CHAPTER - 3

Method
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The current study was aimed at investigating the prevalence and nature of voice problems in call center operators with the following objectives:

- To determine the prevalence of voice problems in CCOs using a self-reported questionnaire.
- To identify the variables associated with increased risk of voice problems in CCOs.
- To determine the functional impact of voice problems in the CCOs.
- To perform a comparative acoustic and perceptual analysis of voice of CCOs (self-reporting of frequent voice problems Vs. not reporting of any voice problems).

The study was conducted in three stages as follows;

Stage 1: Acquisition and Modification of questionnaire developed by Jones et al (2002)
Stage 2: Data collection (completed questionnaires and recorded voice samples)
Stage 3: Analysis and drawing inferences.

3.1 Acquisition and modification of questionnaire

The standardized self-reported questionnaire to study the prevalence and risk factors for voice problems in telemarketers (Jones et al., 2002) was adopted for the present study with the permission of the primary author. Some questions in the questionnaire were modified to suit the requirements of the present study. The modifications were as follows:

- Item numbers (3) and (56) of original questionnaire of multiple choice option to elicit information on work experience and education level were modified to open-ended questions.
Item number (50) indicating the different seasons of western countries was modified to suit the Indian seasons.

Item number (55) seeking information on ethnic background which is not applicable in our society, was deleted.

Three extra questions were added to infer information related to

a) Frequency of vocal symptoms (question number 40);

b) Severity of the vocal symptoms (question number 41);

c) Prevalence of voice problems on the day of survey along with the severity rating (question numbers 52 and 52a).

The modified questionnaire was sent to the original authors (Jones et al.) for their comments and approval. Subsequent to their approval, the questionnaire was given to 15 call center operators for familiarity assessment of the items in it. Owing to ambiguity and difficulty in understanding the terminology in questions specifically, 16, 17 and 26, the following modifications were incorporated;

Item numbers (16) and (17) depicting “how many non-caffeinated beverages” and “how many caffeinated beverages do you drink at work during each shift” respectively were combined into a single question as, “on an average, how many glasses/cups of each of the following do you drink per day” (question number 15) with options of a list of caffeinated and non caffeinated beverages.

Item number (26) of “how would you rate your level of activity outside the work” was deleted as its comprehension was found to be difficult.
The modified questionnaire was once again given to 15 call center operators for
familiarity reassessment. As no further ambiguity or difficulty in understanding the
terminology were reported, it was accepted for use as the final version.

**Description of the questionnaire**

The questionnaire (Appendix I) comprised of 56 questions and was intended to collect information on the following aspects:

- Fifteen questions regarding the employee’s work history and environment
- Fourteen yes/no questions concerning the presence of various symptoms of vocal attrition (excluding the symptoms associated with sore throat, laryngitis, and common cold)
- Six questions concerning biological risk factors for voice problems: intake of beverages, respiratory health, medication use, hearing ability, smoking, and acid reflux
- Four questions to elicit demographic information
- Three questions (personality related) concerning amount, rate, and volume of social speech
- Two questions to rate the frequency and severity of vocal attrition symptoms
- 2 questions to rank the quality of their voice at the beginning and at the end of their work shift
- Two questions regarding the employee’s characterization of and feelings of the presence of any symptoms of vocal attrition
- Two questions regarding the effects of any symptom on the employee’s work and social life
- Two questions regarding previous treatment for symptoms of voice problems
• One question regarding the relationship between seasons of the year and presence of vocal symptoms

• One question concerning participation in vocally demanding activities

• One question regarding previous vocal hygiene education

• One question to indicate the presence of voice problem on the day of survey

The questionnaire included the following response patterns:

• Five-point rating scale

• Select yes/no option

• Select best answer

• Give appropriate answers, wherever required

The self-report method of questionnaire as employed in the current study has the advantage of determining whether the participant reports of a voice problem, which in turn, could be considered to assess the extent to which he or she suffers from vocal dysfunction (Russell et. al., 1998). These questions were posed to CCOs to decide for themselves as to whether or not they had a voice problem and if so, their effect on their profession. Further, they were presumed to reflect on practical estimates of the extent of their impact on the call center workers and their employee organizations; they could, in addition provide guidance to occupational health and safety departments and enable estimation of resources needed to address the problem.
3.2 Data Collection

Selection of call centers

Call centers being one of the fastest growing industries in India in the recent times with over 2,00,000 employees in more than 1,200 centers (Sharma, (2003), a cross sectional survey was attempted in Bengaluru, a metropolis in Southern India, acclaimed as one of the important bases for fastest growing call center industries in India. From the official website (www.bangaloreit.in) of the Department of IT and Biotechnology, Government of Karnataka, the investigator extracted information on 64 call centers in Bengaluru from where the participants have been drawn. Full access to the employee statistics was however, not available.

