

**VOCAL LOAD CHARACTERISTICS IN IMAMS
USING AMBULATORY PHONATION MONITOR**

FARSEENA JABEEN

Register No: 17SLP009

A Dissertation Submitted in Part Fulfilment of Degree of
Master of Science (Speech-Language Pathology)
University of Mysore
Mysuru



**ALL INDIA INSTITUTE OF SPEECH AND HEARING
MANASAGANGOTTHRI
MYSURU -570006**

May 2019

CERTIFICATE

This is to certify that this dissertation entitled “**Vocal load characteristics in Imams using Ambulatory Phonation Monitor**” is a bonafide work submitted in part fulfillment for the degree of Master of Science (Speech-Language Pathology) by the student holding Registration Number: 17SLP009. This has been carried out under the guidance of a faculty member of this institute and has not been submitted earlier to any other University for the award of any other Diploma or Degree.

Dr. M. Pushpavathi

Director

All India Institute of Speech and Hearing
Manasagangothri, Mysuru- 570006

Mysuru

May, 2019

CERTIFICATE

This is to certify that this dissertation entitled “**Vocal load characteristics in Imams sing Ambulatory Phonation Monitor**” has been carried out under my supervision and guidance. It is also certified that this dissertation has not been submitted earlier to any other University for the award of any other Diploma or Degree.

Mysuru
May, 2019

Dr. T. Jayakumar
Associate Professor in Speech Sciences
All India Institute of Speech and Hearing
Manasagangothri, Mysuru- 570006

DECLARATION

This is to certify that this dissertation entitled “**Vocal load characteristics in Imams using Ambulatory Phonation Monitor**” is the result of my own study under the guidance of Dr. T. Jayakumar, Associate Professor in Speech Sciences, Department of Speech-Language Sciences, All India Institute of Speech and Hearing, Mysuru, and has not been submitted earlier to any other University for the award of any other Diploma or Degree.

Mysuru

May, 2019

Register No: 17SLP009

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

“Bismillahi Rahmani Raheem”

“In the name of Allah, the Most Gracious, the Most Merciful”

ACKNOWLEDGEMENT

I, Farseena Jabeen take this opportunity to acknowledge my gratitude to the following people who have been there for me always.

*First of all I would like to thank my guide and mentor **Jayakumar sir**. Thank you for your never ending support, patience and guidance. Thank you for bearing my stupidity and helping me correct my mistakes.*

*Thank you so much **Yasin sir** for modifying and correcting my mistakes, without your help my dissertation wouldn't have been possible.*

*Thanks to all the participants in my study (Imams) for taking their valuable time and readily participating in my study. And I would like to thank **Yeshoda ma'am** and **Reuben sir** for guiding me and Muhmina for our paper work.*

*Big thanks to **Uppa** for being there for me and helping me out in every possible way. Thank you so much for always understanding me patiently. You are my favourite role model!!*

*I would like to thank my **Umma, Big B, Don, Fidha**, for always inspiring me. My love **Abdu**, you are my all the time mood lifter and I love you. I thank **Deedi, Riza, and Rhiya** for always supporting me. Thank you so much **Hinan** for helping me in data collection. And I thank each and every member of my family (Baby cottage) for their support and encouragement.*

*Thanks to my **Sundarigalz** for their positive encouragement and relentless motivation and also for bearing me throughout and understanding. Thank you for your never ending love and support. You guys are my Treasure, Love you galz.*

*A special thanks to **Sarga, Hiba and Alka**, my juniors for always being very supportive and pushing me towards my goal.*

*My heartfelt gratitude to **Jesnu sir and Freddy sir** for showing faith in me and instilling positive thought in me.*

*I personally thank **Kritika** who is not only my classmate but also my posting partner and who is always ready to clear all my doubts. You are the best!!*

*I thank my **dissertation partners** (Renita and Navya) for all your help and support.*

*I thank **Saisree, Gowtham and Shital** who are my best friends and always by my side for my entire endeavour.*

*I thank **Dafiah, Malavika and Anusmitha** for always helping me.*

*Special thanks to **my classmates** (Beautiful monsters) for all their whole hearted support and motivation.*

*I sincerely thank **my special friends** for always listening to me and for being my support and helping hand. Big thanks for bearing my mood and understanding me. Thank you all you guys are always special for me.*

I would also like to thank all the staffs, batch mates, posting partners, juniors, seniors and all involved directly or indirectly in this six years journey. I will always cherish the memories and not forget the relentless support you all have given. Thank you all!!

I thank God Almighty for the blessings he has bestowed upon me and for giving me the strength and wisdom to achieve my dreams.

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Chapter 1

INTRODUCTION

Voice is one of the elements of speech that provides the speaker with vibratory sound upon which speech is produced. It serves as the melody of our speech and provides expression, feeling, intent, and mood to our daily articulated thought (Stemple, Glaze & Klaben, 2000). Voice can be defined as “Normal when the quality is clear, pitch and loudness are appropriate for age, gender and situation, the voice is produced without undue effort, pain strain, or fatigue and the voice is satisfactory to the speaker in terms of fulfilling his or her occupational, social and emotional vocal needs” (Ferrand, 2012). Voice plays a major role in day to day communication and for many of them it is a source of income. In professional voice users, their livelihood depends on voice quality. Occupational or Professional voice user (PVUs) is anyone for whom a good voice quality is essential for their professional competence. PVUs include singers, teachers, priest, clerks, sales people etc.

Koufman (1999) proposed classification of professional voice users as four categories. The Elite Vocal Performer (Level I) is those who need maximum vocal performance and they require very good quality, pitch, range, and loudness. This group includes singers and actors; the typical example of this group is opera singer. The Professional Voice User (Level II) mainly includes priests, receptionists, lecturers, teachers, etc. Moderate voice problem might affect adequate job performance of person in this group. The Non-Vocal Professional (Level III) mainly includes contains business women, businessmen, lawyers, physicians, etc. Severe voice problem would prevent adequate job performance of person in this group. The Non-Vocal Non-Professional (Level IV) is a person for whom vocal quality is not a

precondition to have an adequate job performance. This group contains labourers, clerks, etc.

This classification of professional voice users into different levels serves an important purpose. Persons falling under different levels may have different levels of impact of voice disorder on their occupational performance. The level I and level II professional voice users have very significant social responsibility and change in their voice has direct impact on their work. These effects may be less pronounced in case of level III and level IV class of PVUs. Voice disorders may lead to loss or fear of loss of career, frustration and emotional set back, economical burden, reduced professional competency etc., one of such professional voice users in Muslim community is Imam/ Madrasa (an institute where Islamic theology is taught) teacher.

Imam

Imam is the one who titled as a worship leader of a mosque and they may lead Islamic worship services and provides religious guidance to the Muslim community. They are professional voice users falling under the level II category in the classification of professional voice users.

