

Fundamental Frequency Changes of Persian Speakers Across the Life Span

*Majid Soltani, †Hasan Ashayeri, ‡Yahya Modarresi, §Mahyar Salavati, and ||Hamed Ghomashchi, *†‡§Tehran and ||Qazvin, Iran

Summary: This study was designed to investigate changes in fundamental frequency (F_0) across the life span in Persian speakers. Four hundred children and adults were asked to produce a sustained phonation of vowel /a/ and their voice samples were studied in 10 age groups. F_0 was analyzed using the software *Praat* (Version 5.1.17.). The results revealed that (1) the mean F_0 in both sexes decreases from childhood to adulthood; (2) significant F_0 differences between boys and girls begin at the age of 12 years; and (3) the range of F_0 changes in the life span is greater in men (178.38 Hz) than in women (113.57 Hz). These findings provide new data for Persian-speaking children, women, and men and could be beneficial for Iranian speech and language pathologists.

Key Words: Fundamental frequency—Acoustic analysis—Persian.

INTRODUCTION

Perceptual, acoustic, and aerodynamic measurements are common ways to assess voice. Acoustic assessment is widely used in research and clinical practice. Moreover, acoustic features are linked to the physiological mechanisms of speech and have thus been used to better understand the nature of these mechanisms. Acoustic assessments can facilitate speech research and measuring treatment outcomes.¹ Acoustic analysis of voice consists of various parameters; one of which is fundamental frequency (F_0),² which has been widely reported in voice research. F_0 is correlated with pitch³ and is reflective of the vibration speed and the biomechanical features of the vocal folds.² There is a positive relationship between biomechanical characteristics of vocal folds and F_0 which is the result of stretching of the elastic fibers of the vocal fold cover and the fibers of the vocal ligament.⁴

To determine the appropriateness of voice for a person's age and sex compared with normative data in clinical settings, the prominent role of F_0 cannot be neglected. Logical presumption suggests that genetic, social, and cultural differences may affect certain acoustic features of human voice. Natour and Wingate⁵ reported ethnic and cultural differences of F_0 among Arabic speakers's voice using vowel task. They suggested higher F_0 for Arabic speakers than for speakers of other ethnics such as Indian, Chinese, and Taiwanese. They also focused on the use of reported F_0 value of Arabic speakers by Jordanian speech and language pathologists.⁵ Speech-language pathologists judge their patients' voice by comparing their voice to that of a person of similar age, sex, cultural background, and geographic location.^{6,7} Thus, they need to use normative data

related to F_0 in different decades of life considering their own language to diagnose and treat patients with voice disorders. Therefore, voice scientists and researchers have measured F_0 in different languages using various speech tasks at different ages. Table 1 summarizes some previous studies performed to measure F_0 values. F_0 of Persian-speaking participants has been reviewed in a limited number of studies.^{6,8} Persian is an Iranian language belonging to the Indo-European language family. The dialect investigated in this article is spoken in Tehran (capital of Iran). Persian is classified as a subject-object-verb language and it is not a tone language. The sound system of Persian consists of eight stops, eight fricatives, two affricatives, two nasals and two liquids, a glide, and six vowels. Hence, the first aim of the present study was to provide normative data of F_0 in Persian speakers of Iran in a large age range.

F_0 , as an acoustic parameter of the human voice, changes across the life span like any other physical and functional aspects of anatomical and physiological dimensions.⁹ Because voice is controlled by physiological and neuromuscular processes and these characteristics change over time, voice features are expected to change during life as well. These changes may be due to reasons such as anatomical and physiological maturity of the speech mechanism, variations in sensory feedback, and a decrease or increase in the accuracy or rate of speech motor control.^{3,10} These changes in voice characteristics are important for voice scientists.^{9,11,12} Although F_0 of specific age groups is investigated in many researches, there is still a lack of experimental investigations studying acoustic characteristics of voice during individuals' life span. The reason can be attributed to the fact that in the previous researches conducted in this area, large number of participants with large age ranges were not studied. In some of these researches, just one gender has been studied (A Kelley, Unpublished manuscript, 1977).¹³ Thus, there are some conflicts among the results of these researches, most of which reported English acoustic characteristics (A Kelley, Unpublished manuscript, 1977).^{13–15}

