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Deviations of Voice Characteristics in Female Speech Therapy Students that Smoke Using Dr. Speech

Tafiadis D[3], Toki EI[1,2,3], and Ziavra N[1,2,3]

[1]Laboratory of Audiology, Neurootology and Neurosciences, Department of Speech & Language Therapy, TEI of Epirus, Greece

[2]Laboratory of New Approaches in Communication Disorders, Department of Speech & Language Therapy, TEI of Epirus, Greece

[3]Department of Speech & Language Therapy, School of Health and Welfare, TEI of Epirus, Ioannina, Greece

[*]**Corresponding author:** Dr. Eugenia I. Toki, Assistant Professor, Department of Speech & Language Therapy, Technological Educational Institute (TEI) of Epirus, Ioannina, Greece , Tel: +30 26510 50720, 50753, E-mail: toki@ioa.teiep.gr

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ABSTRACT

It is established in the literature that smoking has an impact on voice characteristics especially on fundamental frequency (F0). Smoking effect has been studied in general and in student populations by sex or profession. The purpose of this study was to examine the voice acoustic characteristics of smoking students in Greece. Particularly, this study focused on early effects of smoking (<10 years) on voice parameters. In total two hundred and ten (210) non-dysphonic female students (aged 18–34) from different departments were recruited. One hundred of these students were nonsmokers and one hundred and ten were smokers. Participants completed two questionnaires and their voices were recorded. Acoustic analysis of voice characteristic was performed with the Dr. Speech Software system. The results of the study showed statistical significance between smoking and habitual F0 for students who smoke. For speech language therapy students that smoke, there was a statistically significant relationship between smoking and mean F0. In addition, smoker subgroups were observed to have significantly lowered acoustic voice parameters in comparison with non-smoker subgroups. The impact of years of smoking and total daily cigarette consumption are also discussed according to current trends.

Key Words: Dr. Speech, Female, Smoking, Speech language therapy students, Voice characteristics

INTRODUCTION

The World Health Organization (WHO) (2016), reports that tobacco use is a preventable cause of mortality and disease. Europe – among all the WHO regions – has the highest occurrence of smoking among adults (28%). Nineteen percent of Europe's smoking adults are females and it is estimated that the prevalence level in 2025 among women will decline to 16%. Unfortunately, Greece has the highest standardized percentage of tobacco smoking with 42.4%, while the global average is 22.7% and Europe's average is 27.3% (WHO, 2016). For women in Greece it was reported that cigarette smoking in 2012 exceeded 30% [1].

An association between smoking and laryngeal pathologies is beyond doubt [2-4]. Smoking is considered as a risk factor in vocal polyps [5] and Reinke edema [6]. Tobacco use is also considered a risk factor for benign vocal fold carcinomas [7-9] and laryngeal lesions [10]. Cigarettes contain carcinogenic substances and in association with similar activities (e.g. excessive alcohol consumption) are considered a risk factor for up to 10% of adult's deaths [11]. Chronic use of cigarettes often leads to laryngeal problems, such as chronic inflammation, erythema, or irritation of laryngeal mucosa [12-14]. Also, people exposed to secondary smoke (non-smokers) can cause harmful effects on laryngeal mucosa [15-17].

Changes in the larynx's structures and epithelium result in deviations of voice characteristics. Those voice changes are often the first symptom and main complaint indicating laryngeal diseases [18,19]. Previous research has documented cigarette smoking affecting perceptual, acoustic, and aerodynamic performance during phonation [20]. Awan and Morrow [21], evaluated smokers using videolaryngeal stroboscopy. They suggested that smoking consistently caused changes in fundamental frequency (F0) characteristics. Sorensen & Horii [22] as well as Murphy & Doyle [23] also reported a lower fundamental frequency (F0) among male smokers when compared with nonsmokers. Similarly, Damborenea et al. [24] and Gonzalez & Carpi found that smokers have lower fundamental frequency and higher perturbation parameters (jitter and shimmer).

Since professional voice users rely on their voices, it is imperative that their voices remain clear and stable throughout the day [25,26] without any influences from various factors, such as tobacco use. Even though voice demands on speech language therapists (SLTs) are high, little attention has been devoted to the risks of smoking on voice for this population, in the literature [26,27].

The prevalence of voice disorders are frequently exhibited prior to employment as SLTs Gottliebso et al. [28] assessed 104 first-year graduate students majoring in speech-language pathology (SLT) using the "Quick Screen for Voice".

Their results suggested that the voice-related problems detected among future SLTs (12%) are higher than the 3–9% prevalence of voice disorders in the general population that Verdolini & Ramig [29] reported. Van Lierde et al [30], stated that the final-year SLT students mentioned hoarseness, laryngeal irritations (25%) and decreased vocal quality in the morning (13%). Also, 81% reported the presence of corporal pain during and/or after speaking. The above findings were not correlated with risk factors such as smoking.

