

Patient-Centered Approach to Assessing Voice Impairment

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 Supplemental content

IMPORTANCE The Voice Handicap Index-10 (VHI-10) is an established instrument with clear utility. However, national agencies are emphasizing the importance of patient-centered assessments beyond diagnostic test results. How patients view the VHI-10 and its items is not known.

OBJECTIVE To understand patients' perceptions of the VHI-10 items and to identify a potential subset of 6 items for use as a shorter patient-centered assessment.

DESIGN, SETTING, AND PARTICIPANTS This was a prospective psychometric and patient-centered study conducted at tertiary care and community-based laryngology practices with consecutive adult patients who presented for laryngology evaluation from January 1, 2023, to December 31, 2024. Consecutive responses to the VHI-10 questionnaire were evaluated using factor and item response theory (IRT) analyses. Participants ranked VHI-10 items and provided qualitative feedback, which was inductively coded. Participants were asked what is "most important to you and your voice experience" when evaluating 3 proposed shorter subsets of the VHI-10.

EXPOSURES VHI-10 questionnaire and 3 subsets of 6 items each, including item ranking (evaluated by factor analysis and item response theory).

MAIN OUTCOMES AND MEASURES Factor analysis and item response theory were used to produce 3 subsets of the VHI-10 for quantitative and qualitative assessment by participants.

RESULTS The analysis included data from 6048 consecutive patients (mean [SD] age, 52.0 [8.4] years; 3326 female [55%] and 2722 male [45%] individuals) with completed VHI-10 questionnaires that were evaluated via factor analysis and item response theory (IRT) assessment. In addition, 461 consecutive patients prioritized the VHI-10 items and 521 rated each of the 3 potential subsets. Factor analysis confirmed unidimensionality and IRT analysis demonstrated that items 4, 3, 6, and 1 had the highest discrimination parameters, while items 6, 7, and 1 were most frequently ranked as most or more important; item 5 was included in all sets because of prior clinician and patient input on its importance. Of the 3 subsets proposed, the patients favored set 1, which was composed of these items from the VHI-10: (1) my voice makes it difficult for people to hear me; (2) people have difficulty understanding me in a noisy room; (3) my voice difficulties restrict personal and social life; (6) I feel as though I have to strain to produce voice; and (7) the clarity of my voice is unpredictable; plus item (5), my voice problem causes me to lose income.

CONCLUSION AND RELEVANCE This psychometric study identified a shorter version of the VHI-10 that may be more patient-centered and clinically sufficient for assessing patients with voice impairments. These findings may form the foundation for additional assessments that are more patient-centered, efficient, and nuanced.

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Characterization and quantification of voice impairments is both complex and nuanced. While one patient may experience a voice disorder as a mild impairment, another patient may perceive it as a substantial limitation.¹ For example, patients who use their voice professionally may find dysphonia to be more detrimental to daily activities than patients who speak or sing avocationally.²⁻⁴ Also, the timing and duration of a voice problem may impact a reported voice handicap score, eg, new acute problems may score worse than long-standing problems.⁵ Because patients' perceptions of their dysphonia may vary despite similar objective measures, a patient-centered approach is beneficial to capturing patients' perception of their voice.

One of the most routinely used and well-studied measures of voice-specific patient-reported outcomes is the Voice Handicap Index (VHI).⁶ This instrument was originally developed as a 30-question tool that quantifies the patient's perception of voice impairment. In subsequent work, a VHI composed of 10 items (VHI-10) was proposed to help curtail the response burden for patients.⁷ The VHI-10 has been validated, with demonstrated high correlation to the original tool, and has been used widely.⁸

Although both the original VHI and subsequent VHI-10 are well-established instruments, questions have been raised about how patients themselves view and prioritize the included items. These queries have arisen as patient-centered approaches continue to be emphasized in health care at large, including through the national Patient-Centered Outcomes Research Institute and Agency for Healthcare Quality and Research.^{9,10} These and other organizational efforts underscore the pervasive emphasis on patient-centered assessments and their importance beyond technical diagnostic test results.

To better incorporate patient perspectives, a protocol was developed to engage patients in prioritizing the items within the VHI-10, with the dual goal of ensuring a patient-centered approach and providing a means to adjudicate between multiple potentially informative subsets of the instrument. This approach, which assesses how patients themselves would guide the prioritization of individual VHI-10 items, was designed to advance the patient-centered mission, while also improving measurement efficiency and decreasing survey fatigue. To do so, we performed a patient-centered assessment of the tool to determine if a particular item subset could offer quantitative and qualitative benefits for both patients and clinicians.

Methods

The study protocol was approved by the Mass General Brigham Institutional Review Board before data collection. Consent was obtained when patients agreed to respond to the questions in this study.

Study Design and Participants

Consecutive adult patients (age ≥ 18 years) who presented for evaluation at a participating tertiary care or community-

Key Points

Questions Which items on the Voice Handicap Index-10 (VHI-10) questionnaire do patients with voice impairment perceive as important and what subset of items would they choose for a shorter assessment?

Findings This psychometric study analyzed data from 6048 patients with voice impairment who completed the VHI-10 questionnaire and identified a 6-item subset for a shorter assessment. Patients chose items 1 (difficult for people to hear me), 2 (difficult to be understood in a noisy room), 3 (my voice restricts my personal/social life), 6 (have to strain to produce voice), and 7 (voice clarity is unpredictable), plus item 5, (causes me to lose income), which was identified by both clinicians and patients as imperative to all sets.

Meaning These findings suggest that a patient-centered subset of the VHI-10 is capable of providing new brevity and preserved nuance when collecting information from patients with voice impairment.

based laryngology clinic from January 1, 2023, to December 31, 2024, prospectively received the VHI-10 instrument through an established electronic system.¹¹⁻¹⁵ Patients were offered the option of providing input on how they viewed the importance of VHI-10 items to help determine whether the set of questions could be shortened. Those who decided to proceed provided input on how they would prioritize the existing VHI-10 items and, qualitatively, what they felt was important to track regarding their voice impairment.