Madrasa is a school or college especially a school attached to mosques where young men and women study Islamic theology (segregated schooling). Madrasa teachers are those who teach in institutions for the study of Islamic theology and religious law. Imams also work as a Madrasa teacher in Madrasas and affiliated Islamic colleges/ Universities. They are involved in vocally demanding tasks at work place such as teaching children at Madrasa (mainly primary level school children), leads daily Congregational prayers at the mosque, each prayer will be held minimum of 5 minutes followed by period of supplication of about 3 minutes. They also deliver

speeches during weekly Friday and two annual congregational prayers, involve in public lectures and educational programs. In addition to this during the month of Ramadan (month of fasting) they lead night prayers for about 1.5 hours at a stretch every night and some days the prayer continues for the whole night. The imams also lead all other special prayers, such as for funeral, prayers for rain, prayers for eclipse and more. It is likely that due to such nature of vocal load they are subjected in their daily work, they are more prone to develop voice disorders

Vocal loading can be defined as “a combination of prolonged voice use and secondary loading factors (e.g. background noise, acoustics, and air quality) affecting the fundamental frequency, type, and loudness of phonation or vibratory characteristics of the vocal folds as well as the external frame of the larynx” (Vilkman, 2004). Vocal load is an important factor in the aetiology of voice disorders. Due to this reason, several researchers have made an attempt to see in what way voice is produced, mainly during working hours when vocal load is more in priest and teachers. Individual who involve in prolonged periods of voice use or vocal loading are at high risk of voice disorders such as vocal nodules, vocal cord polyp, vocal cord cyst, varices, ecstasies, vocal cord sulcus etc., and symptoms of vocal fatigue and Dysphonia. In the initial stages of vocal loading the laryngeal system is in warm up stage but continuous loading leads to vocal fatigue. Majority of studies in this regard have been conducted by recording vocal parameters for small duration using microphones in early days. Devices to measure vocal loading includes Dosimeter, Voice ruler sound level meter, Ambulatory voice monitoring, Ambulatory phonation monitor etc.

Ambulatory phonation monitor

Ambulatory Phonation Monitor (APM) (Model 3200, KayPENTAX, Lincoln Park, New Jersey, USA) is a recently developed device to study the vocal parameters for a sustained period. It is a portable device that objectively documents voice use during a whole day of normal activity. It is an embedded system with computer compatible software and hardware components. It measures amount of time the subject phonates and it gives an estimate of subject's fundamental frequency and vocal intensity during the phonation activity and it provides as a profile of a subject's phonatory behaviour during the time of recording.

It consist of an accelerometer, a small rectangular metal encasement mounted on a round silicone pas with a cable attached to it and the opposite end of this cable is the connector which plugs into the hardware of APM. The accelerometer will be adhered to the anterior base of throat (just above the sternal notch) of the participants, and it picks up the vibrations from the skin. The APM has maximum monitoring time of 12-15 hours and frequency response of the throat sensor is 25-7000Hz. It gives information over a period and will not be affected by the background noise. The APM can record parameters such as, fundamental frequency mode, fundamental frequency average, amplitude average, phonation time, percentage phonation time, cycle dose, and distance dose. The important clinical applications of the APM include study of the vocal load and parameters in professional voice users; can be used for vocal dosimetry in forensic medicine and as real-time biofeedback studies of voice.

Need for the study

Looking through the literature, it is noticed that there are studies conducted to find the Vocal characteristics and vocal symptoms of Imams using voice survey questionnaires, perceptual analysis and acoustic analysis. (Farahat and Mesallam, 2016; Yasin, 2018; Yeshoda et al., 2018).

No studies on nature of vocal load and the parameters that are affect the vocal load in this particular population. Hence understanding the vocal loading characteristics of Imams is very necessary to bring appropriate preventive and remedial measures for the voice problem they face. Thus the current study moves to the next step in understanding this population in terms of studying the vocal load and its effect in the vocal parameters.

Aim of the study

The current study aimed to study the vocal loading characteristics of Imam by using continuous monitoring of phonatory behaviours for 5 hours using APM Instrument.

Objective of the study

To measure the following parameters of APM Instrument in Imams during the regular works hours

- F0 mode
- F0 average
- SPL average
- Phonation time
- Percentage phonation time
- Cycle dose
- Distance dose

Chapter 2

REVIEW OF LITERATURE

Vocal load is an important factor in the aetiology of voice disorders mainly in professional voice users. Due to this reason, several researchers have made an attempt to see in what way voice is produced, mainly during working hours when vocal load is more. Many studies have been done to see the vocal load characteristics in different professionals' falls under level 2 (professional voice users) classification of professional voice users using different methods. Hunter and Titze (2009) used speech voice dosimeter to study the vocal demands in teachers by comparing occupational voice use with non-occupational voice use. Speech voice dosimeter calculated voicing percentage per hour, also average dB SPL and F0. Each group's voice use was compared among 57 teachers for two weeks. The results demonstrated that the voicing percentage per hour for occupational group was twice that of non-occupational voice.

Mehta et al., in 2012 did a study on three types of subjects based on the laryngeal examination to see the presence or absence of laryngeal pathology. The groups include patients with voice disorders (occupation requiring substantial voice use), control group and occupation who are low voice users. Each participant was monitored for 5 working days yielding 30-70 hours of monitoring data per subject. For each hour of monitoring, the total phonation time, cycle dose, and distance dose as well as fundamental frequency and sound pressure level were estimated from the accelerometer signal. Data analysis was performed using a cumulative average technique. From hourly raw parameter data, cumulative parameter averages were calculated for each parameter. These cumulative averages were calculated such that the cumulative average for the first hour is equal to the parameter value of the first

hour; the cumulative average for the second hour is equal to the average of the parameter values for the first and second hour, and so on. The results showed no statistically significant differences among the average error curves for subjects within and across each subject group. For estimating fundamental frequency and sound pressure level, the data provide initial evidence that satisfactory estimates can be obtained after only a few hours. Average errors decrease to about 1% after 20 hours of ambulatory monitoring. In contrast, errors associated with phonation, cycle dose, and distance dose were higher over the first several hours, requiring at least 26 hours of the data to yield errors below 10%. These results provide initial benchmarks to determine the monitoring time necessary to yield the desired accuracy of parameter measurements.

