A Comparison of Voice Activity and Participation Profiles Among Etiological Groups

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Summary: Objectives. The purpose of this study was to determine whether patients with functional voice disorders show voice activity and participation profiles different from those of the organic and neurogenic groups.
Methods. The Korean Version of the Voice Activity and Participation Profile (K-VAPP) was administered to 200 participants (150 patients with functional, organic, and neurogenic voice disorders, 50 for each etiological group, 50 controls without vocal complaint). The K-VAPP subscale scores of the etiological groups were compared, controlling for age, professional use of voice, and severity of voice disorder measured by overall severity of the Consensus Auditory-Perceptual Evaluation of Voice (CAPE-V).
Results. Results of a one-way analysis of variance indicated significant differences in the overall severity across groups (neurogenic > functional = organic > control). Among four groups, the organic group showed higher mean Z-scores of the K-VAPP than the control group, and the functional group showed higher mean Z-scores of the K-VAPP than the organic group. Compared with the neurogenic group, the functional group showed lower mean Z-scores for total score, Activity Limitation Score, SUB3, and SUB5. A comparison among three etiological groups showed that the functional group did not show higher scores than the organic group. On the contrary, the functional group showed a lower total score, Participation Restriction Score, and score for subsection 3 (effect on daily communication) than the neurogenic group.
Conclusions. Psychometric assessment of voice disorders using the K-VAPP could provide clinicians with baseline information that is applicable to various voice disorders. Further studies pertaining to the follow-up of voice disorders with various etiologies are needed to extend its clinical usefulness.
Key Words: Activity limitation−Participation restriction−Voice disorders−Etiology−Psychometric assessment.

INTRODUCTION

The impact of a voice disorder on a patient's life can extend far beyond visible laryngeal abnormalities or audible vocal problems. Therefore, careful consideration of such impacts is necessary when preparing for vocal assessment procedures, which are essential for adequate management of voice disorders.[1] For comprehensive and multidimensional assessment in voice clinics, acoustic and perceptual analyses by clinicians are often accompanied by a subjective self-reported assessment procedure. Such measures are increasingly important mainly because they provide information about any possible discrepancy in the degree of perceived voice impairment between patients and clinicians.[1,2]

One of the tools that adapt the International Classification of Functioning, Disabilities, and Health (ICF) framework is the Voice Activity and Participation Profile (VAPP) by Ma and Yiu.[1] The VAPP is a subjective self-reported voice assessment instrument and consists of 5 subsections and 28 items. As outcomes, total score of the VAPP ($VAPP_{TTL}$), Activity Limitation Score (ALS), Participation Restriction Score (PRS), and subscale scores of five subsections (SUB1−SUB5) are obtained.

To the best of our knowledge, it is the only self-reported psychometric assessment tool based on the ICF framework that takes both activity limitation and participation restriction into consideration. In addition, the attention is paid for the effect of voice disorder on a patient's job. Moreover, effects on daily communication and social communication are reported separately, which could help clinicians to draw up patient-oriented treatment plans. The VAPP has been translated into Korean and its validity, reliability, and responsiveness have been verified.[3,4]

Voice disorders are divided into three groups according to their etiology: functional, organic, and neurogenic.[5] Functional voice disorders include psychogenic voice disorders and voice disorders induced by excessive laryngeal muscle tension (eg, muscle tension dysphonia and voice disorders accompanied by benign vocal fold lesions) are also included. Organic causes include carcinoma, contact granuloma, vocal cysts, hemangioma, hyperkeratosis, infectious laryngitis, laryngeal papilloma, laryngopharyngeal reflux, sulcus vocalis, and congenital abnormalities. Neurogenic voice disorders include voice problems associated with various types of dysarthrias (eg, spastic, flaccid, hypokinetic, and mixed), vocal cord palsy (either unilateral or bilateral), and ab- or adductor spasmodic dysphonia. Although this classification system is not without controversy, it has been widely used in research and clinics.[5,6]

For these subgroups of voice disorders, different voice activity and participation profiles could be suggested.[7] Although patients with different voice problems could show similar dysphonia severity, their subjective voice complaints