Patients were eligible for inclusion if they completed the entirety of the VHI-10 and provided ranking, qualitative input, and/or prioritization data among potential subsets. Data from consecutive patients were included. Patients were excluded if they were not willing to complete the VHI-10, or if they were not willing to rank how important they considered each item to be or to provide input on their preferences for item subsets. Patients providing qualitative input were those who met eligibility criteria and were willing to provide commentary in conjunction with a clinical visit and review of the VHI-10 contents. The specific prompts in the qualitative assessment were: (1) If you would like a chance to shape the questions that are posed to you about your voice and the 10 questions above (referencing a displayed list of VHI-10 items), please comment on what you feel is most important for us to ask you about your voice during your clinical care; and (2) Would you like to provide further feedback or input about these questions? Patients were selected from those who were scheduled for an appointment with laryngologists and speech language pathologists in a joint multidisciplinary clinic. Demographic information, including race and ethnicity, were self-reported.

VHI-10 Instrument

The VHI-10 is a 10-item validated instrument that quantifies the patient's perception of their voice impairment.^{6,16,17} It arose from the originally validated 30-item form in which patients rated experiences of their voice impairment on a scale of 0 (never) to 4 (always).⁷ VHI-10 total score ranges from

0 to 40, with scores greater than 11 suggesting a meaningful handicap due to a voice impairment.^{6,16,17}

Statistical Analysis

Factor analysis was performed to reassess the unidimensionality of items and internal consistency was assessed through Cronbach α . Factor analysis provides data on whether posed questions inherently group together into a similar theme or themes. Ideally this analysis demonstrates high factor loadings to a single common theme or construct being measured, or a set of closely interrelated themes. Thus, a unidimensional scale is focused on 1 issue, ie, voice impairment. Internal consistency describes the extent to which individual items are associated with one another. Ideally, these items have a clear relationship and are not entirely redundant of one another. For these data, a 1-factor model was applied, and principal components analysis was performed; varimax rotation was completed to establish orthogonal parameters. A scree plot was also reviewed (eFigure in Supplement 1).

Item response theory (IRT) was applied via a graded response model, which is suitable for Likert scale items, to evaluate discrimination and location parameters for each item. IRT analyses can determine the amount of information delivered by each item, ie, the discrimination of each studied item (how responses differ among disparate states) and where a response suggests that a patient is within a continuum from never affected to always affected by a voice impairment.¹⁸⁻²¹ Information parameters describe how much information an item holds, while location parameters delineate where on the scale this information is located. Each item has as many location parameters as it has differences among response points, eg, an item with 5 answer options will have 4 location parameters. The location describes the level of difficulty related to specific item responses, and in this context higher locations are indicative of worse underlying voice impairment. Then, these IRT data were used as a foundation for selecting 3 potential subsets of items to prioritize. The electronic system used¹¹⁻¹⁵ prevents incomplete response submission so missing data were not present, although partial completions would have been included in this protocol.

Patients provided input on how they would prioritize individual items within the VHI-10. This incorporation of the patient perspective began with a request to rank the importance of each of the 10 items within the existing instrument. These ranking data were tabulated and quantified with descriptive statistics. Based on these initial ranking data, along with the IRT data already described and qualitative descriptions, 3 shorter sets of VHI items were proposed. Then, patients were offered the opportunity to select among these subsets, according to which set was “most important to you and your voice experience.” Also, a decision was made at the outset to include VHI-10’s item 5 (effect of voice on income) in all proposed subsets because of prior clinician and patient input about its importance, as well as the information it provides regarding those with severe voice disorder.^{7,22} Within the qualitative data collection,^{23,24} patients were queried on what they thought was the most important information to track and understand about their voice impairment, and responses were

Table 1. The Voice Handicap Index-10 (VHI-10) Questionnaire, Overall and Item Scores (n = 521)^a

Item No. and description	Mean score (95% CI)
Overall score	17.6 (16.9-18.4)
1: My voice makes it difficult for people to hear me.	1.9 (1.8-2.0)
2: People have difficulty understanding me in a noisy room.	2.0 (1.9-2.1)
3: My voice difficulties restrict personal and social life.	1.8 (1.7-1.9)
4: I feel left out of conversations because of my voice.	1.5 (1.4-1.6)
5: My voice problem causes me to lose income.	0.8 (0.7-0.9)
6: I feel as though I have to strain to produce voice.	2.0 (1.9-2.1)
7: The clarity of my voice is unpredictable.	2.1 (2.0-2.2)
8: My voice problem upsets me.	2.4 (2.3-2.5)
9: My voice makes me feel handicapped.	1.5 (1.4-1.7)
10: People ask “What’s wrong with your voice?”	1.6 (1.5-1.7)

^a This subset addressing the primary objective was from the total study population of 6048 respondents; the distribution of results within the total group was similar. Minimum score was 0 and maximum was 4, with a maximum total score of 40.

codified via an inductive technique. These data were organized line-by-line in written segments and reviewed for recurring themes within the spectrum of patient responses. Categories were drafted to focus on specific clinical content. An iterative code table was developed with 2 raters before proceeding with the related protocol. Given that the primary objective was to identify the optimal subset, power calculations were based on the postranking selection: 402 patients were needed to achieve a 90% power to detect a significant difference between 3 anticipated proportions. Quantitative data analyses were performed with Stata, version 17.0 (Stata Corp).

Results

The analysis included data from 6048 consecutive patients (mean [SD] age, 52.0 [8.4] years; 3326 female [55%] and 2722 male [45%]) who completed the VHI-10, including 461 consecutive patients who ranked the importance of the individual items within the VHI-10 and 521 patients who provided their preferences from among the 3 proposed shorter subsets. The study population was composed of 1 American Indian (<1%), 18 Asian (4%), 14 Black (3%), 19 Hispanic (4%), and 454 (87%) White individuals. Among those who disclosed their level of education, 96 (18%) completed graduate school, 250 (48%) college, and 63 (12%) high school or equivalent. The most frequent diagnoses within the overall set were laryngopharyngeal reflux (n = 136 [15%]), muscle tension dysphonia, secondary (n = 118; 13%), vocal fold atrophy (n = 109; 12%), vocal fold edema (n = 100; 11%), chronic cough (n = 64; 7%), paralysis or paresis of the vocal fold (n = 64; 7%), scar of the true vocal fold (n = 45; 5%), and subepithelial lesion (n = 36; 4%). VHI-10 data spanned the full possible range of the instrument (0-40), and the mean score indicated a mean response outside the normal range¹⁶ (Table 1).

