**Abstract**

Special educators are those who train children with special needs. They are involved in vocally demanding profession; it is likely that they are vulnerable to get voice problems in due course. Not many studies have been done to investigate the voice characteristics in preschool special educators.

Objectives: The objective of the present study was to investigate the voice characteristics in preschool special educators using objective vocal quality measurement, Dysphonia Severity Index (DSI) and to look for any gender differences. The study also aimed at studying the effect of number of teaching years on DSI.

Method: Eighteen preschool special education teachers, 13 females and 5 males were included in the study. Female participants were further sub grouped based on number of years of teaching experience. Group 1 included teachers having less than 8 years of teaching experience and Group 2 included teachers having more than 8 years of teaching experience. lingWAVES version 2.5 was used to calculate DSI. The parameters extracted for the calculation of DSI were highest frequency, lowest intensity, maximum phonation time and jitter. Data was subjected to suitable statistical analysis.

Results: The values of DSI parameters of special educators were within normal limits when compared with non professional voice users except for the highest frequency in female participants. There was no significant difference found between the DSI values of males and females. Years of teaching experience did not have any effect on the parameters of DSI.

Conclusion: Teaching children with special needs did not have any effect on the most of the DSI parameters for the special educators in the present study. Further researches on larger sample would yield insight about the voice quality of preschool special educators.

Key words: *highest frequency, lowest intensity, maximum phonation time, jitter.*

**INVESTIGATION OF VOICE CHARACTERISTICS IN SPECIAL EDUCATORS USING DYSPHONIA SEVERITY INDEX (DSI)**

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Special educators are those who train children with disabilities (Ysseldyke & Algozzine, 2006). A disability results from a medical, social, or learning difficulty may interfere significantly with the students’ normal growth and development. Indeed it hinders the ability to profit from schooling experiences or the ability to participate successfully in work activities. Common special needs would include [challenges with learning](http://en.wikipedia.org/wiki/Learning_disability), communication i.e., speech and language difficulties, [emotional and behavioral disorders](http://en.wikipedia.org/wiki/Emotional_and_behavioral_disorders), [physical disabilities](http://en.wikipedia.org/wiki/Physical_disabilities) and [developmental disorders](http://en.wikipedia.org/wiki/Developmental_disabilities). They may be diagnosed with a genetic condition that is associated with [mental retardation](http://en.wikipedia.org/wiki/Mental_retardation), various forms of [brain damage](http://en.wikipedia.org/wiki/Brain_damage), may have a [developmental disorder](http://en.wikipedia.org/wiki/Developmental_disorder), may have visual or hearing disabilities, or other disabilities. Dealing with these diverse needs, the challenges of special educators are more. Mainly they are engaged in teaching children with special needs. In other words, they form a group of professional voice users who are defined as those who depend on a consistent, special, or appealing voice quality, as a primary tool of trade and those who, if afflicted with dysphonia or aphonia, would generally be discouraged in their jobs and seek alternate employment (Titze, Lemke, & Montequin, 1997).

Koufman (1999) suggests four categories of professional voice users. *The Elite Vocal Performer, Level I,* is a person for whom even a slight aberration of voice may have dire consequences. Most singers and actors fall into this group, with the opera singer representing the quintessential Level I performer. *The Professional Voice User, Level II,* is a person for whom a moderate vocal problem might prevent adequate job performance. In this, teachers, lecturers and clergy are included. *The Non-Vocal Professional, Level III,* is a person for whom severe voice problem would prevent adequate voice performance. This group includes lawyers, physicians, businessmen and women. *The Non-Vocal Professional, Level IV,* is a person for whom vocal quality is not a prerequisite for adequate job performance. Laborers and clerks fall into this group. Thus special educators can be included under level II of professional voice users for whom a moderate vocal problem might prevent adequate job performance.

When it comes to preschool special educators, the challenges are still higher since they deal with young children. Vocal abuse and misuse are often mentioned as contributory factors for developing functionally based voice disorders such as vocal nodules and vocal fatigue (Colton & Casper, 1996). Studies have shown that such diagnoses are common in preschool teachers, and the prevalence of voice problems, based on questionnaires, vary from 32% to 72% (Axner & Behr, 1995; Sala, Laine, Simberg, Pentti, & Suonpaa, 2001). Fritzell (1996) found that such findings are reported to be more in female preschool teachers.