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are expected to vary. This hypothesis is controversial because some studies have reported similar tendencies in functional and structural voice disorders,[8] whereas others have reported a tendency toward higher perceived severity in organo-functional voice disorder group.[7] Considering that functional voice disorders are mainly caused by vocal abuse or misuse,[5] patients with functional voice disorders might experience different degrees of limitation in voice-related activities or participation, even after the severity of voice problems is controlled. If this hypothesis is confirmed using the K-VAPP, the voice activity and participation profile of a given patient could be used as a guide to set a treatment plan in clinical practice. Together with dysphonia severity, a choice of profession of patient and age might affect the perception of voice problems of the patient.[9–12]

Therefore, the purpose of the current study was to determine whether patients with functional voice disorders show K-VAPP profiles different from the organic and neurogenic groups on controlling for age, severity of voice problems, and professional voice use.

METHODS

Participants

This study was approved by the Institutional Review Board of the Gangnam Severance Hospital (IRB No.: 3-2016-0073). Participants were selected from among the 150 patients who visited the voice clinic in the Gangnam Severance Hospital, Yonsei University Health System (Seoul). By implementing a videostroboscopic examination using a stroboscopy system (model 9100B, KayPENTAX, Lincoln Park, NJ), these patients were diagnosed as having voice disorders with various etiologies by an otolaryngologist. None of the patients had previously undergone any kind of surgical or behavioral intervention or belonged to two or more separate etiological groups. Patients were divided into three etiological groups (functional, organic, and neurogenic, 50 for each group). In the current study, only the benign lesions such as vocal nodules and polyps caused by hyperfunctional voice use in professional voice users were operationally defined as functional etiologies of voice disorders. Distribution of the patient group according to etiologies is summarized in Table 1.

A total of 50 community-dwelling native Koreans living in Seoul were recruited as normal control participants. Our exclusion criteria included a self-reported history of (1) smoking or other neurological or health issues, (2) otolaryngology clinic visits in the past 3 months, and (3) any clinically relevant voice complaint at the date of recording. In addition to the author's acquaintance, patients referred for preoperative voice evaluation before thyroid surgery were also included, but only if they had normal laryngeal stroboscopic findings and perceptually normal voice.[13] The age (within 3 years if possible), gender, and profession of the each group were matched as closely as possible. A Kruskal-Wallis test revealed that there was no difference in age among four groups ($P = 0.140$). A chi-square test revealed that there was a significant difference in profession ($P < 0.001$) among the four groups. Demographic data of each group are presented in Table 2.

TABLE 1.
Distribution of the Patient Group According to Etiologies

Etiological Group	Diagnosis	N (%)
Functional (N = 50)	Vocal polyp	21 (14.0)
	Vocal nodules	19 (12.0)
	Functional dysphonia	7 (4.7)
	Muscle tension dysphonia	3 (2.0)
Organic (N = 50)	Laryngopharyngeal reflux	23 (15.3)
	Intracordal cyst	9 (6.0)
	Sulcus vocalis	5 (3.3)
	Laryngitis	5 (3.3)
	Hyperkeratosis of vocal cords	3 (2.0)
	Laryngeal papilloma	2 (1.3)
	Granuloma of vocal cords	1 (0.7)
	Hemangioma	1 (0.7)
	Vocal cord scarring	1 (0.7)
Neurogenic (N = 50)	Vocal cord palsy, unilateral	26 (17.3)
	Adductor spasmodic dysphonia	19 (12.7)
	Vocal cord palsy, bilateral	2 (1.3)
	Vocal cord paresis, unilateral	1 (0.7)
	Dysarthria, hyperkinetic type	1 (0.7)
	Dysarthria, mixed type	1 (0.7)

Procedures

Each participant was given the K-VAPP to complete. The instruction for the K-VAPP was presented verbally, and the participant was asked to answer the questions him- or herself. Additional explanation of the intended meaning of an item was provided if necessary. As outcomes, K-VAPP$_{TTL}$, ALS, PRS, SUB1−SUB5, and the Z-score of the subscale scores for each participant were calculated.

