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Laryngology

Adaptation and validation of the Italian Singing Voice Handicap Index-10 (SVHI-10-IT)

Adattamento e validazione in italiano del Singing Voice Handicap Index-10 (SVHI-10-IT)

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SUMMARY

Objective. The aim of this study was to adapt and validate the Italian version of the singing Voice Handicap Index-10 (SVHI-10-IT).

Methods. 99 Italian singers were enrolled in the study. All subjects underwent videolaryngostroboscopic examination and were asked to fill out the self-reported 10-item SVHI-10-IT. Laryngostroboscopic examination was pathological in 56 subjects (study group) (56.6%), while it was normal in the remaining 43 singers (control group) (43.4%). Dimensionality, test retest and internal validity for SVHI-10-IT were performed. Videolaryngostroboscopy was used as gold-standard for external validity.

Results. The items of SVHI-10-IT were uni-dimensional and Cronbach's α was 0.853 (95% CI = 0.805-0.892). High and comparable area under curve (AUC:0.93 95% CI = 0.88-0.98) values indicate a good ability of the scale to distinguish between the study and control groups. Based on balanced sensitivity (Se = 83.9%) and specificity (Sp = 86.0%), the optimal cut-off score for a singer's perceived voice handicap was 12.

Conclusions. The SVHI-10-IT is a reliable and valid instrument to evaluate the self-reported singing voice handicap among singers. It can also be used as a quick screening tool since a score higher than 12 is indicative of a problematic voice as perceived by singers.

KEY WORDS: singing, Singing Voice Handicap Index, SVHI, SVHI-10, dysphonia

RIASSUNTO

***Obiettivo**. Questo studio riporta il processo di validazione in lingua italiana del Singing Voice Handicap Index-10 (SVHI-10-IT).*

***Metodi**. 99 cantanti italiani hanno compilato il SVHI-10-IT dopo essere stati sottoposti a laringostroboscopia, utilizzata come gold-standard di validità esterna. 56 soggetti presentavano lesioni patologiche (gruppo di studio) (56,6%), mentre i restanti 43 una morfologia nei limiti (gruppo di controllo) (43,4%). Sul questionario SVHI-10-IT sono state eseguite prove di dimensionalità, test-retest e validità interna.*

***Risultati**. Le variabili del SVHI-10-IT sono risultate uni-dimensionali e l'α di Cronbach era 0.853 (CI 95% = 0,805-0,892). Valori alti e coerenti alla curva ROC (AUC = 0,93; CI 95% = 0,88-0,98) indicano l'abilità del questionario di distinguere tra soggetti patologici e normali con un valore di cut-off di 12, calcolato basandosi su livelli equilibrati di sensibilità (Se = 83,9%) e specificità (Sp = 86,0%).*

***Conclusioni**. L'SVHI-10-IT è uno strumento valido e affidabile per valutare il livello di handicap vocale auto-riferito in una popolazione di cantanti. Può essere applicato come strumento rapido di screening, utilizzando 12 come valore di cut-off indicativo di problema vocale.*

