VOICE USE PROFILE IN THE MOTHERS OF CHILDREN WITH HEARING IMPAIRMENT: A CONTROLLED THERAPY SESSION

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Register No: 14SLP021

This Dissertation is submitted as part fulfillment

for the degree of Master of Science in Speech Language Pathology

University of Mysore, Mysore.

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MANASAGANGOTHRI, MYSORE-570006

MAY, 2016.

CERTIFICATE

This is to certify that this dissertation entitled **"Voice Use Profile in the Mothers of Children with Hearing Impairment: A Controlled Therapy Session"** is a bonafide work in part fulfillment for the degree of Master of Science (Speech Language Pathology) of the student with Registration No. 14SLP021. 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 **"Voice Use Profile in the Mothers of Children with Hearing Impairment: A Controlled Therapy Session"** has been prepared under my 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.

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DECLARATION

This dissertation entitled **"Voice Use Profile in the Mothers of Children with Hearing Impairment: A Controlled Therapy Session"** is the result of my own study under the guidance of **Dr. R. Rajasudhakar**, Lecturer in Speech Sciences, Department of Speech Language Science, All India Institute of Speech and Hearing, Mysore, and has not been submitted earlier to any other University for the award of any other diploma or degree.

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May, 2016.

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CHAPTER-I

INTRODUCTION

The human voice is exposed to various loading factors, especially in the teaching profession. This is also logically true when a person interacts with hearing impaired individuals because of the inherent properties of listener's poor hearing sensitivity.

"Vocal loading is defined as a combination of prolonged voice use and additional 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 loading may be potentially harmful to the tissues of vocal folds causing vocal fold damage (Svec, Popoloand Titze, 2003). Several studies have reported that vocal loading is the major cause of the voice problems in professional voice users such as singers, teachers, and actors and so on.

Quantifying the exposure of the vocal fold tissue to self-induced vibration during periods of phonation is known as the vocal dose. Titze (1994) claimed that vocal fold tissue injury can occur if a critical vibration dose is exceeded. Titze, Svec and Popolo (2003) have reported three vocal doses which are, i) time dose (Dt), ii) cycle dose (Dc), and iii) distance dose (Dd).

Time dose is same as voicing time and measures the total time the vocal folds have spent vibrating. Cycle dose measures the number of oscillations of the vocal folds during the recording period; it depends on both fundamental frequency (F0) and the total phonation time. The distance dose is defined as the total distance accumulated by the vocal folds in a cyclic path during vibration; it depends not only

on the total phonation time and F0, but also on the amplitude of the vocal fold vibration and the vocal intensity (dB SPL). The simplest vocal dose is time dose, often called as the voicing time.

When understanding vocal behaviors outside the clinical setting, the researchers often rely on subjective perception provided by the patient which is likely to be unreliable. Vocal loading can be studied by using microphones, but it is highly susceptible to environmental noise and also it is affected by the communication partner, thus no confidentiality is established. Hence, the instruments which are not affected by noise are reliable to use for measuring vocal load. Ambulatory Phonation Monitor (APM) is a device which is used in the study of vocal loading because it has an accelerometer to sense the vibration at throat where the influence of acoustical ambient noise is nullified.

Thus, studies establishing the efficacy of APM in measuring vocal loading were conducted by various researchers on kindergarten, elementary school, and musical teachers. Morrow and Connor (2011) aimed to quantify the difference in voice use profiles across several variables on seven elementary music and five elementary classroom teachers within the age range of 24 to 58 years. Phonation time, fundamental Frequency (F0), vocal intensity, cycle dose and distance dose parameters were measured by using APM gadget and the authors found that phonation time, F0 and vocal intensity were higher for music teachers than the classroom teachers. The Music teachers had 62% and 90% of greater cycle dose and distance dose, respectively than the classroom teachers. This could be due to elementary music teachers need to use different and sustained frequency more than the classroom teachers.

Remacle, Morsomme, and Finck (2014) compared the vocal loading of kindergarten and elementary school teachers in terms of professional and nonprofessional conditions. 12 kindergarten and 20 elementary school teachers have participated in the study. The parameters measured were F0, sound pressure level (SPL), time dose, distance dose and cycle dose by using APM. The authors found that the kindergarten teachers had greater F0, SPL, time dose, distance dose and cycle dose than the elementary school teachers in both professional and nonprofessional conditions. This indicates that the kindergarten teachers use their voice more often than elementary school teachers and they are more prone to develop a voice disorder.

Ahlander, Pelegrin, Whitling, Rydell and Lofqvist (2014) studied the vocal behavior in teachers with self-estimated voice problems (VP) and compared with their age and school matched healthy voice (VH) colleagues. They considered 14 males and 12 females for VP and VH group, respectively. The parameters measured were F0, SPL, phonation time, time dose and cycle dose by using APM. The authors found that VP group had more phonation time than VH group, though VP group and VH group had no significant difference among F0, SPL, and cycle dose.

Cantarella et al. (2014) analyzed the vocal behavior of call center operators during work time and extra work time, around 92 subjects participated in the study within the age range of 24-50 years. Parameters measured were phonation time, percentage of phonation time, F0, F0 mode, SPL, cycle dose and distance dose by using APM. There was a significant difference found between the percentage of phonation time during working and extra working time. Mean amplitude was higher in subjects who had longer phonation time and higher pitch; this might be due to excessive usage of voice, less hydration and more stress in call center operators.

Many non- professional voice users also have the similar voice problems as professional voice users, but the consequences of such problems are different (Sataloff, 2007). However, voice health is important for everyone. The parents of children with communication disorders especially those of children with Hearing Impairment (HI) are more susceptible to develop voice problems when compared to parents of typically developing children. Shabnam (2012) reported that the prevalence of voice disorder was 26% among mothers of children with hearing impaired than mothers of children with other communication disorders. This is because of the parents of children with HI most of the time use their voice at louder levels. Rekha, Shwetha and Rajasudhakar (2012) studied the voice range profile characteristic in 13 mothers of children with HI and 8 mothers of children with normal hearing. Minimum F0 &mean intensity (I0), maximum F0 & I0 and range of F0 & I0 were measured by computerized speech lab software and the authors found that reduced fundamental frequency and intensity parameters in voice range profile among mothers of children with HI than mothers of children with normal hearing. The authors concluded that the reduced range of F0 value in mothers of children with HI would be because of the inflexibility of vocal folds to vibrate at higher and lower pitch levels. The standard deviation (SD) of the range of F0 was higher in mothers of children with HI compared to mothers of children with normal hearing and the authors attributed this to rough and unstable voice.

Need for the study

Vocal loading is a major factor contributing to voice problems in individuals who work with children having communication disorders starting with the caregivers, Speech–Language Pathologists, special educators and other team members of rehabilitation. In the Indian scenario, owing to lack of services available the

caregivers are often included as active participants in speech-language therapy and home training is recommended to facilitate improvement in children with hearing impairment (HI). Mothers of children with HI (MHI) most often use their voice at louder levels for the prolonged period of time to train their children. Hence, prolonged usage of voice for the purpose of speech language therapy and home training becomes inevitable for the MHI. MHI might speak excessively at the loud voice and also, use lots of repetitions while teaching the concepts with exaggerating speech to ensure that the child understands. Owing to these reasons, it will be interesting to study the differences is the vocal usage of MHI and mothers of children with normal hearing (MNH), if any. Also, there are very limited studies which have been empirically documented the performance of MHI on vocal behaviors. So, the present study aims to document voice use profiles in MHI in a controlled therapy sessions.

Hypothesis

There will be no significant difference in the voice use profile between mothers of children with hearing impairment (MHI) and mothers of children with normal hearing (MNH).

Aim of the study

To measure the voice use profiles in mothers of children with hearing impairment and mothers of children with normal hearing in a controlled therapy session.

Objectives of the study

1) To measure and document F0 mode, F0 average, SPL average, time dose, cycle dose and distance dose in MHI.
2) To measure and document F0 mode, F0 average, SPL average, time dose, cycle dose and distance dose in MNH.

3) To compare F0 mode, F0 average, SPL average, time dose, cycle dose and distance dose parameters between MHI and MNH.