For perceptual assessment and screening of potential literacy problem, all participants were asked to read the first three sentences of the Korean standard passage "Ga-eul."[14] Speech samples were recorded using the *Computerized Speech Lab main program* (CSL model 4150B; KayPENTAX). As aforementioned, only the participants who demonstrated perceptually normal voice (0 on the Grade of GRBAS scale[15]) were included in the control group. Participants who were regarded as having or who reported having difficulty reading the passage were excluded from the study.

For perceptual ratings, the second sentence of the passage "Ga-eul" from each speaker (200 samples) was used. Perceptual judgment was obtained on the overall severity scale of the Consensus Auditory-Perceptual Evaluation of Voice (CAPE-V).[16] Auditory-perceptual evaluation was performed by three speech-language pathologists (SLPs), all of whom had more than 1 year of clinical experiences in vocal assessment (1, 3, and 19 years, respectively) at the department of otolaryngology. In a silent room, those samples were randomly presented to the raters using the monitoring

TABLE 2.
Demographic Data of Etiological Groups

		Functional	Organic	Neurogenic	Control
Age (y)	Range	21–65	19–74	20–86	20–69
	M (SD)	40.76 (11.82)	47.22 (15.36)	47.46 (17.10)	44.78 (13.70)
	Median (IQR)	41.50 (18.25)	46.00 (24.25)	44.00 (25.50)	45.50 (24.00)
Gender, N (%)	Male	14 (28.0)	14 (28.0)	14 (28.0)	14 (28.0)
	Female	36 (72.0)	36 (72.0)	36 (72.0)	36 (72.0)
Job, N [%])	Professional	47 (94.0)	14 (28.0)	9 (18.0)	9 (18.0)
	Nonprofessional	3 (6.0)	36 (72.0)	41 (82.0)	41 (82.0)
Total (N)		50	50	50	50

Abbreviations: M, mean; SD, standard deviation; IQR, interquartile range.

speaker of the CSL. Of the three values measured using a visual analog scale, the median value for each measurement was selected for further analysis.[17] All of the samples were replayed to the raters to obtain inter- and intra-rater reliability using the intraclass correlation coefficient (ICC). Calculating the ICCs, a two-way mixed model was applied for the inter-rater reliability, whereas a one-way random model was applied for the intra-rater reliability.

Statistical analysis

All statistical analyses were carried out using *SPSS 23.0* software (IBM-SPSS Inc., Chicago, IL). The significance level was set at 5% (0.05). For the comparison of the mean Z-scores of the K-VAPP subscale scores and overall severity measures among four groups, a one-way analysis of variance (ANOVA) was used, and Bonferroni post hoc tests were used for pairwise multiple comparisons. To compare the profiles among three etiological groups, multiple regression analyses were carried out. The K-VAPP$_{TTL}$ and subtotal scores were used as dependent variables. Independent variables were etiological groups, age, professional voice use, and overall severity. Two binary dummy variables were used to represent the three etiological groups. Each dummy variable represented the significance of the organic and the neurogenic groups in the regression model compared with the functional group, considering the purpose and focus of the present study. Interpreting test results, Bonferroni corrections were applied to reduce type I error, and only the *P*-values less than .00625 were regarded as significant.

RESULTS

Descriptive data of the K-VAPP raw scores and overall severity measures are presented in Table 3. Inter- and intra-rater reliability of the overall severity measures were evaluated using ICCs, which yielded values of 0.863 and 0.922, respectively.

