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An Acoustic Analysis on Voice Changes in Adults and Geriatrics

Keerthiga S[1], Rohila Shetty[2]

[1]Department of Audiology and Speech Language Pathology
Dr. M.V Shetty College of Speech and Hearing, Manglore University, Mangalore, India

Corresponding Author: Keerthiga S

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ABSTRACT

Objective: This study has established the acoustic analyses on adults and geriatrics in both male and female populations. And to compare the acoustic analyses of both male and female populations
Method: Participants were 118 male and female between the age range of 30 - 60 years, without the signs and symptoms of vocal problems; Praat (6.1.16 version); Vowels /a/ /i/ and /u/.
Result: There is no significant difference ($p > 0.05$) for fundamental frequency (F0), harmonic to noise ratio (HNR), Jitter and Shimmer across the selected age groups (30-39; 40-49; 50-60). Gender comparison of voice characteristics shows high significant difference ($p< 0.01$) in fundamental frequency (F0). Whereas no difference or change in the score were noted for harmonics to noise ratio, jitter and shimmer.
Conclusion: This study, like other investigations, supports the assumption that the fundamental frequency of males increases with age. The female fundamental frequency decreases with age. The male and female voice have no significant difference among the chosen age group in statistical analysis.

Keywords: [Voice, Elderly Voice, Geriatric Voice, Presbyphonia, Voice change, Male and Female Voice]

INTRODUCTION

Voice is produced when air from the lungs passes through vocal folds in the larynx which leads to vibration of the vocal folds. This vibration produces a sound that is modified and shaped by the vocal tract (throat, mouth and nasal passages). Voice disorder can be organic or functional. Organic voice disorders are physiological that result from alterations in respiratory, laryngeal, or vocal tract mechanisms. Functional voice disorders are a result from inefficient use of the vocal mechanism when the physical structure will be normal.

Symptoms of voice disorders can include, hoarseness, roughness, breathiness, strained voice, weak voice, vocal fatigue, throat pain during the conversation. Causes of these symptoms are muscle tension, vocal overuse/misuse, vocal nodules, polyps and cysts, laryngeal cancer, vocal fold paralysis and other neurologic disorders

Voice disorder occurs when voice quality, pitch, and loudness differ or are inappropriate for an individual's age, gender, cultural background, or geographic location (American Speech-Language-Hearing Association [ASHA], Aronson & Bless, 2009). A voice disorder is present when an individual expresses concern an abnormal voice that does not meet daily needs even if others do not perceive it as different or deviant (ASHA, Colton & Casper., 2011).

Aging affects whole organs of the body, and the vocal fold is no expectation. Voice is

produced by a combine activity of respiration, vocal fold vibration, and the resonance. Age- related voice problems have been reported in 10–47% of elderly people over 65 years of age.

Quality of life of the elderly groups become concern with age, organs of voice producing elements will start to deteriorate. The larynx undergoes age- related changes like ossification and calcification of laryngeal cartilages, atrophy and degeneration of the intrinsic muscles, deterioration of cricoarytenoid joints, degenerative changes in the glands of laryngeal mucosa, lamina propria, and in conus elasticus. These may affect vocal fold approximation, or reducing the smoothness of the vocal fold adjustments during phonation. Glandular changes, may cause drying of epithelium, which leads to stiffness the vocal cord cover. Increased cover stiffness could increase instability of the vocal fold vibration and raise the fundamental frequency.

Individuals over the age of 60 years who had been evaluated for vocal problems, voice disorders were most commonly associated with presbyphonia, reflux/inflammation, functional dysphonia, vocal fold paralysis/paresis, and Reinke's edema (Martins et al., 2015). In patients older than 60 years, presbyphonia (*n*=89; 26.5%), functional dysphonia (n = 59; 17.6%), and Reinke's edema (*n* =48; 14%) predominated. (Roy et al., 2016).

Larynx which descends, impact the resonance properties of the vocal tract in seniors, and there is increased risk of aspiration. Vocal deficits are caused by age-related morphological changes in the larynx (presbylarynx). These alterations concern both the ectolaryngeal skeleton and the endolaryngeal soft tissues (particularly the vocal folds). The vocalis muscle, atrophies and becomes hypotonic, which becomes clinically apparent as vocal fold bowing and spindle-shaped glottic chink with loss of air during phonation. The laryngeal mucosa dries out (laryngitis sicca). (Angerstein, 2018).

Vocal rehabilitation in the elderly includes both general and voice-specific therapeutic options. Underlying internal and neurological diseases (e.g. reflux, neurodegenerative or cerebrovascular affections), as well as side effects of drugs must be considered. A healthy lifestyle without pathogenic agents promotes good function of phonatory and respiratory organs. As far as voice therapy is concerned, glottal attack exercises can improve glottal closure during phonation, and relaxation exercises may reduce supraglottic hyperfunctional compression. In special cases with large glottic chink, phonosurgical augmentation of the vocal folds may enhance glottal closure and vocal strength. Vocal hygiene (e. g. regular airway moisturisation) complements voice exercises. In the elderly, singing has proven pychosocial benefits (improvement of well-being and social participation) and verified positive immunological effects (salivary IgA increase). Functional electrical stimulation (FES) is safe way to reverse age-related shrinking of laryngeal muscle fiber diameter. Michael Karbiener et.al; 2016.

