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NORMATIVE NASALANCE VALUES ACROSS STIMULI AND GENDER IN MALAYALAM SPEAKING INDIVIDUALS

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Introduction

Nasality is the common problem in subjects with repaired / unrepaired cleft palate, which affects the speech intelligibility. Nasal resonance is not only seen in disordered speech, even normal speech also consist some amount of nasality. Example: Among the Indian languages, Malayalam has got more nasal resonance than any other languages. Nasality can be assessed by subjective as well as objective methods. Perceptual judgment of nasality is done using various rating scales. These rating scales have used different rating points ranging from five point scale to nine point scales. The judges for these rating scales were from trained speech pathologists to clients themselves. Since this is a subjective task, standard data / normative data cannot be established due to many disadvantages associated with this method. Hence, standard objective methods are essential to assess the velopharyngeal dysfunction and to provide guidelines for suitable rehabilitation method.

Nasometer is a non-invasive measurement technique which can be used outside medical settings. Nasometer assesses the nasality of speech by measuring the acoustic output from both the nasal and oral cavity by using two microphones, separated by an acoustic shield that rests on the upper lip, which is mounted on a head set which gives appropriate position for the microphones. Additionally it

is a personal computer based device that can be easily installed and can measure the nasality at any point of the sample. Extensive studies on the nasometer's validity have generally shown high levels of correspondence between listener judgments and measures made by device [3,7,9]. In addition to research directed to a direct clinical application of Nasometer measurements, there have been investigations into factors that influence nasalance measures in normal speech. These studies have shown that nasalance of normal speech is sensitive to phonetic composition of the speech stimulus [26], native language[1], age and gender [21]. However, the findings are not universally consistent.

Since the Nasometer was introduced in 1986, several articles have appeared in the literature on developing the normative data in various languages. These studies indicated that nasalance scores vary across languages [1,12,18,21,22,23,25,27]. In Indian context, Sunitha, Roopa Nagarajan and Prakash [21] conducted a study to establish the normative data in Tamil speaking individual. In the first phase, ten meaningful sentences using the various sound classes in Tamil were developed. These were repeated by 120 children (60 boys and 60 girls) in the age range of 5 to 15 years. The data was analyzed using the Kay Nasometer (Model 6500) and the results revealed that girls showed higher nasalance value than boys. The results showed the normative for oral stimuli (9-15%), nasal stimuli (58-62%), and predominately oral stimuli (20-40%). The nasalance cut-off ranged between 13% and 17% across the gender and age for Tamil language.

Jayakumar and Pushpavathi [21] studied nasalance values in 50 children (25 males, 25 females) in the age range of 5-10 (mean age 8.1years) years and 50 adults (25 males, 25 females) in the age of 20-35 (mean age 26.1years) years. The subjects were asked to repeat eight oral sentences and eight nasal sentences. The Nasometer II 6400 was used to for the data collection and analysis. The results revealed that in adults, significant difference was evident across gender. In males, for nasal sentences the nasalance value was 48.27 (8.74) and for oral sentences 8.77% (4.76). In females, for nasal sentences the nasalance value was 58.22% (8.40) and for oral sentences 14.69% (5.86).No significant differences were found across gender for children group. This difference was attributed to the basic structural and functional differences between gender, children and adult

There is some controversy regarding gender differences in mean nasalance scores in normal speakers. Mean nasalance score also vary across gender. Gender related differences in nasalance value can possibly be related to basic structural and functional differences across gender. The

resonance of voice is influenced by the size, shape and surface of infraglottal and supraglottal resonating structures and cavities. Previous studies found that female speakers have significantly higher nasalance scores than male speaker on passage containing nasal consonants [7,11,20,25]. Fletcher [7] reported higher nasal value for normal men on nasal sentences. But Hutchinson (1978) reported higher nasal value for women on three reading passages.

Many studies reported that a significant difference was not evident in nasalance scores across gender [22,23,24]. Van Lierde et al.[24] evaluated 33 children (15 girls and 18 boys) in Flemish language. Three different types of stimuli were used. (Oral, oronasal and nasal text). They recorded children producing sounds and the read three texts. They compared the nasal resonance data from the children with those of 58 adults that have been obtained in a previous study. Results suggested that women had higher scores than men during the production of the /u/ in the oro nasal text and the nasal text. But it was not statistically significant. This may be due to the velar length, elevation which is greater for men compare to women.

