

Normative nasalance in Indians speaking Malayalam and Kannada: Influence of native language, gender, and vowels

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ABSTRACT

Background: Normative nasalance values need to be updated frequently to account for dialectal, regional, and linguistic variations across populations. Regular updates ensure the data remains relevant and accurate for clinical assessment and diagnosis.

Objectives: The primary objective of the current study was to establish normative nasalance for adults who are native speakers of Malayalam and Kannada using the NasalView system. Furthermore, this study aimed to investigate the influence of language, gender, and stimuli on the nasalance scores.

Materials and methods: The study recruited 80 native Malayalam-speaking adults (40 males and 40 females) and 80 native Kannada-speaking adults (40 males and 40 females) between 18 to 24 years of age. The nasalance score were obtained with the NasalView system while the participants phonated vowels /a/, /i/, and /u/. Three trials were conducted for each vowel. The obtained data were tabulated for further analysis.

Results: The study revealed significant differences in nasalance values for the vowels /i/ and /u/ between genders and across languages, but not for /a/. The results further revealed that /i/ had the highest nasalance, followed by /u/ and /a/. Nasalance was significantly different between /i/ and /a/ and between /i/ and /u/ but not between /u/ and /a/.

Conclusion: The study has been able to establish nasalance normative for two major Dravidian languages of India that can be used for the clinical diagnosis and management of resonance disorders. Further, it sheds light on the impact of nasalance in geographically diverse multilingual situations.

Introduction

The velopharyngeal (VP) port controls nasality and supports clear speech. Its function is commonly evaluated perceptually using rating scales for hypernasality and hyponasality.¹ Perceptual assessment of VP function is often supported by objective measures, most commonly by Nasometer™ (Kay Elemetrics, Lincoln Park, NJ, USA)² and NasalView™ (Tiger Electronics, Seattle, WA, USA), developed by Awan.³ Both instruments assess nasalance by measuring nasal and oral sound energy. The formula for nasalance is as follows: $\text{nasalance} = \left(\frac{\text{nasal energy}}{\text{nasal energy} + \text{oral energy}} \right) \times 100$. This equation provides the percentage of nasal acoustic energy in relation to the total acoustic energy radiating in the nasal and oral cavities.^{4,5} Though both instruments measure nasalance, their values aren't directly comparable due to differences in hardware, software, and filter settings.⁶

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Nasalance estimations using either of these instruments have been documented for a few languages spoken in India, such as Kannada, Hindi, and Tamil.⁷⁻¹³ However, only a limited number of studies have reported normative data for nasalance, with most of these publications being nearly a decade old.^{9-12, 14} Most of these studies used a Nasometer for nasalance measurement. Normative data thus established vary, with some studies focussing on children and others on adults, making its interpretation and application challenging.

Although Nasometer and NasalView are the most commonly used instruments currently for nasalance measurement, however both differ in their signal processing algorithms, which may account for differences in nasalance scores. The Nasometer employs a bandpass filter centered around 500 Hz, analyzing a limited portion of the speech spectrum, whereas the NasalView system analyzes the full frequency range without such filtering.¹⁵ These methodological differences, along with variations in software resolution, affect the sensitivity and comparability of measurements across devices, reinforcing the need for device-specific normative data.

The NasalView system is gaining recognition as a cost-effective, reliable tool for measuring nasalance, with unique filters setting it apart from the Nasometer. While its affordability supports wider clinical use in India, most existing norms are based on Nasometer data. The lack of normative values for Indian languages in NasalView limits accurate interpretation. There is a pressing need to establish nasalance norms for different Indian languages. Existing values, mainly derived using the Nasometer nearly a decade ago, cannot be directly applied to NasalView data due to system differences. Nasalance measures are vital for diagnosing velopharyngeal dysfunction in individuals with cleft, craniofacial anomalies, dysarthria, and hearing loss. Hence, developing normative scores using the NasalView system is essential to improve diagnostic and treatment outcomes. This study aimed to establish language- and gender-specific nasalance norms for native Malayalam and Kannada speakers aged 18-24, and to compare values across languages, genders, and vowels.

