A Comparison of Speech Acoustic Features in Homosexual and Heterosexual Men

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A Dissertation Submitted in Part Fulfilment of Degree of

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University of Mysore

ALL INDIA INSTITUTE OF SPEECH AND HEARING

MANASAGANGOTHRI, MYSURU - 570 006

May, 2026

CERTIFICATE

This is to certify that this dissertation entitled **"A Comparison of Speech Acoustic Features in Homosexual and Heterosexual Men"** is a Bonafide work submitted as part of fulfilment of the degree of Master of Science (Speech-Language Pathology) of the student with Registration Number P01II24S123026. 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 other Diploma or Degree.

M. Pushpavathi

Mysuru
8th June, 2026

Dr. M. Pushpavathi
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CERTIFICATE

This is to certify that the dissertation entitled **"A Comparison of Speech Acoustic Features in Homosexual and Heterosexual Men"** has been prepared under my supervision and guidance. It is also being certified that this dissertation has not been submitted earlier to any other university for the award of any other Diploma or Degree.

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DECLARATION

This is to certify that the dissertation entitled **“A Comparison of Speech Acoustic Features in Homosexual and Heterosexual Men”** is the result of my own study under the guidance of Dr. K. Yeshoda, Associate Professor in Speech Sciences, Department of Speech Language Sciences, All India Institute of Speech and Hearing, Mysuru and has not been submitted earlier to any other university for the award of any other Diploma or Degree

Mysuru	Register No:
June, 2026	**P01II24S123026**

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CHAPTER 1

INTRODUCTION

The human voice is produced from the vibration of the vocal folds (source) that produces the glottal signals. The vocal tract (filter), thereby shaping the sounds with appropriate resonance as explained by Fant (1960) in Source-Filter Theory. The sound produced by the vocal cords vibrations possesses a habitual frequency, this is the correlate of vocal pitch. The vocal height is determined by the thickness, length and tension of the vocal cords (Suire et al, 2019). While the sound passes through the vocal tract certain frequencies are enhanced thereby, creating a resonant peak termed as formants. The formants majorly determine the voice timber (Titze, 1989). The sex-related dimorphism is majorly contributed by the morphological differences in the vocal apparatus. For example, during puberty, men display lower fundamental frequency and deep resonant frequencies than women due to the contribution of testosterone that exerts a strong influence on size of the larynx and thickness of the vocal cords (Suire et al, 2019). These acoustic dimorphism makes the listener's perception of masculinity and femininity in an individual's voice.

Learned Vocal Behaviours vs. Sexual Dimorphism

Although, the morphological and biological factors contribute in perceiving the acoustic distinction in male and female voices, they do not completely explain the variations seen within the sexes. Researches shows that vocal dimorphism is seen even in pre-pubertal stages, despite of having similar dimensions of vocal tract apparatus (Vorperian & Kent, 2007). This indicates that the vocal behaviours are not always contributed by the biological factors but are partly learnt. Children try to imitate the gender-specific articulatory and vocal patterns to meet the social expectations (Mattingly, 1966).

Sexuality and Voice

During human communication, voice plays a major role in providing very powerful social cues, helping us in interpreting the speaker's age, sex, physical strength, body configuration, identity and sexual orientation (Bachorowski & Owren, 1999; Gelfer & Bennett, 2013; Gelfer & Mikos, 2005; Hillenbrand & Clark, 2009; Hughes et al, 2004; Linville & Fisher, 1985; Lyons et al,2014; Munson et al,2006; ; Ptacek & Sander, 1966; Shipp et al, 1992).

Homosexuality and Voice

Literature suggests that the perception studies conducted previously reveals that the voices of homosexual men are judged to be more "feminine", making this stereotype a legitimate one (Smyth et al, 2003). Thereby, this feminine perception could influence social interaction, clinical evaluations and so on (Fasoli et al, 2017).

For gay speech, few stereotypes exist including higher pitch, variable pitch-modulation pattern, exaggerated and slow articulation of speech and varied formant frequencies making their speech sound more feminine (Rendall et al, 2008; Munson et al, 2006).

Previous Acoustic Research Findings

Some acoustic studies have reported higher fundamental frequency, and larger pitch range in homosexual men than in heterosexual men (Barbuio & Pauline, 2021). Few other studies reported no significant differences between the voices of these two groups (Rendalll et al., 2008). There are inconsistencies in the findings of formant frequencies as well. Literature suggests that few other parameters such as jitter %, shimmer %, harmonics-to-noise ratio may be used as possible markers of sexual orientation (Watts et al., 2017). However, results obtained were mixed. These inconsistencies could be because of the limited sample size, scripted speech sample usage instead of spontaneous speech, and variability in grouping of bisexuals and homosexuals (Smyth et al, 2003; Rieger et al., 2020b).

Rationale and need of the present study

The stereotypes about the vocal features of homosexual men in Indian context, and the inconsistencies seen in the previous researches makes it necessary that exploring the voice of homosexual men is socially and clinically important. Socially, this research is important as it explores how the vocal cues influence the perception of the listeners and reinforce stereotypes. Voice plays a crucial role in identifying the gender role, personality, and even the professional competence to an extent. Stereotypes often characterize "gay sounding" men as being feminine or lacking agency (Fasoli & Maass, 2018), this reinforces stigmatization and exclusion in mainstream and socio-cultural settings.

Although, India has progressed legally, the deep-rooted stereotypes and stigma associated with gay men continues till date, including the soft nature and feminine voice patterns. These stigmas might cause discrimination in various setting including the healthcare settings. In therapy setting, it is necessary for the clinician to be able to differentiate between the voice concerns that are clinically significant such as Dysphonia and identity-driven conscious or unconscious voice modifications that could be negatively judged in society but are not pathological. By not considering the cultural sensitivity, speech therapy might unintentionally legitimize the rigid, ideal and heteronormative “masculine” voice. Therefore, exploring and understanding the convergence of social expectations, sexual orientations and vocal patterns is very important to be understood for providing voice/ speech therapy in Indian context.

While the past studies have focused on the gender distinct voice parameters extensively, minimal works focused on the intra-sexual differences that are related to the sexual orientation. By comparing the voices of homosexual and heterosexual men across various acoustic domains, this study aims to contribute to the existing vocal pedagogy literature on the domain of sexuality and voice. This study will also be a probable attempt to provide empirical data to the answer question arising due to the societal stereotypes.

Aim

The aim of the present study is to examine the voice and vocal tract acoustic characteristics in homosexual and heterosexual men associated with sexual dimorphism.

Objectives

The following are the objectives of the study:

1. To analyse the voice and vocal tract acoustic characteristics in voices of homosexual and heterosexual men.
2. To compare the voice and vocal tract acoustic characteristics between voices of homosexual and heterosexual men.
3. To correlate the mean fundamental frequency (F0 in Hz) and formant frequencies between homosexual and heterosexual men.
4. To document vocal acoustic characteristics based on sexual orientation in Indian male population.

Null Hypotheses

1. There will be no significant difference in the analysed voice and vocal tract acoustic characteristics in voices of homosexual and heterosexual men.
2. There will be no significant difference in the voice and vocal tract acoustic characteristics between voices of homosexual and heterosexual men.
3. There will be no significant difference in the mean fundamental frequency (F0 in Hz) and formant frequencies between homosexual and heterosexual men.

CHAPTER 2
REVIEW OF LITERATURE

The human voice functions as a critical medium for social communication, transmitting not only linguistic information but also cues related to the speaker's sex, age, weight, emotional and mental state, socioeconomic status and sexual orientation (Ellis,1967; Hughes et al, 2004; Munson et al, 2006; Streeter et al, 1977). Over the past few decades, significant advancements have been made in understanding vocal acoustics and the mechanisms through which listeners derive social judgments from these cues.

Acoustic Correlates of Sex Differences in Voice

Due to larger laryngeal structures, males have longer and thicker vocal folds compared to females (Titze, 1989). This anatomical variation results in lower fundamental frequency (f0) in male voices, typically have an average pitch of 120 Hz, whereas female usually have higher average pitch of 230 Hz (Kent & Read, 2015) Titze (1989) highlighted that these differences are not restricted to fundamental frequency alone; increased vocal fold mass and differing vibratory patterns in male also contribute to perceptible differences in their voice quality like harmonic depth and breathiness. Such physiological distinctions provide a biological basis for the acoustic cues that shape listener's social judgements.

Building on this laryngeal differences, Mattingly (1966) investigated the impact of vocal tract size on speaker variability. Through acoustic analysis of adult speakers showed that differences in vocal tract length results in systematic variations in formant frequencies, which reflect vocal tract resonance. Since male vocal tracts are longer than females, their formant frequencies are correspondingly lower. The author suggested that these differences act as an additional and partially independent cue to speaker sex beyond f0. This study served as a key for later investigations into the respective roles of f0 and formants in gender perception.

Bachorowski & Owren (1999) expanded by demonstrating that acoustic cues to both speaker sex and identity are detectable even in very brief segments of speech. Their analysis of short vowel extracted from running speech showed that f0 and formants consistently distinguished male from female speakers, even in the absence of extended prosodic context.

This indicates that the key acoustic information is deeply embedded in speech signal and accessible from very limited speech samples, supporting rapid social perception.

In a developmental context, Vorperian & Kent (2007) showed that sex-related acoustic differences emerge gradually. They reported that sex-related variations in f0 and formant frequencies are minimal in childhood and becomes more pronounced during and after puberty due to hormonal changes that drive the biological changes in laryngeal system. This developmental trajectory highlights the role of biological processes in shaping the acoustic sex differences.

Fundamental Frequency and Formant Frequencies in Gender Perception

Gelfer & Mikos (2005) addressed how listeners weigh different acoustic parameters when making gender judgement by examining the relative role of fundamental frequency and formant frequencies in isolated vowels. Through synthesized stimuli where these acoustic parameters were independently manipulated, the authors found that both cues significantly contributed to gender perception, but f0 had stronger influence. Listeners relied heavily on f0, when f0 and formant cues conflicted. However, formant frequencies remained influential, particularly when f0 values were not clearly indicative of either female or male voices.

Gelfer & Bennett (2013) examined the combined effect of fundamental frequency and vowel formant frequencies on gender perception in more naturalistic speech contexts. Their findings reaffirmed the dominant role of f0 while also highlighting the importance of formant frequencies, particularly for speakers with intermediate f0 values. They concluded that gender perception from voice relies on multiple interacting acoustic cues rather than reliance on a single parameter.

Similarly, Hillenbrand & Clark (2009) showed that both role of f0 and formant frequencies play key role in distinguishing the voices of male and female. They demonstrated that although f0 and formant frequencies are both important, the formant frequencies carry substantial information for gender perception, particularly the F1 and F2. Their findings also revealed significant overlap between male and female distributions for individual acoustic parameters, indicating that listeners must rely on integrating multiple cues to achieve accurate gender classification, which may be challenging under certain listening conditions.

