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A study of VHI scores and acoustic features in street vendors as occupational voice users

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ABSTRACT

Purpose: to investigate acoustic features of phonation and perception of voice handicap in street vendors.
Methods: Eighty-eight participants (44 street vendors, 44 controls) were recruited. The mean age of the group was 38.9 ± 16.0 years (range: 20–78 years). Scores of the Arabic version of the Voice Handicap Index (VHI-Arab) were used for analysis. Acoustic measures of fundamental frequency (F_0), jitter, shimmer, and signal-to-noise ratio (SNR) were also analyzed.
Results: Analysis showed a significant difference between street vendors and controls in the total score of the VHI-Arab ($p < 0.001$) as well as scores of all three VHI-Arab subsections: functional ($p < 0.001$), physical ($p < 0.001$), and emotional ($p = 0.025$). Weak correlations were found among all of the VHI scores and acoustic measures ($-0.219 \leq r \leq 0.355$), except for SNR where a moderate negative correlations were found ($r = -0.555$; -0.4) between the VHI (physical and total) scores and SNR values. Significant differences also were found in F_0, jitter, and SNR among specific subgroups of street vendors when stratified by weekly hours worked ($p < 0.05$), and in jitter ($p = 0.39$) when stratified by educational level.
Conclusions: Perception of voice handicap and a possible effect on vocal quality in street vendors were noted. The effect of factors, namely work hours and educational level, on voice quality should be further studied.

Learning outcomes

Data regarding street vendors' awareness of voice disorders are scarce in the Arab and Palestinian literature. Street vendors strongly perceived voice handicap, and SNR values were lower among street vendors as compared to non-vendors. Work hours per week, age, and educational level did not contribute to the perception of voice handicap among street vendors. The acoustic measures of F_0, jitter, and SNR, on the other hand, seemed to be influenced by work hours per week, probably due to increased vocal use during long work hours. The acoustic measure of jitter was affected by educational level in some vendors' subgroups.

1. Introduction

Professional (or occupational) voice users are people who rely on their voices to perform their jobs (Mitchell, 1996). Examples are

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teachers, singers, telemarketers, vendors, receptionists, health professionals, actors, and priests (Hoffman-Ruddy, Lehman, Crandell, Ingram, & Sapienza, 2001; Mitchell, 1996; Titze, 1994). Given their high vocal demands, voice disorders are common amongst occupational voice users (Seifpanahi et al., 2016). Examples include muscle tension dysphonia (MTD), fibrovascular vocal fold lesions, cysts, scarring, and other types of phonotraumatic voice disorders. Further, in occupational voice users, it is common to find microvascular disorders that lead to vocal fold hemorrhage and laryngitis due to phonotraumatic vocal behaviors (Behlau, Zambon, & Madazio, 2014; Franco & Andrus 2007).

Street vendors, a group of occupational voice users, consist of individuals who sell goods or services to people through a temporary structure in the street or sometimes through head loads (Shaiara, Shanjida, & Shahidul, 2015). They extensively rely on their voices as the primary occupational instrument and sometimes in a phonotraumatic manner; as a result, they are more likely to incur laryngeal pathology and develop voice disorders (Stemple, Roy, & Klaben, 2014). Vocal demands of street vendors include speaking for long hours, shouting, and discussing and haggling in noisy environments (Boominathan, Rajendran, Nagarajan, Seethapathy, & Gnanasekar, 2008). Such behaviors are phonotraumatic, as they create large biomechanical forces as the vocal folds collide (Jiang & Zhang, 2002; Titze, Lemke, & Montequin, 1997; Titze, Švec, & Popolo, 2003). With such behaviors over time, street venders may perceive increased phonatory effort accompanied by decreased phonatory function.

1.1. Phonogenic disorders and occupational voice users

Several studies have been conducted to investigate the effects of voice disorders on occupational voice users, and their results confirm the impact of voice disorders on the social, emotional, and vocational lives of voice users (Giannini, Fischer, Ghirardi, & Ferreira, 2015; Roy, Merrill, Thibeault, Gray, & Smith, 2004a; Smith, Kirchner, Taylor, Hoffman, & Lemke, 1998). The literature shows that voice disorders result in voice disability and/or handicap, which may develop gradually or abruptly (Åhlander, Rydell, & Löfqvist, 2011; Chen, Chiang, Chung, Hsiao, & Hsiao, 2010). Voice disorders in occupational voice users can negatively affect their sense of well-being and satisfaction with their work and can deteriorate their productivity (Franco & Andrus, 2007). Giannini et al. (2015) found an association between voice disorders and loss of work efficiency where work continuity is compromised. Similarly, Åhlander et al. (2011) found that voice disorders compel voice users to skip working-days. Moreover, Roy et al. (2004b) emphasized the negative effects of voice disorders, which included limitations in performance, reductions in inter-communication, missed working-days, and the need to change work type. The findings of Chen et al. (2010) were similar, in that teachers with voice disorders had a noticeable decline in telephone use, social interactions, and overall communication.

Interestingly, American vendors comprised 10% of voice clinic caseloads, which was considered one of the lowest percentages according to Titze et al. (1997). In a survey conducted by Boominathan et al. (2008) in India, it was found that singers, vendors, and politicians had poorer vocal hygiene practices than Indian teachers. 74% percent of Indian vendors under investigation had voice disorders, whereas only 49% of teachers presented with voice disorders (Boominathan et al., 2008). This large percentage of voice disorders among Indian vendors may be related to high demands on voice in this profession.