Brief method of the study

A total of 20 subjects (10 MHI and 10 MNH) were participated in the study. The voice use profile was measured while the mothers were teaching few concepts to their children in a sound treated room for 45 minutes of duration using APM device. The parameters measured were F0 mode, F0 average, SPL average, time dose, cycle dose and distance dose and the same were compared between MHI and MNH.

Implications of the study

- The result of the present study will be used in counselling the MHI about the over use and abuse of voice to avoid phonotrauma.
- The results of the present study would help in planning tailor-made vocal hygiene programs for MHI.
- The results of the present study can be considered clinically as baseline measures of voice use profile in MHI, particularly in connection with teaching concepts/ situation.
- Also, the voice use profile will augment the voice clinician's knowledge about the understanding of vocal loading demands and its effects on voice in MHI.

CHAPTER-II

REVIEW OF LITERATURE

Voice is important from the moment of birth, throughout all stages of our lives from the beginning to the end. The birth cry is the barometer of respiratory and phonatory function and is a signal of the new arrival physical status and separation from the mother. At the end of life span, the respiratory system and its vital connections with intentional phonation weakness, until the person voice is heard no more. The normal voice may be characterized by five aspects such as loudness, hygiene, pleasantness, flexibility and representation (Boone, McFarlane, Von Berg & Zraick, 2010). The normal voice must be *loud* enough to be heard in order to maintain the speech intelligibility to the listener. When the loudness is adequate the speech can be heard and understood even in the noisy conditions like TV, air conditioning, computer typing, and so on. Normal voice should be produced in the *hygienic manner* which refers that a voice without vocal trauma and laryngeal lesions. Normal voice should have *pleasant quality*. The produced voice should be *flexible* enough to express emotions, as we often say a greater deal with the emotional tone of our voice. We can produce different emotions such as sad, excited, and sarcastic and scorn for the same words / sentence. Lastly, the normal voice should *represent* the speaker in terms of age and gender. So, the voice should not represent as either older, younger or as less mature than their age and gender.

Subsystems involved in voice production

In the production of voice, there are three individual subsystems involved which work together for efficient voice production namely respiratory subsystem,

phonatory subsystem, and resonatory subsystem. Let us contemplate the structures and functions of these subsystems, particularly as related to the production of voice.

Respiratory subsystem

Conscious breath control is required for tasks such as such phonation, singing, and professional talking, but in day to day life unconscious and untrained breath support is sufficient for conversation. Respiratory subsystem provides the source for the same, which needs expiration to accomplish vocal fold vibration thus producing voice. For quite breathing, inspired air enters into the lungs through the nasal cavity and to the pharynx through open velopharyngeal port then to oropharynx and hypopharynx respectively. During quite breathing, glottis is partially opened and it remains unchanged for both exhalation and inhalation. Then, the air passes between false vocal folds and true vocal folds and reaches the bottom end of the trachea which is the tracheal bifurcation, otherwise known as the 'carina', where the airway divides into the two bronchial tubes of the lungs. The bronchial tube further branches into divisions known as the bronchioles and they eventually terminate in the lungs in little air sacs known as alveolar sacs. Most of the bronchiole and all the alveoli are covered by the pleural membrane that covers the lungs. However, for speech breathing, the pathway for inspiration remains the same, but the expiration is through the oral cavity majority of the time which enables the human beings to articulate the sounds.

Usually, men use thoracic breathing pattern or abdominal breathing pattern and women use thoracic breathing pattern and professional voice users' use abdominal breathing which is ideal. Those who have developed clavicular breathing and mouth breathing tend to run out of air at the end of the utterances or breathing rate is more which might lead to the voice disorder.

Phonatory subsystem

The primary function of the larynx is to control the exchange of gasses such as oxygen and carbon dioxide in the lungs during the process of respiration. Sitting at the top of the airway, larynx appears to have the function of protecting the airway from any kind of obstructions. The tertiary function is that it helps in swallowing the food or fluid by elevating itself along with oesophagus and trachea. Yet another function of the larynx is that it helps in the production of voice. Voice is produced when the air passed through glottis and the vocal folds are set into vibrations. Voice produced is then transformed in resonance cavities which begin from pharynx, oral and/or nasal cavities. Even though primary function of the larynx is to protect the airway, the larynx and voice production in humans play a major role in emotional and linguistic expression. Description of biological aspects of laryngeal function provides us an early hint of how the biological demands of the airway and the larynx will always take precedence over artistic or communicative vocal production.

Larynx or 'Voice Box' is the main source of voice production. The larynx is a constricted tube with a smooth surface. It is located deep within the strap muscles of the neck. The vertical position of the larynx is C1-C3 in children and C4-C6 in adults with respect to the vertebrae column (Green, 1972). The length of the larynx is 44 mm in adult males and 36 mm in adult females and the circumference is 120 mm in adults (Harjeet, Aggarwal, Sahni, Batra, Rakesh, & Subramanyam, 2010). Cartilages, ligaments and membranes and folds give the framework for the laryngeal structure. The intrinsic and extrinsic laryngeal muscles are connected to this laryngeal framework which helps in vibration and positioning, respectively. The larynx has three paired cartilages such as arytenoids, cuneiform, and corniculate cartilages and three unpaired cartilages such as epiglottis, thyroid, and cricoid cartilages. Especially

arytenoid cartilages help in adduction and abduction of the vocal folds. Arytenoid cartilages have concave and smooth surfaces at the base called 'processes' to which muscles attach. One of such processes is the Muscular Process which is lateral-directed. The intrinsic muscles that attach to this process cause the arytenoids to rock, rotate, and slide on the cricoid cartilage (Neuman, Hengesteg, Kaufman, Lepage, & Woodson, 1994; Selbie, Zhang, Levine, & Ludlow, 1998). The other process involved is the Vocal Process that is anteriorly directed. This forms the posterior attachment for the vocal ligament and vocalis muscle. Intrinsic laryngeal muscles are posterior cricoarytenoids, lateral cricoarytenoids, transverse arytenoid, oblique arytenoids, thyroarytenoids and cricothyroid which help to produce voice and change in pitch. Contraction and relaxation of these muscles result in adduction, abduction and tensing. The vocal folds are two membranous folds each enclosing a narrow band of elastic tissue called vocal ligament which is attached to thyroid cartilage and to vocal process of the arytenoids. In adults, the vocal folds are approximately 20 mm. Anterior 3/5th of the vocal folds are called as membranous and posterior 2/5th of vocal folds is called as cartilaginous. Vocal folds are composed of mucosa and muscle. Vocal fold has five layers such as superficial epithelium, superficial lamina propria, intermediate lamina propria, deep lamina propria and vocalis muscle (Hirano, Kurita, & Sakaguchi, 1989).

Vocal fold vibrations are possible because the vocal folds are located within a fixed laryngeal framework, muscles within the larynx facilitated the vocal fold abduction and adduction, intrinsic laryngeal muscles cause changes in the elastic properties of the vocal folds, affecting their rate of vibrations, and an outgoing airstream also affects the vocal fold vibrations.

Resonatory subsystem

The resonatory subsystem consists of supraglottal, pharynx, oral and/ or nasal cavities and the configuration of resonatory cavity is in F shape. The resonating chamber is to filter and amplify the acoustic signal which was produced at the level of vocal folds. Some areas of the tract, depending on their configuration, are compatible with the periodic vibration coming from the vocal folds and amplify the fundamental frequency and its harmonic. Resonance tube is constantly interrupted at various sites from intrusion and movement of various structures.

Parameters of Voice

The final output of voice is a combination of respiratory activation, phonation, and amplifying resonance. The parameters of voice include pitch, loudness, and quality; these parameters are interdependent of age and gender.

Pitch

The psychological correlation of frequency is called as pitch. The change in the F0 can result in the change in the perception of pitch. The pitch is dependent on the length, mass, and tension of the vocal folds. Pitch decreases as the mass of the vocal folds increase and vice versa. This can be correlated with newborns' or a child's voice as their pitch is very high, approximately 500 Hz (Wasz- Hockert, 1968) in newborn and 240-340 Hz in children (Usha, 1978). This is due to the absence or immature vocalis muscle. As the length of the vocal folds increase, tension increases and mass per unit area reduces, this facilitates in the faster vibration of vocal folds and results in the high pitch as seen in adult females and vice versa in adult males. Thus, the pitch ranges from 180- 240 Hz in adult females and 100- 150 Hz in adult males (Baken & Orlikoff, 2000).