Sodersten, Granqvist, Ham marberg, and Szabo (2002) investigated preschool teacher’s voice during work. In this study, ten healthy female preschool teachers with a mean age of 33 years (range 21–46 years) working in 10 Day Care Centers (DCCs) served as subjects. All the subjects had different years of work experience and they also dealt with children in different age groups (1-3 years; 4-5 years; 6 years). A binaural recording technique was used here. Two microphones were positioned on both sides of the subject’s head, at equal distance from the mouth. A portable Digital Audio Tape (DAT) recorder was attached to the subject’s waist. Recordings were made at two instances: before work (baseline) where a standard reading passage was read and during work where spontaneous speech was recorded. The recording technique allowed separate analyses of the level of the background noise, as well as the subjects’ voice sound pressure level (SPL), mean fundamental frequency, and total phonation time. Results revealed that, mean background noise level for the ten DCCs was 76.1 dBA, which is more than 20 dB higher than what is recommended for speech communication (50–55 dBA). The subjects spoke on an average of 9.1 dB louder, and with higher mean fundamental frequency of 247 Hz during work as compared to the baseline of 202 Hz. Mean phonation time for the group was 17%, which was considered high. It was concluded from the study that preschool teachers have a highly vocally demanding profession.

Amita (2004) compared vocal demands in primary Vs secondary school teachers. In her study, she considered thirteen preschool and fourteen secondary school teachers in the age range of 20-50 years. A questionnaire was used to obtain self appraisal regarding their voice. Acoustic, aerodynamic characteristics were studied in both the groups of teachers. Also, the background noise in class room was measured. The author reported that the secondary school teachers showed increased values for most of the voice parameters. The background noise levels in primary grade classrooms ranged from 78.6 dBSPL to 88.7 dBSPL and in secondary grades the existing noise range was 75.2 dBSPL to 82.3 dBSPL. Thus the noise levels in primary grade classes were higher than the secondary grade classes, though significant difference was not found for the background noise levels.

Rajasudhakar and Savithri (2008) investigated working day effect on voice parameters like intensity, frequency, perturbation related and LTAS measures in a 37 year old normal male special school teacher of hearing impaired. Acoustic and aerodynamic measurements were collected at the beginning and at the end of the class. The result revealed an increase in fundamental frequency, jitter, shimmer and reduction in LTAS values at the end of the day. Voicing time (F0 time) was found to be reduced at the end of the day, indicating the presence vocal fatigue due to voice loading.

Many studies have reported that teachers are at risk for the development of voice problems and often present with vocal complaints (Russell, Oates & Greenwood, 1998; Roy, Merrill, Thibeault, Gray & Smith, 2004). Severe or frequently occurring voice problems may thus lead to a temporary or permanent inability to teach (Roy, Merrill, Gray & Smith, 2005). Various studies are done in the past to investigate the voice characteristics in teachers using acoustic (Sodersten et. al, 2002; Lindstrom, Ohlsson, Sjoholm & Waye, 2010; Geneid, 2013), perceptual (Boominathan, Mahalingam, Samuel, Dinesh & Nallamuthu, 2012) and aerodynamic measurements (Rajasudhakar & Savithri, 2008).

Wuyts, Bodt and Molenberghs (2000) developed an objective multiparameter approach, Dysphonia Severity Index (DSI). They developed it from multivariate analysis of 387 subjects including males and females. DSI is constructed so that a perceptually normal voice corresponds with a DSI of +5 and a severely dysphonic voice corresponds with a DSI of -5, but scores beyond this range are also possible (>+5 or <-5).

In the study by Duffy and Hazlett (2004), DSI was used to examine the vocal quality of 55 training teachers (age range of 21-39 years), from the Postgraduate Certificate in Education (PGCE) course. The 55 subjects were randomly divided into three groups: 23 were in the control group, 20 in the indirect group, and 12 in the direct group. The vocal performance of the three groups was measured at two points over the year of the PGCE course: first before any teaching or training began, and again after the first teaching practice. The training for the indirect and direct groups was provided before the teaching practices. Duffy et al. reported a DSI value of +4.0 (80%), indicating a good vocal quality in 55 student teachers.

