WORKING DAY VOCAL LOADING EFFECT ON VOICE PARAMETERS IN MATHEMATICS AND MALAYALAM LANGUAGE TEACHERS: A COMPARATIVE STUDY

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This dissertation is submitted as a part of fulfillment for the degree of masters of Science

(Speech Language Pathology)

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Mysuru

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April 2018

CERTIFICATE

This is to certify that this dissertation entitled **'Working Day Vocal Loading Effect On Voice Parameters In Mathematics And Malayalam Language Teachers: A Comparative Study'** is the bonafide work submitted as a part of fulfillment for the Degree of Master of Science (Speech Language Pathology) of the student with Registration No: **16SLP020**. This has been carried out under the guidance of a faculty of this institute and has not been submitted earlier to any other University for the award of any other Diploma or Degree.

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CERTIFICATE

This is to certify that this dissertation entitled **'Working Day Vocal Loading Effect On Voice Parameters In Mathematics And Malayalam Language Teachers: A Comparative Study'** has been prepared under my supervision and guidance. It is also certified that this has not been submitted earlier to any other University for the award of any other Diploma or Degree.

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DECLARATION

This is to certify that this Master's dissertation entitled **'Working Day Vocal Loading Effect On Voice Parameters In Mathematics And Malayalam Language Teachers: A Comparative Study'** is the result of my own study under the guidance of Dr. R Rajasudhakar, Reader in Speech Sciences, Department of Speech Language Sciences, All India Institute of Speech and Hearing, Mysuru, and has not been submitted earlier in other University for the award of any Diploma or Degree.

Mysuru,
April 2018.

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Dedicated to

AMMA (My courage), ACHAN (My motivation), VAVA (My Happiness)

And

My BEST & BETTER HALF (Nayana)

Acknowledgment

I express my heartfelt thanks to my guide ***Dr. R Rajasudhakar*** *for his constant support and guidance throughout the year. You have been patient enough and understanding at all points of time. Every time you considered my doubts, clarifications and requests with immense patience. You have always let me explore and learn. You have always been a patient listener and I truly feel honored to have been able to complete this dissertation under your guidance. Thank you so much sir.*

I would like to thank ***Dr. S R Savithri****, Director, AIISH for permitting me to carry out this study.*

My special thanks to ***Dr. Vasanthalakshmi*** *for her guidance with the statistics and patience to clarify my doubts.*

I am extremely thankful to ***Dr. K Yeshodha*** *for all her precious and wise words. Ma'am you have always inspired me. I thank you for elevating my knowledge and love towards the subject "voice".*

*Life is easier if you have someone with same level of cognition (craziness) to share your happiness and sorrows of your life. Jaanu (****Ms. Nayana****), the mitochondria of my life since 6 years (and will be the same in the coming years too). Thanks will not be sufficient for tolerating all my tantrums and mood swings.*

I extend my profound love towards my family. ***Amma*** *(the superpower), who gave me the strength to overcome the obstacles. Amma you are my biggest and greatest blessing. Thank you amma for installing confidence in me whenever needed and you always have something to say which uplift my mood.* ***Achan*** *(the iron man), who brought me into the right path with limited conversations. Your life is the message and the motivation for me to reach my goals.* ***Chinnu****: younger by age and elder by her attitude. Always be the same because I love your autocracy. I thank achachan, ammamma, uncle, aunty, sachu and sai for all your prayers and support. I fall short of words to thank you all for all encouragement and support that you have provided throughout my life.*

No one can be equal to your dad but it takes someone special to be equivalent to dad. ***Sukumaran vellichan*** *you have inspired me in various ways over time and you are one of the reasons for the success that I have achieved till date. A special thanks to my techie "kitchu ettan" with the tag line "any time any help where ever you are I am there". My data collection wouldn't be possible without my amma, sukumaran vellichan and vijayan vellichan. I thank all my vellichans who have take out their precious time for helping me.*

Malhothra (anagha), imthiaz (varsha), the most modern girl (jumana) and wills the devai (devika) are the important members of my AIISH family. You guys made my hostel days wonderful and memorable. Nothing was better than our tea time. Thank you guys for your timely advice and help and tolerating me all these 6 long years.

I would like to express my deep sense of gratitude to all my participants and head masters/mistress for sparing their valuable time with me. Their cooperation and timely help had supported me in successful completion of my dissertation.

Last but not the least I thank my bench mates rev ,reshmu , prinka , amazing classmates plosives , crazy batch mates sustainers and lunatics for making my life over here easier and wonderful. Love you all.

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CHAPTER 1

INTRODUCTION

Communication is a process of exchanging ideas between sender and receiver. This can be verbal or non-verbal and it involves exchange of thoughts, ideas, feelings, emotions to fulfill our desires. Accurate transmission of information from sender to receiver results in successful communication. Language is considered as a primary vehicle for human communication and the principal means for expressing language is speech. Speech is a complex motor action where language is represented acoustically. Production of a speech signal is influenced by the interaction of its components which includes articulation, fluency and voice (Owens, Farinella & Metz, 2014). The sound produced by humans for communicating the information/thoughts/ideas is referred as voice (Zhang, 2016). Vibration of the vocal folds results in the production of voiced sounds whereas sounds produced without vocal fold vibration is referred to unvoiced sounds. Noticeable contrasts produced by the selective alteration of the voice source spectrum helps to convey various linguistic sounds and meaning. Meaning is conveyed by the several features included in the voice source. These features includes prosody, quality, loudness, pitch that convey biological information, paralinguistic information (Sundberg, 1987; Kreiman and Sidtis, 2011) and meaning (Kreiman and Sidtis, 2011).

In today's service oriented society, communication skills are at most important to everyone and the prominent interest was always gained by vocal performance (Timmermans et al., 2002). A person is known as a professional voice user when his/her means for procuring the necessities of living is met through voice usage (Wingate, 2007). Based on the voice usage and risk professional voice users are classified into IV levels by Koufman and Issacson (1991), they are as follows:

- Elite vocal performers (Level I): Mainly includes singers and actors, where a minor variation in the voice has a serious impact on their profession.
- Professional voice users (Level II): This group mainly includes teachers, lecturers, politicians, clergymen, telephone operators and individuals involved in

publicspeaking. Here, a moderate difficulty would affect their appropriate job performances.

- Nonvocal professionals (Level III): This group mainly includes business man, lawyers, physicians where severe vocal problem would hamper their appropriate job performances.
- Nonvocal non-professional (Level IV): This group mainly includes homemaker, laborers and clerks, where their vocal difficulty would not hamper their job performances.

Continuous usage of voice and increasing occupational demand are the major cause of voice problems in these professionals. Increased background noise, lack of adequate environmental acoustics and inadequate humidity in the atmosphere are some of the factors in the occupational setup that contribute to the voice problems (Carding & Wade, 2000; Vintturi et al, 2001). Professional voice users come across lots of vocal problems and these are of different types, some of them includes hoarseness (Jones et al., 2002 &Yiu, 2002), weakness in voice (Smith et al., 1997 and Smith et al., 1998), voice breaks (Sapir, Keidar& Mathers-Schmidt ,1993; Jones et al., 2002), voice loss (Jones et al., 2002) and vocal fatigue (Sapir, Keidar & Mathers-Schmidt ,1993; Smith et al., 1997; Kostyk & Rochet ,1998; Yiu, 2002). Associated physical problems include itching sensation in the throat (Smith et al., 1998 & Jones et al., 2002), dryness in the throat (Sapir, Keidar & Mathers-Schmidt, 1993; Smith et., 1998; Jones et al., 2002), pain or discomfort (Sapir, Keidar & Mathers-Schmidt ,1993; Smith et al., 1997; Jones et al., 2002), laborious speaking (Sapir, Keidar & Mathers-Schmidt ,1993; Smith et al., 1997; Smith et., 1998) and shortness of breath (Sapir, Keidar & Mathers-Schmidt, 1993; Smith et., 1997; Yiu, 2002). Other chronic problems include nodule, polyp, hemorrhage and cysts.

Among the professional group, voice problems are more prevalent in teachers ranging from 38% to 80% whereas incidence rate for other professionals are; 68% in telemarketers, 44% in aerobics instructors (Long et al.,1998) and nearly 4% in salesperson (Coyle, Weinrich & Stemple, 2001). In comparison to non-teachers the prevalence rate of voice problems in teachers was 11% and 58% was career

prevalencewhen compared to 29% among non-teachers (Roy et al., 2004). In a study conducted by Munier and Kinsella (2007), voice problems had a greater prevalence rate of 80% in primary school teachers where vocal fatigue and dryness in throat was the frequent symptoms. Based on a self-reported questionnaire (in 448 primary and secondary school teachers), the prevalence rate of voice problem was found to be 9% (Sebastian, 2012). Ohlsson et al. (2012) conducted a questionnaire study on 1636 teacher students with a mean age of 23 years and reported a prevalence rate of 17%. Among the Indian primary school teachers, prevalence rate of voice problems was 17.4% (Devadas, Bellur & Maruthy, 2017).

The voice problems in teachers can affect their job performances, which in turn can affect the students understanding and hence this results in medical leave (Provenzano & Sampaio, 2010). The causes related to voice problems among teachers are mutifcatorial, which includes physical, environmental and psycho-emotional factors. According to Kooijman (2006), psycho-emotional factors (such as stress, workload, emotions and composition of students) and physical factors are the 2 major risk factors for the development of voice problem. Morrison and Rammage (1993) has reported 4 internal factors that contribute to the voice problems in teachers, that is behaviors that effect voice (such as smoking and shrieking), unevenness in the muscle usage, inappropriate body posture, gastro- esophageal reflux and disturbances in the emotions. Existence of one or more than one of these conditions can cause voice problems. In the occupational setup lengthy working time, extended and unrestricted use of voice are some factors that results in voice problem (Biserra et al., 2014).

Vocal fatigue is one of the most persistent problems experienced by the teachers. The problem starts with the advancement in the working day and is distinguished by changes in the pitch, loudness or quality. These alterations are related to continuous teaching for extended period with atypical pitch, greater tension and loudness. The problem is more obvious by the end of the day and tends to fade following a period of vocal rest (Gotaas & Starr, 1993). Vocal fatigue is experienced by teachers who give more time to the activities that are vocally demanding. When the vocal demands overshoot the vocal capacity of the individual, it results in vocal fatigue. Teachers who deals with

music,drama, physical education and also who put a greater vocal effort to control the class are at high risk of vocal fatigue (McCabe &Titze, 2002).

Four clear cut stages of vocal loading put forth by Kelchner, Toner and Lee (2006) includes vocal warm up (adjusting to the vocal performance), vocal fatigue (physical alteration of the larynx and physical effort associated with the vocal performance) and recovery or rest (Vintturi et al., 2003; Jilek, Marienhagen & Hacki, 2004). According to Titze, Hunter and Švec (2007) vocal loading is the stress experienced by the speech musculature during prolonged speaking. There are lots of vocal loading tasks that involve excess voice usage which in turn results in vocal fatigue (Stemple, Stanley & Lee, 1995; Gelfer, Andrews & Schmidt, 1996; Kelchner, Lee & Stemple, 2003; Vintturi et al., 2003). Prolonged loud reading is one such task; the fatigue that is resulting from these tasks depends on time taken to read and the loudness level (Kelchner, Toner and Lee, 2006).

Several studies have compared the vocal loading in different professionals. Boltežar & Bahar (2014) compared different professional groups like teachers, speech therapists, salespersons, physicians, nurses and catholic priests. The voice problem was mostly seen in teachers and the frequent cause for their voice problem was vocal loading. Respiratory infection was the common cause for the voice problem in other professionals. According to Sala et al. (2001) day care center teachers are at greater risk for developing voice problems when compared to that of nurses. The extend of vocal loading experienced by day care center teachers was more when compared to nurses. In comparison of kindergarten and elementary school teachers, the kindergarten teachers were at greater risk for developing voice problem than elementary school teachers. The vocal load imposed by kindergarten children were more than the elementary school children hence the teachers teaching very young children are at greater risk (Remacle, Morsomme & Finck, 2014).