In the more recent study, Barbuio & Paulino (2021) investigated gender perception by focusing on both acoustic speech characteristics and pitch variability. Their study explored not only the static measures like f0 and formants but also dynamic aspects such as pitch range and variability. They found that pitch variability contributed to gender perception beyond mean f0, indicating that prosodic features such as intonation and pitch modulation, provide additional gender-relevant cues. This suggests that voice-based gender perception depends not just by anatomical properties of the vocal apparatus but also by the habitual speech patterns shaped by biological and sociocultural factors.

Gender Nonconformity and Behavioural Correlates

Bailey & Zucker (1995) examined the link between childhood sex-typed behaviour and later adult sexual orientation through a retrospective and prospective investigations. Their findings demonstrated a consistent association, childhood gender nonconformity and adult homosexuality. The findings from prospective studies showed cross-sex typed or feminine behaviours among boys such as female associated activities, play and peer groups, more likely to identify as homosexual in adulthood. Lesbian women reported comparatively masculine behaviours, interests and activities in childhood, although men showed a stronger association than women. Quantitative review showed large effect size was observed among men. They attribute this pattern to biological predisposition shaping both gender expression and sexual orientation. This finding aligns with the Rendall et al. (2008) hypothesis that sexual orientation-related speech characteristics may develop from early gender nonconformity.

Rendall et al. (2008) examined 2,875 vowel productions across 125 heterosexual and homosexual speakers from southern Alberta, Canada. On analysing formant frequencies and vocal pitch, they reported no significant difference in mean fundamental frequency across sexual orientation groups for either men or women. However, homosexual speakers exhibited significant differences in formant frequencies of particular vowels when compared to heterosexual speakers. Certain formant frequency differences in specific vowel sounds appeared to be related to basic differences in body size, whereas the other remained unexplained by vocal tract anatomy between heterosexual and homosexual speakers. The authors observed that the findings did not support the notion of overall masculinization or feminization in homosexual women and men, respectively. The authors proposed that vowel specific differences may arise from selective imitation of speech characteristics or biosocial factors associated with sexual orientation.

Rieger et al. (2020a) investigated gender nonconformity in bisexual men and women. The authors explored the patterns of childhood and adulthood gender nonconformity among bisexual men and women. Using self-report assessments of the behaviours and activities in childhood, adult gender expression, and personality traits associated with femininity and masculinity was carried out. Their findings indicated that bisexual individuals exhibited intermediate levels of gender nonconformity that occupied intermediate position between those of heterosexual and gay or lesbian groups. Researchers argued for a continuum-based understanding of gender nonconformity aligned with sexual orientation, shaping social perception such as those derived from vocal cues. This insight suggests a more graded relationship between sexual orientation and speech patterns.

Lyons et al. (2014) assessed the ability of detection of sexual orientation, often termed as “gaydar,” by homosexual and heterosexual women. The study examined the ability of homosexual and heterosexual women to detect the sexual orientation of other individual’s by viewing the facial photographs of the target and they accuracy of their responses was analysed. Results showed that both groups performed above-chance levels when identifying the sexual orientation, although, variability occurred in accuracy across different stimuli type and presentation conditions. Homosexual women showed superior accuracy relative to heterosexual women. The study provided evidence that such detection relies on subtle cues related to gender expression including facial appearance. They further concluded that cultural stereotypes, observable appearance-related cues and familiarity with homosexual communities greatly affects the perception of sexual orientation.

Speech Acoustics and Perception of Sexual Orientation

According to Munson et al. (2006), speech signal conveys many layers of information simultaneously in addition to the linguistic message. They explained that speech can communicate a speaker’s emotional state and discourse intentions through variation is fundamental frequency (f0) contours, regional dialect may be reflected from specific articulatory patterns, while unique acoustic features help the familiar listeners obtain indexical information.

In the early 1990s, Gaudio (1994) investigated whether the pitch characteristics differed between homosexual and heterosexual men and whether the listeners can identify sexual orientation from speech. The study aimed to analyse reading samples of self-identified homosexual and heterosexual males focusing on parameters including mean fundamental frequency (F0), pitch range and pitch variability alongside listener judgement tasks. Analysis of reading samples from self-identified homosexual and heterosexual speakers revealed that listeners could identify speaker's sexual orientation at above-chance levels. However, acoustic measures, such as mean f0, pitch range and variability, did not reliably distinguish between the two groups. This mismatch in finding suggested that the cues listeners rely on are more complex or subtle beyond basic pitch parameters.

Smyth et al. (2003) proposed broader theoretical frameworks for understanding perceived sexual orientation in males. The authors developed a dataset of 25 male speakers rated along a continuum from highly gay-sounding to highly straight sounding and examined how the perceptions varied across different discourse types (spontaneous, dramatic etc) and different listener groups. Participants included gay male listeners, mixed-gender listeners of unknown sexual orientation, rated the speech samples under sexual orientation- based and gender-based rating schemes. The acoustic analysis included parameters such as articulatory precision, vowel space and sibilant frequency characteristics with additional comparisons between spoken and written renditions of spontaneous speech. They found that perceptually gay-sounding voices tend to exhibit specific phonetic characteristics stereotypically associated with female speech patterns, including higher-frequency sibilants, more precise articulation and expanded vowel spaces, yet the features did not serve as independent predictors. Instead the judgement reflected the integration of constellation of subtle phonetic and contextual influences. The authors concluded that perception of sexual orientation is best explained by gender-atypicality in speech rather than fixed acoustic markers of sexual orientation.

Munson et al. (2006) investigated whether the listeners could perceive and judge the individual's sexual orientation through their speech using three experiments. The study integrated acoustic analysis with perceptual evaluation to examine "GLB (Gay, Lesbian, Bisexual) speech styles" among both men and women. Experiment 1 examined the acoustic features of read speech focusing on consonant and vowel production. The results revealed significant sex-based differences and subtle variations associated with the sexuality. Gay and bisexual men produced certain vowels with higher F1 frequencies and showed distinctive acoustic properties of the sibilant /s/, while lesbian and bisexual women demonstrated slight differences in vowel formants compared to heterosexual women. Experiment 2 examined listener's perception of speech samples where naive listeners rated whether the speech samples sounded like GLB speech or heterosexual speech style. The participants identified self-claimed GLB speakers as more GLB-sounding than heterosexual speakers. The findings indicated that the listeners relied primarily on subtle acoustic cues and their judgements were influenced significantly by phonetic composition of the word stimuli. In experiment 3 the researchers examined relationship between perceived sexual orientation, perceived height and speech clarity. The results suggested that speech perceived as gay or bisexual in men was associated greater speech clarity, whereas lesbian or bisexual women were judged as taller sounding.

An alternative biosocial account of speech pattern often associated with gay male speech is referred to as the "Queen's English" hypothesis (Rendall et al. 2008). This hypothesis suggested that the speech characteristics may reflect the developmental processes linked to childhood gender nonconformity rather than sexual orientation itself. Evidence suggested that gender-nonconforming children often acquire cross-sex speech patterns during language development, which may persist into adulthood. Rendall et al. (2008) suggested that the acoustic characteristics of "gay speech" may function as indirect markers of early gender nonconformity. This perspective connected the voice perception within the broader context of developmental research on gender expression and identity.

Speech styles functioned as cues to communicate sexual orientation and as an "invisible" social category. It was found that listeners relied on a constellation of acoustic features, rather than any single cue, for finding sexual orientation. The speakers perceived as gay demonstrated greater pitch variability, longer vowel durations and more precise articulation. Sexual orientation is not directly visible like other social categories and had to be inferred from behavioural cues, making voice a critical channel for perception (Fasoli & Sulpizio, 2017). Fasoli & Maass, (2018) reported that voice-based perceptions were found to affect social judgement, which vary depending on the contextual conditions (). Voices perceived as gay were often rated lower in masculinity and competence, and these judgements were influenced by contextual factors.

To address the inconsistencies in literature, Suireet al. (2020) conducted a comparative study between French speaking gay men, heterosexual men, and heterosexual women examining acoustic features, such as fundamental frequency, formant frequencies, harmonic-to-noise ratio, and spectral measures. They examined whether the levels of testosterone influenced the relationship between the sexual orientation and speech acoustic features. The findings suggested that gay men's voices differed from heterosexual men' voice on several acoustic parameters, including, reduced vocal breathiness and greater pitch variations, with these features showing a shift towards heterosexual women's speech patterns. However, the level of testosterone was not found to be significantly influencing the investigated acoustic parameters. They concluded that the differences in homosexual male speech support the faminization hypothesis and are better explained by gender-atypical speech features rather than hormonal or biological determinants.

Holmes et al. (2024) utilized large sample and advanced acoustic analysis methods and identified measurable acoustic variations (F0, pitch range, HNR, jitter, formant frequencies, speech rate and spectral tilt) across male and female speakers of varying sexual orientations. The results showed that homosexual men exhibited narrower pitch range, reduced vocal breathiness and lower pitch compared to heterosexual men, while the homosexual women demonstrated rougher vocal characteristics and lower F4 formants. However, no significant differences were found in measures including F1-F3 formants, speech rate and shimmer. The authors concluded that the sexual orientation is associated with selective acoustic variations rather than generalized vocal masculization or feminization.

Methodological Considerations and Acoustic Measures

The accuracy of research in voice is fundamentally dependent on the tool and methodologies employed. Boersma & Weenink developed Praat, which is most widely used freely downloadable software for phonetic and acoustic analysis. Boersma & Weenink (2001) described Praat as “a computer program for analysing, synthesizing and manipulating speech”, and has been developed continuously since 1992 by Boersma & Weenink (University of Amsterdam). Praat's official manual lists broad range of measures including periodicity, intensity and spectral analysis, formant tracking, perturbation measures among its speech-analysis functions. Crucially, Praat's analytical algorithms are continuously refined for precision. Boersma (1993) demonstrated the accuracy of Praat's autocorrection-based pitch algorithm. Escudero et al (2009) further highlighted that formant tracking can be enhanced by adapting analysis settings (formant ceiling) to specific language or dialects. Núñez-Batalla *et* *al.* (2014) compared Praat with Dr. Speech and observed shimmer and jitter values were similar in both software concluding that Praat is a reliable tool for contemporary acoustic analysis.

The Long-Term Average Spectrum (LTAS) is one of the most effective acoustic measures that analyses long speech segments to characterize glottal spectral properties, including amplitude of the higher harmonics, which influence the voice timber (Pinczower & Oates, 2005). LTAS is widely used to quantify voice quality through spectral energy distribution analysis, and highlights the differences across variables such as sex and age (Master et al., 2006; Pinczower & Oates, 2005). Acoustic measures including spectral slope, tilt, and skewness reflect the relative distribution of low- versus high-frequency energy within the signal. In typical speakers, LTAS-derived energy distribution can differentiate between optimal and suboptimal voice quality (Leino, 2009). While some studies associate spectral tilt to breathiness (Mendoza et al., 1996), others reported minimal relationships, particularly in sustained vowels (Hillenbrand et al., 1994). Furthermore, LTAS can be described using spectral moments, with spectral mean, standard deviation, skewness and kurtosis which describe the distributional properties (Lowell et al, 2011).