Materials and methods

The study was initiated after obtaining ethical approval from the Institutional Ethics Committee (Ref. No. EC/NEW/INST/2022/KA/0174), and all procedures were conducted in accordance with the principles outlined in the Declaration of Helsinki. A total of 160 participants were included; 80 native Malayalam speakers (40 males, 40 females) and 80 native Kannada speakers (40 males, 40 females), aged between 18 and 24 years. Participants were recruited through convenience sampling from a multi-specialty hospital in India between September 2023 and June 2024. All participants were neurotypical and anatomically typical individuals within the specified age range. Informed consent was obtained prior to participation. Individuals with a history of oral-pharyngeal or craniofacial surgeries, recent respiratory infections, or syndromic conditions such as hearing loss or cognitive deficits were excluded from the study.

Nasometry procedure

Nasalance was measured using NasalView system v1.2 (DRS Inc.) installed on a personal computer equipped with an Intel Pentium IV processor and a PCI-28 sound card. Recordings took place in a sound-treated room at a 22.05 kHz sampling rate and 44,100 Hz frequency. Participants were seated upright, and the NasalView headgear was fitted as per guidelines. Following hygiene protocols, participants sustained vowels /a/, /i/, and /u/ at habitual pitch and loudness for as long as possible, with three trials per vowel. The mid, stable 5-second segment from each trial was analyzed, and mean nasalance values were calculated. This process was repeated for all vowels. Final data were analyzed using SPSS version 25.¹⁶

Results

Descriptive statistics were computed for the data, as shown in Table 1. Across both genders and languages, the vowel /i/ exhibited the highest mean nasalance value. The nasalance values for /a/ were similar to those of /u/, a pattern consistent across both male and female participants and across native speakers of Malayalam and Kannada.

Table 1. Mean (and SD) of Nasalance scores (%) for vowels /a/, /i/, and /u/ by language and gender.

Languages	Gender	N	Age (years)	Nasalance /a/	Nasalance /i/	Nasalance /u/
			Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
Malayalam	Female	40	21.77 (2.52)	26.00 (6.77)	42.10 (7.55)	28.51 (6.16)
	Male	40	22.63 (1.75)	26.36 (7.34)	35.16 (5.38)	25.75 (4.10)
Kannada	Female	40	22.78 (1.23)	26.45 (6.10)	38.81 (6.55)	25.88 (3.27)
	Male	40	23.54 (1.07)	24.02 (4.99)	31.72 (5.86)	24.63 (4.73)

Subsequently, the Shapiro-Wilk test was used to assess the normality of the data, which indicated that the data did not follow a normal distribution ($p<0.05$). Therefore, the Mann-Whitney U test was used for pairwise comparisons of nasalance values across languages and

genders. The results are presented in Table 2. As shown in Table 2, the analysis revealed significant differences in the nasalance values for the vowels /i/ and /u/ between genders and across languages but not for vowel /a/.

Table 2. Results of Mann-Whitney U tests comparing nasalance scores across gender and language (Significant values are indicated with asterisks).

Comparison	Vowel	p value
Gender	/a/	0.141
	/i/	0.000**
	/u/	0.004*
Language	/a/	0.610
	/i/	0.005*
	/u/	0.038*

Note: Significant values are indicated with asterisks). *statistically significant at $p < 0.05$; **statistically highly significant at $p < 0.001$.

To examine the rank order of nasalance values for the vowels, a Friedman test was conducted. The analysis revealed that the vowel /i/ had the highest mean rank (2.93), vowel /u/ had the second highest mean rank (1.58),

and vowel /a/ had the lowest mean rank (1.49) as shown in Table 3. A significant difference in nasalance values was observed among the three vowels (/a/, /i/, and /u/), with $p < 0.001$.

Table 3. Mean ranks of nasalance values for vowels /a/, /i/, and /u/ based on Friedman test.

	Mean rank	N	160
Nasalance	1.49	Chi-Square	208.838
Nasalance	2.93	Df	2
Nasalance	1.58	Asymp Sig.	0.000

Note: The Friedman test revealed a statistically significant difference in Nasalance values across vowels, $\chi^2(2) = 208.838$, $p < 0.001$. Higher mean rank indicates higher Nasalance.

The Wilcoxon Signed-Rank test was used as a post hoc analysis following the Friedman test to maintain statistical rationale and clarity. The Wilcoxon Signed-Rank Test revealed a statistically significant difference in nasalance between the vowels /i/ and /a/ ($p < 0.05$), as well as between /i/ and /u/ ($p < 0.05$). In contrast, no significant difference was found between the nasalance values of /u/ and /a/ ($p > 0.05$).