On comparing the vocal loading in elementary classroom teachers (who taught Mathematics, social science and science) to music teachers, music teachers were 4 times more prone to develop voice problems (Morrow and Connor, 2009). Teachers from elementary, secondary and special schools were compared on basis of their vocal behavior. The lessons included German language, foreign languages, natural science,

social and cultural lessons, physical education (Sport), mathematics, and others (including art and home economics). Authors found that, across the lessons, there was a variation in noise SPL and voice SPL in which the largest variation was noted for sports lesson (Nusseck et al., 2017). Ranatala and Vilkman (1999) compared (two groups: one with more voice complaints and other with less voice complaints) 12 primary and secondary female school teachers. Phonation sample (obtained before and after first class as well as last class) and teaching sample (for the first and last class) was analyzed. Authors reported higher F0 and lower perturbation and SPL values in more complaint groups when compared to the group with less voice complaints.

First and last lesson of 33 primary and secondary female school teachers (with a mean age of 43 years) were compared. The marked result of the study was the rise in F0 after vocal loading (Rantala, Vilkman and Bloigu, 2002). Generally vocal loading studies are conducted in laboratory settings (Gelfer, Andrews & Schmidt, 1991; Stemple, Stanley & Lee, 1995). In field, that is, working environment, studies are very scanty (Novak, Dlouha, Capkova & Vohradnik, 1991). Scarcely few studies have been reported in investigating the effect of vocal loading on voice parameters in Indian primary school teachers.

Need for the study

Schools for general education in Indian states are classified as Primary and Secondary. At the primary level there are two subdivisions that is lower primary (LP) which includes classes from 1st standard to 4th standard and upper primary (UP) which includes classes from 5th standard to 7th standard. The primary school teachers teach a diverse group of subjects and per week these teachers have to complete a minimum of 30 teaching hours resulting in extended period of voice use for up to 3 hours (Sivasankar, 2002). In a study conducted in 250 primary school Egyptian teachers the prevalence of dysphonia was found to be 23.2% (Hamid, Eldessouky, Iskender, & Hassan, 2014). The demands faced by teachers in primary schools in India are contrary to other developed countries. When compared to the teachers in other countries the number of students, number of classes per day, background noise level, will be different (Devadas et al., 2017). Vocal demand will

be higher in teaching very young children. Among the teachers, female teachers are at greater risk of developing voice problem when compared to that of males (Van Houtte et al., 2011). The vocal demand imposed by each subject is different. The studies reporting the vocal loading experienced by the teachers taking specific subject is very limited. The vocal loading experienced by the teachers depend upon the subject handled by them as well as their teaching strategy.

The strategies used for teaching mathematics is different from that of the strategies used for teaching language, that is teaching mathematics involves more of visual illustration on the blackboard whereas teaching language involve narration for an extended period of time using modulations in voice (oftently), dictating the answers, reciting poems and explaining stories and so on. Hence, the vocal demand/voice use for teaching mathematics probably would be different from that of language subject. Looking specifically into the effect of a particular subject or course, no study has been reported by investigating the working day effect on vocal loading parameters. Hence, the need arises to investigate in this direction.

The voice produced in the natural environment/occupational set up will be different from that of laboratory settings. Most of the investigations on vocal loading parameters are usually conducted in laboratory settings hence the generalizability of data remains moot in real life situations. For better understanding of the vocal behavior, there is a need to study vocal loading parameters in working environment (work set up: classroom) of the primary school teachers.

Aim of the study

The aim of the present study is to determine the working day vocal loading effect on few voice parameters and F0 time in Mathematics and Malayalam language teachers and to compare between them.

Objectives of the study

1)To determine working day effect on voice parameters such as Fundamental frequency (F0), standard deviation of F0 (SD F0), Jitter, Shimmer and harmonic to noise ratio (HNR) for phonation of vowel /a/ before the first and after the last class.

2)To investigate the active vocal fold vibration time (F0 time) for Malayalam language teachers between first and last class (with an average duration of 5 hours).

3) To investigate the active vocal fold vibration time (F0 time) for Mathematics teachers between first and last class (with an average duration of 5 hours).

4) To compare the active vocal fold vibration (F0 time) between Malayalam and Mathematics teachers.

CHAPTER II

REVIEW OF LITERATURE

Voice is a major means of communication that plays a significant role in everyday life of the individuals. Person's feelings/intuitions/ideas/opinions are conveyed with the help of voice. Larynx comprises of vocal folds that leads to airway constriction. Airflow caused by the contraction of the lungs builds up pressure beneath the vocal folds. When the sub glottal pressure goes beyond the threshold pressure, vocal folds results in self sustained vibration. The air pressure and airflow supplied by the lungs and lower airway are the parts of vocal system (Hixon, 1987). Regulation of the airflow as a result of vocal fold vibration result in the production of voice which is further modified by the vocal tract and gives the output sound. The resultant sounds can be either voiced or voiceless i.e. sounds which are produced by the vibration of the vocal folds are voiced and those produced by channelizing the air through narrow constrictions without involving the vocal fold vibration are voiceless. Pitch, loudness, prosody, voice quality obtained from voice source conveys lot of information and meaning (Zhang, 2016).

Professional voice users

Professional voice users are defined as the individuals whose voice is mainly used to make a living, and nowadays they cover a variety of professions ranging from highly skilled artists to call center workers (John & Poduval, 2015). Professional voice users are not always actors and singers as this group also consist of clergy, receptionists, sales personnel, physicians, teachers and anyone else whose ability to earn a living is affected negatively by the reduction in vocal quality and endurance (Sataloff, 2000). The definition of voice disorders in an occupational context depends on the demands set upon the voice and voice endurance is an essential criterion (Vilkman, 2004). They are classified based on conditions in which they work i.e., those who use their voice in unfavorable conditions (like factory laborers) or those who use their voice for extended period of time (like teachers) or those who use their voice for special purposes (like

singers). Vocal demand for each of these groups varies. As the vocal demand increases the risk of developing voice problems also increases.

Voice problems in professional voice users

Etiological divisions for the voice problem usually seen in professional voice users can be: organic and functional. Abuse/ overuse/ misuse are the functional voice problems and infections/inflammations (like laryngitis/tonsillitis/allergies) or systemic conditions (such as hearing loss, aging, neurological disorders, endocrine disorders) or other conditions like tuberculosis, AIDS, psychological conditions are few other causes. Only a small group of people are experiencing voice problem due to organic cause. Large group of people experience voice problem because of functional misuse or any psychogenic factor (Nierengarten, 2007). Problems seen among professional voice users are also common among the patients seen by a laryngologist.Nodules, polyps, cysts, vocal fold scarring, muscle tension dysphonia, laryngopharyngeal reflux are commonly observed problems in professional voice users. Laryngitis which is a result of overuse, microvascular lesions and related effect of vocal fold hemorrhage are majorly seen among professional voice users (Franco & Andrus, 2007). One's own voice limitations or abuse of the voice are considered as causes of voice problems which are often viewed as personal problems. It is important to show the relationship between voice use and voice disorders in order to develop occupational voice care for individuals who work in vocally demanding professions (Sala, Laine, Simberg, Pentti & Suonpää, 2001; Rantala, Vilkman, & Bloigu, 2002; Södersten, Granqvist, Hammarberg & Szabo, 2002; Vilkman, 2004).

Common voice problems seen in teachers

Vocal fatigue, hoarseness, throat pain, discomfort, weak voice, dryness and lower pitch are some of the noticeable voice problems in teachers (Pekkarinen, Himberg&Pentti, 1992; Sapir, Keidar& Mathers-Schmidt, 1993;Mattiske, Oates& Greenwood, 1998; Roy et al., 2004). Phonotrauma is the most frequently reported risk factor which is due to the

prolonged teaching (Pekkarinen, Himberg, & Pentti, 1992; Smith et al., 1997; Vilkman, 2000; Sala et al., 2001; Roy et al., 2004; Ohlsson et al., 2012).

Vocal fatigue is a common voice problem affecting professional voice (Titze et al., 1997). Teachers are recognized as an at-risk population for developing vocal fatigue (Smith et al., 1997). Vocal fatigue refers to a voice problem that begins as the speaking day progresses and usually disappears after a period of voice rest (Gotaas & Starr, 1993). Mostly teachers speak continuously and loudly, in unfavorable acoustical conditions such as noisy classrooms. Frequent episodes of vocal fatigue in a large number of Indian school teachers have been reported because of high student-teacher ratio, extended teaching hours and poor classroom acoustics (Sivasankar, 2002).

Laukannen. Ilomaki, Leppanen and Vilkman (2008) investigated the relationship of symptoms of vocal fatigue and acoustic variables. Theacoustic variables reflected the type of voice productions of their speech. The effects of vocal loading on these acoustic variables were studied. It was done on 79 female primary school teachers. Females are majority in the teaching profession and they are- known to have about twice as many as voice problems as males. Using a portable digital recorder, a sustained phonation of vowel /a/ were recorded from participants before and after vocally loading task on a working day and also a sample of prose extract was recorded. They were asked to read the prose extract in 2 conditions that is, at a habitual conversational loudness and other at loudly, corresponding to speech in a large, noisy classroom for duration of 1 minute. Phoneme /s/ was excluded from the text sample. A sustained phonation sample of 5-minute duration was also collected. A questionnaire concerning symptoms of vocal fatigue, using visual analogous scale (VAS), related to voice production, tiredness and voce quality was completed by the subjects. Mean F0, SPL, Alpha ratio was analyzed from text reading sample. F0, SPL, jitter and perturbation measures were analyzed from the vowel sample. The results revealed that throat tiredness was more after the working day and also the alpha ratio, F0, SPL values.Perturbation measures (jitter and shimmer) were noted to be lower after the working day. Tiredness of throat was correlated with increase in mean F0 and jitter in loud reading. Changes in acoustic parameters as result of

working day vocal loading mainly indicate increased muscle activity. Voice production did not correlate with symptoms of vocal fatigue but voice fatigue is in turn correlated with amount of speech during working day.

Voice problems in Primary and Secondary school teachers

Smith, Gray, Dove, Kirchner and Heras, (1997) has conducted a study in which teachers and non-teachers (craftsperson, salespeople, health care providers, clerical staff, technicians, and laborers) were compared on the basis of frequency and effect of voice symptom. Questionnaires were obtained from 242 primary and secondary school teachers (between 20-65 years) during the period between 1993 November and 1994 February in northeastern Nevada and a northern Utah school. Voice symptoms were more likely reported by teachers in which hoarseness was frequently observed along with tired/effortful/weak voice or difficulty while speaking (at low tones). Authors concluded that higher risk of voice symptoms are found in teachers.

Treatments for vocal symptoms were seeked more by teachers than nurses as documented in the literature. Pekkarinen, Himberg, and Pentti, (1992) conducted a questionnaire survey in 478 teachers from 26 different schools (like business school, vocational/upper secondary/comprehensive school) in which 66% were women and 34% were men with a response rate of 80%. They had a mean age of 41 years and a mean working experience for 15+/-9.4 years. The questionnaire comprised of 22 questions focusing on 6 vocal symptoms and their rate of occurrence in last 2 years. The control group comprised of 95 nurses (with 98% female and 2% males) with a mean age of 39 +/- 9.6 years & with a mean working year of 15 +/- 8.8 years. Results revealed that vocal symptom complaint were more in teachers than nurses and they had experienced it for prolonged period of time than nurses.

In India, Boominathan, Rajendran, Nagarajan, Seethapathy and Gnanasekar, (2008) has conducted questionnaire survey on 400 professionals which included 100 vendors (72 males and 28 females), 100 singers (54 males and 46 females), 100 politicians (100

males), 100 teachers from high school and higher secondary school (24 males and 76 females). The results revealed that 49% of teachers in India were reported to have voice problems because of the need to speak loudly for extended periods, mostly under unfavorable conditions caused by loud background noise and poor acoustic conditions.