Aljehani, Van Stan, Haynes and Mehta (2015) did a study on religious leaders (Imams) who often exhibit symptoms of voice problems due to prolonged use of their voice. They described the high degree of voice use by an imam who chants extended prayer cycles during the month of Ramadan. Data obtained over 12 days includes acoustic, aerodynamic and endoscopic assessments complement ambulatory voice monitor. They considered 26-year old part-time imam who chanted the extended Taraweeh prayer (extra prayers performed in the month of fasting) for 2 hours after the sunset and the prayer led was using a microphone for amplification. Voice health monitor was used in the study to measure the voice use and it measures sound pressure level, cycle dose, phonation time, fundamental frequency, and distance dose. For clinical assessment of voice and speech, Pneumographic mask was used at first and last week of Ramadan. The voice of the imam was assessed before, during and after the extended period of prayer. The results demonstrated that sound pressure level, fundamental frequency, phonation time, cycle dose and distance were elevated

during prayer chanting compared with daytime vocal dose levels. The clinical assessment results showed air flow measures, subglottal pressure and vocal efficiency ratio values were outside the normative ranges at the end of the Ramadan. The endoscopic assessment results revealed mild fibrovascular changes consistent with heavy voice use. It suggests that due extended periods of vocal demand, there is an increased vocal effort.

Since Imams falls under the classification of professional voice users, they are prone to develop voice related problems. Farahat and Mesallam (2016) studied the prevalence and psychosocial aspect of voice problems in Saudi Imams. The study included 93 Imams and 82 control subjects. They administered Arabic Voice Handicap Index-10 (AVHI-10) and a questionnaire developed by Boltzer (2009) on both the groups. A-VHI-10 scores were compared between both the control group and Imams. Also, Imams scores obtained from A-VHI were compared by considering different variables included in the general questionnaire. The items in the questionnaire were classified under five main categories, they are 1) demographic data and living habits including social status data, age, sex, marital status, and number of offspring; (2) work experience characteristics that affect voice demand including years of experience and whether the subject had teaching assignments (3) impact of voice problems on their career including frequent absenteeism from praying (attend but not leading prayers), thinking of leaving the Imam's career; (4) voice-related symptoms including change in voice, choking, and voice fatigue; and (5) impact of awareness of voice hygienic instructions on their career. Sixty Imam (65%) participated in this study reported a change in their habitual voice. On comparing the results of VHI-10 between imams and control subjects, there was a significant difference demonstrated between the 3 groups regarding the total VHI score as well as

the three domains (functional, physical and emotional). This indicates the self-perception of voice handicap by Imams when asked to evaluate their voices and also signifies the impact of Imams' profession on voice quality.

From the general questionnaire, 65% of Imams participating in this study reported change of their habitual voice. There was no significant difference when comparing VHI scores of different age groups of Imams included in this study. This result matches the findings of other related studies that investigated risk factors and effects of voice problems among teachers. Also, there was no significant difference between voice problems in Imams considering either marital status or number of offspring. Also the results showed no significance difference between the different groups of Imams when VHI scores were compared considering years of professional experience. This is because all of Imams, either in the prayers time or during Khutbah (Friday ceremon), are using microphones during the sermon, so the cumulative effect of prolonged voice use has no major role on their voice. Results revealed that Imams who reported current voice-related complaints didn't show significant higher VHI scores when compared to Imams without voice related complaints. Although one third of Imams included in this study reported extra vocal activities in the form of extra teaching sessions or teaching Muslims to recite the Holy Quran, their VHI scores didn't show significant difference when compared to Imams who have their routine regular sessions with no extra voice activities. 59% of Imams included in this study were not aware of vocal hygiene advices. However, their VHI scores didn't show significant difference when compared to the rest of Imams who were aware about vocal hygiene advices. This could be explained by the low number of Imams who reported voice-related symptoms and not feeling much handicapped by their voice problems.

Sarıca (2018) investigated the prevalence of voice problems in imams and to determine the potential risk factors. A questionnaire was used to obtain information about demographic features, the time in the profession using the voice, the time per day of voice use, microphone use, the frequency of upper respiratory tract infections, allergies, smoking status, the frequency of tea and coffee consumption, night-time eating habits, laryngo-pharyngeal reflux and family history of voice disorders, and the frequency of symptoms related to voice problems such as voice restriction, clearing the throat, voice fatigue and forced use of the voice in 1500 imams randomly selected from mosques in Turkey. To evaluate the effect of the duration of work on the voice, the subjects were separated into 2 groups as those >10 years and <10years in the profession. The mean age of the imams was 19-64 years and the duration of the imams in the profession was 2-45 years. Out of 1500 questionnaires, the completed forms of 514 imams (34% response rate) were included in the study.

The results showed that the vast majority of imams experience voice problems at certain times in their professional life, this problem is continuously experienced in general by 36.6%. Upper respiratory tract infection was seen to be the most common cause leading to voice problems. Other risk factors were reflux, frequent throat clearing, not using a microphone, allergies, not having any voice-breathing training and vocal hygiene. Voice problems were seen at a higher rate in the imams who did not use a microphone compared to those who did. Thus, it can be considered that microphone use could decrease voice problems as there is no need to raise the voice. The significant risk factors causing voice problems in the imams of this study were seen to be upper respiratory tract infection, allergies, reflux, and frequent throat clearing. Frequent throat clearing because of reflux, retronasal discharge or allergy causes mechanical trauma in the larynx with burning and dryness in the throat

resulting in repeated throat clearing and talking loudly to compensate for the voice quality and thus a vicious circle is established. There are also additional duties of reading the Koran, delivering sermons and chanting at weddings and funerals. As many imams do not like or trust their voice, they do not chant. Those who do the chant and have not had voice training have an increased rate of voice complaints because of overload. The provision of education and training related to vocal hygiene, breathing exercises, and correct voice use could be effective in reducing these problems for imams. The results also showed that the lack of knowledge and training of the imams in voice use was a significant risk factor for voice problems, whereas those who were knowledgeable, had received training and applied it in practice reported fewer voice complaints.

Yeshoda et al. (2018) investigated the voice characteristics in Madrasa teachers in terms of a frequency perturbation and noise measures. The study consisted of 20 participants (10 in experimental group and 10 in the control group) in the age range of 41 to 50 years. Participants in the experimental group had 15 years of experience in the service of teaching in Madrasas. The subjects were asked to phonate vowel /a/ at their comfortable pitch and loudness and it was recorded using a portable digital mouth-to-microphone distance of 10cms and 45° off-axis positioning. A three seconds steady portion of the phonated vowel was taken and was subjected to acoustic analysis. The Multi-Dimensional Voice Program (MDVP) of Computerized Speech Lab (CSL) Model 4500 was used to obtain the acoustic parameters of voice. Parameters such as jitter %, Relative average perturbation and Noise to Harmonics ratio were analysed further. The result indicated a considerable increase in the frequency perturbation measures in Madrasa teachers compared to non-teachers, which can be due to the excessive demands in their voice without taking adequate

breaks/ voice rest. Hence, the results suggested that Madrasa teachers are at higher risk of having vocal symptoms including hoarseness, discomfort, increased effort while using their voice, tiring or change in voice quality after short use and difficulty projecting their voice.