Table 2. Item Response Theory Analysis of Item Discrimination and Location Parameter Estimates for a Graded Response Model (N = 6048 Respondents)

Item No. and description	Discrimination parameter estimates: a	Location parameter estimates			
		b_1	b_2	b_3	b_4
1: My voice makes it difficult for people to hear me.	3.57	-0.41	0.07	1.18	1.85
2: People have difficulty understanding me in a noisy room.	3.49	-0.41	0.06	0.95	1.55
3: My voice difficulties restrict personal and social life.	4.21	-0.14	0.34	1.17	1.76
4: I feel left out of conversations because of my voice.	4.44	0.07	0.56	1.36	1.91
5: My voice problem causes me to lose income.	1.60	1.06	1.53	2.26	2.69
6: I feel as though I have to strain to produce voice.	3.66	-0.42	-0.01	0.96	1.61
7: The clarity of my voice is unpredictable.	3.40	-0.59	-0.11	0.83	1.51
8: My voice problem upsets me.	3.10	-0.44	-0.01	0.80	1.35
9: My voice makes me feel handicapped.	3.38	0.17	0.57	1.25	1.69
10: People ask, "What's wrong with your voice?"	2.41	-0.14	0.37	1.35	1.90

Table 3. Prioritization of the Voice Handicap Index-10 (VHI-10) Questionnaire Items by Patients With Voice Impairment (n = 461)

Item No. and description	Ranked, frequency (%)				
	First	Second	Third	Fourth	Fifth
1: My voice makes it difficult for people to hear me.	112 (24.3)	52 (13.3)	45 (13.2)	29 (10.1)	14 (6.0)
2: People have difficulty understanding me in a noisy room.	42 (9.1)	48 (12.2)	39 (11.4)	37 (12.9)	23 (9.8)
3: My voice difficulties restrict personal and social life.	29 (6.3)	21 (5.4)	32 (9.4)	20 (7.0)	23 (9.8)
4: I feel left out of conversations because of my voice.	11 (2.4)	13 (3.3)	22 (6.4)	16 (5.6)	28 (11.9)
5: My voice problem causes me to lose income.	13 (2.8)	8 (2.0)	10 (2.9)	13 (4.5)	7 (3.0)
6: I feel as though I have to strain to produce voice.	117 (25.4)	75 (19.1)	58 (17.0)	38 (13.2)	15 (6.4)
7: The clarity of my voice is unpredictable.	77 (16.7)	78 (19.9)	44 (12.9)	51 (17.8)	19 (8.1)
8: My voice problem upsets me.	40 (8.7)	48 (12.2)	52 (15.2)	41 (14.3)	39 (16.6)
9: My voice makes me feel handicapped.	8 (1.7)	16 (4.1)	8 (2.3)	17 (5.9)	20 (8.5)
10: People ask, "What's wrong with your voice?"	12 (2.6)	33 (8.4)	32 (9.4)	25 (8.7)	48 (20.0)

Dimensionality and Internal Consistency

Factor analysis confirmed unidimensionality, providing a basis for IRT analysis. Cronbach α demonstrated high internal consistency ($\alpha = 0.91$).

Item Response Theory Assessments of Individual VHI-10 Items

Item response theory assessments provided insight into the discriminatory capacity of individual items, along with location parameters (b_1 - b_4 , representing the difficulty of achieving certain scores for a given item; Table 2). Items 4, 3, 6, and 1 had the highest discrimination (ie, I feel left out of conversations because of my voice; my voice difficulties restrict personal and social life; I feel as though I have to strain to produce voice; and my voice makes it difficult for people to hear me). Location parameters suggested that item 7 returned non-never responses within the mildest part of the continuum of voice impairment (the clarity of my voice is unpredictable), followed closely by items 1 and 8 (my voice makes it difficult for people to hear me and my voice problem upsets me), which had similar b_1 location parameters (Table 2). In contrast, a non-never response to item 5 indicted a higher severity within that continuum (my voice problem causes me to lose income). These location parameters are notable findings given that a

principle within these studies is to preserve the ability to assess the full range of possible severity within the measured trait, ie, perceived voice impairment. Thus, maintaining a set with items that span both the mildest and most severe part of the potential continuum of the trait is beneficial.

Development of Proposed Subsets with Patient Input

Patients' ranking of each item in VHI-10 was tabulated to determine their priorities (Table 2). The individual items most frequently prioritized as first by patients were item 6 (strain to produce voice, 117 [25.4%]) and item 1 (difficult to hear voice, 112 [24.3%]). The items most frequently ranked as second by patients were item 7 (clarity unpredictable, 78 [19.9%]) and item 6 (strain to produce voice, 75 [19.1%]) (Table 3). These ranking data, along with the IRT data previously denoted, informed the selection of 3 subsets for patients to further evaluate.

When patients were asked to consider what is "most important to you and your voice experience," 284 (54.5%) selected the subset with items 1, 2, 3, 6, and 7 (set 1); these items are the experience of being difficult to hear, having to strain to produce voice, unpredictable clarity of voice, difficulty in a noisy room, and restrictions on personal and social life, respectively (Table 4). The second most selected subset was the

choice of 148 respondents (28.4%), and included items 1, 6, 3, 4, and 9 (set 2): the experience of being difficult to hear, having to strain to produce voice, restrictions on personal and social life, feeling left out of conversations, and feeling handicapped due to voice, respectively (Table 4). The third subset was selected by 89 patients (17.1%): items 1, 6, 4, 7, and 9 (set 3; Table 4). Each set was also supplemented by the item related to income (item 5), according to the prospectively planned protocol. Therefore, the final optimal VHI-10 subset chosen by the participants was composed of these 6 items: (1) my voice makes it difficult for people to hear me; (2) people have difficulty understanding me in a noisy room; (3) my voice difficulties restrict personal and social life; (6) I feel as though I have to strain to produce voice; and (7) the clarity of my voice is unpredictable; plus (5) my voice problem causes me to lose income, which was included in all subset options.