Vocal spectral features derived from the LTAS along with vocal fold vibratory acoustic characteristics can provide considerable information on the similarities and differences in voice related to sexuality and sexual orientation. This necessitates the need to carry out an investigation to understand the voice acoustic characteristics in voices of homosexual and heterosexual men.

CHAPTER 3
METHOD

The current study employed purposive sampling and cross-sectional, between-group comparative design. A total of 15 Homosexual men and 15 age-gender and education-matched controls (Heterosexual men) in the age group of 20-32 years were included in this study.

Participants

Local Indian nationals participated in this study. 30 participants aged between 20-32 years ($M = 25.4$, $SD = 3.2$) were divided into two groups as Group A and Group B, 15 in each group. Males who openly claimed themselves as “Gay” or “Homosexual” were in Group A and who openly claimed themselves as “Heterosexual” were matched for age and education with participants in Group A, forming the Group B participants. A written consent was collected from all the participants before their participation in the study. All participants were adults who were bi-/multilingual and proficient in English. Therefore, the consent form was provided in English.

Inclusion Criteria

1. Self-identified homosexual and heterosexual men
2. Age range between 20-32 years
3. Bilingual or multilingual Indian
4. Minimum educational qualification of 12^{th} grade

Exclusion Criteria

1. Sexual orientation other than homosexuals and heterosexuals were excluded from the study
2. Individuals with history of speech, language or voice disorders
3. Individuals with current upper respiratory tract infection, cold, or throat illness during recording sessions

4. Individuals with history of undergoing voice therapy or voice rehabilitation
5. Individuals with prior laryngeal surgery or structural abnormalities of vocal tract

Ethical Considerations

The study conformed to the norms specified by the AIISH Ethics Committee. Permission for carrying out the study in the Institute was obtained from the respective authorities. Participation in the study was entirely voluntary and the participants were explained about the rights of withdrawal from the study in the informed consent. Prior written and verbal consent was obtained from all the participants for the participation. Confidentiality was maintained for the collected data. Participant privacy was maintained by not noting personal identifiable information but codes were used to anonymise the audio-recorded data. Audio recordings and documents were securely stored with access restricted to the investigator and research supervisor only. The researcher was not engaged in any misinterpretation, fraud or dishonesty. The researcher adhered to prevailing standard and ethics.

Tasks

a. Phonation: Sustained vowel prolongation of /a, i, u/ for a minimum of 5 seconds each
b. Monologue: Participants chose topics of their interest for monologue delivery
c. Reading of Standard passage: The Rainbow Passage

Procedure

The audio-recording was carried out individually in a neutral venue ensuring quiet or noise-free zone for optimal recording quality and participant comfort. The setting was safe, and free from external disturbances. Each participant performed three tasks. Task one was sustained vowel prolongation task, wherein the participants were instructed to take a deep breath and sustain /a/ vowel as long as possible at a comfortable pitch and loudness. Followed by /i/ and /u/ vowel. The second task was monologue, where the participants selected a topic of their choice and delivered a monologue for two minutes. In the final task, the participants were asked to read “The Rainbow Passage”. Audio recording was carried out using Olympus LS 100. The microphone was placed at a distance of 10cms from the participant’s mouth.

Acoustic Analysis

The audio-recorded speech samples were transferred on to a laptop ASUS vivobook and Praat version 6.4.65 Software was used for acoustic analysis.

Phonation Analysis

The following voice parameters were extracted from the vowel phonation samples.

1. Average fundamental frequency in Hz (F0): Mean value of the fundamental frequency (F0) over a selected portion of a speech signal.
2. Pitch variation in Hz (F0-SD): Standard deviation of fundamental frequency values across a given speech segment.
3. Minimum pitch in Hz: Lowest fundamental frequency identified over a selected portion of voiced segment.
4. Maximum pitch in Hz: Highest fundamental frequency identified over a selected portion of voiced segment.
5. Jitter %: Irregularities in duration of individual cycles in voicing.
6. Shimmer %: Irregularities in amplitude of individual cycles in voicing.
7. Harmonics-to-noise ratio: The degree of acoustic periodicity.
8. Formant Frequencies (F1, F2 and F3): measured as frequencies corresponding to the 1^{st}, 2^{nd}, and 3^{rd} formants respectively for vowel phonations from wideband-spectrograms. The cursor was placed at the steady portion of the formant track corresponding to the phonated vowel (/a/, /i/ and /u/) and the value of each formant was noted in Hz.

Figure 3.1

Example of Phonation Analysis in Praat Showing Waveform and Spectrogram of a Heterosexual Participant during Sustained /a/ Phonation.

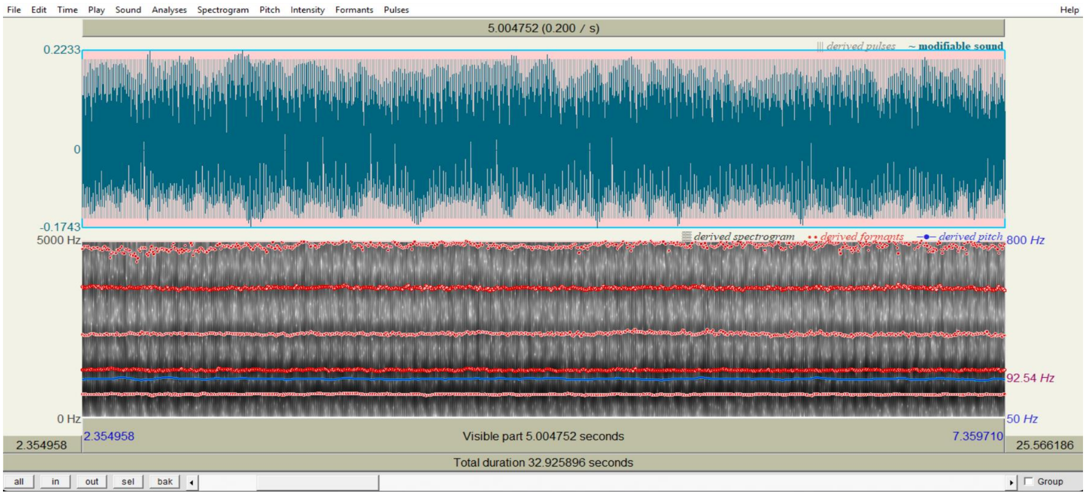
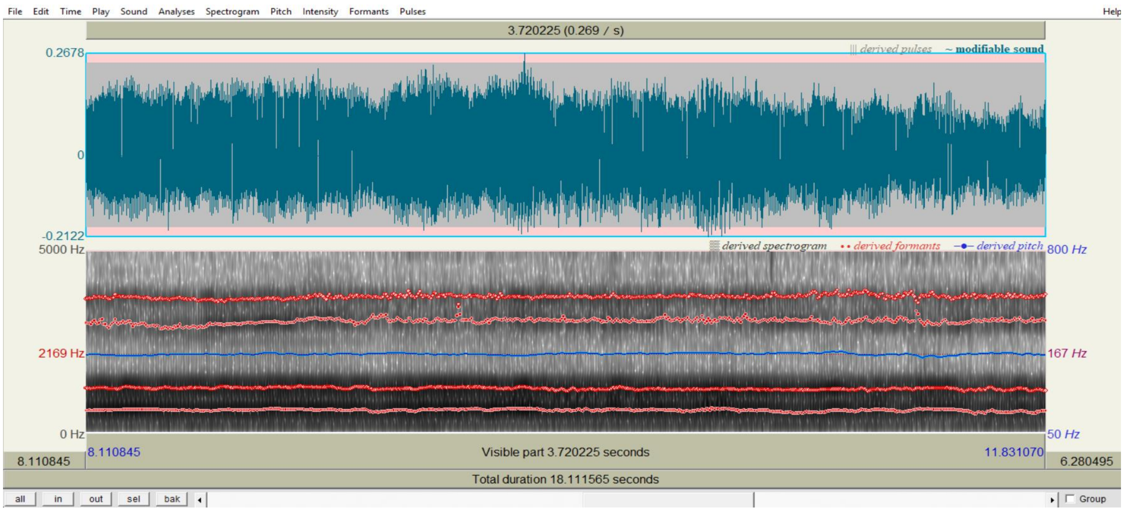


Figure 3.2

Example of Phonation Analysis in Praat Showing Waveform and Spectrogram of a Homosexual Participant during Sustained /a/ Phonation.



Speech Analysis

From the middle 30 seconds of the monologue and read samples, average fundamental frequency in Hz (F0), Pitch variation in Hz (F0-SD), minimum pitch in Hz and maximum pitch in Hz were extracted.

Figure 3.3

Example of Speech Analysis in Praat Showing Waveform and Spectrogram of a Heterosexual Participant during a Monologue on a Chosen Topic.