Yasin (2018) investigated the vocal symptoms and characteristics of 30 Imams and he compared with the age and gender matched normal individuals. A voice survey questionnaire was administered on Imams to understand their vocal symptoms. Acoustic analysis was also done to study the vocal characteristics of Imams by collecting phonation sample from both the groups. The outcome of questionnaire showed that all the participants in the Imams group have experienced voice problem in their carrier. The voice problem in Imams group was attributed to the vocal loading they are subjected to, poor vocal and non-vocal habits and their knowledge about voice care. The results of acoustic analysis showed that the Imams demonstrated difficulty in sustaining periodic vibration in the vocal cords over a specific time which leads to noise component in the voice, perturbation in period of sustained pitch and sustained amplitude during phonation and greater intensity of voice tremor.

APM is one of the majorly used devices for studying the vocal loads in professional voice users. Bottalico, La Malva, and Astolfi (2011) investigated vocal doses and other parameters in primary school teachers in classroom setting. They considered 40 primary school teachers of age range around 27 to 59years old, who are with no special voice training, taken from 6 schools in Italy, in which 36 were females and 4 were male teachers. Based on the type of building and mid-frequency reverberation time in classrooms, teachers were divided into 2 groups of three (1.13 and 0.79s respectively). Ambulatory phonation monitor (APM 3200) was used in the study. Vocal dose and other parameters were considered for the study mainly, time

dose, voicing time percentage, vocal loading index, distance dose under vocal dose parameter. A total of 73 working day samples were collected (3 days, 4 hours per day), in which 54 was traditional lesson samples, where children were sitting at their desk and teacher was close to the black board and data were extracted and analysed separately. The monitored teachers were divided into two groups i.e. A and B, each group included 3 schools. Three schools in group A were built at the end of 19th century and are historic square court building and group B schools were built in 70s and were modern buildings and all the classrooms were in a quiet street area. Questionnaires were also administered after the traditional lessons to obtain the relationship between the objective and subjective data. The results demonstrated that there was no significant difference between the two groups of schools A and B. Unlike vocal dose and other parameters two schools showed difference in noise intensity and disturbances, reverberation and teacher's vocal effort, in which group A showed higher subjective scores than group B. Also there was a significant difference were found between the morning and the afternoon teaching periods concerning mean SPL, which on average increased during the afternoon by about 5dB.

Mesallam (2015) conducted a study in SLPs using the APM device to explore the vocal load characteristics in that population. He considered 13 full-time working female SLPs and control group of 7 full-time working female subjects (from different professional background) who are working at communication and swallowing disorders unit, King Abdulaziz University hospital. All participants were working together in the same working environment with an average duration of 3 years and did not report any history of voice disorders or laryngeal surgery. APM device was used for the study and it measures total phonation time, average vocal intensity and fundamental frequency, cycle dose and distance dose during the whole phonatory

activity. A total of 6 hours recording was taken from all the subjects. Data were normally distributed and parametric statistics were used, independent sample t-test was used to compare the difference in the mean values between SLP group and the control group. The results demonstrated that a significant longer total phonation time and also the vocal load characteristics were significantly higher in the SLPs group than control group. SLPs groups reported a significantly higher cycle dose and distance dose compared to control group. But there was no significant difference reported between the SLPs group and control group when compared the average fundamental frequency and average intensity. This indicates that the SLPs in this study used their habitual pitch and loudness during their daily practice and there was no need for them to increase loudness of their voices or use different pitch. Hence this study shows that increased vocal load might increase the risk for developing voice related problems.

Alhander, Pelegrin, Whitling, Rydell and Lofqvist (2014) studied the vocal performance in teachers with self-estimated voice problems (VP) and compared with their age and school matched healthy voice (VH) colleagues. The hypothesis was that the teachers without voice problem use their voices differently regarding fundamental frequency, sound pressure level, and in relation to the background noise. They considered a group of 28 teachers from 23 schools were selected randomly and they were rated their voices and prevailing voice problem together with the aspect of their teaching environment in a questionnaire. Two groups were decided based on the answers to the questions on voice symptoms from a Swedish validated version of the VHI-T (voice handicap index- throat). The data were collected using Ambulatory Phonation Monitor 3200 Model. The APM measurements of two groups of teachers showed that teachers with self-estimated VP differed from their age-, gender-, and

school-matched VH peers in several aspects of voice use, in particular during teaching sessions. The time and cycle doses were both significantly higher in the group with VP. This suggests a higher vocal load with fewer opportunities for vocal recovery during teaching. Moreover, the pattern of F0 changes in relation to both the room acoustics and the SPL of the voice differed between the groups, possibly indicating a reduced vocal flexibility in the group with VP.

Cantarella, et al. in 2014 conducted a study to analyse the vocal behaviour in call center operators and also to search if there is any correlation between the daily voice dose and the self-perceived voice related handicap. For this purpose they recruited 92-call center operators. Twenty-five were males aged 25-42 years, and sixty-seven were female aged 24-50 years. They were grouped based on their working categories, which included Frontline team (62 subjects), corporate service (22 subjects) and technical team (8 subjects). None of the subjects were under treatment for voice problem at the time of data collection. The working hours ranged from 4 to 10 hours per day. Data was collected on 3 consecutive working days. All the subjects were administered with a general questionnaire which gathered information about the participants' age, gender, smoking habits, and the presence of upper respiratory pathologies and also about their extra activities requiring intensive voice use (teaching, singing, or theatre acting). Apart from general questionnaire, participants were administered with the Voice Handicap Index (VHI) for the self-assessment of perceived voice-related disability. Apart from those questionnaires, Ambulatory phonation monitor was used to see the participants' daily voice dose. It consisted of parameters such as phonation time, percentage phonation time, fundamental frequency average, fundamental frequency mode, mean amplitude, total cycles of vibration and total distance dose. The results of general questionnaire demonstrated

that out of 92 participants 26 subjects were habitual smokers, 23 subjects were having upper respiratory pathologies, and 10 subjects were having extra-work activities such as teaching, singing or theatre acting. Thirty-two subjects were reported to have mild upper respiratory symptoms at the time of APM recording and 7 subjects indicated that they had episodes of extra professional voice misuse or abuse due to screaming an]or singing during APM recording.