Loudness

Vocal loudness is a perceptual correlation of intensity. As the intensity changes, the listener perceives a change in loudness. The primary biomechanical determinant of intensity is sub glottal pressure, medial compression of the vocal folds and duration, speed, the degree of vocal fold closure. Hixon and Abbs (1980) reported that sound pressure level, the primary factor contributing to our perception of the loudness of the voice, is governed mainly by the pressure supplied to the larynx by the respiration pump. Vocal intensity is likely to increase when the vocal folds are adducted for longer duration. Sodersten, Ternstrom, and Bohman (2005) reported that men were able to phonate louder voice than women suggesting that women may be more vulnerable to damage their voice when confronted with the need to talk loud.

Quality

Voice quality is a perceptual correlation related to the sound of the voice beyond its pitch and loudness (Behrman, 2007). The quality of voice is the factor which discriminates between the persons who has same frequency and intensity. Change in the voice quality tends to change at the glottal source and at the resonant characteristics of the vocal tract of the speech production system (Pershall & Boone, 1987). However, the principle of voice quality is not well understood like loudness and pitch. Voice quality is complicate in nature as it is subjective to judge. Voice acceptable to two listeners is not agreeable to the third person. Hence, there is a considerable debate about which objective measures of voice quality correlate with subjective measures. Hammarberg, Fritzell, Gaufin, Sundberg, and Wedin (1980) reported that the abnormal voice quality are breathy, rough, strained, harsh (combination of strained & rough), or hoarse (combination of strained, rough & breathy).

Voice and Aging

The larynx undergoes changes from birth to adolescence and adulthood and into geriatric years. The changes can be noticed in both internal and external larynx. The pediatric larynx is not a smaller version of the adult larynx as there is considerable difference between them in terms of the position of the larynx, size and configuration of the cartilages, and size and fine structure of the laryngeal vocal folds. The position of the larynx is high in children and after puberty, it tends to lower. The laryngeal framework in children is pliable than in adults. The length and fine composition of vocal folds are quite different in children from adults. The length of the vocal fold in newborn is 2.5 to 3.0 mm and growing rapidly till puberty and reaching an adult length of approximately 17-21 mm in adult males and 11-15 mm in adult females (Hirano, Kurita, & Nakashima, 1983). The membranous part of the vocal fold is in the same length as cartilaginous part in children whereas in adults the membranous part is twice than the cartilaginous part. No vocal ligament is present in newborns and an immature one develops at the age of 1-4 years. The lamina propria is a single layer and two layer starts developing at the age of 6-12 years. As the person moves into the 60s and beyond, structural changes across the physiological systems impact the accuracy, speed, range, endurance, coordination, stability and strength of muscular movements (Chodzko-Zajko, 1997). Some of the age-related changes in the larynx are hardening of laryngeal cartilages, atrophy, and degeneration of the intrinsic laryngeal muscles, degenerative changes in lamina propria, deterioration of the crico-arytenoid joint (Kendall, 2007; Linville, 2001). These changes can lead to what is commonly referred as ‘Presbyphonia’.

Voice disorders

Voice disorders can occur as a result of faulty structure or function of the larynx which results in the change in pitch, or loudness or quality of the voice that is different from what is expected from someone of the same age or sex (Smith, Verdolini, & Gray 1996). Boone, Mcfarlane, Von Berg and Zraick (2010) classified the voice disorders fewer than three kinds based on the etiological factors. The first kind is the organic voice disorders which include any laryngeal structural deviations that affect vocal fold vibration. The second kind of voice disorder is neurogenic voice disorder, related to the neurological condition that causes faulty vocal fold closure from either paralysis (or weakness) or from neurological disease. The third kind of voice disorder is functional voice disorders: psychogenic voice disorders which are caused by psychosocial factors, and muscle tension voice disorders (Muscle Tension Dysphonia), which can develop from excessive muscle usage.

Prevalence of voice disorders

Roy, Merrill, Gray, & Smith (2005) has reported that 7% out of 1, 300 adults had voice problems in U.S population.

In children

It is difficult to address the prevalence of voice disorders in children through indirect assessment methods. Hence, face to face assessment including screening and diagnostic techniques and parent or teacher report methods are used. A number of researchers have concluded that between 6 and 9% of school-age children may have voice disorders (Cornut & Troillet-Cornut, 1995; Carding, Roulstone, Northstone & colleagues, 2006) and prevalence rate may actually as high as 20 to 30% (Boyle, 2000; Faust, 2003; Angilillo, Di Costanzo, Angelillo, Costa, Barillari & Barillari, 2008).

Elderly

According to the U.S Census Bureau (DeNavas-Walt, 2010), there are approximately 40 million persons whose age is 65 years or older, comprising about 13% of the total U.S population. The prevalence of voice disorders in those who is non- seeking population over the age 65 years (Hapner, & Johns, 2006; Golub, Chen, Otto, Roy, Smith, Allen, & Merrill, 2007; Cohen and Turley, 2009) reported that between 20 and 30% of persons completing a survey about their voices having a current voice disorder. The prevalence data reported by Roy and colleagues and Golub and colleagues are supported by the findings of Cohen, Kim, Roy, Asche, & Courey (2012) who reported that adults over the age of 70 years are more likely to develop voice disorders. The risk of elderly person having voice disorder is more if the person is also has hearing loss (Cohen and Turley, 2009).

In teachers

It has been estimated that 5 to 10% of the U.S workforce are "heavy occupational voice users" (Titze, Lemke, & Montequin, 1997). The prevalence of voice disorders in U.S teachers have been studied quite extensively among professional voice users and it has been found that prevalence rate ranging from 4 to 50% or even higher (Roy, Merrill, Thibeault, Gray, & Smith, 2004; Munier and Kinsella, 2008). Most of the studies indicated that the prevalence of voice disorders in teachers is higher than that of the general population (Roy and colleagues, 2004). Even the student teachers also at risk for developing voice disorders. Thomas, Kooijman, Donders, Cremers, & De Jong (2007) compared the incidence of voice complaints in student teachers versus students from nonteaching disciplines and reported that the incident rate is 17% for student teachers' compared to slightly less than 10% of their peers. Timmermans, De Bodt, Wuyts, & Van de Heyning (2005)

reported that student teachers experience significantly more symptoms of dysphonia than their peers. Thomas, de Jong, Cremers, & Kooijman, (2006) reported that 90% of future teachers who experienced voice problems during their education experienced voice problems later in their teaching career. A survey conducted by Boominathan, Rajendran, Nagarajan, Seethapathy & Gnanasekhar (2008) found that 49% of high- and higher secondary Indian school teachers experienced voice problems.

In Speech Language Pathologist (SLP)

SLP are the professionals who also rely on healthy voices. SLPs and those who are under training to become SLPs have high vocal loads as they often use their voices with emotions and in stressful contexts, such as speech therapy, counseling, conferencing and public speaking. Gottliebson, Lee, Weinrich, & Sanders (2007) investigated the voice disorders in 104 U.S student SLPs (94% females) and reported that 12 % had perceptual features of dysphonia in their habitual voices which indicate higher prevalence rate than those of the general population of the students. Shwetha (2009) has reported that prevalence rate of voice fatigue symptoms is about 19% in undergraduate students.

Vocal Loading

One of the common factors to develop voice problem is vocal loading. Loading does not necessarily mean overloading. The definition of physiological loading means to function within the normal limit and overloading means pathological function and tissue damage (Sala, Rantala, and Holmqvist, 2015). The load on voice varies based on the needs and requirements of an individual. The vocal load is thus defined as prolonged use of voice at high-intensity level (Lauri, Alku, Vilkman, Sala, & Sihvo, 1997). It has been observed that even healthy voices show a shift towards hyper functional or pressed type of phonation post vocal loading, and

female is more susceptible to vocal loading than males (Lauri, Alku, Vilkman, Sala, & Sihvo, 1997; Vinturi, Alku, Lauri, Sala, Sihvo, & Vilkman, 2001). An increased in vocal load also leads to a change in the phonation pattern (Gottas & Star, 1993). However, vocal health is imperative for everyone. The effects of vocal loading may also be witnessed when a person interacts with hearing impaired individuals because of the inherent properties of listener's poor hearing sensitivity.

