ORIGINAL ARTICLE

Perturbation-related Measures of Voice in Geriatrics: A Normative Using Multidimensional Voice Profile

Deepa N Devadiga[1], Jayashree S Bhat[2], Vasudeva Guddattu[3]

Abstract

Aging causes changes in the speech mechanism that varies from individual to individual. Acoustic cues of aging are regarded as the product of the physiology of the system. The frequency and amplitude perturbations are commonly seen amongst aged voice. It is necessary to discern changes precipitated by normal aging from those that are secondary to the pathological aging process. The aim of the study was to profile the perturbation (frequency and amplitude) norms in aged.

Materials and methods: A total of $n = 162$ participants, in the age range of 60–70 years, were enrolled. The acoustic analysis was done using the Multidimensional Voice Profile (MDVP) software.

Results: The mean values obtained for most of the acoustic measures were observed to be higher with increase in age. Some of the acoustic measures significantly varied across the age groups and the genders.

Conclusion: This normative data will aid in differentially diagnosing the variations in normal aging from those secondary to the pathological aging process.

Keywords: Acoustic evaluation, Aged voice, Perturbation measures.

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Introduction

Acoustic output of the vocal tract is closely associated with underlying physiological mechanisms, and it forms a bridge to human speech perception.[1,2] The computer software-based acoustic analysis has become popular among the professionals interested in voice and their disorders, which provides objective results by adopting the noninvasive mode. There are several software used in analyzing the voice of which Multidimensional Voice Profile (MDVP), presently, is used in routine clinical practice.[3] It is commented that MDVP is the most widely used software for the acoustic analysis of voice globally. It acquires, analyzes, and represents numerically and graphically 33 different parameters from a single vocal segment. It is necessary for clinicians to be able to discern changes precipitated by normal aging from those that are secondary to the pathological aging process.

Aims of the Study

To profile the norms of perturbation- and noise-related measures in geriatrics.

Objectives of the Study

- To profile the perturbation (frequency and amplitude) norms in aged
- To compare across the group and between the genders.

Materials and Methods

A cross-sectional research design with the convenient sampling procedure was adopted for the purpose. The research protocol was approved by institutional ethical committee. A total of 162 participants were recruited for the research.

Participants

The participants were grouped based on their age into two groups: 60–70 years as group I and 71–80 years as group II. Both the groups comprised of 81 participants with 49 males and 32 females with mean and SD age range (males 64.37 ± 3.44; females 64.00 ± 3.45) in group I and (males 75.57 ± 3.02, females 75.31 ± 3.32) in group II.

Selection Criteria

The participants were recruited from the community setup through personal communication. They were explained about the purpose of the study and only those who volunteered were included. An informed consent was obtained from all the participants involved in the research prior to their inclusion in the study. The participants enrolled were 60 and above. The exclusion criteria were those who were unable to follow the verbal commands or instructions or had history of neurologic/psychiatric problems. This information was obtained from the personal health records of the individual,

[1]Department of Speech and Hearing, Manipal College of Health Professions, Manipal Academy of Higher Education, Manipal, Karnataka, India

[2]Department of Audiology and Speech Langauge Pathology, Kasturba Medical College (A Unit of MAHE, Manipal), Mangaluru, Karnataka, India

[3]Department of Data Science, Prasanna School of Public Health, Manipal Academy of Higher Education, Manipal, Karnataka, India

Corresponding Author: Deepa N Devadiga, Department of Speech and Hearing, Manipal College of Health Professions, Manipal Academy of Higher Education, Manipal, Karnataka, India, Phone: +91 9986447191, e-mail: deepa.n@manipal.edu

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or from the spouse, family member, or any other guardian who accompanied the participant, and from the surgical procedures done to the oral and/or laryngeal apparatus in the past.

Procedure

Prior to recording, the participant was seated in a comfortable chair and was instructed to phonate/a/at the most comfortable pitch and loudness. The voice was recorded in a sound-treated room using a dynamic microphone that was maintained at a constant distance of 10 cm from the participant's mouth. The participant was demonstrated the task of sustained phonation and prior to the recording it was ensured that the participant was comfortable and competent in the task. Two trials of sustained phonation with each phonation lasting not less than 3 seconds were recorded. A gap of 2 minutes was given between the trials. The second trial of the sustained phonation task was used for data analysis as most of them performed better in the second trial as compared to the first trial. The obtained sample was analyzed for perturbation (frequency and amplitude) measures.

Statistical Analysis

The statistical analyses were performed using the SPSS (Statistical Package for Social Sciences) software package version 15. Initially, the data were screened for normality. Descriptive statistics (Tables 1 and 2) was employed for the acoustic analysis of voice. Arithmetic mean and standard deviation were used for the variables that followed normal distribution. Log transformation was applied to the skewed variables to derive the geometric mean and geometric standard deviation and was reported as a measure of central tendency for skewed variables. The 95% confidence interval was used as a measure of precision for variables. The two-way ANOVA was used to see the effect of group and the gender on normally distributed/log-transformed variables. The *F* test statistical value, degree of freedom, and *p* value were reported. A *p* value less than 0.05 was considered statistically significant.