Sweeney et al. [22] evaluated 70 normal Irish children with age range of 4 years to 13 years. Children repeated each of the 16 sentences individually. The sentences were presented in groups according to consonant type (High pressure, low pressure and nasal consonant). Normative nasalance scores were obtained for three groups of sentences. The group mean nasalance score for boys was 26% (SD 4.18), and the group means nasalance score for girls was 27% (SD of 4.12). There was no significant difference in nasalance scores between males and female speakers.

The nasometry as an objective measure of perceived nasal acoustic energy involves manipulating the speech sample used. Several speech samples and materials and reading materials (Rainbow passage, zoo Research has shown that the zoo passage (devoid of nasal consonants) is useful in identifying individuals with velopharyngeal dysfunction. Traditionally long passage such as zoo passage was used to assess nasalance. This paragraph contains a variety of oral consonants (plosives, fricatives, glides). The zoo passage has 83 syllables in length and presumably it is sufficiently long to obtain valid and stable measures of nasalance.

Lewis, Watterson and Quint [14] compared the nasalance scores with nine different speech stimuli with vowel content controlled. The subjects were 19 children with velopharyngeal dysfunction and 19 normal children. The stimuli consisted of five sentences and four sustained vowels. One

sentence contained only high front vowel, one contained only high back vowel and so on. The result showed that high vowels were associated with significantly higher nasalance scores than low vowels for both sentence and sustained vowels. Difference was evident among front / back vowel contrasts. These natural difference in oral and nasal sound intensity would some in the direction of increased nasalance on high vowels would explain the findings. However, nasalance scores may be differed by the vowel content of the speech stimulus.

Overall, selection of the speech sample to be used for Nasometer testing has been shown to affect results. Sentence repetition is considered to be an effective way of collecting a speech sample in children [2]. In the evaluation of speakers with nasality and nasal airflow errors, Karnell [13] has recommended the use of separate high-pressure consonant sentences and low-pressure consonant sentences when obtaining nasalance scores. He stated that when nasal turbulence is present, nasalance scores on high- pressure consonant sentences may be artificially high. The elevation of nasalance scores on high-pressure consonant sentences may become apparent in subjects with nasal emission, nasal turbulence, or both if separate nasalance scores are obtained for high-pressure consonants and low-pressure consonant sentences. Sweeney et al. [22] reported that separate analysis of the high-pressure and low-pressure category nasalance scores may inform the clinician's differential diagnosis regarding hypernasality and nasal airflow errors, but it was not well established.

Perceptual ratings of speech nasality are susceptible to problems that influence their reliability for example rating scale used, clinical exposure of the judges on nasality, and the presence of other speech characteristics that may mask the perception of nasality[8]. In individuals with velopharyngeal inadequacy, accurate assessment of the disorder is critical. The above mentioned studies have shown that nasalance of normal speech is sensitive to the phonetic composition of the speech stimuli, native language, regional dialect age and gender. This makes the strong need for establishment of regional norms as there are very few standardized normal nasalance scores for normal speakers in Indian languages.

AIM OF THE STUDY

1) To study the effect of stimuli and gender differences on nasalance scores in Malayalam speaking adult population.

2) To establish normative nasalance scores for adults speaking in Malayalam language using Nasometer II 6400.

3) To compare normative scores across Nasal View and Nasometer II 6400.

METHOD

Participants

Sixty normal subjects (30 Males and 30 Females) in the age range of 18 to 25 years were participated in the present study. Each subject was evaluated by an experienced speech pathologist to check the oral structure and function. Normal speech and language ability were also evaluated informally during five-minute conversation. Background information regarding medical history and hearing ability was collected. Individuals with normal hearing, normal orofacial structure and function, normal speech and language ability were considered for the study. All the participants were native speakers of Malayalam language.

Stimuli:

Two sets of meaningful Malayalam words and sentences were prepared. One set consisted of nasal sentences and nasal words, which had predominantly nasal consonants and the other set was oral sentence and oral words, which predominantly consisted of oral consonants. Each category consisted of 5 words and 5 sentences. An experienced speech language pathologist whose mother tongue was Malayalam assessed the content validity of the stimuli.