1.2. Occupational voice users' perception of voice handicap

In their review, Behlau, Alves Dos Santos LDe, and Oliveira (2014) stressed the importance of self-evaluation as a mean to quantify the impact of voice disorders. Researchers have created tools that can measure the perception of voice handicap (Franic, Bramlett, & Bothe, 2005; Hogikyan & Sethuraman, 1999; Jacobson et al., 1997). The widely used Voice Handicap Index (VHI) tool was developed and validated by Jacobson et al. (1997). This tool is a self-administrated questionnaire consisting of 30 items distributed among 3 domains: functional (F), physical (P), and emotional (E). Each patient is asked to rate the 30 items on a scale from 0 (never) to 4 (always). The total sum of the ratings yields the VHI-Total score that can range from 0 to 120. Higher VHI scores suggest a more severe perceived vocal handicap (Jacobson et al., 1997).

The VHI has been translated into several languages including Arabic (Saleem & Natour, 2010), and studies endorsed the VHI as a valid and highly reliable voice self-rating scale (Seifpanahi, Jalaie, Nikoo, & Sobhani-Rad, 2015). Rosen, Murry, Zinn, Zullo, and Sonbolian, (2000) confirmed that the VHI can assess singers' perception of voice handicap that could not be measured using acoustic or aerodynamic measures. In their study, Marie, Natour, and Haj-Tas (2013) used the VHI to assess Jordanian teachers' perception of vocal handicap, and the results revealed a high perception of vocal handicap in this group. Similarly, Natour, Sartawi, Al Muhairy, Efthymiou, and Marie, (2015) found that Emirati teachers had a high perception of voice handicap.

1.3. Occupational voice users' acoustic measures

As a supplement to rating the perception of voice handicap, objective measures could assist in the accurate diagnosis of voice problems (Niebudek-BoguszKotyło, Kotyło, Politański, & Sliwińska-Kowalska, 2008). Some commonly used measurements are fundamental frequency (F_0), jitter, shimmer, and signal-to-noise ratio (SNR). F_0 is defined as the number of vocal fold vibratory cycles per second (Colton, Casper, & Leonard, 2011). F_0 is utilized for the comparison between intra-subject and inter-subject pitch level (Colton et al., 2011).It is expected that F_0 would be sensitive to structural and physiological changes in the vocal folds tension, and cross sectional mass (Colton et al., 2011). Gorham-Rowan, Fowler and Hapner, (2010) suggested that the changes in F0 and/or loudness reflected a loading response by the laryngeal muscles, as expected to occur following a period of prolonged talking (Humbert et al., 2006; Humbert, Poletto, Saxon, & Kearney, 2008).

Jitter and shimmer are the two common perturbation measures in acoustic analysis. These two measurements are used to verify

the perturbation level in the voice signal (Andrews, 2006), and they are modestly correlated with voice quality characteristics such as hoarseness or roughness (Müller, 2007). Jitter and shimmer indicate the frequency and amplitude variation from one successive cycle to the next (Boone, McFarlane, Von Berg, & Zraick, 2014), and thus can be used as a measure of frequency and amplitude instabilities. A normal voice has a small amount of instability during sustained vowel production attributed to muscle and tissue proprieties. Large variations in perturbation values signal increased instability at the source (laryngeal) level.

SNR is the ratio of signal intensity to noise intensity (Colton et al., 2011). SNR is expected to have an effect on coupling the source and filter characteristics, thus may shed some light on vocal fold function (Gorham-Rowan et al., 2010). Ratio of noise component to harmonic component yields information on the ability of the individual to coordinate source and filter acoustics. Perturbation measures vary between children and adults, and may vary among professional voice users.

1.4. Aims and rationale of the study

Data regarding the perceived vocal handicap in street vendors are scarce, and almost absent in the Arabic and Palestinian literature. Therefore, the current investigation aimed to address this gap. Additionally, the current study aimed at investigating street vendors' acoustic characteristics (F_0, jitter, shimmer, and SNR) and at investigating whether acoustic measures can verify and complement VHI scores in this particular group of occupational voice users. Other factors such as age, work hours/week and educational level also were tested to determine if they had any effect on VHI scores or acoustic measures.

The authors believed that the effect of age, work hours/week and educational level were important variables to be included in the study for a variety of reasons. First, work hours/week may contribute to the accumulation of phonotraumatic behaviors. That is, the more work hours/week a street vendor has, the more frequently s/he is expected to have phonotraumatic behaviors. Second, the educational level was expected to contribute to the general awareness of the vocal hygiene practices, and the nature of phonotraumatic behaviors. Lastly, there are several studies that support the inclusion of age because it may have an effect on vocal function. As such, it might have an effect on both the VHI scores and the acoustic measures (AlBustan, Marie, Natour, & Darawsheh, in press; Marie et al., 2013; Natour et al., 2015). In Arab countries, the profession of street vending is a male-dominated occupation that depends mainly on promoting the merchandise by shouting in public, a matter that Arab societies may regard as degrading for women. Consequently, the authors expected that male participants would far outnumber females in the current investigation.

2. Methods and procedures

2.1. Ethical issues

Ethical approval was granted by the Research Ethics Committee at Birzeit University. Informed consent was secured prior to participation.

2.2. Participants

The sample was comprised of participants over the age of 18 years who were divided into two groups: a group comprised of street vendors and a control group comprised of non-occupational voice users. Participants from both groups who were included in this study self-reported that they were free of flu or cold symptoms and had not undergone any medical surgery known to affect voice (e.g., surgical removal of polyps, nodules, contact ulcer, papilloma, etc.). Participants were individually approached and asked if they were willing to participate in the study over a four month period. Demographic data were collected on age, health condition, vocal hygiene habits, phonotraumatic behaviors, and educational level.