Comparisons of the K-VAPP scores and overall severity ratings among four groups

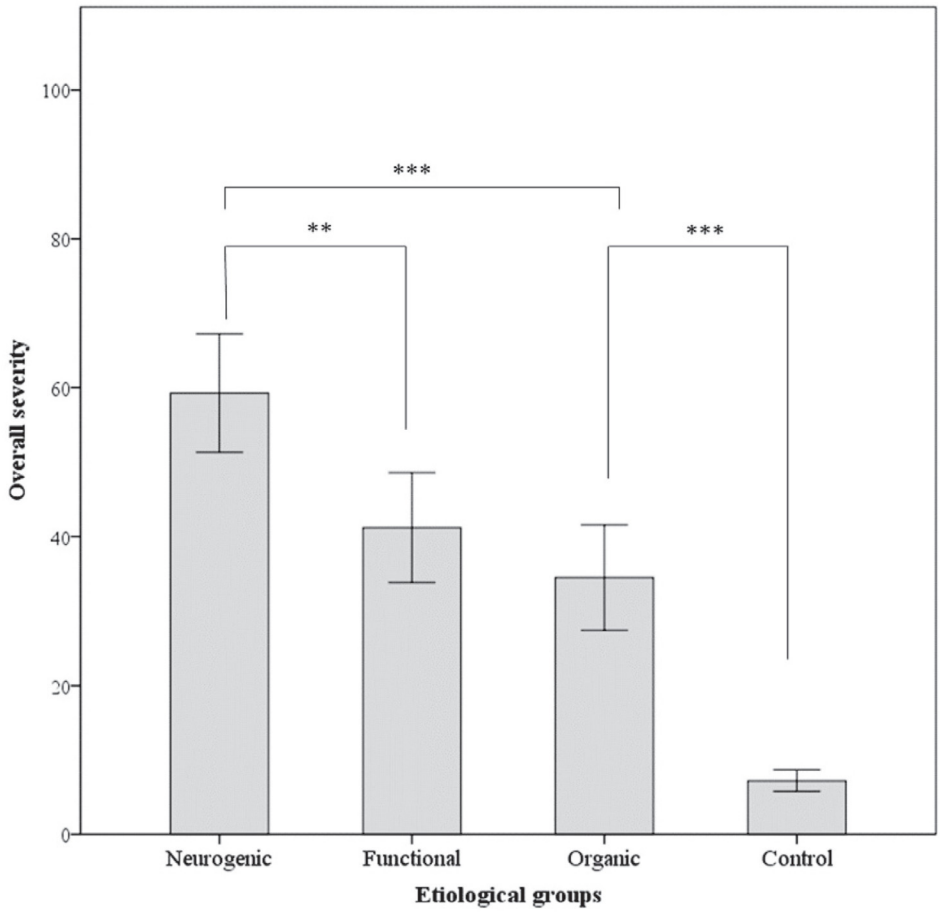
Results of a one-way ANOVA for the CAPE-V overall severity ratings indicated significant differences ($F = 44.321$, $P < 0.001$). Post hoc comparison revealed that all pairs of groups except the pair of the functional and organic groups showed significant differences (neurogenic > functional = organic > control, Figure 1).

Results of a one-way ANOVA indicated significant differences ($P < 0.001$) for mean Z-scores of all subscale scores ($F = 69.102$, 62.967, 49.022, 83.705, 40.932, 54.771, 42.893, 55.014 for K-VAPP$_{TTL}$, ALS, PRS, SUB1–SUB5,

TABLE 3.
Descriptive Data of the K-VAPP Raw Scores and Overall Severity Measures According to the Etiological Groups

	Maximum Score	Functional (N = 50)		Organic (N = 50)		Neurogenic (N = 50)		Control (N = 50)	
		M	SD	M	SD	M	SD	M	SD
K-VAPP$_{TTL}$	280	123.60	64.74	62.34	65.28	158.28	71.28	3.00	7.38
ALS	100	41.00	23.97	18.22	21.86	53.54	26.05	1.10	2.25
PRS	100	40.44	26.42	19.32	23.55	51.18	28.72	0.40	1.51
SUB1	10	6.62	2.52	3.94	3.25	7.20	2.33	0.38	0.90
SUB2	40	21.28	11.78	8.00	10.45	17.68	13.86	0.32	0.96
SUB3	120	45.66	31.35	24.38	29.89	68.40	34.06	0.98	2.42
SUB4	40	14.50	10.91	5.16	8.04	18.64	12.17	0.20	0.70
SUB5	70	35.54	21.00	20.86	21.53	46.36	21.59	1.12	4.91
OS	100	41.20	25.99	34.48	24.92	59.28	27.98	7.20	5.13

Abbreviations: SUB1, 2, 3, 4, and 5, the score of subsections 1, 2, 3, 4, and 5 of the K-VAPP; OS, overall severity measured by the Consensus Auditory-Perceptual Evaluation of Voice.