Mothers of children with Hearing Impairment (MHI)

Hearing loss that is bilateral and permanent is estimated to be present in 1.2 to 5.7 per 1000 live births in U.S (Yoshinaga-Itano, Sedey, Coulter, & Mehl, 1998). The children with hearing impairment have poor residual hearing, inadequate speech, and language skills. As soon the child is diagnosed as having hearing loss, the hearing aids are recommended for them. Just providing the hearing aids are not sufficient to develop speech and language skills. As they need to undergo for speech and language therapy after wearing the hearing aid in order to learn the speech and language skills in terms of comprehension and expression. The speech and language therapy appointments are usually two or three sessions per week and each session sustains for about 30 minutes to 1 hour which is not sufficient to learn the language for children with HI. So caretaker plays a major role in carrying out home training for the same things whatever has been taught in the therapy through different activities in an elaborate manner and most of the time the caretakers are 'Mothers' of the children with HI. Mothers of the children with HI abuse their voice by increasing the loudness, varying the pitch and exaggerate articulation while doing home training. Psycho-emotional factors like stress and anxiety are also reported to be prevalent among the mothers of children with HI during the process of their child rehabilitation (Quittner, Glueckauf, & Jackson, 1990; Quittner, 1991; Lederberg &Golbach, 2001; Pipp-

Siegel, Sedey, & Yoshinaga- Itano, 2002; Hintermair, 2004; Meadow-Orlans, Spencer, & Koester, 2004). For these reasons, mothers of children with hearing impairment are unique in their susceptibility to develop voice problem or disorder as the prevalence of voice problems was 26% among mothers of children with hearing impairment than the mothers of children with other communication disorders (Shabnam, 2012).

Prevalence of voice problem in MHI

Shabnam (2012) compared the prevalence of voice problems between mothers of children with HI (MHI), mothers of children with other communication disorders (MCD) and mothers of children with typical developing (MTD) and also examined the risk factors that cause voice problems. The study consisted of 150 MHI, MCD (50 Mental Retardation + 50 Autism Spectrum Disorders + 50 Delayed Speech and Language) and 150 MTD within the age range of 21-40 years with the mean age of 27.29 years. A questionnaire was used which consisted of questions related to vocal symptoms, medical conditions, socio-demographic characteristics, and vocal health-related factors. In addition, questions which exclusively inquired were the duration of rehabilitation, number of hours of training at home in a day, presence and frequency of loud talking, presence of articulation problems, presence of vocal abusive behaviors, presence of exaggerated speaking, presence of stress at the end of the training session and number of therapy sessions missed due to presence of voice problem and so on. In addition to this, questions related to the duration of amplification, type of amplification device used by the child, type of intervention, mode of communication used by the child, duration of hearing aid usage in a day were also asked from MHI. The authors found that the prevalence of voice disorder was 26 % among MHI, 10% among MCD and could not estimate among MTD since none

were reported of voice problems. Furthermore, the author reported that mothers of children with HI who use speech as a mode of communication, having physical stress at the end of training their child and the year of amplification is <2 years are more likely to develop voice disorder. A higher percentage of mothers of children with HI reported of including in frequent vocal abuse and misuse behaviors compared to mothers of children with other communication disorders.

Also, 4.5% of mothers of HI missed speech therapy sessions as a result of their voice problems. 6.4% and 0.6% among MHI and MCD, respectively sought the help of a general physician while 2.9% and 2% of MHI and MCD, respectively sought help from an ENT.

Psycho-emotional parameters

Stress is associated with life satisfaction and also the development of some physical diseases. Birth of a disabled child with mental, physical disability or deafness imposes an enormous load of stress on the parents especially the mothers. Aliakbari Dehkordi, Kakojoibari, Mohtashami, & Yektakhah (2011) compared stress levels in mothers of children with HI and mothers of children with typically developing or other disability. 120 mothers in four groups of having a child with mental retardation, low vision, hearing impairment and typically developing children were considered for the study and Family Inventory of Life Events (FILE) scale was used to determine the level of stress. The authors found that there is significant difference between stress levels of mothers of children with hearing impaired, mothers of other disabled and normal children in the subscales of intra-family stress, finance, and business strains, the stress of other job transitions, the stress of illness and family care. The authors concluded that since the deafness is the hidden disability, the child with hearing

impairment has set of social and educational problems causing great stress on parents, especially to mothers.

Teachers

Van Houtte, Claeys, Wuyts & Van Lierde (2011) investigated the knowledge of teachers on vocal care, treatment seeking behavior and voice related absenteeism in 994 participants in the age range of 21-65 years with the mean age of 36.5 years. Using a questionnaire which consisted of questions related to ear, nose and throat symptoms, vocal complaints and physical comfort on visual analog scale (VAS). The authors found that more than the half of them (51.2%) had suffered from vocal complaints at some point during their career in teaching and this confirms that teaching is a profession with high vocal demands. Female teachers (38%) suffered significantly more than male teachers (13.2 %) because the woman has shorter vocal folds and produce voice at a higher fundamental frequency. Consequently, there is less tissue mass to dampen a larger amount of vibrations and at the molecular level, women have less hyaluronic acid in the superficial layer of the lamina propria.

Schloneger (2011) documented graduate voice students' voice use before, during and after an intense week of opera rehearsals through APM, daily survey, activity logs, singing voice Handicap Index and stroboscopic laryngeal examinations. The author examined 2 female graduates and both of whom also served as graduate teaching assistants in voice. Monday to Friday was selected for dosimeters monitoring before the opera production week and APM units for an average of 10-14 hours each day over the course of 9 monitoring days. Participants wore APM for 3 study periods consisting of two baseline days before the intensive rehearsal week (such as opera singing, other singing, teaching, and non- rehearsal), 5 days during the intensive rehearsal week and 2 baseline days during the week immediately after the opera

production's completion. The parameters measured using APM were F0, SPL, time dose and distance dose. The authors found that mean phonation time or time dose percentage and daily distance dose average were similar between the pre and post-test periods and intensive week and also the results indicated that these singers were conscious about their voice use during extensive performance demands. Limitation of the study was small sample size, although F0 and SLP values were given in the results which were not discussed elaborately in the study.

Gaskill, O'Brien, & Tinter (2012) used voice dosimeter to study the impact of using portable voice amplifier on vocal dose parameters over three weeks of duration. The study was done in two phases. In phase 1, voice survey was carried out for 300 elementary school teachers using voice- related quality of life (V-RQOL) and the authors found that the 13% of teachers reported that they could not attend their work due to voice related complaints and 11% of the teachers were asked help for the voice complaints. In phase 2, two participants were considered from Phase 1, teacher-I aged 54 years who reported a history of voice related complaints, teacher-II aged 52 years who did not report any complain about the voice and both the teachers has thirty years of teaching experience. The parameters measured were F0, loudness, phonation time, cycle dose and distance dose in the study. Initially, the participants were asked to wear the voice dosimeter for 1st week and during the second week the participants were asked to use the personal voice amplification device. There was a significant reduction in loudness when they were using amplification. However, the effect was generously proportioned in teacher-I. The teacher I also showed a decrease in distance dose regardless of incurring greater phonation time. F0 and cycle dose did not exposed to be affected by the use of amplification throughout the teaching day and both the teachers showed indication of possible moderate effect of correcting their

loudness in the 3rd week following amplification, probably as a means to recalibrate their perceived vocal loudness. The authors concluded that the helpfulness of both vocal dosimeter and amplification in monitoring and modifying vocal dose parameters in an occupational setting. However, the generalization of the phase 2 results is questionable due to very limited number of participants in the study.

Remacle, Morsomme and Finck (2014) aimed to provide quantitative data on daily voice use to determine the differences between professional and non-professional vocal load. There were 32 Belgian-French speaking teachers (12 kindergarten and 20 elementary school teachers) in the age range of 25-58 years were recruited for the study where APM was used for measurement of the vocal load. The parameters studied were F0 mode, F0 average, SPL average, time dose, cycle dose and distance dose. Data collected over a period of 160 days were analyzed. The authors manually separated the professional and non-professional voice use for each day on the basis of diary completed by each participant. To compare professional and non- professional teacher's voice use, a paired student's t-test was performed. All the parameters measured were significantly higher in professional use than non-professional use. The higher F0 and SPL found in the professional environments could be due to the loud background noise, acoustic convergence behavior or accommodation and fewer opportunities for voice rest at school. The authors found that the vocal folds collided with each other more than 1 million times a day at work, plus an additional half million times after work. The distance travelled by the vocal folds were, on average 4 km at work, plus an additional 1 km after the work. Limitations of the study were teaching experience of the participants was not taken into consideration, the age range was very wide and authors could have made a

comparison between the elementary and kindergarten school teachers in terms of professional and non-professional voice use".