There was no significant difference found between the two genders for age, upper respiratory symptoms or off-work habits of voice use. But there was a significant difference found in the mean number of working hours per day for males (7.8 ± 1.3) and females (7.1 ± 1.4). VHI provided information about the participants' perception of their voice health. It showed no difference between genders. Also there was no significant difference related to the number of work hours. The majority of the subjects VHI scores was within the normal limits and was not related to the number of work hours, suggesting that the duration of work hours does not seem to be a critical factor in causing the perception of voice handicap. Results of APM demonstrated no significant difference found in between the two genders. As expected, the average F0, the F0 mode and the total number of vibratory cycles were significantly higher in females. Average amplitude was significantly correlated with the phonation time and the percentage phonation time, it was higher in subjects with longer phonation time. As expected, phonation time in minutes and percentage was higher during work hours whereas F0 was significantly lower. The total phonation time during work was related to the number of work hours, but there was no correlation found between the total phonation time of the whole recording day and number of work hours. While considering the two genders separately, variables like F0, total cycles and total distance were different. Also there was no significant difference found among the

three different working categories. Theoretically the “technical team” is the one with least voice load (only 44% of working time devoted to phone calls) in contrast it showed the highest percentage phonation time and voice amplitude in comparison with the other groups. This finding suggests that the percentage daily time spent on telephone calls is not a determinant factor for the working voice load. The distance dose in working time and in outside working time was significantly correlated with each other. This indicates that “talkative” persons demonstrate also a higher occupational vocal load. In conclusion, the study demonstrated that the number of work hours and the percentage phonation time were not statistically related to the self-perception of voice problems. Also authors says that it is not possible to define a clear-cut safety limits of vocal load in the call center setting and there are other factors contributing for voice disturbances such as environmental conditions, general health status, and mental stress also deserves to get attention within the scope of preserving vocal health.

Buckley, Ohalloran, & Oates in 2015, did a pilot study on elite football coaches to analyse their vocal health and occupational voice use. For this purpose, they included 12 Australian football coaches with the age range 32-48 years, who are working within two national-level football competitions (3 from Australian Rugby Union and 9 from Australian Football League). They were considered as a single group, since both group coaches engaged in an equivalent roles and tasks within both leagues. Data collection was done by wearing Ambulatory phonation monitor (APM) during training session, by semi-structured interviews and by administering Voice Capability Questionnaire (VCQ). Voice Capability Questionnaire is a self-rating questionnaire concerning vocal health at work. Semi-structured interview included coaches perception and awareness of their occupational voice use, their vocal health

experiences and if they have used any method to manage their voices. APM monitoring was done around for 2 hours. The APM results suggested heavy vocal loads for coaches during player training. The results of indicated the presence of some symptoms of voice in coaches. They all suggested that the structure of their working week, workplace tasks, and vocal demands impacted on their voice. Also coaches typically did not consider how to take care their voice during daily work and discussed experiencing voice symptoms as an inevitable part of their jobs.

In a study by Potha, 2016, measured vocal loading parameters in 10 mothers of children with hearing impairment and compared it with 10 mothers of children with normal hearing. Sample was collected in a controlled therapy sessions. The parameters studied in this study were F0 mode, F0 average, SPL average, time dose, cycle dose and distance dose using Ambulatory phonation monitor software. The results demonstrated that the voice use profile parameters like F0 mode, F0 average, SPL average, time dose, distance dose and cycle dose were higher in mothers of children with hearing Impairment.

Chapter 3

METHOD

The purpose of the study was to document the vocal loading characteristics of Imam by continuous monitoring of phonatory behaviours for 5 hours using APM Instrument.

Subjects: Five Imams who met the following inclusion criteria with ages ranging from 29-48 years had participated.

Inclusionary criteria:

- Imams in the age range of 25-50 years who has minimum of 5 years of experience in the service.
- The participants should not have any history of hearing problems, speech and language disorders, psychological, neurological, and cognitive problems.
- The participants had to be free from upper respiratory tract infections or allergies at the time of recording.
- Should be non-smokers and non-alcoholics.

Table 1: Demographic details of all subjects

	Subject 1 (S1)	Subject 2 (S2)	Subject 3 (S3)	Subject 4 (S4)	Subject 5 (S5)
Age/Gender	39yrs/M	36yrs/M	29yrs/M	40yrs/M	48yrs/M
Marital status, and number of offspring	Married and 5 children	Married and 1 child	Unmarried	Married and 2 children	Married and 2 children
Educational qualification	Completed Alim course	Completed Alim course	Completed Hifz-ul-Quran Course	Completed Alim course	Completed Alim course
Working experience	9years	8years	5years	10years	15years
Other occupation	Auto driver	Auto Driver	-	-	-

Instrumentation

Ambulatory Phonation Monitor (APM) (Model 3200, KayPENTAX, Lincoln Park, New Jersey, USA) was used in the study. It measures amount of time subject phonates and it gives an estimate of subject's fundamental frequency and vocal intensity during the phonation activity and it provides as a profile of a subject's phonatory behaviour during the time of recording. It consist of an accelerometer, which is a small rectangular metal encasement (0.33×1.5 inches; 84×56×38 mm) mounted on a round silicone pas with a cable attached to it and the opposite end of this cable is the connector which plugs into hardware of APM. The accelerometer has adhered to the anterior base of throat (just above the sternal notch) of the participants, and it pick up the vibrations from the skin. The dynamic range of the sensor is about 42.1dB and the

sample rate (acquisition mode) is 20 samples/seconds. The weight of the hardware module is < 2lbs (without batteries) and the size is 45.4mm H × 95mm W × 158mm D. It gives information over a period and will not be affected by the background noise.

Calibration: According to the manufacturer's direction, calibration was done before initiating the data collection to ensure that the accelerometer was calibrated for the sound pressure level (SPL) measurement to reliably convert to SPL measurement from accelerometer to PC. The unidirectional microphone provided with the APM unit has a 15cm metal spacer rod that rests above the upper lip when the microphone is held in front of the mouth. For calibration, each participant phonated a sustained vowel /a/ from the softest to loudest vocal production in a single breath. The calibration was completed only when there is a sufficient number of points were obtained that fit a normal regression line. If the APM software indicated a problem with calibration or the experimenter felt the calibration was not adequate, the procedure was repeated until a satisfactory calibration signal was obtained.

Procedure

The participants in this study were explained about the objectives of the study and the task to be carried out and a written consent was obtained from all the participants.

Initially the participants were made to sit comfortably on a chair and the accelerometer (throat sensor) was adhered on the throat using a plastic tape. The throat sensor and hardware module was connected to the PC where the APM is installed. After the connection, the APM was subjected for calibration. After calibration, the accelerometer unit along with the hardware module was detached

from the PC and placed inside the waist pack. The waist pack was tied around the hip of the participants for the data collection. 5 hours data was collected from around 7am to 1pm (beginning at the time of Madrasah teaching). After that the throat sensor was removed from the participant and the hardware module was connected to the PC where data were transferred to the PC for analysis.

