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ORIGINAL RESEARCH

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Relationship among five-factor personality traits and psychological distress with acoustic analysis

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Abstract

Objectives: The relationship between personality traits and psychological distress with acoustic characteristics was investigated in the present study, regarding the existence of dysphonia, abnormal overall voice quality (AOVQ), and dysphonia type.

Methods: Fifty-five participants with dysphonia and 64 participants without dysphonia completed NEO Five-Factor Inventory and Depression, Anxiety, and Stress Scale-21. Jitter, shimmer, noise-to-harmonic ratio (NHR), cepstral peak prominence (CPP), and cepstral peak prominence-smoothed (CPPS) were calculated in sustained vowel /a/ by *Praat*. Three expert speech and language pathologists divided participants with dysphonia into mild, moderate, and severe, based on the AOVQ. Pearson and Spearman correlation tests were performed by *IBM SPSS Statistics*.

Results: The findings were indicative of large correlations between agreeableness with CPP, conscientiousness with shimmer, depression with jitter and shimmer, and anxiety with shimmer in patients with functional dysphonia ($p < 0.05$). The results showed small to medium significant correlations between agreeableness with jitter and NHR, conscientiousness with CPP in participants without dysphonia, and depression with jitter in the participants with dysphonia ($p < 0.05$). Lastly, no significant correlation was observed between personality traits and psychological distress with acoustic characteristics in mild, moderate, and severe AOVQ groups ($p > 0.05$).

Conclusion: In participants with functional dysphonia, personality traits and psychological distress can provide some information about acoustic characteristics and vice versa.

Level of Evidence: 3.

KEYWORDS
anxiety, depression, dysphonia, five-factor personality traits, stress

1 | INTRODUCTION

Voice is one of the vital elements of human communications.[1] Voice amazingly can convey information about identity (e.g., age, sex, social class), and physical features (e.g., height, weight, physical strength).[2–6] Since the beginning of the twentieth century, a question has arisen about whether there was a connection between voice and personality or not.[7] Personality is delineated as

long-standing ways to think, feel, and act.[8] There are several studies in the literature that addressed this issue. A positive correlation was reported between speech rate and competence.[9–11] There is also evidence of an inverse relationship between the speech rate with generosity.[11] The pitch variability combined with loudness was linked to generosity.[12] Trustworthiness, compassion, strength, and nervousness were related to pitch.[13] It was shown that pitch was informative of some personality traits, namely agreeableness and neuroticism, and conscientiousness.[14] Another study showed that speaking loudness was associated with extraversion trait.[15] Extraversion was reported as an easy-to-recognize personality trait for people rather than others.[16] Also, another research showed neuroticism, extraversion, openness, and agreeableness had effects on the speech signal.[17]

Dysphonia refers to voice quality, loudness, or pitch change(s).[1] Alarmingly, 29.9% of people suffer from dysphonia throughout their longetivity.[18] Dysphonia jeopardizes the occupational, social, communicational, and psychological aspects of life.[19] One of the fundamental compartments of dysphonia assessment is acoustic analysis.[1,20] As technology progresses, acoustic characteristics provide easily accessible numerical data that can be used during screening, evaluation, and treatment of dysphonia.[20,21] The acoustic characteristics utility is not bound to analyze the voice signal, but they can predict some information even about the patient's perception of the dysphonia severity and the vocal tract discomfort symptoms.[22] The acoustic characteristics also expose information regarding instantaneous psychosocial features, such as emotion, mood, and stress.[23–26]

To our best knowledge, only two studies examined the effect of dysphonia on the relationship between personality traits and psychological distress with acoustic characteristics.[27,28] Extraversion, openness, and agreeableness traits had relationships with some acoustic characteristics.[28] Toles et al. reported the relationships between personality traits and the acoustic characteristics in singers with dysphonia diagnosed with vocal nodules.[28] The present study was performed to cast light on our hypothesis if personality dimensions are able to change acoustic characteristics or not. We hypothesized that personality dimensions and psychological distress can influence the acoustic characteristics. We also hypothesized that the level of abnormal overall voice quality (AOVQ) and also the voice pathology type (organic, functional, and neurologic) are important factors affecting the relationship between personality dimensions and psychological distress with the acoustic characteristics. Therefore, this study aimed to investigate the correlation between personality dimensions and psychological distress with the acoustic characteristics in participants with/without dysphonia, in participants with mild, moderate, and severe AOVQ, and in participants with organic, functional, and neurologic dysphonia. This work is theoretically and practically necessary, for a better understanding of personality traits that are more at-risk for voice disorders. It can help frame the way the voice care team members approach the treatment for voice disorders.

2 | MATERIALS AND METHODS

2.1 | Ethics and permissions

The study protocol followed the ethical principles of the updated Helsinki Declaration in 2008.[29,30] Research Ethics Committees of School of Nursing and Midwifery & Rehabilitation-Tehran University of Medical Sciences authorized us to implement the study (Official Code: IR.TUMS.FNM.REC.1399.162). A printed informed consent form was given to all the subjects to peruse and signed if complied with it.

2.2 | Participants

The sampling phase was conducted at the head and neck clinic of Amir Alam Hospital, Tehran, Iran. The sample comprised 119 people (55 with dysphonia and 64 without dysphonia) who participated in the study. Fifty-seven percent of all the participants were female, and the remaining 43% were men. Figure 1 illustrates the participants' distribution according to age.

2.3 | Laryngeal imaging

The structure and function of participants' larynx were examined during sustaining high-pitch vowel /i/ with a digital EndoSTROBE system (KARL STORZ, Germany) and a 70° rigid endoscope (KARL STORZ-ENDOSKOPE pulsar stroboscopy system 20140020) by a speech and language pathologist (SLP) and otorhinolaryngologist, concurrently.

