Norms for Nasalance score of Adult Manipuri Speakers

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A Dissertation submitted in part Fulfillment for

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MAY, 2016

CERTIFICATE

This is to certify that this dissertation entitled "**Norms for Nasalance score of Adult Manipuri Speakers"** is a bonafide work submitted in part fulfillment for the Degree of Master of Science (Speech-Language Pathology) of the student (Registration No.: 14SLP014). 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 Diploma or Degree.

Mysuru
May, 2016

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DECLARATION

This is to certify that this dissertation entitled "**Norms for Nasalance score of Adult Manipuri Speakers"** is a result of my own study under the guidance of Dr. T. Jayakumar, Reader in Speech Sciences, Department of Speech-LanguageSciences, All India Institute of Speech, Mysore and has not been submitted earlier to any other university for the award of any Diploma or Degree.

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For I know the plans I have for you," declares the LORD, " plan to prosper you and not to harm you, plans to give you hope and future. Jeremiah 29. 11

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CHAPTER I

Introduction

Human communication involves rich information conveyed through elements of movements, emotion and vocalization. Normal communication includes both verbal and non verbal aspects. Spoken language is one form of communication that enables humans to convey information with specificity and details. Communication is successful when information is accurately transmitted from a sender to a receiver. In almost every human society, primitive or complex the primary mode of communication is by speaking or hearing (Berger, 1978). The majority of individual develop language and communication skills that are used over a lifetime with apparent effort. In most case the occasional miscommunication or misinterpretation is easily corrected for some individuals, however communication breakdown happens because of many factors, cleft lip and palate is also a factors affecting normal communication.

Speech refers to the processes associated with the production and perception of sounds used in spoken language. Speech is unique, complex, dynamic motor activity through which we express our thoughts and respond to and control our environment. These processes include respiration, phonation, resonation and articulation.

Speech production is a process where the concept, ideas and feelings are converted into linguistic code: linguistic code into neural code, further neural code into muscular code and finally muscular code into acoustic signal (Ainsworth, 1975). So, speech which is a type of acoustic signal and its production can be explained in terms of

source signal and resonance of the vocal tract. Normal Velo-pharyngeal function is very necessary during speech or singing, depending on the particular sound to be produces. This mechanism leads to nasality or nasal resonance in production of speech.

Nasality is one of the vital factors in the perception of normal speech as well as disordered speech. Individual with cleft palate, velo-pharyngeal insufficiency/inadequacy exhibit resonance disorder, which affects speech intelligibility. Nasality can be explained in terms of clinical components of resonance disorder such as hypernasality, hyponasality and nasal emission. Hypernasality is a resonance disorder that occurs when there is abnormal coupling of the oral and nasal cavities during speech. Hyponasality may be explained as lack of appropriate nasal air during speaking. Nasal air emission refers to the inappropriate release of the air pressure through the nasal cavity during speech production. It is usually audible and presents as a high frequency, low intensity sound.

Fletcher et al., (1974) have coined the term nasalance to described various measures of the balance between the acoustic energy at the nares, An and Ao can be expressed as a simple ratio, An/Ao to yield a measure that can be referred to as a nasalance ratio (NR) or it can be expressed as a percentage (An/Ao + An) to yield a measure that can be referred to as % Nasalance (% N). Each measure contains the same information, but with a different scale. Nasalance measures are a commonly used diagnostic supplement for the speech evaluation of patients with resonance disorders resulting from cleft palate and other craniofacial disorders and it is commonly used by speech-language pathologist to corroborate a perceptual assessment and to provide an additional quantitative measure. Nasalance is measured by making separate recordings of

the oral and nasal sound pressure levels in speech and then calculating the proportional loudness of the nasal sound pressure as a percentage of the total (i.e., nasal plus oral) sound pressure level.

Perceptual assessment of nasality disorder in speech has always been a challenging factor for speech pathologist. This is because there are many factors which affects the reliability nasality ratings. Amidst all these challenges, perceptual ratings remain to be the task that provides information because of its high validity. Therefore it is commonly used in the assessment of velo- pharyngeal inadequacy either as an exclusive criterion or in combination with other techniques (Pannbacker et al., 1984). Accurate assessment of the nasality disorder is crucial since surgery is the treatment option for children with velo- pharyngeal inadequacy. However, perceptual judgment of speech nasality should not be the only assessment procedure opted before the treatment of the velo-pharyngeal inadequacy (Van Demark et al., 1985, Dalston and Warren, 1986). Other objective procedures such as Nasoendoscopy and Videofluoroscopy should also be taken into consideration to assess Velo-pharyngeal function wherein Nasoendoscopy is an invasive method (Kuehn and Moon, 2005).

In recent years, two other instruments, Nasal View and Oro-Nasal System, have been developed and are being marketed by their manufacturers as less expensive and more practical alternatives to the Nasometer. However, these other two systems have no calibration function. The need for a reliable, objective measure of speech nasality was largely met with the Nasometer with high levels of content validity. It is a noninvasive measurement technique and can be practice out of medical setting.

Nasometer assesses the nasality of speech by measuring the acoustic output from both the nose and mouth, using two microphones separated by an acoustic shield that rests on the upper lip (Fletcher, 1970). Moreover, it is a personal computer-based device and can be easily installed and used in modest clinical settings. The Nasometry was designed primarily for the assessment of hypernasality and includes hardware for the analog filtering of the acoustic signals using a 300 Hz bandwidth filter with a centre frequency of 500Hz. The analog speech is sampled at 120 Hz and nasalance is computed from the DC component of the signal. The instrument has been used for the assessment, rehabilitation and for the research purposes.

Earlier studies on nasalance have reported that there are several factors which influence the nasalance measures. These include phonetic structure of the stimuli that is presented (Fletcher et al., 1989; Watterson et al., 1996), native language (Santos-Terron et al., 1991; Leeper et al., 1992; Anderson, 1996), regional dialect (Seaver et al., 1991; Leeper et al., 1992), gender (Fletcher, 1978; Seaver et al., 1991; Leeper et al., 1992), age (Hutchinson et al., 1978; Leeper et al., 1992), and race (Mayo et al., 1996). However, the findings are not universally consistent. For instance, Litzaw and Dalston (1992) and Kavanagh et al. (1994) found no significant gender differences for adult speakers. Additionally, Kavanagh et al. (1994) found no regional differences for three Canadian regional dialects.

Researchers have examined the effects of speaker characteristics on nasalance scores in normal persons. These speaker characteristics have included age, gender,

regional dialect, and native language. The major factor which affects the nasalance measure was language and the linguistic components.

Nasalance depend on various languages. According to Leeper, Rochet and Mackay (1992) the measurement of nasalance in bilingual Canadian French-American English speakers revealed significant within subject difference in nasalance score across the two language, even when care was taken to match the phonetic content of the reading material. Hence, several studies have been conducted to obtain norms for various languages. Nasalance norms for young adult have been derive for Finnish (Haapanen, 1991), Canadian french (Leeper et al., 1992), Spannish dialect (Anderson, 1996; Nichols, 1999), Japanese (Tachimura, Mori, Fale irata and Wada, 2000), Flemish (Van Lierde, Wuyts, De Bodt and Van Cauwenberg, 2001), Cantonese (Whitehill, 2001); Marathi (Nandurkar,2002); Irish (Sweeney et al., 2004); Tamil (Sunitha et al., 2005) , Kannada (Jayakumar, 2005), European Portugese (Fale and Hub Faria, 2008), Hindi (Nita, 2012), and Malayalam (Gnanavel et al., 2013).