Puglisi, Astolfi, Cutiva and Carullo, (2017) conducted a study to determine the difference in noise and voice condition reported by teachers. Also, to see the relationship between the relationship between the objective voice parameters and voice condition as reported by teachers, as well as to specify the relationship between acoustics of the classroom and the noise condition reported by teachers. 27 primary school teachers were included whose vocal study was done for four days that is from Monday to Thursday. Questionnaire given by Pelegrín and Brunskog (2012) was administered after each tracked lesson (up to 4 hours). It consisted of 7 questions which covered work, voice related and individual features. Information on the fundamental frequency, percentage of phonation time, and vocal sound pressure level was obtained with help of the Voice-Care device (a vocal dosimeter). With the help of the voice care device recording was done in 2phases. First the talk on a well-known topic was recorded (Pre-monitoring phase). Occupational voice involved four hours of daily lesson was recorded. SLM was used to record the indoor noise and the reverberation time was calculated. For both monitoring and pre-monitoring phase,fewer voice complaint teachers showed increased standard deviation of vocal sound pressure level and greater phonation time differences. Decay time (DT40ME), showed association with the noise condition reported by the teachers. The noisier condition inside the classroom was related to the classroom with greater decay time DT40ME.The authors concluded that prevention program should include the respiratory and laryngeal exercises for voice production as the difference in sound pressure level was related to voice conditions reported by teachers. Limitations of the study include lesser sample size due to which generalizability is not possible. Random sampling of teachers and schools was not possible.

Munier and Kinsella, (2007) investigated the prevalence and effect of voice problems in primary school teachers at their working environment. 550 questionnaires containing 85 questions exclusively to assess the patterns of vocal use at their work place and primary school teacher's voice problems were distributed to all the teachers of 45 North County Dublin primary schools. Quantitative and qualitative analysis of responses were done. From the 55% of response rate obtained results indicated voice problems in 27%, irregular voice problem s in 53% whereas 20% had no voice problems. Authors concluded that primary school teachers are at greater risk of developing voice problem than secondary school teachers and the chances of voice rest were found to be very less in them. Dry throat and vocal fatigue were observed to be the most common symptoms. Age of the children taught, chances of vocal rest and workload are considered to be the risk factors that has an effect on teacher's voice. Increasing the awareness regarding the symptoms of voice disorders and appropriate referral to voice therapist or ENT surgeon were some of the measures suggested by the authors to reduce the effect of voice problem.

Teaching as a profession places high sufferance on voice (Pekkarinen & Viljanen, 1991; Rantala, Paavola, Körkkö & Vilkman, 1998; Sapienza, Crandell & Curtis, 1999). Job performances are badly affected by voice problems (Sapir, Keidar & Mathers-Smith, 1993; Smith et al., 1996; Russell, Oates, & Greenwood, 1998; Roy, Merrill Thibeault, Gray & Smith, 2004), and due to voice problems about 20% of the teachers fail to attend workdays as reported (Sapir et al., 1993; Smith et al., 1997; Roy et al., 2004).

Voice problems in Pre-school/ Primary and Secondary school teachers

Södersten, Granqvist, Hammarberg and Szabo, (2002) studied 10 preschool teachers voice during their working day. They were fitted with two microphones on either side of their head which maintained equidistant from mouth and Digital Audio Tape recorder was placed on their waist. The task involved in this binaural recording technique was to read a standard passage before their work and spontaneous speech during the working hour. Background noise, mean fundamental frequency, sound pressure level and the total

phonation time was analyzed in the study by authors. The results revealed that background noise at the day care center (where teachers were working) was 20 dB higher ie.76.1 dBA (range 73.0-78.2) where the allowed level is 50-55 dBA. Mean phonation time was 17% which was noted to be higher. Higher F0 (247 Hz) was observed and the teachers spoke 9.1 dB louder than their baseline. The authors concluded that on the basis of profession and working condition preschool teachers are found to have high vocal demand.

Pizolato et al. (2013) investigated factors that were considered to be risk for developing voice problem in teachers and with the help of acoustic analysis it was associated with the existence of voice changes in 102 teachers from Piracicaba middle public schools and 11 teachers from elementary school. Participants included 81 females and 21males with a mean age of 42.48years.The questionnaire included socio demographic information, organization of their work, working environmental aspects, signs and symptoms related to their voice problem and their behavioral habits. During non-teaching hour, 6 seconds phonation sample (/i/) was elicited within the classroom. Fundamental frequency, jitter, shimmer, noise to harmonic ratio and harmonic-to-noise ratio were analyzed from the phonation sample. Results revealed that 66.66% (67) of teachers were in continuous voice use & shouting during daily work. Prevalence rate of hoarseness for the past 6 months affected 52.96 % of the teachers. Alterations in the fundamental frequency were lesser in males when compared to that of females. Elementary Education II and Middle school teaching (includes 5^{th}grade to 10^{th} grade) were less likely to have voice alteration of the fundamental frequency in comparison with elementary school teachers (1st to 4th grade). Teachers with less changes in vocal intensity was teaching in noise free environment when compared to those who taught in the environment with noise. Thus, authors denote a significant relation between environmental noise and mean vocal intensity. The mean vocal intensity was found to be 76.29 ± 4.63 dB higher than the maximum value considered. There was no significant association observed between presence of dysphonia, experience, number of students in the class. Authors concluded that females were reported to have greater chances of voice disorders along with higher intensity. Configuration of glottis and fibronectin and hyaluronic acid quantity in men's

and women's vocal tract may explain the higher prevalence rate of Reinke's edema and nodules in females.

Devadas, Bellur and Maruthy (2017) have conducted a questionnaire survey in 24 private and 80 government primary schools in India. In spite of the subject they handle, all teachers were included for the study and 73% response rate was obtained for the distributed(1500) questionnaires. The authors concluded that from 1082 primary school teachers in India, 188 teachers were found to have voice problem which accounts a prevalence rate of 17.4%. Most frequently reported symptom is voice tiredness after long hours of teaching which is followed by, sore/dry throat, strain in voice, tension in neck muscle and difficulty in projecting voice. The study included private and government schools of only Mysore district. Nevertheless, of the subject/course that the teacher taught, all teachers (Mathematics/Music/Physical education) were involved in the study.

Teachers voice use in the occupational settings

In both laboratory settings (Stemple, Stanley & Lee, 1995; Vilkman, Lauri, Alku, Sala &Sihvo, 1999) and in field conditions (Jonsdottir, Laukkanen, Vilkman, 2002; Rantala, Vilkman & Bloigu, 2002) studies have reported that there is a rise in F0 for professional voice users after a working day. When compared to morning lecture F0 in school teachers, it was found to be higher after afternoon lecture (Rantala, Haataja, Vilkman & Korkko, 1994).

Rajasudhakar and Savithri (2008) had conducted a study in 34-year adult who has 8-9 years experience of teaching hearing impaired children in preschool. Authors have adapted Rantala &Vilkman`s (1999) nine voice symptom questionnaire and administered it. Aerodynamic assessment(slow vital capacity- SVC and force vital capacity- FVC) was done at the onset and end of the day. Sustained phonation was recorded at the beginning and end of the class and class room speech was recorded using digital audio tape recorder. First and last class sample of 30-35 minutes was recorded. PRAAT software was used to measure pitch periods. Mean F0, Minimun F0, Maximum F0, Standard

deviation of F0, mean jitter, shimmer, mean intensity, LTASS, range F0, were analyzed using vaghmi software. The F0 time was measured at 3 instances of 4 minutes duration of first, middle as well as last class sample. That is, T1, T2, T3 as the first, middle and last 4 minutes for the first class, respectively. T4, T5, T6 was the first, middle and last 4 minutes for the last class teaching sample, respectively. Results revealed less vocal fatigue symptoms, based on the score (13) obtained from the questionnaire. FVC and SVC were decreased at the end of the day when compared to the starting of the day. There was increase in F0, jitter/shimmer values at the end of the day. Whereas, SD F0, number of harmonics, beta and gamma ratios were found to be decreased, at the end of the day when compared to that of beginning of the day. Authors relate the rise in F0 to i) either as compensatory strategy or ii) to grab the attention of the children. Rise in F0 after the last class when compared to first class was due to vocal loading that was the most distinct result of the study. On comparing the first class to last class, voicing time was noted to be reduced which the authors associate to vocal fatigue. Limitations of the study include smaller sample size (one male special educator) and the teacherdealt with hearing impaired children regularly and not with normal hearing children, hence generalizing it to normal school teacher is questionable.

Similarly, Rajasudhakar and Savithri (2009a) examined the effect of working day on the changes in the acoustics measures after continuous teaching. This study was conducted in a 32-yearold female primary school teacher with an experience of 12 years.One-day speech sample was recorded with the help of Digital audio tape recorder (DAT). The phonation sample for vowel /a/ was recorded at 4 different conditions before and after the first class, after lunch break and after the last class. F0 time/voicing period was analyzed from the speech sample with the help of PRAAT software. Jitter, F0 and standard deviation of fundamental frequency (SD F0) was extracted from the phonation sample and analyzed by using Dr. Speech software. The results revealed that the voicing time was 1 hour 49 minutes and 48 seconds. Percentage of vibration time for class teaching was 83.42% and for non-teaching was 16.57%. Total duration of voicing for one day was 5 hours 48 minutes. There was a increase in F0, SD F0 and jitter towards the end of the day when compared to the beginning of the day. The rise in these acoustics measures like

F0, SD F0 and jitter at the end of first class was attributed to vocal warm up. After the lunch reduction seen in these measures were related to the adjustment of the vocal system to the situational demands. The acoustics measures were reported to be increased towards end (last class) when compared to the beginning (first class). Limited sample size was the limitation of the study and hence, generalizability of data is difficult.

Rajasudhakar and Savithri (2009b) carried out a study in two primary school teachers with the aim i) to develop an easy technique to measure voicing periods at occupational setting, ii) to test the technique on 2 primary school teachers during a usual working day, iii) and to estimate the vocal recovery index (Is) in 2 participants. The first teacher was 32 years old with 12yearsof teaching experience and taught 2^{nd} and 3^{rd} grade children. The second teacher was 42 years old with 20 years of teaching experience and taught 4^{th} and 5^{th} grade children. With the help of a Digital Audio Tape recorder (DAT), teacher's voice sample of a normal working day was recorded. Entire day's voice usage was noted by the teachers. 6 hours speech sample was divided into 36 segments of 10 minutes duration. Voicing period was measured by using PRAAT software and then voicing percentage and vocal recovery index were also calculated. Voicing percentage for first teacher was reported to be 31.46% which is 1 hour 49 minutes 48 seconds. During classroom teaching the vibration of the vocal folds were to an average of 83.42% and outside the classroom it was about 16.57%. Cumulative average for vocal vibration in classroom teaching was 83.42% and 17.71% for outside the classroom in second teacher. Percentage of voicing was observed to be higher in first teacher when compared to that of second teacher. This was related to the frequent repetitions and demonstrations needed in teaching the lowerclass children when compared to that of higher class. This change in voicing percentage was also attributed to the age of the teachers, years of experience and the subjects handled at the time of recording. For the first teacher, the vocal recovery index was 0.68 and 0.77 in second teacher. More vocal index is related to lesser period of voicing. The authors concluded that technique described in the study is an alternate method to estimate the voicing period. Smaller sample size and same teacher handling different subjects (as the percentage of voicing can vary withsubjects) are some of the limitations of the study.

Rajasudhakar and Savithri (2010) investigated the consequence of vocal rest on acoustics features following a working day in 12female primary preschool teachers (age ranging from 23-42 years) with an experience of 8.6 years. Voice samples were recorded in 3 conditions on 2 regular days (Monday and Tuesday) using a DAT recorder. Reading sample obtained from a standardized Kannada reading passage and phonation of vowel /a/ were obtained from the participants. Both were recorded at three different intervals i.e., prior to starting of school (Monday morning), after school (Monday evening) and after 16-18 hours of voice rest (Tuesday morning). After recording the phonation of vowel /a/ the participants were instructed to read a standardized Kannada passage of 42 words. Acoustic parameters like fundament frequency of phonation (pF0), SD F0, SF0, Jitter, Shimmer, HNR were analyzed from phonation sample with the help of PRAAT software. From the reading sample HNR, jitter, shimmer and fundamental frequency of speech/reading sample (sF0) was analyzed. The results revealed that frequency measures (from the phonation sample) like pF0, SD F0 were significantly higher after vocal loading in comparison with prior teaching condition. Jitter, shimmer and sF0 were lower before the starting of the class and were found to be increased after vocal loading. These values were found to be decreased after a period (16-18 hours) of voice rest. HNR measure did not show any significant difference across these 3 conditions. The increase in these measures after vocal loading was attributed to the increase in muscular and structural tension of the vocal fold. The reduction of these measures after a period of voice rest related to the regaining of blood and water supply to the laryngeal structures. Small sample size is the limitation of the study.