Stathopoulos et al¹⁴ tried to use a systematic data set of a large number of participants to survey F_0 changes during life span. They studied the changes of acoustic features in vowels through the life span of 192 English-speaking participants aged 4–93 years. They demonstrated that for men, F_0 decreased continuously from age 4 to 50 years with a stronger trend than

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From the *Department of Speech Therapy, Iran University of Medical Sciences, Tehran, Iran; †Department of Basic Sciences, Iran University of Medical Sciences, Tehran, Iran; ‡Department of Linguistics, Institute for Humanities and Cultural Studies, Tehran, Iran; §Department of Physical Therapy, University of Social Welfare and Rehabilitation Sciences, Tehran, Iran; and the ||Faculty of Industrial and Mechanical Engineering, Islamic Azad University, Qazvin Branch, Qazvin, Iran.

Address correspondence and reprint requests to Hasan Ashayeri, Department of Basic Sciences, School of Rehabilitation Sciences, Iran University of Medical Sciences, Tehran, Iran. E-mail: ashayerih.neuroscientist@yahoo.com

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TABLE 1.
Summary of Studies Conducted to Measure F_0 Values

Study	Language	Ethnicity	Speech Material	Age of Subjects (y)	Number and Sex of Subjects	Mean of Frequency (Hz)
Biever and Bless ²⁷			Vowel /i/	20–28	20 (F)	193
				60–77	20 (F)	191
Hollien and Shipp ¹³	English	—	Reading	20–29	25 (M)	120
				30–39	25 (M)	112
				40–49	25 (M)	107
				50–59	25 (M)	118
				60–69	25 (M)	112
				70–79	25 (M)	132
				80–89	25 (M)	146
Wheat and Hudson ⁴²	English	Black	Spontaneous speech	6	50 (M)	219.50
					50 (F)	211.30
Glaze et al ²⁸	English	—	Sustained /ha/	5–11	59 (M)	225.92 (M)
					62 (F)	237.56 (F)
Awan and Mueller ³⁴	English	White	Picture description	5–6	35 (15 M and 20 F)	243.35 (M), 240.07 (F)
		African American			35 (18 M and 17 F)	231.48 (M), 241.31 (F)
		Hispanic			35 (16 M and 19 F)	248.04 (M), 248.99 (F)
Sapienza ²²	English	African American	Sustained /a/	18–28	20 (10 M and 10 F)	123.95 (M), 223.10 (F)
		White			20 (10 M and 10 F)	124.53 (M), 214.90 (F)
Andrianopoulos, et al ⁴⁰	English	Caucasian	Sustained /a/	22–29	10 (5 M and 5 F)	128.31 (M), 233.46 (F)
		African American			10 (5 M and 5 F)	127.56 (M), 227.99 (F)
		Indian			10 (5 M and 5 F)	137.60 (M), 251.64 (F)
		China			10 (5 M and 5 F)	154.21 (M), 266.73 (F)
Cappellari and Cielo ³²	Portuguese	Brazilian	Sustained /a/	4	7	255.06
				5	11	253.18
				6	5	248.87
Natour and Wingate ⁵	Arabic	Jordanian	Sustained /a/	5–7	100 (50 M and 50 F)	267.77 (M), 274.18 (F)
				18–24	200 (100 M and 100 F)	131.34 (M), 231.13 (F)
Dehqan et al ⁶	Persian	Iranian	Sustained /a/	20–30	30 (15 M and 15 F)	113.1 (M), 214.53 (F)
				31–40	30 (15 M and 15 F)	112.8 (M), 214.36 (F)
				41–50	30 (15 M and 15 F)	112.56 (M), 215.04 (F)
Ghorbani et al ⁸	Persian	Iranian	Sustained /a/	9	40 (20 M and 20 F)	259.69 (M), 273.65 (F)
				11	40 (20 M and 20 F)	243.21 (M), 265.21 (F)
				13	40 (20 M and 20 F)	231.41 (M), 253.53 (F)
				15	40 (20 M and 20 F)	170.77 (M), 238.48 (F)
				20	40 (20 M and 20 F)	126.73 (M), 228.34 (F)
				30	40 (20 M and 20 F)	120.44 (M), 224.28 (F)
				40	40 (20 M and 20 F)	116.21 (M), 215.87 (F)
				50	40 (20 M and 20 F)	121.98 (M), 196.09 (F)

Abbreviations: M, male; F, female.

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