The qualitative input provided by participants brought forth multiple related themes (Table 5). Patients were asked to focus on concepts not already included in the VHI-10. Themes that arose included fatigue with voice, pain with voice, vocal damage and healing, and daily activities. In addition, related symptoms that could impact voice included throat clearing, sinonasal symptoms, cough interference with voice, and associated dysphagia. Patients also commented on the existing items and noted if they did not have a remaining problem with their voice, relative to the VHI-10 problems posed. Some patients commented on existing item concepts, such as voice clarity, unpredictability, and strain.

Discussion

This study used a combination of psychometric assessments and patient-centered approaches to provide insights into and to direct the selection of an item subset that could support a more efficient evaluation of voice impairment. Items were identified within the VHI-10 that had the highest discrimination parameters, were most inclusive span of location parameters, and were ranked as the most important by patients, ultimately focusing on the subset of 6 items: 1, 2, 3, 5, 6, and 7 (set 1).

Advanced testing techniques have helped further our understanding of how individual questions can perform. More specifically, IRT²¹ has formed the basis for broad-scale assessments, such as the Scholastic Aptitude Test and the Patient-Reported Outcome Measurement Information System, whose development has been supported by the US National Institutes of Health.²⁵ IRT analyses demonstrate how individual questions perform, independent of other questions, in a given questionnaire, thus affording an understanding of the extent and degree of potential information within each individual item.^{21,26} The amount of information and discrimination that can be conveyed by single questions can be determined, so that the benefits that each has relative to each other can be learned. These data can also form the basis for future studies which develop adaptive tests and determine whether they have similar advantages to the adaptive instruments already developed in otology.^{14,15,18}

Table 4. Selections Made From 3 Sets of Items Proposed for a Shortened Voice Handicap Index (n = 521)

Set	No. (%)	Items No. and description
1	284 (54.5)	1: My voice makes it difficult for people to hear me.
		6: I feel as though I have to strain to produce voice.
		2: People have difficulty understanding me in a noisy room.
		3: My voice difficulties restrict personal and social life.
		7: The clarity of my voice is unpredictable.
2	148 (28.4)	1: My voice makes it difficult for people to hear me.
		6: I feel as though I have to strain to produce voice.
		3: My voice difficulties restrict personal and social life.
		4: I feel left out of conversations because of my voice.
		9: My voice makes me feel handicapped.
3	89 (17.1)	1: My voice makes it difficult for people to hear me.
		6: I feel as though I have to strain to produce voice.
		4: I feel left out of conversations because of my voice.
		7: The clarity of my voice is unpredictable.
		9: My voice makes me feel handicapped.

Hearing loss is broadly based²⁷⁻³⁵ and IRT has been applied within the Inner EAR instrument¹⁵ to create an adaptive version, which was shown to stabilize the association between subjective and objective outcomes regardless of psychological status.^{14,15,18} In the original instrument, psychological status was an effect modifier of the association between subjective patient reports of hearing ability and objective audiometry results, such that these were only associated in patients with better psychological status, whereas it was lost among those with worse psychological status. However, the IRT-based adaptive version preserved a robust association between subjective and objective outcomes, regardless of psychological status. It is possible that IRT-identified items better elucidate underlying latent traits (eg, functional hearing ability, voice impairment), regardless of the other traits within the population tested, which is important when administering instruments on a large scale.^{13,36-40}

The VHI-10 has been a highly effective instrument in reporting patient perceptions of voice impairment and remains a vital validated instrument, as does the original 30-item VHI. Prior versions have been proposed based on psychometric assessments, but to our knowledge, no other versions have engaged in such an assessment while incorporating a patient-centered perspective. Since the inherent goal of a validated instrument is to capture patient experience, this approach provides not only a scientifically rigorous method but also identifies content that is of most value to quantify and track from the patient perspective, which is novel to this instrument. This innovative aspect provides the potential to expand its applications, given that using a validated instrument cannot only help to understand the patient experience, but also to avert measurement bias and detection bias as well.^{13,41} A similar blend of psychometric rigor and clinical practicality drove the successful application of validated instrument items in other fields.^{14,15,39} The VHI content is focused on the patient experience and this study newly introduces a patient-driven component to assess how an additional subset of items from the VHI-10 could be applied.^{13,14,41}

Table 5. Qualitative Input From Patients With Voice Impairment, Coded by Inductive Method (n = 103)

Theme	Explanation	Example quote
Concepts already included in the VHI-10		
Voice strain	Voice strain and work speech is of concern	I have to really strain to be heard. I keep clearing my throat. I have to work hard to carry on a conversation or say anything because of hoarseness.
Voice clarity	Clarity of voice is emphasized	Speaking clearly is paramount to me.
Voice unpredictability	Unpredictable timing is raised	Never know when my voice is going to change.
Concepts already included in VHI-10 family of instruments		
Voice problems related to singing	Impaired singing ability is of concern	My ability to produce clear, consistent notes when I sing. Often, I try to sing and either a wrong note, or no note at all comes out. I also find myself coughing after singing for a short amount of time—when I cough, I am usually producing mucus from my throat. After clearing it, I am able to sing for a little while, then the mucus returns.
Voice-related symptoms		
Fatigue with voice	Voice use is associated with a tired sensation	When my voice is hoarse it is more of a tired feeling...I just thought maybe I was run down.
Pain with voice	Pain arises with voice usage	Speaking causes pain in my throat. I need to learn how to speak without straining my voice.
Vocal damage and healing	Mitigation of damage and progression of voice health	Vocal health, prevent damage, understand if I'm healing.
Daily life activities	Voice issues have negatively impacted daily activities or communication	How it affects my daily work life—and to some extent my related social responsibilities at the school. This is my major concern since I am a professor at a [type of] school.
Additional symptoms that affect voice		
Throat clearing and/or mucus	Impacted or frequent inability to clear throat or mucus in throat	After a few minutes of talking my voice sounds gravelly and I am frequently clearing my throat.
Allergies and sinus issues	Voice is impacted by chronic sinus and allergy symptoms	I am coming to address the wheezing issues. I was recommended by my allergist. Coincidentally, I seen [sic] a speech therapist to address voice clarity issues.
Cough interference with voice usage	A chronic cough often interferes with speaking	Chronic cough makes it difficult to speak. Frequently speaking interrupted but coughing.
Swallowing or obstruction in throat as a related symptom	Swallowing or obstruction is causing an issue, regardless of the results on test	Although testing indicates my swallowing is fine, most of my problems seem to start when I attempt to swallow. The feeling that something is constricting my throat and affecting breathing and swallowing—only sometimes—but very scary when it happens! Bronchial spasms are the technical term, I think.
Comments about the existing survey administration		
Suggestions regarding the items	Participants suggested areas to improve items	These questions are hard to answer and ambiguous because they don't distinguish between intensity of each factor and frequency. I feel as though my answers depend on my mood and what's more on my mind the moment I'm answering.
No problem with voice	No remaining voice problems	I do not have a problem with my voice (ie, posttreatment).