Numerous research supports the ageing changes in anatomical structures and their impact on voice. The purpose of the current study is to analyze the voice characteristics in adult and geriatric population and to investigate the age-related changes on acoustic characteristics of voice.

LITERATURE REVIEW

Respiratory power and vocal fold function is reduced, and the motor function of resonant organs such as the palate, lip, and tongue are weakened. The vocal fold often becomes thin and weak, which causes atrophy of the vocal fold. The vibration of the Vocal fold is weakened with the glottal insufficiency, and the voice becomes harsh, breathy, and central nervous system which control of the vocal organs can also be affected by aging. Phonatory duration is shortened, and the pitch changes.

The elderly tends to have lower airway resistance than younger people. However, no strong evidence exists on whether aging has an impact on expiratory pressure and sound pressure level but elderly tends to have a weaker ability to regulate the larynx than the young. An aging sign in voice include reduced volume and endurance, voice tremors (shakiness), breathy voice, reduced or loss of resonance and endurance. Male voice tends to become higher, and female voice become lower, but individual variations are wide. These voice changes can reduce speech intelligibility, which then causes a negative impact on the quality of life.

Voice changes in Male:

Studies have concluded that F0 (fundamental frequency) tends to be higher in elderly than in younger men. Brown et al, compared SFF (speaking fundamental frequency) among the young, middle-aged, and elderly groups and found that SFF was significantly higher inthe elderly than in the other two groups. Other studies conducted by Mysak, Hollien and Shipp, and Honjo and Isshiki support these findings. However, some studies have reported that voice pitch decreases or remains stable in men, even during aging. In general, elderly men speak with a higher tone than younger men.

Voice changes in Female:

Studies have concluded that pitch is considered to decrease because of the structural changes in the vocal folds after menopause. The vocal folds in postmenopausal women show oedematous changes, and their voice pitch tends to become lower and the postmenopausal female speak with a lower pitch than premenopausal female. McGlone and Hollien (1963) found no significant difference in frequency of between elderly and younger women.

Boulet and Oddens in 48 elite vocal performers show that 77% (37/48) of the subjects experienced vocal changes around the age of 50. In female's hormonal changes can also cause changes in voice. After menopause there is cessation of progesterone, a reduction in estrogen and the appearance of androgen. These hormonal changes alter the physical characteristic of the vocal folds and consequently affect phonation. Reduced estrogen and increased androgen are responsible for increase in vocal fold mass (i.e., they become oedematous), and the lowering of the vocal pitch.

Overall, voice pitch changes, differently according to an individual's gender. Various studies explained that changes in voice pitch due to aging have arrived at different conclusions. Treatment of an aging voice is difficult. Voice therapy consisting of respiratory training and vocal function exercise help to improve the voice in mild case of dysphonia. Injection laryngoplasty or medicalization thyroplasty is applied to reduce the glottal gap by augmentation of the vocal folds, but the effects are limited because the vibratory properties ofthe vocal fold are rarely improved. Recently, a regenerative approach has been attempted, to revive the vocal fold mucosa using basic fibroblast growth factor, which stimulates growth offibroblast in the vocal fold and the modulates the function. Further research is warranted to improve therapeutic tools for the age- related voice problems.

Honjo & Isshiki (1980) examined laryngoscopic and voice changes in aged persons with a mean age of 75 years. The findings obtained were: the aged men tended to show marked vocal fold atrophy and/or edema, with a higher fundamental frequency of voice than young men, and the aged women tended to have vocal fold edema and slight hoarseness, with a lower fundamental frequency than young women. Voice changes in senescence are characterized by slight hoarseness or a noticeable change in fundamental frequency of voice. Change in the mass of vocal folds, due, for example, to atrophy or edema, is considered to be the greatest factor in these voice changes.

Tanaka, Hirano & Chijiwa (1994) investigating the causes and mechanisms of vocal fold bowing, consecutive fiberscope video recordings of 127 patients with VFP, 33 with sulcus vocalis, 33 with laser surgery, and 33 with dysphonia having no clinically noticeable organic lesion were reviewed. Sixty-nine percent of the paralyzed vocal folds had bowing, and the occurrence of bowing was significantly related to the activity of the thyroarytenoid muscle as measured by electromyography. All vocal folds with sulcus presented with bowing. Thirty-five percent of the vocal folds that had laser surgery had bowing. The extent of tissue removal was closely related to the occurrence of bowing. Twelve cases with no organic lesion had vocal fold bowing. Of these 12 patients, 8 were male and 9 were older than 60 years. Some aging process in the mucosa was presumed to be the cause of the bowing in this age group of patients without clinically noticeable organic lesions.