Results

Frequency-related Perturbation Measures

The analysis of variance for the parameter mean Jita indicated no significant difference, F (1, 158) = 0.96, $p = 0.33$, between the participants of group I and group II. In terms of gender, the mean Jita was higher for males as compared to the females in both the groups and was statistically significant, F (1, 158) = 80.47, $p < 0.05$. However there was no significant group gender interaction, F (1, 158) = 1.33, $p = 0.25$. For the parameter mean Jitt, mean RAP, and mean PPQ, there was no significant difference observed between the participants of group I and group II. The analysis of variance revealed F (1, 158) = 1.49, $p = 0.22$, for parameter mean Jitt, F (1, 158) = 1.08, $p = 0.30$, for mean RAP, and F (1, 158) = 1.72, $p = 0.19$ for the parameter mean PPQ. The analysis of variance also revealed no gender, F (1, 158) = 0.02, $p = 0.88$, and group gender interaction, F (1, 158) = 0.99, $p = 0.32$, for the parameter mean Jitt, no gender, F (1, 158) = 0.03, $p = 0.87$, and group gender interaction, F (1, 158) = 0.69, $p = 0.40$, for the parameter RAP and for PPQ with no gender, F (1, 158) = 0.00, $p = 0.97$, and group gender interaction, F (1, 158) = 1.07, $p = 0.30$, respectively. For the parameter the mean sPPQ with F (1, 158) = 6.09, $p < 0.05$, and parameter mean vFo F (1, 158) = 3.07, $p < 0.05$ differed significantly between the participants of group I and group II. The analysis of variance revealed no main effect of gender, F (1, 158) = 0.19, $p = 0.66$, and group gender interaction, F (1, 158) = 1.82, $p = 0.18$, for mean sPPQ and with no main effect of gender, F (1, 158) = 0.06, $p = 0.80$, and group gender interaction, F (1, 158) = 0.04, $p = 0.84$, for mean vFo.

Table 1: Mean values of frequency-related perturbation measures among group I participants

	Males		*Females*	
Parameters	*Mean ± SD*	*95% CI for mean*	*Mean ± SD*	*95% CI for mean*
Jita/us	119.68 ± 1.99	96.64–148.26	94.47 ± 2.31	72.46–123.10
Jitt/%	1.49 ± 2.06	1.21–1.83	1.64 ± 2.15	1.27–2.13
RAP/%	0.87 ± 2.09	0.7–1.07	0.97 ± 2.15	0.75–1.27
PPQ/%	0.84 ± 2.22	0.67–1.05	0.95 ± 2.19	0.73–1.25
sPPQ/%	1.29 ± 2.15	1.05–1.58	1.42 ± 2.04	1.11–1.84
vFo/%	2.61 ± 2.15	2.12–3.21	2.75 ± 2.23	2.12–3.56

Note: Jita, absolute jitter (us); Jitt, jitter percent (%); RAP, relative average perturbation (%); PPQ, pitch period perturbation quotient (%); sPPQ, smoothed pitch period perturbation quotient (%); vFo, fundamental frequency coefficient variation (%) are expressed in geometric mean and standard deviation

Table 2: Mean values of frequency-related perturbation measures among group II participants

	Males		*Females*	
Parameters	*Mean ± SD*	*95% CI for mean*	*Mean ± SD*	*95% CI for mean*
Jita/us	155.22 ± 2.35	125.34–192.29	92.50 ± 1.82	70.95–120.54
Jitt/%	1.94 ± 2.26	1.57–2.38	1.69 ± 1.79	1.31–2.19
RAP/%	1.09 ± 2.35	0.88–1.35	1.00 ± 1.81	0.77–1.31
PPQ/%	1.13 ± 2.32	0.90–1.40	0.99 ± 1.85	0.75–1.29
sPPQ/%	2.00 ± 1.98	1.63–2.45	1.63 ± 2.01	1.27–2.09
vFo/%	3.29 ± 1.92	2.67–4.06	3.31 ± 2.14	2.56–4.29

Note: Jita, absolute jitter (us); Jitt, jitter percent (%); RAP, relative average perturbation (%); PPQ, pitch period perturbation quotient (%); sPPQ, smoothed pitch period perturbation quotient (%); vFo, fundamental frequency coefficient variation (%) are expressed in geometric mean and standard deviation

Table 3: Mean values of amplitude-related perturbation measures among group I participants

	Males		*Females*	
Parameters	*Mean ± SD*	*95% CI for mean*	*Mean ± SD*	*95% CI for mean*
ShdB/dB	0.43 ± 1.83	0.36–0.52	0.34 ± 1.83	0.27–0.42
Shim/%	4.79 ± 1.78	4.07–5.65	3.68 ± 1.76	3.00–4.52
APQ/%	3.70 ± 1.75	3.17–4.31	2.67 ± 1.69	2.20–3.23
sAPQ/%	6.14 ± 1.72	5.31–7.09	5.00 ±1.60	4.18–5.98
vAm/%	21.15 ± 8.37	18.41–23.89	17.22 ± 8.83	13.83–20.62