2.4 | Questionnaires

Personality is thought to be a holistic entity comprised of several pieces, named traits. One of the well-known tools to measure personality traits is NEO Five-Factor Inventory (NEO–FFI) questionnaire. NEO–FFI is a questionnaire to evaluate the five chief personality traits, namely neuroticism (tendency to be sad, scared, and unstable), extraversion (tendency to be friendly, outgoing, and happy), openness (tendency to the imagination, curiosity, and exploration), agreeableness (tendency to be benevolent, frank, and modest), and conscientiousness (tendency to be hard-working, determined, and orderly).[31,32] NEO–FFI incorporated 60 statements with a Likert-based scoring system (from 0, Strongly Disagree to 4, Strongly Agree).[31] The internal consistency of neuroticism, extraversion, openness, agreeableness, and conscientiousness in Persian NEO–FFI was 0.87, 0.75, 0.96, 0.70, and 0.85, respectively.[33] Depression, Anxiety, and Stress Scale-21 (DASS-21) is a questionnaire to assess depression, anxiety, and stress in mature people.[34] DASS-21 has 21 statements.[34] The rating of DASS-21 is based on Likert (from 0, Did not apply to me at all-Never, to 3, Applied to me very much, or most of the time-Almost always).[34] The internal consistency of Persian DASS-21 was reported as 0.77 (depression), 0.78

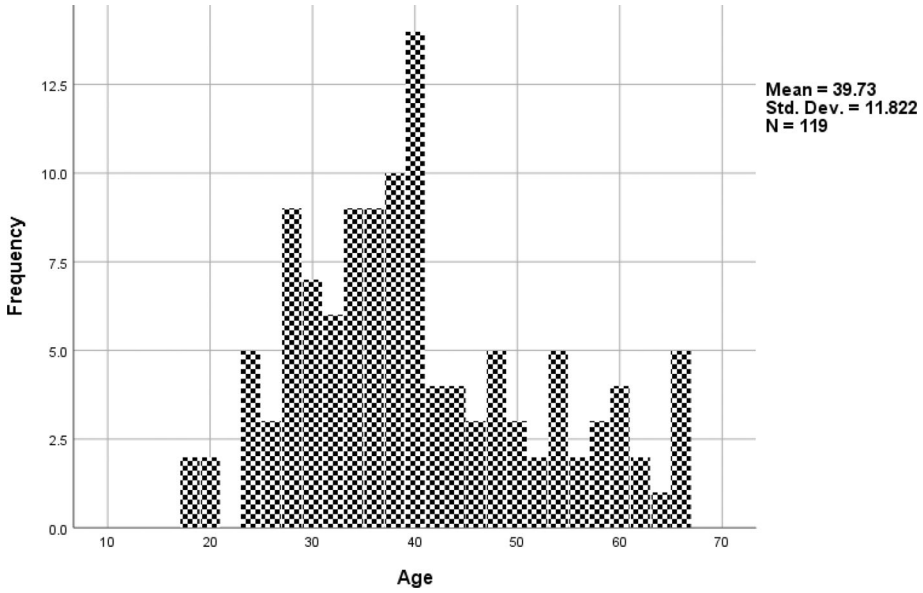

FIGURE 1 The distribution of participants by age ($n = 119$).

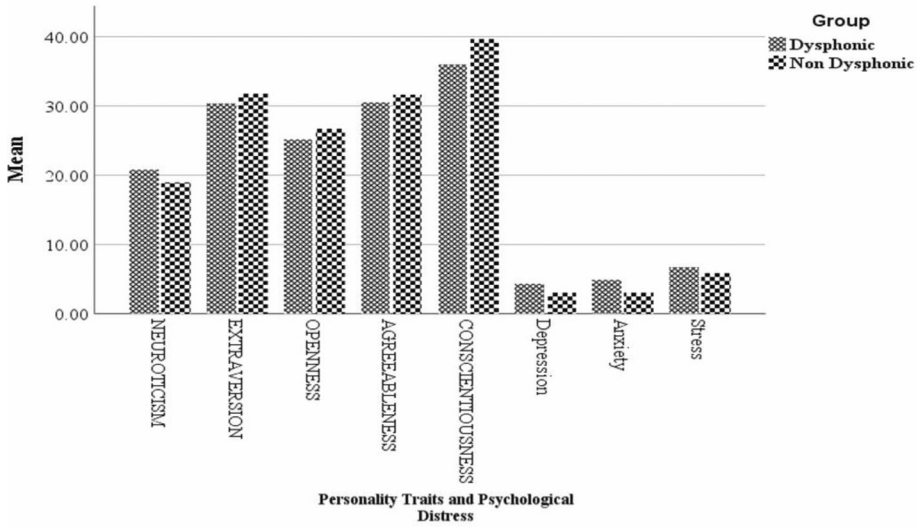

FIGURE 2 Personality traits scores by the existence of dysphonia ($n = 119$).

(stress), and 0.79 (anxiety).[35] The participants were asked to complete the printed forms of NEO–FFI, and DASS-21, setting no time limit.

2.5 | Vocal stimuli

The voice recordings were captured in a sound-treated *booth* with less than 38 decibels of ambient noise.[36] Zoom H5 Handy recorder (Zoom Corporation, Japan) was fixed at 10 cm and 45° from the participant's mouth via a pedestal.[36] The Participants articulated the tasks of ATSHA (the Persian form of Consensus Auditory-Perceptual Evaluation of Voice) at their comfortable pitch and loudness: vowels /a/ and /i/ for about 3–5 s, six sentences, and connected speech (Tell me about your voice problems).[37,38]

2.6 | Acoustic analysis

Acoustic methods for voice analysis are generally divided into time-based and frequency-based. The most commonly used time-based parameters are jitter, shimmer, and vocal noise measures (e.g., noise-to-harmonic ratio [NHR]).[39] Jitter and shimmer calculate the short-term changes of fundamental frequency and intensity of voice signal, respectively. NHR measures the ratio of noise energy to harmonic energy of a voice signal.[20] The cepstral measures (e.g., cepstral peak prominence [CPP], and cepstral peak prominence-smoothed [CPPS]) as frequency-based parameters are being widely used for the last two decades in research and clinical practice.[40] The periodicity of energy in the acoustic signal is extractable from the cepstral measures.[1] Although the algorithm for calculating CPP and CPPS differs from each other, these two measurements are usually used together as a

TABLE 1 Correlation between personality traits and psychological distress with acoustic characteristics by the existence of dysphonia ($n = 119$).