Controls were required to be non-occupational voice users. Thus, teachers, coaches, singers, lawyers, judges, psychologists, counselors, telephone operators, interviewers, speech-language pathologists, actors, and singers were excluded from the study. Convenience sampling method was adopted in this research due to the limited number of street vendors.

2.3. Procedures

First, participants were asked the question "how much are you troubled with your voice?" The responses to the question were measured on a 7-point scale, with 1 indicating "not troubled at all" and 7 indicating "most troubled". Then, participants completed the self-administered VHI-Arab. After that, participants were asked the post question "how much are you satisfied with you voice?". Their responses were determined according to a 10-point scale, with 1 indicating the least satisfaction and 10 indicating the most (Saleem & Natour, 2010). The consistency of participants' responses was tested through these pre- and post-questions in order to minimize the familiarity effect that may occur with question items (Saleem & Natour, 2010).

After completing the VHI-Arab, participants also were asked to produce two consecutive trials of the sustained vowel/a:/at a comfortable pitch and loudness. All recorded voice samples were obtained using the time frequency analysis software program for 32-bit Windows/TF32 (Milenkovic 2001, Madison,WI) using a unidirectional Mini 3.5 mm Flexible Microphone (HDE, Japan, frequency response range: 20–16000 Hz and sensitivity −47 dB0dB = 1 V/Pa at 1 Khz). Sampling frequency was 22.050 kHz, mouth-to-microphone distance was set at 10 cm, and the microphone was held at a 45° angle from the mouth to reduce potential noise resulting from oral airflow. The recording procedure was conducted in a quiet room to ensure acceptable recording quality.

Participants were asked to initiate phonation one second before recording the voice sample. Once initiated, phonation continued

for approximately five seconds, and the middle 3 s were saved for analysis. The second trial of phonation was checked in the TF32 analysis to ensure zero error, and if free of error, only the second sample was selected for analysis purposes. If not, the sample was deleted and not included in analysis. The error was calculated using the 'error tap' function provided by the TF32 software. The values for the acoustic measures of F_0, shimmer, jitter, and SNR were saved for further statistical analysis.

2.4. Statistical analysis

Data were analyzed using SPSS Version 22.0 (2016, IBM Corporation New York). A Pearson-r test was conducted for the pre- and post-questions aimed to determine the consistency of the participants' responses.

Street vendors' VHI-Arab scores were compared with preset cutoff scores following Marie et al. (2013) where the cutoff scores were defined as one SD above the mean, as follows: the functional subscale 7.6 (4.3 ± 3.3), the physical subscale 7.3 (4.4 ± 2.9), the emotional subscale 3.7 (1.6 ± 2.1), and the total cutoff score 16.5 (10.3 ± 6.2).

A Multivariate Analysis of Variance (MANOVA) was employed to compare between street vendors and the controls in the acoustic measures (F_0, jitter, shimmer, and SNR), and the VHI-Arab subscale scores (physical, functional, and emotional) and total VHI-Arab scores. Tukey Post hoc test was utilized to identify subgroup comparisons that caused significant differences, if any. A 2-way ANOVA test was implemented to investigate differences between educational level and work hour street vendor subgroups. Bonferroni Post hoc test was utilized to identify subgroup comparisons that caused significant differences.

3. Results

The total sample comprised of 88 participants over the age of 18 years: 44 were street vendors (40 males and 4 females), and 44 non-professional voice users (40 males and 4 females). The age range of the sample was 20–78 yrs (38.9 ± 16.0 yrs). In terms of other demographic data, 34 (77.3%) street vendors reported shouting to promote sales, and none of them reported current or prior use of amplification. None of the controls reported having to shout while performing occupational duties. Educational level was subcategorized into primary and below, preparatory, secondary, and post-secondary. Table 1 summarizes the participants' demographic data.

Age was subcategorized as shown in Table 2. Concerning work hours, all controls worked a maximum of 40 h per week, a standard weekly workload. The number of weekly work hours of street vendors ranged from 10 to 98 h per week with a mean of 62.1 ± 21.4 h per week. The number of years that street vendors had worked ranged from one to 40 years with a mean of 17.2 ± 11.4 years. Work hours per week were subcategorized as follows: 10–40 h/week (A), 41–50 h/week (B), 51–60 h/week (C), 61–70 h/week (D), 71–80 h/week (E), and 81–100 h/week (F). The numbers of participants in each subcategory are demonstrated in Table 2.

3.1. VHI-Arab scores (street vendors versus controls)

3.1.1. The consistency of participants' responses

The Pearson r test revealed a negative moderate correlation between participant ratings of trouble vs. satisfaction with voice for both groups (vendor group: r = −0.572; control group: r = −0.568).

3.1.2. The VHI-Arab scores and the cutoff scores

Eighteen (40.9%) street vendors exceeded the cutoff score for the functional subscale, 28 (63.6%) for the physical subscale, 26 (59.1%) for the emotional subscale, and 29 (65.9%) for the total VHI. None of the mean scores of the VHI (functional, physical, emotional and total) of the controls exceeded the cutoff scores (see Table 3).

3.1.3. The VHI-Arab scores comparison

The results of a MANOVA revealed significant differences in VHI-Arab scores between the vendor and control groups

Table 1
Demographics of Participants.