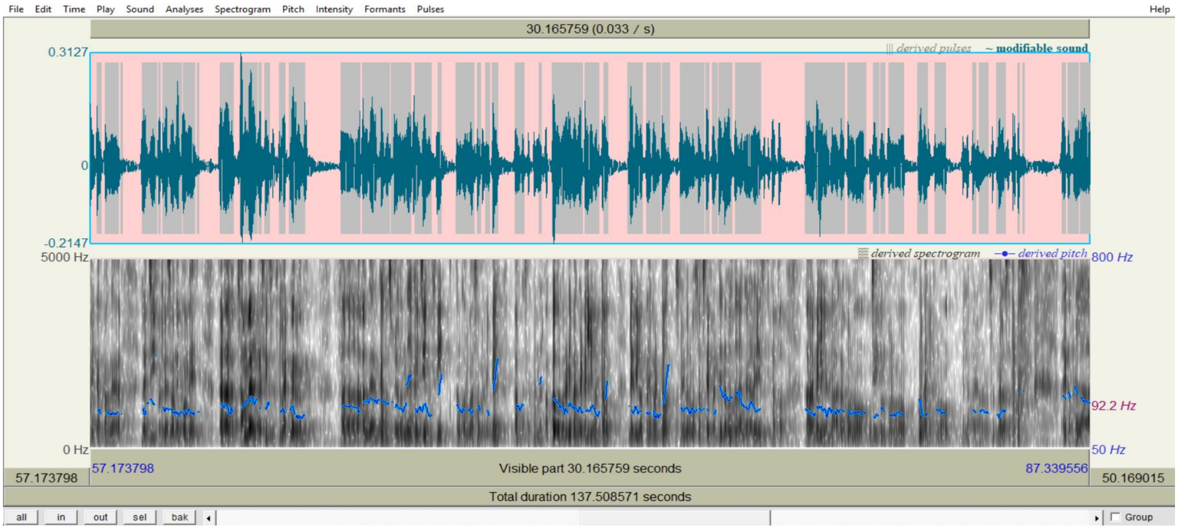
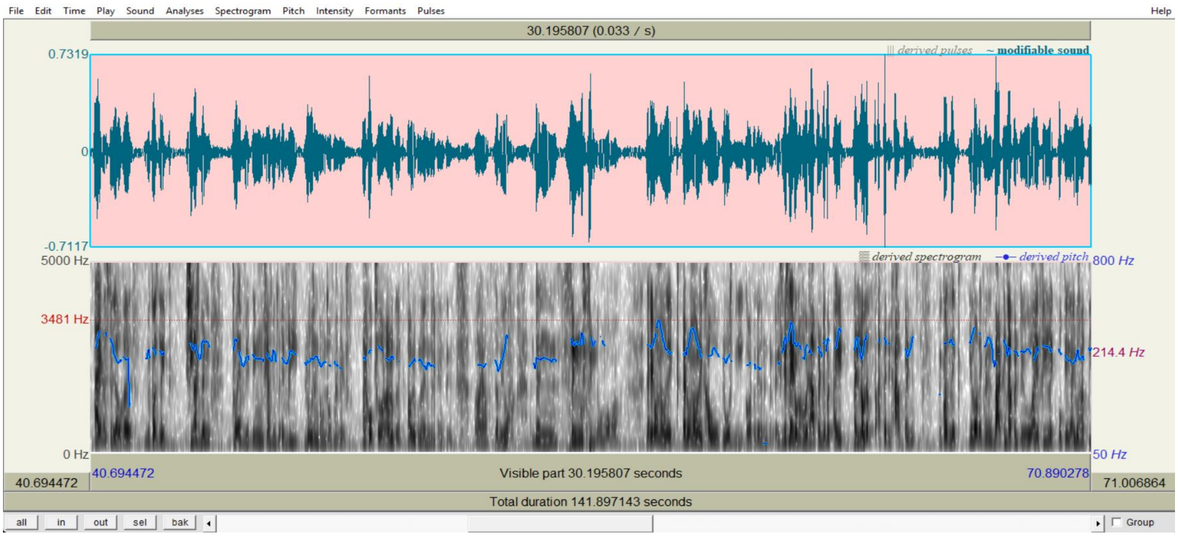


Figure 3.4

Example of Speech Analysis in Praat Showing Waveform and Spectrogram of a Homosexual Participant during a Monologue on a Chosen Topic.



LTAS

The middle 30 seconds of read samples were subjected to Long-term average spectrum (LTAS) analysis using PRAAT version 6.4.65. The following four spectral moment measures were included:

1. Spectral mean: The average values of the LTAS distribution, representing its central tendency.
2. Standard deviation: The spread or variability of LTAS distribution around the mean.
3. Skewness: The spectral tilt of the LTAS. It could be positive skew (tail extending to the right) or negative skew (tail extending to the left)
4. Kurtosis: The peakedness of the LTAS distribution, where steep distributions yield positive kurtosis values and flat distribution yield negative values.

Figure 3.5

Example of the LTAS Spectrum of a Heterosexual Participant during Reading of "The Rainbow Passage".

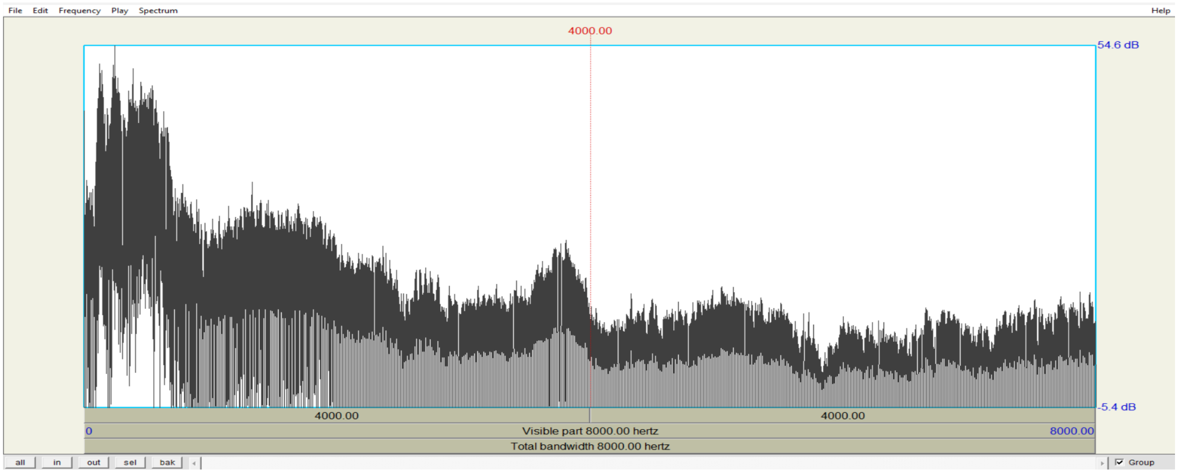
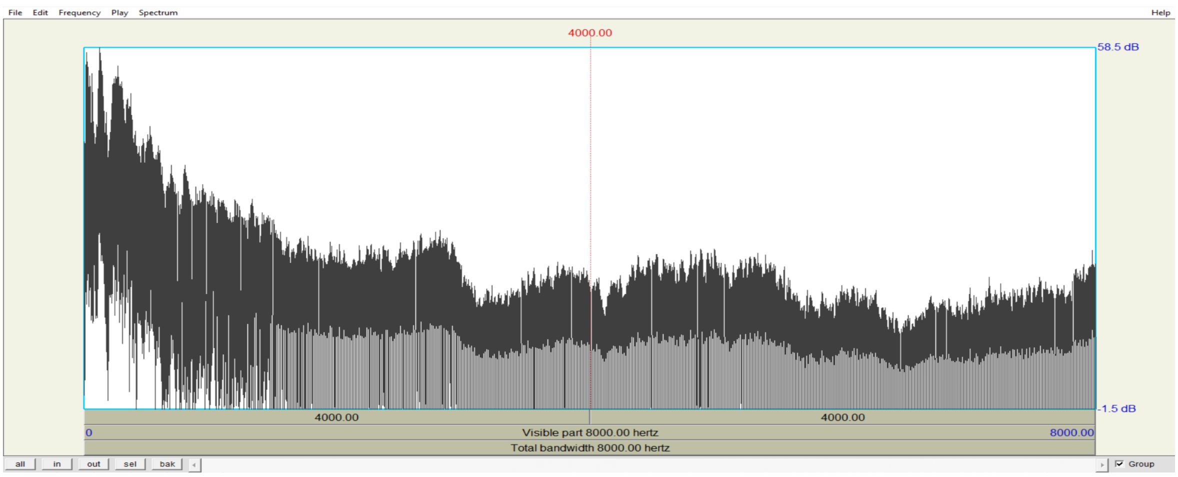


Figure 3.6

Example of the LTAS Spectrum of a Homosexual Participant during Reading of "The Rainbow Passage".



Statistical Analysis

Each acoustic parameter (F0, F0-SD, jitter %, shimmer %, HNR, F1-F3 and LTAS) was dependent variable and the sexual orientation of the individual was the independent variable. All the acoustic parameters were tabulated and statistical analysis was carried out using SPSS version 26.00, as per the objectives of the study.

Shapirowilk's test was carried out to check the normality. Appropriate test for correlation analysis was performed. Normality assumption was not met for parameters including third formant frequency (F3) and shimmer values of sustained phonated /u/ sample, as well as the mean and standard deviation pitch in monologue sample and the mean pitch and minimum pitch in the reading sample. Therefore, for the above-mentioned parameters Mann-Whitney U test was employed to compare these parameters between the two groups. For the remaining acoustic parameters that satisfied the assumption of normality, (MANOVA) Multivariate Analysis of Variance was used to compare between the groups. To assess the correlation between variables within group, Pearson's or Spearman's Rank test was performed depending on the normality characteristics of the data.

CHAPTER 4
RESULTS

The statistical analysis carried out to evaluate the objectives were as follows:

1. Mean, standard deviation, median, and intra quartile range were obtained as a part of descriptive analysis for both groups.
2. To check the normality of data, Shapiro-Wilk test was administered.
3. Variables that satisfied the assumption of normality were subjected to parametric Multivariate Analysis of Variance (MANOVA) for group comparison.
4. Variables that did not satisfy the assumption of normality were analysed using non-parametric Mann-Whitney U test.
5. To examine the correlation between variables, Pearson's or Spearman's Rank test was performed depending on the normality characteristics of the data.

The results are discussed under each objective. The findings pertaining to the following objectives are presented below:

1. **To analyse the voice and vocal tract acoustic characteristics in voices of homosexual and heterosexual men.**
2. **To compare the voice and vocal tract acoustic characteristics between voices of homosexual and heterosexual men.**

Phonation Analysis

The mean scores were compared between the homosexual and heterosexual groups across different acoustic parameters that were extracted from phonation analysis and are tabulated as follows:

Table 4.1

Mean and Standard Deviation of the acoustic parameters for sustained /a/ phonation in Homosexual and Heterosexual Groups.

Acoustic Parameters	**Mean**		**SD**	
	Homosexuals	**Heterosexuals**	**Homosexuals**	**Heterosexuals**
F0	128.04	126.22	22.57	16.62
F0-SD	1.32	1.23	0.51	0.37
Minimum Pitch	124.47	122.63	22.27	16.37
Maximum Pitch	132.15	129.43	22.11	16.82
Jitter	0.47	0.31	0.18	0.09
Shimmer	6.96	4.05	3.22	1.16
HNR	14.01	16.55	4.65	2.45
F1	588.79	676.88	71.05	48.83
F2	1257.44	1212.11	74.42	92.55
F3	2769.51	2610.62	160.91	166.53

Sustained Vowel /a/

Table 4.1 summarizes the mean and standard deviation of acoustic parameters recorded during sustained /a/ phonation for homosexual and heterosexual groups. The normality of the data obtained from sustained vowel /a/ was assessed using Shapiro-Wilk's test. The results indicated that all the parameters followed a normal distribution ($p>0.05$). Consequently, parametric test, Multivariate Analysis of Variance (MANOVA) was administered to compare between the acoustic parameters between two groups. The multivariate effect of sexuality on the combined acoustic parameters was statistically significant, (Wilks' $\Lambda = 0.351$, $F(10,19) = 3.513$, $p = 0.009$, $\eta p^2 = 0.649$), indicating a large effect size. As depicted in figure 4.1, 4.2 and 4.3, significant group differences were observed for acoustic parameters including F1, F3, SHIMMER and Jitter. Statistically, a significant group difference was observed for the parameters including F1: $F(1,28)=15.660$, $p < 0.001$, $\eta p^2=0.359$; F3 $F(1,28)=7.062$, $p < 0.001$, $\eta p^2=0.201$, Shimmer: $F(1,28)=10.819$, $p <0.001$, $\eta p^2=0.279$; and Jitter: $F(1,28)=8.628$, $p<0.001$, $\eta p^2=0.236$. The effect sizes of all these four parameters were large. No significant group difference was observed for F2, F0-SD, F0, HNR, minimum and maximum pitch ($p>0.05$).