Discussion

India is a highly multilingual nation, comprising 22 scheduled languages and approximately 100 non-scheduled languages, including English. These 22 scheduled languages collectively encompass 243 distinct languages, while languages spoken by fewer than 10,000 individuals are not included in this enumeration.¹⁷ Although Hindi accounts for a significant proportion of speakers (41.03%), Dravidian languages such as Kannada and Malayalam—each spoken by around 3-4% of the population—exhibit unique phonological characteristics of both linguistic and clinical importance. Despite their relevance, these languages remain underrepresented in nasalance research using standardized tools such as the NasalView system. The inclusion of Kannada and Malayalam in the present study helps fill a critical gap by generating normative nasalance data for linguistically diverse, yet underrepresented, Indian languages. Many languages within India's multilingual framework possess rich oral traditions that warrant focused empirical inquiry. By contributing data from two distinct Dravidian languages,

this study offers a stepping stone for future nasometric research to encompass a wider range of Indian languages, supported by evolving speech assessment technologies.

Influence of stimuli and instrument

The current study established language- and gender-specific nasalance norms for native Malayalam and Kannada speakers aged 18-24 using the NasalView system. Comparison across languages, genders, and vowels showed significant differences for /i/ and /u/, but not for /a/. These results differ from the previous studies, who found language- and gender-based differences using different stimuli and the Nasometer by Kay Elemetrics.^{8,14} One study reported higher nasalance in Malayalam speakers, while the other found gender differences using word and sentence stimuli.^{8,14} The variation noted between the current and these previous studies can be due to differences in both stimuli and instruments used by them. The two instruments i.e., Nasometer and NasalView, differ in their signal processing algorithms, filter settings, and calibration procedures, which can impact the magnitude and sensitivity of nasalance measurements. Hence, instrument-related variability is likely a major contributor when comparing results across studies using different systems.¹⁵

The absence of gender differences for the stimuli /a/ in the current study may also be attributed to instrumental variations. Unlike earlier studies that used the Nasometer, this study employed the NasalView, which differs in filter settings and analytical algorithms. These hardware and

software differences could influence the detection of gender-based variations in nasalance.

Moreover, physiological variables—such as shorter vocal tract length in females, differences in fundamental frequency (F_0), and nasal airflow patterns—as well as methodological factors like stimulus type, number of repetitions, and experimental context, have all been shown to influence the sensitivity to gender-related differences in nasalance.¹⁸⁻²⁰ Additionally, instrumental settings, particularly differences in microphone sensitivity, filter algorithms, and calibration between devices like the NasalView and Nasometer, may affect nasalance measurement outcomes.^{1,15}

In the present study, although gender differences emerged clearly for high vowels /i/ and /u/, no significant gender effect was observed for the low vowel /a/. This null result may be attributed to the open articulation and lower inherent vowel height of /a/, which leads to less oral constriction and more stable resonance, making it potentially less sensitive to subtle variations in velopharyngeal activity.²¹ Furthermore, the NasalView system may be less sensitive in detecting such small differences compared to the Nasometer, especially for acoustically simpler vowels like /a/.^{1,15}

Interestingly, despite Malayalam being nasal-dominant, it did not significantly affect the nasalance of /a/. Further, no measurable difference was found between Kannada and Malayalam speakers for this vowel. This finding stands in contrast to that of Girish and colleagues who reported differing nasalance values using the Nasometer.²¹ In the present study, we propose that the lack of significant variation for the vowel /a/ may be influenced by India's unique sociolinguistic context—particularly macro-level multilingualism and individual-level (micro) multilingual experiences, which are further discussed in the following paragraphs.

Influence of India's macro-level multilingualism

India's multilingual landscape is globally unique and unparalleled. The Constitution of India recognizes 22 Scheduled Languages, reflecting the nation's rich linguistic diversity. According to the Indian Census of 2001, Kannada is the native language of 3.69% of India's population, while Malayalam is spoken by 3.21%.^{17,22} Among Kannada speakers, 28.44% are bilingual, and 12.15% are trilingual, whereas 28.75% of Malayalam speakers are bilingual, and 16.60% are trilingual. A common trend among multilingual speakers of Kannada and Malayalam is the preference for English and Hindi as additional languages. Studies show English is often the first choice, followed by Hindi.¹⁷

Participants were primarily university students from English-medium schools, and Hindi was typically acquired through formal education or media exposure. Additionally, India's multilingual environment likely facilitated informal acquisition of other regional languages through family, social interactions, and media. This broad language exposure may reflect macro-level multilingualism, where multiple languages subtly influence each other. In this context, it is possible that the native language exerted

a limited effect on the nasalance of /a/. These findings may be consistent with earlier research suggesting that multilingualism can influence aspects of a speaker's native language, including phonetic and prosodic features such as nasalance.^{23,24} Thus, we hypothesize that India's macro-level multilingualism could have influenced vowel nasalance in our participants, highlighting the fluid and dynamic nature of speech production in a multilingual society.