There are several studies available on nasalance score in different language for the purpose of assessing and managing resonance impairment. Rainbow passage, Zoo and Nasal Passage are the widely used stimuli for developing normative. The Rainbow passage consist of a mixture of nasal and oral consonant in the approximate proportion found in standard American English, also known as phonetically balance (PB) passage. The Zoo passage consists of only oral speech sounds and was designed to evaluate the degree of hypernasality in a subject's speech. The nasal passage contain 35% nasal consonant, which is three times greater than the frequency of occurrence of nasals in

standard American English and was designed to assess the presence of hypo-nasality in subject's speech (Seaver, Daltson, Leeper and Adams, 1991). Studies were also done in Indian Languages by Nandurkar (2002), Sunitha et al., (2005) Jayakumar (2005), Nita (2012) and Gnanavel et al., (2013) using oral and nasal sentences as stimuli in Marathi, Tamil, Kannada, Hindi and Malayalam language respectively. Arya (2009), Ravindra (2009) considered oral and nasal sentences and paragraph in Hindi and Malayalam languages respectively. As the nasalance value is different across language and stimuli, it is essential to establish normative data of all the language and stimulus. It is also determine by the number of nasal sounds and the frequency with which these occur in the language. Among the Indian language, Manipuri is one language which has 3 nasal consonant i.e., /m/, /n/ and /ŋ/ (Chelliah S L, 1990). Meithei (Meitei) /ˈmeɪteɪ/ or Manipuri /mænɨˈpʊəri/ is a Sino-Tibetan language. It is the main language and lingua franca in the southeastern Himalayan state of Manipur, which is located in northeastern India. Meithei is also used by the people in other states of India such as Assam and Tripura, and in neighboring countries such as Bangladesh and Myanmar. Meithei is a Sino-Tibetan language. It has lexical resemblances to Kuki and Tangkhul Naga. It is spoken by around 1.5 million people (2010 census). There are no exact estimates of incidence of cleft lip and palate in Manipur state till now but there are reports stating the overall incidence of the problem in North East is higher than in the rest of the country. The reason why the incidence of cleft is higher in the North Eastern populace is not exactly nor conclusively known.

In addition, nasalance is also found to vary across genders in normal speakers. These variations in the nasalance across gender are attributed to the differences in

structural and functional framework between the genders. These differences include size, shape, and surface of infraglottal and supraglottal cavities and structures. Earlier studies have reported that female speakers have significantly higher nasalance scores than male speakers when measured using a nasal passage (Seaver et al., 1991; Van Lierde et al. 2001). In contrast, increased nasalance scores were obtained for male speakers compared to females on nasal passage (Fletcher, 1979).

Very limited studies have done on the effect of age on nasalance value. Trindade (1997) did a study on three groups of speaker: Children younger than 11 years, adolescent (11 to 17 years, and adult (17 years). He found out that children had significantly lower nasalance scores during production of non nasal passage for normal Brazilian Portuguese speakers. No statically significant difference in scores was found between children and adolescents. Similar results were also reported by Fletcher et al. (1989). Some studied had used different stimulus for children and adults (Jayakumar, 2008). However, few should showed clear age group difference in nasalance score.

Nichols (1999) found out that there is minimal difference between adults (4%) and younger children (5%) for on nasal passage. Though small difference was seen, yet it was significant. Whitehill (2001) reported no significant correlation between age and mean nasalance score. But this result was attributed to small sample considered for the study.

In the study done by Van Lierde et al. (2003), the results revealed that the adults had significantly higher nasal resonance scores for the vowel /a/, /i/,/u/ and when stimuli

consisted of nasal sounds. They also reported that age related difference in nasal resonance scores were not based on obvious alteration in Velo-pharyngeal function, but more related to developmental change in speech mechanism and difference in speech programming. When comparison of nasal resonance score of male and female adults were compared with those of male and female children, age had a significant effect on the vowel /a/ across gender. Their results corroborate the findings of Seaver et al. (1991) and Leeper et al. (1992) who reported higher nasal resonance score for adult than children.

Assessment of resonance disorder in speech has been traditionally proved to be a difficult perceptual task for speech pathologies. Objective evaluation of velo-pharyngeal function is the key to diagnosis and therapy control of velo-pharyngeal dysfunction. Hence in order to select the treatment, the need for a reliable, objective measure of speech nasality with high level of content validity was largely met with the Nasometer. It employs non invasive techniques and can be used easily outside medical setup. Nasometry validity has generally shown high levels of correspondence between listener's judgment of speech nasality and the nasalance measure made by the device (Hardin et. al, 1992). Thus, the studies have shown that the nasalance values of speech are influenced by the phonetic composition of the language, native language, regional dialect, gender and age. This concludes the strong need for developing normative nasalance scores which is region specific since there are few standardized normal nasalance scores for normal speakers that have been established in Indian languages including languages such as Manipuri population.

Aim of the study

The aim of the study was to develop normative scores on Nasometer for adult population whose native language is Manipuri.

Objective of the study

The objectives of the study were

1) To obtain nasalance norm (Mean and Standard deviation) for oral and nasal Manipuri sentences in adult population.

2) To estimate a normative score (Mean and Standard deviation) for English Zoo passage and Nasal passage in native adult speaker of Manipuri.

3) To examine nasalance scores as a function of gender for oral and nasal Manipuri sentence in adult if any.

CHAPTER II

Review of Literature

Speech refer to the processes associated with the production and perception of sounds used in spoken language. Speech is unique, complex, dynamic motor activity through which we express our thoughts and respond to and control our environment. These processes include respiration, phonation, resonation, articulation

Speech disorders may arise from deficits related to the form and functions of any one of these respiratory, phonatory, resonatory, and/or articulation mechanism. Individuals with cleft palate, velo- pharyngeal inadequacy/insufficiency, dysarthria present with resonance disorders. Nasality can be explained in terms of clinical components of resonance disorders such as hypernasality, hyponasality and nasal emission. Hypernasality may be explained may be explained as a present as the productions of vowels or vowel-like consonants. Hypernasality may be explained as lack of appropriate nasal air during speaking. The term nasal emission is the presence of turbulent noise production during the production of high pressure consonants.

Various objective methods have been developed for assessing the nasality. These methods can be classified as direct and indirect methods. Direct objective methods such as nasal endoscopy and video fluoroscopy are widely used to evaluate the velo-pharyngeal dysfunctional which has greater reliability. However, nasal endoscopy is invasive and video fluoroscopy exposes clients to radiations. Additionally, these

techniques must be conducted in medical settings and thus are not always available to speech language pathologies.

Fletcher et al. (1974) have coined the term nasalance to describe various measures of the balance between the acoustic energy at the nares, (An) and the acoustic energy at the mouth, (Ao) during speech, this balance between An and Ao can be expressed as a simple ratio, An/Ao +An to yield to a measure the can be referred to as % Nasalance (%N) .Each measure contains the same information, but with a different scale. In 1986, Kay Element introduced an addition to the instrumental devices available to clinicians working with subject who manifest velopharyngeal impairments. This device is known as Nasometer, a microcomputer-based instrument that calculates "nasalance'. This computer based instrument employs microphones on either side of a sound separator plate, which rests on the upper lip.