Instrumentation:

The Nasometer II, (6400) a microcomputer based system developed by Fletcher[7] and manufactured by Kay Elemetrics (1982) was used to record the data. The Nasometer consists of head set containing a sound separator with microphones on either side which detects oral and nasal components of the speech which rests on the subject's upper lip. The signal from each of the microphones is filtered individually and digitized by customized electronic modules. The resulting signal is a ratio of nasal**:** nasal plus oral acoustic energy in term of percentage (nasalance) multiplied by hundred.

$$\text{Nasalance} = (\text{Nasal} / \text{Nasal} + \text{Oral}) \times 100$$

Procedure:

The Nasometer was setup in a suitable quiet recording room. The instrument was calibrated prior to the experiment based on the instructions provided in the manual. The subjects were assessed and recorded individually. After selecting the subjects, they were seated comfortably, and the Nasometer headset was placed on the subject's head. The position of the Nasometer head set was adjusted and secured firmly in accordance with the manufacturer's instructions. In particular the angle of the metal sound bottle against the subjects face was checked throughout the recording to ensure that it maintained its position. The subjects were instructed to repeat speech stimulus (words and sentences) after the speech pathologist for a reliable output. At the end of each stimulus, an interval of two seconds was provided, so that the instrument acquired the sentences with a separation, and it allowed for subsequent identification of different stimuli for analysis.

Data Analysis:

The mean, maximum, minimum nasalance for each stimulus (10 words and 10 sentences) in each category were calculated. Using the Nasometer statistical function, these scores were then recorded in a separate sheet form suitable for subsequent statistical analysis using "SPSS" program package version 18. Descriptive statistics, paired "t" test and Mixed ANOVA were used for analysis.

RESULTS

The present study aimed at establishing the normative values for Nasometer II (Model 6400) in Malayalam language for adults. The data was analyzed using descriptive statistic, paired t test, and Mixed ANOVA using SPSS software (version, 18.0) package.

a) Effect of Gender on Nasalance scores of Malayalam speaking Individuals

The normative mean nasalance values for adult Malayalam speaking individuals for words and sentences across gender were depicted in Table 1. The mean values were lesser for words compared to sentences. In words and sentences, the oral stimuli have lesser mean values compared to nasal stimuli.

Gender	Mean and S.D for Nasalance scores for different stimuli in (%)			
	Oral words	Nasal words	Oral sentences	Nasal sentences
Males	28.50 (9.27)	75.66 (4.65)	24.58 (7.49)	77.95 (3.46)
Females	34.90 (7.88)	77.95 (3.46)	28.85 (8.62)	71.83 (4.39)

Table 1: Normative mean nasalance values for words and sentences across gender.

The Mean nasalance scores for the words and sentences were more for females compared to males across oral and nasal stimuli. The Mixed ANOVA was carried out to find the significant difference across gender for all the stimuli. The results showed there was a significant difference across gender for all the stimuli (words and sentences) at 0.01 levels.

b) Effect of stimuli on nasalance scores of Malayalam speaking individuals.

The average mean nasalance scores for words were greater than that of sentences in both oral and nasal conditions across both genders and these were depicted in the Table 1. The Mixed ANOVA results showed statistically significant difference between words and sentences at F (2, 167) at 0.001 levels. Paired t-test results showed significant differences between oral and nasal words (t = -29.592) ($p<0.01$). There was a significant difference ($p<0.01$) across oral and nasal sentences (t = -31.586).