Echternach, Nueck, Dippold, Spahn & Richeter (2014) analyzed vocal effort while teaching lesson using vocal loading test (VLT) in 101 vocally healthy student teachers (74.3% females and 25.7% males) with the mean age of 26.7 years (SD 2.8 years), Subjects were asked to read the standardized German text over for 10 min time frame louder than 80 dB which were measured at a distance of 30 cm from the mouth and VLT was done using Ling Waves software. VoxLog system including an accelerometer during a real teaching lesson for about 45 minutes for the duration of 7 days and vocal doses were measured from this, such as time dose, cycle dose and distance dose and radiated energy dose. Independent t-test and dependent t-test were used for statistical analysis. The authors found that all the subjects were able to sustain the VLT and there were no stoppages before the end of the vocal loading. The VoxLog data showed that the VLT was associated with higher F0, greater sound pressure level and a higher phonation time in the real teaching lesson. Vocal dose measurements exhibited no significant difference between the VLT and the teaching lesson; however radiation energy dose was greater while performing the VLT. Limitations of the study were only healthy subjects were included and vocal doses during the teaching condition might be individualistic and dependent on many factors such as a number of pupils, the room acoustics, and teaching subjects.

Rajasudhakar & Savithri (2009) quantified the amount of voice use on a single working day in a primary school teacher and measured the changes in acoustic parameters of voice such as mean F0, SD of F0 and mean jitter using a portable, light-weight digital audio tape (DAT) recorder. A normal 32-year-old adult female teacher who teaches Kannada, Environmental science and Mathematics courses to second and

third-grade children was considered by the authors. The stroboscopic evaluation was done before the voice recording to ensure normal vocal fold vibration, the amplitude of vocal vibration, quality of mucosal wave and glottis closure. The recording of voice samples was done on a normal working day (Monday) for six hours and the subject was asked to maintain a log sheet where information about vocal activities throughout the day was noted. Sustain phonation of /a/ sound was recorded for four times, i.e. before the first class, after the first class, after the lunch, and after the last class. CoolEdit and PRAAT software were used for analysis of the sample. The authors found that the total voicing time was 6568.94 sec (99.99 %) in which 5479.99 sec (83.42%) during work and 1088.95 sec (16.57 %) during the non-teaching time. The teacher's vocal folds were vibrating a cumulative average of 31.46% during work time. This indicates that the teacher in this study used her voice excessively, vigorously within the short period of 6 hours and the voice usage was maximum at classroom setting where the teacher prolonged, raised her voice loudly for a long period in the presence of background noise to make every student heard. The F0 was increased by 7.24 Hz towards the end of the day and this might be caused by the speaker compensatory reaction to alterations in their voice. The SD of F0 was increased by 1.02Hz than baseline and this may be indicative of instability of laryngeal function caused by impaired coordination of vocal fold movements. The jitter value also increased from starting of the day to end of the day by 0.84%. However, it was a single case study and it cannot be generalized.

Rajasudhakar and Sachin (2010) aimed to measure and document three vocal doses such as time dose, cycle dose and distance dose using APM in eight primary school teachers in the age range of 23-58 years from private and government schools whose teaching experience varied between 2- 35 years. The APM was acquired and

recorded from 9:00 a.m to 5:00 p.m from Monday to Friday consecutively and log sheet was given to the teacher to note down about their voice use. The results revealed a trend that is increasing the percentage of time dose from Monday to Friday and the average time dose was 21%. The time dose values are higher for private school teachers than the government school teachers, this could be due to the private school teacher working hours is more than the government school teachers. The average cycle dose was 1130434 and it was gradually reduced from Monday to Friday because of vocal fatigue effect. It depends on the nature of work, teaching methodologies, a number of courses taught and experience. The cycle dose was higher in private school teachers than in government school teachers. The authors reported that the average distance dose was 9248 meters across eight teachers. It is mainly dependent on the intensity of the voice, as louder voice has the larger displacement of vocal folds on the oscillation path thereby higher the distance the vocal fold travels.

Speech Language Pathologist (SPL)

Gottliebson, Lee, Weinrich, and Sanders (2007) studied a set of 104 students, in their first year of graduation who were training to be SLPs in two universities, in order to determine their voice problems. The participants were initially assessed using the Quick Screen for Voice. Those participants who were seen to have failed during the screening procedure were required to complete a questionnaire regarding voice problems, medical history, daily habits, and voice use. An endoscopic examination was carried out if the responses on the questionnaire indicated presence of voice problems in these participants. Fourteen percent of the participants failed in the screening as they had two or more abnormal voice characteristics such as glottal fry, juvenile resonance, hoarse, breathy, or strained phonation, abnormal low pitch on sustained vowels, and voice breaks during the frequency range. Twelve percent of the

104 participants failed both the screening and follow-up questionnaire as reported of self-reported dysphonia, medical history with voice-related side effects, difficulty with excessive voice use, and voice problems occurring daily or weekly. The endoscopic evaluation revealed that one of the participants presented with bilateral vocal nodules. Thus, the authors speculated that the voice problems among future SLPs (12%) are more common than in the general population (3-9%). However, the authors concluded that future SLP's voice problems are less frequent than those reported among education majors (21%) and all college students (17%).

Shwetha (2009) studied the prevalence of vocal fatigue symptoms, voicing periods and short-term vocal recovery index (Is) in SLP students. She examined 74 B.sc (Speech and Hearing) students randomly in the age range of 18-22 years and questionnaire was used to study the prevalence of Vocal Fatigue, 5 of the students in which 1 male and 4 female who provided at least 4 therapy sessions per day for children with developmental disorders were considered in the study. A portable light –weight digital audio tape recorder was used. Adobe audition and PRAAT software were used for analysis. The result indicated that vocal fatigue was reported by 19% of the SLP student. Percent voicing duration in the subjects of the study was 52%-69%, this could be due to the students most of the time work with children with communication disorders who were beginning stage of the therapy. There was no change in mean, maximum and minimum F0 across days and between pre and post therapy sessions. However, mean and maximum F0 increase from pre to post therapy sessions in all subjects, this could be due to increasing loudness tend to increase F0 in order to draw the attention of the child. The 'Is' varied from 0.33-0.47 and this shorter short term recovery index indicated the vocal folds likely to have injured. Limitations of the study were, authors could have used state of art gadget to measure the vocal

loading like APM and participants experience could have been considered as a factor and sub-grouped them based on the experience in order to see the change in vocal fatigue across the groups.

Warhurst, Madill, McCabe, Heard, and Yiu (2012) investigated the production of a clear voice in speech pathology students using acoustic and auditory-perceptual analyses in Forty-one first year (beginning) female student SLPs whose age range are within 17–25 years. All tasks were audio recorded in a soundproof booth using a C420III cardioids microphone (AKG Acoustics, Vienna, Austria), placed 5 cm from the student's mouth. There were no differences in the distribution of vocal clarity between student cohorts and the voice conditions. The graduating students' voices had significantly less jitter and shimmer than the voices of the beginning students. No significant differences in the acoustic measures were found between the two voice conditions. Clear voices had a significantly higher harmonic-to-noise ratio (HNR) and lower jitter (%) and shimmer (%) than unclear voices. The graduating student SLPs did not produce perceptually clearer voices than the beginning student SLPs. The students' performance voices were not perceptually clearer than their habitual voices. The perceptually clear voice was associated with significantly higher HNR (dB) and lower jitter.