From the listed 64 BPO centers, Human Resource (HR) heads/authorized personnel of 25 voice based call centers’ who had responded to the investigator were contacted personally and appraised of the study. The responses were forthcoming from 11 centers to participate in the questionnaire survey after extracting an assurance of maintaining the confidentiality. Of them, only five agreed to permit the recording of their employees’ voice samples. Non participation of all the companies identified is attributed mainly to non grant of permission from their management, organization and their company policies. Those centers who had agreed to participate in the survey differed in terms of number of employees. Employee strength in these 11 companies ranged from 250 to 3,500. The survey was conducted from September, 2007 through December, 2007.
Data collection - Completed questionnaires

Two thousand printed questionnaires were distributed across the 11 call centers. The number of questionnaires distributed varied across the call centers depending on the agreement with the management/HR managers. The number of questionnaires distributed was around 100 and 250 respectively in companies with employee strength of less than and over 1000 respectively. Filled questionnaires were collected through the HRs after a week. Follow up of non-responders was restricted by their busy work schedule and inability to consult them individually. For the purpose of acoustic and perceptual analysis of voice, convenient sampling was done as only five call centers permitted recording of the voice samples of their employees.

Selection of subjects for acoustic and perceptual analysis of voice

The acoustic and perceptual analysis of CCO’s voices was included in the study to determine the nature and extent of the voice disorders. Out of eleven call centers, only five permitted the recording of voice samples of limited number of their employees. Based on the questionnaire response, the samples were divided into two groups;

i) Those reporting frequent voice problems i.e., reporting two or more vocal symptoms from the list of 14 for every 2-3 months or more frequently.

ii) Those not reporting of any vocal symptoms.

List of employees in each group was prepared from the companies which consented to their recording. Convenient sampling, according to the availability of the employees from the list was done for the purpose of recording and analysis. A total of 104 voice samples were recorded with 61 samples of males and 43 of females. 61 samples of males comprised of 36
who reported frequent voice problems and 25, not reporting of any vocal symptoms. 43
samples of female employees included 23 from those who reported frequent voice problems
and 20, who did not report of any vocal symptoms.

**Acoustic analysis of voice**

*Recording of voice sample for acoustic analysis of voice:* Voice samples were recorded with
the participants comfortably seated in a quiet room, mostly in their company office cabins.
The acoustic ambience of these rooms was quite similar across the five companies with
identical furnishings: a large table, four to six chairs, closed doors, windows with curtains and
centralized air conditioning. During the period of voice recording, the air conditioning unit
was turned off to minimize the noise levels in the recording room. A condenser microphone
(Samson CO3U USB Multi-pattern condenser mic - Appendix-IV) was placed at 6 cm and at
45° angle from the participant’s lips. The recording was done on the hard disk of a personal
laptop computer (IBM ThinkPad - Appendix-IV) installed with a Wave Surfer recording
software (Appendix-IV). The speech sample was recorded at a sampling rate of 44,100 Hz, bit
rate of 256 kbps and stored in the hard disc in*.wav format. The participants were to phonate
vowel /a/ at their comfortable pitch, loudness and duration. Each participant was given two to
three trials prior to actual recording.

**Acoustic parameters analysed:** Multi-Dimensional Voice Program (MDVP) was used for the
acoustic analysis of the recorded samples (Appendix-IV). The recorded voice samples were
captured by the Multi Dimensional Voice Program (MDVP; model 5105, Kay Elemetrics
Corp.), using Computerized Speech Lab (CSL) hardware for analysis and interpretation of the
data. The MDVP uses analog/digital hardware to sample speech at 50 kHz prior to analysis of
sustained phonation. The initial and final parts of the phonation of vowel /a/ were eliminated and a 3 sec signal (the central part of the phonation being the most regular, least affected by onset and offset of the vocal signal) was captured and analyzed for the following MDVP acoustic parameters (Appendix-II).