PAROLE CHIAVE: *canto, Singing Voice Handicap Index, SVHI, SVHI-10, disfonia*

Introduction

The voice is the most extraordinary tool in the human relations. It expresses

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our state of being and is the elective way for communicating emotions. In addition, the voice is one of the main elements of one's identity, even sexual, and it becomes an instrument of pleasure when listening or producing a sound. To determine how a voice pathology can alter the quality of life, a multiparametric clinical evaluation of the voice is needed, which includes perceptual, self-evaluation and instrumental analysis. There are several patient-reported outcome tools frequently used to determine the impact of voice impairment and evaluate the results of possible treatment. These include: the Voice Quality of Life questionnaire [1], the Voice Symptom Scale [2], the Voice Handicap Index (VHI) [3] and the VHI-10 [4]. The VHI and the VHI-10 are the most commonly used questionnaires for patient self-assessment. The VHI has been developed and translated into more than 20 languages to assess the perceived voice handicap and at least nine translations of the shorter version, the VHI-10, have also been published [5].
Singers constitute a particular population that pays close attention to the disturbances of singing voice [6]. For professional or non-professional singers, any small deviation in voice quality can have consequences on their quality of life, causing problems in the emotional sphere. Therefore, singers have particular demands from their voice. A specific questionnaire, the Singer Voice Handicap Index (SVHI), has been created with the aim of measuring the physical, social, emotional and economic impact of voice problems on singers' lives [7]. The SVHI is a specific tool to assess self-perceived handicap associated with singing problems and is more reliable and valid than the VHI to assess the singer's voice problems [8]. It consists of 36 items to which subjects must answer with a score between 0 and 4, with zero equal to "never" and 4 equal to "always". Statements are related to the physical, emotional and social aspects arising from a disturbed singing voice. This reliable tool has been adapted and validated for many languages, including Italian [9]. According to Cohen et al. [10], the SVHI with 36 statements [7] can be difficult to apply in all singers, especially when used for repeated measurements. For this reason, the same authors have developed and validated a shorter version of the SVHI, the Singing Voice Handicap Index-10 (SVHI-10) [10], for which other validations have been carried out [11-13]. Although the SVHI-10 subscales are described [11], in the literature there are no studies analysing in detail the factorial structure of the questionnaire to evaluate the presence or absence of subscales (Functional, Physical and Emotional). The SVHI-10 has a five-point rating scale, with zero equal to "never", 1 equal to "almost never", 2 equal to "sometimes", 3 equal to "almost always", and 4 equal to "always". The higher the score, the greater the self-perception of disability regarding a singing voice problem. The adaptation and validation in other languages of self-administered questionnaires is important not only to develop valid and reliable tools that can be used in different countries, but also to confirm universally usable reference values.
The Italian version of the SVHI-36 has proven its validity and reliability [9], but the SVHI-10 version has not yet been validated in the Italian context. Therefore, the purposes of this study were to adapt and validate the Italian version of the Singing Voice Handicap Index-10 (SVHI-10-IT) and to determine the cut-off value using videolaryngostroboscopy diagnoses as external criteria.

Materials and methods

Design and setting

This observational cross-sectional single-centre study was conducted in the ENT and Phoniatric private centre of Pisa, Italy. Singers included in the study performed different music genres (contemporary commercial music and classic) and came from a range of experience levels (singing student, amateur or professional).
A total of 99 Italian singers (known patients or new afferent ones) who were evaluated consecutively in the private ENT and Phoniatric centre were enrolled in the study. Overall, participants had a mean age of 29.8 years (sd 9.7; range 18-54 years), with demographic characteristics shown in Table I. All subjects underwent videolaryngostroboscopic examination and were asked to fill out the self-reported 10-item SVHI-10-IT. To ascertain the inter-rater reliability of videolaryngostroboscopic examination, Cohen's kappa coefficient was calculated between two observers. Laryngostroboscopic examination was pathological in 56 subjects (study group) (56/99; 56.6%), while it was normal in the remaining 43 singers (control group) (43/99; 43.4%) (Cohen's kappa 0.938; p-value = 0.001).
To confirm test-retest reliability of the SVHI-10-IT, patients were invited to complete the questionnaire for a second time, approximately 2 weeks after the first administration. Medical data were collected by review of medical care records. Absent responses were checked by the authors after receiving the questionnaire and patients were eventually asked to answer to the missing items.

SVHI-10 questionnaire

The SVHI-10 was developed and validated at the Duke University Medical Center of Carolina [10]. It provides a measure of the severity of voice handicap associated with singing voice problems. It consists of 10 items, six of which under the physical subscale, and the remaining 4 belonging to the functional (2) and emotional (2) domains, respectively. As the SVHI-10 is a self-administered tool, subjects are asked

Table I. Demographic characteristics of the study and control groups.

Parameter	Study group (n. 56)	Control group (n. 43)	P-value
Age (years)			
Mean ± SD	29.3 ± 9.4	30.4 ± 10.2	0.592*
Gender n (%)			
Female	30 (53.6%)	24 (55.8%)	0.824**
Male	26 (46.4%)	19 (44.2%)	
Singing status n (%)			
Amateur	16 (28.6%)	12 (27.9%)	0.992**
Student	25 (44.6%)	19 (44.2%)	
Professional	15 (26.8%)	12 (27.9%)	
Singing style n (%)			
Contemporary commercial music	39 (69.6%)	31 (72.1%)	0.791**
Classic music	17 (30.4%)	12 (27.9%)	

** Independent t-test; ** Chi-square.*

to rate each statement on a 5-point ordinal Likert scale from "0" to "4", with higher scores indicating a more severe voice problem-related disability. The sum of individual scores produces the overall score, ranging from 0 to 40, with higher scores representing greater levels of voice problems.