The signal from each microphone is filtered and digitized by custom electronic module. Band-pass filter is also one of the important instrumentation of Nasometer. Band-pass filters (two in number) consists of cascaded low pass and high pass 4 pole butterworth filters, with -3dB points of 350 Hz and 650 Hz respectively. Thus energy below about 300Hz and above 750 Hz would be significantly attenuated components would therefore include the voice fundamental frequency component would therefore include the fundamental frequency component (especially for adult male voices) and formant energy above the first formant for most vowels (Rothenberg, 1999). The data are then processed by computer and accompanying software. (Dalston et al., 1991a, 1997; Seaver et al, 1991; Nellis et al., 1992)

Investigations have been done to determine the aspects which influence the nasalance score of a normal speaker. These studies have shown that nasalance of normal speech is sensitive to the phonetic structure of the speech stimulus (Fletcher et al., 1989; Watterson et al., 1996), native language (Santos-Terron et al., 1991; Leeper et al., 1992; Anderson, 1996), regional dialect (Seaver et al., 1991; Leeper et al., 1992), gender (Fletcher, 1978; Seaver et al., 1991; Leeper et al., 1992), age (Hutchinson et al., 1978; Leeper et al., 1992), and race (Mayo et al., 1996). However, the findings are not universally consistent. For instance, Litzaw and Dalston (1992) and Kavanagh et al. (1994) found no significant gender differences for adult speakers. Additionally, Kavanagh et al. (1994) found no regional differences for three Canadian regional dialects.

Normative data nasalance score in different languages for adult population

There are several studies available on nasalance score in different language for the purpose of clinical assessment and management of resonance impairment. Most normative data were collected from English speaking Caucasian American Children and adult using reading passage as stimuli (Eg. Rainbow passage, Zoo passage and Nasal Passage). The Rainbow passage contain a mixture of oral and nasal consonant in the approximate proportion found in standard American English, also known as phonetically balance (PB) passage. The Zoo passage contains only oral speech sounds and was designed to assess the degree of hypernasality in a subject's speech. The nasal passage contain 35% nasal consonant, which is three times greater than the frequency of occurrence of nasals in standard American English and was designed to test the presence of hypo-nasality in person's speech (Seaver, Daltson, Leeper and Adams, 1991). These

studies indicated that nasalance scores were also done in Indian Languages by Nandurkar (2002), Sunitha et al., (2005) Jayakumar (2008), and Nita (2012) using oral and nasal sentences as stimuli in Marathi, Tamil, Kannada and Hindi language respectively. Arya (2009), Ravindra (2009) considered oral and nasal sentences and paragraph in Hindi and Malayalam languages respectively. As the nasalance value is different across stimuli, it is essential to establish normative data of all the stimuli (Vowels to paragraph).

Haapanen (1991) studied the nasalance scores in finnish population to obtain reference nasalance score using Nasometer 6200 II. The study consisted of total 50 subjects in whom 42 were normal healthy group (group H) and 8 subjects had cleft lip and alveolus (group CLA) in the age range of 3 to 54 years. Speech material consisted of the three different types of sentences. Results indicated that the mean nasalance value for non nasal sentence varied from 9.6 % to 14.8% depending on the sentence type. The variation of nasalance varied from 20.4 % to 22.7%. Finnish scores between 22% and 29 % might be regarded as normal.

Tachimura, Mori, Hirata, & Wada (2000) examined nasalance score variation for normal adult Japanese speaker of mid west dialect and the gender difference in average mean nasalance score. Nasalance score were obtained using a Nasometer model 6200. The sample stimulus “Kitsutsuki passage”, constructed of four sentences containing no Japanese nasal sounds, was used three times by each subject. They considered one hundred normal adult speakers (50 women and 50 men) of Japanese as subjects. The subject’s age range was 19 to 35 years. A mean nasalance score as well as an overall average nasalance value across speaker was calculated for each subject. The average

mean nasalance score for the normal Japanese speaker was 9.1 %. There was no statistical significant across gender. Average mean score of 9.8 % and 8.3 % were obtained for the female and male speakers respectively.

Hirschberg, Bók, Juhász, Trenovszki, Votisky & Hirschberg (2006) developed normative nasalance score in Hungarian language. He also compared the results with the data of other language and to evaluate the co-relation between nasalance scores and perceptual rating of nasality. The subjects taken were 30 children aged 5-7 year and 45 adults in the 20-25 years age group. In the latter group 15 subjects were speech therapist and 30 phonetically untrained people-15 males and 15 females. Speech stimuli included phonation of isolated vowels, articulation of spirants, cyclical repetition of affricates, and pronunciation of various (oral, nasal, mixed type) sentences and evaluation of the nasalance score in continuous speech was recorded. Two hundred and forty eight children of kinder garden age were examined. The mean value of the nasalance score using the oral sentence “zsuzci kutyaja ugat” was 11-13 %, nasal sentence (“ a mjom banant enne”) 56% while that of the mixed sentence representing the Hugrarian language (“jo napot kivanok”) was 30-40% range. The authors concluded that the resonance grows with aging and they did not find any difference across gender. The nasalance score was greater with phonetically trained adults compared to phonetically untrained.

Jayakumar (2005) developed normative data on nasalance in Kannada language for children and adults. The study considered 50 adults within the age range of 20-35 years. The results revealed that the nasalance values were different between genders; with

males having higher nasalance values than females. This difference in scores was attributed to the structural and functional differences between the genders.

Mahesh and Pushpavathi (2008) developed normative data on nasalance for non native English speakers. They also investigate gender difference on nasalance score. 35 males and 35 females with the age range of 18-30 years were taken for the study. Nasalance value ranged from 8%-27%, in males and 9%-28% in females.

Okalidou (2010) derived nasalance norms and effect of gender in nasalance score in Greek adults. The stimuli included corpus of linguistic material: i) a nasal text, an oral and balanced, ii) a set of nasal sentence and 4 sets of oral sentence and iii) repetition of each of 12 syllables types (8 oral and 4 nasal). Eighty monolingual healthy young adult speakers of Greek, 40 males (mean age 21 years) and 40 females (mean age 20.5 years) with normal speech and hearing characteristics were included in the study. The Nasometer (Model 6200 III) was used to estimate nasalance scores. Results of this study indicated that the mean nasalance scores obtain for the G-nasal text (40%)were significantly higher than those obtained for the oronasal 27% and 22% G-oral text. For sentences and syllables orally loaded material yield lower nasalance loaded material.

Akcam (2011) obtained normative nasalance scores for adult and children speaking Turkish language. 35 normal speaking children and 125 adult participants were taken for the study. Nasometer (Model 6200) was used. The task was repetition of 3 passages that were categorized according to the amount of nasal consonants (oral, oronasal and nasal passage). The result indicated a group mean ± standard deviation

nasalance score of children for oral passage, oronasal passage and nasal passage were 15.23% (±4.87), 37.69% (±4.42) and 49.00 (±6.99) respectively. Nasalance scores for the adult group were 15.77% (±13.15), 38.46% (±11.11) and 49.49% (±10.28) respectively. The results suggest the significant difference in mean nasalance score for oral versus nasal material for both the groups.