	Vendors	Controls	TOTAL
Age Range (yrs)	20–75	21–78	20–78
Age (yrs) μ ± SD	39.9 ± 15.6	38.0 ± 16.4	38.9 ± 16.0
Gender male N (%)	40 (90.9%)	40 (90.9%)	80 (90.9%)
Gender female N (%)	4 (9.1%)	4 (9.1%)	8 (9.1%)
Educational Level			
Primary & below N (%)	16 (36.4%)	0 (0.0%)	16 (18.2%)
Preparatory N (%)	5 (11.4%)	1 (2.3%)	6 (6.8%)
Secondary N (%)	21 (47.7%)	14 (31.8%)	35 (39.8%)
Higher education N (%)	2 (4.5%)	29 (65.9%)	31 (35.2%)

Note. N = Number, μ = Mean, SD = Standard Deviation, yrs = Years.

Table 2
Participants' Distribution across Subgroups.

Age			Level of Education		Work (hours/week)		
Subgroup	Category	N	Subgroup	N	Subgroup	Category	N
A	20–29	36	Primary & below	16	A	10–40	7
B	30–39	12	Preparatory	6	B	41–50	5
C	40–49	19	Secondary	35	C	51–60	9
D	50–59	9	BA+ (undergraduate or more)	31	D	61–70	6
E	60–69	6			E	71–80	6
F	70–79	6			F	81–100	11

Note. N = Number.

Table 3
Descriptive Statistics and Significance of the Results of the VHI Scores and Acoustic Measures (Vendors- Controls).

	Subjects	μ	± SD	N	Sig.
VHI-F	Street vendors	7.11	± 5.06	44	< **0.001****
	Controls	1.02	± 1.36	44	
VHI-P	Street vendors	10.25	± 5.18	44	< **0.001****
	Controls	1.39	± 1.17	44	
VHI-E	Street vendors	4.82	± 5.24	44	**0.025***
	Controls	0.68	± 0.60	44	
VHI-Total	Street vendors	22.18	± 12.05	44	< **0.001****
	Controls	3.09	± 2.11	44	
F0	Street vendors	138.10	± 30.54	44	0.777
	Controls	138.12	± 32.06	44	
Shimmer	Street vendors	5.48	± 4.88	44	0.650
	Controls	1.90	± 2.10	44	
Jitter	Street vendors	0.91	± 1.54	44	0.680
	Controls	0.37	± 0.43	44	
SNR	Street vendors	16.00	± 4.04	44	**0.016***
	Controls	24.54	± 6.17	44	

**Note.* N = Number, μ = Mean, SD = Standard Deviation, Sig. = Significance, *Significant at the 0.05 Level, **Significant at the 0.001 Level.

($p < 0.001$). There were significant differences between the vendor and control groups in the total VHI-Arab scores ($p < 0.001$) and the following VHI-Arab subscale scores: functional ($p < 0.001$), physical ($p < 0.001$), and emotional ($p = 0.025$).

3.1.4. Effect of age on VHI scores

No significant differences in the VHI-Arab scores were found between vendors and controls for the factor of age ($p = 0.142$). No significant differences were reported for the main effect of age on the subscales and total score of the VHI-Arab ($ps > .05$).

3.1.5. Effect of educational level on VHI scores

No significant differences in the VHI-Arab scores were found between vendors and controls for the factor of educational level ($p = 1.000$). No significant differences were reported for the main effect of educational level on the subscales and total score of the VHI-Arab ($ps > .05$).

3.1.6. Effect of gender on VHI scores

Only four female street vendors could be recruited in the current investigation since this profession is uncommon to women in the Arab region as previously mentioned. The four female street vendors' descriptive statistics are listed in Table 4. When the descriptive results of the females (controls vs. street vendors) were compared, the female vendors had a higher perception of vocal handicap in all of the VHI subscales and total VHI-Arab score. Comparing female and males vendors, female vendors had higher VHI functional, physical, and emotional scores than the male vendors, while male vendors had higher VHI physical scores.

3.2. Acoustic measures (street vendors versus controls)

3.2.1. Acoustic measures comparison

A significant difference was found between vendor and control groups only for SNR ($p = 0.016$), but not for the other three acoustic measures (Table 3).

3.2.2. Effect of age on acoustic measures

A MANOVA revealed no statistically significant differences for the main effect of age between the vendor and control groups for the following acoustic measures: shimmer, jitter, and SNR ($ps > .05$). However, a significant difference was found for F_0 ($p < .001$).

Table 4
Descriptive Statistics for Female Street Vendors, Female Controls, and Males Street Vendors.

	Female street vendors N = 4					Female controls N = 4	Male street vendors N = 40
	Female1	Female2	Female3	Female4	μ ± SD	μ ± SD	μ ± SD
Education	Primary	Primary	Secondary	Secondary	Primary-Secondary	Secondary − BA +	Primary − BA +
Age(category)	65 (E)	75 (F)	62 (E)	66 (E)	67 ± 5.60	59.5 ± 14.98	37.23 ± 13.59
F0	198.00	247.70	232.30	212.30	222.58 ± 21.87	223.05 ± 15.50	129.65 ± 13.66
Shimmer	16.40	2.14	2.72	1.93	5.80 ± 7.08	0.76 ± 0.14	5.45 ± 4.73
Jitter	0.98	0.46	0.31	0.35	0.53 ± 0.31	0.22 ± 0.03	.95 ± 1.61
SNR	25.68	22.20	18.90	21.80	22.15 ± 2.78	25.50 ± 2.95	15.38 ± 3.62
VHI-F	16.00	9.00	9.00	7.00	10.25 ± 3.95	0.50 ± 0.58	6.80 ± 5.10
VHI-P	7.00	7.00	12.00	6.00	8 ± 2.71	1.75 ± 0.50	10.48 ± 5.33
VHI-E	17.00	5.00	3.00	0.00	6.25 ± 7.46	0.25 ± 0.50	4.68 ± 5.08
VHI-Total	40.00	21.00	24.00	13.00	24.5 ± 11.33	2.50 ± 1.00	21.95 ± 12.23

Note. N = Number, μ = Mean, SD = Standard Deviation.