Videolaryngostroboscopic examination

Videolaryngostroboscopic examinations were performed via a rigid endoscope using the Ecleris digital stroboscope led, stroboled model (Ecleris USA, Medley, FL, USA). The examination was based on visualisation of subjects at comfortable loudness and modal phonation of the /e/ vowel sound in agreement with the criteria listed by Hirano's book on videostroboscopy [14]. Glottal closure configuration, vocal fold edge, vocal fold vibratory characteristics, and mucosal wave represented the main parameters evaluated. Laryngeal pathology and functional dysfunction (supraglottic hyperfunction) were assessed. All stroboscopic examinations were stored on a hard disk for re-evaluation at a later stage.

Statistical analysis

We analysed the Singing Voice Handicap Index-10 (SVHI-10-IT) statements collected in our study to adapt and validate the Italian version using four standard questionnaire validation steps: 1) Translation procedure of the SVHI-10-IT; 2) Test-Retest Reliability; 3) Internal validity; 4) External validity. Subsequently; 5) Principal Component Analysis (PCA) was used to explore the SVHI-10-IT factorial structure and identify the latent variables indicated by our observed variables. Finally, we performed a confirmatory factor analysis (CFA) via 6) Structural Equation Modelling (SEM) to confirm the presence of one or more latent variables. All statistical analyses were completed using Stata/SE 13.1 and SPSS Version 24. Categorical variables were expressed as percentages, and continuous variables were expressed according to their mean and standard deviation (SD).

Translation procedure of the SVHI-10-IT

The 10 items of the SVHI-10 were translated according to international guidelines [15] as follows: (1) two independent Italian translations were obtained from two independent translators who were native Italian speakers with proficiency in English. Cross-cultural adaptation was achieved during a consensus meeting. (2) The back-translation from Italian to English was carried out by a native English speaker who was not involved in developing the initial version. (3) The original and the back-translated English versions were compared to ensure that there were no differences in the meaning of the statements in the questionnaire; inconsistencies were discussed and resolved among the translators until a final version was obtained. A pilot test was performed in a small sample (n = 10) aimed at clarifying the exact wording for each item. Since the questions were correctly interpreted by all subjects, no item was modified. The average time necessary to complete the SVHI-10-IT was less than 4 minutes, and the questionnaire was well understandable and acceptable in most subjects.

Test-retest reliability

Reproducibility of the scale was estimated through a test-retest reliability in a 2-week window. The agreement between the repeated measures was examined using the intraclass correlation coefficient (ICC). An ICC < 0.40 was rated as poor agreement, values between 0.40 and 0.75 as fair to good agreement and values > 0.75 as excellent agreement [16].

Internal validity

Cronbach's alpha was used to assess internal consistency with values above 0.7 indicating desirable levels. The Cronbach's alpha cut-off were: $0.7 \leq \alpha < 0.8$, Acceptable; $0.8 \leq \alpha < 0.9$, Good; $0.9 \leq \alpha$, Excellent [23]. Additionally, to investigate the psychometric properties of the items, inter-item association and Cronbach's alpha with deleted items were also computed.

External validity

An independent sample t-test was used to assess differences in SVHI-10-IT mean scores between control and study groups. In order to determine optimal thresholds for SVHI-10 Italian version when compared to videolaryngostroboscopic diagnoses, Receiver Operator Characteristic (ROC) curve analysis was performed. To determine the best balance between sensitivity and specificity, the Youden index (Y = sensitivity+specificity-1) was chosen as the criterion for selecting cut-off values. Statistical analysis was performed using SPSS, v.24.0 (IBM Corporation, Natick, MA, USA and statistical significance was set at $p \leq 0.05$ (two-sided).

SHI-10-IT factorial structure and structural equations model analysis (SEM)

Principal Component Analysis (PCA) was performed to explore the SVHI-10-IT factorial structure and to identify the latent variables indicated by our observed variables [8,11]. To explore the SVHI-10-IT construct validity as proposed in other works, the PCA was performed to evaluate the dimensionality of 10 items into the domains of physical, functional, and emotional categories. The number of dimensions and the item loading structure of PCA with orthogonal rotation (varimax method) was conducted on the correlation matrix of the SVHI-10-IT items. Three classical criteria from PCA were used: 1) eigenvalue rule (number of factors with eigenvalues > 1); 2) Scree plot (number of factors before the break in the Scree plot); 3) factor loading rule (item–factor correlations > 0.32, suggested for behavioral phenotypes interpretation). To facilitate interpretation, the authors usually employ cut-off points in rotated factor loadings to find factor names. For instance, in epidemiology it is frequent to use a cut-off of 0.30, i.e., variables with loadings lower than this cut-off are not considered when creating the name of the factor. In this application, we used a cut-off of 0.50.