Note: ShdB, shimmer in dB (dB); Shim, shimmer percent (%); APQ, amplitude perturbation quotient (%); sAPQ, smoothed amplitude perturbation quotient (%) are expressed in geometric mean and standard deviation. vAm, peak-to-peak amplitude coefficient of variation (%) is expressed in arithmetic mean and standard deviation

Table 4: Mean values of amplitude-related perturbation measures among group II participants

	Males		*Females*	
Parameters	*Mean ± SD*	*95% CI for mean*	*Mean ± SD*	*95% CI for mean*
ShdB/dB	0.54 ± 2.02	0.45–0.65	0.45 ± 2.14	0.35–0.56
Shim/%	5.93 ± 1.96	5.03–6.99	4.48 ± 1.58	3.65–5.49
APQ/%	4.58 ± 1.84	3.92–5.34	3.33 ± 1.55	2.75–4.03
sAPQ/%	7.40 ± 1.71	6.40–8.54	6.09 ± 1.57	5.09–7.28
vAm/%	21.82 ± 10.40	19.08–24.56	23.99 ± 11.26	20.60–27.39

Note: ShdB, shimmer in dB (dB); Shim, shimmer percent (%); APQ, amplitude perturbation quotient (%); sAPQ, smoothed amplitude perturbation quotient (%) are expressed in geometric mean and standard deviation. vAm, peak-to-peak amplitude coefficient of variation (%) is expressed in arithmetic mean and standard deviation

Amplitude-related Perturbation Measures

The analysis of variance showed significant difference statistically, $F(1, 158) = 5.40$, $p < 0.05$, for the parameter mean ShdB between the participants of group I and group II. It also revealed significant effect of gender, $F(1, 158) = 4.26$, $p < 0.05$. However, there was no significant group gender interaction, $F(1, 158) = 0.09$, $p = 0.75$ (Table 3). For the parameter, mean Shim, the analysis of variance revealed significant main effect of age, $F(1, 158) = 4.72$, $p < 0.05$, and gender, $F(1, 158) = 8.36$, $p < 0.05$, but there was no significant group gender interaction, $F(1, 158) = 0.00$, $p = 0.93$. For the parameter, the mean APQ, the analysis of variance revealed significant main effect of age, $F(1, 158) = 6.07$, $p < 0.05$, and gender, $F(1, 158) = 13.34$, $p < 0.05$, but, there was no significant group gender interaction, $F(1, 158) = 0.00$, $p = 0.97$. The analysis of variance for parameter mean sAPQ revealed significant main effect of age, $F(1, 158) = 5.41$, $p < 0.05$, and gender, $F(1, 158) = 5.89$, $p < 0.05$. But there was no significant group gender interaction, $F(1, 158) = 0.00$, $p = 0.95$. The analysis of variance for parameter mean vAm revealed significant main effect of age, $F(1, 158) = 5.68$, $p < 0.05$. There was no main effect for gender, $F(1, 158) = 0.31$, $p = 0.58$, and for group gender interaction, $F(1, 158) = 3.82$, $p = 0.05$ (Table 4).

Discussion

Frequency-related Perturbation Measures

The aging induces instability in vocal fold vibration. The stiffness of the vocal cord cover that increases with aging leads to instability of the vocal fold vibrations.[4] This instability is measured through the fluctuations in frequency and amplitude. In the present research, there was an increase observed for frequency-related perturbation measures with age except for mean Jita. Increased frequency perturbations have been reported in the literature among the geriatrics, which supports the findings of the present research.[5] The changes in the epithelium, which reduce the structural support, seem to attribute to increase in the perturbation measures.[6] Moreover, previous investigations have stated that these increased frequency fluctuations appear to be more related to the health status, which is also in line with current observations. In this research, the jitter was observed to be higher in participants of group II, wherein the participants also had rated their health to be poor.[7] As the age advances, the changes in the structures is more extensive, especially in males as compared to females contributing for the jitter variations,[8] which is also seen in the present research with the jitter being higher among the male participants of group II.

Amplitude-related Perturbation Measures

The shimmer is found to have high correlation with aging.[7] Shimmer was higher among the group II participants in the current research. These variations being higher among the males are attributed to structural change seen among aged males, which are extensive as compared to the females,[9] at par with the observations of this research.

Conclusion

Aging being diverse and heterogeneous population, the results of the current research will provide serve as a database for acoustic measures of voice, among the geriatric group in the age range of 60–80 years. The fluctuations with respect to frequency and amplitude are common among the aged group. Hence, this data will aid in differentially diagnosing the variations in normal aging from those secondary to pathological aging process. The intervention efficacy can also be determined by using this database.

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