Voice disorders in general population

Hillman, Heaton, Masaki, Zeitel and Cheyne (2006) determined the impact of dysphonia severity on the accuracy of accelerometer-based estimation of vocal function in 6 normal subjects which comprised of 3 males and 3 females and 18 patients with voice disorders. The dysphonic group has divided into three groups such as mild, moderate and severe and each group consisted of 3 males and 3 females. The simultaneous recording was made of oral acoustic and neck skin acceleration signals

as subjects performed speech task in a sound-treated room. The oral speech signal was recorded from a headset- suspended microphone (Sennheiser MK E2) and vocal folds vibrations were recorded from miniature accelerometer (model BU7135, Knowles Electronics, Inc, Itasca, Illinois). The speech task included sustained phonation of /a/ and reading a rainbow passage and a monolog were used to measure the parameters such as phonation time, fundamental frequency and sound pressure level. Descriptive statistics and t-test were used to compare the voice measures between accelerometer and microphone based signal and autocorrelation method was used to calculate F0. The magnitude of phonation time difference between the two methods clearly increased with increase in the level of dysphonia severity. There was no statistically significant difference was found in F0 between two methods. The average error magnitudes for vowel-calibrated data showed a tendency to overestimate the average sound pressure levels of mildly to severe dysphonia monolog speech. There was a steady increase in the amount that the accelerometer-based measures exceeds the microphone based measurements as the level of dysphonia increased from mild to severe because of increase in aperiodic energy.

Ghassemi et al. (2014) differentiated vocal hyper function (Vocal Nodule) from the normal pattern of vocal behavior using non- invasive ambulatory measures (smart phone) in 12 pair of trained adult singers. All the participants were females with an average age of 21.6 years. All the subjects were monitored for one week during waking hours. The parameters measured were F0, SPL, time dose, cycle dose and distance dose. The authors found that there was no significant difference in phonation time between the vocal nodule and normal groups. The subjects with vocal fold nodule had higher F0 and SPL and deviation from their baseline as their monitoring period progressed, possibly reflecting increased difficulty in producing the

phonation. Vocally normal group also had an increase in their F0 and SPL but the values are within the range of baseline. However, it is not possible to determine the extent to which differences observed in the vocal behavior of the patients with vocal nodules preceded or followed the information of nodule. Limitations of the study are periods of singing, duration of monitoring per day were not mentioned and mentioned parameters such as cycle dose and distance dose were not discussed in the results or in the discussion section.

Lien et al. (2015) studied the use of neck-skin acceleration for relative fundamental frequency (RFF) analysis. The control group comprised of 20 adults in which 18 women and 2 men aged 18-87 years and the experimental group comprised of 40 adults with voice disorder in which 35 women and 5 men aged 18-75 years. Among 40 adults with voice disorders 21 had been diagnosed as a vocal polyp, cyst, nodule and remaining were diagnosed as muscle tension dysphonia by a board-certified laryngologist. Two sets of different models of the same equipment were used for recording such as Sennheiser PC 131 and MKE104 for headset microphone and Knowles BU-21771 and BU-27135 for the miniature accelerometer. The stimuli consisted of four sentences and three uniform utterances and each sentence loaded with three voiced-voiceless- voiced instances. The RFF was estimated from the microphone and accelerometer and PRAAT was used for analysis. Tuckey's test was used for post hoc analysis. RFF estimated from the accelerometer was found to be just as reliable as that derived from the microphone. The mean RFF values in voice disorder group were lower than healthy voice group. The authors concluded that microphone is widely accessible in clinics but using neck-placed accelerometers can help to overcome noisy test environment. The limitation of the study was that

recording length was lesser than 5 minutes per participants and Lombard effect was not explained.

Van San, Mehta, Zeitels, Burns, Barbu & Hillman, (2015) aimed to determine the significant differences in voice use between patients with phonotraumatic vocal lesions across 1 week and normal matched controls across 1 day using Smartphone-based APM over 14 hours per day. The authors examined 70 adult females in which 35 of them with vocal fold nodule or polyps and 35 of them were age, sex and occupation matched normal individuals. Parameters measured were F0, SPL, cycle dose, distance dose and time dose. Paired t-test and Kolmogorov-Smirnov tests were used for statistical analysis. The authors found that no statistically significant differences between patients and their age-matched controls regarding average measures of SPL, F0, and vocal doses. The lack of difference might be due to the compensatory effort by the pathological group to maintain normal values for these parameters in the presence of vocal pathology. Phonotraumatic lesions appear to employ phonatory adjustments that maintain vocal SPL and Vocal dose measures are based on the estimation of vocal fold vibration rather than the vocal fold contact patterns. F0 variability between the groups resulted in statistically significant differences with moderate effect sizes. The limitation of the study was that no information regarding in which condition or situation the data was collected in the study.

To conclude, studies have been done to investigate the prevalence of voice disorder in MHI, mental stress in MHI, vocal loading in professional voice users and disorder population. However, till date, no studies have documented the voice use profile of mothers of children with hearing impairment using APM software to

quantify the vocal folds vibratory behaviors to our knowledge while teaching (in structured method). Hence, the objectives of the present study are:

- ✓ To measure and document F0 mode, F0 average, SPL average, time dose, cycle dose and distance dose in MHI.
- ✓ To measure and document F0 mode, F0 average, SPL average, time dose, cycle dose and distance dose in MNH.
- ✓ To compare F0 mode, F0 average, SPL average, time dose, cycle dose and distance dose parameters between MHI and MNH.

CHAPTER III

METHOD

Participants

The purpose of this study was to document and compare the voice use profile parameters between mothers of children with hearing impairment and mothers of children with normal hearing using the APM software. For this purpose, two groups of participants were participated in the study. Group-I consisted of ten mothers of children with hearing impairment (MHI) and Group-II consisted of ten mothers of children with normal hearing (MNH). The participants were within the age range of 25 to 35 years.

Inclusion criteria for Group - I

- Ten mothers in the age range of 25-35 years who had children with hearing impairment have participated in the study, where the children's hearing loss varied between severe to profound loss and who were the users of binaural behind the ear hearing aid.
- It was ensured that children were using hearing aids at least for 1 year in duration and attending speech and language therapy at least for 6 months to 1 year.
- It was also ensured that the mothers of children with hearing impairment were free from sensory problems such as hearing loss and vision loss, motor speech disorders such as dysarthria or apraxia of speech, and other communication disorders.
- Participants without any history of chronic smoking and alcohol consumption, intubation, neurological disorders, systemic illness, and surgery /accident / trauma related to the head and neck were included in the study.

- Further, to be included in the study, the participants had to be free from upper respiratory tract infections or allergies on the days of testing.

Table 3.1

Details of the participants in group-I

S.No	Mother (M)	Mother's Age	Child's Age/ Gender	Duration of Amplification use	Duration of therapy attended
1	M1	28 years	5 years/ Male	3 years	2.6 years
2	M2	28 years	7 years/ Male	2.2 years	2 years
3	M3	25 years	6 years/ Female	1.6 years	1 year
4	M4	30 years	6 years/ Female	2.6 years	2 years
5	M5	33 years	4 years/ Female	3 years	1.6 years
6	M6	29 years	4 years/ Female	2 years	1.2 years
7	M7	28 years	6 years/ Male	2 years	2 years
8	M8	27 years	4 years/ Female	1.6 years	1.6 years
9	M9	30 years	7years/ Male	2.4 years	1.9 years
10	M10	26 years	5 years/ Female	1.8 years	1.4 years

Mean age of mothers=28.4 years & mean age of children= 5.4 years

Inclusion criteria for Group - II

- ✓ Ten mothers in the age range of 25-35 years who had children with normal hearing participated in the study.
- ✓ It was ensured that the participants were free from sensory problems such as hearing loss and vision loss, motor speech disorders such as dysarthria or apraxia of speech, and other communication disorders.
- ✓ Participants without any history of chronic smoking and alcohol consumption, intubation, neurological disorders, systemic illness, and surgery /accident / trauma related to the head and neck were included in the study.

- ✓ Further, the participants had to be free from upper respiratory tract infections or allergies on the day of testing.

