Chapter V

Discussion

The results indicated several points of interest. *First of all 66.48% of teachers responded to the questionnaire in Phase I.* The response rate is relatively lower when compared to the response rate reported by Russell, Oates and Greenwood (1998) who reported a response rate of 75%, and relatively higher than that reported (31%) by Kooijman, de Jong, Thomas, Huinck, Donders, Graamans and Schutte’s (2006). The difference could be due to the differences in method and the number of participants involved. Russell et al. (1998) employed 1168 teachers using mail survey method. Kooijman et al. (2006) considered 1878 primary and secondary school teachers. In the present study the questionnaire were directly collected by the experimenter. Teachers’ absenteeism on the day of returning the questionnaire or loss of questionnaire by the teachers, disinterest of the participants to fill the questionnaire could be some of the reasons for the low response rate in the present study.

*Second, 79% primary school teachers scored ≤ 17 and were considered as FC group and 21% primary school teachers scored > 17 on questionnaire and were considered as MC group.* Rantala and Vilkman (1999) reported a variation of percentages of voice complaints from 10.3% to 84.6% in their study, which comprised of 12 primary and secondary school teachers on the basis of 17 as cutoff score. The present study comprised larger samples when compared to Rantala et al.’s (1999) study. The results of the present study support the findings of Rantala et al. (1999) who reported higher percent of vocal fatigue scores in MC group and lesser percent of vocal fatigue scores in FC group.
Third, the mean, standard deviation and median of vocal fatigue scores in FC group (11.4, 2.47, 11) were significantly lower than those in MC group (22.7, 4.58, 21). The results are not in consonance with those of Rantala et al. (2002) who reported the mean voice complaints scores for FC group was 6 and MC group was 31. The participants included in their study were 33 female primary and secondary school teachers. The differences between the studies could be attributed to the differences in the type of participants, (only primary school teachers participated in the present study and primary and secondary school teachers participated in Rantala et al.’s study) and the number of participants (482 in the present study and 33 in Rantala et al.’s study).

Fourth, the reported symptoms were significantly higher in MC group compared to FC group. The results were in consonance with the findings of Rantala et al. (1999) and Rantala et al. (2002) where the FC group had lesser voice complaints scores than MC group. The results of the present study also supported the findings of Sliwinska-Kowalska et al. (2006) who found that 69% of 425 primary and secondary school teachers surveyed reported to have voice problems. Smith, Gray, Dove, Kirchner and Heras (1997), in a self reported questionnaire, found that 38% of teachers reported work-related voice problem. The percentage of voice problems reported in Smith et al.’s (1997) study was low compared to the present study. This indicates that the voice fatigue /complaints scores were more in Indian school teachers (79% in present study) than in Western counter parts.

Fifth, the number of years of teaching experience was positively correlated with vocal fatigue scores in MC group. The results of the present study are in agreement with the results of Sliwinska-Kowalska et al. (2006) who reported that the teacher’s
years of teaching experience was positively associated with lifetime voice disorders. On the other hand, the results of the present study was not in consonance with the findings of Kooijman et al. (2006) who reported that ‘number of students in classroom’ was significantly a contributing risk factor than ‘number of years of teaching experience’ and ‘teaching hours per week’. These differences in the results might be attributed to the differences in the target population, teaching environment, different method employed by the two studies.

**Sixth, factors like shouting while watching sports, history of gastro-esophageal reflux disorders (GERD), number of visits to ENT, medical treatment, classroom noise and difficulty speaking loudly were significantly higher in MC group compared to FC group.** Kooijman et al. (2006) reported the internal factor (hearing) and external factor (acoustics-noise) to be a meaningful risk factor for the development of voice complaints. The results of the present study partially support these results with regard to external factor (noise) and not the internal factor. The result that MC group had significantly more teachers suffering from allergies and GERD than FC group is in consonance with that of Andrews (2006) who reported that allergents affects the mucous membrane lining the vocal tract including the upper respiratory tract which in-turn affects the voice production. Kjellen and Brudin (1994) found significant voice problem (hoarse voice) in thirty patients who exhibited pathological gastro esophageal reflux disorders. The results of the present study support those of Andrews (2006) and Kjellen and Brudin (1994) who revealed that more teachers reported to have allergies and GRED in MC group. Besides allergies and GERD, susceptibility of other factors to vocal fatigue and its influence needs to be investigated further.
Seventh, the average voicing periods were higher in group II (MC) compared to group I (FC) which is in consonance with Rantala et al. (1999) who reported that the F0 time or voicing periods for MC group (82.3) was higher than the FC group (72.4). The authors in the above study considered only three 4-minutes samples of first and the last class for F0 time measurements. The three 4-minute samples consisted of beginning, middle and end of the lesson for analysis. The present study considered the entire working hour from morning to evening for F0 time or voicing period measurements. Rantala et al. (1999) concluded that the F0 time is a bigger risk factor for vocal fatigue. Hence, the higher voicing periods in MC group could be one of the causes for higher scores on vocal fatigue symptoms questionnaire. Also, significantly higher mean rank (6.5) was observed in MC group compared to FC group (2.5) indicating significant higher time dose (voicing periods) in group II (MC).