Analysis

The APM software generated the results automatically in graph form, once the data was transferred to the PC. Then the recommended options were selected to view the numerical value of seven parameters in a word document, which are required and the same was saved on the PC. The following parameters were extracted for analysis:

- 1) ***Phonation time:*** It expresses the duration of time during which the vocal folds have been in phonatory vibration.
- 2) ***Percentage phonation time:*** It is the percentage of the recording time during which the vocal folds have been in the phonatory vibration.
- 3) ***F0 mode:*** The most no. of times a particular fundamental frequency occurred in a phonation/speech over the period of recording.
- 4) ***F0 average:*** It is an average of fundamental frequency over the period of recording.
- 5) ***SPL average:*** It is an average sound pressure level (SPL) of the voice over the period of recording.
- 6) ***Cycle dose:*** It is the total no. of cycles completed by the vocal folds on the vibratory trajectory.
- 7) ***Distance dose:*** It is the total distance travelled by vibratory vocal folds.

For the purpose of comparing our study with other study, descriptive statistical analysis was carried using Statistical Package for the Social Sciences (SPSS) software package (Version 21.0). Mean and standard deviation values of each parameter of Imams are given in the Table 3. Mean and standard deviation of the present and the other four studies have been given in the Table 4.

Chapter 4

RESULTS AND DISCUSSION

The current study aimed to study the vocal loading characteristics of Imam by continuous monitoring of phonatory behaviour for 5 hours using Ambulatory Phonation Monitor. A total of 5 Imams were participated in the study in the age range of 28-49 years. The parameters using APM measured were phonation time, percentage phonation time, F0 mode, F0 average, Average amplitude, Cycle dose and total distance dose for about 5 hours (started during Madrasah teaching time). The obtained values are given in the Table 2. Mean and standard deviation of all parameters are obtained and it is given in the Table 3.

Table 2: Obtained APM values of all subjects

	S1	S2	S3	S4	S5
SPL Calibration	SPL = (Acc - 24.86)/0.47 + 48.89	SPL = (Acc - 7.23)/0.87 + 48.89	SPL = (Acc - 19.83)/0.43 + 48.89	SPL = (Acc - 30.76)/0.31 + 48.89	SPL = (Acc - 8.54)/0.80 + 48.89
Data Samples	378390	363435	353309	421862	362280
Total Exam Duration	05:05:19	05:02:51	05:05:25	05:05:33	05:03:54
Phonation Time	01:27:07	01:20:28	00:24:35	00:43:22	01:25:09
% Phonation time	27.44%	26.57%	8.35%	14.46%	28.21%
F0 Mode (Hz)	140 Hz	152 Hz	128 Hz	152 Hz	140 Hz
F0 Average (Hz)	168.64 Hz	174.89 Hz	162.26 Hz	177.24 Hz	159.73 Hz
Average Amplitude	76.26 dB	81.07 dB	82.53 dB	82.43 dB	85.55 dB
Total Cycle dose	881177	842763	239230	461254	814354
Total Distance Dose	5771.30 meters	6642.34 meters	2390.05 meters	4050.60 meters	7788.61 meters

S=Subject

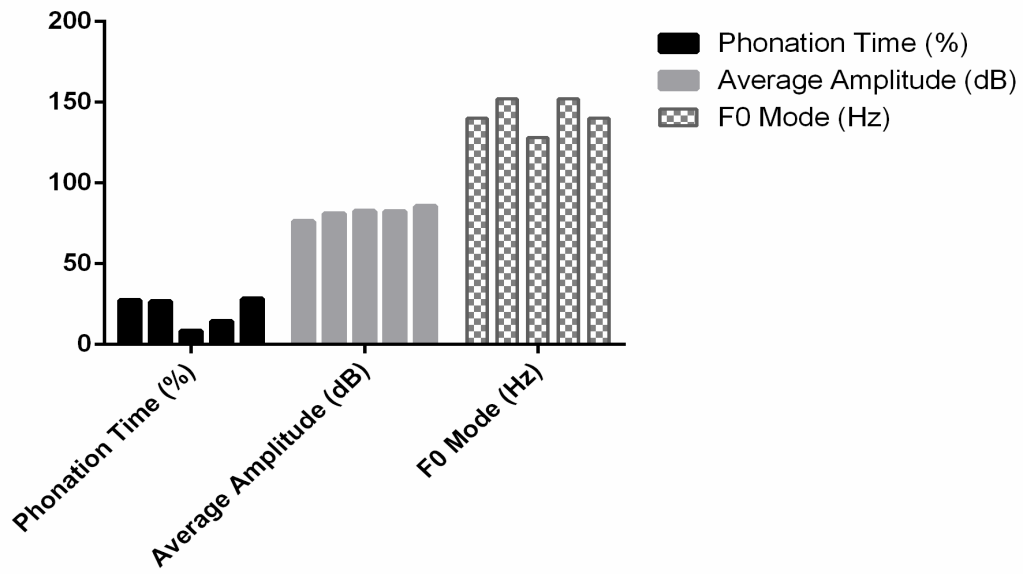


Figure 1: Bar diagram of percentage phonation time, Average amplitude and F0 mode of the five subjects.

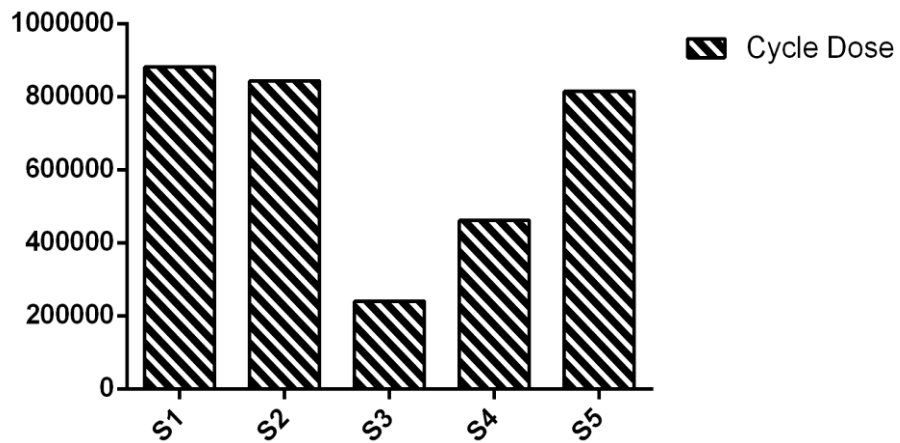


Figure 2: Bar diagram of cycle dose of all the subjects.