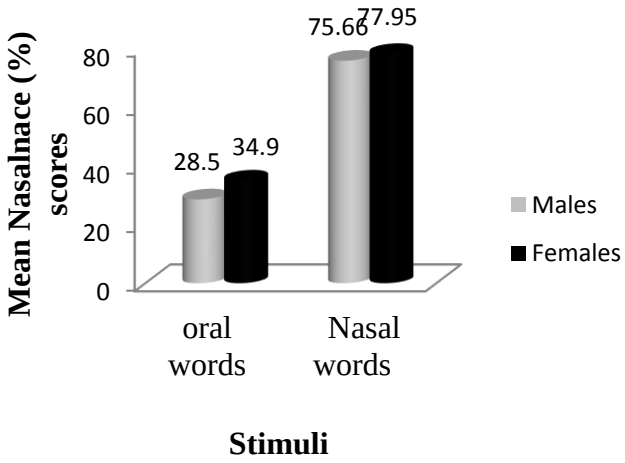

Figure 1: Mean nasalance scores for words across gender

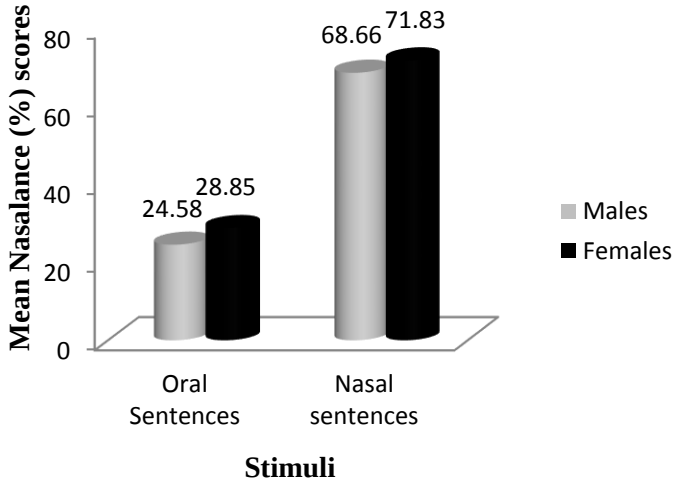

Figure 2: Mean nasalance values for sentences (oral and nasal) across gender

The above figures 1 and 2 shows that the mean nasalance scores for nasal conditions were greater than that of the oral conditions for both words and sentences.

c) Comparison of normative scores across Nasal View and Nasometer II 6400

The mean normative nasalance scores obtained from Nasometer II were compared with the scores obtained from Nasal view from previous study [5].

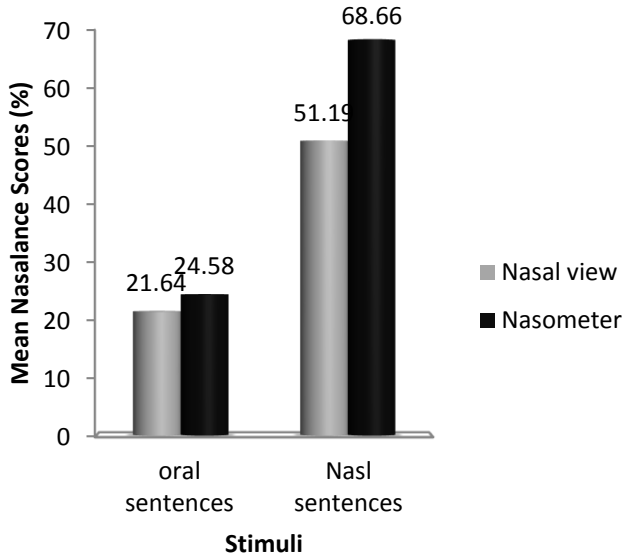

Figure 3: Mean nasalance scores for Males across nasal view and nasometer

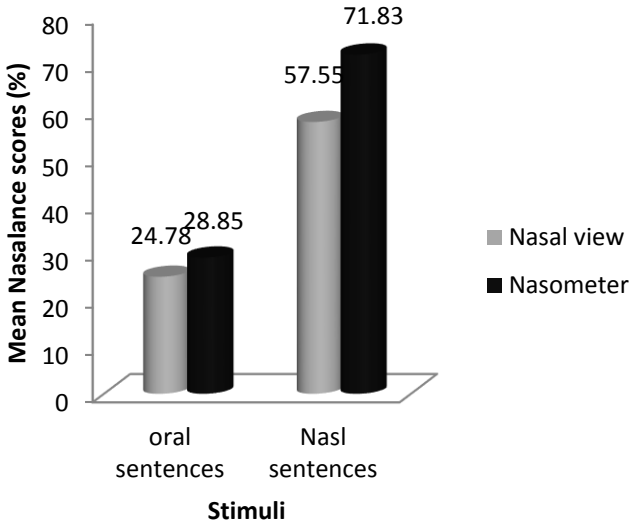

Figure 4: Mean nasalance scores for females across nasal view and nasometer

The results were depicted above as figure 3 and figure 4. In Figure 3, the mean nasalance values for standard nasal and oral sentences were compared for males across nasal view and nasometer. For oral sentences, the nasalance score for nasal view (21.64%) was lesser than that of nasometer II (24.58%). And for nasal sentences, the nasalance score for nasal view (51.19%) was lesser than that of nasometer II (68.66%). In figure 4, the mean nasalance values for standard nasal and oral sentences were compared for females across the two instruments. For both oral and nasal sentences the nasalance scores for nasal view was lesser than nasometer. And females had higher nasalance scores compared to males for both nasal view and nasometer II.