Among teachers the music teachers are roughly 4 times more prone to develop voice problems when in comparison to the classroom teachers. A study by Morrow and Connor (2011) aimed to compare the voice use profiles between 7 elementary classroom teachers (taught Mathematics, science and social studies only to grade 3 students) and 5 elementary music teachers (who taught students from KG till Grade 5) across different variables. The study concerned amount and intensity of vocal use and vocal load among

the subjects. There were 6 female teachers and 1 male music teacher in the age range of 24 to 58 years. All elementary classroom teachers were females. The music teachers had significantly larger values than the classroom teachers for all measured variables like fundamental frequency (F0), total phonation time and vocal intensity. Recordings were taken for 5 full teaching days of 1 week using KayPENTAX ambulatory phonation monitor. The study concludes that music teachers had increased vocal load compared to the elementary classroom teachers. Only one male subject was included in the study for music group and sample size is less for both the music and elementary classroom teachers.

Alexander, Shetty and Mathew (2017) had compared the acoustic measures such as F0, intensity (SPL), perturbation measures (jitter and shimmer), HNR in pre and post teaching condition of a normal working day. The study also aimed to investigate the parameter that was most sensitive and an objective measure that can be used to identify the individuals at risk for developing vocal fatigue. The study included 30 primary school teachers (15 males and 15 females) in the age range of 28 – 35 years with 10 to 12 years of experience. The task included a general conversation of 3 minutes, phonation of vowel /a/ and repetition of a slogan "may god bless the world". These recordings were done in a quite environment before the first class and after the last class. PRAAT software was used to extract parameters like mean pitch, maximum pitch, minimum pitch, voice breaks, HNR and perturbation measures. In comparison of preand post teaching condition statistical significance were noted only for number of voice breaks in both males and females. Significance was most in conversation task. For slogan repetition task only in males, statistical significant difference was seen for mean pitch. Authors concluded that an effective parameter to predict the vocal fatigue in males and females was the increase in number of voice breaks for the conversation task. Increase in pitch was observed to be a predictor only for males. Poor vocal hygiene was attributed to the difference in acoustic parameters across the day.

Since teachers are at risk of developing voice problem due to prolonged teaching. Nusseck et al., (2017) studied the factors that are associated with teacher's voice during their teaching time. The study aimed to analyze the vocal behavior with the help of voice dosimeter for a particular lesson in 133 teachers that includes 99 males (mean age: 27.7 years) and 34 females (mean age: 26.2 years) teachers. Teachers were from elementary, secondary, and a special school (where children with attention, learning difficulties and developmental or neurological disorders were taught) where normal curriculum was followed. The lessons include German language, foreign languages, Natural science, Social and cultural lessons, Physical education (Sport), Mathematics, and others (including art and home economics) with duration of 48 minute and authors recorded one teaching class. Noise SPL in the classroom, phonation time, F0 and voice SPL of teachers were measured. Calculation of vocal loading doses and teacher's voice and noise SPL correlations were also included in the analysis. Across the lessons, there was a variation in noise SPL and voice SPL in which the largest variation was noted for sports lesson. All over the lesson there was variation in mean noise SPL with larger values at the onset and end of lessons. There was variation in noise SPL along with voice SPL in some teachers where as in others there was constant high value for voice SPL. Voice SPL of a teacher shows a strong correlation with F0, Noise SPL of the classroom and vocal SPL. During teaching a teacher's voice SPL was found to be related to noise SPL of the classroom and vocal SPL. This study highlights the importance of reducing vocal loading. The authors concluded that there was a significant association between noise SPL of the classroom and vocal SPL behavior of the individual to that of voice SPL of the teachers at the time of their teaching.

Voice use of teachers with amplification

Jónsdóttir, Laukkanen and Siikki (2003) studied the alterations in the quality of teacher's voice with and without amplification. Five teachers (3 females, 2 males) with a mean age of 51 years from 3 different educational setups participated in the study (sixth to college, primary school, and university). First and last class of a hard working day was recorded with head mounted microphone and DAT recorder. First recording was done without any

amplification device after which teachers were given this device for use till the next recording i.e. next week same day with the amplification device. Acoustic analysis included LTASS, 3 samples of 2 minutes duration was taken from the first, middle and end of the first and last class. Using sound level meter (SLM), SPL measure was obtained. More tilted spectrum and lower SPL values were noted in the case of amplification. Quality of voice was observed to be better and also the vocal fatigue was reported to be less. Without amplification, authors found that there were no remarkable changes. This decrease in spectral tilt after loading may not indicate vocal fatigue it shows the adaptation that is taking place in response to the loading. Steeper slope obtained with the use of amplification system in the classroom speech was attributed to decreased SPL which is in turn related to soft closing of the vocal folds. Softer closing of vocal folds results in lesser stress on the vocal fold tissues hence the fatigue experienced by the teachers were less while the amplification device was in use. So, the authors concluded that changes in the acoustic measures signify positive adaptation to the vocal loading and in case of absence of these signs vocal fatigue is expected.

Gaskill, Brien and Tinter (2012) studied how vocal amplification is affecting occupational voice dose. A study was conducted in 2 elementary school teachers. Based on the scores obtained from (VRQOL) voice related quality of life survey conducted in 13 elementary school only 2 teachers were selected for the study. Teacher 1 was 57 years old & 39 years of work experience who had voice problem. Teacher 2 with the age of 52 years and 31 years of teaching experience had no vice problem. They had to wear vocal dosimeter for 3 weeks and voice amplification device at second week. Fundamental frequency, vocal fold cycle dose, vocal intensity, distance dose was measured. There was a reduction in vocal intensity and distance dose with the use of amplification device in teachers 1.When amplification device was used, vocal intensity was observed to be reduced for both the teachers. Result was more prominent in teacher 1 and per hour overall reduction was noted in the distance dose of teacher 1. Teaching was reported to be easy with the help of amplification device and teacher 1 experienced less vocal fatigue when amplification device was used. Teacher 2 had neutral opinion regarding the use of amplification device. Larger variation in the cycle dose from the baseline was noted and

there was no evident change of pattern for 2 to 3 weeks when compared to the baseline. Across the 3 weeks, there was an overall rise in cycle as well as distance dose for teacher 2. During the use of amplification device, the visible reduction in intensity was moderate. This study highlights the importance of amplification in classroom settings/working environment. The authors concluded that the use of amplification device reduce the vocal loading that occurs during classroom teaching and in turn results in the reduction in vocal intensity. Generalizing the results is questionable with limited sample size.

Voice alterations during vocal loading can be understood to a larger extend in the occupational setup. The studies reporting the vocal loading experienced by the teachers in the occupational set up are very limited.Focusing specifically into the effect of a particular subject or course, no study has been reported by investigating the working day effect on vocal loading parameters. Hence, the need arises to investigate in this direction.

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CHAPTER III

METHOD

Participants

Two groups of subjects were included in the study. Group I consisted of 5 phono normal Mathematics teachers and group-II consisted of 5 phono-normal Malayalam language teachers. The age of the participants in the two groups ranged from 30 to 45 years. All the participants in group I and II were female upper primary school teachers working in Kerala government schools.

Common inclusion criteria for both groups of teachers

1) These subjects had no history of voice problem
2) The subjects were free from asthma, hypertension, allergies, gastro esophageal reflex disorder, and did not report of any speech, language, voice and hearing disorder at the time of recording.
3) The subjects had minimum 5 years of teaching experience.
4) Taught only 5^{th} to 7^{th} standard children with class strength ranging between 30 to 50 students (Preferably a co-educational setup).
5) Average teaching hours per day included 4-5 classes of 30-45 minutes duration.
6) Taught the students in a classroom with an area ranging from 400-600 square feet with adequate ventilation.

7) The teachers did not take any extra classes or private tuition other than their scheduled school hours.

Inclusion criteria for Mathematics teachers (Group I)

1) Participants did not teach any subject other than Mathematics.

Inclusion criteria for Malayalam language teachers (Group II)

1) Teaching methodology used by language teachers mainly included lecturing.
2) Did not teach any subject other than their area of expertise (Malayalam language).

Instrumentation

A light weighted (54 grams), portable digital audio tape recorder (Olympus digital voice recorder WS-100) was used for recording both phonation and teaching sample. PRAAT (Boersma & Weenink, 2009) software was used for the acoustic analysis of voice parameters and F0 time measurement.

Procedure

All teachers were explained about the aim of the study, both written and oral consent were taken from them. Subjects were instructed to phonate vowel /a/ for 5-6 seconds before the first class (condition I) and after the last class (condition II) of a normal working day. For classroom speech, teachers were asked to wear the Digital audio tape recorder (DAT) around the neck, where a constant (10 -12cm) microphone to mouth distance was maintained. Then teachers were instructed to take the class as usual without being conscious about the DAT recorder which was worn around their neck. The entire duration of first and last class teaching was recorded for Mathematics as well as Malayalam language teachers. Both the phonation sample and classroom speech of first and last class were recorded in classroom setup for both the group of teachers.

Acoustic Analysis

PRAAT software was used to analyze voice parameters such as F0 time, Fundamental frequency (F0), standard deviation of F0 (SD F0), perturbation measures (jitter and shimmer) and harmonic to noise ratio (HNR). The F0 time was measured from first and

last class teaching sample. It was measured at 3 instances of 5 minutes duration of first as well as last class sample. That is, first 5 minute (T1), middle 5 minute (T2), last 5 minute (T3) of the first and the corresponding instances (T4, T5 & T6) of last class of the teaching sample. From these truncated sample of 5 minutes duration students' voice and other external noise were removed. Duration of the edited sample and degree of voice breaks were obtained from the voice report on PRAAT. Percentage of voicing was then calculated by subtracting the degree of voice breaks from 100. In order to calculate the voicing duration, the obtained percentage of voicing was substituted into the formula, voicing duration; percentage of voicing × edited duration of the (5 minutes) sample/100. F0, SD F0, perturbation parameters (Jitter& Shimmer) and HNR measures were extracted from phonation sample of vowel /a/ at two conditions (Prior to the first and after the last class).

Statistical Analysis

The Statistical Package for Social Sciences (SPSS) version 21 was used for the statistical analysis. Descriptive statistics: Mean, Standard deviation and median were calculated for the voice parameters measured at two conditions between two groups, as well as for the voicing duration (F0 time) obtained for first and last class of teachers. Since the numbers of participants were 5 in each group, non - parametric test was done. The analysis was carried out separately for voice parameters obtained from phonation sample and F0 time measured from the teaching sample. Mann – Whiney U test was done to compare the 2 conditions for voice measures obtained during the phonation task between the groups. Comparison of condition I and condition II within Malayalam language teachers and Mathematics teachers was done using Wilcoxon Signed Rank test. Again Mann – Whiney U test was performed to compare F0 time (voicing duration) across six time intervals (T1, T2, T3, T4, T5 and T6) and average of first 3 instances and last 3 instances of five minutes duration between two groups. Comparison of F0 time from the average of 3 time intervals (5 minutes duration) within group I and group II was done using Wilcoxon Signed Rank test. Friedman's test was done to see within group comparison of F0 time (at six point of time) in both the groups. In order to find out, at what time interval

significance occurred within the group, a pair wise comparison was done by using Wilcoxon Signed Rank test.

CHAPTER IV

RESULTS

The aim of the present study is to determine the working day vocal loading effect on few voiceparameters in Mathematics and Malayalam language teachers and to compare between them. This includes the measurement of(i) the working day effect on voice parameters such as Fundamental frequency (F0), standard deviation of F0 (SD F0), jitter, shimmer and harmonic to noise ratio (HNR) for phonation of vowel /a/ before the first and after the last class; (ii) the active vocal fold vibration time (F0 time) of Malayalam language teachers between first and last class and(iii) the active vocal fold vibration time (F0 time) of Mathematics teachers between first and last class.