			With dysphonia					Without dysphonia				
			Jit (%)	Shim (%)	NHR (dB)	CPP (dB)	CPPS (dB)	Jit (%)	Shim (%)	NHR (dB)	CPP (dB)	CPPS (dB)
N	*r*		−0.229[b]	0.128[a]	−0.154[b]	0.037[a]	0.076[a]	−0.037[b]	0.030[a]	0.016[b]	0.096[a]	0.053[a]
	p value		0.093	0.352	0.261	0.786	0.580	0.772	0.817	0.899	0.425	0.680
	95% Confidence Interval of *r*	Lower	-	-	-	-	-	-	-	-	-	-
		Upper	-	-	-	-	-	-	-	-	-	-
E	*r*		0.043[b]	−0.083[a]	−0.005[b]	−0.005[a]	−0.052[a]	0.189[b]	−0.182[a]	0.215[b]	0.031†	−0.040[a]
	p value		0.755	0.546	0.968	0.972	0.708	0.135	0.151	0.088	0.808	0.757
	95% Confidence Interval of *r*	Lower	-	-	-	-	-	-	-	-	-	-
		Upper	-	-	-	-	-	-	-	-	-	-
O	*r*		0.117[b]	−0.033[a]	0.007[b]	−0.142[a]	−0.176[a]	−0.217[b]	0.184[a]	−0.233[b]	−0.127[a]	−0.057[a]
	p value		0.396	0.810	0.961	0.302	0.200	0.085	0.146	0.064	0.317	0.653
	95% Confidence Interval of *r*	Lower	-	-	-	-	-	-	-	-	-	-
		Upper	-	-	-	-	-	-	-	-	-	-
A	*r*		−0.019[b]	−0.084[a]	0.071[b]	−0.114[a]	−0.001[a]	0.279[b]	−0.103[a]	0.335[b]	0.053†	−0.015[a]
	p value		0.893	0.542	0.605	0.409	0.995	0.026*	0.417	0.007*	0.677	0.905
	95% Confidence Interval of *r*	Lower	-	-	-	-	-	0.064	-	0.126	-	-
		Upper	-	-	-	-	-	0.460	-	0.536	-	-
C	*r*		0.134[b]	−0.216[a]	0.176[b]	−0.171[a]	−0.099[a]	0.143[b]	−0.204[a]	0.102[b]	−0.248[a]	−0.213[a]
	p value		0.331	0.113	0.198	0.213	0.472	0.259	0.105	0.423	0.048*	0.091
	95% Confidence Interval of *r*	Lower	-	-	-	-	-	-	-	-	−0.451	-
		Upper	-	-	-	-	-	-	-	-	0.003	-
D	*r*		−0.292[b]	−0.198[a]	−0.213[b]	0.222[a]	0.215[b]	−0.062[b]	−0.007[b]	−0.043[b]	0.062[b]	0.037[b]
	p value		0.031*	0.147	0.118	0.104	0.114	0.628	0.956	0.734	0.625	0.773
	95% Confidence Interval of *r*	Lower	−0.499	-	-	-	-	-	-	-	-	-
		Upper	0.054	-	-	-	-	-	-	-	-	-
An	*r*		−0.234[b]	−0.209[b]	−0.232[b]	0.115[a]	0.168[b]	−0.045[b]	−0.013[b]	−0.168[b]	−0.017[b]	−0.021[b]
	p value		0.085	0.126	0.088	0.402	0.220	0.726	0.921	0.186	0.894	0.868
	95% Confidence Interval of *r*	Lower	-	-	-	-	-	-	-	-	-	-
		Upper	-	-	-	-	-	-	-	-	-	-

(Continues)

TABLE 1 (Continued)

			With dysphonia					Without dysphonia				
			Jit (%)	Shim (%)	NHR (dB)	CPP (dB)	CPPS (dB)	Jit (%)	Shim (%)	NHR (dB)	CPP (dB)	CPPS (dB)
S	*r*		−0.036[b]	−0.038[a]	−0.112[b]	−0.077[a]	−0.085[a]	−0.033[b]	0.166[a]	−0.113[b]	0.029[a]	0.052[a]
	p value		0.793	0.785	0.415	0.576	0.535	0.793	0.191	0.375	0.818	0.681
	95% Confidence Interval of *r*	Lower	-	-	-	-	-	-	-	-	-	-
		Upper	-	-	-	-	-	-	-	-	-	-

Abbreviations: A, agreeableness; An, anxiety; C, conscientiousness; CPP, cepstral peak prominence; CPPS, cepstral peak prominence-smoothed; D, depression; dB, decibel; E, extraversion; Jit, jitter; N, neuroticism; NHR, noise to harmonic ratio; O, openness; S, stress; Shim, shimmer.

[a]Pearson correlation coefficient.

[b]Spearman's rank correlation coefficient.

*Statistical significance at $p < 0.05$.

complement. To assess the effect of these two different algorithms on the relationship between personality traits and psychological distress with acoustic analysis, jitter, shimmer, NHR, CPP, and CPPS of 3 middle seconds of sustained vowel /a/ were computed by *Praat*.[41] The standard protocols were applied for cepstral analysis.[42,43]

2.7 | Auditory-perceptual evaluation

The audio samples were auditory-perceptually inspected based on the overall severity (OS) score of ATSHA.[37,38] The numerical ranges OS <10, 10 ≤ OS <40, 40 ≤ OS <70, and OS ≥70 were used to classify the participants into those without dysphonia, with mild dysphonia, with moderate dysphonia, and with severe dysphonia, respectively.[44] Initially, two SLPs with expertise in the voice disorders field listened discretely to all the voice samples in a quiet room and pick a number from 0 to 100. In conditions where the two SLPs' scores belonged to different numerical ranges (e.g., one score in the range of mild and another score in the range of moderate), the third SLP was invited to rate. Then the two SLPs' scores or three SLPs' scores were averaged. At last, the averaged VAS values were converted to ordinal scores: participants without dysphonia, and participants with mild, moderate, and severe AOVQ.