Confirmatory factor analysis (CFA) via Structural Equation Modelling (SEM)

Finally, CFA via SEM was performed to test the SVHI-10-IT factorial structure highlighted by the PCA. The CFA, which is a special case of what is known as structural equation modeling (SEM), was used to test an overall measurement model that included correlated latent variables [18]. SEM typically refers to models where causal relationships are investigated between latent variables. The CFA process determines whether the hypothesised structure provides a good fit to the data, or whether a relationship exists between the observed variables and their underlying latent, or unobserved, constructs [19]. The overall model fit was assessed using different statistics. First, chi-square analysis was used. The other indices included the Root Mean Square Error of Approximation (RMSEA) (values between 0.05 and 0.08 indicate acceptable fit, and values < 0.05 good fit), Comparative Fit Index (CFI) (values > 0.90 indicate reasonable fit, > 0.95 good fit), and Standardised Root Mean Square Residual (SRMR) (values < 0.10 indicate good fit). The measurement model was first tested to ensure that each of the observed variables was a sufficient indicator of the hypothesised latent variables. Next, the model including the hypothesised pathways was evaluated.

Sample size calculation

To determine optimal sample-size of this study, we refer to the frequently promoted N:t rule of thumb concerns the minimum recommended ratio of sample size (N) to number of items (t) of the questionnaire. Various N:t ratios were proposed in literature, the typical 10:1 ratio; 7:1 ratio; 5:1 ratio, but also the 3:1 and 2:1, was suggested [20]. In particular, SVHI has 10 items. Thus, with t = 10, we estimated a minimal sample size of 20 = 10 x 2, or N = 30 for a 3:1 ratio, or N = 50 for a 5:1 ratio, or N = 70 for a 7:1 ratio, or N = 100 for 10:1 ratio.

Results

Patients

No significant differences in age ($p = 0.592$) or gender ($p = 0.824$) were observed between the study group and controls. Singing status distribution was the same in both groups. Singing students were the majority, being 44.6% in the study group and 44.2% in the control group. Professional singers were 26.8% of participants in the study group and 27.9% in the control group. Amateur singers made up 28.6% of the study group and 27.9% of the control group. The singing style also did not differ between the two groups; most singers were under the category "contemporary commercial music" (Study group: 69.6% *vs* Control group: 72.1%; $p = 0.791$), while the others were classic music singers. Table II shows the distribution of the study group diagnoses, which included laryngopharyngeal reflux (LPR) (26.8%), vocal nodules (21.5%), submucosal oedema (19.6%), polyps (10.7%), functional dysphonia (8.9%), cysts (7.1%), corditis (3.6%) and vascular lesions (ectasia) (1.8%).

Table II. Primary diagnosis in the study group.

Primary diagnosis	%
Laryngopharyngeal reflux (LPR)	26.8
Vocal nodules	21.5
Submucosal oedema	19.6
Polyps	10.7
Functional dysphonia	8.9
Cysts	7.1
Corditis	3.6
Vascular lesion (ectasia)	1.8

Test-retest reliability and psychometric properties

Eighty-five per cent of the overall sample (study group: 45/56; control group: 39/43) completed the SVHI-10-IT at two time points. SVHI-10-IT total scores between first and second visits were used to assess the test-retest reliability, which was good with an ICC value of 0.79 (95% confidence interval (CI) = 0.67-0.87). Among the SVHI-10-IT items, the ICC varied between 0.72 and 0.87.

SVHI-10-IT Cronbach's alpha was 0.853 (95% CI = 0.805-0.892), showing good internal consistency of the questionnaire. The psychometric properties examined showed a good level for all items, as displayed in Table III. The items presenting the highest values were "I feel something is missing in my life because of my inability to sing", "I have no confidence in my singing voice" and "I have trouble making my voice do what I want it to". The item with the lowest value of total correlations was "It takes a lot of effort to sing", leading the Cronbach's alpha to increase to 0.849 with its elimination.