Sato & Hirano (1997) investigated morphologic characteristics of elastic fibers in the superficial layer of the lamina propria of aged vocal folds. Excised human adult vocal folds and the results concluded that the morphologic and metabolic changes of elastic fibers in the most important vibrating portion (superficial layer of the lamina propria) of the aged vocal folds contribute partially to aging of the voice.

Lundy, Silva, Casiano, Lu & Xue (1998) investigated to review the cause of hoarseness in all patients older than 65 years and to determine any correlation with advancing age and other demographic factors. Additionally, we wanted to determine the effect vocal pathology has on objective voice measures with advancing age. The result reveals that the two most common causes of hoarseness found in 393 patients older than 65 years were vocal fold bowing and unilateral vocal fold paralysis, followed by benign vocal fold lesions, voice tremor, and spasmodic dysphonia. Although objective measures of vocal function were abnormal compared with reported normative data, they did not increase in severity with advancing age.

Pontes, Brasolotto & Behlau (2005) evaluated the relationship between voice complaint and deviant vocal fold status with special regard to presbylarynx, in patients aged more than 60 years, with pharyngeal-laryngeal complaint. The presence of presbylarynx was accompanied by less voice complaint than the presence of vocal fold mucosa alterations, which in turn are more common where an absence of presbylarynx exists.

Takano, Kimura, Nito, Imagawa, Sakakibara & Tayama (2010) analyzed the trend in the number of patients with aging-related vocal fold atrophy, and to assess the characteristics of senile change of vocal function. MPT (Maximum Phonation Duration) correlated negatively with age, while MFR (Mean Air Flow Rate) correlated positively with age. Mean Air Flow Rate (MFR) was higher in presbylarynx than normal elderly person.

Boominathan, Mahalingam, Samuel, Babu & Nallamuthu (2012) profiled voice characteristics of elderly teachers above 60 years of age through comprehensive voice assessment and the Stroboscopy revealed sarcopenic changes of vocal muscles, such as discoloration of vocal folds, incomplete closure, and reduced mucosal waves. On GRBAS scale rated as predominantly breathy, asthenic, and strained. Dysphonia Severity Index revealed mild to moderate deviation (0.07 in males and 0.16 in females). However, on self- evaluation of voice through Voice Disorder Outcome Profile, scores revealed certain physical changes with less or no obvious functional limitation.

Sebastian, Babu, Oommen & Ballraj (2012) investigated age related changes in the parameters of voice in geriatric normal subjects, which has been scarcely reported in the Indian literature. Result shows that there weren't any significant changes in the acoustic parameters either in males or in females across the age of 60 years to 80 years. The normative values observed for

adult male f0 131.60 and adult female f0 228.26, geriatric male f0 140.28and geriatric female f0 187.48 and adult male jitter 0.73, adult female jitter 0.99 and geriatric male jitter 0.744, geriatric female jitter 0.5225.

Gregory, Chandran, Lurie & Sataloff (2012) investigated dysphonia in this cohort andthe results shows that high average VHI score indicated that these geriatric patients experienced significant dissatisfaction because of their dysphonia. The problem was of sufficient magnitude to result in a high percentage of patients proceeding with treatment.

Monnappa & Balasubramanium (2015) determined cepstral characteristics of voice in healthy aging individuals. Results showed that there was an increase in the cepstral measures with aging, thus suggesting that the harmonic structure of voice is not affected in healthy aged individuals. Gender also influences the cepstral measures in healthy aging population.

Çiyiltepe & Şenkal (2017) investigated dysphonia and therapy modalities in this cohort. Results reveals that Fundamental frequency perturbation may be affected in ageing, both genders same values detected. Vocal nodules in 23.9 % (*N* = 22) was the most common diagnosis associated with the voice complaints, followed by laryngopharyngeal reflux in
10.8 % (*N* = 10) and paresis in 9.78 % (*N* = 9). VHI scores varied greatly, ranging from 4 to 92, with an average score of 42.7. Multidimensional voice program scores showed that fundamental frequency (F0) tends to rise as a function of age in men (mean 283.66 ± 23.7).

Bruzzi, Salsi, Minghetti, Negri, Casolino & Sessa (2017) described aging process of the vocal folds and the main features of the aged voice and concluded that the elderly people undergoes mechanical, anatomical and functional changes: alterations of the pulmonary bellows, systemic changes like hormonal disregulation, and laryngeal changes, that resulting in hoarseness, which is difficult to treat.

Rapoport, Menier & Grant (2018) reported impact of aging is as inevitable in the larynx as on all biologic systems. The muscles of larynx have the potential to atrophy, the elastin fibers of lamina propria thin with age, and mucous production diminishes. As a result, vocal folds fail to approximate appropriately and the stress on once-robust vocal folds increases. These changes present as poor voice quality, vocal tension, tremor, and altered fundamental frequency. Rather than consider presbyphonia as an immutable diagnosis, we must see it as an opportunity to elevate our standard of care and set goals to work for therapeutic improvement of voice quality.

Galluzzi & Garavello (2018) performed comprehensive review of the literature regarding presbyphonia and the reviewed evidence regarding aging voice has shown that presbyphonia is considered a clinical entity that could impact the quality of life in elderly. Speech therapy is effective for improving voice performances.