Paired sample t-test was performed to calculate any statistically significant difference between the nasalance scores obtained from nasometer II and Nasal view. The results showed that there was no statistically significant difference ($t = 0.144$, $p= 0.895>0.05$) between the instruments on nasalance scores for both nasal and oral sentences.

DISCUSSIONS

The primary aim of the present study is to establish normative nasalance values for Malayalam speaking adults for words and sentences using Nasometer (6400.II). The summary of the normative data for Malayalam speaking adults is shown in Table 1**.** The reported normative nasalance data provide important reference information for the assessment of nasality disorders. Speech pathologist can measure the nasality for the diagnosis and effect of a specific therapy approach and the plastic surgeon can evaluate the effect of different surgical techniques.

Very few Indian studies have done on developing a normative data in Indian context. The above results indicate that there is a difference evident in nasalance value for oral and nasal sentences across various languages. Even though the present study is not aimed at comparing scores across languages, an effort was made to analyze the data. These results support the findings of authors [20,23,24] who reported variation in the nasalance value across various languages. In the present study 60 adults with equal number of males and females were participated. The normality scores obtained for nasal and oral sentences and words were compared. Significant difference was found among adults across gender. The results can be possibly attributed to the basic structural and functional differences across gender. The mechanism for velopharyngeal valuing has been found to be different for men and women. Mc Kerns and Bzoch [17] suggested that velar length is greater in men, the height of elevation is greater and the inferior point or contact is most usually above palatal plane. In the female, the similar results are not found. The other finding that supports the present result is the acoustic transmission of palate. As the age increases the sympathetic transfer of acoustic energy from oral cavity to the nasal cavity also increases in females [10].

Previous studies found that female speakers have significantly higher nasalance scores than male speaker on passage containing nasal consonants [12,16,20,25]. In the present study it also had been found that females had higher nasalance value in both words and sentences. The results were attributed to increased respiratory effort and increased nasal cross-sectional area in female. In the present study the average mean nasalance values for words were significantly higher both in oral and nasal conditions compared to the sentences. The reason for this difference could be attributed to the characteristic phonetic structure of the nasal and oral stimuli. Production of nasal stimuli induces transfer of acoustic energy into the nasal cavity through the open velopharyngeal port. During the production of oral sounds, the velopharyngeal port is closed which accounts for the reduction in transfer of acoustic energy into the nose and an increase in oral acoustic energy. The observed variation in nasalance across oral and nasal stimuli could also be attributed to the influence of phonetic nasal content of individual stimuli on the nasalance values, an effect demonstrated by Fletcher, Adams and Mc Cutcheon [8]. On the whole, transpalatal transfer of energy accounts for nasalance of speech stimuli[6].

The mean nasalance scores were grater for nasometer II than that of nasal view for both oral and nasal sentences. These results were similar to that of a study done by Lewis and Watterson[15]. This may be primarily due to the filter settings between the two instruments. The Nasometer measures sound intensity in a 300-Hz band around a center frequency of 500 Hz. Thus, most of the acoustic energy measured by the Nasometer would be associated with vowels, and primarily just the first formant of vowels. The Nasal View, however, measures sound intensity across the entire speech spectrum, so it is measuring and summing all of the acoustic energy associated with both vowels and consonants. The Nasal View does not recognize the natural distinctions across vowels. But regardless of the reason, the Nasal View did not detect the expected oral nasal intensity difference between vowels in a connected speech

Mean nasalance scores may be influenced by the phonemic characteristics of a language. Consequently, the number of nasal sounds in that language as well as frequency of occurrence of nasal sounds may be an important factor. Among the Indian languages Malayalam has got more nasal resonance than any other languages. Malayalam has six nasal consonants, all of which are prevalently used (bilabial, alveolar, palatal, retroflex and velar). In addition to these nasal sounds, nasalization of vowels is also highly prevalent, which may account for increased nasal resonance[19]. Over all the

present study adds to the body of evidence that there are stimuli and gender differences in nasalance scores. Clinically the normative data reported in the present study may help identifying children with resonance disorders. It may also be used to monitor the success of the rehabilitation techniques such as speech therapy and surgery.

CONCLUSIONS

The present study aimed to study the stimuli and gender effects on mean nasalance scores of normal Malayalam speaking individuals. Results revealed significant difference between two different stimuli and gender. The females showed significantly higher mean nasalance scores than males for all the stimuli. Overall this study adds to the body of evidence that there are gender differences in nasalance values. Also, this study supports the existing literature on normative data in various languages and helps to quantify the hypernasality in clinical population.

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