Abbreviation: VHI-10, Voice Handicap Index-10 (VHI-10) questionnaire.

Voice problems not only affect patients with professions that require prolonged or strenuous use of their voice, but all who experience a loss of function.⁴² The negative effects can also have tangible financial repercussions, including missed work, school, and other daily activities.^{38,43,44} For that reason, the VHI-10 item related to lost income from voice, which focuses less on specific symptoms and more on the very practical monetary effects, has been retained throughout successive versions of VHI since its inception. Although the discrimination parameter for this item is low, it has a high uniqueness seen in factor analysis, and IRT data suggest that it best represents the spectrum of voice impairment, which is more severe within the continuum of possible states.

Although the VHI-10 was abbreviated from the 30-item version, it and other validated instruments are often no longer administered in isolation, especially given that clinical intake mechanisms have increasing sophistication that surpasses simple rote administration of a static question set across all patients.¹¹⁻¹⁵ Instead, VHI-10 can be administered as part of a larger data capture that can be customized to each patient's presentation.¹¹⁻¹⁵ As such, increased efficiency among ques-

tion sets is prized. In addition, in the current climate of physician burnout and patient cognitive overload, a less is more approach can be favored by respondents and clinicians alike. Furthermore, because the larynx is central to not only voice, but also breathing and swallowing, VHI versions may frequently be coadministered with tools evaluating other common laryngology symptoms, eg, EAT-10³⁹ or related sleep and breathing assessments⁴⁵⁻⁴⁹—with a cumulative response burden—such that additional brevity has value.

In the future, these data could support an adaptive version of the VHI-10, which could be another high-utility tool to measure patient voice impairment. For example, a patient with no voice complaints would benefit from a version that provides fewer questions, once the targeted items clearly indicate that impairment is low or nil. In other patients, it could focus on more severe disease, with a response burden that changes according to the presenting state. It could potentially also recognize the clinical situation (eg, presenting for a breathing concern) and adapt the vetted questions being offered to more personally relate to the specific presentation. Additional research that builds on this study will move us

further toward assessments that simultaneously provide efficiency and precision.

Voice has a substantial impact^{42,50} and patients also identified issues (pain and fatigue) that they felt were important and extend beyond the VHI-10 items. Vocal fatigue was considered important and related, and there is a validated instrument that focuses on these items, the Vocal Fatigue Index.⁵¹ In addition, other laryngology-related concerns are addressed by instruments such as the Cough Symptom Index and the Eating Assessment Tool.^{39,52} Also, given the key functions of the larynx within the unified airway,⁵³⁻⁵⁸ dyspnea, sleep quality, and reflux are additional associated aspects.⁴⁵⁻⁴⁹ A future adaptive effort could incorporate various aspects of associated intake mechanisms to optimize efficiency to benefit both patients and clinician alike. It could also benefit those in practice areas beyond otolaryngology given that the voice and larynx can be affected by interventions for nonlaryngeal disease.⁵⁹⁻⁷⁰

Limitations

There are limitations to this study. Included patients were 18 years or older, and external validity is limited to patients of this age group. Given that age can affect associations between variables^{71,72} and that voice changes with age,⁷³ age-related effects may be a topic for future study. The present results also arise from a broad population, without sex- or race- and ethnicity-specific results. In addition, we did not separately account for psychological status, which has been shown to have

an effect on the interpretability of subjective or patient-centered outcomes.⁷⁴⁻⁷⁶ Further study is needed to determine whether there is convergent validity and responsiveness to change.^{7,13,14,58,77} Also, only the English version of VHI-10 in the US was used, and there may be limitations in generalizability of these results to the translated versions of VHI-10 or in other English-speaking countries. In addition, the results may not be applicable to groups with broader racial and ethnic backgrounds, and frequency matching with the US population was not incorporated into the study design. Similarly, laryngeal diagnoses and pathologic findings were not sampled in predetermined frequencies or used as the basis of subgroup analyses, and the underlying impairments could potentially affect patient preferences. These elements are worthy of future research.

Conclusions

The findings of this psychometric study indicate that although the VHI-10 remains a critical instrument for assessing patient-perceived voice impairment, these patient-centered data, combined with the results of IRT analyses, may form the basis of a patient-driven shorter version of the VHI-10. These findings potentially offer an adaptive version of voice assessment that has the capacity to be patient-centered, with new brevity and preserved nuance.

