in teachers and more so in teachers with and without dysphonia. Hence, the present study aimed to simulate vocal fatigue by vocal loading test and compare the voice characteristics of Primary School Teachers with and without dysphonia complaints, pre and post vocal loading test.

The objectives of the study are (1) To investigate subjective perception of voice problems in teachers with dysphonia and without dysphonia. (2) To investigate the effects of vocal loading test on the acoustic parameters of voice in teachers with and without dysphonia.

MATERIALS AND METHODS

Participants: 28 female primary school teachers in the age range of 25-51years with a mean age of 35.82 years volunteered to participate in the study. The participants had a mean teaching experience of 7.71 years. The teacher's history of visit to ENT for voice related problems in last six months was noted. Further the teacher's subjective appraisal of their voice problems was assessed using voice handicap index (VHI) questionnaire. VHI contains three subscales 1) physical, 2) emotional and 3) functional, scored from 0-4, which specify phonation complaints. The low VHI value (0–30 scores) may relate to few (slight) or early voice problems; 30 to 60 scores may represent moderate handicap (i.e. discomfort, vocal fatigue or voice loss) and 61–120 scores may suggest severe voice disorders. To get a score indicating the subject's proneness to Dysphonia-related problems, the points were summed according to the level of disability and subjects were divided into 2 groups:-

1. Those subjects with VHI scores in moderate to severe disability were categorized as Group I Dysphonic (D) and
2. Those subjects with VHI scores in normal to mild disability were categorized as Group II Normophonic (N)

Instruments used: A portable, light-weight Sony digital voice recorder was used for collection of voice samples. PRAAT software was used to extract acoustic parameters of voice i.e. Fundamental Frequency (F0), Harmonic to noise ratio, Jitter, and Shimmer.

Recording procedures: Initially the teachers in the study were ensured about the research objectives and a written consent was obtained from all of them. The teachers were asked to produce sustained phonation of /a/ vowel at comfortable pitch and loudness for at least 5sec pre and post vocal loading test.

Vocal loading test: The teachers were asked to read aloud a text for 30 minutes under exposure of 80dBSPL white noise. This method of vocal loading was selected based on study conducted by Niebudek-Bogusz. [11]

Acoustic analysis: The voice samples recorded pre and post vocal loading test were analyzed using PRAAT software. The acoustic parameters such as fundamental frequency (F0), pitch

perturbation quotient (jitter), amplitude perturbation quotient (shimmer) and harmonic to noise ratio (HNR) were extracted for pre and post vocal loading test voice recordings.

Statistical analysis: The mean and SD values of F0, jitter, shimmer and HNR pre and post Vocal Loading for both the groups were calculated. The data was subjected to paired T - test to find out significant differences between and within groups pre and post vocal loading test at 95% confidence levels.

RESULTS

Voice Handicap Index (VHI): The mean overall VHI value for teachers of Group I (D) was higher (46.6) compared to Group II (N) (9.3) indicating a statistically significant difference ($p<0.05$) between both the groups. The results of VHI are displayed in Figure 1.

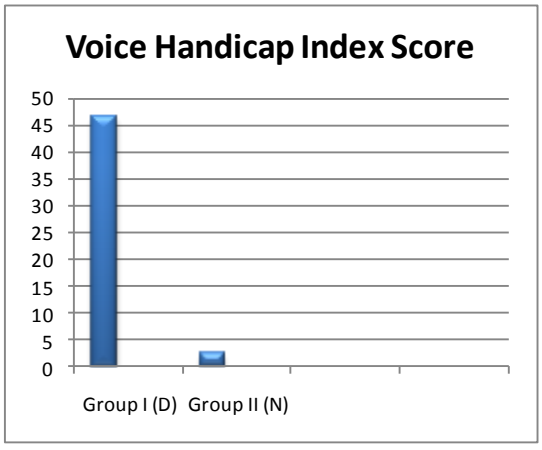

Figure1: The Mean values of VHI of Group I (D) and Group II (N) teachers

Findings of voice parameters between both the groups of teachers Pre vocal loading test: The mean F0 of Group I dysphonic teachers (D) (211.65) was lower compared to group II normophonic teachers (N) (227.64). The mean Jitter % was high in group I (D) teachers (0.434) compared to group II (N) teachers (0.280). The mean shimmer was high in group I (D) teachers (0.365) compared to group II (N) teachers (0.232). The mean HNR value was lower in group I (D) teachers (20.16) compared to group II (N) teachers (23.64). All the mean values of voice parameters across both the groups of teachers were found to be statistically significant ($p<0.05$) in pre vocal loading condition.

Findings of voice parameters pre and post vocal loading test in Group I (D) and Group II (N) teachers:

Fundamental frequency (F0): The mean overall F0 (Hz) of sustained phonation of Group I (D) (211.65) minimally increased from pre vocal loading to post vocal loading condition (213.34). In Group II (N) F0 (227.64) has increased from pre vocal loading to post vocal loading condition (239.30). On overall observation of mean F0 there was a statistically significant difference ($P<0.05$) in only group II normophonic (N) teachers pre to post vocal loading test compared to group I dysphonic (D) teachers. The results are presented in Table 1.

Table 1: Fundamental frequency F0 between and within Group I (D) and Group II (N) teachers.