Figure 4.1

Bar Graph Representing the Group Difference in Formant Values of Sustained /a/ Phonation.

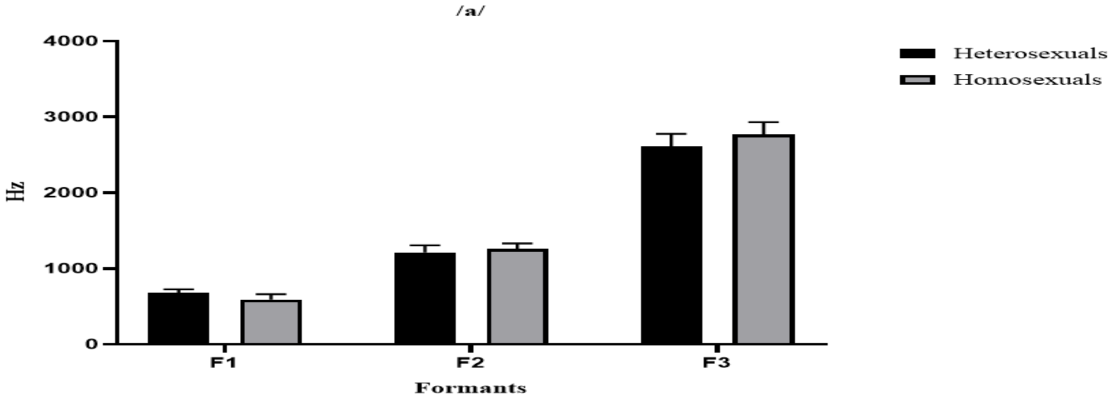


Figure 4.2

Bar Graph Representing the Group Difference in Shimmer Values of Sustained /a/ Phonation.

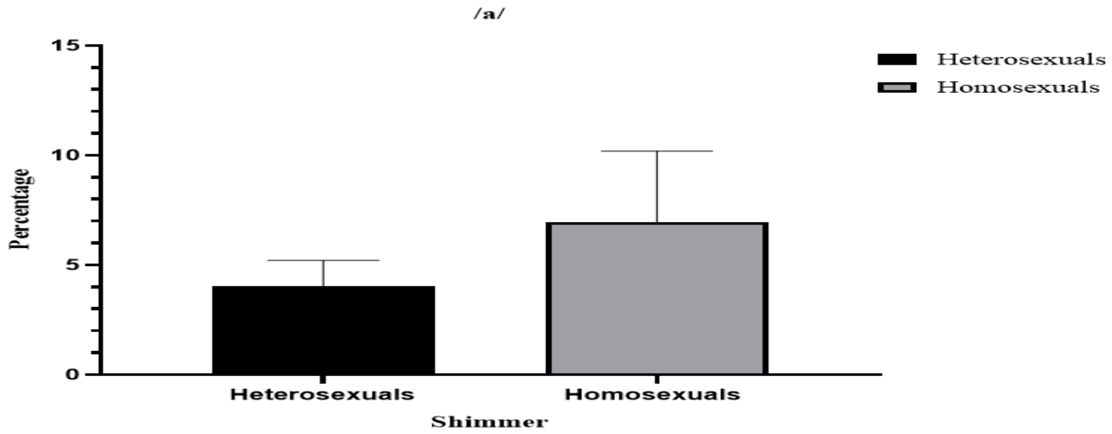


Figure 4.3

Bar Graph Representing the Group Difference in Jitter Values of Sustained /a/ Phonation.

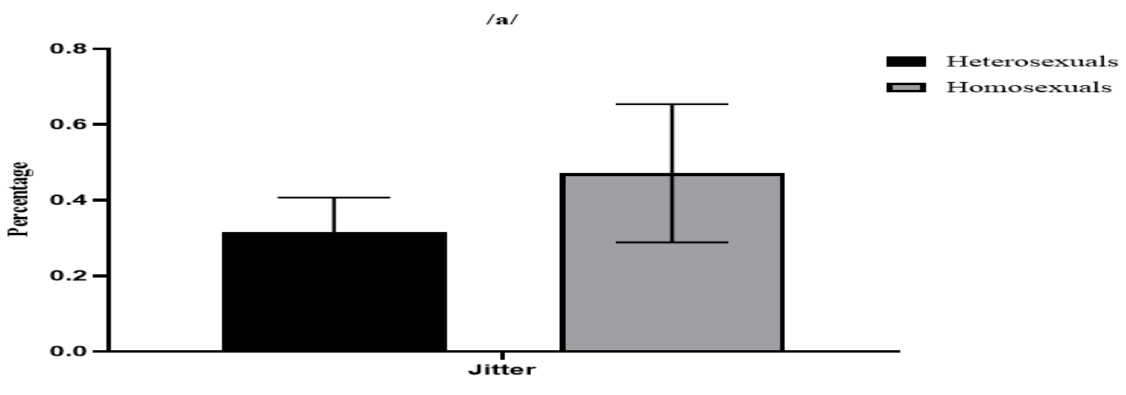


Table 4.2

Mean and Standard Deviation of the Acoustic Parameters for Sustained /i/ Phonation in Homosexual and Heterosexual Groups.

Acoustic Parameters	Mean		SD	
	Homosexuals	Heterosexuals	Homosexuals	Heterosexuals
F0	136.26	129.85	26.11	17.73
F0-SD	1.20	1.04	0.25	0.44
Minimum Pitch	132.74	127.30	26.12	17.50
Maximum Pitch	140.49	133.10	25.80	17.93
Jitter	0.41	0.34	0.19	0.17
Shimmer	8.94	5.15	5.34	2.23
HNR	15.50	16.17	4.10	2.30
F1	296.23	299.78	42.95	21.87
F2	2461.87	2301.82	122.66	127.31
F3	3202.41	2954.36	157.82	123.45

Sustained Vowel /i/

Table 4.2 summarizes the mean and standard deviation (descriptive data) of acoustic parameters recorded during sustained /i/ phonation for homosexual and heterosexual groups. Prior to inferential statistical analysis, the normality of the data was examined using Shapiro-Wilk's test, and the data followed a normal distribution ($p>0.05$). Therefore, Multivariate Analysis of Variance (MANOVA) was administered to compare the acoustic parameters between the two groups. The MANOVA revealed a statistically significant multivariate effect of sexuality on combined acoustic parameters, (Wilks' $\Lambda=0.266$, $F(10,19) = 5.237$, $p=0.001$, $\eta p^2=0.734$), indicating large effect size. As depicted in figure 4.4 and 4.5, a significant group difference was observed for the parameters including F2 $F(1,28)=12.293$, $p<0.002$, $\eta p^2 =.305$; F3 $F(1,28)=22.987$, $p <0.001$, $\eta p^2=0.451$, Shimmer: $F(1,28)=6.423$, $p<0.001$, $\eta p^2=0.187$, values indicating large effect size. No significant group difference was observed for F1, F0-SD, F0, HNR, jitter, minimum and maximum pitch ($p>0.05$).

Figure 4.4

Bar Graph Representing the Group Difference in Formant Values of Sustained /i/ Phonation.

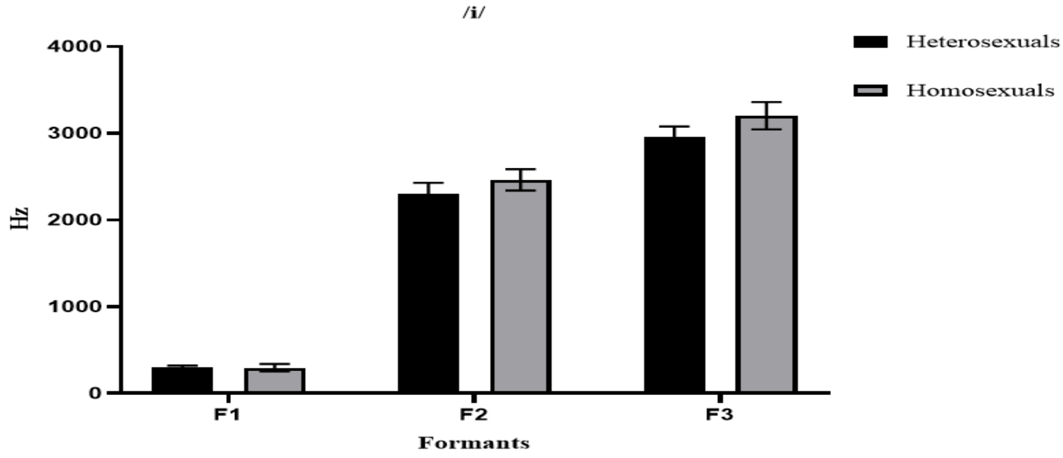
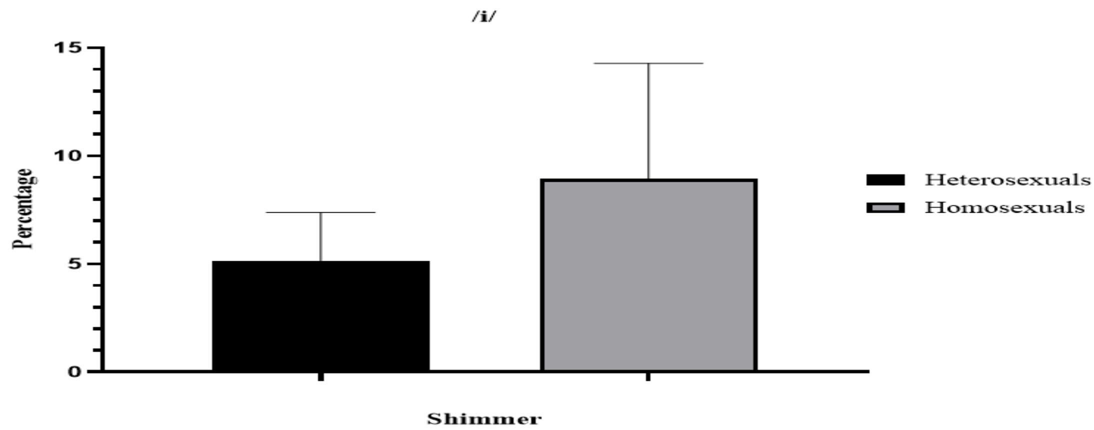


Figure 4.5

Bar Graph Representing the Group Difference in Shimmer Values of Sustained /i/ Phonation.