External validity

Independent t-test and ROC curve analysis

SVHI-10-IT mean score was 6.0 ± 4.0 among the control group and 17.0 ± 5.9 in the study group (p = 0.0001). The mean scores were not significantly different between singing style: 12.5 ± 7.9 for modern and 11.6 ± 6.6 for classic singers (p = 0.570). Different averages in the SVHI-10-IT were not observed among students (10.9 ± 6.5), amateurs (14.5 ± 6.9) and professionals (12.2 ± 9.3) (Anova p-value = 0.142). The ROC curve analysis was performed to define the cut-off point, specificity and sensitivity. The observed Youden Index (YI) for the SVHI-10-IT was equal to 0.700 and the optimal cut-off point determined was 12. The Area Under the ROC curve was 0.93.0 (95% CI = 0.88-0.98) and high sensitivity and specificity were observed (Se = 83.9%; Sp = 86.0%).

Construct validity

All the coefficients of the correlation matrix among SVHI-10-IT items were greater than 0.3, suggesting that all 10 items could be significantly taken into account. For SVHI-10-IT items, the PCA identified two Principal Components (PC) with eigenvalues > 1. The first eigenvalue was equal to 4.335

Table III. Psychometric properties: item-total correlation and Cronbach's alpha if item 1 was deleted.

	Corrected item-total correlation	Cronbach's Alpha if item 1 was deleted
Item 1. (P) It takes a lot of effort to sing *Mi occorre un notevole sforzo per cantare*	0.457	0.849
Item 2. (F) I am unsure of what will come out when I sing *Non sono sicuro/a di cosa verrà fuori quando canto*	0.508	0.843
Item 3. (P) My voice "gives out" on me while I am singing *La mia voce viene meno mentre canto*	0.518	0.843
Item 4. (E) My singing voice upsets me *La mia voce cantata mi irrita, mi agita*	0.541	0.841
Item 5. (F) I have no confidence in my singing voice *Non mi fido della mia voce cantata*	0.651	0.830
Item 6. (P) I have trouble making my voice do what I want it to *Ho problemi nel far fare alla mia voce ciò che voglio*	0.644	0.831
Item 7. (P) I have to "push it" to produce my voice when singing *Devo "spingere" per produrre la mia voce quando canto*	0.490	0.844
Item 8. (P) My singing voice tires easily *La mia voce cantata si stanca facilmente*	0.602	0.835
Item 9. (E) I feel something is missing in my life because of my inability to sing *Sento che manca qualcosa alla mia vita a causa dei miei problemi nel canto*	0.654	0.829
Item 10. (P) I am unable to use my "high voice" *Sono incapace di utilizzare i toni acuti*	0.521	0.842

Table IV. Factor loadings coefficients: the contribution of each observed variables considered as predictor, to define the components.

Rotated component matrix	Component	
	Physical	Emotional-functional
Item 1. (P) It takes a lot of effort to sing	0.670	0.070
Item 2. (F) I am unsure of what will come out when I sing	0.110	0.758
Item 3. (P) My voice "gives out" on me while I am singing	0.691	0.175
Item 4. (E) My singing voice upsets me	0.096	0.821
Item 5. (F) I have no confidence in my singing voice	0.184	0.871
Item 6. (P) I have trouble making my voice do what I want it to	0.568	0.477
Item 7. (P) I have to "push it" to produce my voice when singing	0.701	0.140
Item 8. (P) My singing voice tires easily	0.846	0.138
Item 9. (E) I feel something is missing in my life because of my inability to sing	0.364	0.696
Item 10. (P) I am unable to use my "high voice"	0.646	0.230

and the second equal to 1.573, which explained for 59.10% (first eigenvalue 43.34% + second eigenvalue 15.73%) of the observed total variance; the Scree plot pointed out two PCs. Thus, rotation was performed, and dimensionality of the SVHI-10-IT was explored. Applying a factor loading cut-off of |0.50| to simplify the interpretation of the factor structure, we observed two factors (Tab. IV). The first factor, labeled the "Physical Component", was strongly influenced by the following statements: item 1: (P) It takes a lot of effort to sing; item 3:(P) My voice ''gives out'' on me while I am singing; item 10: (P) I am unable to use my ''high voice''; item 6: (P) I have trouble making my voice do what I want it to; item 7: (P) I have to ''push it'' to produce my voice when singing; item 8: (P) My singing voice tires easily. Cronbach's alpha for the "Physical Component" was 0.812 (CI 95% = 0.748-0.864). The second factor, labeled the "Emotional-Functional Component", was strongly influenced by the statements: item 4: (E) My singing voice upsets me; item 5: (F) I have no confidence in my singing voice; item 2: (F) I am unsure of what will come out when I sing; item 9: (E) I feel something is missing in my life because of my inability to sing. The Cronbach's alpha for the "Emotional-Functional Component" was 0.832 (CI 95% = 0.770-0.880).