2.8 | Statistical analysis

The normality distribution of personality traits and psychological distress scores in different groups of participants (with dysphonia/without dysphonia, mild/moderate/severe AOVQ, and organic/functional/neurologic dysphonia) was separately determined by the Shapiro–Wilk test. Supposing the normal distributions, the Pearson correlation test was used to examine the relationship between personality traits and psychological distress with acoustic characteristics. In the case of a non-normal distribution, the Spearman correlation test was used. For the judgment of the magnitude of correlation coefficient effect size, suggested ranges for the social sciences were applied: 0.10–0.29 = small, 0.30–0.49 = medium, and 0.50–1.00 = large.[45] The entire data analysis was done utilizing *IBM SPSS Statistics*.[46] In addition, the resampling approach (i.e., bootstrapping) for significant correlations was used to calculate the confidence interval for the significant correlation coefficients. Those correlations with lower variances between lower and upper extents are our more robust data in comparison with the correlations with a high fluctuation.

3 | RESULTS

The results of videolaryngostroboscopy showed that there were 33 (60.00%) organic, 12 (21.80%) functional, and 10 (18.20%) neurologic participants with dysphonia. The results of auditory-perceptual assessments showed that out of patients, 24 (43.70%) had mild,

TABLE 2 Correlation between personality traits and psychological distress with acoustic characteristics by AOVQ ($n = 55$).

		AOVQ														
		Mild					Moderate					Severe				
		Jit (%)	Shim (%)	NHR (dB)	CPP (dB)	CPPS (dB)	Jit (%)	Shim (%)	NHR (dB)	CPP (dB)	CPPS (dB)	Jit (%)	Shim (%)	NHR (dB)	CPP (dB)	CPPS (dB)
N	*r*	−0.335[b]	0.200[a]	−0.222[b]	−0.070[a]	0.067[a]	0.013[a]	−0.153[a]	0.087[b]	−0.260[a]	−0.273[a]	0.056[a]	−0.010[a]	0.176[a]	0.435[a]	0.179[a]
	p value	0.089	0.348	0.297	0.745	0.754	0.952	0.485	0.693	0.231	0.208	0.895	0.982	0.677	0.281	0.671
E	*r*	0.016[b]	0.066[a]	−0.300[b]	0.305[a]	0.166[a]	0.145[a]	−0.021[a]	0.037[b]	0.064[a]	0.032[a]	−0.301[a]	0.248[a]	−0.313[a]	−0.163[a]	0.064[a]
	p value	0.939	0.761	0.154	0.148	0.437	0.510	0.923	0.866	0.773	0.885	0.469	0.554	0.450	0.700	0.880
O	*r*	0.171[b]	0.013[a]	−0.023[b]	−0.185[a]	−0.359[a]	0.201[a]	−0.200[a]	0.085[b]	−0.185[a]	−0.123[a]	−0.352[a]	0.221[a]	−0.256[a]	−0.274[a]	0.202[a]
	p value	0.425	0.950	0.915	0.387	0.085	0.357	0.360	0.700	0.399	0.577	0.392	0.600	0.525	0.511	0.631
A	*r*	−0.049[b]	−0.180[a]	−0.215[b]	−0.186[a]	0.131[a]	0.011[a]	0.034[a]	0.149[b]	0.019[a]	−0.051[a]	−0.036[a]	0.377[a]	−0.089[a]	0.386[a]	0.368[a]
	p value	0.819	0.401	0.313	0.384	0.541	0.959	0.879	0.496	0.931	0.817	0.932	0.358	0.833	0.345	0.370
C	*r*	−0.102[b]	0.023[a]	−0.109[b]	0.153[a]	0.227[a]	0.251[a]	−0.305[a]	0.153[b]	−0.143[a]	−0.102[a]	−0.434[a]	0.240[a]	−0.431[a]	−0.194[a]	0.087[a]
	p value	0.635	0.913	0.613	0.476	0.286	0.249	0.156	0.485	0.515	0.644	0.283	0.566	0.287	0.646	0.837
D	*r*	−0.245[b]	0.122[a]	−0.164[b]	−0.032[a]	−0.031[a]	−0.210[a]	0.003[a]	−0.108[b]	0.146[a]	0.160[a]	0.187[a]	−0.418[a]	0.385[a]	0.002[a]	−0.253[a]
	p value	0.249	0.571	0.445	0.881	0.887	0.337	0.991	0.622	0.508	0.467	0.658	0.303	0.347	0.997	0.546
An	*r*	−0.185[b]	0.250[a]	−0.196[b]	0.001[a]	0.095[a]	−0.326[a]	−0.023[a]	−0.281[b]	0.014[a]	0.055[a]	0.329[a]	−0.649[a]	0.439[a]	−0.124[a]	−0.665[a]
	p value	0.388	0.238	0.358	0.995	0.658	0.128	0.917	0.195	0.950	0.803	0.427	0.082	0.276	0.770	0.072
S	*r*	0.046[b]	0.122[a]	−0.115[b]	−0.306[a]	0.146	−0.093[a]	−0.207[a]	−0.071[b]	−0.282[a]	−0.220[a]	0.550[a]	−0.607[a]	0.630[a]	0.046[a]	−0.433[a]
	p value	0.831	0.572	0.591	0.146	0.158	0.672	0.343	0.748	0.192	0.312	0.157	0.110	0.094	0.915	0.284

Note: *Statistical significance at $p < 0.05$.

Abbreviations: A, agreeableness; An, anxiety; AOVQ; abnormal overall voice quality; C, conscientiousness; CPP, cepstral peak prominence; CPPS, cepstral peak prominence-smoothed; D, depression; dB, decibel; E, extraversion; Jit, jitter; N, neuroticism; O, openness; S, stress; Shim, shimmer; NHR, noise to harmonic ratio.

[a]Pearson correlation coefficient.

[b]Spearman's rank correlation coefficient.

TABLE 3 Correlation between personality traits and psychological distress with acoustic characteristics by pathology type ($n = 55$).