Nita (2012) conducted a study to obtain normative data on nasalance values for Hindi speaking adults. Fifty adults (25 males and 25 females in the age range of 17-30 years) with normal speech, language and hearing were assessed. Vowel /a/, /i/, /u/ were taken as stimuli and nasalance score were obtained for the subject across gender. They reported that vowel /i/ had higher nasalance score compared to other vowels across gender. The result indicated the increased nasalance value was seen in female compared to male nasalance mean score in male speaker for oro-words, sentences and paragraph was 20.40% (6.17), 16.12% (5.75), 13.64% (4.93) respectively and for nasal words, sentences and paragraph was 56.08% (6.20), 57.44% (7.04), % 8.20 % (8.01) respectively. In female speakers, nasalance value for oral words, sentences and paragraph was 24.24% (7.83), 21.92% (6.89), respectively and for nasal words, sentences and paragraph 59.76% (6.78), 61.60% (7.12), 63.32% (7.25) respectively.

Normative data of nasalance score across gender

There are some controversy research reports regarding gender difference in mean nasalance scores in normal speakers. Studies have concluded that the variations in nasalance across genders were due differences in the structural and functional framework

along with changes in size, shape and surface of the resonating structures and cavities. Several studies have concluded that male speakers had higher nasalance values compared to females (Seaver et al., 1991; Van Lierde et al. 2001) whereas this was contradicted by certain other evidences which concluded that women had higher nasalance values (Hutchinson, 1978).

Seaver (1991) studied the nasometric values for normal nasal resonance of normal 148 English speaking adult subjects. The subjects include 92 female and 56 male in the age range of 16.17 years to 63.33 years with the mean age of 33.07 years. Reading passage, nasal passage, the rainbow passage and the zoo passage were used as a stimulus. The results indicated that mean nasalance scores for nasal sentence range from 57% to 66 % mean nasalance score for the rainbow passage was ranging from 11% to 22%. The authors reported a significant difference across the nasalance scores of the three passages. Nasal sentence showed higher nasalance scores than rainbow and zoo passage. The male subjects had significantly lower nasalance than the female subject on the nasal sentence. Authors have discussed the variables associated with the increase nasal air flow rate in female speaker in terms of respiratory efforts, increased nasal cross sectional area and filter characteristic of the Nasometer. The authors also explained that the difference could be due to larger nasal cross sectional area in females than in males resulting in increase amount of sound energy radiated from the nasal cavity in them.

Van Lierde (2001) found nasalance scores for oronasal text and nasal texts were higher for the female group (female nasalance score 57.4%, male nasalance score 54.2 %). But no significant difference was found for the oral text (female nasalance score

11.6%, male nasalance score 10.2 %). No statistically significant difference was found across gender for oral passage. The data suggest that the female subjects exhibited nasalance scores for oronasal passage. The results were due to basic structural and functional difference across gender. A large number of laryngeal and velo- pharyngeal anatomical, physiological and aero dynamical gender related difference may affect the functioning of resonance system. The mechanism for velo- pharyngeal valving has been found to differ for men and women.

Many of the studies reported that a significant difference was not evident in nasalance scores across gender (Van Lierde et al. 2003, Sweeney et al. 2004).

Van Lierde et al. (2003) had examined nasalance score in Flemish language. 58 adults were included in the study. They have used oral, oronasal and nasal text stimuli. Recordings were made and nasal resonance data was obtained. Results suggested that women had higher scores than men during the production of the /u/ in the oro nasal text and nasal text. But it was not statistically significant.

Sweeney et al. (2004) investigated typically developing Irish children in the age range of 4 – 13 years. Sixteen sentences were presented according to consonant type (high pressure low pressure and nasal consonant). Normative nasalance scores were calculated and they found that the group mean nasalance score for boys was 26% (SD 4.18) and for girls it was 27 % (SD of 4.12). They could not find any significant gender difference in nasalance score.

Normative data of nasalance score across age group

Very limited studies have done on the effect of age on nasalance scores. Trindade (1997) studied three groups of speaker: Children younger than 11 years, adolescent (11 to 17 years, and adult (17 years). The results revealed that children had significantly lower nasalance scores during production of non nasal passage for normal Brazilian Portuguese speakers. There was no statically significant difference in scores between children and adolescents. Similar results were also reported by Fletcher et al. (1989).

Nichols (1999) reported the minimal difference between adults (4%) and younger children (5%) for on nasal passage. Even though the small difference was seen, it was significant. The result was in agreement with Santos Erron et al. (1991) who reported lesser average nasalance for non-nasal materials increase as the age increase.

Whitehill (2001) reported no significant correlation between age and mean nasalance score. But this result was attributed to small sample considered for the study.

Van Lierde et al. (2003) reported that the adults had significantly higher nasal resonance scores for the vowel /a/, /i/, /u/ and when the reading stimuli included nasal consonants. They also suggested the age related difference in nasal resonance scores were not based on obvious alteration in velo- pharyngeal function, but more related to developmental change in speech mechanism and difference in speech programming. When comparison of nasal resonance score of male and female adults were compared with those of male and female children, age had a significant effect on the vowel /a/ across gender.

CHAPTER III

Method

Participants

Eighty typical Manipuri speaking adults participated in the study. The participants were divided into two groups wherein 40 females in the age range of 17-35 years constituted the first group and the second group consisted of 40 males in the age range of 17-35 years. All the participants were native Manipuri speakers. Mean age of the group is 26 and the literacy level of the subjects were PUC and above.

The background information regarding medical history and information about hearing sensitivity of every participant were collected before the recording. The oral mechanism examination and linguistic skills of the participants were evaluated informally by an experienced Speech Pathologist before the session. The participants who satisfied the criteria of having normal hearing sensitivity, oro-facial structure and function and speech-language abilities were only considered for the study.

Stimuli

Two sets of meaningful Manipuri sentences were prepared. One set consisted of nasal sentences, which contained predominantly nasal consonants and the other set constituted oral sentences, containing only oral consonants. Each category consists of 10 sentences. The sentences are selected by an experienced speech language pathologist whose native language is Manipuri. The sentences selected ranged in length from three to four words (6 to 10 syllables). Two common passage i.e Zoo passage which is an oral

paragraph (Fletcher, 1972), and Rainbow passage which is a phonetically balance paragraph (Fletcher, 1972) were also be used as stimuli to measure the nasalance in English text.

Instrumentation

The Nasometer II (6450) a microcomputer based system developed by Kay Elemetric, NJ was used for collecting the data. The Nasometer consist of head set containing a sound separator with microphones on either side which detects oral and nasal components of speech which rest on the upper subject's upper lip. The signal from each of the microphones is filtered individually and digitized by customized electronic modules. This software program was loaded to Workstation, Z100 computer. The resulting signal was the ratio of nasal/nasal+oral acoustic energy in terms of percentage (nasalance) X100

Nasalance= (nasal/ nasal+ oral) X 100

The Nasometer was set up in a suitable quiet laboratory. Calibration of the Nasometer was done every day before the actual measurement.

Procedure

Each subject was made to seat with his or her head in an upright position. The height of the seat was adjusted so that subjects could read the stimulus exhibited on the display without moving their head. The Nasometer head set was adjusted and secured firmly according to the manufacture's instruction. All subjects were asked to read the stimulus three times. This was repeated after 30 minutes on the same subject for the

purpose of test and re-test reliability (10% of the subjects). The nasalance trace will be monitor continuously throughout each recording to ensure that the data has being captured. At the completion of each session, the nasalance traces were store on computer file for analysis. An average value of mean nasalance score for each subject will be obtain by averaging three mean scores, each of which were displayed using the analysis function of the Nasometer program.

