# Determination of Fundamental Frequency and Voice Intensity in Iranian Men and Women Aged Between 18 and 45 Years

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**Summary: Objectives.** Acoustic measurements have become an essential aspect of voice assessment during the last few decades, and studies have established that normative data is necessary for acoustic analysis. In this study, two aspects of voice are reviewed. These two factors are fundamental frequency and intensity. This study was designed to establish the normal acoustic analysis parameters in normal Iranian adults.

**Methods.** In this cross-sectional study, 200 healthy randomly selected subjects (100 men and 100 women) were assessed. Data collection was carried out using the *Studio Speech* software and Laryngograph processor (Laryngograph Ltd, London, UK), type: PCLX at the Larynx and Voice Disorders Clinic of Rasoul-e-Akram Hospital under comfortable phonation.

**Results.** The value of fundamental frequency in reading was greater for women (170–240 Hz) than for men (107–140 Hz). Also, the value of intensity was greater for women (73.54–84.99 dB) than for men (72.40–86.03 dB).

**Conclusion.** The present study developed the normal data for fundamental frequency and intensity in Iranian speakers aged between 18 and 45 years. We concluded, fundamental frequency has significant differences between men and women, but intensity has no significant difference between them.

**Key Words:** Fundamental frequency–Intensity–Video stroboscopy–Voice analysis.

## INTRODUCTION

Acoustic measurements have become an essential aspect of voice assessment during the last few decades and studies have established that normative data is necessary for acoustic analysis. Voice acoustic analysis often includes several important aspects that we have studied on two factors:

1. Average fundamental frequency (F0) that reflects habitual pitch, it is determined by the number of cycles produced by the vocal folds per second.
2. Intensity is a force or stress with which a sound is produced by a speaker, and is the attribute of loudness of the sound to the listener. It is usually expressed in decibel.

The vocal folds of men and women are different both in size and vibration. Difference in size and vibration between women and men may result in different phonation. Several studies have found that the membranous vocal fold length and laryngeal size for men were greater than that for women, and that this contributed to a lower fundamental frequency in men.[1–6]

Besides, the tension of the vocal fold in women was greater than that in men,[2,3,6] and this contributed to a greater vocal fold tension and higher fundamental frequency in women.[7,8]

Several studies found acoustic differences between adult women and men during speech. In women, the fundamental frequency in both sustained phonation and reading was higher than that in men.[4,9–18] The frequency range in men while reading was larger than that in women.[9–11,17,19]

People of different races were different in their phonation frequency and possibly in phonation intensity. Morris[20] proposes that speaking fundamental frequency is similar for white and African-American boys, whereas African-American boys exhibited greater speaking fundamental frequency variability than Caucasians.

Hudson[18] and Fitch and Holbrook[9] found that young African-American adults who had larger body size than whites also showed a lower speaking fundamental frequency, greater speaking frequency variability, and a greater speaking frequency range. This body size influence hypothesis was supported by several authors,[21] whereas it was disputed by others.[22–24] Also, Kahane[25] and Hirano et al[26] found that the length of the vocal folds in Japanese adult men and women were shorter than those of Caucasian Americans. The laryngeal size of Japanese and Taiwanese adult could also be smaller than that of Caucasian Americans, which may result in higher speaking fundamental frequency for Japanese and Taiwanese men and women than for Caucasian Americans.[4,27]

Typically, a voice is perceived as sounding normal provided that it meets certain expectations associated with a person's community, society, culture, age, gender, and profession. A voice disorder exists when quality, pitch loudness, and flexibility of a person's voice differs from the voices of others of similar age, gender, and cultural group.[28]

The reasons that we have done this research are: there is no similar research in reading a text. Great number of people have participated in the research randomly. There is a need of comparison between other races and in other parts of the world. Outcomes can be useful to the extent and duration of voice therapy.

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It is noticeable that the frequency and intensity of the voice can be different according to the size of larynx of the people and also to cultural differences in different parts of the world. That these differences can define the number of sessions that is needed.