Influence of India's micro-level multilingualism

Beyond national-level multilingualism, India's micro-level multilingualism may also explain the lack of nasalance differences for /a/ between Kannada and Malayalam speakers. The study was conducted in Mangalore, a linguistically diverse border city where multiple languages coexist. Daily exposure to Kannada, Malayalam, Tulu, Konkani, Byari, Hindi, and English fosters constant language switching across contexts—work, home, and social settings.

Such multilingual immersion promotes linguistic adaptation, influencing diction, prosody, and resonance. This ongoing interplay shapes phonetic planning and execution, affecting vocal tract resonance and, consequently, nasalance. In this study, /a/ showed similar nasalance across groups, likely due to its simple articulation. Vowels like /i/ and /u/, which demand more articulatory precision, may be less sensitive to linguistic influence, accounting for their observed variability. Thus, the local multilingual environment significantly impacts speech production and nasalance.

Limitations

One limitation of the present study is the use of only three vowels as stimuli. This approach was chosen to obtain nasalance measures from acoustically stable and coarticulation-free speech samples. While vowels are commonly used in nasometric evaluations due to their sustained nature and ability to reflect oral-nasal resonance more clearly, this limits the generalizability of findings to more complex speech. The study did not include words, sentences, or paragraphs, as standardized and validated linguistic materials in Kannada and Malayalam are currently unavailable. As a result, the absence of speech segments containing voiced consonants or connected speech may have restricted the ability to fully capture nasalance characteristics in more naturalistic speaking contexts. Larger sample sizes and detailed language background profiling in future studies may help strengthen the validity and clarity of the results.

Conclusion

The study establishes normative nasalance values for vowels /a/, /i/, and /u/ in native Malayalam and Kannada speakers across genders. Unlike previous studies, /a/ showed no significant variation by language or gender, while /i/ and /u/ did. These results highlight that nasalance is shaped by more than anatomy or equipment—it's also shaped by linguistic context. Factors like multilingual

exposure, gender, instrument used, and stimulus type all play a role. Hence, clinicians should adopt an individualized approach that considers a speaker's linguistic and environmental background for accurate diagnosis.

Ethical approval

This study was performed in line with the principles of the Declaration of Helsinki. Approval was granted by the Institution Ethics Committee (Date: 30th August, 2023; INST. EC/EC/229/2023; Reg. No: EC/NEW/INST/2022/KA/0174).

Consent

Informed consent was obtained from all individual participants included in the study.

Data

Data are available from the corresponding author upon reasonable request.

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Conflict of Interest

The authors declare no conflict of interest.

CRediT authorship contribution statement

All authors contributed to the study's conception and design. **Anjitha A Prabhu**: material preparation, data collection, data analysis, first draft of the manuscript preparation and comment; **Deepthi KJ**: conceptualized the study, planned the methodology, supervised the research, contributed to result interpretation, and provided critical revisions to the manuscript. All authors read and approved the final manuscript.