Data Analysis

Data was estimated for all the sets of stimuli. Data files were subjected to a screening process to ensure that no inaccurate data are included in calculation of population. Once the data is screened for the entire subject, the mean, maximum, minimum nasalance for each stimulus in each set was calculated. Mean value of each stimulus was calculated. Using the Nasometer statistical function, these score were computed into a separate sheet suitable for subsequent statistical analysis using "SPSS" program software package (version 18.0 package). Descriptive statistic, independent "t" tests and Mann- Whitney U test was used for analysis.

CHAPTER IV

Results

The present study aimed to establish the normative nasalance values for Nasometer II (Model 6450) for Manipuri language in adult population. Descriptive statistic, Independent t test and Mann-Whitney 'U' test was used to understand the data. The data was analyzed using SPSS software (version, 18.0) package.

The results were presented under the following headings:

a) Normality and reliability of the nasalance data

b) Nasalance score for individual nasal sentences and oral sentences

c) Effect of gender on nasalance scores of Manipuri speaking individuals

d) Normative value for nasalance

a) Normality and reliability of the nasalance data

Normality test was done to check the distribution nature of the data. Scores of nasal sentence falls under normality except for two sentences however most of the oral sentences scores falls under non-normal distribution and Zoo passage and Rainbow passage also do not follow the normality trend. Thereby a non- parametric test was selected to analyze the data. Table 1 shows K-S value for nasalance value (Normality).

	Kolmogorov-Smirnov (n=80)	
	K-S score	p-value
Nasal sentence		
1	0.08	0.20*
2	0.05	0.20*
3	0.07	0.20*
4	0.06	0.20*
5	0.08	0.19*
6	0.07	0.20*
7	0.08	0.20*
8	0.06	0.20*
9	0.08	0.20*
10	0.12	0.00
Total	**0.08**	**0.20***
Oral sentence		
1	0.11	0.01
2	0.09	0.08*
3	0.12	0.00
4	0.09	0.08*
5	0.15	0.00
6	0.10	0.02
7	0.13	0.00
8	0.10	0.02
9	0.08	0.20*
10	0.12	0.00
Total	**0.09**	**0.04**
English passages		
Zoo passage	**0.08**	**0.20***
Rainbow passage	**0.08**	**0.20***

* - *Non- normal distribution*

Table 1.K-S value for nasalance value (Normality)

Reliability of nasalance scores

Test retest reliability was used to check the reliability of the nasalance score. Cronbach's Alpha Reliability Coefficient was estimated for mean nasal and oral sentences. The result should 0.87 and 0.92 respectively for nasal and oral sentences. Similarly it was also estimated for Zoo passage and Rainbow passage. The result should 0.85 and 0.82 respectively for Zoo passage and Rainbow passage.

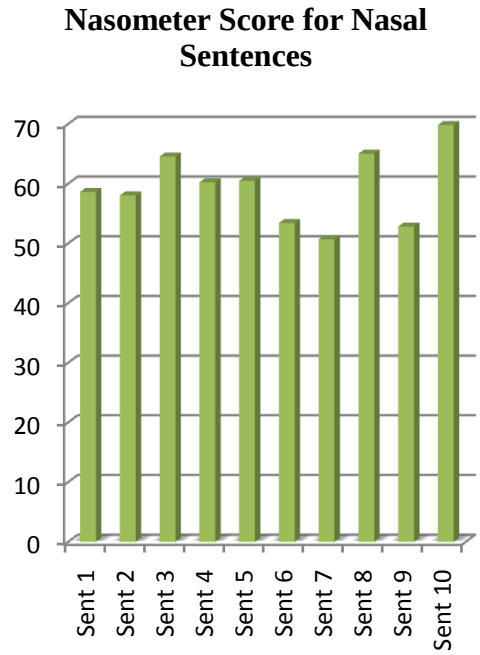
b) Nasalance score for individual nasal and oral sentences

Mean nasalance score for all the nasal and oral sentences was obtained through descriptive statistical analysis. The mean scores, standard deviation, range and median scores are depicted in the table 2 for each sentence. The standard deviation for nasal sentence was within scores of 9 except for two individual sentences. However, the standard deviation for oral sentences was comparatively higher than nasal sentence. The mean nasalance value for oral and nasal sentences has been depicted in Figure 1 & 2.

		Mean	SD	Range (Min &Max)	Median
Nasal sentence	1	58.61	8.64	39.00-80.00	80.00
	2	58.02	6.96	43,00-75.00	75.00
	3	64.53	7.75	45.00-81.00	81.00
	4	60.21	8.28	41.00-76.00	76.00
	5	60.46	10.35	3.00-78.00	78.00
	6	53.41	9.78	33.00-77.00	77.00
	7	50.65	9.95	29.00-73.00	73.00
	8	65.01	8.76	46.00-83.00	83.00
	9	52.81	10.09	28.00-74.00	74.00
	10	69.83	8.06	46.00-84.00	84.00
	Total	**59.46**	**7.21**	**42.50-76.00**	**60.50**
Oral sentence	1	23.96	12.26	6.00-61.00	23.00
	2	20.46	10.33	6.00-45.00	19.50

	3	22.48	10.86	6.00-52.00	21.00
	4	25.27	12.42	7.00-58.00	24.00
	5	20.93	11.24	6.00-49.00	17.50
	6	22.22	10.88	7.00-45.00	20.00
	7	18.85	9.22	6.00-40.00	16.50
	8	22.18	9.04	3.00-45.00	22.00
	9	21.22	10.57	5.00-54.00	20.00
	10	25.06	9.65	8.00-52.00	23.00
	Total	**22.58**	**9.53**	**7.00-44.50**	**20.75**

Table 2. Nasalance score for individual nasal and oral sentences



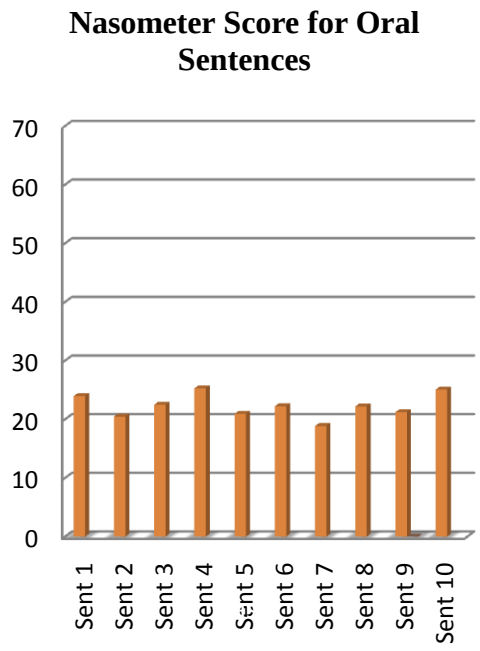


Figure1. Nasalance score for nasal sentences *Figure 2. Nasalance score for Oral sentences*

c) Effect of Gender on Nasalance scores of Manipuri speaking Individuals

i) Comparison of nasal sentences across gender

The normative mean nasalance values for adult Manipuri speaking individuals for individual nasal sentences and the overall mean across gender are depicted in table 3. The mean values for four individual nasal sentences were higher for male while for remaining

sentences; the mean nasalance scores were higher in female. The standard deviation for males was higher than female. The mean values and standard deviation were similar in both the genders. Mann- Whitney 'U' test was done to find the significant difference across gender. The result showed that there was no significant difference between males and females for nasal sentences.