Note: $^{**}p < .01$, $^{***}p < .001$.

FIGURE 1. Group comparison of overall severity measured by the Consensus Auditory-Perceptual Evaluation of Voice.

respectively). Figure 2 is a radial plot that shows the results of post hoc comparison using Bonferroni tests. For all subscale scores, the organic group showed higher scores than the control group, and the functional group showed higher scores than the organic group. Compared with the neurogenic group, the functional group showed lower scores for K-VAPP$_{TTL}$, ALS, SUB3, and SUB5.

Comparisons of the K-VAPP scores among etiological groups on controlling severity

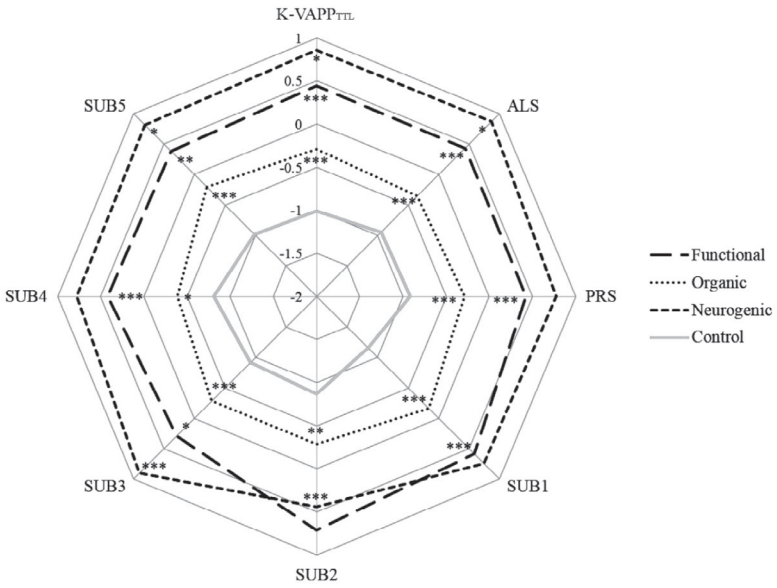
Coefficients of regression models predicting the K-VAPP scores are summarized in Table 4. For all models, organic and neurogenic etiological groups were coded as dummy variables, whereas functional group was set as reference group. The fact that multicollinearity existed was not problematic (VIF < 10). The results revealed that all models of the K-VAPP scores were significant ($P < 0.001$).

As shown in Table 4, the results also revealed that there was no difference in the K-VAPP scores between the functional and organic groups. On the contrary, the functional group showed lower K-VAPP$_{TTL}$ ($P = 0.005$), PRS ($P = 0.005$), and SUB3 score ($P = 0.004$) than the neurogenic group. Overall severity showed significance for all subtotal scores except for SUB2. Figure 3 illustrates a radial plot of the ß coefficients of the K-VAPP among the three etiological groups.

DISCUSSION

The purpose of the current study was to determine whether patients with functional disorders, which are mainly caused by vocal misuse or abuse, would show different self-perceptions for vocal problems of similar severity, and consequently, different K-VAPP profiles from those of the organic or neurogenic voice disorder groups. The current data revealed that the scores of the functional and organic groups did not differ, whereas the functional group showed lower K-VAPP$_{TTL}$, PRS, and SUB3 than the neurogenic group, when the overall severity and other important variables were controlled.