Voice parameters such as Fundamental frequency (F0), standard deviation of F0 (SD F0), perturbation measures (jitter and shimmer) and harmonic to noise ratio (HNR) were obtained from the phonation sample (/a/) and F0 time is from the teaching sample. Statistical Package for Social Sciences (SPSS) version 21 was used for the statistical analysis. Since the numbers of participants are 5 in each group, non -parametric test was done.

The results of the present study are discussed under 2 sub headings;

(a) Voice parameters; and
(b) F0 time

(a) Voice parameters:

(i) Between group comparison

Table 1: Mean, Standard Deviation (SD) and Median for the voice parameters measured at two conditions between two groups

Parameters	Conditions	Malayalam (G-I)			Mathematics (G-II)		
		Mean	SD	Median	Mean	SD	Median
F0 (in Hz)	Condition I (First Class)	211.27	24.07	205.45	219.23	23.52	230.24
	Condition II (Last Class)	207.19	29.63	211.40	176.39	14.65	173.94
SD F0 (in Hz)	Condition I (First Class)	1.78	0.52	1.83	1.58	0.45	1.34
	Condition II (Last Class)	1.66	0.36	1.53	1.82	0.67	1.66
Jitter (in Hz)	Condition I (First Class)	0.33	0.12	0.32	0.28	0.09	0.31
	Condition II (Last Class)	0.33	0.14	0.32	0.39	0.29	0.31
Shimmer (in dB)	Condition I (First Class)	4.50	1.28	4.40	3.67	1.26	4.09
	Condition II (Last Class)	5.28	2.06	5.50	5.26	1.87	4.79
HNR	Condition I (First Class)	19.4	2.44	19.88	21.07	3.57	19.48
	Condition II (Last Class)	18.6	3.72	18.58	18.00	2.01	18.85

Table 1 shows that in condition I, the measured voice parameters such as SD F0, jitter, shimmer and HNR values were found to be higher in group I (Malayalam language) teachers than group II teachers. On the other hand, F0 was lower in group I teachers. F0 was found to be increasedby 6 Hz in Malayalam and by 57 Hz in Mathematics teachers at condition II from condition I. SD

F0was found to be decreased by 0.3 Hz in Malayalam language teachers and it was increased by 0.32 Hz in Mathematics teachers at condition II. There is no change observed in jitter in two groups at conditions II. Shimmer was noted to be increased in condition II when compared to that of condition I in both the groups. Whereas, there is a reduction in HNR at condition IIin both the groups and statistical significant difference was not observed for any of the above mentioned voice parameters in both groups between two conditions.

Table 2: Results of Mann Whitney U test for group comparison at condition I and II for phonation task

	Condition I		**Condition II**	
Voice parameters	**/z/**	**p value**	**/z/**	**p value**
F0	0.94	0.34	1.77	0.07
SD F0	0.52	0.62	0.10	0.91
Jitter	0.52	0.60	0.41	0.67
Shimmer	1.35	0.17	0.10	0.91
HNR	0.31	0.75	0.10	0.91

Table 2 shows the results of Mann – Whiney U test for group comparison at 2 conditions for voice measures obtained from the phonation task.Since all p valuesare greater than 0.05, there was no statistical significant difference observed between the two groups for any of the voice parameters in condition I and condition II.

(ii) Within group comparison

Table 3: Results of Wilcoxon Signed Rank test for within group comparison for phonation task in group I

	/z/	p value
F0 (Condition II – Condition I)	0.67	0.50
SD F0 (Condition II – Condition I)	0.94	0.34
Jitter (Condition II – Condition I)	0.00	1.00
Shimmer (Condition II – Condition I)	1.21	0.22
HNR (Condition II – Condition I)	0.94	0.34

Table 3 shows the comparison of condition I and condition II within Malayalam language teachers (group I) using Wilcoxon Signed Rank test. There was no statistical significant difference observed for any of the above mentioned voice parameters when compared across two conditions within Malayalam language teachers. The p values obtained for each parameter were noted to be >0.05 which indicated no statistical significance.

Table 4: Results of Wilcoxon Signed Rank test for within group comparison for phonation task in group II

	/z/	p value
F0 (Condition II – Condition I)	1.75	0.08
SD F0 (Condition II – Condition I)	0.40	0.68
Jitter (Condition II – Condition I)	0.13	0.89
Shimmer (Condition II – Condition I)	1.21	0.22
HNR (Condition II – Condition I)	1.48	0.13

Table 4 shows the comparison of condition I and condition II within Mathematics teachers (group II) using Wilcoxon Signed Rank test. There was no statistical significant difference observed for any of the above mentioned voice parameters when compared across two conditions

within Mathematics teachers. The p values obtained for each parameter were noted to be >0.05 which indicated no statistical significance.

To summarize, the measured five acoustic parameters did not show significant difference between 2 group of teachers and conditions. However, there was a marginal significant difference observed for fundamental frequency (F0) parameter compared to other parameters for between group comparison (p is 0.07) in condition II and withingroup comparison (p is 0.08) in group II.

(b) F0 time:

(i) Between group comparison

F0 time was measured from first and last class teaching sample of teachers in both the groups. The F0 time wasmeasured at 3 instances of 5 minutes duration of first as well as the last class sample. That is,first 5 minute (T1), middle 5 minute (T2), last 5 minute (T3) of the first class andfirst 5 minute (T4), middle 5minute (T5), last 5 minute(T6) of the last classteaching sample and voicing duration (VD)was calculated for each five minute sample.

Table 5: Mean, SD and Medianof Voicing duration (F0 time) at first and last class of teachers in both groups

		Malayalam (Group I)			Mathematics (Group II)		
		Mean (in seconds)	**SD**	**Median**	**Mean** (in seconds)	**SD**	**Median**
First Class (Morning)	**T1**	161.02	33.5	177.45	110.69	43.39	96.49
	T2	174.57	27.77	180.88	131.77	58.17	135.24
	T3	158.84	30.62	162.29	163.02	23.08	162.41
Average	**Avg (VD1)**	164.81	27.02	172.47	135.16	13.30	133.25
Last Class (Evening)	**T4**	140.31	31.07	126.07	98.49	48.98	96.86
	T5	150.13	31.05	159.91	115.69	52.61	104.27
	T6	137.97	62.92	98.86	130.20	49.39	142.49
Average	**Avg (VD2)**	142.80	27.03	151.86	114.79	43.81	108.92

[Avg (VD1) = T1+T2+T3/3; Avg (VD2) = T4+T5+T6/3]

Table 5 shows the Mean, Standard deviation and Median of voicing durationcalculated from 3 instances of 5 minute duration from first and last class. In Malayalam language teachers, it was observed that there was a gradual rise followed by a reduction in voicing duration from beginning to the end of first class. A sharp rise and fall in voicing duration from beginning to the end of last class was also noted from table 5. Whereas, in Mathematics teachers a typical rising pattern was observed for the first class. A gradual rise in F0 time was observed from the beginning of the last class to the end of the last class. The average median F0 time for group I teachers was higher (172 seconds) when compared to group II teachers (133 seconds) in first class. Also, the average median F0 time for group I teachers were higher (152 seconds) when compared to group II teachers (109 seconds) in last class. Average voicing duration was observed to be reduced at the end of the last class in both the groups when compared to the beginning of the first class. The reduction in F0 time was more in Mathematics teachers (24 seconds in group II) than Malayalam language teachers (20 seconds in group I).

Table 6: Results of Mann Whitney U test for F0 time (voicing duration) across six time intervals and average of first and last 3 instances of five minutes duration between two groups

Parameters	/z/	p value	Average F0 time	/z/	p value
T1	1.77	0.07			
T2	0.94	0.34	**Avg (VD1)**	1.77	0.76
T3	0.30	0.75	**(First class)**		
T4	1.14	0.25			
T5	0.94	0.34	**Avg (VD2)**	1.149	0.25
T6	1.10	0.91	**(Last class)**		

Table 6 shows the comparison of six instances of voicing duration between Malayalam and Mathematics teachers obtained from the first and last teaching class. Also, the comparison between average of the 3 time interval of 5 minute duration (first class) with the similaraverage (3 instances of five minutes duration) obtained from last class are depicted in table 6. Since, all p values are greater than 0.05, there was no statistical significant difference observed for any of the 5 minute duration between the 2 groups. Also, the average F0 time for first class (VD1) and for last class (VD2) was found to have no statistical significant difference between the groups.

(ii) Within group comparison

Table 7: Results of Wilcoxon Signed Rank test for within group comparison for F0 time between first and last class in group I and group II

Avg VD2 – Avg VD1	/z/	p value
Group I (Malayalam)	2.02	0.43
Group II (Mathematics)	0.94	0.34

Table 7 shows the results of Wilcoxon Signed Rank test for the comparison of average F0 time of 3 instances of five minutes duration from the first class and the last class within group I and group II.Since, the p values are >0.05 in both the groups there is no statistical significant difference observed.

Table 8: Results of Friedman's test for within group comparison of F0 time (at six point of time) in both the groups

	N	χ^2	df	p value
Group I	5	7.17	5	0.20
Group II	5	11.28	5	0.04*

(* significant difference at 0.05 level)

Table 8 shows the comparison of six instances of voicing duration within Malayalam language (Group I) and Mathematics teachers (Group II). Statistical significance was observed at 0.05 level for Mathematics teachers in within group comparison. Whereas, statistical significance was not observed in Malayalam language teachers for F0 time (at 6 time points).

In order to find out, at what5 minute time interval,the significant difference occurred within the group, a pair wise comparison was done by using Wilcoxon Signed Rank test.

Table 9: Results of pair wise comparison using Wilcoxon Signed Rank test within group II

Interval	/z/	p value
T2 - T1	0.67	0.50
T3 – T1	2.02	0.043*
T4 - T1	0.67	0.50
T5 - T1	0.13	0.89
T6 - T1	0.67	0.50
T3 - T2	0.94	0.34
T4 - T2	0.67	0.50
T5 - T2	0.67	0.50
T6 - T2	0.13	0.89
T4 - T3	2.02	0.043*
T5 - T3	2.02	0.043*
T6 - T3	1.75	0.08
T5 - T4	1.21	0.22
T6 - T4	1.21	0.22
T6 - T5	0.45	0.68

From table 9, significant difference in voicing duration (F0 time) was seen between T3 - T1,T4 - T3 and T5 - T3 in Mathematics teachers (Group II) and no significant differences were found for voicing duration (measured at 6 instances) at other time intervals. Voicing duration at T3 was found to be significantly higher (162 seconds) compared to the voicing duration at T1 (96 seconds), T4 (97 seconds) and T5 (104 seconds).

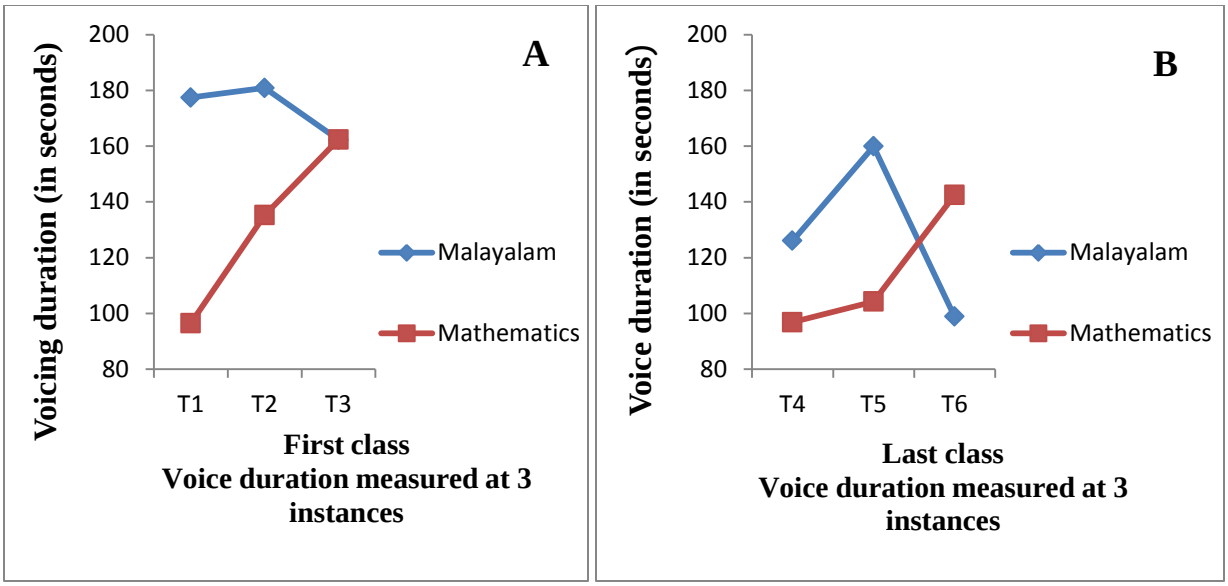

Figure 1: Panel A- F0 time (voicing time) at the first class(T1, T2, T3) andPanel B- F0 time at the last class (T4, T5, T6) between 2 groups of teachers.