The purpose of this study was to examine the voice acoustic characteristics of female smoker students in Greece and particularly in future SLTs. Specifically, this study focused on early effects of smoking (<10 years) on voice perturbations using Dr. Speech Software system.

MATERIALS AND METHODS

Participants

The study was carried out by the Department of Speech Language Therapy at the Technological Educational Institute (TEI) of Epirus, Ioannina Greece. This research and its aims were presented to students, and their consent to participate was obtained. Several of the 210 female students were recruited from School of Health and Welfare – TEI of Epirus. Subjects that had a history of any laryngeal disorder or trauma or any problems with the upper or lower respiratory system in the previous two weeks (symptoms of cold, chronic rhinitis or post-nasal drip) were excluded. Participants that reported alcohol or drug addiction, frequent complaints of heartburn and symptoms consistent with gastroesophageal reflux disease (GERD) and laryngopharyngeal reflux (LPR) were excluded as well. Smokers were defined those who smoked two cigarettes a day for at least 5 consecutive years. Non-smokers were defined as those who did not smoke for at least 5 years before the study.

Data Collection

All students completed the Voice Evaluation Form, a consensus-based template from American Speech-Language-Hearing Association [31] to copy their voice backgrounds. They were also administered the Voice Handicap Index (VHI) a culturally adapted and validated questionnaire in the Greek language [32]. VHI was chosen because of its use with other populations experiencing voice disorders [33-36] and it has cross-cultural adaptation in many languages [37-43] Both questionnaires served as tools to ensure that no other contributing factors influenced voice sampling.

Measurements

Participants were seated in a recording room during data collection. A sound level meter (Extech, 407730 Digital Sound Meter) was used to maintain intensity under 40dB. Students were allowed to rehearse three times before recording. They were asked to sustain the vowels /a/ and /e/ for at least 5 seconds at a comfort pitch [44]. The /a/ sound was chosen because it has been used by many researchers [4,22]. The /e/ sound was chosen since it elevates the larynx and it is used during video stroboscopic evaluation [21]. Voice measurements were taken consistent with the National Center for Voice and Speech recommendations [45]. Voice and perturbation analysis was.

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performed with Dr. Speech software, version 4.0 (Tiger electronics Inc., MA). The habitual F0 (Hz), mean F0 (Hz), percent jitter, percent shimmer, harmonic-to-noise-ratio (HNR in dB) and intensity (dB) were measured. [46,47].

Statistical Analysis

Normally distributed variables are expressed as mean ± standard deviation; while variables with skewed distribution are expressed as median (interquartile range). A student's t-test was computed to compare variables between the four study groups. The Mann-Whitney Test was used for the comparison of continuous variables between the four study groups. Multiple linear regression models attempted to determine the relationship between more explanatory variables and a response variable by fitting a linear equation to observed data. All reported p values were two-tailed. Statistical significance was set at $p<0.05$ and analyses were conducted using SPSS statistical software (version 19.0).

RESULTS

From the two hundred and ten (210) female participants, one hundred and ten (110) were students majoring in SLT (i.e., majors) and one hundred (100) were students from different departments (i.e., non-majors). In total, 52.4% (110 students) were smokers and 47.6% (100 students) were non-smokers. From the smoker's subgroup 54.5% (60 students) were majors and 45.5% (50 students) were non-majors. Likewise, of the non-smokers, 50% (50 students) were majors and 50% (50 students) were non-majors.

The sample mean age was 22.12 years (SD: ± 2.33) and ranged from 19 to 34 years; the mean age of smokers was 22.21 years (SD: 2.38) and non-smokers was 22.09 (SD: ± 2.29). The average years of smoking was 2.16 (SD: ± 1.29) and the numbers of cigarettes per day was 13.19 (SD: 6.65). The Voice Handicap Index total score was 25.00 with SD: ± 12.08 (min: 8, max: 58), the functional subscale mean was 7.91 SD: ± 4.62 (min: 1, max: 24), the physical subscale mean: 8.16 SD: ± 4.51 (min: 1, max: 23) and the emotional subscale mean was 8.04 SD: ± 4.12 (min: 1, max: 19).

Comparison of Acoustic Characteristics

A student's t-test was conducted for comparing voice acoustic characteristics means between all subgroups. Statistically significant data are presented in the following:

There was a significant difference in the scores of the mean F0 for non-majors (M= 263.36, SD= 19.42) and majors that don't smoke (M= 248.85, SD= 29.61); $t(98) = 2.876$, $p< .05$ and of the mean habitual F0 for non-majors (M= 264.35, SD= 19.31) and majors (M= 249.02, SD= 29.34); $t(98) = 3.063$, $p< .05$; for sustained voicing of /e/.

T-test comparison of voice acoustic characteristics means between non-smoker majors and smoker non-majors, revealed there was a significant difference for habitual F0 of non-majors (M= 258.66, SD= 19.18) and majors (M= 227.06, SD= 26.56); $t(108) = 7.019$, $p< .01$ and for the mean F0 of non-majors (M= 258.66, SD= 19.56) and majors (M= 226.74, SD= 26.22); $t(108) = 7.124$, $p< .01$; for sustained voicing of /e/.