Confirmatory factor analysis via structural equation modelling

SEM was performed to confirm the latent variable highlighted in the PCA and, as described in Table V, the two SVHI-10-IT components (Physical and Emotional-Functional) provided an acceptable explanation for their corresponding observed variables, since all the coefficients were above 0.400 [21]. Standardised regression coefficients, reported in Table V, explain the contribution of each of the observed variables considered as predictor, to define the components. Thus, for the Physical component, the most important predictors were SVHI-10-IT Item 6 ("I have trouble making my voice do what I want it to") ($\beta = 0.805$, SE = 0.057, $p < 0.0001$), and SVHI-10-IT Item 8 ("My singing voice tires easily") ($\beta = 0.728$, SE = 0.061, $p < 0.0001$). The annoyance the singer feels when he/she hears his/her own voice (SVHI-10-IT Item 4: $\beta = 0.734$, SE = 0.055, $p < 0.0001$) and the insecurity of what will come out when he/she sings (SVHI-10-IT Item 2: $\beta = 0.863$, SE = 0.043, $p < 0.0001$) were the most important predictors in the Emotional-Functional component.

The standardised paths of SVHI-10-IT factorial structure highlighted via Structural Equation Modelling (SEM) from the two components to their respective variables were specified in Figure 1. The Structural Model Fit indices suggested that the proposed model fits the data ($\chi 2 = 34.78$ [df = 28, $p = 0.176$], RMSEA = 0.049, SRMR was 0.050 and CFI = 0.982). The indices for the proposed model showed that the measurement model fits adequately [21] and all standardised paths were significant (Fig. 1). Finally, the "Physical" and "Emotional-Functional" components were positively associated ($\beta = 0.656$, SE = 0.078, $p < 0.0001$).

Discussion

Singers represent a special population with high risk for developing and perceiving alterations of voice compared to non-singing subjects [6]. Within this framework, to better understand the manifold problems of the singing voice, a specific questionnaire, the SVHI, was created with the aim of measuring the physical, social, emotional and economic impact of voice problems on singers' lives [7]. This reliable tool has been adapted and validated for many languages, including Italian [9]. Due to the fact that the SVHI can be difficult to apply to all singers, Cohen et al. developed and validated a shorter version of the SVHI, the SVHI-10 [10]

Table V. Standardised regression coefficient for the Structural Model.

SVHI-10 component	SVHI-10, observed variables	Standardised regression coefficient	Standard error	P > z	Standardised regression coefficient (95% CI)
Physical	**Item 1**. (P) It takes a lot of effort to sing	0.439	0.094	0.0001	0.253-0.625
	Item 3. (P) My voice "gives out" on me while I am singing	0.652	0.088	0.0001	0.479-0.825
	Item 6. (P) I have trouble making my voice do what I want it to	0.805	0.057	0.0001	0.691-0.919
	Item 7. (P) I have to "push it" to produce my voice when singing	0.554	0.078	0.0001	0.400-0.707
	Item 8. (P) My singing voice tires easily	0.728	0.061	0.0001	0.608-0.849
	Item 10. (P) I am unable to use my "high voice"	0.644	0.072	0.0001	0.502-0.786
Emotional-functional	**Item 2.** (F) I am unsure of what will come out when I sing	0.863	0.043	0.0001	0.777-0.950
	Item 4. (E) My singing voice upsets me	0.734	0.055	0.0001	0.625-0.842
	Item 5. (F) I have no confidence in my singing voice	0.715	0.058	0.0001	0.560-0.830
	Item 9. (E) I feel something is missing in my life because of my inability to sing	0.643	0.068	0.0001	0.509-0.777