Tukey post-hoc comparisons of scores among age subgroups revealed a significant difference in the *F*0 scores between A, B, C, and D age subgroups (20–59 yrs) and subgroup E (60–69 yrs), but not between E and F (60–79 yrs) subgroups ($p = 0.745$), where the *p*-values were E-A ($p < .001$), E-B ($p = .003$), E-C ($p < 0.001$), E-D ($p = 0.005$). A significant difference also was found in the F_0 scores between F (70–79 yrs) and A (20–29 yrs) age subgroups, and F and C (40–49 yrs) age subgroups with corresponding *p*-values of F-A ($p = 0.038$) and F-C ($p = 0.043$).

3.2.3. Effect of educational level on acoustic measures

No significant differences were found between the vendors group and control group in the main effect of educational level on all of acoustic measures ($ps > .05$).

3.2.4. Effect of gender on acoustic measures

According to the means and standard deviation of the female street vendors, as compared to those of the male street vendors, the authors found no noticeable differences among the acoustic measures other than females (both vendors and controls) exhibiting higher F_0 values than male vendors. Shimmer was noticeably lower for female controls when compared to female street vendors (5.80 ± 7.08), which was also lower than the shimmer for male vendors (5.45 ± 4.73). Jitter was higher for male vendors as compared to females (controls and vendors). The SNR values for females (controls and vendors) were higher than those of the male vendors. (Table 4).

3.3. Correlation between the acoustic measure and the VHI scores

In this study a Pearson's r value of 0.1–0.19 was considered a very weak correlation, a value of 0.2–0.39 weak, a value of 0.4–0.59 a moderate one, a value of 0.6–0.79 strong, and a value of 0.8–1.0 very strong (Dancey & Reidy, 2004; Mukaka, 2012) .The Pearson r test revealed weak correlations were found among all of the VHI scores and all of the acoustic measures (F0, shimmer, jitter, and SNR; $-0.219 \leq r \leq 0.355$, the P values for correlations are shown in Table 5). Except for the VHI physical and SNR ($r = -0.555$; $p < 0.001$), and the VHI total and SNR($r = -0.4$; $p < 0.001$), there were moderate negative correlations.

3.4. Effect of work hours per week of street vendors

The results of a 2-way ANOVA revealed significant differences for the main effect of work hours per week between street vendors' subgroups ($p < 0.001$).

Table 5
Correlation between VHI scores and Acoustic Measures.

		F0	Shimmer	Jitter	SNR
VHI functional	Pearson Correlation	0.052	0.288**	0.038	−0.219*
	Sig. (2-tailed)	0.629	0.007	0.728	0.040
VHI physical	Pearson Correlation	−0.042	0.355**	0.121	−0.555**
	Sig. (2-tailed)	0.700	0.001	0.263	0.000
VHI emotional	Pearson Correlation	0.011	0.243*	0.080	−0.209
	Sig. (2-tailed)	0.921	0.023	0.457	0.051
VHI total	Pearson Correlation	0.005	0.347**	0.094	−0.400**
	Sig. (2-tailed)	0.962	0.001	0.382	0.000

Note. * = Correlation is significant at the 0.05 level (2-tailed).** = Correlation is significant at the 0.01 level (2-tailed).

Table 6
Significance of the Effects of Hours/Week and Educational Level on the VHI Scores and Acoustic Measures of the Vendors' Group.

Work Hours/Week		Educational Status	
Dependent Variable	Sig.	Dependent Variable	Sig.
F0	< **.001****	F0	0.285
Shimmer	**.063**	Shimmer	0.127
Jitter	< **.001****	Jitter	**.039***
SNR	**.004***	SNR	0.164
VHI-F	0.664	VHI-F	0.821
VHI-P	0.673	VHI-P	0.706
VHI-E	0.713	VHI-E	0.846
VHI-Total	0.553	VHI-Total	0.805

Note. Sig. = Significance, *Significant at the 0.05 Level, **Significant at the 0.001 Level.

3.4.1. Effect of work hours per week on VHI scores

A 2-way ANOVA showed no significant differences for the effect of work hours/week on all VHI-Arab subscale and total scores (*ps* > 0.05; Table 6).

3.4.2. Effect of work hours/week on acoustic measures

Significant differences were found in the main effect of work hours/week for the following acoustic measures: F_0 ($p < .001$), jitter ($p < .001$), and SNR ($p = 0.004$). There was a trend towards significance in the effect of work hours/week on shimmer ($p = .063$).

Bonferroni post-hoc testing revealed a significant difference in F_0 scores between the A subcategory (10–40 work hours/week) and all other subcategories ($p < 0.001$ for all subcategories). There was also a significant difference in the jitter scores between the F (81–100 h/week) subcategory and all other work hours/week subcategories, for which corresponding *p*-values were F-A(10–40 h/week) ($p < 0.001$), F-B (41–50 h/week) ($p < 0.001$), F-C (51–60 h/week) ($p < .001$), F-D (61–70 h/week) ($p = 0.019$), F-E (71–80 h/week)($p = 0.027$). There was a significant difference in the SNR values between the A subcategory and the following other subcategories: A-C ($p = 0.002$), A-D ($p = 0.003$), A-E ($p = 0.009$), but not between the A-B ($p = 0.982$) and A-F ($p = 0.069$) subcategories.