**Frequency measures**

- Average Fundamental Frequency (F0)
- Mean Fundamental Frequency (MF0)
- Highest Fundamental Frequency (Fhi)
- Lowest Fundamental Frequency (Flo)
- Standard Deviation of F0 (STD)
- Phonatory F0-Range in semi-tones (PFR)

**Frequency perturbation measures**

- Absolute Jitter (Jita)
- Jitter Percent (Jitt)
- Relative Average Perturbation (RAP)
- Pitch Perturbation Quotient (PPQ)
- Smoothed Pitch Perturbation Quotient (sPPQ)
- Fundamental Frequency Variation (vF0)

**Amplitude perturbation measures**

- Shimmer in dB (ShdB)
- Shimmer percent (Shim)
- Amplitude Perturbation Quotient (APQ)
• Smoothed Amplitude Perturbation Quotient (sAPQ)
• Peak- to - Peak Amplitude Variation (vAm)

Noise related parameters
• Noise to Harmonic Ratio (NHR)
• Voice Turbulence Index (VTI)
• Soft Phonation Index (SPI).

Tremor related measures
• Amplitude Tremor Intensity Index (ATRI)
• F0 - Tremor Intensity Index (FTRI)
• F0 - Tremor Frequency (Fftr)
• Amplitude Tremor Frequency (Fatr)

Sub-harmonic components
• Number of Sub-harmonic Segments (NSH)
• Degree of Sub-harmonics (DSH)

Voice breaks measures
• Degree of Voice Breaks (DVB)
• Degree of Voiceless (DUV)
• Number of Voice Breaks (NVB)
• Number of Unvoiced Segments (NUV)
Perceptual analysis of voice

**Recording of voice samples for perceptual analysis of voice:** In this study, Consensus Auditory Perceptual Evaluation of Voice (CAPE-V) scale was used after obtaining prior permission from the concerned (Appendix-III). This scale was used as it is reported to be more sensitive to small differences within and among subjects (Karnell et al., 2007; Kempster et al., 2009). CAPE-V is a scale developed from a consensus meeting sponsored by American Speech-Language-Hearing Association’s (ASHA) Division 3: Voice and Voice disorders, and the Department of Communication Science and Disorders, University of Pittsburgh in 2002. It includes specific protocols that designate the tasks, procedures and scaling routine that improves the inter-rater reliability.

According to the specifications of CAPE-V, three different tasks were audio recorded using similar settings for the acoustic analysis. The first task was recording the phonation of lax and tense vowels (/a /& /i/) three times, each at a steady and comfortable pitch and loudness level. This task provides an opportunity to listen to a participant’s voice without any articulatory influences.

The second task was reading of six English sentences with different phonetic contexts, and described by Kempster et al., (2009) as: (1) *The blue spot is on the key again* (to examine the co-articulatory influence of three vowels;/a, i, u/); (2) *How hard did he hit him?* (to examine the soft glottal attacks and voice less to voiced transitions); (3) *We were away a year ago* (all voiced phonemes provides a context to judge one’s ability to link one word to another or spasms); (4) *We eat eggs every Easter* (vowel initiated words provide information on hard glottal attacks); (5) *My mama makes lemon muffins* (numerous nasal consonants provide
opportunity to assess the presence of hypo nasality); (6) Peter will keep at the peak (all oral sounds provide information on intraoral pressure and possible hyper nasality or nasal emission).

The third task was recording of natural conversational speech of around 20 seconds. The subjects were asked standard interview questions concerning their education, work and family. Model for each task was provided before recording the sample along with one or two trials. The samples were stored in Microsoft Windows wave format (*.wav) and copied in a single track with an inter-stimulus interval of 5 seconds using Adobe version 3.0 (Appendix-IV). The recorded samples were then randomized (samples of those reporting frequent voice problems and no voice problems) and copied to a CD.

**Procedures of auditory perceptual evaluation:** Three qualified speech language pathologists (faculty at the Department of Speech and Hearing) with more than five years of experience and good knowledge of English language served as judges. All of them had hearing thresholds of 20 dB HL or lower for 250, 500, 1000, 2000, 4000, and 8000 Hz as evaluated by pure tone audiometry. They were familiarized with CAPE-V perceptual evaluation scale by the experimenter. To familiarize them with CAPE-V rating scale, they were engaged in listening exercises with pre-recorded pathological voice samples (non-study) till they were comfortable with the CAPE-V. They were then instructed to rate the quality of the samples played to them. The perceptual evaluation was performed in a sound treated room of the department (Speech Science Lab). The recorded speech samples were played using HP Desktop Pentium IV Computer, using Adobe Audition through loudspeakers (Tannoy, 034856) at a consistent and comfortable intensity level with the listener seated 3ft away from the loudspeaker. A separate
session was arranged for each judge. Each judge performed the perceptual evaluation in one session (one day) with pauses in between suiting their convenience and with no limit on the number of times they could listen to the recorded samples. The judges were required to rate the performance using CAPE-V rating form. Only one form was used for each subject. In case of discrepancies across tasks, the judges were instructed to put tick marks with the task number and mark it as “I” at the right end of the scale; and leave the line unlabeled with a single tick mark if there was no difference across the tasks and marking as “C” at the right end of the scale.