Figure1(panel A) depicts the plot obtained between Median value of voicing duration at different time points[which includes the initial (T1), middle (T2) and last (T3) five minute] of the first class.In Malayalam language teachers, the voicing duration decreased from the beginning of the first class (T1:177.45) to the end of first class (T2:180.88 to T3:162.29).Whereas, in Mathematics teachers, typical rising pattern was observed, showing the rise in voicing duration (T1:96.49) from first class followed by a sharp rise(T2:135.24 to T3:162.41)towards the end of first class.Panel B depicts the plot obtained between Median value of voicing duration at different time points [which includes the initial (T3), middle (T4) and last (T5) five minute] of the last class. In Malayalam language teachers, a sharp rise in F0 time from T4:126.07 to T5:159.91 followed by a sharp fall to T6:98.86 were seen in the last class. Whereas, in Mathematics teachers,a gradual rising (from T4:96.86) was observed in the beginning of last class followed by a complete rise (from T5:104.27 to T6:142.49) by the end of last class.

From figure 1, it can be seen thatthe trend of F0 time is decreasing from first class to last class in Malayalam teachers. On the other hand, the F0 time in Mathematic teachers, increase from first class to last class. The F0 time curve is placed higher for Malayalam language teachers (Group I) when compared to Mathematics teachers (Group II) in the figure 1.

CHAPTER V

DISCUSSION

The aim of the present study was to investigate the working day vocal loading effect on few voice parameters and F0 time in Mathematics and Malayalam language teachers and to compare between them. From the two groups of teachers (group I: Malayalam language teachers & group II Mathematics language teachers) voice parameters were measured from the phonation sample which was recorded before the first and after the last class. F0 time was measured from the first and last class teaching sample and these recordings were made in the classroom setup using a Digital audio tape recorder (DAT). F0, SD F0, jitter, simmer, HNR were extracted from the phonation sample. These parameters were compared between both the groups of teachers.

The results of the present study indicate several points of interest:

First, All measured voice parameters such as SD F0, jitter, shimmer and HNR values were found to be higher in group I (Malayalam language) teachers than group II teachers in condition I. On the other hand, F0 was lower in group I teachers. Generally, the Malayalam language teachers are involved in prolonged loud teaching in the classroom from the beginning of their teaching career (mean working years: 12 years) that resulted in overuse of voice. Over a period of time this would have altered the vocal fold vibratory patterns. The periodicity of the vocal fold vibration would get hampered owing to this. The increased values of jitter, shimmer, SD F0 and HNR in group I teachers can be attributed to the altered vibration of the vocal folds. Further, the increased values of acoustic parameters such as jitter and SD F0 in phonation of vowel /a/ reflected poor stability of vocal fold vibration. Due to the repeated vibration of vocal folds there is a resultant increase in the colloidal forces between vocal folds. The prolonged use of voice in teachers (in general) would alter these acoustic features. These values are relatively higher in Malayalam language teachers (group I) when compared to group II teachers due to above mentioned factors that need to be investigated further. Owing to the poor stability of vocal fold vibration, noise component would have contributed more in the

voice product that contains poor harmonics. Thus, there is increased HNR in group I teachers. Increased shimmer value in group I teachers can be attributed to poor stability of respiratory support or variations in the sub-glottal pressure. Novak (1991) reported reduced F0 in females even after vocal loading this was attributed to increased vocal/mental effort and hypertony of the laryngeal muscles. In the current study, reduced F0 in condition I could be because of the cumulative effect of continuous vibration of the vocal folds for past 12 years that could have resulted in the weakness of thryroarytenoid muscles which led to the reduction in F0 for Malayalam language teachers.

Second, F0 was found to be increased by 6 Hz in Malayalam and 57 Hz in Mathematics teachers at condition II from condition I. Malayalam language teachers are involved in continuous voice usage involving lots of voice modulations. By the end of a typical working day this prolonged voice usage could have resulted in reduction in flexibility of vocal folds due to which the F0 hike is lesser in Malayalam language teachers when compared to Mathematics teachers. According to Södersten, Granqvist, Hammarberg and Szabo, (2002) higher F0 after vocal loading is attributed to higher vocal demands phased by teachers whereas, Rantala, Vilkman and Bloigu,(2002) have reported that the rise in F0 after a working day is the compensatory reactions for the physiological changes such as changes in mucosa, increase in vibratory frequency of glottal force for adduction. Other reasons could be, increase in subglottal pressure increases the tension on the vocal fold that would in turn increases the F0. When compared to morning lecture, F0 in school teachers was found to be higher than after afternoon lecture (Rantala, Haataja, Vilkman & Korkko, 1994). Laukkanen et al. (2008) reported that there was an increase in F0 after the working day. The authors correlated the tiredness to the increased F0 in teachers after the vocal loading. The rise in F0 can be attributed to i) either as a compensatory strategy used by the teachers in order to overcome the vocal fatigue/changes in their voice quality or ii) to get the attention of the children as they were observed to be more restless towards the end of last class which is in consonance with the findings of Rajasudhakar and Savithri (2008). Even though the F0 alterations are more evident in females, the F0 changes noted in the present study between 2 conditions in both groups was not statistically significant. According to Pizolato et al. (2013) alterations of F0 in teachers teaching 5^{th} grade to 10^{th} gradewere less when compared to that of teachers teaching $1^{st}$to

4th grade.

Third, SD F0 did not show any significant increase or decrease in both the groups from condition I to condition II; this could be because of less sample size. Also, no change in SD F0 can be attributed to group data effect where the individual participant representation would get masked. According to Oppong (2013), group data would get nullified of any effect of variables. Rajasudhakar and Savithri (2008) have reported reduction in SD F0 after vocal loading. Higher SD F0 after vocal loading could be attributed to the variability in the laryngeal function which could be due to the impairment in the coordination of movements that could be an indication of vocal fatigue (Kroemer & Grandjean, 1997). The results of the present study did not support the findings of Kroemer and Grandjean, (1997) and Rajasudhakar and Savithri (2008) who reported that increased SD F0 after vocal loading. The SD F0 in the present study did not undergo any change is probably due to small sample size or group data comparison.

Fourth, there was no change observed in jitter in both the groups from condition I to II. This is an unusual finding on jitter which may be due to the smaller sample size. Studies have shown increased, decreased or no significant change in the jitter value when measured after vocal loading. Alexander, Shetty and Mathew (2017) did not observe any significant difference in jitter value after vocal loading over the working day. Laukkanen et al.(2008) reported reduction in jitter after working day vocal loading. Authors have correlated lower perturbation value to the increased muscle tonus and hyperfunctional production of voice. Higher jitter value is related to the tiredness of throat which might have resulted from the reduction in the muscle tonus and weakened neuro-motor control that have resulted from vocal fatigue. Rajasudhakar and Savithri (2009a) reported increase in jitter towards the end of the day when compared to the beginning of the day. The present study did not find any such changes after vocal loading (teaching) and this result is in consonance with the findings of Verstraeteet al. (1993) and Alexander et al. (2017)where they reported no changes on jitter after vocal loading.

Fifth, shimmer was found to be increased in condition II when compared to that of condition I in both the groups.Even though the finding was not statistically significant, this could be attributed to smaller sample size. In the continuous teaching process teachers could not be able to maintain the vibration of the vocal fold steadily and the subglottal pressure varies which in turn increased the shimmer value. Shimmer was lower before the starting of the class and was found to be increased after vocal loading (Rajasudhakar & Savithri, 2010). As the authors reported that the increase in the shimmer after vocal loading could be attributed to the increase in muscular and structural tension of the vocal fold. The present study found relative increase in shimmer after vocal loading (condition II) and this result is in agreement with Rantala and Vilkman (1999) and Rajasudhakar and Savithri (2010) findings who reported increased shimmer after vocal loading or last class.

Sixth, there was a reduction in HNR at condition II from condition I in both the groups. The continuous teaching can result in aperiodic vibration of the vocal folds due to which there would be an incomplete adduction of vocal folds. This incomplete adduction may probably lead to frequent air escape through the vocal folds due which noise level might have increased and this could have resulted in decreased HNR. The results of the present study were in consonance with the findings of Rajasudhakar and Savithri (2008) where HNR was reported to be reduced after vocal loading task. These findings were not statistically significant which is in line with the findings of Alexander, Shetty and Mathew (2017) and these differences in findings can be attributed to methodological differences in above studies.

Seventh, the average median F0 time for group I teachers were higher (172 seconds) when compared to group II teachers (133 seconds) in first class. Also, the average median F0 time for group I teachers were higher (109 seconds) when compared to group II teachers (109 seconds) in the last class. That is, the average median F0 time (voicing duration) was higher in Malayalam language teachers (group I), both in first and last class.This could be attributed to the teaching strategy used by group I (Malayalam language) teachers. The Malayalam language teachers are involved in continuous usage

of voice for extended period of time. Their teaching skills involves reciting poem, narrating stories or incidents using modulations in voice. This would in turn increase the vocal loading. These language teachers use lots of vocal effort especially while using onomatopoetic words to grab the attention of children and to make the lesson interesting. Hence, the vocal load for language teachers could be higher than that of Mathematics teachers. In case of Mathematics teachers, they get a shorter moment of vocal rest during the class, this could be when they are solving the sum on the blackboard or while the students are copying from the board or when the students are solving the mathematic sum. Hence, the extend of voice usage (reflected as F0 time) is lesser in Mathematic teachers when compared to that of Malayalam language teachers (group I). The same is reflected graphically in Figure 1, where F0 time curve was relatively placed high in the graph for Malayalam (group I) language teachers than Mathematics teachers (group II) both at the first as well as last class.

Eighth, average voicing duration was observed to be reduced at the last class in both the groups when compared to the first class.This drop in F0 time in both the groups at the last class can be attributed to vocal fatigue. The results of the present study supports the findings of Rajasudhakar and Savithri (2008) who reported that voicing time was reduced from first class to last class and this would have resulted from vocal fatigue. The reduction in F0 time from first class to last class in both groups was not statistically significant and this might be due to small sample in each group.

Ninth, results of within group comparison for F0 time (at six point of time) in both the groups revealed a significance found only in Mathematics teachers (group II). The significant differences were found between the intervals T3 - T1, T4 - T3 and T5 - T3. Voicing duration at T3 was found to be significantly higher compared to the voicing duration at T1, T4 and T5. T3 is the last 5 minute of first class, whereas T1, T4 are the initial 5 minute of first and last class and T5 is the middle 5 minute of last class. By the end of every class, Mathematics teachers give homework which is mainly dictated by them. The students are more restless towards the end of the class so the teachers indulge in continuous repeated speaking in order to control the class. Whereas, in the initial part of the classes these teachers indulge in the voice usage by taking the attendance and

correcting the home work carried out by the students due to which the voicing duration is comparatively lesser in the initial 5 minute duration (T1 & T4) of the class than middle (T5) and last 5 minute of the class.