3.5. Effect of educational level of street vendors

The results of a 2-way ANOVA revealed significant differences for the main effect of educational level ($p = .002$) between street vendors' subgroups.

3.5.1. Effect of educational level on VHI scores

A 2-way ANOVA revealed no significant differences in the VHI total scores and the scores of all of its subscales between all of the educational level's subgroups in the vendor's group (Table 6).

3.5.2. Effect of educational level on acoustic measures

As for acoustic measures, a 2-way ANOVA revealed significant differences for jitter only ($p = 0.039$; Table 6). Bonferroni post-hoc testing revealed significant differences in jitter between the following educational level subcategories: primary-secondary ($p = 0.000$), primary − BA + ($p = .012$). There was also a significant difference in SNR scores between the preparatory-secondary educational levels ($p = 0.043$).

4. Discussion

The purpose of the current investigation was to examine street vendors' perception of voice handicap and to compare it with the perceived voice handicap of non-professional voice users. A secondary aim was to examine the effects of factors such as work hours, age, and educational level on voice as evidenced by changes in acoustic measurements, namely F_0, jitter, shimmer, and SNR. Consistent with expectations, significant differences were found between the VHI scores of vendors and controls. In addition, an effect was found for factors such as educational level and number of work hours on some acoustic parameters. The negative moderate correlation for the vendor group and for the control group indicated that the responses of the participants were consistent (Mukaka, 2012). The subsequent sections discuss the study's results in light of published findings from the extant literature.

4.1. VHI-Arab

Street vendors' VHI scores exceeded the cutoff scores of the controls in n = 18 (40.9%) for the functional subscale, n = 28 (63.6%) for the physical subscale, n = 26 (59.1%) for the emotional section, and n = 29 (65.9%) for the total VHI score. Particularly,

the scores for the total VHI and its three subsections were significantly higher in street vendors compared to the control group. This finding signified that street vendors were aware of their voice handicap functionally, physically, and emotionally. This finding confirmed those reported by Marie et al. (2013) and Natour et al. (2015), who found that teachers, as another category of occupational voice users, were conscious of their voice handicap functionally, physically, and emotionally.

A considerable number of street vendors had a higher perception of voice handicap on the physical and the emotional subscales in particular (n = 28, 63.6%; and n = 26, 59.1%, respectively), but to a lesser degree on the functional subscale (n = 18, 40.9%). This might be because the physical subscale was designed through statements that describe the sensation of laryngeal discomfort towards the vocal outputs of pitch, loudness and quality (Jacobson et al., 1997). The emotional subscale, on the other hand, included items representing the emotional response to the perceived vocal difficulty, while the functional subscale included statements regarding the impact of the perceived vocal difficulty on daily activities. As such, street vendors were probably making a collective statement that their perception of voice handicap did not affect their daily activities to a great degree. That is, street vendors did feel discomfort towards their vocal output and perceived vocal handicap; nevertheless, it may not have affected their daily activities to a great degree. This speculation could be confirmed by the phonotraumatic behaviors they performed during their daily job requirements. In fact, it was observed during data collection that street vendors were practicing stressful vocal behaviors such as yelling, shouting, arguing, and projecting their voices in over-crowded commercial areas in order to promote/sell their merchandise. Hence, this result was expected and is in agreement with investigations targeting other groups of occupational voice users (Fritzell, 1996; Marie et al., 2013; Natour et al., 2015; Rusell, Oates, & Greenwood, 1998; Smith et al., 1998; Vilkman, 2000).

The significant difference between the street vendor and the control groups' VHI-Arab subscales and total scores could be related to the pattern of phonotraumatic behaviors mentioned above (i.e., shouting with no amplification devices). The insignificant difference found in the scores of street vendors and controls in the effects of age and educational level suggests that those two factors may not contribute to both groups' perception of voice handicap as measured by the VHI-Arab.

4.2. Acoustic measures

When comparing the acoustic measures of both groups with normative data from several studies (e.g. Baken & Orlikoff, 2000; Banh et al., 2009; Natour & Wingate, 2009), all acoustic measures of the control group were within the range of normal. Normative data for F_0 range from 119 to 140 Hz for adult males and 215–250 Hz for adult females from different age ranges. As for jitter%, it is less than 1.04 for both males and females. Shimmer% ranges between 2.6–4.00% for males, and 2.30–3.00% for females. As for SNR, the values range between 22.00–25.00 dB for males, and 23.00–26.00 dB for females. As such, acoustic measures of SNR (μ = 16.00 dB) and shimmer (μ = 5.48) of the vendor group were not within the range of values from normative data. This finding indicated that the acoustic signal of street vendors did not completely lie within normal limits, which suggested that their vocal fold vibratory behavior was abnormal and might be due to poor vocal health status of some vendors.

The street vendor and control groups did not differ significantly in terms of three other acoustic measures: F_0, shimmer, and jitter. The latter two measures are labeled as "F_0 dependent" and as such the stability of F_0 is expected to be influential on shimmer and jitter (Baken & Orlikoff, 2000). The difference in SNR, on the other hand, was significant. This result was expected (Street vendors' SNR 16.00 ± 4.04; Controls' SNR 24.54 ± 6.17) (Table 3), and the difference was in favor of the controls. It is documented in the literature that greater SNR values indicate a better voice quality (Speaks, 1999; Stemple et al., 2014), presumably from healthier vocal folds that vibrate more consistently.