Crawley , Dehom , Thiel , Yang, Cragoe, Mousselli , Krishna & Murry (2018) determined what distinguishes pathologic presbyphonia from presbylaryngis. Presbylaryngis is present in most ambulatory people older than 74 years. Some will endorse pathologic presbyphonia that has a negative effect on their voice and quality of life. Pathologic presbyphonia seems to be influenced by respiratory capacity and sex.

Ziegler & Hapner (2018) examined voice use objectively using vocal dosimetry in older adults with presbyphonia and the result found that older adults with presbyphonia exhibit low time doses, which were in contrast to high vocal doses published on teachers, patients with dysphonia, and even office workers. We found differences in vocal dose as a function of sex and employment status. Though a limited sample, findings suggest patients with presbyphonia may demonstrate low vocal dose, which may be a useful target in treatment.

Bokare, Patel, Velmurugan & Kulkarni (2019) analyzed the trend in the number of patients with aging-related voice changes, and to assess the characteristics of senile change of vocal function and the results shows that 22.64% subjects were aware of a problem with the voice. In (92.45%) hoarseness was the most common complaint among the subjects. The mean fundamental frequency was found to increase in males while decrease in females as age increases. Maximum phonation time showed steady declining trend with age in either sex. Laryngopharyngeal reflux (68%) with twice as high scores in males as in females. Video stroboscopy revealed incomplete glottic closure as most common feature. Bowing in males (53.85%) while longitudinal gap type in females (60%). vocal fold edema in females and vocal fold atrophy in males as the most common feature.

Mathew & Shilpa (2019) established prevalence of etiological factors for dysphonia in elderly individuals in rural India and the results reveals that the common causes for dysphonia were laryngopharyngeal reflux disease (23%), carcinoma larynx (12%) and presbylaryngis (8%). The most common cause for dysphonia among females was laryngopharyngeal reflux disease (17%), followed by vocal palsy (5%) and spasmodic dysphonia (4%). Carcinoma larynx (12%) was the most common cause for dysphonia among males, followed by laryngopharyngeal reflux (6%) and presbylaryngis (6%). Geriatric dysphonia is an often-overlooked symptom of greater underlying disease as evidenced in this study.

Kost & Sataloff (2020) reviewed age-related dysphonia in the elderly is more common than appreciated because it is an under-reported symptom. In findings many older individuals with recognized clinical signs of presbylarynx, such as vocal atrophy, report a normal voice. This suggests that the mere presence of presbylarynx does not necessarily result in presbyphonia. Summary Recognition of presbyphonia is important because of its significant impact on quality of life. Appropriate diagnosis is essential in order to provide effective therapy.

Unlu & Akkoca (2021) investigated difference between older people with nasal septum deviation (NSD) and older people without NSD in terms of degree of aging voice using objective and subjective voice assessment tools. Findings says that the present study, NSD does not seem to have an effect on voice aging, and also it can be suggested that septoplasty will not have an effect on preventing presbyphonia.

MATERIALS & METHODS

SUBJECTS:

Females and Males between the age group of 30 – 60 years were participated in the current study. Total 118 participants were divided as 3 groups. Groups were separated on considering the age and gender. Subjects with any signs and symptoms of voice change or any history of vocal pathology or neurological disorder that impacts the voice were excluded from this study.

Group – A: 30-39 years of age (Male and Female)

Group – B: 40-49 years of age (Male and Female)

Group – C: 50-60 years of age (Male and Female)

HARDWARE DEVICE:

The voice samples were recorded using, Sennheiser Culture Series Wideband Headset (SC60-USB-CTRL) comes with noise canceling microphone which filters out ambient noise for optimum speech clarity.

SOFTWARE:

Collected samples were acoustically analyzed using Praat (6.1.16 version) software. Praat is a free computer software for speech analysis. It was designed, and continues to be developed, by Paul Boersma and David Weenink from 1991.

PROCEDURE:

A questionnaire for females regarding their age, any significant history of voice problem, menopausal and pregnancy status. Males regarding their age, any significant history of voice problem, smoking and drinking habits were answered by the participants prior to sample collection. Participants voice were informally assessed by two authors, speech therapists. Only the normal voice without any signs and symptoms of voice related disorders were considered to be as participants in this study. Sample recording was carried out in a quite environment with less noise. A hardware device connected to HP laptop and the microphone was roughly placed 3 inches away from participants.

Participants were instructed to be seated relaxed and after an inhalation, produce sustained vowel /a/ /i/ and /u/ in their comfortable and habitual level of pitch and loudness lasting longer than 3 seconds. All the collected samples were recorded with Sennheiser Culture Series Wideband Headset. In order to analyze the voice sample beginning and end of the recorded sample was discarded and the middle part of 3 second is taken as a sample and were analyzed using Praat software in 6.1.16 version.