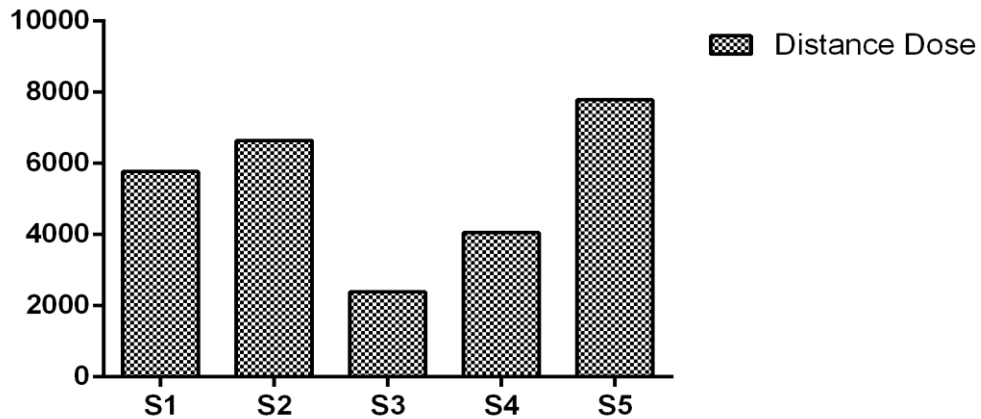


Figure 3: Bar diagram of distance dose of all the subjects.

Subject-1: 39 years old Male with 9 years of experience as Imam. He is married and has 5 children. He has done his undergraduate in Alim course. (The Alim course is a comprehensive study of the Islamic Sciences, the breadth of which includes expertise in: Arabic grammar, Tajweed (set of rules in which the words of Quran should be pronounced), Literature, Tafseer Al-Qur'an (exegesis of Quran), Hadith (sayings of the Prophet Muhammad), Islamic Law (Fiqh), and Islamic History). He also takes extra Quran classes for adults (thrice a month). Apart from the profession of Imam, he also works as an Auto driver. Total monitored time for this subject was 05:05:19 hours, in that 01:27:07 was the phonation time, which means percentage phonation time, is 27.44%. The data showed that the most frequently occurred F0 was 140 Hz and the average F0 was 168.64 Hz. When we looked into the average amplitude of his voice, it was 76.24 dB SPL. Values of Total cycles of vibration (cycle dose) and total distance dose were 881177 and 5771.30 meters respectively. The results of phonation time revealed that S1 has higher phonation time compared to all other participants. The reason can be attributed to the continuous use of their voice while teaching in madrasah in early mornings, daily 5 times prayer or the talkative nature of the person, or due to the other job (Driving) during the monitoring time. Amplitude average was

less in this subject compared to other participants; the reason for this can be that he usually speaks with soft voice. Also he had higher cycle dose measurements even though mode and average fundamental frequency was lower than other participants, the reason can be due to the high vocal demand in their profession and also due to the duration of the voice usage during the monitoring time.

Subject-2: 36 years old male with 8 years of experience in the service. He is married and has a child. He has completed his degree in Alim course. Apart from the profession of Imam, he also works as an Auto driver. The data was collected for 05:02:51 hours, in which phonation time was 01:20:28 hours which means, percentage phonation is 26.57%. His F0 mode was 152 Hz and F0 average was 174.89 Hz. Average amplitude of voice showed 81.07 dB SPL. Cycle dose and distance dose were 842763 and 6642.34 meters respectively. When the parameters (F0 mode, cycle dose and distance dose) were compared, it was found that the values were higher in S2 compared to S3, S4, and S5. Our finding on high F0 mode and average is supported by Shwetha (2009). She has reported that increase in vocal load and increase in loudness tend to increase in F0. Also it has been reported that there is increase in fundamental frequency after vocal loading (Rantala, Vilkanm, & Bloigu, 2002)

Subject-3: He is 29 years old with education qualification in Hifz-ul-Quran course (course involving in memorization of the whole Qur'an with its meaning) and has about 5years of experience in the service and unmarried. The total monitoring time was 05:05:25 hours. Phonation time was 00:24:35 minutes and 8.35% were the percentage phonation time. F0 mode and F0 average are 128 Hz and 162.26 Hz respectively. Average amplitude of his voice was 82.53 dB SPL. Total cycles of vibration and total distance dose were 239230 and 2390.05 meters respectively.

Compared to all other participants, phonation time, percentage phonation time, F0 mode, cycle dose and distance dose were very less in S3. The reason for this can be attributed to his age, years of experience, marital status and the educational qualification. Comparatively he is younger (29 years) and less experienced (5 years of service) compared to other participants. His vocal usage is relatively less than the other participants at home since he is unmarried whereas the other participants were married and have children. Also his degree is different from others. It was a course in Hifz-ul-Quran where the person has to memorize the whole Quran and its meaning whereas Alim course is much broader relatively. They are mainly involved in leading the daily congregational prayers, other special prayers and Madrasa teaching and not much involved in preaching and public speaking like other participants. The main role of this subject was to lead daily congregational prayers and Madrasa teaching. Hence, the reason for reduced phonation time and percentage phonation time is at the time of recording the daily vocal activity was less compared to other participants.

Subject-4: He is 40 years old, with educational qualification in Alim course and has 10 years of working experience. He is married and has 2 children. After the madrasah teaching, he also takes class (1 and half hour) for people doing the Islamic pilgrimage. The total monitoring time was 05:05:33. Phonation time was 00:43:22 minutes and 14.46% were the percentage phonation time. F0 mode and F0 average are 152 Hz and 177.24 Hz respectively. Average amplitude of his voice was 82.43 dB SPL. Total cycles of vibration and total distance dose were 461254 and 4050.60 meters respectively. F0 Mode is same as in S2 and higher than the other participants but also F0 average was more in S4 (177.24 Hz) than all other participants. Higher F0 Mode may be the reflection of vocal load due to Madrasa Teaching, leading Prayers and the

special classes he conducts and higher F0 Average can be attributed to fluctuations in pitch during recitation of the Quran in prayers.

Subject-5: He is 48 years old, with 15 years of experience in the service. His educational qualification is degree in Alim course. He is married and has 2 children. He involved in public lecture on the day of monitoring. He involves in speaking much and has frequent throat clearing behaviour. He usually speaks little loud compared to the other 4 participants. Total monitored time was 05:03:54 hours, in that 01:25:09 was the phonation time, which means percentage phonation time is 28.21%. The data showed the most frequently occurred F0 (F0 Mode) was 140 Hz and the average F0 was 159.73 Hz. When we look into the average amplitude of his voice, it was 85.55 dB SPL. Values of Total cycles of vibration and total distance dose were 814354 and 7788.61 meters respectively. Average amplitude was higher in S5 compared to all other participants. The reason can be his general vocal behaviour (Speaking loudly). Distance dose was more in S5 compared to all other participants which again reflects the high vocal loudness. The distance travelled by the vocal fold highly influenced by the vocal intensity. With higher subglottic pressure the vocal folds are set apart relatively higher.