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REFERENCES

- Hanschmann H, Lohmann A, Berger R. Comparison of subjective assessment of voice disorders and objective voice measurement. *Folia Phoniatr Logop*. 2011;63(2):83-87. doi:10.1159/000316140
- Ebersole B, Soni RS, Moran K, Lango M, Devarajan K, Jamal N. The influence of occupation on self-perceived vocal problems in patients with voice complaints. *J Voice*. 2018;32(6):673-680. doi:10.1016/j.jvoice.2017.08.028
- Pestana PM, Vaz-Freitas S, Manso MC. Prevalence, characterization, and impact of voice disorders in Fado singers. *J Voice*. 2020;34(3):380-386. doi:10.1016/j.jvoice.2018.10.015
- Ortiz AJ, Toles LE, Marks KL, et al. Automatic speech and singing classification in ambulatory recordings for normal and disordered voices. *J Acoust Soc Am*. 2019;146(1):EL22. doi:10.1121/1.5115804
- Behrman A, Sulica L, He T. Factors predicting patient perception of dysphonia caused by benign vocal fold lesions. *Laryngoscope*. 2004;114(10):1693-1700. doi:10.1097/00005537-200410000-00004
- Johnson AJB, Grywalski C. The Voice Handicap Index (VHI): development and validation. *Am J Speech Lang Pathol*. 1997;6(3):66-70. doi:10.1044/1058-0360.0603.66
- Rosen CA, Lee AS, Osborne J, Zullo T, Murry T. Development and validation of the Voice Handicap Index-10. *Laryngoscope*. 2004;114(9):1549-1556. doi:10.1097/00005537-200409000-00009
- Timmons Sund L, Collum JA, Bhatt NK, et al. VHI-10 scores in a treatment-seeking population with dysphonia. *J Voice*. 2023;37(2):290. doi:10.1016/j.jvoice.2020.12.017
- Selby JV, Beal AC, Frank L. The Patient-Centered Outcomes Research Institute (PCORI) national priorities for research and initial research agenda. *JAMA*. 2012;307(15):1583-1584. doi:10.1001/jama.2012.500
- Howard AF, Warner L, Cuthbertson L, Sawatzky R. Patient-driven research priorities for patient-centered measurement. *BMC Health Serv Res*. 2024;24(1):735. doi:10.1186/s12913-024-11182-x
- Shin JJ. An electronic interface to routinize outcomes assessment and streamline clinic workflow. *Laryngoscope*. 2017;127(5):1058-1060. doi:10.1002/lary.26160
- Shin JJ, Carroll TL, Prince AA, Landman AB. The utility and feasibility of extending beyond traditional patient descriptions in daily practice. *Laryngoscope*. 2020;130(suppl 3):S1-S13. doi:10.1002/lary.28467
- Carroll TL, Lee SE, Lindsay R, Locandro D, Randolph GW, Shin JJ. Evidence-based medicine

in otolaryngology, part 6: patient-reported outcomes in clinical practice. *Otolaryngol Head Neck Surg.* 2018;158(1):8-15. doi:10.1177/0194599817731759

14. Kim M, Corrales CE, Prince AA, et al. Validation of a novel adaptive inner EAR scale to intelligently quantify the impact of hearing loss. *Laryngoscope.* 2025;135(7):2521-2528. doi:10.1002/lary.32087

15. Kim M, Willard EG, Corrales CE, et al. Mitigation of effect modification by psychological status in patients with hearing loss. *JAMA Otolaryngol Head Neck Surg.* 2024;150(7):537-544. doi:10.1001/jamaoto.2024.0898

16. Arffa RE, Krishna P, Gartner-Schmidt J, Rosen CA. Normative values for the Voice Handicap Index-10. *J Voice.* 2012;26(4):462-465. doi:10.1016/j.jvoice.2011.04.006

17. Young VN, Jeong K, Rothenberger SD, et al. Minimal clinically important difference of voice handicap index-10 in vocal fold paralysis. *Laryngoscope.* 2018;128(6):1419-1424. doi:10.1002/lary.27001

18. Jessen A, Ho AD, Corrales CE, Yueh B, Shin JJ. Improving measurement efficiency of the inner EAR scale with item response theory. *Otolaryngol Head Neck Surg.* 2018;158(6):1093-1100. doi:10.1177/0194599818760528

19. Liu DT, Phillips KM, Speth MM, Besser G, Mueller CA, Sedaghat AR. Item response theory for psychometric properties of the SNOT-22 (22-Item Sinus Outcome Test). *Otolaryngol Head Neck Surg.* 2022;166(3):580-588. doi:10.1177/01945998211018383

20. M. LF. Applications of Item Response Theory To Practical Testing Problems. 1st Edition ed: Routledge 1980.

21. Nguyen TH, Han HR, Kim MT, Chan KS. An introduction to item response theory for patient-reported outcome measurement. *Patient.* 2014;7(1):23-35. doi:10.1007/s40271-013-0041-0

22. DeVore EK, Carroll TL, Edelen M, Rosen C, Shin JJ. Improving measurement efficiency of the Voice Handicap Index-10 with item response theory. *Laryngoscope.* 2025;135(8):2854-2862. doi:10.1002/lary.32161

23. Raol N, Pattisapu P, Ikeda AK, Lowers J, Joe S, Shin JJ. Evidence-based medicine in otolaryngology part 17: a qualitative research primer. *Otolaryngol Head Neck Surg.* 2025;172(3):1099-1108. doi:10.1002/ohn.1120

24. Ikeda AK, Suarez-Goris D, Reich AJ, et al. Evidence-based medicine in otolaryngology part 16: qualitative and quantitative methods-contrasting and complementary approaches. *Otolaryngol Head Neck Surg.* 2025;172(3):1092-1098. doi:10.1002/ohn.469

25. Fries JF, Witter J, Rose M, Cella D, Khanna D, Morgan-DeWitt E. Item response theory, computerized adaptive testing, and PROMIS: assessment of physical function. *J Rheumatol.* 2014;41(1):153-158. doi:10.3899/jrheum.130813

26. Chenault M, Berger M, Kremer B, Anteonis L. Item response theory applied to factors affecting the patient journey towards hearing rehabilitation. *Audiol Res.* 2016;6(2):159. doi:10.4081/audiore.2016.159

27. An YY, Lee ES, Lee SA, et al. Association of hearing loss with anatomical and functional connectivity in patients with mild cognitive

impairment. *JAMA Otolaryngol Head Neck Surg.* 2023;149(7):571-578. doi:10.1001/jamaoto.2023.0824

28. Garcia Morales EE, Croll PH, Palta P, et al. Association of carotid atherosclerosis with hearing loss: a cross-sectional analysis of the atherosclerosis risk in communities study. *JAMA Otolaryngol Head Neck Surg.* 2023;149(3):223-230. doi:10.1001/jamaoto.2022.4651

29. Rosenfeld RM, Shin JJ, Schwartz SR, et al. Clinical practice guideline: otitis media with effusion executive summary (update). *Otolaryngol Head Neck Surg.* 2016;154(2):201-214. doi:10.1177/0194599815624407

30. Ikeda AK, Prince AA, Chen JX, Lieu JEC, Shin JJ. Macrolide-associated sensorineural hearing loss: a systematic review. *Laryngoscope.* 2018;128(1):228-236. doi:10.1002/lary.26799