To summarize, Malayalam language teachers had higher voicing duration compared to Mathematics teachers because of the difference in the course that they taught and also teaching strategy used by them. The subject handled by the teachers plays an important role in the vocal load experienced by them. According to Morrow and Connor (2009) music teachers were reported to have increased vocal loading as their vocal demands are more in the occupational settings when compared to other subject teachers. Nusseck et al., (2017) reported highest vocal loading for sports lessons as the noise and voice SPL was increased for sports lesson that lead to an increase in F0 which in turn increased the vocal strain. Since the Malayalam language teachers (group I) are involved in continuous speaking for extended period of time with modulations in voice, the vocal demands would be higher in them when compared to Mathematics teachers (group II). F0 time curve is placed higher for Malayalam language teachers for both first and last class when compared to Mathematics teachers indicated higher F0 time in Malayalam language teachers. They start the class with a higher F0 time (more vocal fold vibration) when compared to group II teachers which gradually decrease towards the end of the class due to fatigue. The decreased voicing duration in Mathematics teachers at the beginning of first and last class could be because of the routine activities carried out like taking attendance, clearing the doubts of the students and correcting the homework. These activities would involve lesser voicing duration when compared to that of classroom teaching. There is increased voicing duration towards the end of first and last class in Mathematics teachers as they dictate the home work towards end of the last class and since the students are more restless towards the end of the class, the teachers need to raise their voice and speak continuously. Statistical significant difference was not obtained for most of the measured variables; this could be because of the limited sample size. Hence, the study can be carried out considering a larger sample size.

CHAPTER VI

SUMMARY AND CONCLUSIONS

The present study was aimed to investigate the working day vocal loading effect on few voice parameters in Malayalam and Mathematics teachers. A total of 10 participants (5 Malayalam and 5 Mathematics teachers) in the age range of 30 – 45 years were recruited in the present study. The participants were divided into 2 groups; group I (5 Malayalam Language teachers) and group II (5 Mathematics teachers). All the participants in group I and II were female upper primary school teachers working in Kerala government schools.

Using a Digital audio tape recorder (DAT), phonation and teaching sample was recorded in the classroom setup. The subjects were instructed to phonate vowel /a/ for 5-6 seconds before the first class (condition I) and after the last class (condition II) of a normal working day. The entire duration of first and last class teaching was recorded for Mathematics as well as Malayalam language teachers using the DAT recorder that was worn around their neck.

PRAAT software was used for the analysis. Voice parameters such as F0 time, Fundamental frequency (F0), standard deviation of F0 (SD F0), perturbation measures (Jitter and Shimmer) and harmonic to noise ratio (HNR) were extracted from the phonation sample. The F0 time was measured from first and last class teaching sample at 3 instances of 5 minutes duration. That is, first 5 minute (T1), middle 5 minute (T2), last 5 minute (T3) of the first and the corresponding instances (T4, T4 & T6) of the last class of the teaching sample.

The result of present study revealed several points of interest:

First, In condition I, all measured voice parameters such as SD F0, jitter, shimmer and HNR values were found to be higher in group I (Malayalam language) teachers than group II teachers. On the other hand, F0 was lower in group I teachers. Increased values of acoustic parameters such as jitter and SD F0 in phonation of vowel /a/ reflected poor stability of vocal fold vibration. Owing to the poor stability of vocal fold vibration, noise component would have contributed more in the voice product that contains poor harmonics. Thus, there is increased HNR in group I teachers. Increased shimmer value in group I teachers can be attributed to poor stability of respiratory support or variations in the sub-glottal pressure. In the present study, reduced F0 in condition I could be because of the cumulative effect of continuous and prolonged vibration of the vocal folds for the past 12 years that could have resulted in the weakness of thryroarytenoid muscles which led to the reduction in F0 for Malayalam language teachers.

Second, F0 was found to be increased by 6 Hz in Malayalam and 57 Hz in Mathematics teachers at condition II from condition I. This could be attributed to the reduction in flexibility of vocal folds (by the end of a typical working day due to prolonged usage) due to which the F0 hike was lesser in Malayalam language teachers when compared to Mathematics teachers. The rise in F0 can be attributed to i) either as a compensatory strategy used by the teachers in order to overcome the vocal fatigue/changes in their voice quality or ii) to get the attention of the children as they were observed to be more restless towards the end of last class.

Third, SD F0 did not show any significant increase or decrease in both the groups from condition I to condition II; this could probably because of less sample size.

Fourth, there was no change observed in jitter in both groups from condition I to II. This unexpected finding on jitter may be due to the smaller sample size. Studies have shown increased, decrease or no significant change in the jitter value when measured after vocal loading.

Fifth, shimmer was observed to be increased in condition II when compared to that of condition I in both the groups. This could be attributed to the inability to maintain the vibration of the vocal fold steadily because of the variations in the sub-glottal pressure

which in turn increases the shimmer value. The obtained finding was not statistically significant between the conditions and this could be attributed to smaller sample size

Sixth, there was a reduction in HNR at condition II from condition I in both the groups.This could be attributed to theaperiodic vibration of the vocal folds because of continuous, prolonged and extended period of teaching due to which there could be incomplete adduction in the vocal fold.

Seventh, the average median F0 time for group I teachers were higher (172 seconds) when compared to group II teachers (133 seconds) in first class. Also, the average median F0 time for group I teachers were higher (109 seconds) when compared to group II teachers (109 seconds) in the last class.F0 time reflects the vocal fold vibration time. Increased F0 time in first and last class for Malayalam language teachers (group I) indicated more vibration of vocal fold execution in them. That is, group I teachers outperformed in terms of vocal fold vibration time than group II teachers in classroom teaching. The differences in F0 time in both the groups are either due to the "subjects" that they handle/teach or due to their teaching style/ methodology. The latter is of individual variable that varies between person to person that needs to be investigated further.

Eighth, average voicing duration was observed to be reduced at the last class in both the groups when compared to the first class**.** This drop in F0 time in both the groups at the last class can be attributed to vocal fatigue. The reduction in F0 time from first class to last class in both groups was not statistically significant and this might be due to small sample in each group.

Ninth, results of within group comparison for F0 time (at six point of time) in both the groups revealed significance only in Mathematics teachers (group II). The significant differences were found between the intervals T3 - T1, T4 - T3 and T5 - T3. Voicing duration at T3 was found to be significantly higher compared to the voicing duration at T1, T4 and T5. This could be attributed to the continuous speaking by Mathematics teachers towards the end of last class. Whereas, lesser voicing duration is in the initial 5 minute duration (T1 & T4) of the class than middle (T5) and last 5 minute of the class is

due to the minimal voice usage which is depended on the routine activities carried out at that time.

Implications of the present study

i) The results of the present study would augment the voice clinician's understanding about the risk factors for developing voice problem in language teachers.

ii) Results of the present study can supplement the knowledge of speech language pathologists (SLPs) in counseling the professional voice users, especially in upper primary school teachers.

iii) From the present study results, tailor made management strategy can be planned for Malayalam language teachers since the vocal fold vibration was noted to be higher in this group when compared to Mathematics teachers.

Limitations of the present study

i) Sample size is limited.

ii) The data was collected on a random working day which was not controlled in the present study. As the vocal loading may vary for a hard working day (working day with maximum number of teaching hours) against easeful working day (with limited number of teaching hours).

iii) Test – retest reliability was not carried.

iv) Vocal loading effect was investigated within a single working day in the present study but the teachers vocal demand varies in a week hence the effect has to be studied for minimum of 3 consecutive days.

v) The results of the present study are restricted to only Mathematics and Malayalam language.

vi) The teaching methodology was not controlled in the present study and they were free to use their natural/convenient teaching strategy.

Future directions

Results of the present study warrants further research in following directions,

i) The study can be carried out further considering a larger sample size.

ii) Studies can employ the collection of phonation and teaching sample of a hard working day.

iii) Studies can be warranted to investigate the vocal loading in male teachers and to compare with that of female teachers.

iv) Studies can be done to investigate the vocal loading in other subject/course teachers.

REFERENCES

Alexander, S. A., Shetty, P. P., & Mathew, K. (2017). Acoustic Analysis of Indian Teachers' Voice: Pre and Post Teaching Circumstances. *Indian Journal of Otolaryngology and Head & Neck Surgery*, 1-4.

Biserra, M. P., Giannini, S. P., Paparelli, R., & Ferreira, L. P. (2014). Voice and work: a study of determinants of changes through teachers' discourse. *Saúde e Sociedade*, *23*(3), 966-978.

Boersma, P., &Weenink, D. (2009). Praat: doing phonetics by computer (Version 5.1. 05)[Computer program]. Retrieved May 1, 2009.

Boltežar, L., &Bahar, M. Š. (2014). Voice Disorders in Occupations with Vocal Load in Slovenia/GlasovneTežave V Poklicih Z GlasovnoObremenitvijo V Sloveniji. *Slovenian Journal of Public Health*, *53*(4), 304-310.

Boominathan, P., Rajendran, A., Nagarajan, R., Seethapathy, J., &Gnanasekar, M. (2008). Vocal abuse and vocal hygiene practices among different level professional voice users in India: a survey. *Asia Pacific Journal of Speech, Language and Hearing*, *11*(1), 47- 53.

Carding, P., & Wade, A. (2000). Managing dysphonia caused by misuse and overuse: Accurate diagnosis and treatment is essential when the working voice stops working,*British medical journal*, 321(7276), 1544-1545.

Coyle, S. M., Weinrich, B. D., &Stemple, J. C. (2001). Shifts in relative prevalence of laryngeal pathology in a treatment-seeking population. *Journal of Voice*, *15*(3), 424-440.

Devadas, U., Bellur, R., &Maruthy, S. (2017). Prevalence and Risk Factors of Voice Problems Among Primary School Teachers in India. *Journal of Voice*, *31*(1), 117.e1–117.e10.

Franco, R. A., & Andrus, J. G. (2007). Common diagnoses and treatments in professional voice users. *Otolaryngologic Clinics of North America*, *40*(5), 1025-1061.

Gaskill, C. S., O'Brien, S. G., &Tinter, S. R. (2012). The effect of voice amplification on occupational vocal dose in elementary school teachers. *Journal of Voice*, *26*(5), 667-e19.

Gelfer, M. P., Andrews, M. L., & Schmidt, C. P. (1996). Documenting laryngeal change following prolonged loud reading: a videostroboscopic study. *Journal of voice*, *10*(4), 368-377.

Gotaas, C., & Starr, C. D. (1993). Vocal fatigue among teachers. *Folia Phoniatrica et Logopaedica*, *45*(3), 120-129.

Hamid, A. A. A., Eldessouky, H. M., Iskender, N. M., & Hassan, E. M. M. (2014). Dysphonia in teachers: is it only a matter of voice misuse?. *The Egyptian Journal of Otolaryngology*, *30*(3), 272.

Hixon T. J. (1987). *Respiratory Function in Speech and Song* (College-Hill Press, Boston, MA:), Chap. 1.

Jilek, C., Marienhagen, J., &Hacki, T. (2004). Vocal stability in functional dysphonic versus healthy voices at different times of voice loading. *Journal of voice*, *18*(4), 443-453.

John, R., &Poduval, J. D. (2015). Voice training for professional voice users. *International Journal of Scientific Reports*, *1*(1), 65-68.

Jones, K., Sigmon, J., Hock, L., Nelson, E., Sullivan, M., &Ogren, F. (2002). Prevalence and risk factors for voice problems among telemarketers. *Archives of Otolaryngology–Head & Neck Surgery*, *128*(5), 571-577.

Jónsdóttir, V., Laukkanen, A. M., &Siikki, I. (2003). Changes in teachers' voice quality during a working day with and without electric sound amplification. *Folia phoniatrica et logopaedica*, *55*(5), 267-280.

Jónsdottir, V., Laukkanen, A. M., &Vilkman, E. (2002). Changes in teachers' speech during a working day with and without electric sound amplification. *Folia Phoniatrica et Logopaedica*, *54*(6), 282-287.

Kelchner, L. N., Lee, L., &Stemple, J. C. (2003). Laryngeal function and vocal fatigue after prolonged reading in individuals with unilateral vocal fold paralysis. *Journal of Voice*, *17*(4), 513-528.

Kelchner, L. N., Toner, M. M., & Lee, L. (2006). Effects of prolonged loud reading on normal adolescent male voices. *Language, speech, and hearing services in schools*, *37*(2), 96-103.

Kooijman, P. G. C., De Jong, F. I. C. R. S., Thomas, G., Huinck, W., Donders, R., Graamans, K., & Schutte, H. K. (2006). Risk factors for voice problems in teachers. *Folia phoniatrica et logopaedica*, *58*(3), 159-174.

Kostyk, B. E., & Rochet, A. P. (1998). Laryngeal airway resistance in teacherswith vocal fatigue: A preliminary study. *Journal of Voice*, *12*(3), 287-299.