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As for comparing means of acoustic voice characteristics between smoker and non-smoker, non-majors, there was a significant difference in the mean F0 of smokers (M= 206.38, SD= 9.80) and non-smokers (M= 230.58, SD= 23.10); t (98) = -6.818, p< .01, for sustained voicing of the /a/ sound.

Likewise, between non-smoker and smoker majors, comparison of voice acoustic characteristics means was considered. A significant difference was noted for the mean F0 of smoker majors (M= 212.16, SD= 25.58) and non-smoker, non-majors (M= 227.56, SD= 22.88); t (108) = -3.332, p= .01, for sustained voicing of /a/. Similarly, significant differences in the scores for the habitual F0 of smoker majors (M= 227.06, SD= 26.56) and non-smoker majors (M= 249.02, SD= 29.34); t (108) = -4.117, p< .01 and for the mean F0 of smoker majors (M= 226.74, SD= 26.22) and non-smoker majors (M= 248.85, SD= 29.61); t (108) = -4.153, p< .01; and for sustained voicing of /e/, were computed.

A comparison of means for acoustic voice characteristics between smoker majors and non-smoker and non-majors, reported significant differences in the mean F0 of smoker (M= 212.09, SD= 25.58) and non-smokers (M= 230.58, SD= 25.58); t (108) = -3.943, p< .01, for sustained voicing of /a/ sound. Also, significant differences were reported for the habitual F0 of smokers (M= 227.06, SD= 26.56) and non-smokers (M= 264.79, SD= 19.36); t (108) = -8.359, p< .01 and for the mean F0 of smokers (M= 226.64, SD= 26.22) and non-smokers (M= 263.58, SD= 19.38); t (108) = -8.245, p< .01, for sustained voicing of /e/.

Significant differences of the habitual F0 of smoker majors (M= 227.06, SD= 26.56) and non-majors (M= 258.66, SD= 19.18); t (108) = 7.019, p< .01 and of the mean F0 of smokers (M= 226.64, SD= 26.22) and non-smokers (M= 262.64, SD= 16.59); t (108) = 7.124, p< .01, were obtained for sustained voicing of /e/.

For non-normally distributed voice characteristics, a Mann-Whitney Test was administered. A statistically significant lower HNR (dB) for non-smoker majors (Mdn= 23.21) compared to non-smoker, non-majors (Mdn= 25.92), U= 759.00 p= .01 for voicing /a/ sound was found; the same statistically significant higher intensity (dB) for non-smoker majors (Mdn= 61.00) compared to non-smoker, non-majors (Mdn= 58.86), U= 953.00 p< .05 for voicing /a/ sound was attained. For sustained voicing of /e/ sound, the Mann-Whitney Test revealed statistically significant lower % jitter for non-smoker majors (Mdn= .18) than the non-smoker, non-majors (Mdn= .45), U= 511.50 p< .01 (Table 1).

The same statistically significant lower habitual F0 (Hz) for smoker non-majors (Mdn= 204.34) compared to non-smoker majors (Mdn= 226.29), U= 476.00 p< .01 and lower intensity (dB) for non-smoker majors (Mdn= 61.00) than smoker non-majors (Mdn= 61.50), U= 759.00 p< .05 for voicing the /a/ sound were detected. For sustained voicing of /e/ sound, the Mann-Whitney Test revealed statistically significant lower %jitter for non-smoker majors (Mdn= .18) than the smoker non-majors (Mdn= .46), U= 449.00 p< .01 (Table 2).

	Non-smoker majors (N= 50)	Smoker non-majors (N= 50)		
	Median (IQR)	**Median (IQR)**	**Mann Whitney U**	**P**
Voicing of /a/				
Habitual F0 (Hz)	226.29 (209.34 -242.96)	230.37 (211.42 – 244.84)	1133.00	.420
%jitter	.20 (.17 – .24)	.20 (.13 – .23)	1040.00	.146
%shimmer	.51 (.22 – .85)	.51 (.23 – .77)	1180.00	629
HNR (dB)	23.21 (21.76 – 26.24)	25.90 (23.92 – 27.36)	759.00	.01
Intensity (dB)	61.00 (58.00 – 66.00)	58.86 (55.90 – 65.28)	953.00	.040
Voicing of /e/				
%jitter	.18 (.13 – .22)	.45 (.23 – .78)	511.50	.000
%shimmer	.31 (.21 – 1.06)	.54 (.21 – .82)	1247.50	.986
HNR (dB)	25.95 (24.25 – 28.45)	25.59 (23.59 – 26.88)	1043.50	.155
Intensity (dB)	59.50 (58.00 – 65,25)	60.00 (58.00 – 66.00)	1196.50	.708

Table 1: Comparison of voice acoustic characteristics between non-smoker majors and non-smoker non-majors assessed by sustained voicing of /a/ and /e/