Nasal sentences	Male		Female		|Z|- value	p-value
	Mean	SD	Mean	SD		
1	59.25	9.47	57.98	7.81	1.01	0.30
2	58.30	7.03	57.75	6.97	0.56	0.57
3	65.65	7.38	63.43	8.05	1.43	0.15
4	60.05	7.63	60.38	8.97	0.22	0.82
5	59.10	11.98	61.83	8.35	0.04	0.29
6	51.77	10.15	55.05	9.24	0.55	0.12
7	50.60	10.41	50.70	9.61	0.13	0.89
8	64.90	8.88	65.13	8.75	0.05	0.95
9	51.65	10.49	53.98	9.68	0.87	0.38
10	70.35	8.01	69.33	8.19	0.48	0.62
Total	**59.30**	**7.23**	**59.63**	**7.28**	**0.16**	**0.86**

Table 3. Mean Nasalance score, SD and |Z| value for nasal sentence across gender.

ii) Comparison of oral sentence across gender

Table 4 depicts the nasalance value for oral sentence across gender. It shows that female exhibit higher score than males. The entire mean for individual sentence was higher for female than male. The standard deviation for individual sentence was also higher for female than male. Mann- Whitney U test was carried out to find the significant difference across genders for oral stimuli. The result shows that there was no significant difference across genders for oral sentences.

Oral sentences	Male		Female		|Z|- value	p- value
	Mean	SD	Mean	SD		
1	21.22	10.08	26.70	13.69	1.79	0.07
2	18.20	9.01	22.72	11.16	1.83	0.06
3	21.00	9.25	23.97	12.20	1.84	0.39
4	23.37	10.52	27.17	13.94	1.05	0.29
5	19.07	10.06	22.80	12.15	1.20	0.22
6	19.50	9.82	24.95	11.33	2.15	0.03
7	17.62	8.87	20.07	9.52	1.07	0.28
8	20.47	8.01	23.90	9.77	1.20	0.22
9	20.10	9.20	22.35	11.80	0.57	0.56
10	24.47	9.27	25.65	10.11	0.25	0.79
Total	**20.95**	**8.33**	**24.21**	**10.44**	**1.21**	**0.22**

Table 4. Mean Nasalance score, SD and |Z| value for oral sentence across gender

iii) Comparison of Zoo passage and Rainbow passage across gender

The below table 5 depicts that mean score of females had higher score for zoo passage and rainbow passage. To find the significant difference across gender for both the passage, Mann- Whitney U test was carried out. The results revealed that there is no significant difference across gender for both the passages. Figure 3 shows the mean nasalance score for oral sentences, nasal sentence, Zoo passage and Rainbow passage.

	Male		Female		|Z|- value	p- value
	Mean	SD	Mean	SD		
Zoo passage	16.97	7.79	18.7	7.28	1.98	0.32
Rainbow passage	38.00	7.31	38.95	7.37	1.12	0.26

Table 5.Nasalance score for zoo passage and rainbow passage across gender

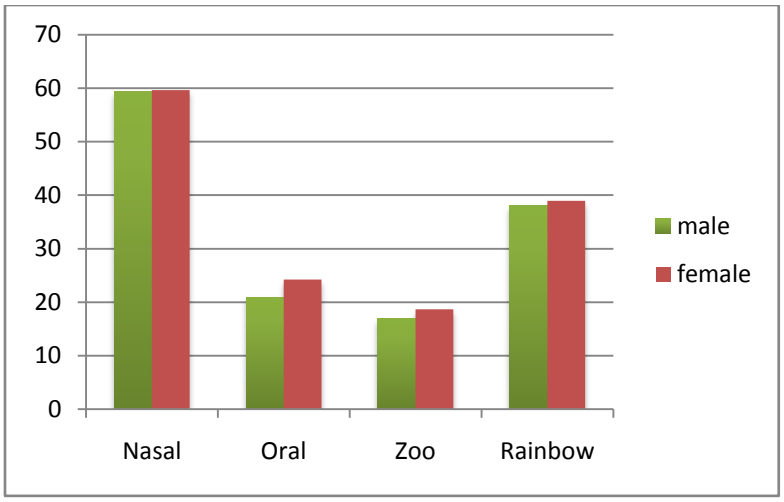


Figure 3. Nasalance score for Nasal, Oral, Zoo and Rainbow passage across

d) Normative value for nasalance

In the present study, nasalance score did not show any gender difference in any of the sentences (or) passages. Hence, the gender division was removed and the overall mean nasalance for adult population in adult population in Manipuri language was given in table 6. The normative was separately given for nasal and oral sentences along with Zoo and Rainbow passage. The scores were depicted in table 6. The median score and the range for sentences and passages were also depicted in the table. Since there was no significant difference across gender, the results are shown as a combine score.

	Mean	SD	Median	Range (Min- Max)
Nasal sentences	59.46	7.21	60.50	42.50-76.00
Oral sentences	22.58	9.53	20.75	7.00-44.50
Zoo passages (Oral)	17.84	7.54	17.00	1.00-41.00
Rainbow passages (Phonetically balanced)	38.00	7.36	37.00	25.00-58.00

Table 6. Normative nasalance value for Manipuri language in adult population

CHAPTER V

Discussion

The present study aimed to obtained normative nasalance values for Manipuri speaking adults using different type of speech sample. There are no normative nasalance score available for Manipuri speaking individuals. The secondary aim of the study was to establish normative nasalance scores for Manipuri speaking adults for oral passage (Zoo passage) and phonetically balanced passage (Rainbow passage) . The study also focused on the effect of genders

Results of the present study revealed a considerable difference across the mean nasalance obtained from oral and nasal stimuli. It also shows that mean nasalance value obtained for nasal sentence is higher i.e. 59.46% (7.21) than the mean nasalance score obtained for oral sentence i.e. 22.58 % (9.53).

This increase in the mean scores for nasal sentences could be attributed to the phonetic composition within the nasal and oral stimuli. In addition, it could be because of the structural specifications with respect to the resonating cavities. While production of nasal stimuli, the acoustic energy gets transferred to the nasal cavity through the open velopharyngeal port whereas production of oral sounds is characterized by a closed velopharyngeal port. This closed port manifests the reduction in transfer of energy into nasal cavity resulting in an increase in oral acoustic energy. Thus, 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 (1989) and it is well documented finding.

Results of the present study supports the findings of Haapanen et al. (1991), Whitehill et al. 2000, Van Lierde et al. 2001, Okalidou et al 2010 and Akcam et al 2011 who reported a significant difference in nasalance across stimuli. Among the Indian studies, the present study results also support the findings of Jayakumar T (2005), Nita (2012) and Gopi Shankar et al (2013).

Jayakumar T (2005) conducted a study to develop normative nasalance data in Kannada language for adults using Nasometer. The results of the study showed a significant difference across nasal (Male: 48.27% and female; 58.22%) and oral stimuli (male: 8.77% and female: 14.69%). The author concluded that this difference could be attributed to difference in characteristic phonetic structure of the nasal and oral stimuli. Similar finding was also reported by Gopi Shankar et al. 2013 where they observed variation in nasalance score across nasal (male:77.95% and female: 71.83%) and oral stimuli (Male: 24.58% and female: 28.85%) 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 (1989). On the whole, transpalatal transfer of energy accounts for nasalance of speech stimuli.