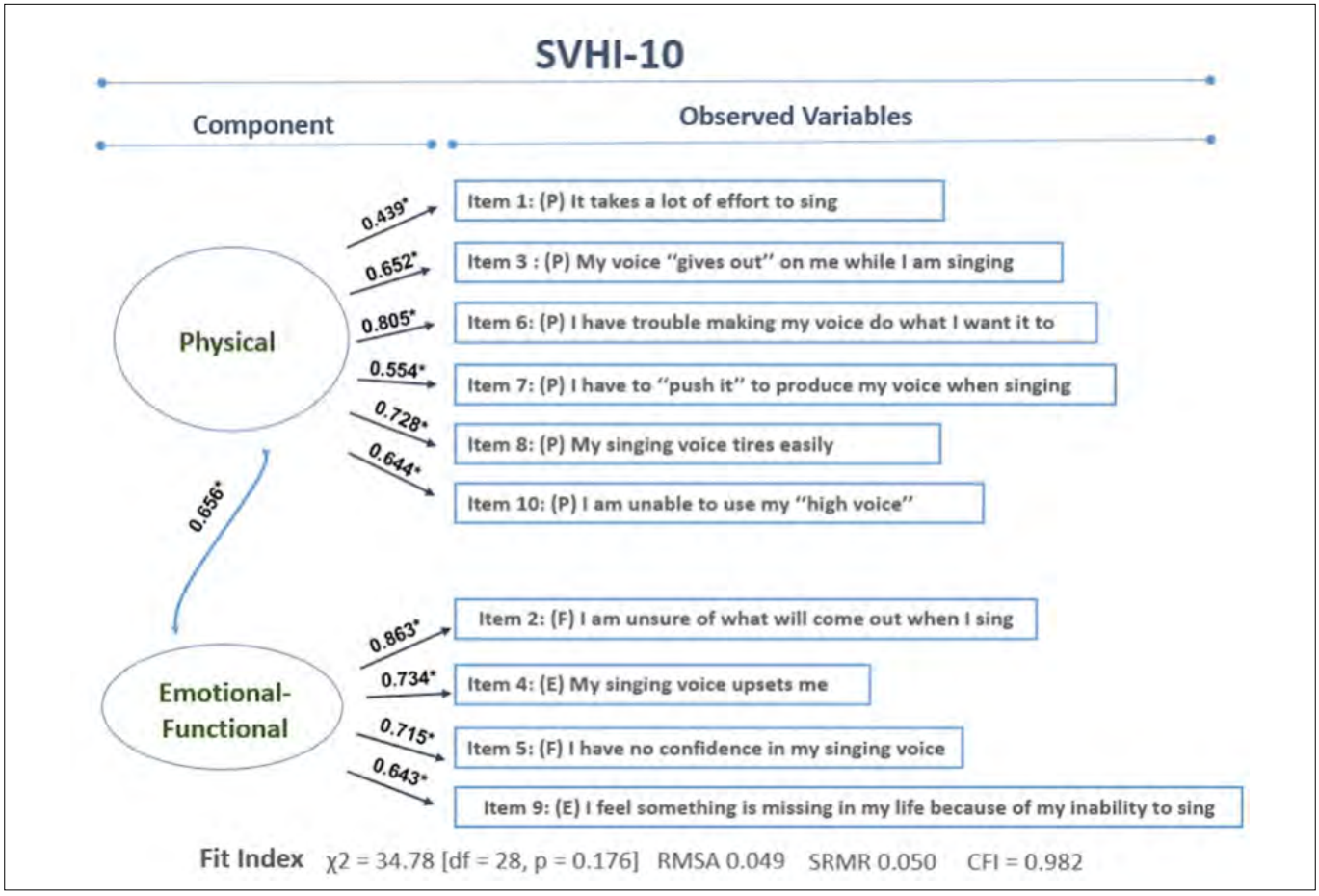

Figure 1. The Structural Model; χ^2: Chi-square; RMSEA: Root Mean Square Error of Approximation; SRMR: Standardised Root Mean Square Residual; CFI: Comparative Fit Index.