	Non-smoker majors (N= 50)	Smoker non-majors (N= 50)		
	Median (IQR)	**Median (IQR)**	**Mann Whitney U**	**P**
Voicing of /a/				
Habitual F0 (Hz)	226.29 (209.34 -242.96)	204.34 (202.45 – 208.03)	476.00	.000
%jitter	.200 (.177 – .242	.19 (.18 – .23)	1192.00	.688
%shimmer	.505 (.227 – .857)	.59 (.35 – .95)	1038.50	.145
HNR (dB)	23.21 (21.76 – 26.24)	25.38 (23.98 – 26.89)	894.00	.014
Intensity (dB)	61.00 (58.00 – 66.00)	61.50 (56.04 – 65.00)	1066.50	.205
Voicing of /e/				
%jitter	.18 (.13 – .22)	.46 (.23 – .78)	511.50	.000
%shimmer	.31 (.21 – 1.06)	61 (.34 – .86)	975.50	.986
HNR (dB)	25.95 (24.25 – 28.45)	25.86 (24.38 – 27.29)	1169.00	.577
Intensity (dB)	59.50 (58.00 – 65,25)	62.50 (58.00 – 66.00)	1071.00	.212

Table 2: Comparison of voice acoustic characteristics between non-smoker majors and smoker non-majors assessed by sustained voicing of /a/ and /e/

The Mann-Whitney Test also revealed statistically significant lower habitual F0 (Hz) for smoker majors (Mdn= 209.05) in comparison with non-smoker majors (Mdn= 226.29) U= 935.50 p= .01 for voicing the /a/ sound (Table 3).

	Non-smoker majors (N= 50)	Smoker non-majors (N= 50)		
	Median (IQR)	**Median (IQR)**	**Mann Whitney U**	**P**
Voicing of /a/				
Habitual F0 (Hz)	226.29 (209.34 -242.96)	209.05 (197.21 – 228.40)	935.50	.001
%jitter	.200 (.177 – .242)	.21 (.17 – .25)	1363.00	.410
%shimmer	.505 (.227 – .857)	.78 (.31 – 1.62)	1186.50	.060
HNR (dB)	23.21 (21.76 – 26.24)	23.59 (21.30 – 25.14)	1411.00	.593
Intensity (dB)	61.00 (58.00 – 66.00)	63.00 (58.25 – 66.00)	1401.50	.553
Voicing of /e/				
%jitter	.18 (.13 – .22)	.19 (.16 – .22)	1303.50	.237
%shimmer	.31 (.21 – 1.06)	.49 (.27 – .1.24)	1194.50	.067
HNR (dB)	25.95 (24.25 – 28.45)	24.70 (23.14 – 28.18)	1211.00	.083
Intensity (dB)	59.50 (58.00 – 65,25)	59.50 (58.00 – 65.00)	1454.50	.783

Table 3: Comparison of voice acoustic characteristics between non-smoker majors and smoker majors assessed by sustained voicing of /a/ and /e/ sounds

Statistically significant lower habitual F0 (Hz) were identified between smoker majors (Mdn= 209.05) and non-smoker, non-majors (Mdn= 230.37), U= 794.50 p< .01, as well as statistically significant lower %shimmer for non-smoker, non-majors (Mdn= .51) in comparison with smoker majors (Mdn= .78), (Mdn= .51), U= 1035.00 p= .05, when voicing /a/. As for sustained voicing of the /e/ sound, the Mann-Whitney Test indicated statistically significant higher %jitter for non-smoker, non-majors (Mdn= .45) than the smoker majors (Mdn= .19), U= 614.00 p< .01; (Table 4).

Statistically significant higher habitual F0 (Hz) occurred between non-smoker, non-majors (Mdn= 230.37) and smoker non-majors (Mdn= 204.34), U= 320.00 p< .01, for the voicing of /a/ (Table 5).

Statistically significant higher HNR (dB) for smoker majors (Mdn= 23.59) than for smoker non-majors (Mdn= 25.38), U= 908.50 p< .01 for voicing /a/ was noted. For sustained voicing of the /e/ sound, the Mann-Whitney Test indicated statistically significant higher %jitter for smoker majors (Mdn= .46) than for non-majors (Mdn= .19) that smoke, U= 518.50 p< .01 (Table 6).