			Dysphonia														
			Organic					Functional					Neurologic				
			Jit (%)	Shim (%)	NHR (dB)	CPP (dB)	CPPS (dB)	Jit (%)	Shim (%)	NHR (dB)	CPP (dB)	CPPS (dB)	Jit (%)	Shim (%)	NHR (dB)	CPP (dB)	CPPS (dB)
N	*r*		−0.243[a]	0.055[a]	−0.148[b]	−0.076[a]	−0.112[a]	−0.438[a]	0.426[a]	−0.308[b]	0.104[a]	0.442[a]	−0.079[b]	−0.283[a]	0.265[b]	0.035[a]	0.009[a]
	p value		0.173	0.760	0.413	0.673	0.533	0.155	0.168	0.330	0.749	0.151	0.829	0.429	0.459	0.923	0.980
	95% Confidence Interval of r	Upper	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Lower	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
E	*r*		0.166[a]	−0.088[a]	0.081[b]	−0.075[a]	0.018[a]	0.117[a]	−0.272[a]	−0.088[b]	0.341[a]	−0.319[a]	−0.049[b]	0.259[a]	−0.318[b]	−0.122[a]	−0.037[a]
	p value		0.356	0.628	0.656	0.680	0.922	0.717	0.392	0.786	0.278	0.313	0.894	0.470	0.371	0.738	0.918
	95% Confidence Interval of *r*	Upper	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Lower	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
O	*r*		0.165[a]	−0.210[a]	0.197[b]	−0.195[a]	−0.168	−0.074[a]	0.288[a]	−0.308[b]	−0.099[a]	−0.480[a]	−0.399[b]	0.431[a]	−0.085[b]	0.032[a]	0.282[a]
	p value		0.358	0.242	0.272	0.276	0.351	0.818	0.363	0.330	0.760	0.114	0.254	0.214	0.815	0.930	0.429
	95% Confidence Interval of *r*	Upper	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Lower	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	*r*		0.018[a]	−0.127[a]	−0.017[b]	−0.117[a]	−0.063[a]	−0.053[a]	−0.283[a]	−0.263[b]	−0.582[a]	−0.012[a]	−0.159[b]	0.366[a]	−0.455[b]	0.411[a]	0.367[a]
	p value		0.920	0.482	0.926	0.516	0.729	0.870	0.372	0.408	0.047*	0.970	0.662	0.298	0.186	0.237	0.298
	95% Confidence Interval of *r*	Upper	-	-	-	-	-	-	-	-	−0.906	-	-	-	-	-	-
		Lower	-	-	-	-	-	-	-	-	0.092	-	-	-	-	-	-
C	*r*		−0.115[b]	−0.024[b]	−0.004[b]	−0.048[b]	0.091[b]	0.517[a]	−0.713[a]	0.485[b]	0.012[a]	0.039[a]	−0.178[b]	0.241[a]	−0.111[b]	−0.357[a]	−0.357[a]
	p value		0.525	0.894	0.984	0.789	0.614	0.085	0.009*	0.110	0.971	0.904	0.623	0.503	0.760	0.312	0.698
	95% Confidence Interval of *r*	Upper	-	-	-	-	-	-	−0.128	-	-	-	-	-	-	-	-
		Lower	-	-	-	-	-	-	0.934	-	-	-	-	-	-	-	-
D	*r*		−0.195[b]	0.107[b]	−0.230[b]	0.260[b]	0.169[b]	−0.577[a]	−0.736[a]	−0.486[b]	0.230[a]	0.431[a]	−0.204[b]	−0.232[a]	0.211[b]	0.101[a]	0.161[a]
	p value		0.276	0.554	0.198	0.145	0.348	0.049*	0.006*	0.110	0.471	0.162	0.572	0.520	0.559	0.781	0.658
	95% Confidence Interval of *r*	Upper	-	-	-	-	-	−0.896	−0.933	-	-	-	-	-	-	-	-
		Lower	-	-	-	-	-	−0.081	0.609-	-	-	-	-	-	-	-	-
An	*r*		−0.321[b]	0.171[b]	−0.234[b]	0.104[b]	0.136[b]	−0.212[a]	−0.685[a]	−0.486[b]	0.103[a]	0.109[a]	−0.102[b]	−0.242[b]	0.285[b]	−0.127[b]	−0.057[b]
	p value		0.068	0.341	0.190	0.564	0.449	0.509	0.014*	0.110	0.749	0.736	0.780	0.501	0.425	0.726	0.875
	95% Confidence Interval of *r*	Upper	-	-	-	-	-	-	−0.918	-	-	-	-	-	-	-	-
		Lower	-	-	-	-	-	-	−0.163	-	-	-	-	-	-	-	-

TABLE 3 (Continued)

		Dysphonia														
		Organic					Functional					Neurologic				
		Jit (%)	Shim (%)	NHR (dB)	CPP (dB)	CPPS (dB)	Jit (%)	Shim (%)	NHR (dB)	CPP (dB)	CPPS (dB)	Jit (%)	Shim (%)	NHR (dB)	CPP (dB)	CPPS (dB)
S	*r*	−0.114[b]	−0.061[b]	−0.201[b]	−0.093[b]	−0.143[b]	−0.002[a]	0.019[a]	−0.088[b]	−0.240[a]	−0.253[a]	0.006[b]	−0.377[a]	0.364[b]	−0.133[a]	−0.116[a]
	p value	0.526	0.737	0.262	0.608	0.426	0.996	0.954	0.785	0.452	0.427	0.987	0.283	0.301	0.715	0.750
	95% Confidence Interval of *r* Upper	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Lower	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations: A, agreeableness; An, anxiety; C, conscientiousness; CPP, cepstral peak prominence; CPPS, cepstral peak prominence-smoothed; D, depression; dB, decibel; E, extraversion; Jit, jitter; N, neuroticism; NHR, noise to harmonic ratio; O, openness; S, stress; Shim, shimmer.

[a]Pearson correlation coefficient.

[b]Spearman's rank correlation coefficient.

*Statistical significance at $p < 0.05$.

23 (41.80%) had moderate, and 8 (14.50%) had severe AOVQ. The participants' NEO–FFI and DASS-21 scores were depicted in Figure 2.

The results of correlation tests showed that there was no significant correlation between personality traits and psychological distress with the acoustic characteristics in participants with/without dysphonia ($p > 0.05$) (Table 1), except for small to medium correlations between agreeableness with jitter and NHR, between conscientiousness with CPP in participants without dysphonia, and between depression with jitter in participants with dysphonia ($p < 0.05$).