Table 3.2

Details of the participants in group-II

S. No	Mother	Mother's Age	Child's Age/ Gender
1	M1	25 years	6 years/ Female
2	M2	30 years	5 years/ Female
3	M3	28 years	5 years/ Female
4	M4	32 years	6 years/ Female
5	M5	28 years	7 years/ Female
6	M6	28 years	5 years/ Female
7	M7	27 years	4 years/ Male
8	M8	26 years	3 years/ Male
9	M9	32 years	6 years/ Female
10	M10	30 years	6 years/ Female

Mean age of mothers= 28.6 years & mean age of children= 5.3 years

Common criteria

1. Children language age was relatively matched between the groups.
2. Mothers' native language was Kannada.

Test material: Colorful and age appropriate flash cards were used to teach concepts such as action verbs, colors, and prepositions by MHI and MNH. The three set of flashcards included action verbs such as sleeping, brushing, eating, drinking, and walking were used. The six set of flashcards consisted of colors like white, black, and red and the four set of flashcards on prepositions that include 'on, under and front' were used as materials.

Instrumentation

"Ambulatory Phonation Monitor (APM) software (Model 3200, KayPENTAX, Lincoln Park, New Jersey, USA)" was used in the study. It is a portable, commercially available and widely used device to measure the vocal loading objectively over a full day of normal activity. APM is a computer compatible software and hardware system. It measures the amount of time a person phonated, when phonation occurred, it estimates the vocal intensity and fundamental frequency. It consists of an accelerometer, which is small rectangular metal encasement (.33 x.15 inches; 84 x 56 38 mm) mounted on a round silicone pad with a cable attached to it and the opposite end of this cable is the connector which plugs into APM. The accelerometer has adhered to the anterior base of the neck just above the Sternal notch of the participants, and it deliberated the vibrations from the skin. The APM has maximum monitoring time of 12 hours and frequency response of the throat sensor is 25- 7000 Hz. The dynamic range of the sensor is about 42.1 dB and the sample rate (acquisition mode) is 20 samples/ seconds. The weight of the hardware module is <2lbs (without batteries) and the size is 45.4 mm H x 95 mm W x 158 mm D. It gives the information about the phonation over a period and was not affected by the background noise.

Calibration: According to the manufacturer's directions, calibration procedure was completed before initiating data collection to ensure that the accelerometer was calibrated for sound pressure level (SPL) measurement to reliably convert to SPL measurement from accelerometer to PC. The unidirectional microphone supplied with the APM unit has a 15-cm metal spacer rod that rests above the upper lip when the microphone is held in front of the mouth. For calibration, each participant phonated on a continuous /a/ vowel from the softest to loudest vocal production in one breath.

The calibration was accepted by the APM software (KayPENTAX, Lincoln Heights, NJ) if 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

For all the children who were participated in the study, Receptive and Expressive Language Test was administered by qualified Speech Language Pathologist (SLP) in order to find out the language age of the children and then it was matched between the groups. The mothers in both the groups were explained about the objectives of the study and the tasks to be carried out in the session. Written consent was obtained from all the participants, which is shown in Appendix.

Figure 3.1. Ambulatory Phonation Monitor (APM) gadget a) connection between throat sensor and APM hardware module; b) APM has worn by a participant in the waist pack. c) APM- hardware module, throat sensor, Vibro- tactile unit, adhesive glue and glue remover, PC connector.

Figure 1 shows the APM hardware unit and accessories and a subject worn the device. The participants were made to sit comfortably on a chair and the throat sensor

(accelerometer) was adhered on the throat (above the Sternal notch) with 3M Transpore plastic tape. The throat sensor along with hardware module was connected to a PC where the APM was installed. After the connection, the APM was subjected for calibration. After the 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 data collection. The mothers were asked to sit in a sound treated room comfortably with their children and teach the concepts using 3 set of flashcards of action verbs and 6 set of flashcards of colors on the 1st session, 3 set of flashcards on action verbs and 4 set of flash cards of prepositions on the 2nd session and 2 set of flashcards of action verbs, colors and prepositions on the 3rd session. Mothers were instructed to ask questions about the concepts which were taught to the children in the session to make sure the children understand the concepts. Each session was sustained for about 45 minutes and those three sessions were spread over on three different days. After every 45 minutes of the session, the throat sensor was removed from the participant and the hardware module was connected to the PC where the data was transferred to the PC. The average of three session's vocal loading parameters was considered 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 six parameters in a word document, which are required, and the same was saved on the PC. The following parameters were extracted for analysis:

1. ***F0 mode:*** The most number of times a particular fundamental frequency (F0) occurred in phonation/ speech over the duration of monitoring.

2. ***F0 average:*** It is an average fundamental frequency (F0) over the duration of monitoring.
3. ***SPL average:*** It is an average sound pressure level (SPL) of the voice over the duration of monitoring.
4. ***Time dose:*** It is the total phonation time, measured in seconds. The Phonation time is the total time that the vocal folds are vibrating.
5. ***Cycle dose:*** It is the total number of cycles accomplished by the vocal folds on the vibratory trajectory.
6. ***Distance dose:*** It is the total distance travelled by the vocal folds

Statistical analysis

Analyses were done using Statistical Package for Social Sciences 20.0 (SPSS, Inc., Chicago, IL) software. Descriptive statistics were carried to calculate the mean, median, and standard deviation for the measured six parameters for each group. All the measured parameters were subjected to testing of normality using SHAPIRO-WILK's test of normality. There were only four parameters (F0 Mode, F0 Average, Time Dose and Cycle Dose) met the normality criteria, so the parametric test (Independent two sample t-test) was done to see the significant difference between the groups and other 2 parameters (SPL Average and Distance Dose) did not meet the normality criteria, hence, non-parametric test (Mann-Whitney U test) was done to see the statistical significance between the groups.

CHAPTER-IV

RESULTS

The present study is aimed to document and compare the voice use profile parameters in MHI and MNH. A total of twenty participants in the age range of 25-35 years participated in the study and the participants were grouped into two as group-I consisted of ten MHI and group-II consisted of ten MNH. The voice use profile parameters were measured using APM software such as F0 mode, F0 average, SPL average, time dose, cycle dose and distance dose for 45 minutes duration of three sessions on three days. After every session of therapy, the parameters were extracted from the APM device and saved. The values of these 45 minutes therapy sessions were averaged for each subject in both groups. Thus, obtained values were tabulated and subjected to statistical analysis using SPSS software (20.0 version).

Descriptive Statistics

The mean and standard deviation of six parameters were calculated for both the groups which are shown in table 4.1. The mean for all the parameters namely F0 mode, F0 average, SPL average, time dose, cycle dose and distance dose in group-I were higher when compared to group-II.

Table 4.1

Mean and Standard deviation (SD) of six parameters in Group-I and II

Parameters	**Group-I**		**Group-II**	
	Mean	SD	Mean	SD
F0 mode (Hz)	226.40	34.31	207.46	16.49
F0 average (Hz)	271.13	33.44	216.26	15.41
SPL average (dB)	76.84	5.29	63.68	4.98
Time dose (%)	30.24	6.08	11.47	5.54
Cycle dose (Cycles)	251529.54	80266.54	58989.13	27992.12
Distance dose (Meters)	1136.26	426.61	191.52	170.66

Statistical tests were used to check the significant difference between groups on six parameters. Independent two- sample t-test was done for comparison of parameters between group-I and group-II. There was a statistically significant difference was found for F0 mode, F0 average, time dose and cycle dose between group-I and II at 0.01 levels. That is, the parameters like F0 mode, F0 average, time dose and cycle dose were significantly higher in group-I compared to group-II. Table 4.2 shows the results of the Independent 2 sample t-test for group comparison of four parameters.

Table 4.2

Results of Independent two- sample t-test for group comparison (for 4 parameters)

Parameters	**df**	**F**	**Sig**
F0 mode	18	0.651	0.01*
F0 average	18	16.068	0.01*
Time dose	18	11.406	0.01*
Cycle dose	18	9.553	0.01*

**p<0.01*

From table 4.1, the mean values of SPL average and distance dose were higher in group-I compared to group-II. Mann- Whitney U test was done to compare the results between group-I and II for the 2 parameters namely SPL average and distance dose. The results revealed a statistically significant difference between the group-I and-II in both SPL average and distance dose parameters at 0.01 levels. That is, the SPL average and distance dose parameters were significantly higher in group-I than group-II. Table 4.3 shows the results of Mann-Whitney U test for group comparison of 2 parameters.