Hakkesteegt, Brocaar, Wieringa & Feenstra (2006) investigated the age and gender effect on the DSI. The DSI of 118 non smoking adults (69 females, 49 males within the age range of 20-70 years) without voice complaint was measured. They concluded from the study that the age has a significant effect on the DSI and on its parameters highest frequency and lowest intensity only in females. Whereas, gender has no effect on the DSI. It has a significant effect on the parameters highest frequency and maximum phonation time.

In a study by Van Lierde, Claeys, Dhaeseleer, Deley, Derde, Herregods, Strybol and Wuyts (2010) used an objective multiparameter approach, the Dysphonia Severity Index (DSI) to examine the voice quality of 143 female student teachers with a mean age of 20.8 years (range: 18.1–41.8 years). DSI is designed to ascertain an objective correlate of the perceived vocal quality. The DSI is based on the weighted combination of set of voice measurements which includes Maximum Phonation Time (MPT), highest frequency (F-high), lowest intensity (I-low), and the jitter. The result of the study revealed an objective vocal quality value (DSI) of +2.6, indicating a perceptually normal voice for the subjects.

Jayakumar and Savithri (2012) evaluated DSI in Indian population. One hundred and twenty participants (60 males and 60 females within age range of 18-25) volunteered for the study. The DSI parameters were compared with the previous studies by Hakkesteeg et al (2006) and Wuyts et al (2000). Results of the study showed noticeable difference between Indian and European population on MPT, highest frequency, and DSI values. It also showed gender difference on DSI with females exhibiting higher DSI when compared with males which is contradicting with the findings by Hakkesteegt et al. (2006).

Though studies have been done to investigate voice measures in teachers (Van Lierde et al, 2010; Grillo & Fugowski, 2011) and special educators (Rajasudhakar and Savithri, 2008); but not many studies are done to investigate the objective vocal quality in preschool special educators. Since special educators are involved in vocally demanding profession; it is likely that they are vulnerable to get voice problems in due course. The present study was thus aimed at examining the voice characteristics of preschool special educators using an objective multiparameter approach.

Objectives of the study:

* To investigate the voice characteristics in preschool special educators using objective vocal quality measurement, Dysphonia Severity Index (DSI).
* To investigate for any gender differences.
* To study the effect of number of teaching years on DSI.

**Method**

**Participants**

18 preschool special educators including 13 females (age range: 26 to 46 years with a mean age of 33 years) and 5 males (ranging in age from 26 to 37 years with a mean age of 30.2 years) working at All India Institute of Speech and Hearing, Mysore, participated in the study. All the subjects had a minimum of one year of teaching experience. They used their voice for teaching purpose for 6 hours in a day for 5 days in a week. They teach children with hearing impairment, mental retardation, autism, and multiple disabilities. All the teachers were proficient in English. None of the subjects had any history of hearing defects, neurological, or velopharyngeal problems. And they did not complain of having any ear infection at the time of recording. One teacher had undergone Tympanoplasty in early childhood. Among the participants, two females and one male reported of strain in voice when they used their voice for a long period of time.

Female participants were further sub grouped based on years of teaching experience as group 1 (<8 years of teaching experience) and group 2 (>8 years of teaching experience). This was done to study the effect of years of teaching experience on DSI. Details of the subjects participated in the study are given in table 1.

Table 1: *Demographic details of the participants*

|  |  |  |  |
| --- | --- | --- | --- |
| **Subjects** | **Age/Gender** | **Years of** **teaching experience** | **Mother Tongue** |
|  1 | 28 years/Female | 6 | Malayalam |
| 2 | 44 years/ Female | 22 | Malayalam |
| 3 | 27 years/ Female | 5 | Gujarati |
| 4 | 26 years/ Female | 4 | Urdu |
| 5 | 35 years/ Female | 15 | Tamil |
| 6 | 46 years/ Female | 20 | Kannada |
| 7 | 33 years/ Female | 7 | Kannada |
| 8 | 35 years/ Female | 8 | Telugu |
| 9 | 35 years/ Female | 7 | Telugu |
| 10 | 36 years/ Female | 3 | Kannada |
| 11 | 27 years/ Female | 6 | Malayalam |
| 12 | 32 years/ Female | 9 | Kannada |
| 13 | 33 years/ Female | 8 | Kannada |
| 14 | 26 years/Male | 2 | Kannada |
| 15 | 30 years/Male | 3 | Kannada |
| 16 | 29 years/Male | 10 | Kannada |
| 17 | 29 years/Male | 1 | Kannada |
| 18 | 37 years/Male | 13 | Malayalam |