Without statistical control of overall severity, the organic group showed higher scores than the control group and the functional group showed higher scores than the organic group. Compared with the neurogenic group, the functional



Abbreviations: K-VAPP, the Korean Version of the Voice Activity and Participation Profile; K-VAPP$_{TTL}$, Total score of the K-VAPP; ALS, Activity Limitation Score; PRS, Participation Restriction Score; SUB1, 2, 3, 4, and 5, The score of subsection 1, 2, 3, 4, and 5 of the K-VAPP.
Note: *$p < .05$, **$p < .01$, ***$p < .001$

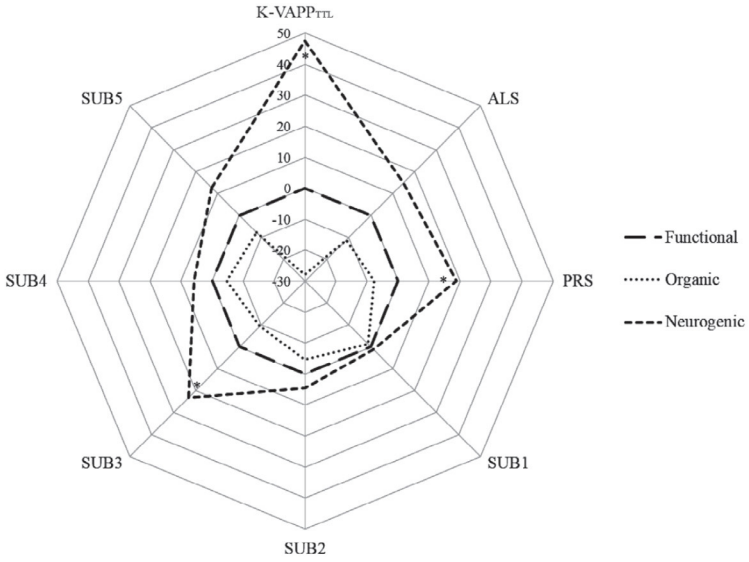
FIGURE 2. A radial plot of mean Z-scores of the K-VAPP subscale scores according to etiological groups. SUB1, 2, 3, 4, and 5, the score of subsections 1, 2, 3, 4, and 5 of the K-VAPP.

group showed lower scores only for K-VAPP$_{TTL}$, ALS, SUB3, and SUB5. Although there is a shortage of previous studies comparing the VAPP profiles across etiological groups, the current data are in accordance with a study which reported that patients with functional voice disorders showed a tendency for higher scores than the organic group (K-VAPP$_{TTL}$, ALS, SUB2, SUB4, and SUB5).[7] The functional group showed higher scores compared with the organic group, partly due to the operational definition of functional voice disorders used in the current study. Professional voice users, who experience more vocal abuse or misuse, report more vocal complaints.[18] The functional group in the current study, in which voice problems were caused by vocal abuse or misuse,[5,7,8] was mainly composed of professional voice users (94%). Behavioral problems in these patients frequently induce injuries in the membranous structures of the vocal cords, which limits voice activity and further restricts participation in those activities.[7]

TABLE 4.
Coefficients of Regression Models Predicting the K-VAPP Scores of Three Etiological Groups

Model		Age	Professional	Organic	Neurogenic	OS
K-VAPP$_{TTL}$		−1.035	30.641	−27.902	47.549	0.960
	P	0.008	0.031	0.077	0.005*	<0.001**
ALS		−0.408	9.285	−11.239	14.860	0.413
	P	0.003*	0.060	0.042	0.011	<0.001**
PRS		−0.446	13.289	−7.624	18.877	0.274
	P	0.004*	0.019	0.224	0.005*	0.002*
SUB1		−0.030	1.499	−1.180	1.057	0.048
	P	0.052	0.007	0.057	0.106	<0.001**
SUB2		−0.278	9.752	−4.633	4.565	0.061
	P	<0.001**	<0.001**	0.091	0.115	0.103
SUB3		−0.427	8.712	−9.442	23.264	0.495
	P	0.021	0.194	0.207	0.004*	<0.001**
SUB4		−0.149	4.109	−4.788	5.907	0.130
	P	0.017	0.070	0.058	0.028	<0.001**
SUB5		−0.151	6.568	−7.860	12.756	0.225
	P	0.242	0.163	0.134	0.022	0.002*

* $P < 0.00625$, **$P < 0.001$.
Abbreviations: SUB1, 2, 3, 4, and 5, the score of subsections 1, 2, 3, 4, and 5 of the K-VAPP; OS, overall severity measured by the Consensus Auditory-Perceptual Evaluation of Voice.