which, however, has not been validated in the Italian context. Therefore, the aims of this study were to adapt and validate the Italian version of SVHI-10 (SVHI-10-IT) and to determine its psychometric properties when translated.
In fact, in singers, whether students, professionals, or amateurs, each small variation in singing voice can determine a deviation in their quality of life, with important consequences from emotional and functional points of view. In case of a voice alteration as a consequence of both organic and functional disturbances, there might be alterations in the emotional and functional sphere that can further worsen both the quality of life and self-perception of the problem. Thus, a vicious circle between physical, functional and emotional spheres may have detrimental effects on a singer's ability to withstand the problem, which can hardly be solved if not correctly diagnosed in the various components. Therefore, as singers have specific needs from their voice, their evaluation concerning voice complaints requires a multiparametric approach. This approach should include patient-reported outcomes, along with clinician-based perceptual evaluations and instrumental analyses [22].
According to our results, construct validity was tested using reliability analysis and was confirmed by good Cronbach's alpha index (0.853), test-retest coefficient and significant association between total score (ICC: 0.79) and for each item (ranged from 0.72 to 0.87). This finding is comparable with the original version of SVHI-10 [10] and with other SVHI-10 validation studies [11,13,23]. Cohen and Rangarajan reported an excellent Cronbach's alpha above 0.930 and in the Kannada and Turkish validation the reliability index was equal to 0.91. All the item-total correlation coefficients were found to be higher than 0.45 and Cronbach's alpha coefficients obtained when any item was deleted demonstrated that all the items are consistent with the questionnaire. A ROC curve analysis was performed to determine the sensitivity and specificity of the index. The AUC, which was equal to 0.93, demonstrated the high accuracy for the system [24]. In our results, high sensitivity and specificity values (Se = 0.839; Sp = 0.860) indicated that the SVHI-10-IT owns a good capability of reflecting the singers' self-perceived handicaps. With respect to videolaryngostroboscopic diagnoses, our cut-off point was 12, which was equal to the Turkish validation, but higher than that obtained in the Kannada validity study [12,13] and compared to the results of a recent Systematic Review and Meta-Analysis [25]. As such, PCA was conducted to determine construct validity and to answer the question: is SVHI-10-IT one-dimensional or does it have different underlying dimensions? Construct validity analysis performed by PCA showed that SVHI-10-IT items were two-component: the first dimension refers to Physical aspects, while the second includes Emotional and Functional aspects. To the best of our knowledge, this is the first study that explores, through Principal Component Analysis (PCA) and Structural Equation Model (SEM), the best indicators for voice handicap in singers, considering both the involvement of each VHI-10 variable of the different components affecting singers' voices (Physical, Emotional and Functional) and the relationship between the two components. Our study showed that the SVHI-10-IT lists six statements related to voice physical aspects, with the remaining four being related to emotional and functional needs. In research conducted in the USA, aiming to compare the differences in the scores between VHI-10 and SVHI-10 in professional singers and students, Renk and colleagues categorised the SVHI-10 items into the broad categories of Physical (P: items 1, 3, 6, 7, 8, 10), Functional (F: items 2, 5), and Emotional (E: 4, 9) [8]. Nevertheless, in the same study, after comparing the items means, it was reported that SVHI-10 seems to have only two statements related to function with the remaining eight being related to emotional and physical needs. However, to confirm the results of our study also from a clinical point of view, the items that investigate the functional component (Items 5 and 2: "I have no confidence in my singing voice" and "I am unsure of what will come out when I sing") appear closely related to those investigating the emotional component (Items 4 and 9: "My singing voice upsets me" and "I feel something is missing in my life because of my inability to sing"). On the contrary, the items investigating the physical component (Items 1, 3, 6, 7, 8,10) seem to mainly investigate the problem of the voice resulting from a disorder of the phono-articulatory system. In the final analysis, as shown by our results, the physical component also correlated with the emotional/functional one (Fig. 1).
Our study has some limitations, the sample size in this research being not extremely large and the results referring to subjects enrolled in a single centre. A multicentre investigation would improve future studies by providing larger samples with more generalisable findings.

Conclusions

Our results suggest that the SVHI-10-IT is a reliable and valid tool for evaluating the self-reported singing voice handicap among singers. A SVHI-10-IT score of 12 can be used as the indicative cut-off point of a perceived problematic voice in singers. Furthermore, the SVHI-10-IT factorial structure was explored and the two dimensions describing Physical and Emotional/Functional aspects were described. Future studies are needed to confirm the factorial structure and validate the subscales of the SVHI-10.

Conflict of interest statement

The authors declare no conflict of interest.

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Author contributions
AN, LB, MRB, SB: designed the study, interpreted the study results, and wrote the article; AN: directed study implementation including quality assurance and control; AN, MRB, BF, SC, LB: interpreted the study results and wrote the article; AT: prepared data for statistical analysis; LB: performed statistical analysis; AN: supervised field activities. All authors critically reviewed the article for important intellectual content and approved the final manuscript.

Ethical consideration
The study is observational cross-sectional single-center study and conducted in a private center. We enrolled both known patients and new afferent patients to the ENT and Phoniatric private Center of Pisa. According to General Data Protection Regulation (GDPR) the written statement were signed by each subject. All subjects read the purpose of the study and agreed to answer the ten questions of the proposed questionnaire (Singing Voice Handicap Index-10). Although this study is registered as European Union electronic Register of Post-Authorisation Studies (EU PAS) 41469, we do not have documentation submitted to the ethics committee. As a private center, each patient has viewed and signed the document concerning Information about the processing of personal data of patients (Directive 95/46/EC - GDPR), which also includes the use of data for scientific research purposes. Ethical approval was not required for this study in accordance with local guidelines.

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