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	Non-smoker majors (N= 50)	Smoker non-majors (N= 50)		
	Median (IQR)	**Median (IQR)**	**Mann Whitney U**	**P**
Voicing of /a/				
Habitual F0 (Hz)	2230.37 (211.42 – 244.84)	209.05 (197.21 – 228.40)	794.50	.000
%jitter	.20 (.13 – .23)	.21 (.17 – .25)	1105.50	.017
%shimmer	.51 (.23 – .77)	.78 (.31 – 1.62)	1035.00	.005
HNR (dB)	25.90 (23,92 – 27,36)	23.59 (21.30 – 25.14)	772.50	.000
Intensity (dB)	58.86 (55.90 – 65.28)	63.00 (58.25 – 66.00)	1401.50	.553
Voicing of /e/				
%jitter	.45 ((.23 – .78)	.19 (.16 – .22)	614.00	.000
%shimmer	.54 (.21 – .82)	.490 (.27 – .1.24)	1262.00	.153
HNR (dB)	25.59 (23.59 – 26.88)	24.70 (23.14 – 28.18)	1405.50	..571
Intensity (dB)	60.00 (58.00 – 66,00)	59.50 (58.00 – 65.00)	1377.00	.457

Table 4: Comparison of voice acoustic characteristics between non-smoker, non-majors and smoker majors assessed by sustained voicing of /a/ and /e/ sounds.

	Non-smoker majors (N= 50)	Smoker non-majors (N= 50)		
	Median (IQR)	**Median (IQR)**	**Mann Whitney U**	**P**
Voicing of /a/				
Habitual F0 (Hz)	230.37 (211.42 – 244.84)	204.34 (202.45 – 208.03)	320.00	.000
%jitter	.20 (.13 – .23)	.19 (.18 – .23)	1101.50	.304
%shimmer	.51 (.23 – .77)	.59 (.35 – .95)	953.00	.041
HNR (dB)	25.90 (23,92 – 27,36)	25.38 (23.98 – 26.89)	1099.00	.298
Intensity (dB)	58.86 (55.90 – 65.28)	61.50 (56.04 – 65.00)	1184.50	.651
Voicing of /e/				
%jitter	.45 (.23 – .78)	.46 (.25 – .64)	1215.00	.809
%shimmer	.54 (.21 – .82)	.61 (.34 – .86)	1036.50	.141
HNR (dB)	25.59 (23.59 – 26.88)	25.86 (24.38– 27.29)	1127.50	.398
Intensity (dB)	60.00 (58.00 – 66,00)	62.50 (58.00 – 68.00)	1123.50	.379

Table 5: Comparison of voice acoustic characteristics between non-smokers non-majors and smoker non-majors assessed by sustained voicing of /a/ and /e/ sounds

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	Non-smoker majors (N= 50)	Smoker non-majors (N= 50)		
	Median (IQR)	**Median (IQR)**	**Mann Whitney U**	**P**
Voicing of /a/				
Habitual F0 (Hz)	204.34 (202.45 – 208.03)	209.05 (197.21 – 228.40)	1228.00	.102
%jitter	19 (.18 – .23)	.21 (.17 – .25)	1303.00	.235
%shimmer	.59 (.35 – .95)	.78 (.31 – 1.62)	1383.00	.482
HNR (dB)	25.38 (23.98 – 26.89)	23.59 (21.30 – 25.14)	908.50	.000
Intensity (dB)	61.50 (56.04 – 65.00)	63.00 (58.25 – 66.00)	908.50	.089
Voicing of /e/				
%jitter	.46 (.25 – .64)	.19 (.16 – .22)	518.50	.000
%shimmer	61 (.34 – .86)	.49 (.27 – 1.24)	1470.50	.859
HNR (dB)	25.86 (24.38 – 27.29)	24.70 (23.14 – 28.18)	1270.50	.168
Intensity (dB)	62.50 (58.00 – 68.00)	59.50 (58.00 – 65.00)	1196.00	.066

Table 6: Comparison of voice acoustic characteristics between smoker majors and smoker non-majors assessed by sustained voicing of /a/ and /e/ sounds

Multiple Linear Regressions

Multiple linear regressions were designed to predict changes in smoker majors' voice characteristics based on years of smoking and number of cigarettes smoked daily. No significant regression equation was found for %jitter [F (2, 56) = .285, NS], with an R2 of .073, % shimmer [F (2, 56) = 2.818, NS] with an R2 of .027, mean F0 [F (2, 56) = 1.407, NS] with an R2 of .014, HNR [F (2, 56) = .082, NS] with an R2 of .001 and intensity [F (2, 56) = 2.882, NS] with an R2 of .027, for sustained voicing of /a/. Significant equation for habitual F0 during sustained voicing of /a/ [F (2, 56) = 14.744, p< .01] with an R2 of .124 was also determined.

Likewise, during sustained voicing of /e/, no significant regression equation was found for % jitter [F (2, 56) = .151, NS] with an R2 of .001, % shimmer [F (2, 56) = 2.7371, NS], with an R2 of .023, HNR [F (2, 56) = 2.030, NS] with an R2 of .019 and intensity [F (2, 56) = .546, NS] with an R2 of .005, for smoker majors. Significant regression equation was found for sustained voicing of /e/ and habitual F0 [F (2, 56) = 8.402, p< .01] with an R2 of .076 and mean F0 [F (2, 56) = 6.688, p< .05] with an R2 of .061.