**Procedure**

lingWAVES version 2.5 (WEVOSYS, Germany) was used to calculate DSI. Initially, the subjects were instructed to phonate vowel /a/ at a comfortable pitch and loudness. Following this, they were instructed to phonate vowel /a/, starting at a comfortable pitch gliding up to the highest pitch. Similarly the participants were instructed to phonate starting from the comfortable loudness to the lowest possible loudness. MPD was calculated based on the sustained phonation task of vowel /a/ at habitual pitch and loudness after deep inhalation. From the above tasks, the following acoustic measures were extracted: jitter (%), minimum intensity (I-low, dB (A), maximum phonation time (MPT, sec) and Maximum frequency (F0-high, Hz).

The lingWAVES software calculated the DSI score automatically. The software uses the following formula to calculate DSI score:
**DSI = 0.13 x MPT + 0.0053 x F 0 -high - 0.26 x I 0 -low - 1.18 x jitter + 12.4**

**Statistical analysis**

SPSS V16 (SPSS, Norusis, 1992, Chicago, IL) was used for the statistical analysis of the data. Mann-Whitney U test was used to determine the statistical differences between the groups.

**Result and Discussion**

Mean, standard deviation (SD), and p values for the DSI measures are tabulated. Results are discussed under three sub-headings:

**(i) DSI in preschool special educators**

Table 2 shows mean, standard deviation, and p value for the DSI parameters: Jitter, Minimum intensity, Maximum Phonation Duration, Maximum F0 for male and female subjects.

Table 2: *Mean, SD and p values for the DSI measures in male and female subjects*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Parameters | MaleMean (SD) | FemaleMean (SD) | p value |  |
| Jitter (%) | .14(.07) | .47(.80) | .428 |  |
| MinimumIntensity(dB) | 50.3(5.77) | 46.96(5.03) | .349 |  |
| MPT (sec) | 18.67(6.85) | 12.97(3.56) | .054 |  |
| Maximum F0 (Hz) | 524.60(161.16) | 472.68(180.05) | .767 |  |
| DSI | 4.36(.67) | 3.83(2.18) | .430 |  |

From Table 2, it can be seen that the DSI score for male and female subject were 4.36 and 3.83 respectively which indicated normal vocal function (Wuyts et al., 2000). Mean Jitter for male participants were found to be 0.14% and 0.47% for female participants. Similar result was found in the study by Hakkesteeg et al (2006) in normal subjects. Mean minimum intensity for the two groups was 50.3 dB and 46.96 dB respectively which indicated normal findings, according to the study done by Hakkesteeg et al (2006) and Jayakumar and Savithri (2012). MPT ranged from 11.82 sec to 25.52 sec in male special educators whereas for female special educators the MPT ranged from 9.41 sec to 16.53 sec. This is in concordance with the findings in normal subjects by Jayakumar and Savithri (2012), indicating normal MPT range for both male and female special educators. Mean of maximum F0 was found to be 524.60 Hz for male participants. This was in accordance with the findings by Hakkesteeg et al (2006) and Jayakumar and Savithri (2012). Whereas the mean maximum F0 was found to be 472.68 Hz for female participants, which is not in consonance with the findings of previous studies on normal non professional voice users. In other words, mean maximum F0 was found to be deviant for female special educators, from the norm. Around 50% of the female participants in the present study hesitated to perform the task for highest pitch where they had to achieve the falsetto. This could be the possible reason for the deviancy.

