The Effect of Smoking on the Dysphonia Severity Index in Females

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Introduction

The purpose of this study was to compare groups of young adult female smokers and nonsmokers on the multiparameter DSI. Developed by Wuyts, De Bodt, Molenberghs, et al., the DSI makes use of a combination of several voice measures that may be obtained from the voice range profile, as well as basic aerodynamic and acoustic analyses: the highest phonational frequency (F₀ High in Hz), lowest intensity (I Low in dB), maximum phonation time (MPT in s), and jitter (%). The focus on young adult female smokers stems from the fact that a trend for an increase in young female smokers appears to be a worldwide phenomenon. In industrialized nations such as Denmark and Germany, alarming trends for young women to smoke at a greater rate than young men have been noted, and a recent study reported that, for the first time, in Sweden women have a higher prevalence of daily smoking than men. Data compiled by the World Health Organization indicate an alarming trend for rising prevalence of smoking in females in other parts of the world, with particular concern for women in developing nations. It has been hypothesized that reasons for tobacco uptake in young women may include cultural, psycho-social and socioeconomic factors, such as body image, peer pressure and addiction. Concern has also been raised that females may be more apt to suffer the detrimental effects of smoking than their male peers. Despite the increased knowledge regarding the adverse health effects of smoking, it appears that more needs to be done to increase awareness of the impact of smoking on women’s health.

Methods

Subjects were 30 female nonsmokers and 30 female smokers (Total $N = 60$) between the ages of 18-30 years of age. All subjects were volunteers free of voice complaints and had no prior history of any significant laryngeal trauma or disorders. In addition, subjects who reported significant history of chronic respiratory disorder, frequent episodes of heartburn, reflux, chronic cough, dysphagia, or previous medical conditions consistent with diagnosis of laryngopharyngeal reflux (LPR) or gastroesophageal reflux disease (GERD) were excluded from this study. For the purposes of this study, a smoker was defined as any subject who, at the time of this study, had smoked at least two cigarettes per day for at least one year. All of the subjects in the nonsmoker category were those who, at the time of this study, did not smoke and who had not smoked for at least five years prior to the study. All subjects reported no history of significant injury or trauma to the vocal folds/larynx, passed a hearing screening of 20 dB at .5, 1, 2, and 4 kHz, and were perceived as having normal voice characteristics of pitch, loudness, and quality.

Procedures

Each subject was asked to complete the following tasks:

1) Highest promotional frequency (F₀ High): Each subject was asked to go up a scale (using the vowel /ɑ/) until they reached their highest pitch level without losing control of the voice (i.e., no pitch or phonation breaks). The highest pitch level was digitally recorded at 44.1 kHz, 16 bits of resolution
using Sound Forge v. 4.0 and later analyzed using the TF32 speech/voice analysis program for the highest frequency level (in Hz).

2) Lowest intensity level (I Low): Each subject was asked to sustain the vowel /ɑ/ at a comfortable pitch as quietly as possible. Three trials were elicited. Each production was analyzed for the intensity level (in dB) using the Aerophone II. Mouth-to-microphone distance was 15 cm. To convert this to the commonly used 30 cm mouth-to-microphone distance, 6 dB may be subtracted from the 15 cm mouth-to-microphone distance intensity level. Sound intensity is expected to decrease by 6 dB when the distance from the source is doubled.

3) Jitter: To obtain a measure of jitter, the subject was instructed to chant “1, 2, 3, 4” at a comfortable pitch and loudness and then sustain that phonation of /ɑ/ for 2-3 seconds at that similar pitch level. This elicitation method was utilized to obtain a sample that closely approximates the subjects’ habitual speaking pitch. Three trials were elicited. Each production was digitally recorded at 44.1 kHz, 16 bits of resolution using Sound Forge v. 4.0. The central 1 second of each sustained vowel was later analyzed for jitter (%) using the TF32 program.

4) Maximum Phonation Time (MPT): The subject was asked to hold out a sustained vowel (usually /ɑ/) for as long as possible after a maximum inhalation. Three trials were elicited. Each trial was timed with a digital stopwatch to calculate the duration (in seconds).

**DSI Formula**

The DSI formula is derived from a weighted combination of the following vocal parameters: highest frequency (Hz), lowest intensity (dB), maximum phonation time (s), and jitter (%). The DSI was calculated using the maximum performances for F0 High and MPT, the lowest intensity, and the lowest jitter. Results were entered into the following formula:

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\text{DSI} = 0.13 \times \text{MPT (s)} + 0.0053 \times F_0 \text{ High (Hz)} - 0.26 \times I \text{ Low (dB)} - 1.18 \times \text{Jitter (％)} + 12.4
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**Results:** Significant differences between young adult female smokers and nonsmokers were observed on the overall DSI, with reduced DSI scores in smokers primarily due to reductions in F0 High and increases in I Low. In addition, a strong partial correlation between MPT and the overall DSI in smokers indicates that reductions in respiratory support and/or phonatory may be influencing their DSI results.

**Conclusions:** The observed significant differences between smokers and nonsmokers on the DSI and component vocal function measures may be indicative of early changes in vocal function secondary to smoking. Reductions in frequency and dynamic range are consistent with previous reports regarding the possibility of increased vocal fold mass as a result of smoking. In addition, the results of this study indicate that significant differences in the DSI between groups may be observed in subjects with perceptually normal vocal quality and with normal levels of vocal perturbation.