The purposes of this study were: to compare the fundamental frequency and intensity range between normal adult Iranian men and women, and to compare the mean of fundamental frequency and intensity between normal adult Iranian men and women.

It is important that measurements do not replace the perceptual judgment but that they allow a more precise diagnosis, provide more evidence for therapeutic interventions, and are useful as feedback for patients in therapy (Tables 1 and 2).

## METHODS AND MATERIALS

### Subjects

Two hundred Farsi-speaking Iranian adults (100 women and 100 men) were involved in the study. All test subjects were between 18 and 45 years of age. The mean age in women was 31.6 years and in men was 29.2 years. Subjects were also screened on former problems with breathing, voice, neurological diseases, and structural abnormalities in the larynx, mouth, or throat, using a questionnaire. Subjects who had a problem were omitted from the research. All subjects met the following criteria: no history of smoking, heavy drinking, laryngeal surgery hearing impairment, respiratory problems, neurological problems, or singing training; and normal voice condition, as judged by the perceptual evaluation and video stroboscopic examination with a 70° rigid telescope by the second author, who performed the acoustic examination in a sound proof room with the subjects in a sitting position.

### Instrumentation

Data collection was performed, using the Laryngograph processor (Laryngograph Ltd; Type PCLX, with PCLX DSP card), microphone and electrodes, and the *Speech Studio* software, at the voice laboratory. Laryngograph processor, which provides the laryngograph and speech pressure waveform and period marking pulses, is an all-in-one electro-laryngograph microphone preamplifier, and speech or laryngograph-based fundamental frequency ("pitch") extractor.

The *Speech Studio* software currently contains two programs: (1) SPEAD (Speech Pattern Element Display and Acquisition): a real time speech display system, and (2) Qa (Quantitative analysis): an off-line program for providing extensive analysis of the structure of continuous speech. *Speech Studio* has programs to examine difficulties with pitch and loudness control.

### Voice sample

Frequency and intensity range data were obtained from reading a standard passage in Farsi. The passage contained 138 commonly used words. All 23 consonants and six vowels in Farsi were involved in the passage. Before testing, all subjects were asked to practice the reading passage to induce the fluency

**TABLE 1.**
**Mean Value of F0 and Average F0-Variation (SD) to Eight Investigations That Report Results From Adult Men and Women Speakers in the Same Setting**

| Investigation | Sex | Age (Years) | F0 | SD |
|---|---|---|---|---|
| Chen (1974), Mandarin Chinese | M | 30–50 | 108 | 4.1 |
| | F | 30–50 | 184 | 3.8 |
| Johns-Lewis (1986), English (reading) | M | 24–49 | 128 | 4.35 |
| | F | 24–49 | 213 | 4.5 |
| Graddol (1986), English (reading) | M | 25–40 | 131 | 4.55 |
| | F | 25–40 | 219 | 3.9 |
| Hollien and Shipp (1972) | M | 30–39 | 112 | — |
| Saxman and Burk (1967) | F | 30–40 | 196 (271–222) | 2.5 |
| Sheng Hwa Chen, Mandarin | M | — | 110 | 13.6 |
| | F | — | 196 | 23.2 |
| Fitch (1990), English | M | — | 112.90 | 13.60 |
| | F | — | 206 | 15.30 |
| Pegoraro Krook (1988), Swedish | M | — | 112.30 | 7.63 |
| | F | — | 195.5 | 25.5 |
| Terasawa et al (1984), Japanese | M | — | 122 | 19.9 |
| | F | — | 238.60 | 16.81 |
| Hudson & Holbook (1981) | | | | |
| 1. English/Caucasian-American | M | — | 116.65 | — |
| | F | — | 217 | — |
| 2. English/African-American | M | — | 110 | 16.21 |
| | F | — | 193 | 18.58 |

*Abbreviation:* SD, standard deviation.