Sustained Vowel /u/

The descriptive statistics of acoustic parameters recorded during sustained /u/ phonation for homosexual and heterosexual groups are presented in Table 4.3. Most of the acoustic parameters obtained from sustained /u/ phonation followed a normal distribution ($p>0.05$). However, F2 and shimmer % did not satisfy the assumption of normality ($p>0.05$). Therefore, MANOVA was administered for those parameters that were normally distributed, while the non-parametric Mann-Whitney U test was used for F2 and shimmer%.

The MANOVA revealed no statistically significant multivariate effect of sexuality on combined acoustic parameters, (Wilks' $\Lambda=.0571$, $F(8,21)=1.973$, $p=0.101$, $\eta p^2=0.429$), indicating overall group difference was not significant. However, significant group differences were observed for the parameters including F3 $F(1,28)=5.950$, $p=0.021$, $\eta p^2=0.175$, and Jitter: $F(1,28)=12.468$, $p=0.001$, $\eta p^2=0.307$, as depicted in figure 4.6 and 4.8 respectively. The values are indicating large effect size. No significant group difference was observed for F1, F0-SD, F0, HNR, minimum and maximum pitch ($p>0.05$). Further, Mann-Whitney U test revealed significant group difference for F2 ($Z= -2.592$, $p=0.010$) and Shimmer ($Z= -3.132$, $p=0.002$), as depicted in figure 4.6 and 4.7 respectively.

Table 4.3

Mean and Standard Deviation of Acoustic Parameters for Sustained /u/ Phonation in Homosexual and Heterosexual Groups.

Acoustic Parameters	Mean		SD	
	Homosexuals	**Heterosexuals**	**Homosexuals**	**Heterosexuals**
F0	134.52	133.16	23.38	16.86
F0-SD	1.25	1.01	0.45	0.30
Minimum Pitch	131.40	130.65	23.20	16.90
Maximum Pitch	138.31	136.57	23.91	17.04
Jitter	0.42	0.24	0.18	0.07
Shimmer	9.26	4.58	4.83	2.34
HNR	14.56	15.29	4.02	2.96
F1	338.07	359.50	35.89	29.55
F2	922.18	827.39	110.63	77.36
F3	2652.77	2530.89	170.45	91.57

Figure 4.6

Bar Graph Representing the Group Difference in Formant Values of Sustained /u/ Phonation.

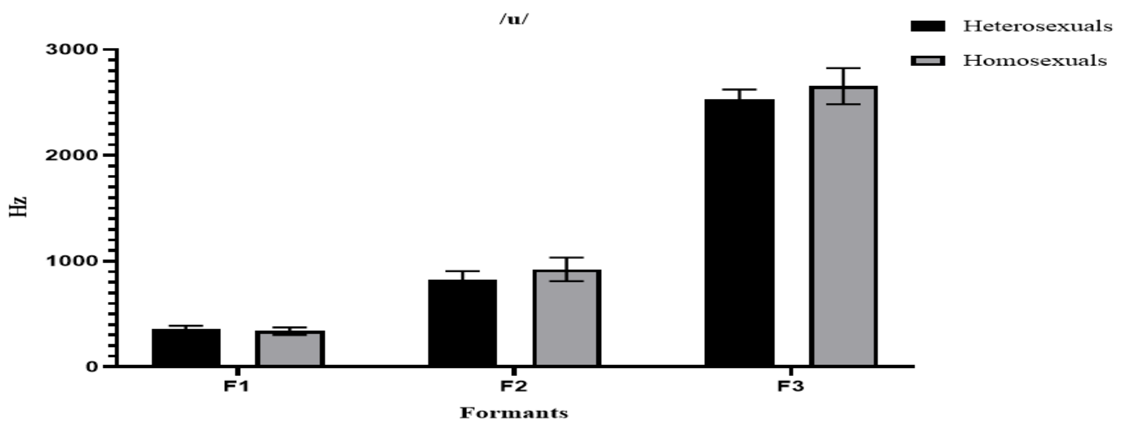


Figure 4.7

Bar Graph Representing the Group Difference in Shimmer Values of Sustained /u/ Phonation.

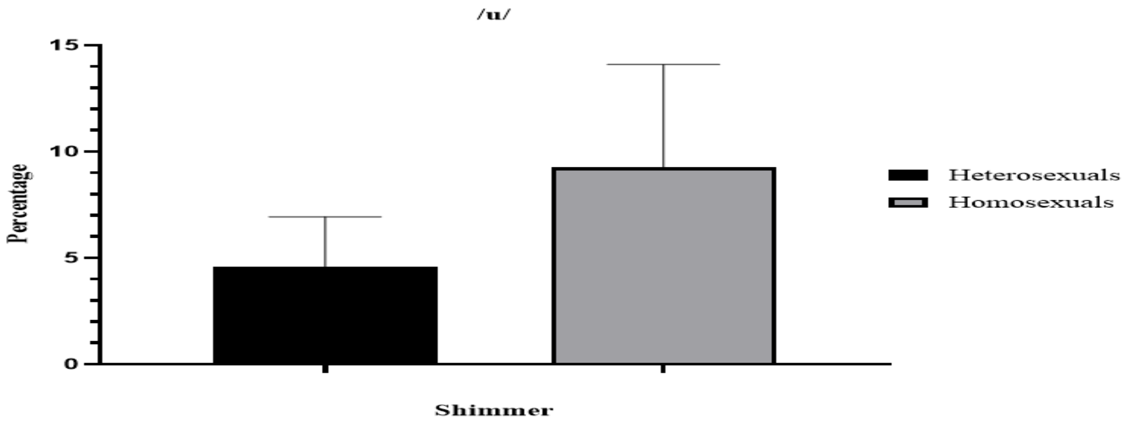
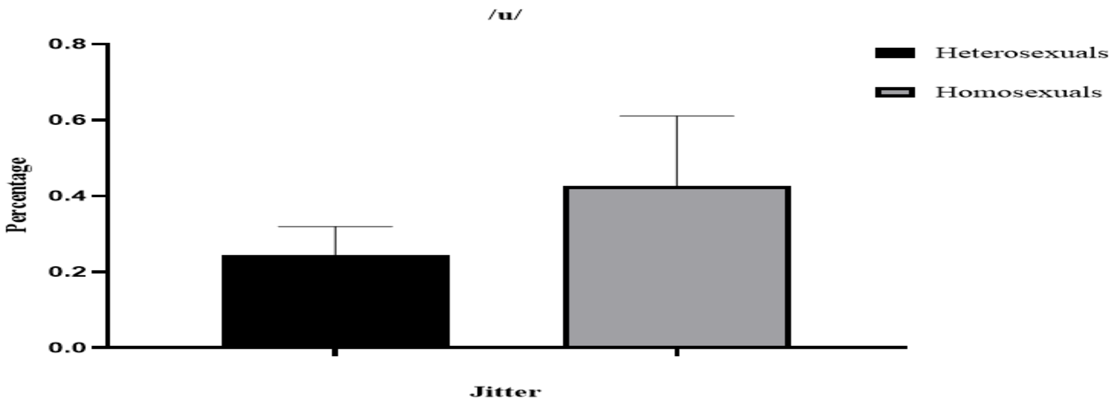


Figure 4.8

Bar Graph Representing the Group Difference in Jitter Values of Sustained /u/ Phonation.



Speech Analysis

Table 4.4

Mean and Standard Deviation of Acoustic Parameters for Monologue in Homosexual and Heterosexual Groups.

Acoustic Parameters	Mean		SD	
	Homosexuals	Heterosexuals	Homosexuals	Heterosexuals
F0	140.07	126.19	27.78	17.75
F0-SD	22.59	22.59	6.14	4.81
Minimum Pitch	97.99	103.20	16.57	15.90
Maximum Pitch	241.20	192.39	42.80	44.45

Monologue Sample

Table 4.4 shows the descriptive statistics of acoustic parameters of monologue of both groups. For monologue sample, normality test indicated that two parameters did not confirm the normal distribution assumption. Therefore, statistical analysis involved both MANOVA and Mann-Whitney U test depending on the distribution characteristics of the parameters. MANOVA revealed multivariate effect was statistically significant, (Wilks'Λ=0.672, $F(2,27)=6.597$, $p=0.005$, $\eta p^2=0.328$), indicating a large effect size. A significant group difference was observed for Maximum pitch: $F(1,28)=9.384$, $p=0.005$, $\eta p^2=0.251$. The values indicating large effect size. No significant group difference was observed for Minimum pitch ($p>0.05$). Further, Mann-Whitney U test revealed significant group difference for F0-SD (Z= -3.961, p=0.000) but no significant group difference for F0 (Z= -1.016, p=0.310).

Table 4.5

Mean and Standard Deviation of the Acoustic Parameters for Reading in Homosexual and Heterosexual Groups

Acoustic Parameters	Mean		SD	
	Homosexuals	**Heterosexuals**	**Homosexuals**	**Heterosexuals**
F0	137.45	133.02	26.51	15.01
F0-SD	17.14	12.58	5.50	2.61
Minimum Pitch	103.53	106.10	19.47	15.71
Maximum Pitch	214.43	193.84	40.48	33.56

Reading Sample

The information about descriptive statistics including the mean and standard deviation of acoustic parameters during a read sample is given in Table 4.5. For reading sample, normality test indicated that two parameters did not confirm the normal distribution assumption. Therefore, statistical analysis involved both MANOVA and Mann-Whitney U test depending on the distribution characteristics of the parameters. MANOVA revealed multivariate effect was statistically significant, (Wilks'Λ =0.762, $F(2,27)=4.226$, $p=0.025$, $\eta p^2=0.238$), indicating a large effect size. A significant group difference was observed for SD-F0: $F(1,28)=8.378$, $p=0.007$, $\eta p^2=0.230$, indicating large effect size. No significant group difference was observed for Maximum pitch ($p>0.05$). Further, Mann-Whitney U test revealed no significant group difference for F0 ($Z= -.228$, $p=0.820$), and Minimum pitch ($Z= -.933$, $p=0.351$).