The significant difference in F_0 between vendors and controls that was reported for the main effect of age is understandable. The literature reported changes in F_0 resulting from the aging voice (e.g. Boone et al., 2014; Colton et al., 2011; Stemple et al., 2014). All other acoustic measures (jitter, shimmer, and SNR) were comprehensibly insignificant.

Although a higher educational level may be expected to indicate better awareness of voice care practices, the educational level had an insignificant effect on any of the acoustic measures of both street vendors and control groups.

4.3. Correlation between the acoustic measure and the VHI scores

In the current study, weak correlations between acoustic measures and VHI scores were found. This finding corresponds with the findings from the studies conducted by Natour et al. (2015) and Marie et al. (2013), who confirmed that there was no correlation between teachers' perception of voice handicap and their acoustic measurements. This finding also corresponded with several researchers who studied the association between self-perception scales and acoustic measurements such as Wheeler, Collins, and Sapienza, (2006) who studied the relationship between the standard deviations of VHI scores and the acoustic measures of F_0, jitter, shimmer, and SNR. Their findings suggested that acoustic measurements likely did not serve as a predictor of VHI's scores.

Street vendors' higher perception of voice handicap may have been reflected in smaller values of SNR, a relatively stable acoustic measure (Natour & Saleem, 2009). This result was supported by the fact that there were moderate negative correlations (r = −0.555; r = −0.4) between the VHI (physical and total) scores and the SNR values, which indicates that the higher the SNR scores, the less perceptible the vocal handicap was. Perhaps street vendors who have perceived a handicap for a long time become accustomed to such a perception. In Natour et al. (2015) teachers, unexpectedly, reflected better SNRs than the control group even though they had a high perception of voice handicap. Thus, future research needs to further address the correlation between acoustic measures (namely, SNR) and the perception of vocal handicap.

4.4. Street Vendors' subgroups comparison (work hours/week)

Differences in VHI scores and its subcategories (functional, physical, and emotional) among all of the subcategories of hours/week of the vendor group were insignificant. Thus, it seemed that the perception of voice handicap was not affected in this particular group of street vendors by work hours per week. That is, working 20 or 80 h per week, for example, with all the phonotraumatic behaviors that street vendors assumed, would probably have resulted in the perception of voice handicap regardless of work hours per week.

However, work hours per week seemed to influence the F_0, jitter and SNR of this group. This finding maight indicate an effect of fatigue on F_0, jitter and SNR. Shimmer was not affected though there was a trend toward significance ($p = 0.063$). Fatigue was reported to affect acoustic measurement. For example, Laukkanen, Ilomäki, Leppänen, and Vilkman (2008) found that after a working day, F_0 was higher and jitter and shimmer values were lower and accompanied by reports of the presence of vocal tiredness. The effect of work hours per week on acoustic measures of street vendors was evidenced by the significant difference in the F_0 scores between the (A) subcategory (10–40 work hours/week) and all other subcategories (40 + h/week) and the significant difference in the jitter scores between the F subcategory (81–100 h/week) and all other work hours/week subcategories. Thus, it seemed that the cut point where the F_0 scores get adversely affected by fatigue resulting from long work hours was when exceeding 40 h of work/week. When exceeding 80 h of work/week, jitter gets adversely affected. Of most interest, was the significant difference in the SNR scores, since it was proven to be a relatively stable acoustic measure (Natour & Saleem, 2009), between the following subcategories: A (10–40 h/w) and C (51–60 h/w), A and D (61–70 h/w), A and E (71–80 h/w), and a tendency towards significance between A and F (81–100 h/week) with no significance between A and B (41–50 h/w) subcategories. This last finding might mean that street vendors who worked from 10 and up to 50 h/week h have a similar vocal quality as evidenced by similar SNRs. However, the voice quality may get affected by longer (i.e. 51 h/week) work hours/week.

Longer work hours can probably be related to one of the vocal doses that Titze et al. (2003) defined and described, namely the time dose. The time dose represented the accumulation of the total phonation time. The authors defined the safety which they measured to be 17 min of continuous vocalization. It was estimated that vocal folds travel about 0.5 m per second of continuous phonation, which suggested that the safety distance of 520 m can be reached after 17 min of continuous vocalization. Thus, street vendors who worked longer hours per week may have exceeded safety in terms of total phonation time. This increased time dose would suggest an association between longer work hours and an increased opportunity of vocal fold collision and higher impact stress, a matter which would increase the risk of phonotrauma.

4.5. Street vendors' subgroups comparison (educational level)

VHI total scores and its subcategories (functional, physical, and emotional) between all the educational level subcategories were not significant. This finding meant that the perception of voice handicap was not affected by educational level in this particular group of street vendors.

As for acoustic measures, a significant difference was found in SNR between the preparatory (13.56 ± 2.70) and secondary (16.41 ± 3.72) educational levels. Further, significant differences in the jitter scores were found between subcategories primary (1.49 ± 2.40) and secondary (0.51 ± 0.35), and also between primary and BA + (0.40 ± 0.07). These differences might indicate an association between educational level and awareness of strategies for improving voice quality regardless of the long-term effects on vocal fold structure and function. However, Natour et al. (2015) found that teachers (BA + level of education) used a way to increase their SNR (or improve their voice quality) through employing the phonotraumatic behavior (i.e. speaking loudly). Therefore, the effect of educational level and its association with phonotraumatic behaviors are not conclusive and need further investigation.