Eighth, the average mean and median percent of voicing in group II (MC) was higher (27.3% and 25.30%) compared to group I (18.66% and 19.28%). The average mean and median percentage of voicing of primary school teachers was 22.98 and 22.29, respectively. However, percent of voicing was not significantly different between groups. Also, there was no effect or influence of days (across Monday to Friday) on voicing percent. These results are in consonance with those of Masuda et al. (1993) who reported a voicing percent of 21% in an eight hours workday, and in partial agreement with the findings of Sala et al.’s (2001) study who reported the average speaking time of day care teacher was 40%. Also, the results are in consonance with the results of Titze, Hunter and Svec (2007) who found a voicing percent of 23% in classroom working condition. The results of the present study also support the findings of Bottalico and Astolfi (2012) who reported 29% of voicing in thirty six female primary school teachers in Italy. The above comparison indicates
that the teachers in the present study used their voice more excessively, forcefully within shorter period of nearly 7 hours.

**Ninth, the mean F0, minimum F0 and maximum F0 values in group I (FC) were higher compared to group II (MC) both in the morning/starting of the day and evening/end of the day.** However, the difference was not statistically significant across the days and between morning and evening. Mean F0, minimum F0, and maximum F0 increased from Monday to Wednesday and reduced on Thursday and further on Friday in group I. The increased frequency related parameters from Monday to Wednesday can be attributed to vocal warm-up, where the laryngeal system learnt to adopt the requirements or demands in the school situation after the first day of teaching. Rantala, Vilkman and Bloigu (2002) also observed the same phenomenon where certain acoustic parameters like F0, shimmer, and jitter increased after first 4 minutes of teaching sample and they attributed the F0 increase to compensations for the physiological changes. The results of the present study did not support the findings of Stemple et al. (1995) who reported no change in fundamental frequency before and after two hours of loud reading in normal individuals. The F0 rise can be attributed to weakness of the thyroarytenoid muscle. The cover and transition layers of vocal folds become stiffen due to loosening of muscular portion of the thyroarytenoid muscle. This sequentially increases the rate of vibration in vocal folds and hence a rise of F0 (Stemple, Stanley & Lee, 1995). Vilkman, Lauri, Alku, Sala, and Sihvo (1999) explained the changes as relating to the speakers’ compensatory reactions to alterations in their voice. That is, the speaker increased the frequency of vocal fold vibration and increased the glottal adductory forces which were the two compensatory mechanisms that the speaker used for the physiological alterations (it could be changes in the mucosa). Indirectly, it manipulates the F0 by the
increased constriction that influenced the sub glottal pressure which appends tension to the vocal folds and subsequently, raises the F0. Remacle, Morsomme, and Finck (2014) attributed the higher F0 in kindergarten teachers after prolonged teaching as acoustic convergence behavior or accommodation. Further, they explained the convergence as ‘a tendency of speakers to imitate various features of one’s speech so that they are more similar. The present study supports the F0 rise to compensatory explanation and/or acoustic convergent behavior rather than the hypothesis of muscle weakness. Though there is no straight way of exploring the changes due to loading in the metabolic or functional state of the vocal folds yet, the question about the physiological reason for loading changes remains unanswered.

*Tenth, the intensity related measures - mean I0, minimum I0 and maximum I0 - were higher in group II (MC) compared to group I (FC).* Furthermore, the intensity related parameters were increasing from Monday to Friday in both the groups and also higher at the end of the day compared to beginning of the day. But, there was no significant difference between groups on intensity related measures (except Friday), no effect of days i.e. from Monday to Friday (except minimum I0 in group II – at the beginning of the day) and conditions, i.e. beginning of the day or end of the day. The results of the present study are not in agreement with the results of Rantala et al. (1999) and Rantala et al. (2002) who reported louder voice among FC group and reduction in SPL dB at the end of the day. The reasons for increased I0 related values in group II and increased I0 values at the end of the day in the present study could be attributed to the demand placed on their vocal systems in the working environment. In such scenario, the teacher in group II (MC group) may tend to increase the I0 of voice due to poor acoustic background (elevated noise level) that is present in the classroom and, contribution of Lombard effect (Gramming, Sundberg, Ternstrom,
The increased intensity also affects the frequency parameters which are known to rise with SPL. The other reason for increased intensity could be because of accommodation effect. The reason for increased intensity related measures only on Friday in group II (morning) is not known, and needs to be explored further by considering large sample.