**(ii) Gender difference in DSI**

The result of Mann Whitney test revealed that there is no significant difference in DSI score between male and female preschool special educators. This is consistent with the findings in the study by Jayakumar and Savithri (2012). In their study they had found out no gender effect on DSI score for a group of normal subjects. According to Wuyts et al. (2000) only one version of the DSI can be used for both males and females because the gender effect is canceled out due of the opposite behavior of the MPT and Maximum F0 for female and male subjects. No counteracting balance between MPT and F0 high was observed in the present study. Rather maximum F0 was found to be higher in male subjects compared to females. As mentioned before, around 50% of the female participants in the present study hesitated to perform the task for highest pitch where they had to achieve the falsetto. Whereas all the male participants attempted the task achieving falsetto voice. This could be the possible reason for the males having high F0 compared to females. Another reason can be attributed to the unequal number of subjects in each group. Table 2 shows that mean MPT was lower for female subjects than male subjects which has marginal significant difference (p=0.054). In most of the studies, the mean MPT in males are higher than in females (Wuyts et al., 2000; Hakkesteegt et al., 2008; Jayakumar and Savithri, 2012). Since males have larger lung volume than females, researches support that larger lung volume and better airflow rate will help in getting voice for longer duration (Hirano, Koike & Von Leden, 1968). Jitter percentage was found to be 0.14% and 0.47% for male and female participants respectively. Although the results revealed that there was no significant difference for Jitter between male and female subjects, the mean jitter was found to be more for female subjects than the male subjects. This is in concordance with the result of study reported by Wuyts et al. (2000) and Jayakumar and Savithri (2012). The gender effect was not evident in the present study for minimum intensity. Hakkesteegt et al. (2006) reported in their study that minimum intensity did not differ between the genders. Similar result was found in the study by Jayakumar and Savithri (2012).

**(iii)Comparison across females special educators based on years of teaching experience**

DSI parameters like Jitter, Minimum intensity, MPT, maximum frequency were compared for the two groups of female special educators. Table 3 shows the mean, standard deviation and p value for the two groups of subjects.

Table 3: *Mean, SD and p values for the DSI measures in females special educators based on years of teaching experience.*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Parameters | Less than 8 years experience (SD) | More than 8 years experience (SD) | p value |  |
| Jitter (%) | .76(1.11) | .23 (.34) | .062 |  |
| MinimumIntensity(dB) | 49.26 (4.78) | 45 (4.68) | .116 |  |
| MPT (sec) | 13.53 (4.67) | 12.5 (2.57) | .721 |  |
| Maximum F0 (Hz) | 523.37 (180.92) | 429.22 (181.06) | .283 |  |
| DSI | 3.23 (2.41) | 4.34 (2.01) | .317 |  |

The result of the statistical analysis revealed no significant difference for the DSI parameters between the two groups. The result indicated that there is no influence of years of teaching experience on vocal quality in female preschool special educators. Although not significant, DSI score was found to be better for the group with more teaching experience or older participants. The obtained finding is in concordance with the findings of the study done by Goy, David, Fuller, and Lieshout (2013). When we compare the individual measures of DSI for any age effect, there was no significant difference for jitter between the two groups. In Hakkesteegt et. al. (2006) study on DSI measures in normal male and female subjects, (age range of 20-79 years), they found no effect of advancing age on the MPT and jitter for female subjects. Hollien, Dew and Philips (1971) found no effect on the highest frequency with advancing age in their group of subjects (male and female) in the age range of 18 to 38 years. Both the studies support the findings of the present study on MPT, jitter and highest frequency. In the study by Hakkesteegt et al. (2008), the lowest intensity became significantly higher with advancing age in female subjects. The above study is contradicting with the findings of the present study. Minimum intensity in group II is relatively low than group I, but it was not significantly low value. Experienced female special educators were able to phonate in the lowest possible intensity compared to that of less experienced female special educators. It can be speculated that, experienced female special educators had better control of their voice since they are more experienced in their voice usage. This needs to be investigated further on larger sample for its replicability.

**Conclusions**

Present studyinvestigated the voice characteristics in preschool special educators using quantitative vocal measure using DSI. Results have shown that the DSI scores of both male and female preschool special educators were normal like non educators and there was no no gender effect on the measures for male and female preschool special educators. It was also found that there was no effect of number of years of teaching experience on DSI. The results of the present study cannot be generalized to all preschool special educators, since number of subjects considered in the present study was small. This is a preliminary attempt to investigate voice characteristics in preschool special educators dealing with children with hearing impairment, mental retardation, autism and multiple disabilities. Further researches on larger sample would yield better insight about the voice quality of preschool special educators.

**Acknowledgements**

The investigators would like to thank Dr. S. R. Savithri, Director, All India Institute of Speech and Hearing, Mysore, for granting permission to conduct the study at the institute. Thanks to all the participants for their cooperation to carry out the study. The investigators also extend thanks to Dr. K.S Prema, H.O.D of Department of Special Education, AIISH, Mysore, for support in the study. Also, Thanks to Dr. M. S. Vasanthalakshmi, and Mr. Santhosh C.D, Lecturers in Biostatistics, AIISH, Mysore, for the statistical analysis.

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