Koufman, J. A., & Isaacson, G. (1991). The spectrum of vocal dysfunction. *Otolaryngologic Clinics of North America*, *24*(5), 985-988.

Kreiman, J., &Sidtis, D. (2011). *Foundations of voice studies: An interdisciplinary approach to voice production and perception*. West Sussex, United Kingdom: John Wiley & Sons.

Kroemer, K. H., &Grandjean, E. (1997). *Fitting the task to the human: a textbook of occupational ergonomics*. Taylor & Francis.

Laukkanen, A. M., Ilomäki, I., Leppänen, K., &Vilkman, E. (2008). Acoustic measures and self-reports of vocal fatigue by female teachers. *Journal of Voice, 22*(3), 283-289.

Long, J., Williford, H. N., Olson, M. S., & Wolfe, V. (1998). Voice problems and risk factors among aerobics instructors. *Journal of Voice, 12*(2), 197-207.

Mattiske, J. A., Oates, J. M., & Greenwood, K. M. (1998). Vocal problems among teachers: a review of prevalence, causes, prevention, and treatment. *Journal of Voice, 12*(4), 489-499.

McCabe, D. J., &Titze, I. R. (2002). Chant therapy for treating vocal fatigue among public school teachers: a preliminary study. *American Journal of Speech-Language Pathology, 11*(4), 356-369.

Morrison, M. D., &Rammage, L. A. (1993). Muscle misuse voice disorders: description and classification. *Acta oto-laryngologica*, *113*(3), 428-434.

Morrow, S. L., & Connor, N. P. (2011). Comparison of voice-use profiles between elementary classroom and music teachers. *Journal of Voice, 25*(3), 367-372.

Munier, C., & Kinsella, R. (2007). The prevalence and impact of voice problems in primary school teachers. *Occupational Medicine*, *58*(1), 74-76.

Nierengarten, M. B. (2007). Diagnosis and treatment of vocal problems in professional voice users. *Entoday*, *2*(6), 16-17.

Novak, A., Dlouha, O., Capkova, B., &Vohradnik, M. (1991). Voice fatigue after theater performance in actors. *Folia Phoniatrica et Logopaedica*, *43*(2), 74-78.

Nusseck, M., Richter, B., Spahn, C., &Echternach, M. (2017). Analysing the vocal behaviour of teachers during classroom teaching using a portable voice accumulator. *Logopedics Phoniatrics Vocology*, 1-10.

Ohlsson, A. C., Andersson, E. M., Södersten, M., Simberg, S., &Barregård, L. (2012). Prevalence of voice symptoms and risk factors in teacher students. *Journal of Voice*, *26*(5), 629-634.

Oppong, S. H. (2013). The problem of sampling in qualitative research. *Asian journal of management sciences and education*, *2*(2), 202-210.

Owens Jr, R. E., Farinella, K. A., & Metz, D. E. (2014). *Introduction to communication disorders: A lifespan evidence-based perspective*. Pearson Higher Ed.

Pekkarinen, E., &Viljanen, V. (1991). Acoustic conditions for speech communication in classrooms. *Scandinavian Audiology*, *20*, 257–63.

Pekkarinen, E., Himberg, L., &Pentti, J. (1992). Prevalence of vocal symptoms among teachers compared with nurses: A questionnaire study. *Scandinavian Journal of Logopedics and Phoniatrics*, *17*(2), 113-117.

Pelegrín-García, D., &Brunskog, J. (2012). Speakers' comfort and voice level variation in classrooms: Laboratory research. *The Journal of the Acoustical Society of America*, *132*(1), 249-260.

Pizolato, R. A., Mialhe, F. L., Cortellazzi, K. L., Ambrosano, G. M. B., CornacchioniRehder, M. I. B., & Pereira, A. C. (2013). Evaluation of risk factors

for voice disorders in teachers and vocal acoustic analysis as an instrument of epidemiological assessment. *Revista CEFAC, 15*(4), 957-966.

Provenzano, L. C. F. A., &Sampaio, T. M. M. (2010). Prevalence of vocal dysfunction in teachers from the state education, licensed from classroom. *Revista CEFAC, 12*(1), 97-108.

Puglisi, G. E., Astolfi, A., Cantor Cutiva, L. C., &Carullo, A. (2017). Four-day-follow-up study on the voice monitoring of primary school teachers: Relationships with conversational task and classroom acoustics. *The Journal of the Acoustical Society of America, 141*(1), 441-452.

Rajasudhakar, R., &Savithri, S. R. (2008). Working-day effects on voice and measurement of voicing time in a special school teacher of hearing impaired. *Proceedings of the International Symposium on Frontiers of Research on Speech and Music (FRSM-2008),* 399-402

Rajasudhakar, R., &Savithri, S. R. (2009a). Voicing periods in a primary school teacher. *Journal of All India Institute of Speech & Hearing, 28*, 36-41.

Rajasudhakar, R., &Savithri, S. R. (2009b). Fundamental frequency and perturbation changes under vocal loading. *In the Proceedings of National Symposium on Acoustics (NSA-2010),* (pp. 26-28).

Rajasudhakar, R., &Savithri, S. R. (2010). Effects of teaching and voice rest on acoustic voice characteristics of female primary school teachers. *Journal of All India Institute of Speech and Hearing, 29*(2), 198-203.

Rantala, L., &Vilkman, E. (1999). Relationship between subjective voice complaints and acoustic parameters in female teachers' voices. *Journal of Voice*, *13*(4), 484-495.

Rantala, L., Haataja, K., Vilkman, E., &Körkkö, P. (1994). Practical arrangements and methods in the field examination and speaking style analysis of professional voice users. *Scandinavian Journal of Logopedics and Phoniatrics*, *19*(1-2), 43-54.

Rantala, L., Lindholm, P., &Vilkman, E. (1998). F0 change due to voice loading under laboratory and field conditions. A pilot study. *Logopedics Phoniatrics Vocology*, *23*(4), 164-168.

Rantala, L., Paavola, L., Körkkö, P., &Vilkman, E. (1998). Working-day effects on the spectral characteristics of teaching voice. *Folia Phoniatrica et Logopaedica, 50,* 205–211.

Rantala, L., Vilkman, E., &Bloigu, R. (2002). Voice changes during work: subjective complaints and objective measurements for female primary and secondary school teachers. *Journal of Voice, 16*(3), 344-355.

Remacle, A., Morsomme, D., &Finck, C. (2014). Comparison of vocal loading parameters in kindergarten and elementary school teachers. *Journal of Speech, Language, and Hearing Research, 57*(2), 406-415.

Roy, N., Merrill, R. M., Thibeault, S., Parsa, R. A., Gray, S. D., & Smith, E. M. (2004). Prevalence of voice disorders in teachers and the general population. *Journal of Speech, Language, and Hearing Research*, *47*(2), 281-293.

Roy, N., Merrill, R.M., Thibeault, S., Gray, S.D., & Smith, E.M. (2004). Voice disorders in teachers and the general population: effects on work performance, attendance, and future career choices. *Journal of Speech, Language, and Hearing Research, 47,* 542-551.

Russell, A., Oates, J., & Greenwood, K.M. (1998). Prevalence of voice problems in teachers. *Journal of Voice, 12,* 467–479.

Sala, E., Laine, A., Simberg, S., Pentti, J., &Suonpää, J. (2001). The prevalence of voice disorders among day care center teachers compared with nurses: a questionnaire and clinical study. *Journal of Voice*, *15*(3), 413-423.

Sapienza, C.M., Crandell, C.C., & Curtis, C. (1999). Effects of sound-field amplification on reducing teacher's sound pressure level in the classroom. *Journal ofVoice*, *13,* 375–381.

Sapir, S., Keidar, A., & Mathers-Schmidt, B. (1993). Vocal attrition in teachers: survey findings. *International Journal of Language & Communication Disorders*, *28*(2), 177-185.

Sataloff, R. T. (2000). Professional voice users: the evaluation of voice disorders. *Occupational medicine (Philadelphia, Pa.)*, *16*(4), 633-47.

Sebastian, S. (2012). Risk factors for hyperfunctional voice disorders among teachers. *Online Journal of Health and Allied Sciences*, *11*(2).

Sivasankar, M. (2002). Effects of vocal fatigue on voice parameters of Indian Teachers. *Indian Journal of Otolaryngology and Head & Neck Surgery*, *54*(3), 245- 247.

Smith, E., Gray, S. D., Dove, H., Kirchner, L., & Heras, H. (1997). Frequency and effects of teachers' voice problems. *Journal of voice*, *11*(1), 81-87.

Smith, E., Lemke, J., Taylor, M., Kirchner, H. L., & Hoffman, H. (1998). Frequency of voice problems among teachers and other occupations. *Journal of voice*, *12*(4), 480-488..

Smith, E., Verdolini, K., Gray, S., Nichols, S., Lemke, J.H, Barkmeier, J., Hove, H., & Hoffman, H. (1996). Effects of voice disorders on quality of life. *Journal of MedicalSpeech-Language Pathology, 4,* 223–244.

Södersten, M., Granqvist, S., Hammarberg, B., & Szabo, A. (2002). Vocal behavior and vocal loading factors for preschool teachers at work studied with binaural DAT recordings. *Journal of Voice, 16*(3), 356-371.

Stemple, J. C., Stanley, J., & Lee, L. (1995). Objective measures of voice production in normal subjects following prolonged voice use. *Journal of Voice, 9*(2), 127-133.

Timmermans, B., De Bodt, M. S., Wuyts, F. L., Boudewijns, A., Clement, G., Peeters, A., & Van de Heyning, P. H. (2002). Poor voice quality in future elite vocal performers and professional voice users. *Journal of Voice*, *16*(3), 372-382.

Titze, I. R., Hunter, E. J., &Švec, J. G. (2007). Voicing and silence periods in daily and weekly vocalizations of teachers. *The Journal of the Acoustical Society of America*, *121*(1), 469-478.

Titze, I. R., Lemke, J., &Montequin, D. (1997). Populations in the US workforce who rely on voice as a primary tool of trade: a preliminary report. *Journal of Voice*, *11*(3), 254- 259.

Van Houtte, E., Claeys, S., Wuyts, F., & Van Lierde, K. (2011). The impact of voice disorders among teachers: vocal complaints, treatment-seeking behavior, knowledge of vocal care, and voice-related absenteeism. *Journal of voice*, *25*(5), 570-575.

Verstraete, J., Forrez, G., Mertens, P., &Debruyne, F. (1993). The effect of sustained phonation at high and low pitch on vocal jitter and shimmer. *Folia Phoniatrica et Logopaedica*, *45*(5), 223-228.

Vilkman E. (2004) Occupational safety and health aspects of voice and speech professions. *Folia Phoniatrica et Logopaedica*, 56: 220-253.

Vilkman, E. (2000). Voice problems at work: A challenge for occupational safety and health arrangement. *Folia Phoniatrica et Logopaedica, 52*, 120–125.

Vilkman, E., Lauri, E. R., Alku, P., Sala, E., &Sihvo, M. (1999). Effects of prolonged oral reading on F0, SPL, subglottal pressure and amplitude characteristics of glottal flow waveforms. *Journal of Voice*, *13*(2), 303-312.

Vintturi, J., Alku, P., Lauri, E. R., Sala, E., Sihvo, M., &Vilkman, E. (2001). Objective analysis of vocal warm-up with special reference to ergonomic factors. *Journal of Voice*, *15*(1), 36-53.

Vintturi, J., Alku, P., Sala, E., Sihvo, M., &Vilkman, E. (2003). Loading-related subjective symptoms during a vocal loading test with special reference to gender and some ergonomic factors. *Folia Phoniatrica et Logopaedica*, *55*(2), 55-69.

Wingate, J. M., Brown, W. S., Shrivastav, R., Davenport, P., & Sapienza, C. M. (2007). Treatment outcomes for professional voice users. *Journal of Voice*, *21*(4), 433-449.

Yiu, E. M. (2002). Impact and prevention of voice problems in the teaching profession: embracing the consumers' view. *Journal of Voice*, *16*(2), 215-229.

Zhang, Z. (2016). Mechanics of human voice production and control. *The Journal of the Acoustical Society of America*, *140*(4), 2614-2635.