Groups	Vocal loading task	Mean	Standard deviation	n	Minimum	Maximum	T value	P value
Group I (D)	Pre	211.65	34.80	14	150.53	258.48	0.252	0.80
	Post	213.34	39.25	14	156.24	261.62		
Group II (N)	Pre	227.64	34.02	14	147.79	283.42	2.155	0.05
	Post	239.30	32.42	14	171	271.90		

Jitter %: The mean jitter % increased slightly from pre vocal loading to post vocal loading test in both the groups. The Group I (D) teachers mean jitter value increased from pre vocal loading (0.434) to post vocal loading test (0.489). The Group II (N) mean jitter value increased from pre vocal loading (0.280) to post vocal loading test (0.365). These differences pre to post vocal loading test were not statistically significant ($P>0.05$) in both the groups. The results are presented in Table 2.

Table 2: Jitter% between and within Group I (D) and Group II (N) teachers

Groups	Vocal loading task	Mean	Standard deviation	n	Minimum	Maximum	T value	P value
Group I (D)	Pre	0.434	0.15	14	0.227	0.788		
	Post	0.489	0.14	14	0.306	0.835	1.208	0.24
Group II (N)	Pre	0.280	0.08	14	0.148	0.394		
	Post	0.365	0.15	14	0.153	0.599	1.890	0.08

Shimmer (dB): The overall mean shimmer (dB) increased across both the groups of teachers from pre to post vocal loading. The Group I (D) shimmer value pre vocal loading (0.365) rose to post vocal loading (0.422) and was found to be statistically significant (P<0.05) but marginal. The mean shimmer value for Group II (N) pre vocal loading (0.232) rose to post vocal loading (0.271) which was statistically significant (P<0.05). The results are presented in Table 3.

Table 3: shimmer dB between and within Group I (D) and Group II (N) teachers

Groups	Vocal loading task	Mean	Standard deviation	n	Minimum	Maximum	T value	P value
Group I (D)	Pre	0.365	0.07	14	0.275	0.522		
	Post	0.422	0.11	14	0.209	0.615	2.154	0.05
Group II (N)	Pre	0.232	0.08	14	0.12	0.37		
	Post	0.271	0.07	14	0.138	0.391	2.482	0.02

Harmonic to Noise Ratio (HNR): The mean overall HNR of sustained phonation of Group I (D) (20.16) minimally decreased from pre vocal loading to post vocal loading condition (18.97). In Group II (N) HNR (23.64) has decreased from pre vocal loading to post vocal loading condition (21.38). On overall observation of mean HNR there was a statistically significant difference (P<0.05) in only group II normophonic (N) teachers pre to post vocal loading test compared to group I dysphonic (D) teachers. The results are presented in Table 4.

Table 4: HNR between and within Group I (D) and Group II (N) teachers

Groups	Vocal loading task	Mean	Standard deviation	n	Minimum	Maximum	T value	P value
Group I (D)	Pre	20.16	2.87	14	15.63	25.28		
	Post	18.97	2.41	14	14.62	22.65	1.480	0.16
Group II (N)	Pre	23.64	2.96	14	18.95	26.67		
	Post	21.38	3.48	14	17.91	27.82	2.570	0.02*

DISCUSSION

The study findings are discussed as following.

Firstly, the findings indicated a strong correlation between the objective voice measurements and self ratings of voice handicap on VHI in both the group of teachers with and without dysphonia. Secondly on observation of values of F0 there was an increase in pre to post vocal loading in both the groups of teachers. However, the differences were statistically significant only in normophonic group of teachers. Similar findings of increase of F0 were observed in the study conducted by Rajasudhakar & Savithri [12] where five female primary school teachers were evaluated for effect of vocal loading on F0 and intensity perturbation. One of the possible explanations for this may be that the prolonged use of voice results in slackening of the muscular layer of thyroarytenoid muscle leading to the cover and transition layers of the vocal fold stiffening. This results in the increase of vocal folds rate of vibrations and a rise of F0. [13]

Thirdly, the findings of perturbation jitter and shimmer increased from pre-to-post vocal loading test in both teachers with and without dysphonia as reported in the previous studies. [12] This could be attributed to increase in structural and muscular tension of vocal folds due to prolonged voice use resulting in the irregular vocal fold vibrations. However, only shimmer was found to be significant on the statistical test for both the group of

teachers. The shimmer results are not in agreement with Angelique study findings; this can be due to methodological differences.

Fourthly, the findings of HNR indicated a decrease after vocal loading test in both the groups of teachers and the differences were statistically significant only in normophonic group of teachers. The possible reason for these findings can be the vocal loading having an impact on vocal stability in both the groups of teachers and more so in normophonic teachers. [14] On overall comparison of all the four acoustic parameters, i.e., fundamental frequency, jitter, shimmer and HNR in teachers with and without dysphonia, there was a higher impact of vocal loading in teachers without dysphonia resulting in higher voice instability. However, these results cannot be generalized and to get more insights into effect of vocal loading in teachers with and without dysphonia a need for further studies focusing on larger groups and with various types of vocal loading tests across different environments is felt.

CONCLUSION

With this study finding it can be inferred that all the acoustic voice parameters were sensitive enough to document the short-term effect of vocal loading test in teachers with and without dysphonia. The findings of vocal loading test along with self rating can significantly contribute to the objective voice examinations and may also be useful in the diagnosis and management of early stage of dysphonia in teachers and other professional voice users. Hence, it is strongly recommended to implement the vocal education and vocal hygiene during the training of the teachers. Further the vocal loading test can also be incorporated as a part of battery in routine clinical voice evaluations especially for professional voice users.

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