The parameters taken up for this study were as follows:

- Fundamental frequency, F0 in (Hz)- Rate of vibration of the vocal folds.
- Jitter in (%) - Cycle to cycle variation of frequency.
- Shimmer in (dB) - Cycle to cycle variation of amplitude.
- Harmonics to Noise Ratio, HNR in (dB)

STATISTICAL ANALYSIS

All the above parameters were statistically analyzed using ANOVA test, Kruskal Wallis ‘‘H” test, independent sample ‘‘t’’ test and Mann Whitney ‘‘U” test.

RESULT

Table 4.1 ***Acoustic Characteristics of F0 and HNR for adult male and geriatric male***

Males		30-39		40-49		50-60		"F"	p value
		Mean	S.D.	Mean	S.D.	Mean	S.D.		
Frequency (Hz)	/a/	130.77	12.98	132.43	18.04	136.17	18.52	0.489	0.616
	/i/	136.92	15.68	139.39	18.58	144.49	21.05	0.760	0.473
	/u/	137.82	17.30	147.75	26.76	149.11	21.00	1.518	0.229
HNR (dB)	/a/	20.36	3.31	21.93	4.36	20.71	3.62	0.804	0.454
	/i/	21.34	5.95	22.65	4.15	21.78	6.75	0.230	0.795
	/u/	25.37	4.67	25.06	5.30	24.88	5.87	0.040	0.961

From table 4.1 it can be noted that there is no significant difference ($p > 0.05$) for fundamental frequency (F0) and harmonic to noise ratio (HNR) across age group. But, the F0 for the vowels /a/, /i/, and /u/ indicates a slight increase in mean scores with age. The harmonic to noise ratio (HNR) for the vowel /a/, /i/ and /u/ shows no variation in the mean scores.

Table 4.2 ***Acoustic Characteristics of Jitter and shimmer for adult male and geriatric male***

Males		30-39		40-49		50-60		KruskalWallis "H"	p value
		Median	IQR	Median	IQR	Median	IQR		
Jitter (%)	/a/	0.37	0.26 to 0.48	0.31	0.22 to 0.38	0.31	0.22 to 0.39	1.864	0.394
	/i/	0.26	0.20 to 0.39	0.29	0.16 to 0.41	0.24	0.18 to 0.31	1.786	0.409
	/u/	0.23	0.19 to 0.41	0.25	0.21 to 0.45	0.23	0.18 to 0.35	0.611	0.737
Shimmer(dB)	/a/	0.33	0.27 to 0.44	0.24	0.18 to 0.39	0.21	0.17 to 0.38	4.734	0.094
	/i/	0.19	0.13 to 0.51	0.21	0.13 to 0.25	0.24	0.13 to 0.39	0.563	0.755
	/u/	0.25	0.19 to 0.33	0.19	0.13 to 0.37	0.23	0.17 to 0.33	0.649	0.723

Table 4.2 shows that the acoustic characteristics of jitter and shimmer has no significant difference ($p > 0.05$) across the age groups and no variation is noted in the medianscores.

Table 4.3 ***Acoustic Characteristics of F0 and HNR for adult female and geriatric female***

Females	Vowels	30-39		40-49		50-59		"F"	p value
		Mean	S.D.	Mean	S.D.	Mean	S.D.		
Frequency	/a/	201.75	27.38	201.39	29.31	204.06	34.09	0.049	0.953
	/i/	216.98	23.38	204.88	33.10	207.96	35.59	1.108	0.336
	/u/	221.73	30.02	212.30	23.92	206.73	39.05	1.455	0.241
HNR	/a/	20.91	3.66	20.46	6.31	21.13	4.28	0.107	0.899
	/i/	23.48	5.32	21.16	7.38	23.89	5.49	1.246	0.294
	/u/	26.86	4.42	25.58	6.68	26.67	5.47	0.354	0.703

Table 4.3 indicates no significant difference (p > 0.05) for mean fundamental frequency (F0) and harmonic to noise ratio (HNR) according to the age group. For the vowel /i/ and /u/, fundamental frequency (F0) mean scores shows a fraction of fall as age increases. Whereas the fundamental frequency (F0) for vowel /a/ and the harmonic to noise ratio (HNR)for vowel /a/, /i/ and /u/ shows no noticeable difference in the mean scores.

Table 4.4 ***Acoustic Characteristics of Jitter and shimmer for adult female and geriatric female***

Females		30-39		40-49		50-60		Kruskal Wallis"H"	p value
		Median	IQR	Median	IQR	Median	IQR		
Jitter (%)	/a/	0.37	0.29 to 0.52	0.26	0.21 to 0.47	0.31	0.25 to 0.65	4.206	0.122
	/i/	0.19	0.16 to 0.39	0.26	0.18 to 0.44	0.28	0.16 to 0.41	1.388	0.500
	/u/	0.27	0.18 to 0.47	0.25	0.16 to 0.45	0.29	0.20 to 0.42	0.128	0.938
Shimmer(dB)	/a/	0.27	0.21 to 0.60	0.2	0.15 to 0.43	0.22	0.17 to 0.35	3.486	0.175
	/i/	0.18	0.12 to 0.26	0.22	0.14 to 0.43	0.15	0.13 to 0.21	1.734	0.420
	/u/	0.17	0.09 to 0.30	0.21	0.12 to 0.42	0.15	0.11 to 0.55	1.519	0.468

Table 4.4 indicates no significant difference (p > 0.05) for jitter and shimmer across the age groups and no minor variation was seen in the median scores.