Abbreviations: K-VAPP, the Korean Version of the Voice Activity and Participation Profile; K-VAPP$_{TTL}$, Total score of the K-VAPP; ALS, Activity Limitation Score; PRS, Participation Restriction Score; SUB1, 2, 3, 4, and 5, The score of subsection 1, 2, 3, 4, and 5 of the K-VAPP.
Note: $^{*}p < .00625$.

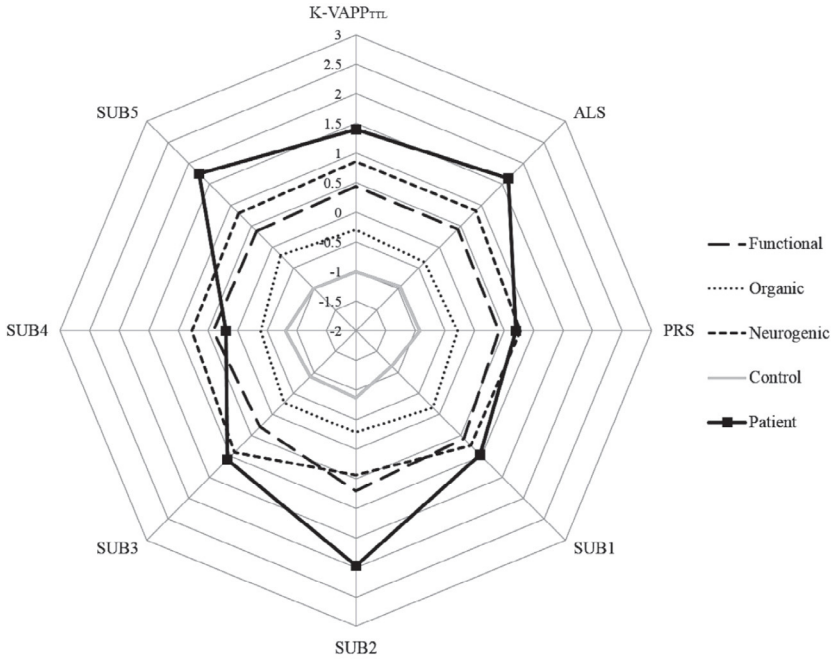
FIGURE 3. A radial plot of ß coefficients of the K-VAPP among three etiological groups. SUB1, 2, 3, 4, and 5, the score of subsection 1, 2, 3, 4, and 5 of the K-VAPP.

A comparison among three etiological groups after controlling for severity showed that the functional and organic groups did not show a difference in their K-VAPP profiles. This is in contrast to the previous results that were derived without statistical control for the severity of voice problems.[7] These results indicate that severity could be a crucial factor for voice complaints as etiology. This implies the need for further studies that contain various spectrums of severity and that match the severity across groups, a lack of which was an obvious limitation of the current study. The importance of severity control in studies of voice disorders is supported by a study pertaining to dysarthric patients and severity of dysarthria.[19] In further studies, regardless of underlying vocal pathologies, severity groups could be compared with regard to the K-VAPP profiles. In addition, the K-VAPP profiles of groups with different levels of breathiness and roughness could also be explored.

Contrary to the case of the organic group, the functional group showed lower K-VAPP$_{TTL}$, PRS, and SUB3 scores than the neurogenic group. Higher scores for the neurogenic group are consistent with previous studies using the Voice Handicap Index (VHI),[20–22] although these results are not confirmed by studies using the VAPP due to a lack of related studies. The higher K-VAPP$_{TTL}$ and PRS of the neurogenic group seem, although to be considered with caution, to indicate that neurogenic voice disorders might be associated with psychological characteristics of the patients. In fact, neurogenic voice disorders such as spasmodic dysphonia give patients substantial stress following the onset of the disorder,[23] which is also reflected in changes in the VHI scores after treatment.[24] A study reporting that the neurogenic group showed less vocal tract symptoms than the organic group supports this, as it indicates that neurogenic voice disorders are less related to physical factors.[25]

It is interesting that patients with functional voice disorders did not show significant differences in ALS, SUB1, SUB2, SUB4, and SUB5 scores compared with other patient groups. This supports that the overall effect of a voice disorder depends not only on etiology but also on other factors that might be explored as influential for activity limitation and participation restriction. Besides etiological groups, age, profession, and overall severity were used as independent variables in the regression models, and these factors showed significance in several subscale scores of the current data.