Nita (2012) also reported a significant difference in nasalance score across nasal (male: 57.44% and female: 61.60%) and oral stimuli (male: 16.12% and female:

21.92%) in Hindi speakers. She concluded that the findings can be attributed to the change of closure of velopharyngeal port.

A considerable difference was evident between mean nasalance obtained from oro-nasal passage (Rainbow passage) and oral paragraph (Zoo passage). Rainbow passage contains 11.6 % of nasal consonant whereas Zoo passage do not have nasal consonant. Since Rainbow passage contain nasal consonant, it has higher nasalance score than Zoo passage. Similar findings were reported by several authors (Seaver., 1991, Anderson., 1996, Whitehill., 2000, Van Lierde et al., 2001, Tim Bressmana., 2005). Mahesh and Pushpavathi (2008) also reported the similar findings in their study. They developed normative data on nasalance for Zoo passage and Rainbow passage for non-native English speakers in Indian population. Their results showed that nasalance value for Rainbow passsage was17.5% in males and 18.5% in female and for Zoo passage was 27.93% in males and 31.39% in females. Indian study (Mahesh & Pushpavathi., 2008 and present study) has higher nasalance score in Zoo passage than other western studies. Table 7 shows the mean for Zoo passage (oral passage) and Rainbow passage (Phonetically balanced) in different population.

Author (year)	Gender	Zoo passage (Mean)	Rainbow passage (Mean)
Present Study (2016)	Male	16.97	38.00
	Female	18.70	38.95
Mahesh & Pushpavathi (2008)	Male	17.50	27.93
	Female	18.50	31.39
Tim Bressmann (2005)	Both	13.45	39.01
Van Lierde et al., (2001)	Male	12	32
	Female	13	34
Seaver (1991)	Both	11	32

Table 7. Mean of Oral Passage and Oro-nasal Passage in Different population

The present study also investigated the effect of gender on nasalance value. In the present study 40 males and 40 females' subject participate in the study. The nasalance value was compared across all the stimuli in both males and females. The results shows that there was no significant nasalance mean scores for nasal stimuli in males and females. However, the results show that the nasalance scores were greater in females compared to males for oral sentences, Zoo passage and Rainbow passage.

Author (year)	Language (Indian)	Gender	Mean Nasal sentences (SD)	Mean Oral sentences (SD)	Gender difference
Present study (2016)	Manipuri	Male	59.30 (7.23)	20.95 (8.33)	Absent
		Female	59.63 (7.28)	24.21 (10.44)	
Gopi Shankar (2013)	Malayalam	Male	77.95(3.46)	24.58 (7.49)	Present
		Female	71.83 (4.39)	28.85 (8.62)	
Nita (2012)	Hindi	Male	57.44 (7.04)	16.12 (5.75)	Present
		Female	61.60 (7.12)	21.92 (6.89)	
Jayakumar T (2005)	Kannada	Male	48.27 (8.74)	08.77 (4.76)	Present
		Female	58.22 (8.40)	14.69 (5.86)	

Table 8. Nasalance value across different Indian language

There is some controversy concerning gender differences in nasalance score variation. Some studies have reported significantly higher nasalance scores for female speakers for the nasal passage, the Rainbow passage, or both (Seaver et al., 1991; Leeper et al., 1992) and some studies reported gender difference for Zoo passage (Dalstons et al, 1990). Other studies reported that there was no gender difference (Seaver et al., 1991; Leeper et al., 1992; Litzaw and Dalston, 1992; Mayo et al., 1996; Vallino-Napoli and Montgomery, 1997; van Doorn et al., 1998). Table 8 shows nasalance value across different Indian language where majority of the Indian study showed gender difference. In the current study, there was no significant difference between scores of female and male for nasal and oral sentence in Manipuri

and Zoo passage and rainbow passage. However, there was a higher nasalance score in females for Oral sentences, Zoo passage and Rainbow passage. This can be attributed to the anatomical and physiological reasons. The functioning of resonance system is affected by laryngeal and velo- pharyngeal anatomical, physiological and aero-dynamic gender related difference. The mechanism for velo- pharyngeal opening and closing is reported to be different for man and women.

Mckerns and Bzock (1970) reported gender difference in the pattern of orientation and movement of velopharyngeal closure. They observed that male speakers showed higher velar elevation and place of closure, greater velar length and larger distance between the tip of uvula and the posterior pharyngeal wall. Men demonstrated larger variability in velopharyngeal closure across various consonants (Kuehn and Moon (1998). This variability can be attributed to a reduced upward movement of the velum which resulted in inadequate Velopharyngeal closure force.

The present results also support the findings of Tachimura et al. (2000) where they examined nasalance score variation for normal adult Japanese speaker of mid west dialect and the gender difference in average mean nasalance score. A mean nasalance score as well as an overall average nasalance value across speaker was calculated for each subject. The average mean nasalance score for the normal Japanese speaker was 9.1 %. There was no statistical significant across gender. Average mean score of 9.8 % and 8.3 % were obtained for the female and male speakers respectively.

Similar results were also found in the study done by Hirschebrg et al. (2005) where they developed normative nasalance score in Hungarian language. He also compared the results with the data of other language and to evaluate the correlation between nasalance scores and perceptual rating of nasality. The authors concluded that the resonance grows with aging and they did not find any difference across gender. The nasalance score was greater with phonetically trained adults compared to phonetically untrained.

Whitehill et. al. (2000) also studied to find the effect of gender difference on mean nasalance scores and found that there was no significant difference in nasalance value for the nasal sentence, oral paragraph or oro-nasal paragraph across gender.

One of the main aims of the study is to develop normative data for nasalance value in Manipuri speaking adults. Establishing the normative for clinically significant abnormalities is important in many areas of medical epidemiology. It can be approached from a clinical or statistical perspective (Baker and Rose, 1984). Normative nasalance scores were set as those that give the best overall correct prediction of the presence or absence of abnormal nasality. Table 9 and 10 shows the normative nasalance scores for Manipuri speaking adults.

Gender	Mean for oral sentence (SD)	Mean for nasal sentence (SD)	Zoo passage (SD)	Rainbow passage (SD)
Male	20.95 (8.33)	59.30 (7.23)	16.97 (7.79)	38.00 (7.31)
Female	24.21 (10.44)	59.63 (7.28)	18.7 (7.28)	38.95 (7.37)

Table 9. Normative Nasalance scores for Manipuri speaking adults with gender difference

Stimuli	Mean	SD
Nasal sentences	59.46	7.21
Oral sentences	22.58	9.53
Zoo passages (Oral)	17.84	7.54
Rainbow passages (Phonetically balanced)	38.00	7.36

Table 10. Normative Nasalance scores for Manipuri speaking adults without gender difference.

In the present study, it was observed that they have normal resonance but for few subjects the normative nasalance scores were more than two standard deviation beyond the mean. Compare to other Indian studies, the standard deviation was higher in oral sentence (9.53). This may be attributed to the dialectal variation used in different region of the state. Thus clinicians must know that normative nasalance scores acts as a guide only to the limit of nasalance that correspond to the perception of normal resonance. Moreover the little variation around the mean score should be observed carefully.