Table 4.5 ***Gender comparison of F0 and HNR for 30- 39 years of age group***

30-39	Vowels	Male 30-39		Female 30-39		sig
		Mean	S.D.	Mean	S.D.	
Frequency	/a/	130.77	12.98	201.75	34.09	< 0.001*
	/i/	136.92	15.68	216.98	35.59	< 0.001*
	/u/	137.82	17.30	221.73	39.05	< 0.001*
HNR	/a/	20.36	3.31	20.91	4.28	0.589
	/i/	21.34	5.95	23.48	5.49	0.184
	/u/	25.37	4.67	26.86	5.47	0.251

Figure 4.1 ***Shows gender comparison of fundamental frequency (F0) for 30- 39 years of age group***

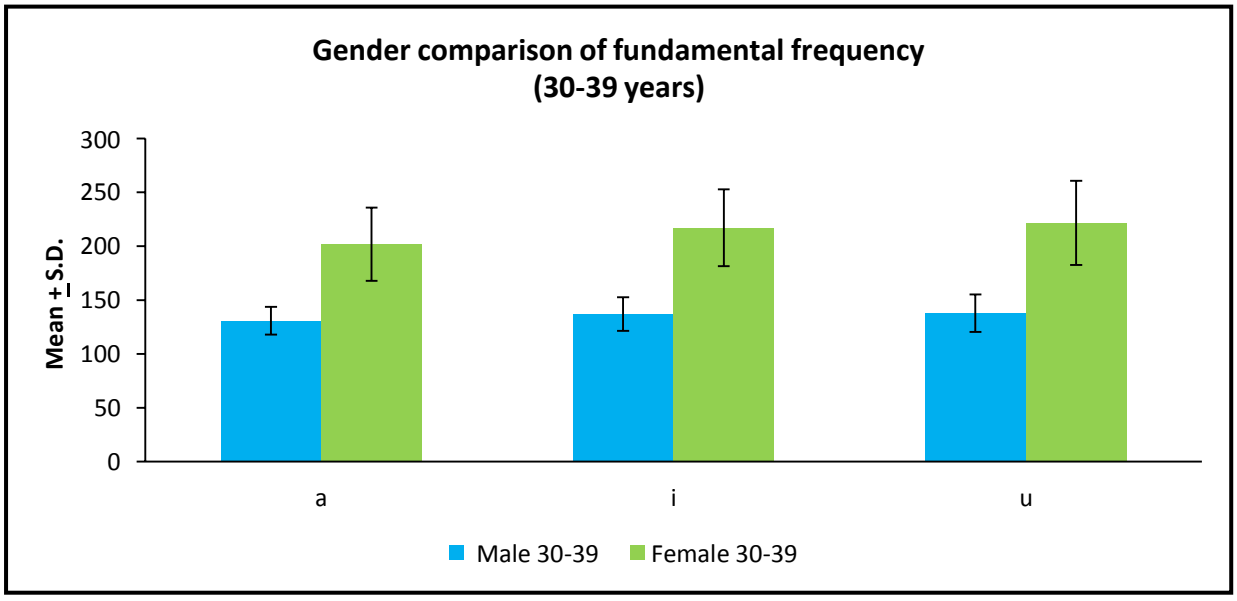

Table 4.6 ***Gender comparison of F0 and HNR for 40- 49 years of age group***

40-49	Vowels	Male 40-49 Mean	S.D.	Female 40-49 Mean	S.D.	sig
Frequency	/a/	132.43	18.04	201.39	29.31	< 0.001*
	/i/	139.39	18.58	204.88	33.10	< 0.001*
	/u/	147.75	26.76	212.30	23.92	< 0.001*
HNR	/a/	21.93	4.36	20.46	6.31	0.445
	/i/	22.65	4.15	21.16	7.38	0.486
	/u/	25.06	5.30	25.58	6.68	0.805

Figure 4.2 ***Shows gender comparison of fundamental frequency for 40- 49 years of age group***