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References

- [1] Henningsson G, Kuehn DP, Sell D, Sweeney T, Trost-Cardamone JE, Whitehill TL. Universal parameters for reporting speech outcomes in individuals with cleft palate. *Cleft Palate Craniofac J*. 2008; 45(1) :1-17. doi: 10.1597/06-086.1
- [2] Fletcher SG, Frost M, Druce P. Measurement of nasality with the Nasometer. *Cleft Palate J*. 1989; 26: 1-5.
- [3] Awan SN, Ziegler W, Deger K. Analysis of nasalance: NasalView. In: *Clinical Phonetics and Linguistics*. London, Whurr: 1997; pp 518-25.
- [4] Fletcher SG. Theory and instrumentation for quantitative measurement for nasality. *Cleft Palate J*. 1970; 7(2): 601-9.
- [5] Fletcher SG. "Nasalance" vs. listener judgements of nasality. *Cleft Palate J*. 1976; 13(1): 31-44.
- [6] Sudarshan Reddy BM, Sheela S, Kishore Pebbili G. Comparison of nasalance values obtained from nasality visualization system and Nasometer II. *J All India Inst Speech Hear*. 2012; 31: 30-3.
- [7] Deepthi KJ, Pushpavathi M. The effect of vowels on the nasalance values in Kannada-speaking preschoolers with repaired cleft of lip and palate. *Int J Interdiscip Res Innov*. 2018; 6(3): 383-8. Available from: www.researchpublish.com
- [8] Girish KS, Pushpavathi M, Satish HV. Influence of native language on nasalance values in Kannada and Malayalam speakers. *J Cleft Lip Palate Craniofac Anomal*. 2021; 8(2): 111-8.
- [9] Jayakumar T, Pushpavathi M. Normative score for Nasometer in Kannada. *Student Res AIISH*. 2005; 7: 44-53.
- [10] Arya P, Pushpavathi M. Normative nasalance value in Hindi language [Master's dissertation]. Mysore: University of Mysore; 2009. (Unpublished, personal communication).
- [11] Sunitha, Roopa N, Prakash B. Proceedings of 4th Annual Congress of Indian Society of Cleft Lip, Palate & Craniofacial Anomalies (Abstract). *Proc 4th Annu Congr Indian Soc Cleft Lip Palate Craniofac Anomal*. 1994.
- [12] Pokharel A, Naina P, Sebastian S, Syed K, John M, Varghese A. Normative nasalance scores in Tamil-speaking Indian children. *Logoped Phoniatr Vocol*. 2020; 47: 1-6. doi: 10.1080/14015439.2020.1849391
- [13] Jayakumar T, Soonan VV, Thankamany VR, Benoy JJ. Nasalance, nasal airflow and perceived nasality in carnatic singers and non-singers. *Indian J Otolaryngol Head Neck Surg*. 2024; 76(1): 5-18. doi: 10.1007/s12070-023-03994-w.
- [14] Kuppusamy G, Sankar G, Mariswamy P. Normative nasalance values across stimuli and gender in Malayalam-speaking individuals. *Otolaryngol Online J*. 2013; 3: 85-98.
- [15] Bressmann T, Sader R, Whitehill TL, Samman N, Marciniak C. Comparison of nasalance scores obtained with the Nasometer, the NasalView, and the OroNasal System. *Cleft Palate Craniofac J*. 2005; 42(4): 423-9. doi: 10.1597/03-159.1
- [16] IBM Corp. IBM SPSS Statistics for Windows, Version 25.0. Armonk (NY): IBM Corp; 2017.
- [17] Mallikarjun B. Patterns of Indian multilingualism. *Lang India [Internet]*. 2010 Jun;10(6). Available from: <http://www.languageinindia.com>
- [18] Mishima K, Mori Y, Sugahara T, Minami K. Gender and dialectal differences in nasalance scores in a Japanese population. *J Craniomaxillofac Surg*. 2008; 36(3): 146-9. doi: 10.1016/j.jcms.2007.09.005
- [19] Kim HK, Park IS, Yoon HY. Dialectal and gender differences in nasalance for a Mandarin population. *Clin Linguist Phon*. 2016; 30(6): 451-64. doi: 10.3109/02699206.2016.1142591

- [20] Ibrahim HM, Hamzah HS, Nordin NAM, Ahmad R, Abdul Wahab N. Speech stimuli and nasalance scores among Mandarin-speaking Malaysian children. *Clin Linguist Phon.* 2020; 34(12): 1063-74. doi: 10.1080/02699206.2020.1793815
- [21] Zajac DJ, Mayo R. Aerodynamic and acoustic measures of velopharyngeal function in normal speakers. *Cleft Palate Craniofac J.* 1996; 33(3): 235-41. doi: 10.1597/1545-1569_1996_033_0235_aaamov_2.3.co_2
- [22] Office of the Registrar General & Census Commissioner, India. Census 2001 data online [Internet]. India.Gov. in National Portal of India; 2001 [cited 2025 Aug 20]. Available from: <https://www.india.gov.in/census-2001-data-online>
- [23] Kroll JF, Dussias PE. The benefits of multilingualism to the personal and professional development of residents of the US. *Foreign Lang Ann.* 2017; 50(2): 248-59.
- [24] Han Q, Tian JX, Chen HC. L3 prosody: Cross-linguistic influence of prosodic features in Mandarin and English by Cantonese multilinguals. In: *L3 Development After the Initial State*. Amsterdam: John Benjamins Publishing Company; 2023. pp 96-120.