The results of correlation tests showed that there was no significant correlation between personality traits and psychological distress with the acoustic characteristics in mild, moderate, and severe AOVQ groups ($p > 0.05$; Table 2).

The results of correlation tests showed that there was no significant correlation between personality traits and psychological distress with the acoustic characteristics in organic, functional, neurologic dysphonia ($p > 0.05$) (Table 3), except for large correlations between agreeableness with CPP, between conscientiousness with shimmer, between depression with jitter and shimmer, and between anxiety with shimmer in functional dysphonia ($p < 0.05$).

4 | DISCUSSION

Generally speaking, the aim of this study was to investigate the correlation between the different personality traits and psychological distress with acoustic characteristics. Besides, it was attempted to analyze the probable effects of AOVQ and voice pathology type on this relationship. We hypothesized that there was a relationship between the different personality traits and psychological distress and this relationship is predisposed to change regarding the AOVQ and voice pathology type. The results which indicated significant relationships between some of these measurements confirmed our hypothesis to some extent. However, our hypothesis about the influence of the level of AOVQ was not verified.

The acoustic perturbation measures (including jitter and shimmer) calculate the differences of the acoustic signal cycle-by-cycle that are the result of irregular vocal folds vibration.[20] NHR computes the harmonic and non-harmonic parts of the voice signal.[20] The cepstral analysis (including CPP and CPPS) measure the periodicity of energy in the acoustic signal.[1] According to a literature review article, the cepstral analysis was recognized as a valid evaluation to diagnose dysphonia in several languages.[40]

One of the results of the present study was that participants with dysphonia in general demonstrated only a small relationship between one personality trait and psychological distress item and jitter. These findings are at odds with the previous research by Kasefy et al. that showed openness had a large correlation with shimmer. It is assumed this difference might be due to the smaller sample size of this study done by Kasefy et al.[27] Small to medium correlations between agreeableness with jitter and NHR and between conscientiousness with CPP were observed in participants without dysphonia. This finding is somewhat incongruent with the past study which found no

correlation between agreeableness and jitter in participants without dysphonia. As mentioned above, this difference might be attributed to the smaller sample size of the previous study.[27] Furthermore, a negative weak correlation between depression and jitter was found only in the dysphonia group. The results of bootstrapping technique are indicative of a relatively great variance of correlation coefficients in a larger resampled population. Therefore, these results should be regarded with caution.

Although the AOVQ (mild, moderate, and severe) did not impact the relationship between personality traits and psychological distress and acoustic characteristics, pathology type did which is a novel and interesting outcome. These outcomes were thought to justify the lack of relationship between personality traits and psychological distress and acoustic characteristics in the dysphonia group in general. Large correlations between agreeableness with CPP, conscientiousness with shimmer, depression with jitter and shimmer, and anxiety with shimmer were found only in functional dysphonia. Like the outcomes of correlations in participants with/without dysphonia, numerical intervals of correlation coefficients in the functional group are not small. Therefore, these data should be considered with caution too. Among these, however, the variance of the correlation coefficient between depression and shimmer is low which can be interpreted that this relationship is possible to be observed in the population. It appears that the personality traits and psychological distress profile could potentially influence the acoustic output in participants with functional dysphonia but there are certainly other factors that were not measured or analyzed and they are impacting this relationship; because the correlation does not necessarily imply causation per se. No similar study was found to compare these results.

One of the most common etiology of dysphonia is vocal misuses, harmful behaviors for the larynx (e.g., loud talking, throat clearing, etc.).[20] The vocal misuses can lead to functional (e.g., muscle tension dysphonia) and structural (e.g., vocal nodule) laryngeal pathologies.[20] It is noteworthy that the root of vocal misuse is not necessarily personality, though, personality might predispose the individual to be more likely to partake in certain vocal behaviors.[47,48]

Roy et al. (2000) and Roy et al. (2000) revealed that vocal nodules were related to high extraversion (sociality) while functional dysphonia is bound with low extraversion and high neuroticism (lack of emotional control and over-reactivity).[1,47,48] As high extraversion is related to higher loudness, we assumed that there would be a relationship between extraversion with CPP and CPPS in organic and functional groups; because CPP and CPPS are influenced by intensity.[15,49] Although there was no relationship between neuroticism in general with the acoustic characteristics in the functional group, anxiety, and depression as key elements of neuroticism had correlations with jitter and shimmer which is a verification on the TTVD.[47,48] It seems that patients with functional dysphonia relative to other types of dysphonia show their personality traits and psychological distress profile in their voice to a greater degree.

It is recommended to subside the measurement errors, clinicians assess voice in a multi-dimensional manner by using multiparametric tests.[50] Some of these mostly acoustic-based tests have been recently developed and showed good results: Dysphonia Severity Index, Acoustic Voice Quality Index, Cepstral Spectral Index of Dysphonia, Acoustic Breathiness Index, and Acoustic Psychometric Severity Index of Dysphonia.[51–55] In that light, perhaps developing new combinational multiparametric tests using different acoustic characteristics, personality traits, and psychological distress data side by side leads to more promising results during voice assessment of patients with functional dysphonia. The accuracy of this assumption is required to be examined in detail in upcoming studies. Likewise, new models can be made to quantitatively assess personality from the acoustic characteristics for job qualification.

This study encountered some curbs. First, One of the fundamental problems with the results is related to the fact that they are just simple correlations, and the problem the authors are seeking to address is quite complex. The relationship between personality and acoustics is not as simple as these results make it seem–that relationship is almost certainly moderated by the diagnosis. The major finding is that there are relationships in the functional dysphonia group, but we know from previous studies that personality is related to the presence of functional dysphonia (but this is not the case in all individuals with functional dysphonia).[47,48] We also know that functional dysphonia affects voice output.[1] The upcoming work should utilize more complex statistical analyses such as moderation regression analysis to further investigate how much variance each link accounts for. Second, the participants were not equally distributed among the AOVQ and pathology type groups. There is still a concern that the sample size in the functional group is quite small, especially since that is where significant results were found. The small sample could be inflating the results. There needs to be an investigation of patients with functional dysphonia with a larger sample to provide further evidence to support the present findings. Third, regarding the study design, the personality traits and psychological distress data were just captured in one snapshot. Longitudinal studies are imperative to reach conclusions about the relationship between personality traits and psychological distress and acoustic characteristics. Fourth, the averaged cepstral analysis in three different vocal tasks (sustained vowel, reading a standard sentence, and non-standard connected speech) was more powerful than the cepstral analysis in only one vocal task in differentiating different levels of AOVQ.[56] However, all the cepstral analysis in this study was applied to the vowel /a/. Fifthly, the participants' personality traits and psychological distress data were captured using self-report questionnaires that are prone to bias.[57] The participants were not interviewed face-to-face by a clinical psychologist.