Table 4.3

Results of Mann- Whitney U test for group comparison (2 parameters)

Parameter	**Median**	**/Z/**	**Asymp. Sig**
SPL average (dB)	69.09	3. 447	0.001*
Distance dose (meters)	543.16	3.780	0.000*

*p<0.01

To summarize the results, there were six parameters measured in the study namely F0 mode, F0 average, SPL average, time dose, cycle dose and distance dose in

the both groups. Results of the statistical tests revealed that all the 6 measured parameters (vocal use profile) were significantly higher in group-I (Mothers of children with HI) compared to group-II (Mothers of children with normal hearing).

CHAPTER-V

DISCUSSION

The primary objective of the study present was to measure and document voice use profile in mothers of children with HI (MHI) and mothers of children with normal hearing (MNH), respectively in a controlled therapy situation. Further, the secondary objective of the study was to compare voice use profiles parameters between MHI and MNH.

The present study is an exploratory study done to document and compare the vocal loading parameters in MHI and MNH. As per our knowledge, ours is the first attempt to document and compare the vocal loading parameters in the mothers' of children with HI and normal hearing.

The results of the present study are discussed under the following headings:

a) SPL average
b) F0 mode and F0 average
c) Time dose
d) Cycle dose
e) Distance dose

a) ***SPL average***

The SPL average is an average sound pressure level (SPL) of the voice over the duration of monitoring and the results revealed that the mean value of SPL average was higher for MHI (77 dB) than MNH (64 dB), owing to the reason that MHI spoke/ taught their children by increased loudness and excessive vocal stress compared to MNH because of inherent properties of the children with HI. The similar finding was reported by Terasa and Díaz-Román (2015) as the parents of ADHD children had habitually increased excessive loudness than the controlled group and

Shabnam (2012) reported that vocal stress was considered to be higher in 42% of mothers of children with hearing impairment than mothers of children with other communication disorders (26%).

b) F0 mode and F0 average

F0 mode is the most number of times a particular fundamental frequency occurred in phonation/ speech over the duration of monitoring and F0 average is an average fundamental frequency (F0) over the duration of monitoring. The results revealed that the mean value of F0 mode and F0 average were higher for MHI (226 Hz & 271 Hz, respectively) than MNH (207 Hz& 216 Hz, respectively). The higher pitch in MHI (group-I) can be attributed to the reason that exaggerated speech and excessive intonation variations in order to grab the attention of children with HI. The results of the present study is in consonance with the findings of Titze et al. (2003) who reported that the vocal loading was greater for exaggerated speech than for normal or monotone speech. Shabnam (2012) reported that MHI group used exaggerated speaking strategy with their children than mothers of children with other communication disorders (MCD). Shwetha (2009) reported that increase in vocal load and increase in loudness tend to increase in F0.

c) Time dose

The time dose is the total time that the vocal folds are vibrating and the present study found that the mean value of time dose was significantly higher for MHI (20.24%) than MNH (11.47 %). The possible reason for the higher time dose in MHI (group-I) can be excessive talking, excessive repetition of the same information and more elaboration of the information on concepts in order to make the children with HI to understand.

d) Cycle dose

Cycle dose is the total number of vocal folds vibrations/ cycles achieved on oscillatory trajectory and the results revealed that the mean value of cycle dose was higher for MHI (251530 Cycles) than MNH (58989 Cycles). The probable reason for the higher cycle dose in MHI (group-I) could be excessive vibration of the vocal folds. As motioned earlier, the mean value of the time dose was higher for MHI; hence, the cycle dose was also higher.

e) Distance dose

The distance dose is the total distance travelled by the vocal folds and the present study found that the mean distance dose was higher for MHI (1136.26 meters) than MNH (191.52 meters). Rajasudhakar and Sachin (2010) reported that the distance dose parameter is dependent on the loudness, as the loudness of the voice has a larger displacement of vocal folds on the oscillation path thereby higher the distance the vocal folds travels.

It is known that, one must alter the verbal expression while communicating with a person who is suffering from sensory loss (e.g. Hearing impairment).Usually, the level at which one speaks tend to increase the loudness so that the intended message reaches the hearing impaired individuals audibility level. Hence, increase in loudness simultaneously brings about increase in pitch too (Seikel, King & Drumright, 2015).

Higher pitch indicates that the vibration of vocal folds is more. Also, increased loudness indicates that the displacement of vocal fold is more while vibrating. Owing to the above reasons, the cycle dose and distance dose were higher in MHI (group-I) than MNH (group-II). In general, MHI tend to speak/ teach more by repeating the

concepts to make it clear for better understanding. This lead to the increase in the time dose in MHI compared to MNH.

A statistically significant difference was found between MHI and MNH in all six parameters, as MHI were excessive and vigorous in talking/ teaching with their children in order to stimulate them in terms of comprehension and expression of the language skills than MNH. The similar findings were reported by Terasa and Díaz-Román (2015) as the parents of the ADHD group spoke more frequently faster and more forcefully than parents of the control group.

By having more values on voice use profile parameters in MHI group, it hints that they are misusing or abusing their voice (when compared with MNH). This would result in developing voice problems in the long run. The results of the present study supports the findings of Shabnam (2012) who reported that MHI group had an increased frequency of vocal abuse and misuse behaviour than the MCD.

CHAPTER-VI

SUMMARY AND CONCLUSION

The present study aimed at measuring vocal loading parameters in mothers of children with hearing impairment (MHI) and mothers of children with normal hearing (MNH) and to compare the same between the groups in a controlled therapy sessions. Two groups of subjects participated in the study where group-I consisted of 10 MHI and group-II consisted of 10 MNH.

The vocal loading parameters measured in the study were F0 mode, F0 average, SPL average, time dose, cycle dose and distance dose using Ambulatory Phonation Monitor software, while mothers teaching few concepts namely action verbs, colors and preposition to their children for 45 minutes of duration in a sound treated room on three days. The mothers were engaged in teaching concepts such as action verbs, colors and preposition to their children. The accelerometer based APM data was transferred into the computer memory and measured parameters were averaged.

The results of the present study revealed that the voice use profile parameters like F0 mode, F0 average, SPL average, time doe, cycle dose and distance dose were higher in mothers of children with hearing impairment (group-I) compared to mothers of children with normal hearing (group-II). Hence, the null hypothesis taken in the study was rejected.

From the above findings, it can be concluded that mothers of children with HI use their voice more often and excessively than mothers of children with normal hearing and they are more prone to develop voice problems over a period of time.

Implications of the study

The result of the present study would be used in counselling the MHI about the over use and abuse of voice to avoid phonotrauma. It helps in planning tailor-made vocal hygiene programs for MHI. Clinically, the results could be considered as baseline measures of voice use profile in MHI, particularly in connection with teaching concepts/ situation. Also, the voice use profile augments the voice clinician's knowledge about the understanding of vocal loading demands and its effects on voice in MHI.

Limitations of the study

- Vocal fatigue and parental stress factors were not considered in the present study which might have influence on voice.
- Data were collected from simulated laboratory condition (not in natural settings)
- Only three concepts or lexical categories were taken to teach the children in the present study.
- The present study did not consider the education of the mothers.

Future directions

1. The future studies can focus on objective documentation of voice use profile in mothers with other communication disorders such as mother of children with cerebral palsy, mental retardation, autism spectrum disorders, specific language impairment and Attention Deficit Hyperactive Disorder.
2. The future study can focus on objective documentation of voice use profile in Special educators of hearing impairment on professional teaching and non-teaching hours.

3. Voice use profile data from APM can be correlated with Videostroboscopic findings. Also, pre-post therapy/home training comparison of change in voice can be documented by self-perception questionnaires along with APM data.

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APPENDIX

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TOPIC: '*Voice use Profile in Mothers of Children with Hearing Impairment: A Controlled Therapy Session'.*

I, Potha Soundar Raj , Master student, doing dissertation regarding the above mentioned topic under the guidance of Dr. R. Rajasudhakar, Dept of Speech Language Sciences at AIISH. I would be measuring the vocal loading parameters such as F0 Mode, F0 Average, SPL Average, Time Dose, Cycle Dose and Distance Dose using 'Ambulatory Phonation Monitor' for 45 minutes of duration in three sessions, when the mother is teaching their children on different concepts. It will be helpful in understanding the vocal behavior in mothers. I assure you that the details and information collected will be kept confidential and used only for academic research purpose.

Consent

I (Mrs.....) have been informed about the aim and implication of the study as mentioned above. I hereby agree to participate in the study.

Signature

Date