The authors noted that factors (i.e., the work hours/week and the educational level) that affected acoustic measures, especially in the street vendors' subgroups comparisons, did not affect VHI scores and its subcategories. This finding emphasizes the earlier discussion of the finding of this study: the lack of correlation between acoustic measures and the perception of vocal handicap.

4.6. Notes on descriptive statistics of the female participants

The SNR means were lower in the female street vendors than the female controls (Table 4). This can be explained, again, by the work environment in which the female street vendors have to function in addition to their phonotraumatic behaviors. Female vendors generally had higher SNRs than male vendors. This might be attributed to the fact that all of the female vendors were from the A work hours/week category (10–40 h/week), i.e., less working hours compared to the male street vendors. This finding was comparable to results of Natour et al. (2015) where the mean SNR was significantly higher in female teachers (i.e., reflecting better voice quality) than male teachers. For female street vendors, this finding might indicate a better voice quality for lower amounts of phonotraumatic behaviors, especially shouting. Lesser shouting in female street vendors may be explained by the cultural tendency of considering shouting inappropriate for female street vendors. However, this possible explanation remains subjective in nature.

The differences in mean shimmer and jitter for both the female and male street vendors were not noticeable. However, shimmer was noticeably higher in the female street vendors, while jitter was somewhat higher compared to female controls. This might be because female street vendors, unlike the female controls, functioned in a noisy atmosphere and practiced phonotraumatic behaviors as it was the case for all participants in the street vendors' group.

One of the female vendors (F1, Table 4) had the highest VHI scores and a lower than normal $F_0 = 198$ Hz, which was below the norms for females (Baken & Orlikoff, 2000; Natour & Wingate,2009), and the highest jitter and shimmer among the females street vendors. Surprisingly, this same female vendor had a higher SNR than the other three female vendors. The case might be that this

female vendor had a better SNR because of less phonotraumatic behaviors, or a different vocal pathology that impacted her vibratory behavior differently. However, this remains a speculation that needs further voice instrumental assessment.

5. Conclusion

This study aimed at investigating the perception of voice handicap in street vendors as occupational voice users and comparing it with that of non-occupational voice users. Another aim was to examine the correlation between VHI scores and acoustic measures. Furthermore, the study aimed at exploring the effects of factors of work hours, age, and educational level on voice quality and perceived level of vocal handicap. Street vendors had a high perception of voice handicap (reflected by the total scores of the VHI and its three subsections) in comparison with the control group of non-occupational voice users. These results are emphasized through the phonotraumatic behaviors that vendors were observed to perform during their daily job requirements at the time of data collection. It was also found that age and educational level did not contribute to the perception of voice handicap. As for acoustic measures, street vendors' who had higher perception of voice handicap than the controls had smaller SNR values, or worse voice quality.

For vendors' subgroups comparisons, the range of work hours per week for most street vendors who participated in the current investigation was relatively high. However, it did not affect the perception of voice handicap in this particular group of street vendors. The acoustic measures of F_0, jitter and SNR, on the other hand, seemed to be influenced by work hours per week, probably due to the effect of fatigue. It seemed that the cut points of 40 and 50 h of work/week were when street vendors exceeded vocal safety as reflected by the F_0 scores and SNR values respectively. That is, street vendors who worked longer hours per week may have exceeded the safety in terms of total phonation time. Thus, it was understandable that the fatigue street vendors may have experienced stemmed from prolonged muscle activity (up to 100 h/week in this study), especially when accompanied by phonotraumatic behaviors such as shouting. Another source of fatigue in this particular group of street vendors may have stemmed from the "mental" status reflected by the vendors' trials to continue "selling their goods" regardless of vocal consequences (Solomon, 2008).

The educational level of the street vendors did not affect their perception of overall voice handicap nor in any subcategory (i.e., functional, physical, emotional). But again, the acoustic measure of jitter was affected for some educational level subcategories. This study suggested an association between the educational level and knowledge of strategies for improving vocal quality, some of which can be phonotraumatic. However, knowledge of such vocal improvement strategies was not necessarily combined with awareness of their adverse effects on vocal health, vocal folds' structure, and function.

Female street vendors generally had higher SNRs than male street vendors, probably because of the fewer hours per week, although this result was not conclusive due to the small number of female street vendors in this research and in actual life.

6. Future research

There were various practical limitations confronted by the researchers throughout the process of data collection. The participants' inclusion criteria relied on their self-report of having no flu or cold symptoms and no surgeries that affect voice. Future research should consider obtaining formal medical diagnoses of the laryngeal status for both recruited groups of the vendors and the controls. Another limitation of this study was the limited sample size, especially for female street vendors. Future research studies need to include larger and more representative samples. The effect of gender on the VHI scores and the acoustic measures were not studied on a large scale in the current investigation. It was hard to locate female street vendors due to socio-cultural factors that made such occupation gender-defined and rarely practiced by females.

Large scale studies are scarce, and there is a need to conduct studies on a large-scale population of occupational voice users. Future studies need to be directed at investigating the impact of voice disorders, the interventions on the health, quality of life and job satisfaction of street vendors using the VHI and objective methods of evaluation.

Several of the findings of this study need to be further explored. The correlation between the acoustic measures (namely, the SNR values) and the perception of vocal handicap needs to be further examined. Additionally, the effect of work hours and educational level on voice quality and its association with phonotraumatic behavior need further investigation.

Comparing street vendors to other professional voice users was not within the scope of the current investigation. However, research on other professional voice users (singers in particular) is underway by the authors.

Conflict of interest statement

The authors report no conflicts of interest with the research described in this article.

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