5 | CONCLUSION

In a nutshell, the acoustic characteristics, including jitter, shimmer, NHR, and CPP is influenced by some aspects of personality traits and psychological distress, such as agreeableness, conscientiousness, depression, and anxiety. The majority of the observed correlations between personality traits and psychological distress with acoustic characteristics were in the functional dysphonia group. Contrary to

AOVQ, the voice pathology type can be an effective factor in the relationship between personality traits and psychological distress with acoustic characteristics in patients with dysphonia. The current findings can be expanded and used to develop innovative multiparametric assessment tests; these tools provide a more detailed picture of voice in patients with functional dysphonia.

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CONFLICT OF INTEREST STATEMENT

The authors report no conflict of interest.

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REFERENCES

1. Stemple JC, Roy N, Klaben BK. *Clinical Voice Pathology Theory and Management*. Plural Publishing; 2014.
2. Moyse E, Beaufort A, Brédart S. Evidence for an own-age bias in age estimation from voices in older persons. *Eur J Ageing*. 2014;11(3):241-247.
3. Aronovitch CD. The voice of personality: stereotyped judgments and their relation to voice quality and sex of speaker. *J Soc Psychol*. 1976;99(2):207-220.
4. Giles H. Ethnicity markers in speech. *Social Markers Speech*. 1979;6:251-289.
5. Krauss RM, Freyberg R, Morsella E. Inferring speakers' physical attributes from their voices. *J Exp Soc Psychol*. 2002;38(6):618-625.
6. Cole EF, Quinn JL. Personality and problem-solving performance explain competitive ability in the wild. *Proc R Soc B*. 2012;279(1731):1168-1175.
7. Allport GW, Cantril H. Judging personality from voice. *J Soc Psychol*. 1934;5(1):37-55.
8. Twenge JM, Campbell WK. *Personality Psychology: Understand Yourself and Others*. Pearson; 2016.
9. Brown BL, Strong WJ, Rencher AC. Perceptions of personality from speech: effects of manipulations of acoustical parameters. *JASA*. 1973;54(1):29-35.
10. Brown BL, Strong WJ, Rencher AC. Fifty-four voices from two: the effects of simultaneous manipulations of rate, mean fundamental frequency, and variance of fundamental frequency on ratings of personality from speech. *JASA*. 1974;55(2):313-318.
11. Smith BL, Brown BL, Strong WJ, Rencher AC. Effects of speech rate on personality perception. *Lang Speech*. 1975;18(2):145-152.
12. Ray GB. Vocally cued personality prototypes: an implicit personality theory approach. *Commun Monogr*. 1986;53(3):266-276.
13. Apple W, Streeter LA, Krauss RM. Effects of pitch and speech rate on personal attributions. *J Pers Soc Psychol*. 1979;37(5):715-727.
14. Imhof M. Listening to voices and judging people. *Int J List*. 2010;24(1):19-33.
15. Scherer KR. Personality inference from voice quality: the loud voice of extroversion. *Eur J Soc Psychol*. 1978;8(4):467-487.
16. Funder DC. Accurate personality judgment. *Curr Dir Psychol*. 2012;21(3):177-182.
17. Breil SM, Osterholz S, Nestler S, Back MD. 13 contributions of nonverbal cues to the accurate judgment of personality traits. *Oxford Handbook Accurate Personality Judgment*. 2021;195.
18. Roy N, Merrill RM, Gray SD, Smith EM. Voice disorders in the general population: prevalence, risk factors, and occupational impact. *Laryngoscope*. 2005;115(11):1988-1995.
19. Ma E, Yiu E. Voice activity and participation profile: assessing the impact of voice disorders on daily activities. *J Speech Lang Hear Res*. 2001;44:511-524.
20. Boone DR, McFarlane SC, Berg SLV, Zraick RI. *The Voice and Voice Therapy*. Pearson Education; 2014.
21. Gunjawate DR, Ravi R, Bellur R. Acoustic analysis of voice in singers: a systematic review. *J Speech Lang Hear Res*. 2018;61(1):40-51.
22. Saeedi S, Aghajanzadeh M, Khoddami SM, Dabirmoghaddam P, Jalaie S. Relationship of cepstral analysis with voice self-assessments in dysphonic and normal speakers. *Eur Arch Otorhinolaryngol*. 2022;280:1803-1813.
23. Hopkins CS, Ratley RJ, Benincasa DS, Grieco JJ. Evaluation of voice stress analysis technology. *Proceedings of the 38th Annual Hawaii International Conference on System Sciences*; 2005:20b.
24. Ververidis D, Kotropoulos C. Emotional speech recognition: resources, features, and methods. *Speech Commun*. 2006;48(9):1162-1181.
25. Cummins N, Scherer S, Krajewski J, Schnieder S, Epps J, Quatieri TF. A review of depression and suicide risk assessment using speech analysis. *Speech Commun*. 2015;71:10-49.
26. Giddens CL, Barron KW, Byrd-Craven J, Clark KF, Winter AS. Vocal indices of stress: a review. *J Voice*. 2013;27(3):390.e21.
27. Kasefy S, Torabinezhad F, Rasouli M, Zareifaskhodi B, Saffarian A. The relationship between acoustic characteristics and personality dimensions in patients with dysphonia. *Iran Rehabil J*. 2020;18(3):337-344.
28. Toles LE, Roy N, Sogg S, et al. Relationships among personality, daily speaking voice use, and phonotrauma in adult female singers. *J Speech Lang Hear Res*. 2021;64(12):4580-4598.
29. Puri K, Suresh K, Gogtay N, Thatte U. Declaration of Helsinki, 2008: implications for stakeholders in research. *J Postgrad Med*. 2009;55(2):131-134.
30. Rickham P. Human experimentation. Code of ethics of the world medical association. Declaration of Helsinki. *BMJ*. 1964;2(5402):177.
31. Costa PT, McCrae RR. *Revised NEO personality inventory and NEO five-Factor inventory: NEO PI-R*. NEO-FFI. Psychological Assessment Resources Odessa; 1992.
32. McCrae RR, Costa PTJ. Empirical and theoretical status of the five-factor model of personality traits. *Sage Handbook of Personality Theory and Assessment*. Sage; 2008:273-294.
33. Bahrami B, Dolatshahi B, Pourshahbaz A, Mohammadkhani P. Comparison of personality among mothers with different parenting styles. *Iran J Psychiatry*. 2018;13(3):200.
34. Lovibond SH, Lovibond PF. *Manual for the Depression Anxiety Stress Scales*. Psychology Foundation of Australia; 1996.
35. Soleimani M, Mohammadkhani P, Dolatshahi B, Alizadeh H, Overmann KA, Coolidge FL. A comparative study of group behavioral activation and cognitive therapy in reducing subsyndromal anxiety and depressive symptoms. *Iran J Psychiatry*. 2015;10(2):71-78.
36. Patel RR, Awan SN, Barkmeier-Kraemer J, et al. Recommended protocols for instrumental assessment of voice: American speech-language-hearing association expert panel to develop a protocol for instrumental assessment of vocal function. *Am J Speech-Lang Pathol*. 2018;27(3):887-905.
37. Khoramshahi H, Khatoonabadi AR, Khoddami SM, Dabirmoghaddam P, Ansari NN. Responsiveness of Persian version of consensus auditory perceptual evaluation of voice (CAPE-V), Persian version of voice handicap index (VHI), and praat in vocal mass lesions with muscle tension dysphonia. *J Voice*. 2018;32(6):770.e21-770.e30.
38. Salary Majd N, Maryam Khoddami S, Drinnan M, Kamali M, Amiri-Shavaki Y, Fallahian N. Validity and rater reliability of Persian version