31. Kachniarz B, Chen JX, Gilani S, Shin JJ. Diagnostic yield of MRI for pediatric hearing loss: a systematic review. *Otolaryngol Head Neck Surg.* 2015;152(1):5-22. doi:10.1177/0194599814555837

32. Shin JJ, Keamy DG Jr, Steinberg EA. Medical and surgical interventions for hearing loss associated with congenital cytomegalovirus: a systematic review. *Otolaryngol Head Neck Surg.* 2011;144(5):662-675. doi:10.1177/0194599811399241

33. Chen JX, Kachniarz B, Shin JJ. Diagnostic yield of computed tomography scan for pediatric hearing loss: a systematic review. *Otolaryngol Head Neck Surg.* 2014;151(5):718-739. doi:10.1177/0194599814545727

34. Jiang K, Spira AP, Lin FR, Deal JA, Reed NS. Hearing loss and fatigue in middle-aged and older adults. *JAMA Otolaryngol Head Neck Surg.* 2023;149(8):758-760. doi:10.1001/jamaoto.2023.1328

35. Ishai R, Halpin CF, Shin JJ, McKenna MJ, Quesnel AM. Long-term incidence and degree of sensorineural hearing loss in otosclerosis. *Otol Neurotol.* 2016;37(10):1489-1496. doi:10.1097/MAO.0000000000001234

36. Culpepper SA. the reliability and precision of total scores and IRT estimates as a function of polytomous IRT parameters and latent trait distribution. *Appl Psychol Meas.* 2013;37(3). doi:10.1177/0146621612470210

37. Huang HY. Mixture IRT Model with a higher-order structure for latent traits. *Educ Psychol Meas.* 2017;77(2):275-304. doi:10.1177/0013164416640327

38. 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. doi:10.1097/01.mlg.0000179174.32345.41

39. Ahanotu A, DeVore EK, Carroll TL, et al. Can EAT-10 become EAT-5? Improving measurement efficiency of dysphagia with item response theory. *Laryngoscope.* 2023;133(12):3327-3333. doi:10.1002/lary.30732

40. Shin JJ, Randolph GW, Rauch SD. Evidence-based medicine in otolaryngology, part 1: the multiple faces of evidence-based medicine. *Otolaryngol Head Neck Surg.* 2010;142(5):637-646. doi:10.1016/j.otohns.2010.01.018

41. Mallur P, Ikeda A, Patel A, et al. Evidence-based medicine in otolaryngology part 14: falsehood and bias. *Otolaryngol Head Neck Surg.* 2023;168(6):1584-1595. doi:10.1002/ohn.215

42. DeVore EK, Carroll TL, Shin JJ. Is a voice-specific instrument more indicative of stroboscopy results than common clinical queries? *Laryngoscope.* 2020;130(4):992-999. doi:10.1002/lary.28207

43. Roy N, Merrill RM, Thibeault S, Gray SD, Smith EM. Voice disorders in teachers and the general population: effects on work performance, attendance, and future career choices. *J Speech Lang Hear Res.* 2004;47(3):542-551. doi:10.1044/1092-4388(2004/042)

44. Isetti D, Meyer T. Workplace productivity and voice disorders: a cognitive interviewing study on presenteeism in individuals with spasmodic dysphonia. *J Voice.* 2014;28(6):700-710. doi:10.1016/j.jvoice.2014.03.017

45. Gartner-Schmidt JL, Shembel AC, Zullo TG, Rosen CA. Development and validation of the Dyspnea Index (DI): a severity index for upper airway-related dyspnea. *J Voice.* 2014;28(6):775-782. doi:10.1016/j.jvoice.2013.12.017

46. Gilani S, Quan SF, Pynnonen MA, Shin JJ. Obstructive sleep apnea and gastroesophageal reflux: a multivariate population-level analysis. *Otolaryngol Head Neck Surg.* 2016;154(2):390-395. doi:10.1177/0194599815621557

47. Kezirian EJ, Hussey HM, Brietzke SE, et al. Hypopharyngeal surgery in obstructive sleep apnea: practice patterns, perceptions, and attitudes. *Otolaryngol Head Neck Surg.* 2012;147(5):964-971. doi:10.1177/0194599812453000

48. DeVore EK, Chan WW, Shin JJ, Carroll TL. Does the Reflux Symptom Index predict increased pharyngeal events on HEMII-pH testing and correlate with general quality of life? *J Voice.* 2021;35(4):625-632. doi:10.1016/j.jvoice.2019.11.019

49. Digoy GP, Shukry M, Stoner JA. Sleep apnea in children with laryngomalacia: diagnosis via sedated endoscopy and objective outcomes after supraglottoplasty. *Otolaryngol Head Neck Surg.* 2012;147(3):544-550. doi:10.1177/0194599812446903

50. DeVore EK, Carroll TL, Rosner B, Shin JJ. Can voice disorders matter as much as life-threatening comorbidities to patients' general health? *Laryngoscope.* 2020;130(10):2405-2411. doi:10.1002/lary.28417

51. Nanjundeswaran C, Jacobson BH, Gartner-Schmidt J, Verdolini Abbott K. Vocal Fatigue Index (VFI): development and validation. *J Voice.* 2015;29(4):433-440. doi:10.1016/j.jvoice.2014.09.012

52. French CT, Irwin RS, Fletcher KE, Adams TM. Evaluation of a cough-specific quality-of-life questionnaire. *Chest.* 2002;121(4):1123-1131. doi:10.1378/chest.121.4.1123

53. Fokkens W, Reitsma S. Unified airway disease: a contemporary review and introduction. *Otolaryngol Clin North Am.* 2023;56(1):1-10. doi:10.1016/j.otc.2022.09.001

54. Wang DE, Lam DJ, Bellmunt AM, Rosenfeld RM, Ikeda AK, Shin JJ. Intranasal steroid use for otitis media with effusion: ongoing opportunities for quality improvement. *Otolaryngol Head Neck Surg.* 2017;157(2):289-296. doi:10.1177/0194599817703046

