

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

<sup>1</sup>Yeshoda, K., <sup>2</sup>Rajasudhakar, R., <sup>3</sup>Jayakumar, T., <sup>4</sup>Amoolya, G., & <sup>5</sup>Deepthi Damodaran

### Abstract

*Special educators are those who educate children with special needs. They are involved in vocally demanding profession; especially those who deals children with Hearing Impairment and Mental retardation. It is likely that they are vulnerable to develop voice problems in due course. Not many studies have been done to investigate the voice characteristics of special educators working in preschool set up. The objective of the present study was to investigate the voice characteristics of special educators working in preschool, using objective vocal quality measurement (Dysphonia Severity Index, DSI). It is also focused on studying the effect of number of teaching years on DSI. Eighteen special educators who educate special children were included in the study. Among them, thirteen were females and five were 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 (WEVOSYS German) was used to calculate DSI. The parameters extracted for the calculation of DSI were lowest intensity, highest frequency, maximum phonation time and jitter. Mann-Whitney U test was used to find the effect of gender and number of teaching years. 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. 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:** *lowest intensity, highest frequency, maximum phonation time, jitter.*

Special educators are those who train children with disabilities (Ysseldyke & Algozzine, 2006). World Health Organizations, International classification of Impairment, Disabilities and Handicaps (1980) defined disability as any restriction or lack (resulting from an impairment) of ability to perform an activity in the manner of within the range considered normal for a human being. A disability would result from a medical, social, or learning difficulty, which may interfere significantly with students' normal growth and development. Indeed it hinders the ability to profit from schooling experiences or the ability to participate successfully in work activities. The special needs include learning difficulties, communication disorders, developmental disorders, physical disabilities, emotional and behavioral disorders. They may be having a genetic condition which is associated with different forms of brain damage, mental retardation, may have hearing or visual 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 an individual for whom even a small abnormality in voice may have dire consequences. Most actors and singers fall into this particular group. *The Professional Voice User, Level II*, is an individual for whom a moderate degree of voice problem may prevent adequate work performance. Teachers, clergy and lecturers are included in this group. *The Non-Vocal Professional, Level III*, is an individual for whom severe voice problem would prevent adequate work performance. Lawyers, businessmen, physicians, and women are included in this group. *The Non-Vocal Professional, Level IV*, is an individual for whom voice quality is not a condition for adequate work performance. This group includes laborers and clerks. Special educators can be included under level II of professional voice users for whom a moderate degree of voice problem may prevent adequate work performance.

<sup>1</sup>Yeshoda, K., Reader in Speech Sciences, All India Institute of Speech and Hearing (AIISH), Mysore, E-mail: k\_yeshoda@hotmail.com, <sup>2</sup>Rajasudhakar, R., E-mail: rajasudhakar82@gmail.com, <sup>3</sup>Jayakumar, T., E-mail: jayakumar82@gmail.com, Lecturer in Speech Sciences, AIISH, Mysore-06, <sup>4</sup>Amoolya, G., JRF, AIISH, Mysore-06, E-mail: amoolya021@gmail.com, & <sup>5</sup>Deepthi Damodar, Speech-Language Pathologist, E-mail: deepthidamodar88@gmail.com

When it comes to preschool special educators, the challenges are still higher since they deal with younger children. Vocal abuse and misuse are considered as contributory factors for developing functional voice disorders like 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 in them vary from 32% to 72%, based on questionnaires (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, Hammarberg, and Szabo (2002) investigated preschool teacher's voice during work. In this study, ten normal female preschool teachers (mean age of 33 years) working in 10 Day Care Centers (DCCs) served as subjects. All 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). Two microphones were positioned on either side of the subject's head. A portable Digital Audio Tape (DAT) recorder was attached to the subject's waist. The recordings were made at two instances: before work (baseline) where a standard reading passage was read and during work where spontaneous speech was recorded. Level of the background noise, and also the subjects' mean fundamental frequency, voice sound pressure level (SPL), and total phonation time were measured. Results revealed that, mean background noise level was 76.1 dBA for the 10 Day Care Centers, which is more than 20 dB higher than what is recommended for speech communication (50–55 dBA). The subjects spoke with higher mean fundamental frequency of 247 Hz compared to the baseline mean fundamental frequency of 202 Hz and an average of 9.1 dB louder at work. Mean phonation time was found to be 17 % which was considered to be high. Thus, it was concluded from the study that preschool teachers have a 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 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 dBSPL to 88 dBSPL and in secondary grades the existing noise range was 75 dBSPL to 82 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 towards the end of the day, indicating the presence of vocal fatigue due to voice loading.

Many studies have reported that teachers are at risk for the development of voice problems and they are commonly reported with having vocal complaints (Russell, Oates & Greenwood, 1998; Roy, Merrill, Thibeault, Gray & Smith, 2004). Severe or frequent occurrence of such voice problems may thus lead to temporary or even 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, Sjöholm & Wayne, 2010; Geneid, 2013), perceptual (Boominathan, Mahalingam, Samuel, Dinesh & Nallamuthu, 2012) and aerodynamic measurements (Rajasudhakar & Savithri, 2008).