Alike for smoker non-majors, multiple linear regressions were designed to predict changes of voice characteristics based on years of smoking and number of cigarettes smoked daily. No significant regression equation was found for %jitter

[F (2, 56) = .285, NS], with an R2 of .073, %shimmer [F (2, 56) = 2.818, NS] with an R2 of .027, HNR [F (2, 56) = .082, NS] with an R2 of .001 and intensity [F (2, 56) = 2.882, NS] with an R2 of .027, for sustained voicing of /a/. A significant regression equation was found for sustained voicing of /a/ with smoker non-majors for habitual F0 [F (2, 56) = 16.084, p< .01] with an R2 of .251 and mean F0 [F (2, 56) = 1.407, NS] with an R2 of .014.

As for sustained voicing of /e/, no significant regression equation was found for habitual F0 [F (2, 46) = 16.084, p< .01] with an R2 of .251, %jitter [F (2, 46) = .300, NS] with an R2 of .006, %shimmer [F (2, 46) = .144, NS] with an R2 of .003, mean F0 [F (2, 46) = 2.696, NS] with an R2 of .053, HNR [F (2, 46) = 1.998, NS] with an R2 of .040 and intensity [F (2, 46) = .542, NS] with an R2 of .011. A significant regression equation was found for sustained voicing of /e/ with smoker non-majors for habitual F0 [F (2, 46) = 4.560, p< .05] with an R2 of .098.

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DISCUSSION

Overall, studies [4,24] highlighted the negative impact of smoking on female voice acoustic characteristics. The results of this study agreed similar to the aforementioned studies, especially for females intending to become SLTs. Despite SLT majors being aware of factors leading to voice disorders, including smoking, more than half of them engaged in this habit even though they put themselves at risk of developing laryngeal symptoms [27-30,48]. These laryngeal symptoms could lead to a voice disorder in the future [28].

To summarize fundamental frequency (F0) was significantly lower for smoker majors compared to non-smokers. Smoker mon-majors had significantly lower F0 in comparison with non-smokers. The results of the study support the literature on the effects of cigarette smoking and the fundamental frequency values for sustained phonation of /a/ and /e/ [22,24,49, 50].

This lowering effect of fundamental frequency, F0, for all smokers in this study is probably associated with changes in vocal fold mass due to smoking, which is in line with previous research [4,14,49,51]. Another likely causative factor lowering the F0 is the years of smoking [4,52,53]) in combination with the number of cigarettes smoked daily. However, the effect of these factors was low, probably due to the sample consisting of early smokers. This needs to be explored further.

Statistically significant differences of the frequency perturbation parameter (%jitter) were observed for smokers in this study. This result is in alignment with Gonzalez & Carpi [4], even though other studies report similar changes though not statistically significant [54,55].

The results of this study also revealed that majors had higher voice amplitude during recording, in comparison with non-majors, whether they were smokers or not. This may have occurred because majors are more familiar with such types of clinical voice procedures [4,24].

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The high percentage of female smoker majors in this study was notable. It was not only higher than the European female average, but even higher than the prevalence of smoking reported by WHO (2016).

In this study, no consideration to other factors (e.g. environmental) that may influenced voice characteristics was made. Also, no consideration was given to the frequency that non-smoking students were exposed to smoking environments. Future research should consider investigating populations that differ in sex, age, profession, voice pathologies and so forth. Additionally, investigating different types of voice sampling or new technologies may provide useful insights regarding this topic.

CONCLUSION

This study examined the voice acoustic fundamental frequency and amplitude parameters of Greek female majoring in speech language therapy and non-majors who smoke by using the Dr.Speech software system. Specifically, this study focused on the early effects of smoking (<10 years) on those parameters. The results of this study indicated that smoking (i) influences some voice acoustic characteristic measurements (F0, %jitter); (ii) but is not statically significant for other voice parameters in smoking subjects (%shimmer, HNR, intensity).

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REFERENCES

1. Liu L, Edland S, Myers MG, Hofstetter CR, Al-Delaimy WK. Smoking prevalence in urban and rural populations: findings from California between 2001 and 2012. Am J Drug Alcohol Abuse. 2016; 42: 152-161.

2. Byeon H. Relationships among smoking, organic, and functional voice disorders in Korean general population. J Voice. 2015; 29; 312-316.

3. Garnett JD. Tobacco and laryngeal pathology. W V Med J. 2001; 13-16.

4. Gonzalez J, Carpi A. Early effects of smoking on the voice: a multidimensional study. Med Sci Monit. 2004; 10: CR649-CR656.

5. Gnjatic M, Stankovic P, Djukić V. The effect of smoking and forced use of the voice to development of the vocal polyps. Acta chirurgica iugoslavica. 2009; 56: 27-32.

6. Marcotullio D, Magliulo G, Pezone T. Reinke’s edema and risk factors: clinical and histopathologic aspects. Am J Otolaryngol. 2002; 23; 81-84.

Cite as: Tafiadis D, Toki EI, Ziavra N. Deviations of Voice Characteristics in Female Speech Therapy Students that Smoke Using Dr. Speech. J Commun Disorder Assist Technol. 2017; 1: 1-18.