Table 4.6

Mean and Standard Deviation of LTAS Spectral Moments in Homosexual and Heterosexual Groups

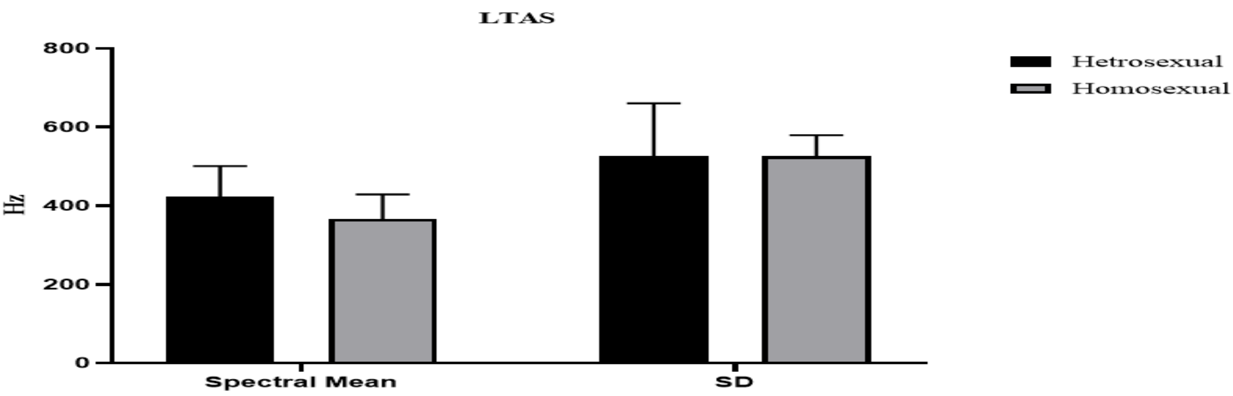
Acoustic Parameters	Mean		SD	
	Homosexuals	Heterosexuals	Homosexuals	Heterosexuals
Spectral mean	366.79	422.88	61.98	78.20
Standard deviation	525.74	526.57	53.83	134.08
Skewness	7.93	7.17	1.65	2.15
Kurtosis	88.30	77.14	18.26	48.84

LTAS Analysis

Table 4.6 provides mean and standard deviation of LTAS spectral movement measures for both groups. Normality test indicated that Kurtosis did not confirm the normal distribution assumption, while other spectral movement measures followed the normal distribution. Therefore, statistical analysis involved both MANOVA and Mann-Whitney U test depending on the distribution characteristics of the parameters. MANOVA revealed that the multivariate effect of sexuality on the spectral movement measures was not statistically significant, (Wilks'$\Lambda=0.771$, $F(4,25)=1.855$, $p=0.150$, $\eta p^2=0.229$), indicating a moderate to large effect size. A significant group difference was observed for Spectral Mean: $F(1,28) =4.789$, $p=0.038$, $\eta p^2=0.145$, indicating large effect size. No significant group differences were observed for Standard Deviation and Skewness ($p>0.05$). Further, Mann-Whitney U test revealed no significant group difference for Kurtosis ($Z= -1.514$, $p=0.130$). A descriptive representation of these group differences is provided in figure 4.11.

Figure 4.11

Bar Graph Representing the Group Difference in Spectral Movement Measures (Spectral Mean and Standard Deviation) of LTAS.



The findings pertaining to objective 3 are presented below:

3. **To correlate the mean fundamental frequency (F0 in Hz) and formant frequencies between homosexual and heterosexual men.**

To examine the correlation between the mean fundamental frequency (F0) and formant frequencies (F1, F2, and F3), Pearson's Correlation analysis or Spearman's Rank Correlation analysis was performed based on the normality characteristics of the data, as determined using Shapiro-Wilk's Test. The correlation analysis was carried out separately for homosexual and heterosexual men across three sustained phonation tasks (/a/, /i/ and /u/). The results revealed no statistically significant correlation between the F0 and formant frequencies in either group across any of the sustained phonation tasks (p>0.0.5). These findings suggest that variations in mean fundamental frequency were not significantly associated with variations in formant frequencies among the two groups.

The findings pertaining to objective 4 are presented below:

4. **To document vocal acoustic characteristics based on sexual orientation in Indian male population.**

Visual examination of the descriptive analysis (mean values) indicated that pitch-related parameters, including mean fundamental frequency (F0), standard deviation of F0 (F0-SD), minimum F0 and maximum F0, were comparatively higher in homosexual men than in heterosexual men for all the sustained vowel phonation tasks (Tables 4.1-4.3). Similarly for connected speech tasks, the F0 obtained during both monologue and reading tasks were observed to be higher among homosexual men compared to heterosexual men. In addition, homosexual men demonstrated lower minimum pitch values and higher maximum pitch values across both tasks, suggesting a relatively wider pitch range in this group. The group differences in pitch-related parameters for monologue and reading tasks depicted in Figures 4.9 and 4.10, respectively.

Figure 4.9

Bar Graph Representing the Group Difference in Acoustic Parameters in Monologue Speech.

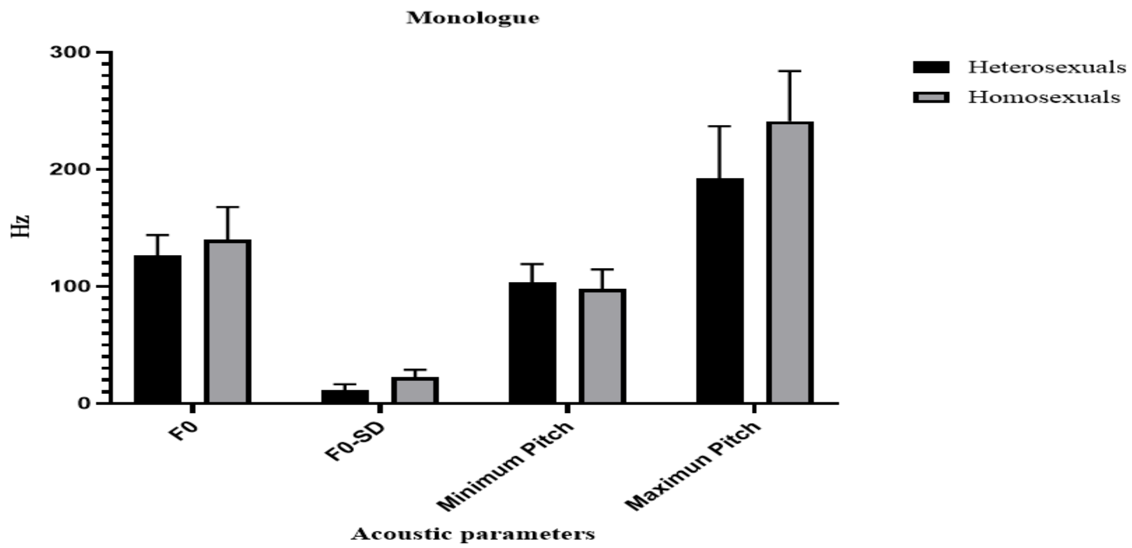
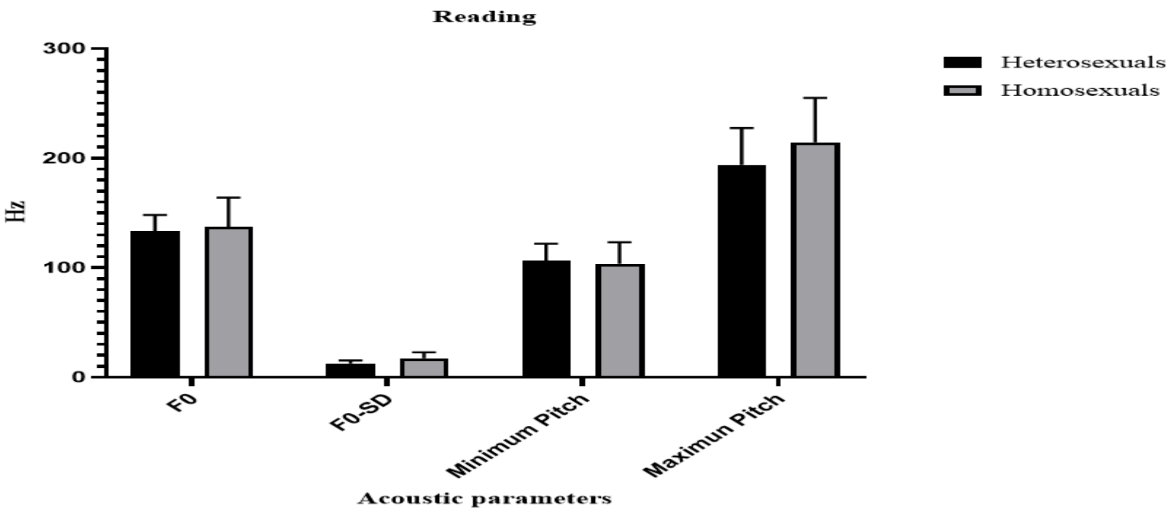


Figure 4.10

Bar Graph Representing the Group Difference in Acoustic Parameters during Reading.



CHAPTER 5

DISCUSSIONS

The major objectives of the study were as shown below and results were tabulated according to these objectives. The objectives 1 and 2 were combined to discuss the results.

- To analyse and compare the voice and vocal tract acoustic characteristics in voices of homosexual and heterosexual men.
- To correlate the mean fundamental frequency (F0 in Hz) and formant frequencies between homosexual and heterosexual men.
- To document vocal acoustic characteristics based on sexual orientation in Indian male population.

To analyse and compare the voice and vocal tract acoustic characteristics in voices of homosexual and heterosexual men

The study identified significant differences in acoustic parameters between the speech of homosexual and heterosexual men. During sustained phonation tasks, the homosexual men exhibited significantly different vocal tract resonance patterns and greater vocal perturbation measures. On analysing sustained /a/ phonation, it was found that gay men had lower F1 and higher F3 values, indicating relatively expanded vowel space compare to heterosexual men. Pierrehumbert et al. (2004) similarly observed that gay men produced more dispersed vowel spaces than heterosexual men and this pattern was interpreted as adopting a female-like articulatory precision.

In the current study, elevated F3 values in homosexual population was observed across all sustained phonation tasks including /a/, /i/ and /u/ sounds, reflecting a tendency toward expanded articulation. Previous research has similarly suggested that acoustic differences associated with sexual orientation are characterized by selective alterations in formant frequencies rather than a complete feminization of speech. For instance, Munson et al. (2006) observed that homosexual men differed from heterosexual men on specific vower formants, particularly F1 in /ɛ/ and /æ/. Likewise, Rendall et al. (2008) reported elevated F4 values for

/æ/ and higher F2 values for /oʊ/ in homosexual men. Sulpizio et al. (2015) identified higher F1 for /ɛ/ among homosexual German speakers. In contrast, Holmes et al. (2024) found no significant differences in Formant frequencies between homosexual and heterosexual men. Such discrepancies may be explained by difference in linguistic and cultural background of the population participated in the study. Nevertheless, the findings of the present study are consistent with the observations of Pierrehumbert et al. (2004) who found that gay speakers do not consistently raise all the formants or shorten their vocal tract characteristics as women do, which is consistent with the observation in this study, as the formant shifts are selective, such as, higher F3 but not higher F1 across different vowel phonation tasks.

Homosexual men exhibited higher perturbation measures (jitter and shimmer) in sustained phonation than compared to heterosexuals, suggesting greater aperiodicity in gay men’s voice. By contrast, Suire et al. (2020) reported that French speaking gay men demonstrated less breathy voice than heterosexual men, and Holmes et al. (2004) found no significant differences across individuals with different sexual orientation in shimmer values. The differences in perturbation measures could be due to cross-linguistic factors or due to the differences in tasks used for analysis, the current study utilized sustained phonation task whereas the other studies used connected speech.