Wuyts, De Bodt, Molenberghs, Remacle, Heylen, Millet, Van Lierde, Raes, and Heyning (2000) developed an objective multiparameter approach to measure voice quality using Dysphonia Severity Index (DSI). They developed it from multivariate analysis of 387 subjects including males and females. The DSI is based on the weighted combination of set of voice measurements: Maximum Phonation Time (MPT), lowest intensity (I-low), highest frequency (F-high), and jitter. A perceptually normal voice corresponds with a DSI score of +5 whereas a severe dysphonic voice corresponds with a DSI score of -5. Scores exceeding this range are also possible (>+5 or <-5).

Duffy and Hazlett (2004) investigated the vocal quality of 55 training teachers (age range of 21-39 years) using DSI. They were divided into three groups: 23 subjects were in the control group, 20 were in the indirect group and 12 were in the direct group. The vocal performance of the three groups of training teachers were measured at two instances during the one year course: first before the training began, and for a second time after the

first teaching practice. They reported a DSI score of +4.0 (80%), which indicates good vocal quality in 55 student teachers.

Hakkesteegt, Brocaar, Wieringa & Feenstra (2006) investigated 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 that age has an effect on the DSI value and on its parameters highest frequency and lowest intensity only in females. Whereas they found that gender has no effect on the DSI. It has a significant effect on the parameters highest frequency and maximum phonation time.

Van Lierde, Claeys, Dhaeseleer, Deley, Derde, Herregods, Strybol and Wuyts (2010) used DSI to examine the voice quality of 143 female student teachers (mean age of 20.8 years). The result of the study revealed DSI score of +2.6, indicating a perceptually normal voice for the subjects.

Jayakumar and Savithri (2012) measured DSI parameters in Indian population. One hundred and twenty participants (60 females and 60 males with age range of 18-25) volunteered for the study. The DSI measures were compared with the studies by Wuyts et al (2000) and Hakkesteeg et al (2006). Results of the study showed significant difference between Indian and European population on highest frequency, MPT and DSI values. DSI score was higher in female subjects when compared with male subjects which is contradicting with the findings by western population.

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 using DSI. Since special educators are in a profession that places high vocal load, it is hypothesized that they are more prone to develop voice problems eventually. The present study was thus aimed at examining the voice characteristics of preschool special educators using objective multiparameter approach.

Objectives of the study:

- To investigate the voice characteristics in preschool special educators using Dysphonia Severity Index (DSI).
- To investigate effect of gender and number of teaching years.

**Method**

*Participants* : Eighteen special educators who educate special children, included for the present study 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) who were working at All India Institute of Speech and Hearing, Mysore. All participants had a minimum of one year of teaching experience. They used their voice for minimum of 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 participants in the study had any history of hearing related complaints, neurological, or velopharyngeal problems. None of them complained 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 participants in the study are given in table 1.

*Table 1: 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:* Ling WAVES 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. Then they were instructed to phonate vowel /a/, starting at a comfortable pitch and then

gliding up to the highest pitch possible. Similarly they 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.

*Statistical analysis:* SPSS Version 16 (SPSS, Norusis, 1992, Chicago, IL) was used to perform the statistical analysis of the data. Mann-Whitney U test was used to find out the statistical differences between the groups and the effects of gender and number of years of experience.

**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 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.

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).

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

Parameters	Male Mean (SD)	Female Mean (SD)	p value
Jitter (%)	0.14 (0.07)	0.47 (0.80)	0.428
Minimum Intensity(dB)	50.3 (5.77)	46.96 (5.03)	0.349
MPT (sec)	18.67 (6.85)	12.97 (3.56)	0.054*
Maximum F0 (Hz)	524.60 (161.16)	472.68 (180.05)	0.767
DSI	4.36 (0.67)	3.83 (2.18)	0.430

\*p ≤ 0.05

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 reduced for female special educators, from the norm. Seven of the female participants in the present study were not able to perform the task to their higher capacity. This could be the possible reason for the deviancy.

(ii) *Gender difference in DSI:* The result of Mann Whitney-U test revealed that there is no significant difference in DSI score between male and female preschool special educators. This result is consistent with the findings of Jayakumar and Savithri (2012). In their study they had found 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 F0 high and MPT was observed in the present study. Rather maximum F0 was found to be higher in male subjects compared to females. Seven of the female participants in the present study were not able to perform the task to their higher capacity. 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 participants than male participants which has significant difference (p=0.054). In most of the studies, it is found that the mean MPT in males are higher than in females (Wuyts et al., 2000; Hakkesteeg et al., 2008; Jayakumar and Savithri, 2012). Arnold (1955) reported that MPT demonstrates the general status of the patient’s respiratory system. Since males have higher lung volume than females, researches support that higher lung volume and also better airflow rate will facilitate 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 participants, the mean jitter was found to be more for female participants than the male participants. 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.

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 special educators. Although not significant, DSI score was found to be better for the group with more teaching experience or older participants.

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 (%)	0.76 (1.11)	0.23 (.34)	0.062
Minimum Intensity(dB)	49.26 (4.78)	45 (4.68)	0.116
MPT (sec)	13.53 (4.67)	12.5 (2.57)	0.721
Maximum F0 (Hz)	523.37 (180.92)	429.22 (181.06)	0.283
DSI	3.23 (2.41)	4.34 (2.01)	0.317

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. Hakkesteegt et. al. (2006) reported that the 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 statistically significant. 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**

The present study investigated the voice characteristics in special educators who educated children with special needs, using quantitative vocal measure using DSI. Results have shown that the DSI scores of both male and female special educators were normal like non educators and there was 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 should be generalized with caution, since number of participants 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 and different set up would yield better insight about the voice quality of preschool special educators.

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