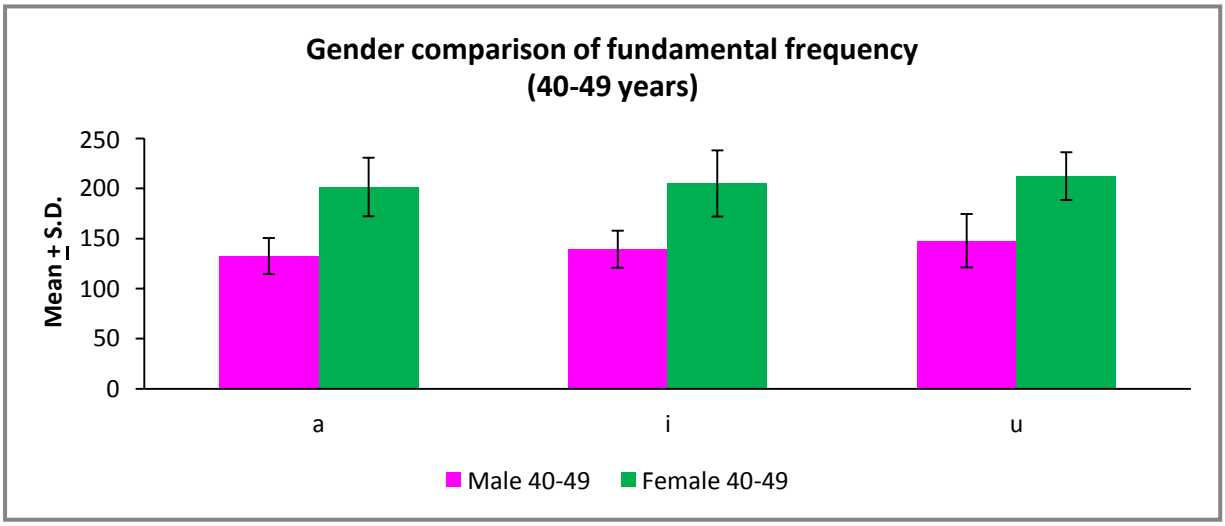

Table 4.7 ***Gender comparison of F0 and HNR for 50- 60 years of age group***

50-60	Vowels	Male 50-60 Mean	S.D.	Female 50-60 Mean	S.D.	sig
Frequency	/a/	136.17	18.52	204.06	34.09	< 0.001*
	/i/	144.49	21.05	207.96	35.59	< 0.001*
	/u/	149.11	21.00	206.73	39.05	< 0.001*
HNR	/a/	20.71	3.62	21.13	4.28	0.761
	/i/	21.78	6.75	23.89	5.49	0.316
	/u/	24.88	5.87	26.67	5.47	0.361

Figure 4.3 ***Shows gender comparison of fundamental frequency for 50- 60 years of age group***

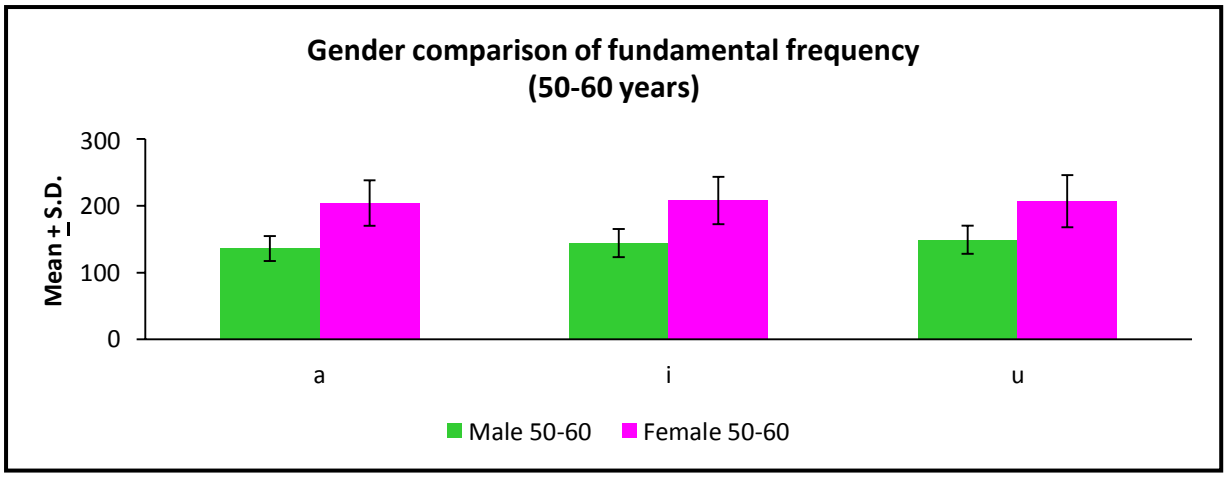

Table 4.8 ***Gender comparison of jitter and shimmer for 30 – 39 years of age group***

30-39		Male 30-39 Median	Median	Female 30-39 Median	IQR	sig
Jitter (%)	/a/	0.37	0.26 to 0.48	0.37	0.29 to 0.52	0.559
	/i/	0.26	0.20 to 0.39	0.19	0.16 to 0.39	0.075
	/u/	0.23	0.19 to 0.41	0.27	0.18 to 0.47	0.745
Shimmer (%)	/a/	0.33	0.27 to 0.44	0.27	0.21 to 0.60	0.284
	/i/	0.19	0.13 to 0.51	0.18	0.12 to 0.26	0.432
	/u/	0.25	0.19 to 0.33	0.17	0.09 to 0.30	0.063

Table 4.9 ***Gender comparison of jitter and shimmer for 40 – 49 years of age group***