of the consensus auditory perceptual evaluation of voice. *Audiology*. 2014;23(3):65-74.
39. Hasanvand A, Salehi A, Ebrahimipour M. A cepstral analysis of normal and pathologic voice qualities in Iranian adults: a comparative study. *J Voice*. 2017;31(4):508.e517-508.e523.
40. Aghajanzadeh M, Saeedi S. Efficacy of cepstral measures in voice disorder diagnosis: a literature review. *J Modern Rehabil*. 2022;16(2):120-129.
41. Boersma P, Weenink D. *Praat: Doing Phonetics by Computer (Version 6.1.50)[Computer Software]*. Institute of Phonetic Sciences, University of Amsterdam; 2021.
42. Phadke KV, Laukkanen A-M, Ilomäki I, Kankare E, Geneid A, Švec JG. Cepstral and perceptual investigations in female teachers with functionally healthy voice. *J Voice*. 2018;34(3):485.e33-485.e43.
43. Maryn Y, Weenink D. Objective dysphonia measures in the program Praat: smoothed cepstral peak prominence and acoustic voice quality index. *J Voice*. 2015;29(1):35-43.
44. Mizuta M, Abe C, Taguchi E, Takeue T, Tamaki H, Haji T. Validation of cepstral acoustic analysis for normal and pathological voice in the Japanese language. *J Voice*. 2020;17 S0892-1997(20):30325-30328.
45. Cohen J. *Statistical Power Analysis for the Social Sciences*. Routledge; 1988.
46. IBM SPSS Statistics. *(Version 25) [Computer software]*. IBM SPSS Inc; 2017.
47. Roy N, Bless DM, Heisey D. Personality and voice disorders: a multitrait-multidisorder analysis. *J Voice*. 2000;14(4):521-548.
48. Roy N, Bless DM, Heisey D. Personality and voice disorders: a superfactor trait analysis. *J Speech Lang Hear Res*. 2000;43(3):749-768.
49. Brockmann-Bauser M, Van Stan JH, Sampaio MC, Bohlender JE, Hillman RE, Mehta DD. Effects of vocal intensity and fundamental frequency on cepstral peak prominence in patients with voice disorders and vocally healthy controls. *J Voice*. 2019;35(3):411-417.
50. Saeedi S, Aghajanzadeh M, Khatoonabadi AR. A literature review of voice indices available for voice assessment. *J Rehabil Sci Res*. 2022;9(4):151-155.
51. Latoszek BB, Maryn Y, Gerrits E, De Bodt M. The acoustic breathiness index (ABI): a multivariate acoustic model for breathiness. *J Voice*. 2017;31(4):511.e11-511.e27.
52. Lee SJ, Choi H-S, Kim H. Acoustic psychometric severity index of dysphonia (APSID): development and clinical application. *J Voice*. 2019;35(4):660.e19-660.e25.
53. Maryn Y, Corthals P, Van Cauwenberge P, Roy N, De Bodt M. Toward improved ecological validity in the acoustic measurement of overall voice quality: combining continuous speech and sustained vowels. *J Voice*. 2010;24(5):540-555.
54. Peterson EA, Roy N, Awan SN, Merrill RM, Banks R, Tanner K. Toward validation of the cepstral spectral index of dysphonia (CSID) as an objective treatment outcomes measure. *J Voice*. 2013;27(4):401-410.
55. Wuyts FL, Bodt MSD, Molenberghs G, et al. The dysphonia severity index: an objective measure of vocal quality based on a multiparameter approach. *J Speech Lang Hear Res*. 2000;43(3):796-809.
56. Saeedi S, Aghajanzadeh M, Khoddami SM, Dabirmoghaddam P, Jalaie S. The validity of cepstral analysis to distinguish between different levels of perceptual dysphonia in the Persian vocal tasks. *J Voice*. 2022;S0892-1997;(22):112-116.
57. Bauhoff S. Self-report bias in estimating cross-sectional and treatment effects. *Encycloped qual life well-being Res*. 2014;5798-5800.

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