Analysis of connected speech samples (monologue and reading), revealed differences in pitch behaviours with respect to sexual orientation. Homosexual men tended to use higher mean F0 and exhibited a wider pitch range than heterosexual men, although the group differences in mean F0 were not always statistically significant. Notably, homosexual men’s maximum pitch and F0 variability (F0-SD) were significantly higher across both the connected speech tasks. This finding implies that the gay men utilize a more modulated intonation. These patterns are consistent with several previous studies. Suire et al. (2020), who found gay men displayed significantly greater pitch modulation than straight men. Barbuio and Paulino (2021) reported that Portuguese gay men had a mean F0 about 11% higher and 43% greater variability than heterosexual men. Earlier studies by Gaudio (1994) and Baeck et al. (2011) also described gay men have more variable and higher-pitched speech (although, still lower than that of women’s average pitch). Pierrehumbert et al. (2004) observed that homosexual men used expressive intonation resembling those of women instead of adopting a low-pitched style associated with stereotypical masculine speech.

In contrast, Holmes et al. (2024) reported lower pitch and reduced pitch range in homosexual men. Similarly, Rendall et al. (2008) and Munson et al. (2006) reported no significant differences in mean F0 or F0-SD by sexual orientation. Overall, the findings of this study conducted among Indian men showed the stereotypical pattern of gay men exhibiting slightly feminized intonation patterns, although average F0 differences were not statistically significant.

Long Term Average Spectrum (LTAS) used for analysing the spectral movement measures showed that homosexual men had a lower spectral mean (indicating more low-frequency energy) than heterosexuals. This could indicate subtle differences in the voice quality. Since LTAS measures are rarely reported in sexual-orientation research, there is little direct comparison. Mendoza et al. (1996) reported that female voices typically exhibit greater aspiration noise and a flatter spectral slope in higher formant regions, yielding lower spectral tilt. Based on this framework, a lower spectral mean would generally be associated with less high-frequency energy, a characteristic more commonly observed in male voices. The fact that gay men in our study showed a lower spectral mean is inconsistent with expectations of vocal feminization. Nevertheless, Leino (2009) highlighted the influence of voice quality on LTAS energy distribution. Consequently, the present result may reflect subtle differences in voice quality rather than a straightforward gender-related acoustic variation. Since LTAS has rarely been used in sexual-orientation research, additional research is needed to validate and interpret this finding.

To correlate the mean fundamental frequency (F0 in Hz) and formant frequencies between homosexual and heterosexual men

Overall, the aim of the study was to examine the influence of sexual orientation on voice production characteristics. The correlation analysis revealed no statistically significant association between the formant frequencies and fundamental frequency. Hillenbrand & Clark (2009) similarly reported that F0 and formant cues provide independent information about speaker sex, with F0 having slightly greater perceptual importance. The findings of present study implies that source and filter parameters may vary independently across sexual orientation groups and not that one is a byproduct of the other. Furthermore, lack of F0-formant correlation suggests that homosexual men may acquire certain feminine features or vocal styles without fully mimicking the anatomical characteristics typically associated with female voices.

To document vocal acoustic characteristics based on sexual orientation in Indian male population

Based on descriptive statistics, the Indian homosexual men generally demonstrated comparatively higher pitch-related parameters across sustained phonation tasks. In connected speech tasks the homosexual men demonstrated relatively higher mean F0, lower minimum pitch, and higher maximum pitch values, suggesting a comparatively wider pitch range than heterosexual men. This is in line with several Western studies reporting greater pitch variability or range in homosexual men. Gaudio (1994) found that self-identified gay men were rated as sounded more feminine and that their pitch range and variability tended to be higher than straight men. Suire et al. (2020) similarly reported that French gay men exhibit significantly higher pitch modulation than heterosexual men. These findings support a modest feminization of gay men's intonation (higher and more modulated pitch). However, results are not uniform. Munson et al. (2006) found no differences in mean F0 or pitch range between homosexual and heterosexual men and Holes et al. (2024) found that homosexual men have lower mean F0 and a narrower pitch range than heterosexual men.

Although, studies in the literature had reported at least a subtle feminization of gay men's speech although the results are mixed. Many factors including linguistic context, cultural background, and biological factors including hormones could play a role in voice variations. This study conducted with Indian population shows results that are in line with western findings of greater pitch variability and articulatory expansion in homosexual men's speech though other aspects including, shimmer, jitter, and formant patterns are different.

In general, the findings of this study document the presence of a few distinct acoustic characteristics, such as, formant frequencies, perturbation measures and pitch variability in the voices of homosexual men compared to the heterosexual group. These findings contribute toward documenting vocal acoustics characteristics associated with sexual orientation in the Indian male population and provide preliminary evidence supporting variations in vocal characteristics associated with sexual dimorphism and sexual orientation.

CHAPTER 6
SUMMARY AND CONCLUSION

The present study aimed to examine the voice and vocal tract acoustic characteristics in homosexual and heterosexual men associated with sexual dimorphism, through the following objectives:

1. To analyse the voice and vocal tract acoustic characteristics in voices of homosexual and heterosexual men.
2. To compare the voice and vocal tract acoustic characteristics between voices of homosexual and heterosexual men.
3. To correlate the mean fundamental frequency (F0 in Hz) and formant frequencies between homosexual and heterosexual men.
4. To document vocal acoustic characteristics based on sexual orientation in Indian male population.

The current study employed purposive sampling and cross-sectional, between-group comparative design. A total of 30 Indian male participants between 20-32 years participated in this study, comparing 15 Homosexual men and 15 age-gender and education-matched Heterosexual men.

Speech samples were collected through three tasks including, sustained vowel phonation (/a/, /i/, /u/), monologue speech and reading of "The Rainbow Passage". Recorded voice samples were then subjected to acoustic analysis using Praat software version 6.4.65.

Descriptive statistics including mean, standard deviation. Median and interquartile range were obtained for all the acoustic parameters. Shapirowilk's test was used to assess the normality of the data distribution. The variables satisfying normality assumptions were analysed using Multivariate Analysis of Variance (MANOVA), whereas non-normally distributed variables were analysed using the Mann-Whitney U test. To assess the correlation between variables within each group, Pearson's correlation analysis or Spearman's rank correlation analysis was performed based on the normality characteristics of the data.

Across the sustained phonation tasks significant acoustic differences were observed between homosexuals and heterosexual men. For sustained vowel /a/, significant group differences were identified for F1, F3, shimmer and jitter, whereas F2, F0, F0-SD, HNR, minimum and maximum F0 did not differ significantly between the groups. For sustained /i/ phonation, significant group difference was observed for F2, F3 and shimmer, while the remaining parameters showed no significant group differences. In sustained vowel /u/, although the overall multivariate effect was not statistically significant, significant group differences were observed for F3, jitter, F2 and shimmer, whereas, no significant differences were found for F1, F0, F0-SD, HNR, minimum pitch and maximum pitch.

Analysis of connected speech task demonstrated significant group differences in selected pitch-related parameters. In monologue task, MANOVA revealed a significant multivariate effect with maximum pitch showing significant group differences. Mann-Whitney U test analysis further demonstrated significant differences in F0-SD, where F0 did not significantly differ between the groups. Similarly, for reading task, MANOVA demonstrated a statistically significant multivariate effect, with significant group differences were observed for maximum pitch, maximum pitch, or F0.

Long-Term Average Spectrum (LTAS) analysis revealed that overall multivariate effect of sexuality on LTAS measures was not statistically significant. However, spectral mean demonstrated a significant group difference with large effect size, whereas SD, skewness and kurtosis demonstrated no significant differences between the groups.

Correlation analysis using Pearson's or Spearman's rank correlation analysis, revealed no statistically significant relationship between mean fundamental frequency (F0) and formant frequencies across the sustained phonation tasks in either homosexual or heterosexual men.

Homosexual men generally demonstrated relatively higher pitch-related parameters across sustained phonation tasks. In connected speech tasks the homosexual men demonstrated relatively higher mean F0, lower minimum pitch, and higher maximum pitch values, suggesting a comparatively wider pitch range than the heterosexual men.

In conclusion, the findings of the current study show the manifestation of certain distinctive acoustic characteristics in the voices of homosexual men compared to the heterosexual group, predominantly with respect to formant frequencies, perturbation measures and pitch variability. These findings provide primary confirmation of variations in vocal characteristics associated with sexual dimorphism and sexual orientation and lead toward documenting vocal acoustics characteristics associated with sexual orientation in the Indian male population. This is a preliminary study with a modest sample size and purposive sampling method, hence cautious generalization has to be made. Nonetheless, this study provides the first detailed acoustic profile of Indian homosexual and heterosexual male voice.

Clinical Implications

Many individuals with diverse gender identity and sexual orientation could seek health care services for dysphonia or other voice related issues. SLPs providing therapy for such persons must need solid knowledge about the speech and vocal features that are most relevant to clients' preferences, making sure that the therapy outcomes effectively align with the person's desired outcome. Thus, the study will be useful in sociolinguistic understanding, and clinical practice including voice assessment and therapy.

1. The current study's findings help us in establishing a baseline acoustic data of homosexual men.
2. By establishing a baseline, it might be helpful for the Speech Language Pathologist to understand the difference between the natural variation in acoustic features of the voice due to sexual orientation and pathological conditions.
3. This study helps in reducing the risk of misdiagnosing the natural variation in homosexual voice as a pathological condition.
4. As this study helps in understanding that sexual orientation can influence the voice features, this awareness might help the SLPs from stigmatizing during the therapy.
5. The findings of this study help in setting up realistic and individualized goals for therapy.

Limitations

1. The sample size of the participants could be expanded. Although 30 participants are statistically adequate for a preliminary study, a small sample size limits the generalization of the findings.
2. The age range utilized in the study was limited, therefore making it challenging to generalize the study findings to adolescent, middle-aged and older-aged population.
3. The participants were not randomly selected rather a purposive sampling method was used which might introduce selection bias.

4. Speech patterns might could differ across various linguistic and cultural contexts. Since this study was conducted on Indian male within a specific linguistic and cultural context, direct generalization of the study findings to speakers from other linguistic and cultural background could be limited.
5. Furthermore, the existing literature lacks sufficient studies conducted in Indian population, thereby limiting the comprehensive insights into the current research findings.

Future Directions

1. This study is a preliminary study, and there is a need to replicate the study on a larger sample size, including different linguistic and cultural population in India.
2. The research may be extended to wider age groups.
3. Future investigations may include exploration of addition sexualities in both the genders groups.
4. Future studies may include additional acoustic features for a more comprehensive evaluation and perceptual measures for understanding the social perception.

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