7. Haque MR, Abdullah M, Alauddin M, al-Haroon A, Majed MA. Carcinoma larynx--topographical distribution. Mymensingh Med J. 2002; 11: 15-21.

8. Espinosa J, Bravo P, Baron MG. Influence of tobacco on laryngeal carcinoma in Spain. Neoplasma. 1991; 39; 319-322.

9. Schultz P. Vocal fold cancer. Eur Ann Otorhinolaryngol Head Neck Dis. 2011; 128: 301-308.

10. de Las Casas Battifora RM, Ramada Rodillac JM. Functional dysphonia and benign vocal cord lesions in professional voice users. Arch Prev Riesgos Labor. 2011; 15; 21-26.

11. Zaquia Leão H, Galleano Zettler C, Cambruzzi E, Lammers M, Rigon da Luz Soster P, et al. The Effects of Passive Smoking on Laryngeal and Tracheal Mucosa in Male Wistar Rats During Growth: An Experimental Study. J Voice. 2016; 31:126.e19-126.e24.

12. Chai L, Sprecher AJ, Zhang Y, Liang Y, Chen H, et al. Perturbation and nonlinear dynamic analysis of adult male smokers. J Voice. 2011; 25; 342-347.

13. Fitzpatrick TM, Blair EA. Upper airway complications of smoking. Clin Chest Med. 2000; 21; 147-157.

14. Hirabayashi H, Koshii K, Uno K, Ohgaki H, Nakasone Y, et al. Laryngeal epithelial changes on effects of smoking and drinking. Auris Nasus Larynx. 1990; 17: 105-114.

15. Stark MJ, Rohde K, Maher JE, PhD, Pizacani BA, Dent CW, et al. The impact of clean indoor air exemptions and preemption policies on the prevalence of a tobacco-specific lung carcinogen among nonsmoking bar and restaurant workers. Am J Public Health. 2007; 97: 1457-1463.

16. Stayner L, Bena J, Sasco AJ, Smith R, Steenland K, et al. Lung cancer risk and workplace exposure to environm ental tobacco smoke. Am J Public Health. 2007; 97; 545-551.

17. Tse LA, Yu IT, Au JS, Yu KS, Kwok KP, et al. Environmental tobacco smoke and lung cancer among Chinese nonsmoking males: might adenocarcinoma be the culprit? Am J Epidemiol. 2009; 169; 533-541.

18. De Weese D D, Saunders WH. Textbook of Otolaryngology. Academic Medicine. 1964; 39: 976.

19. Ballenger JJ, Cole RI. Diseases of the Nose, Throat, Ear, Head, and Neck. Plastic and Reconstructive Surgery. 1985; 76: 966.

20. Chai L, Sprecher AJ, Zhang Y, Liang Y, Chen H, et al. Perturbation and Nonlinear Dynamic Analysis of Adult Male Smokers. J Voice. 2011; 25: 342-347.

21. Awan SN, Alphonso VA. Effects of smoking on respiratory capacity and control. Clinical linguistics & phonetics. 2007; 21; 623-636.

22. Sorensen D, Horii Y. Cigarette smoking and voice fundamental frequency. Journal of communication disorders. 1982; 15: 135-144.

23. Murphy CH, Doyle PC. The effects of cigarette smoking on voice-fundamental frequency. Otolaryngology--Head and Neck Surgery. 1987; 97: 376-380.

24. Damborenea Tajada J, Fernández Liesa R, Llorente Arenas E, Naya Gálvez MJ, Marín Garrido C. The effect of tobacco consumption on acoustic voice analysis. Acta otorrinolaringologica espanola. 1998; 50: 448-452.

25. Warhurst S, Madill C, McCabe P, Heard R, Yiu E. The vocal clarity of female speech-language pathology students: an exploratory study. J Voice. 2012; 26: 63-68.

26. Titze IR, Lemke J, Montequin D. Populations in the US workforce who rely on voice as a primary tool of trade: a preliminary report. J Voice. 1997; 11: 254-259.

27. Searl J, Bailey E. Vocal behaviors of student actors and student speech-language pathologists. Voice and Speech Review. 2014; 8: 5-26.

28. Gottliebson RO, Lee L, Weinrich B, Sanders J. Voice problems of future speech-language pathologists. J Voice. 2007; 21: 699-704.

29. Verdolini K, Ramig LO. Review: occupational risks for voice problems. Logopedics Phoniatrics Vocology. 2001; 26: 37-46.

30. Van Lierde KM, D'haeseleer E, Wuyts FL, De Ley S, Geldof R, et al. The objective vocal quality, vocal risk factors, vocal complaints, and corporal pain in Dutch female students training to be speech-language pathologists during the 4 years of study. Journal of voice. 2010; 24: 592-598.

31. American Speech Language Hearing Association. (Ed.). (October, 1997). Voice Evaluation Template. Retrieved November 01, 2014.