The distances of markings made by the judges on the visual analog scale (CAPE-V scoring sheet) were measured physically using a measuring scale. They were measured from the left end of the scale, thereby relating the results in a proportion to the total 100 mm length of the line to describe the degree of deviancy. In the present study, the 100mm visual analog scale was arbitrarily divided into four sections in order to understand the severity of the perceived vocal parameter based on an earlier study (Akanksha, 2009). The average rating falling within the range of 0 - 9mm was considered as of normal voice quality; within the range of 10 - 39mm, as mild deviancy; 40 - 69mm, as moderate deviancy and more than 70mm, as severe deviancy. The visual analog scale ratings were divided into four sections based on the following studies. Akanksha (2009), correlated the scores obtained on the visual analog scale to that of ordinal scale using Spearman’s Correlation Co-efficient and found higher correlation between the two scales amongst all the voice attributes of the CAPE-V. For example, the rating of 0-9mm on visual analog scale correlated with normal voice quality while; 10 - 39mm correlated with rating of mild and; 40 - 69mm correlated with moderate, and score of more than 70mm, with severe degree of rating. In a similar study, Karnell et al.,
compared the scores obtained for voice disordered patients on GRBAS scale to that of CAPE – V scale. They reported that 29 patients who were rated with the GRBAS system as having voices that were within normal limits or G0 corresponded to low CAPE-V ratings (mean 0.6, SD 1.8). Similarly, they also found that patients perceived as having some degree of dysphonia based on GRBAS G ratings were rated with the CAPE-V instrument as follows: G1 had mean rating of 11.9 (SD 7.4), G2 had a mean rating of 44.8 (SD 11.9), and G3 had mean rating of 71.1 (SD 13.0) on CAPE-V rating scale. Based on the aforesaid studies, the present study included these four categories of vocal severity rating for easier quantification and comparisons between the raters for inter rater reliability.

Reliability

Inter and Intra-rater reliability of perceptual evaluation by the three judges for different tasks was analyzed using Intra-class Correlation Coefficients (ICC). Inter-rater reliability was evaluated by comparing the perceptual ratings of severity of the voice samples among the three listeners. Intra-rater reliability of the judgment was evaluated for the 15 (10%) voice samples which were rated by all the three listeners for the second time in a separate session.

3.3 Statistical analysis

The following statistical methods were employed with justification provided to analyze the data:

- Frequency and percentage were used to summarize categorical variables; mean and SD, minimum, maximum were used to summarize continuous variables.
• Pearson’s Chi-square test to compare the differences in prevalence of vocal symptoms, frequency and severity, their effect on job performance, social interaction and vocal problems on the day of survey among males and females.

• Adjusted odds ratio with corresponding 95% confidence interval with multiple logistic regression using Wald forward selection criteria used to assess the association between vocal attrition symptoms and different influencing risk factors (demographic, vocational, personality, biological).

• Mann-Whitney U test used to compare the different acoustic parameters between the two groups of CCOs; those reporting frequent vocal attrition symptoms and those not reporting frequent vocal symptoms. It was used to estimate the significance of changes in acoustic parameters in relation to experiencing frequent vocal symptoms and not experiencing vocal symptoms.

• One sample t-test used to compare the acoustic parameters of CCOs with the Indian normative data base for MDVP acoustic parameters.

• Intra-class Correlation Coefficient (ICC) used to measure the inter and intra rater reliability of the perceptual analysis ratings.

SPSS software version 15 was used for the analysis of all the data. P < 0.05 was considered as statistically significant.

Prior to data collection, the protocol was presented before the Manipal University Ethical committee. On its approval, the study was conducted in accordance with the stipulated guidelines. The questionnaire used in the study included a covering letter explaining the broad outline of the research topic with assurance of confidentiality of the participants. The
participants were required to sign a consent form for documentation and future reference purposes.

The analyzed data was scrutinized and appropriate inferences drawn and discussed in the following chapters of results and discussion.