Table 3: Mean and standard deviation (SD) values of APM parameters across Imams

Parameters	Mean	SD
Phonation Time	1:04:08.20	0:28:25.565
% of Phonation Time	21.00	9.04
F0 Mode	142.4	10.04
F0 Average	168.60	7.57
Amplitude Average	81.60	3.647
Cycle dose	647755.60	283700.756
Total Distance Dose	5328.60	2135.529

All the Imam participants involved in the study leads daily Congregational prayers at the mosque. They were also involved in Madrasah teaching (primary school level children) for around 2 hours continuously every day except on Sundays. In the Madrasah the classes were conducted in a big hall, where each class was separated using a screen. Each class had around 10-12 children. Also all the subjects were less aware of the vocal hygiene.

Overall, the results suggests that, higher values of phonation time, percentage phonation time, F0 mode, cycle dose and distance dose can be attributed to duration of the voice usage, phonatory behaviour and the higher experience in the service. A study by Koul, in 2004 had similar findings. The aim of the study was to find the nature of voice characteristics in teachers of primary and secondary grades using questionnaire and objective measures. Having class in the noisy environment and also the longer duration of the teaching experience are the contributing factors for increased vocal load or demand.

Four research studies on voice using Ambulatory monitor was selected to see the vocal parameters in different groups. The first study was done by Boudreaux et al., in 2011 and titled “Using the ambulatory phonation monitor to measure the vocal parameters of older people with and without Parkinson's disease”. The parameters considered in the study were phonation time, Average amplitude and F0 average. Second study was done by Cantarella et al., in 2014 and titled as Ambulatory Phonation Monitoring in a Sample of 92 Call Center Operators. The parameters considered in the study were phonation time, percentage phonation time, F0 mode, F0 average, Amplitude average, total distance dose, and total cycles of vibration. The third study was done by Potha, in 2016 and titled as “Voice Use Profile in the Mothers of Children with Hearing Impairment: A Controlled Therapy Session”. The parameters considered in the study were time dose, average amplitude, Fo average, Fo mode, percentage phonation time (time dose) Cycle dose and distance dose. Fourth study was done by Buckley et al., in 2015 and titled as “Occupational Vocal Health of Elite Sports Coaches: An Exploratory Pilot Study of Football Coaches” and the parameters considered in the study were phonation time, percentage phonation time, vocal intensity average, F0 average and F0 mode. The details of participants and the data obtained from all studies have been given in the table 4.

Table 4: Subject details and mean value of the APM parameters across different studies

Parameters	Vocal load in imams	Voice load in Non-Parkinson's group (Study 1)	Call center operators (Study 2)	Mothers of hearing children (Study 3)	Football Coaches (Study 4)
Gender	5-Males	3-Males 2-Females	25-Males	10-females	12-Males
Age (mean)	25-50 years	67-85 years	25-42 years	25-32 years	32-48 years
Total Exam Duration (hours)	05:02:51	24:00:00	21:00:00	2:25:00	1:08:25
Phonation time	1:04:08	53.14	87.9	-	13.40
% Phonation time	21.01	-	7.1	11.47	19.25
Vocal intensity (dB SPL)	81.60	81.15	71.3	63.68	83.67
F0 average (Hz)	168.60	177.49	133.8	216.26	150.00
F0 mode (Hz)	142.4	-	117.0	207.46	124.72
Cycle dose (cycles)	647755.60	-	2646.8	58989.13	
Distance dose (meters)	5328.60	-	692 133.2	191.52	-

The results of the current study were compared with other four studies. The current study had total monitoring time of around 5 hours and other three studies had monitoring time ranging 1.8 hours to 24hours. Since the monitoring time was different in each study; the parameters considered for comparison are percentage phonation time, F0 mode and Average amplitude. When we looked into the percentage phonation time; it was higher in Imams (21.01 ±9.04) compared to other

four studies. This may be due to the continuous use of their voice while teaching in Madrasah in early mornings, daily 5 congregational prayers, extra educational programs (Quran classes and classes for Islamic pilgrimage (Hajj)) also two of them were engaged in other jobs (as auto drivers) for financial support.

Amplitude is higher in Imams compared to all four studies. The reason for high amplitude average in Imams can be because they are habituated with raised voice since they involve in teaching at Madrasa and public speaking. Amplitude average was less in study-2 (71.3 ± 4.5) and study-3 (63.68 ± 4.98) compared to other studies. In study 2 call center operators spend most time in telephone calls and the author reported that the percentage daily time spent on telephone calls is not a determinant factor for the working voice load. Vocal parameters in Mothers with hearing impaired children and mothers with hearing children were compared in study-3 and the author reported that mean amplitude value was less in mothers with hearing children compared to mothers with hearing impaired children.

The results of F0 mode revealed that the values were higher in Imams (142.4 ± 10.04) compared to the study-2 (117.0 ± 18.4) and study-4 (124.72 ± 20.15). The higher F0 mode in Imams can be attributed to the reason that during the congregational prayer and supplication the Imam has to recite the Quranic verses with more vocal effort to project it clear and melodic to the people following him in the prayer and also while public speaking, they often tend to use loud voice for good projection of voice. Shwetha (2009) has reported that increase in vocal load and increase in loudness tend to increase in F0.

Chapter 5

SUMMARY AND CONCLUSION

The current study aimed to study the vocal loading characteristics of Imam by using continuous monitoring of phonatory behaviours for 5 hours using Ambulatory Phonation Monitor (APM) Instrument. A total of 5 Imams were volunteered for the study. Vocal loading parameters measured in the study were phonation time, percentage phonation time, F0 mode, F0 average, amplitude average, cycle dose and distance dose using APM instrument. About 5 hours of recording data was collected from each Imam during their normal daily activity. All APM parameter was compared among the participants. The results revealed that, phonation time, percentage phonation time, F0 mode, cycle dose and distance dose were higher in four out of five (80%) Imams.

The result of the present study clearly shows that the Imams are having high vocal load due to the duties done by them. The reasons for the high vocal load can be attributed to Imam's age, marital status, years of experience in the service, educational qualification, vocal and non-vocal behaviours, class room settings (acoustics), number of students or listeners in the class room, and additional job.

Also the present study was compared with four other APM data with other type of voice users. The parameters considered were Percentage phonation time, F0 mode, and Amplitude average. These three parameters were higher in the Imams compared to participants in the other studies (call center operators, non-Parkinson group, mothers of hearing children, and soccer coaches). The reason for this could be due to the high vocal demand and the vocal behaviours in Imams compared to other participants.

Limitations

- Age matched control group was not present.
- Only 5 Imams were considered in the study.
- Data was not collected separately for Madrasah teaching and additional working time.

Future direction

- Future study can be done in Imams including more number of subjects using APM to find the vocal loading in that population.
- Future study can be done in Imams during their working time and extra activity time separately using APM or any other ambulatory monitoring devices.

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