55. Roditi RE, Shin JJ. The influence of age on the relationship between allergic rhinitis and otitis

- media. *Curr Allergy Asthma Rep*. 2018;18(12):68. doi:10.1007/s11882-018-0826-2
56. Brar T, Marino MJ, Lal D. Unified airway disease: genetics and epigenetics. *Otolaryngol Clin North Am*. 2023;56(1):23-38. doi:10.1016/j.otc.2022.09.002
57. Miglani A, Brar TK, Lal D. Unified airway disease: surgical management. *Otolaryngol Clin North Am*. 2023;56(1):169-179. doi:10.1016/j.otc.2022.09.013
58. Feng AY, Kim M, Prince AA, et al. Validation of a novel allergy-specific domain for the 22-item sino-nasal outcomes test. *Otolaryngol Head Neck Surg*. 2024;170(3):937-943. doi:10.1002/ohn.605
59. Orzell S, Joseph R, Ongkasuwan J, Bedwell J, Shin J, Rao N. Outcomes of vocal fold motion impairment and dysphagia after pediatric cardiothoracic surgery: a systematic review. *Otolaryngol Head Neck Surg*. 2019;161(5):754-763. doi:10.1177/0194599819858594
60. Chandrasekhar SS, Randolph GW, Seidman MD, et al; American Academy of Otolaryngology-Head and Neck Surgery. Clinical practice guideline: improving voice outcomes after thyroid surgery. *Otolaryngol Head Neck Surg*. 2013;148(6)(suppl):S1-S37. doi:10.1177/0194599813487301
61. Silver Karcioglu A, Abdelhamid Ahmed AH, Feng Z, et al. Return of vocal fold motion and surgical preservation of invaded recurrent laryngeal nerves after the use of neoadjuvant therapy in patients presenting with advanced thyroid cancer and vocal fold paralysis: the Lazarus effect. *Thyroid*. 2023;33(10):1259-1263. doi:10.1089/thy.2023.0136
62. Liddy W, Wu CW, Dionigi G, et al. Varied recurrent laryngeal nerve course is associated with increased risk of nerve dysfunction during thyroidectomy: results of the surgical anatomy of the recurrent laryngeal nerve in thyroid surgery study, an international multicenter prospective anatomic and electrophysiologic study of 1000 monitored nerves at risk from the International Neural Monitoring Study Group. *Thyroid*. 2021;31(11):1730-1740. doi:10.1089/thy.2021.0155
63. Sinclair CF, Bumpous JM, Haugen BR, et al. Laryngeal examination in thyroid and parathyroid surgery: an American Head and Neck Society consensus statement. *Head Neck*. 2016;38(6):811-819. doi:10.1002/hed.24409
64. Balakrishnan K, Bauman N, Chun RH, et al. Standardized outcome and reporting measures in pediatric head and neck lymphatic malformations. *Otolaryngol Head Neck Surg*. 2015;152(5):948-953. doi:10.1177/0194599815577602
65. Gilani S, Pynnonen MA, Shin JJ. National practice patterns of antireflux medication for chronic rhinosinusitis. *JAMA Otolaryngol Head Neck Surg*. 2016;142(7):627-633. doi:10.1001/jamaoto.2016.0937
66. Brietzke SE, Ishman SL, Cohen S, Cyr DD, Shin JJ, Kezirian EJ. National database analysis of single-level versus multilevel sleep surgery. *Otolaryngol Head Neck Surg*. 2017;156(5):955-961. doi:10.1177/0194599817696503
67. Diercks GR, Rastatter JC, Kazahaya K, et al. Pediatric intraoperative nerve monitoring during thyroid surgery: a review from the American Head and Neck Society Endocrine Surgery Section and the International Neural Monitoring Study Group. *Head Neck*. 2022;44(6):1468-1480. doi:10.1002/hed.27010
68. Wu CW, Dionigi G, Barczynski M, et al. International neuromonitoring study group guidelines 2018: part II: optimal recurrent laryngeal nerve management for invasive thyroid cancer-incorporation of surgical, laryngeal, and neural electrophysiologic data. *Laryngoscope*. 2018;128(suppl 3):S18-S27. doi:10.1002/lary.27360
69. Shindo ML, Caruana SM, Kandil E, et al. Management of invasive well-differentiated thyroid cancer: an American Head and Neck Society consensus statement. AHSN consensus statement. *Head Neck*. 2014;36(10):1379-1390. doi:10.1002/hed.23619
70. Randolph GW, Shin JJ, Grillo HC, et al. The surgical management of goiter: Part II. Surgical treatment and results. *Laryngoscope*. 2011;121(1):68-76. doi:10.1002/lary.21091
71. Roditi RE, Veling M, Shin JJ. Age: an effect modifier of the association between allergic rhinitis and Otitis media with effusion. *Laryngoscope*. 2016;126(7):1687-1692. doi:10.1002/lary.25682
72. Willard EG, Stanlie A, Mou D, et al. Is age an effect modifier of the association between body mass index and physical function in patients with obesity? *Surg Endosc*. 2025;39(5):3079-3086. doi:10.1007/s00464-025-11659-8
73. Rojas S, Kefalianos E, Vogel A. How does our voice change as we age? A systematic review and meta-analysis of acoustic and perceptual voice data from healthy adults over 50 years of age. *J Speech Lang Hear Res*. 2020;63(2):533-551. doi:10.1044/2019_JSLHR-19-00099
74. Kim M, Li A, Prince AA, et al. Psychological status as an effect modifier of the association between allergy symptoms and allergy testing. *Otolaryngol Head Neck Surg*. 2024;171(3):894-901. doi:10.1002/ohn.846
75. Zhou AS, Prince AA, Maxfield AZ, Shin JJ. Psychological status as an effect modifier of the association between sinonasal instrument and imaging results. *Otolaryngol Head Neck Surg*. 2020;163(5):1044-1054. doi:10.1177/0194599820926129
76. Bigelow RT, Reed NS, Brewster KK, et al. Association of hearing loss with psychological distress and utilization of mental health services among adults in the United States. *JAMA Netw Open*. 2020;3(7):e2010986. doi:10.1001/jamanetworkopen.2020.10986
77. Yueh B, McDowell JA, Collins M, Souza PE, Loovis CF, Deyo RA. Development and validation of the effectiveness of [corrected] auditory rehabilitation scale. *Arch Otolaryngol Head Neck Surg*. 2005;131(10):851-856. doi:10.1001/archotol.131.10.851