32. Helidoni ME, Murry T, Moschandreas J, Lionis C, Printza A, et al. Cross-cultural adaptation and validation of the voice handicap index into Greek. J Voice. 2010; 24: 221-227.

33. Amir O, Ashkenazi O, Leibovitzh T, Michael O, Tavor Y, et al. Applying the Voice Handicap Index (VHI) to dysphonic and nondysphonic Hebrew speakers. J Voice. 2006; 20: 318-324.

34. Moerman M, Martens JP, Dejonckere P. Application of the Voice Handicap Index in 45 patients with substitution voicing after total laryngectomy. European Archives of Oto-Rhino-Laryngology and Head & Neck. 2004; 261: 423-428.

35. Niebudek-Bogusz E, Woznicka E, Zamyslowska-Szmytke E, Sliwinska-Kowalska M. Correlation between acoustic parameters and Voice Handicap Index in dysphonic teachers. Folia Phoniatrica et Logopaedica. 2010; 62: 55-60.

Cite as: Tafiadis D, Toki EI, Ziavra N. Deviations of Voice Characteristics in Female Speech Therapy Students that Smoke Using Dr. Speech. J Commun Disorder Assist Technol. 2017; 1: 1-18.

36. Rosen CA, Murry T. Voice handicap index in singers. J Voice. 2000; 14: 370-377.

37. Behlau M, Alves Dos Santos Lde M, Oliveira G. Cross-cultural adaptation and validation of the voice handicap index into Brazilian Portuguese. J Voice. 2011; 25: 354-359.

38. Guimarães I, Abberton E. An investigation of the Voice Handicap Index with speakers of Portuguese: preliminary data. J Voice. 2004; 18: 71-82.

39. Hsiung MW, Lu P, Kang BH, Wang HW. Measurement and validation of the voice handicap index in voice-disordered patients in Taiwan. J Laryngol Otol. 2003; 117: 478-481.

40. Nawka T, Wiesmann U, Gonnermann U. Validation of the German version of the Voice Handicap Index. HNO. 2003; 51: 921-930.

41. Ohlsson AC, Dotevall H. Voice handicap index in Swedish. Logopedics Phoniatrics Vocology. 2009; 34:60-66.

42. Verdonck-de Leeuw IM, Kuik DJ, De Bodt M, Guimaraes I, Holmberg EB, et al. Validation of the voice handicap index by assessing equivalence of European translations. Folia Phoniatrica et Logopaedica. 2008; 60: 173-178.

43. Woisard V, Bodin S, Puech M. The voice handicap index: impact of the translation in French on the validation. Revue de laryngologie-otologie-rhinologie. 2003; 125: 307-312.

44. Stemple JC, Stanley J, Lee L. Objective measures of voice production in normal subjects following prolonged voice use. J Voice. 1995; 9: 127-133.

45. Titze IR. Workshop on acoustic voice analysis: summary statement. National Center for Voice and Speech. 1995.

46. Gelfer MP, Fendel DM. Comparisons of jitter, shimmer, and signal-to-noise ratio from directly digitized versus taped voice samples. J Voice. 1995; 9: 378-382.

47. Zhang Y, Jiang JJ, Wallace SM, Zhou L. Comparison of nonlinear dynamic methods and perturbation methods for voice analysis. J Acoust Soc Am. 2005; 118: 2551-2560.

48. Couch S, Zieba D, Van der Linde J, Van der Merwe A, et al. Vocal effectiveness of speech-language pathology students: Before and after voice use during service delivery. S Afr J Commun Disord. 2015; 62: 1-7.

49. Gilbert HR, Weismer GG. The effects of smoking on the speaking fundamental frequency of adult women. Journal of Psycholinguistic Research. 1974; 3: 225-231.

50. Pinto AG, Crespo AN, Mourão LF. Influence of smoking isolated and associated to multifactorial aspects in

vocal acoustic parameters. Braz J Otorhinolaryngol. 2014; 80: 60-67.

51. Müller KM, Krohn BR. Smoking habits and their relationship to precancerous lesions of the larynx. J Cancer Res Clin Oncol. 1980; 96: 211-217.

52. Figueiredo DCD, Souza PRF, Gonçalves MIR, Biase ND. Análise perceptivo-auditiva, acústica computadorizada e laringológica da voz de adultos jovens fumantes e não-fumantes. Rev Bras Otorrinolaringol. 2003; 69: 791-799.

53. Queija DS, Barros APB, Dedivitis RA, Corazza VR, Silva VFC, et al. Avaliação laringoestroboscópica, perceptiva e computadorizada da voz de tabagistas do gênero masculino. Rev Bras Cir Cabeça Pescoço. 2006; 35, 93-96.

54. Guimarães I, Abberton E. Health and voice quality in smokers: an exploratory investigation. Logopedics Phoniatrics Vocology. 2005; 30: 185-191.

55. Wan P, Huang Z. The effect of smoke and alcohol abuse to voice. Lin chuang er bi yan hou tou jing wai ke za zhi. 2008; 22: 686-687.

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