**Eleventh, the mean and median short term vocal recovery index (Iₘ) was significantly lower in group II (0.72 and 0.75) compared to group I (0.81 and 0.80).** Lower the Iₘ value higher the risk of vocal folds injury (Titze, 2002). Titze (2002) reported that the short-term vocal recovery index in teachers was 0.67, and telephone marketers were 0.3. The group average of mean and median Iₘ value (including FC and MC group) were 0.76 and 0.77 which is almost similar to that in Titze’s study. Lower Iₘ in group II (MC group) indicated higher risk of vocal fold injuries owing to reduction in the blood circulation, water to tissue, calcium and poor removal of lactic acid. This episode is due to constriction of blood vessels associated with increased intramuscular pressure during contraction. Reduced blood supply to vocal folds may arise due to fatigue-inducing mechanism in two ways; (a) poor blood flow would inhibit the ability to remove the lactic acid from contraction muscles, and (b) restock diminished oxygen levels and energy compound stores. This could potentially damage the laryngeal tissues (Welham & Mac lagan, 2003).

**Twelfth, participants in group I (FC) had lower vocal fatigue symptoms, lower voicing periods (time dose) and higher frequency related measures compared to group II (MC).** Lower voicing periods should have lower the vocal fatigue symptoms as the vocal folds vibrations are not high. In such a condition, the vocal folds are flexible, not exhausted, and hence it is possible to have higher F0 related measures.
On the other hand, an increase in voicing periods will induce vocal fatigue resulting in tired or vocal loaded vocal folds and hence lower frequency related measures in group II (MC).

To summarize, the vocal fatigue symptoms were significantly higher in MC group compared to FC group. Teachers in MC group have experienced the vocal fatigue symptoms more ‘in the evening’ and ‘while teaching’ compared to FC group teachers. Generally, the tiredness of voice might happen after prolonged teaching, usually at the end of the work day or sometimes during teaching it might be experienced by most of the teaching professionals. Also, teachers in MC group had significant correlation between ‘number of years of teaching experience’ and ‘vocal fatigue symptom scores’. Increased years of teaching experience have a direct relation of having voice problems due to over use of voice in the long run. Few precipitating factors were significantly higher in MC group than FC group teachers. Voicing periods for a weeks’ duration was significantly higher in group II (MC) compared to group I (FC). Also, the percent voicing was higher in group II (MC) compared to group I (FC). The obtained results indicated excessive voice usage in group II where the vibration of vocal folds were higher in group II (MC) teachers, though the teaching hours per day, students’ strength, classroom size and classroom acoustics and so on were similar between two group of teachers. Frequency related parameters were higher in group I (FC) indicated compensatory mechanism to physiological change or due to accommodation effect. Intensity related measures were higher in group II (MC) indicated vocal demand due to the working environment or physiological response to increase the intensity to get the arousal/attention of the students at the end of the day or due to Lambard effect. Short term vocal recovery index was lower in group II
(MC) indicated higher risk of vocal fold injury because of reduced blood circulation, water to tissue and calcium and poor removal of lactic acid.

The present study established the prevalence of vocal fatigue symptoms in primary school teachers especially in Mysore city. Further, it provided the amount of cumulative vocal fold vibration at work on a single work-day and weekly as well. The short term vocal recovery index would augment in predicting the influence of vocal loading or prolonged voice use on tissue damage. The results of the present study would aid in counseling and planning intervention strategies for individuals with vocal fatigue symptoms due to excessive voice usage. Also, it would help in planning tailor made vocal hygiene programs.

The present study derived the prevalence data from four hundred and eighty two primary school teachers only. Large number of teachers including secondary school teachers can be consider in future studies. Data on time dose using voicing periods were measured from eight of ten teachers only, where the present study employed manual methods of measuring time dose which is time consuming. Other variables like courses or subject taught, grade level(s), teaching methodology and so on may be consider in future studies. Also, future investigations are warranted on voice dose measurements in different levels of professional voice users.