40-49		Male 40-49		Female 40-49		sig
		Median	Median	Median	Median	
Jitter (%)	/a/	0.31	0.22 to 0.38	0.26	0.21 to 0.47	0.854
	/i/	0.29	0.16 to 0.41	0.26	0.18 to 0.44	0.960
	/u/	0.25	0.21 to 0.45	0.25	0.16 to 0.45	0.473
Shimmer (%)	/a/	0.24	0.18 to 0.39	0.2	0.15 to 0.43	0.764
	/i/	0.21	0.13 to 0.25	0.22	0.14 to 0.43	0.64
	/u/	0.19	0.13 to 0.37	0.21	0.12 to 0.42	0.947

Table 4.10 ***Gender comparison of jitter and shimmer for 50 – 60 years of age group***

50-59		Male 50-59		Female 50-59		sig
		Median	Median	Median	IQR	
Jitter (%)	/a/	0.31	0.22 to 0.39	0.31	0.25 to 0.65	0.414
	/i/	0.24	0.18 to 0.31	0.28	0.16 to 0.41	0.515
	/u/	0.23	0.18 to 0.35	0.29	0.20 to 0.42	0.423
Shimmer (%)	/a/	0.21	0.17 to 0.38	0.22	0.17 to 0.35	0.894
	/i/	0.24	0.13 to 0.39	0.15	0.13 to 0.21	0.132
	/u/	0.23	0.17 to 0.33	0.15	0.11 to 0.55	0.571

Table 4.5, 4.6, 4.7, 4.8, 4.9, 4.10 and figure 4.1, 4.2, 4.3 shows high significant

DISCUSSION

Results obtained showed no significant difference or variation in the values for fundamental frequency, harmonics to noise ratio, jitter and shimmer for male as well as female across the selected age groups for the vowels /a/ /i/ and /u/. The same is correlating with a study done by Sebastian S, Babu S, Oommen NE, Ballraj A. (2012) and it showed no significant change in the acoustic parameters either in males or in females across the age of 60 years to 80 years.

The scores of fundamental frequency F0 in males, showed a minor variation as age increase from 30 – 60 years. The same is correlating with Decoster & Debruyne (2000), found that F0 was higher in older males but Stathopoulos, Huber & Sussman (2011), found significant non- linear of F0 in males. Pontes et al (2015) discovered that geriatric males exhibited a higher F0, whereas geriatric females had a lower F0 compared with the younger population.

When comparing the fundamental frequency (F0) of females, there is no significant difference is seen among the age groups but there is a noticeable decrease in F0 scores for the vowel /i/ & /u/. The same is correlating with Goy, N Fernandes, Pichora-Fuller, Lieshout (2013) found that F0 decreased with age in females. Eichhorn, D Kent, Austin, K Vorperian (2018) Women experience a significant decrease in F0, which is likely related to menopause

The result of this present study showed no significant difference for harmonics to noise ratio, jitter and shimmer for both male and female participants. The same is correlating with Sebastian S, Babu S, Oommen NE, Ballraj A. (2012) found no significant difference in the voice parameters of jitter, shimmer across the age groups of male and female subjects

In this study, the results of cross comparison across gender (i.e., male v/s female) yields high significant score for fundamental frequency whereas harmonics to noise ratio, jitter and shimmer shows not much difference. The same is correlating with Sebastian S, Babu S, Oommen NE, Ballraj A. (2012) shows Males differed from females significantly for the parameters of fundamental frequency and formant frequencies (f1 and f2) only and not for the parameters of jitter and shimmer.

CONCLUSION

As age increases, the number of cells in the vocal fold decreases and the viscoelasticity of the vocal fold mucosa changes. The way and amount to which voice amplitude and frequency control mechanisms vary with ageing is not well known. This study aimed to analyze the voice characteristics of adult and geriatric. Voice measures were recorded from healthy adult males and females. Participants produced sustained phonation of vowel /a/ /i/ and /u/ several factors like noise, intensity during the phonation,

sampling rate, microphone quality and placement were considered which may affect the quality of recordings for acoustic analysis. About 3 seconds of the recording from the beginning andend of the recorded sample was not selected in a frame for analysis. The middle best frame was selected for analysis. All the selected frames were analyzed using a Praat software and the data were statistically analyzed. The result revealed that the considered parameters, fundamental frequency (Hz), jitter (%), shimmer (dB) and harmonics to noise ratio (dB) for both female and male has no significance difference ($p > 0.05$) on vowel /a/ /i/ /u/. In gender comparison with respect to age group, the statistical analysis of fundamental frequency F0 shows a significant difference, but the other voice characteristics, hormonic to noise ratio, jitter and shimmer had no significant difference.

The age range in this study was restricted and the sample size was insufficient, so the study indicated that both male and female voices have no significant difference among the chosen age group in statistical analysis. However, mean and median results differ significantly across male and female groups. This study, like other investigations, supports the assumption that the fundamental frequency of males increases with age. The female fundamental frequency decreases with age.

LIMITATION:

Limited samples when considered as a group

Results were not significant as because of less intervals between the selected age groups

A clear medical history was not considered

FUTURE DIRECTION:

Future study may try finding geriatric voice change with relevant sample size and with clear-cut medical history.

Declaration by Authors

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