It has also been observed that the mean of oral sentences are higher in Manipuri language compare to other language studied in Indian context. The findings of Jayakumar T (2008) in Kannada language showed that the mean of oral sentences for male was 08.77% and for female was 14.69 % which is lower compared to the results of the present study. Also the findings from Nita (2012) in Hindi language showed similar results where the mean of oral sentences for male was 16.12% and for female were 21.92%. In contrast, Gopi Shankar et al (2013) results showed a similar trend as the present study for the mean nasalance scores of oral sentences. The mean of oral sentences for male is 24.58% and for female is 28.85 %. This may be attributed to the higher nasal resonance in Manipuri (aboutworldlanguages.com) and Malayalam in comparison to Kannada, Hindi and other Indian language. In addition, nasalization of vowels is also highly prevalent in Manipuri,

which may account for overall increment in the nasalance value in the normative score across stimuli.

CHAPTER VI

Summary and Conclusion

Resonance disorder occurs mostly due to velopharyngeal function which plays an important role in shaping the sounds produced by vocal folds. The isthmus between oral and nasal cavities is opened during the production of nasal consonants so that some air escapes through the nose. On the other side, it must be closed to produce the consonants that require high pressure in the oral cavity. Therefore, the amount of acoustic energy emitted to oral cavity and nasal cavity changes depending on the type of the voice produced. The percentage of nasal acoustic energy within a speech signal is known as nasalance. Nasalance or nasalance score is calculated by using the formula [(nasal acoustic energy/nasal and oral acoustic energy) *100]. The more the air passes through the nasal passage during speech, the higher the nasalance score is, and vice versa. It generally reflects the perceived degree of nasality.

Nasometer is a computer-based device and provides the user a nasalance score of a speech sample that is a numeric output of nasal acoustic energy. Therefore, it is a useful objective tool to evaluate velopharyngeal inadequacy and to monitor the changes in velopharyngeal function and nasal resonance. However, there are no studies on nasalance score in Manipuri language using Nasometer. Therefore, the present study aimed at establishing the normative nasalance score in Manipuri speaking adults.

In this study, we had considered 80 normal (40 males and 40 females) with normal oral structure and functions. All the participants were native speakers of Manipuri. The stimuli consist of the following

Set 1- 10 nasal sentences in Manipuri

Set 2- 10 oral sentences in Manipuri

Set 3- Zoo passage & Rainbow passage

The instrument used for data collection was Nasometer II (model 6450) and the recording was done in a sound proof room. The instrument was calibrated each time prior to data collection. The Nasometer headset was placed and positioned properly on the subject's head and the subject is asked to read the sentence and the passage presented. The nasalance trace was monitored continuously throughout each recording to ensure that the data were being captured. At the completion of each session, the nasalance trace was stored on computer file for analysis. Descriptive statistics, independent t-test and Mann-Whitney 'U' test using SPSS software version 18.0 package was used for data analysis.

The present study aimed to develop normative nasalance score for Manipuri speaking adults. The nasalance score were also compared across gender. Table 11 shows the normative nasalance score with the standard deviation.

	Mean	SD
Nasal sentences	59.46	7.21
Oral sentences	22.58	9.53
Zoo passages (Oral)	17.84	7.54
Rainbow passages (Phonetically balanced)	38.00	7.36

Table 11. Mean normative nasalance value in Manipuri

The present study revealed that that the nasal sentences and passage containing nasal sounds exhibited higher nasalance score than oral stimuli in both males and

females. This finding can be attributed to velopharyngeal closure mechanism with relation to structure of the stimuli.

In the current study, there was no significant difference between scores of female and male for nasal sentences and oral sentences in Manipuri and also for Zoo passage and rainbow passage. However, there was a higher nasalance score in females for Oral sentences, Zoo passage and Rainbow passage. This can be attributed to the anatomical and physiological reasons. The functioning of resonance system is affected by laryngeal and velopharyngeal anatomical, physiological and aero-dynamic gender related difference. The mechanism for velopharyngeal opening and closing is reported to be different for man and women.

The present study revealed that there is considerable difference between nasal and oral stimuli. Clinically the normative data of the present study may help in identifying person with resonance disorders. It may also be used to monitor the success of the rehabilitation techniques such as speech therapy and surgery.

Clinical Implication

1) The normative score developed from the current study will help in assessment of adult population with various resonance disorders in clinical and research conditions.

2) In specific, it can help in changes in resonance following surgical procedures such as pharyngoplasty, uvulopalatopharyngoplasty, maxillectomy, and functional endoscopic sinus surgery, prosthetic management.

3) As a biofeedback instrument for resonance speech therapy.

Limitation of the present study

- Limited age range were considered
- The dialectal variation in Manipuri language was not considered
- Limited number of subjects were taken

Future Directions

- Normative nasalance data need to be develop for children and geriatric population
- Normative Nasalance score across dialectal variation should be investigated.
- Nasal and oral Standard passage can be developed in Manipuri language and the effect of it in Manipuri language can be seen.

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Appendix

Nasal sentence

1) মা য়াম্না হানুরে
/ma yamna hanu:re/

2) মা খোএ মানৈ
/ma kho:I mana:i/

3) মা চিন কুম্লে
/ma chIn̨ kumlE/

4) মাসি মচা অহন্নৈ
/masi matʃa ahanni/

5) লম হুইনা য়েল মাগা পুখ্রে
/lam huIna yen man̨a pu:khre/

6) হৌদোন্গ না উচি তানৈ
/houdon̨ na uchi ta:naI/

7) পুখ্রি দা ঙ য়াম লেই
/pukhri d̨a n̨a ya:mleI/

8) মগি মনৈ য়ম্না লেই
/magI minaI ya:mna leI/

9) মৈ য়ম্না থগত লু
/maI ya:mna thagatlu

10) অঙং মাঙ সন্না রি
/ an̨an̨ man̨a sanna-ri/

Oral sentence

1) ঐহক চদ চারা গে
/aihak chak tʃarage/

2) য়েত্তা চত্লো
Ye:tta tʃatlo/

3) ঐ থাবক চিল্লে
/ai thabak chi:lle/

4) ঐ অথপ্প লৈকৈ দগি লকই
/ai athappa leIkaId̨agi lak I/

5) থাবক তৌবা কাল্লি
/thabak touba kalli/

6) করিগি ঐবু কৌদে
/karigi eibu kaude/

7) পুখ্রি চৌরক্লে
/pukhri chourakle/

8) গারি তরেত লক্কা দৌরি
/gari taret lakka dauri/

9) থাবল লেই কয়দা ফাজাগে
/thabal leI kayada fajabage/

10) এরুও গি স্কুল দা চত্লুসি
/erup gi skul da tʃatlusI/

Rainbow Passage (English Oro-nasal Paragraph)

When the sunlight strikes raindrops in the air, they act like a prism and form a rainbow. The rainbow is a division of white light into many beautiful colors. These take the shape of a long round arch with its path high above, and its two ends apparently beyond the horizon. There is according to legend a boiling pot of gold at one end. When a man looks for something beyond his reach, his friends say he is looking for the pot of gold at the end of the rainbow.

Zoo Passage (English Oral Paragraph)

Look at this book with us. It's a story about a zoo. That is where the bears go. Today it's very cold out of doors, but we see a cloud overhead that's a pretty white fluffy shape. We hear that straw covers the floor of cages to keep the chill away; yet a deer walks through the trees with her head high. They feed seeds to the birds so they're able to fly.