For instance, age showed negative correlation with ALS, PRS, and SUB2 scores. This implies the necessity of further studies related to differences in the perception of one's voice disorder between age groups, with particular focus on elderly patients. Compared with acoustic or perceptual studies, there is a shortage of studies pertaining to self-perception or quality of life changes caused by aging effect.[12,26] More detailed studies related to the characteristics of self-perceived voice problems in specific professions could also provide more information about the subjective activity and participation problems of those who are vulnerable to voice problems.[9,27] A recent study about teachers in Finland reported that teachers with recurrent vocal symptoms, especially those who reported weekly vocal symptoms, showed the potential to demonstrate more severe voice activity limitation and participation restriction.[28] Other studies of different professions such as teachers,[29,30] telecommunicators,[31] sports instructors,[32] and SLPs[33] using the VHI or Voice-Related Quality of Life (V-RQOL) have reported the tendency for professional voice users to have more sensitivity to voice problems.



Abbreviations: K-VAPP, the Korean Version of the Voice Activity and Participation Profile; K-VAPP$_{TTL}$, Total score of the K-VAPP; ALS, Activity Limitation Score; PRS, Participation Restriction Score; SUB1, 2, 3, 4, and 5, The score of subsection 1, 2, 3, 4, and 5 of the K-VAPP.

FIGURE 4. An example of the K-VAPP Z-score profile of a female call center operator with functional dysphonia. SUB1, 2, 3, 4, and 5, the score of subsections 1, 2, 3, 4, and 5 of the K-VAPP.

Using the profiles of the mean Z-scores according to etiological groups in the present study, tailored intervention strategies for each patient could be suggested. Figure 4 illustrates a radial plot of a call center operator with functional dysphonia in the current data.

Considering that functional dysphonia is a sort of functional voice disorder, this patient's profile seems to indicate the necessity of not only behavioral intervention (ALS) but also additional management related to psychosocial support (SUB5). In addition, this patient is suffering from difficulties in her professional performances (SUB2), which is in accordance with previous studies pertaining to the activity limitation and participation restriction of call center operators.[31] This patient shows lower PRS compared with ALS, and this could reflect that she has lower opportunity to change her job, even if voice disorder affects her professional performances enormously. In this case, it is highly recommended for a clinician to take this into consideration for any clinical decision-making. This profile is also characterized by the relatively small effect of her voice disorder on social communication, which could also be utilized by planning treatment strategies for psychosocial support. To enhance time-efficiency and clinical feasibility, a customized Excel sheet could be used to provide a clinician with an informative radial graph just by coding the raw scores of a given patient.

Thus, the results of an initial assessment using the K-VAPP could be interpreted and used for future treatment plan. However, it is yet to be discovered how profiles of voice disorders with complex etiologies (eg, paradoxical vocal fold movement) or multiple underlying disease conditions (eg, LPR plus vocal nodules) would be revealed. A comparison between pre- and post-treatment profiles would also provide detailed information about the degree of progress by behavioral intervention methods for a certain etiological group.[34,35] In addition, the K-VAPP profile changes of patients with diseases showing frequent recurrences (eg, laryngeal papillomatosis by viral infection) could be explored across repetitive surgical interventions, as a study using the VHI and the Rand Short Form Health Survey (SF-36) revealed particularly lower quality of life in several domains (physical functioning, emotional role functioning, and the mental component summary score).[36]

CONCLUSIONS

In summary, a comparison among three etiological groups showed that the functional group did not show higher scores than the organic group, whereas the functional group showed lower scores than the neurogenic group. It is believed that the current profile data captured by the K-VAPP could provide clinicians with baseline information that is applicable to various voice disorders and can be used as local normative data in Korean clinics. Limitations of the current study pertaining to operational classification of functional voice disorder or unmatched severity among groups, although statistically controlled, imply the need for use of appropriate classification methods and severity matching in further studies.

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