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Speech Range Profile in Indian Adults

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Abstract This was a cross sectional study aimed to obtain the speech range (SRP) profile normative for the Indian adults in the age range of 18-40 years. 30 males and 30 females in the age range of 18-40 years with normal voice participated in this study. VRP Model 4326 of CSL 6103 from Kay Elemetrics was used for recording and measuring the SRP. The participants were asked to count as long as they could in one breath at their most comfortable pitch and loudness level. The highest frequency (maxf), the lowest frequency (minf), the maximum intensity (maxi), and the minimum intensity (mini) along with the frequency and intensity range were obtained from each participant. Statistical measures were applied for obtained data using SPSS 10.0 for Windows (SPSS Corporation, Chicago, IL). The mean SRP min-f, max-f and frequency range values were significantly lower in males when compared to the females. There was not much of variation in the mean SRP min-l values in both the genders. A higher mean SRP max-l and intensity range was obtained in males in comparison with females though not significant statistically. The normative data obtained on SRP in the adult males and females in this study offers a valuable tool in the assessment and management of voice disorders. Further research can be directed towards obtaining normative data in the other age groups and also on different vocal pathologies.

Keywords *Speech Range Profile; Voice Range Profile; Voice Disorders*

1. Introduction

Acoustic measures have been developed in the past to quantify the vocal parameters. These parameters reflect the vocal fold vibratory pattern. The advantage of these acoustic measures is that they can be used to quantify and track changes in voice post treatment. One such measure, often used by the Speech Language Pathologists is the voice range profile (VRP). It is a graphical representation that reflects the speaker's ability to produce maximum and minimum intensities at fixed percentages of his maximum frequency range of phonation under controlled conditions of vowel production and mouth opening [1]. VRP gives us information about the interaction of frequency and intensity variables occurring during the sustained phonation. This measure appears to be valuable in assessing the normal and abnormal voices.

VRP assessment has the limitation of ambiguity in understanding the instructions. Subjects often tend to increase and decrease the loudness at different pitch ranges. The normative data for VRP has

been established in the western context [2, 3, 4], inspite of this limitation. One more practical problem in obtaining a VRP relates to the amount of time involved. Though an automated procedure was proposed to elicit VRP, there was no clear and systematic procedural suggestion for recording to elicit true vocal limits. Yet another issue relates to the reliability and validity of the voice ranges obtained using VRP. Also, sustained phonation is a highly simplified speech behavior which is not equivalent to a dynamic speech conversation. All these problems can lead to high inter and intra subject variability of the vocal frequency and intensity limits elicited [5]. Inspite of these limitations, VRP is often used in the clinical settings.

Instead of using maximum performance profiles, the profiles can also be obtained using connected speech such as counting, which is a speaking VRP or speech range profile (SRP). This is a graphical display of frequency intensity interactions occurring during functional speech activity. It reflects not just the subject's vocal frequencies and intensity, but also the interaction between these two variables occurring during the functional speech activity. SRP is a less time consuming procedure with easy to follow instructions in clinical routine compared to VRP.

Ternstrom, Andersso and Bergman evaluated the effect of body massage on SRP in a group of vocally healthy subjects. In their study, SRP's were elicited by making them read aloud a standard text and were analysed using the *phog 1.0* program. Results revealed a significant increase of speech profile area after a 30 minute body massage, suggesting an increase of speech voice ranges. Their results suggest that speech profile area could be sensitive measure to detect voice changes [6]. Ma et al., concluded that SRP would be an acceptable alternative to traditional VRP for screening the presence of dysphonic in a busy clinic where quick screening results are desirable [7].

It is clear from the above studies that SRP has a potential for clinical application. However in the contemporary clinical outlook, its popularity is limited. Earlier studies were restricted to VRPs and only countable investigations exist with regard to SRPs in the western context. Due to shorter administration time and simpler methodological procedure involved, the SRP lends itself to application as a screening tool for dysphonics and thus a valuable tool to differentiate dysphonic from normal voice [7]. It was also reported that SRP is as efficient as VRP in predicting the presence of dysphonia. To the best of our knowledge, there are no studies on SRP measure in the Indian context. Hence, the present study was carried out with an aim of obtaining normative data for the SRP in the Indian adults in the age range of 18-40 years for males and females. Also, we were interested in investigating the gender differences in SRP in the adult group.

2. Materials and Methods

Present study was conducted in a multi disciplinary tertiary care hospital after obtaining ethical approval from the Institutional ethical board.

2.1. Participants

30 males and 30 females within the age range of 18-40 yrs [8] with normal voices participated in this study. Their voices were perceptually rated as normal by an experienced Speech Language Pathologist on GRBAS rating scale. None of the participants had received any treatment for voice earlier or during the time of testing. Participants with history of vocal abuse/misuse, respiratory disorders, smoking and hormonal dysfunctions were excluded from this study. An informed consent was obtained from all the participants prior to recruiting them in the study.

2.2. Instrumentation

VRP program, conventionally available as an option (VRP, Model 4326) for the CSL 4150 from Kay Elemetrics was used for recording and measuring the SRP. It provides a two dimensional plot of an amplitude range as a function of frequency range during the functional speech activity.

2.3. Procedure

All the voice samples were directly recorded into CSL 4150 hardware using a dynamic microphone which was maintained at a constant distance of 10cm from the participant's mouth. Prior to the actual recording, subjects were seated in a comfortable chair. The SRP was recorded by asking the participants to count as long as they could in one breath at their most comfortable pitch and loudness. The recordings were repeated if the participants themselves considered that the pitch and loudness used in recordings were different from those of daily conversational speech. Instructions were repeated as and when required.

2.4. Data Analysis

All the SRP's in the age range of 18-40 years were analyzed. Four profile boundary points, including the highest frequency (maxf), the lowest frequency (minf), the maximum intensity (maxi), and the minimum intensity (mini) were obtained from each profile. The maximum intensity point was taken from the highest intensity value of the upper intensity contour. Similarly, the minimum intensity point was taken from the lowest intensity value of the lower contour. The two points where the upper and the lower intensity contour merged at the highest frequency and the lowest frequency gave rise to the boundary points of the max-f and min-f respectively. The difference between the max-f and min-f values gave rise to the frequency range (f0-range). The difference between the max-I and the min-I values gave the intensity range (i-range). The profile points and the ranges were calculated automatically by the software itself.

2.5. Statistical Analysis

Statistical analysis was performed with SPSS 10.0 for Windows (SPSS Corporation, Chicago, IL). Descriptive statistics was employed to describe all the study parameters. The mean and standard deviation for each measure was obtained for both males and females. Independent t-test was employed to compare the significance of difference between the means across the gender for the frequency and intensity range.

3. Results

In the present study, SRP measure was obtained from the normal adults in the age range of 18-40 years. The results are detailed in the Table 1 below.

Table 1: The SRP Values in Indian Adults

S. No.	Parameters	Males		Females	
		Mean	SD	Mean	SD
1	Min-f (Hz)	107	19	176	23
2	Max-f (Hz)	124	26	205	21
3	Frequency Range (Hz)	17	26	29	10
4	Min-I (dB)	83	6	82	5
5	Max-I (dB)	93	8	90	4
6	Intensity Range (dB)	10	5	8	3

Results of Independent t-test indicated that mean SRP min-f and max-f values were significantly lower in male group as compared to the female group. Females exhibited a wider frequency range as compared to males at $p < 0.001$. The mean SRP min-I values in males and females did not show much variation. A higher mean SRP max-I was obtained in males as compared to females. Males showed a higher mean intensity range as compared to the females though not significant statistically.

4. Discussion

Clinicians often rely on visual tools in the assessment and management of patients with voice disorder. One such visual tool is the Speech Range Profile (SRP). Since it is figure or a shape, most clinicians use pattern recognition to identify abnormal voices with resultant subjectivity and variability among the clinicians. Hence the extraction of parameters from the figure such as highest frequency (maxf), the lowest frequency (minf), the maximum intensity (maxi), minimum intensity (mini), frequency range (f0-range) and intensity range (i-range) was recommended to make this measure objective. But there is need for developing normative SRP values in the Indian context. Hence, the present study was carried out in normal Indian adults in the age range of 18-40 years.

Frequency range refers to the range of frequencies that a person produces during the functional speech activity. Normal young adults should be able to produce a phonation range of about three octaves, with singers range slightly higher than non singers [9]. In the present study the female subjects exhibited a higher frequency range (29 Hz) compared to male subjects (17 Hz) suggesting higher frequency range in the habitual speech of female participants compared to males. Results also indicated that Mean SRP min and maximum frequency values were lower in males when compared to females.

Intensity range refers to the range of vocal intensities that a person can produce during the functional speech activity. Normal speakers should be able to produce minimum intensities of around 50 db and maximum intensity of around 110 db [10]. Intensity for males is reported to be slightly higher than the females [9]. A similar trend was observed in this study with increased intensity range in males (10 dB) as compared to the females exhibiting 8 dB during the habitual speech production. Results also indicated that the mean SRP min-I values in males and females did not show much variation. However, higher mean SRP max-I was observed in males as compared to females. This reduced frequency and intensity range could probably be due to the counting task which is monotonous. Hence further studies are required to develop normative on SRP using various speech tasks like narration, reading etc.

In the literature, SRP has been studied in some vocal pathology. Ma et al., recorded SRP by asking the subjects to read aloud the Cantonese passage "north wind and the sun" at their most comfortable pitch and loudness as in daily conversation. It was observed that the presence of laryngeal mass lesions in subjects with dysphonia resulted in a significantly lower mean SRP high frequency than the control group. The mean SRP low-frequency of the subjects with dysphonia and the control groups were similar because the reading task did not demand subjects to push to their physiological vocal limits for the production of lowest speaking frequency. This finding suggests that the high speaking frequency area is more vulnerable to laryngeal mass lesions than low speaking frequency area [7]. Hence the obtained normative serves as a reference for comparison against disordered voices. This normative on SRP enables the voice clinician to evaluate the characteristics of voice during the functional speech activity.

5. Conclusion

The present study attempted to obtain a normative data for the SRP in the age range of 18-40 years for males and females. The normative data obtained offers a valuable tool for the Indian speech

language pathologists in the assessment and management of patients with voice disorders. This could also be used to track the changes following the vocal treatment and also to assess the efficacy of the given treatment procedure. The findings of the study can be strengthened by expanding the research on a larger population and in different communicative environments. Further, the future research can be directed towards obtaining normative data in the other age groups. It is also important to plan studies on different vocal pathologies.

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