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AUDIOLOGY

Gender-related differences in the prevalence of voice disorders and awareness of dysphonia

Differenze correlate al sesso nella prevalenza delle patologie della voce e nella consapevolezza della disfonia

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SUMMARY

Objective. Considering the impact of dysphonia on public health and the increasing attention to patient-centred care, we evaluated sex-related differences in the prevalence of benign voice disorders, awareness of dysphonia and voice therapy (VT) results.

Methods. One hundred and seventy-one patients, 129 females and 42 males, with functional or organic benign dysphonia underwent Voice Handicap Index (VHI), auditory-perceptual dysphonia severity scoring (GRBAS) and acoustic analysis (Jitter%, Shimmer%, NHR) before and after VT.

Results. Prevalence of each voice disorder was significantly higher among females. Mean time-to-diagnosis (time elapsed until medical consultation) was not different between males and females. The refusal of therapy and VT adherence (mean number of absences and premature dropout) were similar in the two groups. Pre-VT VHI and "G" parameter were worse in women. The percentage of women with abnormal acoustic analysis was significantly higher. Post-VT VHI gain was higher in women, whereas "G" parameter improvement did not differ by sex.

Conclusions. Our study showed a higher prevalence of voice disorders in females. Awareness of dysphonia was not gender related. Females started with worse voice subjective perception and acoustic analysis, but they perceived greater improvement after therapy.

KEY WORDS: dysphonia, voice therapy, gender, Voice Handicap Index, acoustic analysis

RIASSUNTO

Obiettivo. *Valutare le differenze legate al sesso nella prevalenza dei disturbi benigni della voce, nella consapevolezza della disfonia e nei risultati della terapia vocale (TV).*

Metodi. *171 pazienti, 129 F e 42 M, con disfonia benigna, funzionale o organica, sono stati sottoposti a: Voice Handicap Index (VHI), valutazione uditivo-percettiva di gravità della disfonia (GRBAS) e analisi acustica (Jitter%, Shimmer%, NHR) prima e dopo TV.*

Risultati. *La prevalenza di ciascun disturbo della voce era significativamente più alta nelle donne. Il tempo atteso per il consulto medico non era diverso tra F e M. Il rifiuto della terapia, il numero medio di assenze e l'abbandono prematuro erano simili nei due gruppi. Il VHI e il parametro "G" pre-TV erano peggiori nel gruppo F. La percentuale di donne con analisi acustica anormale era significativamente più alta. Il guadagno di VHI post-TV era maggiore nelle donne, mentre il miglioramento del parametro "G" non differiva in base al sesso.*

Conclusioni. *Il nostro studio ha mostrato una maggiore prevalenza di disturbi della voce nelle donne. La consapevolezza della disfonia non era correlata al genere. Le donne presentavano una percezione soggettiva della voce e un'analisi acustica peggiori, ma percepivano un miglioramento maggiore dopo la terapia.*

PAROLE CHIAVE: *disfonia, terapia vocale, genere, Indice di handicap vocale, analisi acustica*

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Introduction

Excluding the well-known epidemiological discrepancy in the distribution of oncological pathologies (*e.g.,* greater male predisposition to laryngeal cancer) supported by habits such as smoking and alcohol which are more common in males, little attention is paid to sex-related differences in the management and treatment of voice diseases [1].

Some anatomical and physiological differences of the phonatory system between the two sexes are widely known, such as the different distribution of hyaluronic acid in the vocal folds which in women is not homogeneous, exposing them more easily to vocal trauma [2]. Similarly, a difference in collagen has been documented in adults, with higher levels in men [3]. Gender differences were also found in phonatory physiology in terms of subglottic pressure (greater in women) and resistance capacity of the membranous vocal fold to phonotrauma (greater in males) [4]. The aging process also seems to have a different impact on the larynx of men and women [5], with a progressive thinning of the vocal fold mucosa and the superficial layer of the lamina propria, an increase in fundamental frequency, a reduction in vocal fold contact in men and an opposite trend in women.

The gender differences observed in the measurement of some acoustic parameters, such as Jitter% (more altered in men), Soft Phonation Index (more altered in women), fundamental frequency (naturally more acute in women), pitch and number of vibratory cycles (higher in women), has led some authors to underline the need to develop different protocols for objective assessment of the voice based on gender [6].

It is known that women are more likely to develop a voice disorder than men [7]. Women naturally experience several periods of hormonal imbalance throughout their lifetime that may be related to a higher prevalence of muscle tension dysphonia [8]. Receptors for sex hormones have been found on vocal folds, suggesting a link between hormone levels and vocal fold function, which might cause changes in voice production [9]. Banai [10] showed that voices of naturally cycling women had higher minimum pitch in the late follicular phase compared with the other phases. In addition, voice intensity was at its lowest in the luteal phase.

Psychosocial and socioeconomic characteristics, personality and behavioural traits, as well as spoiled habits, affect voice production. Personality traits and temperament in women, more than in men, can influence the development of vocal pathologies [11]. However, a causal relationship between personality and vocal pathology has not yet been shown. Furthermore, for women, a certainly higher impact of dysphonia on the quality of life has been demonstrated [12]. Pharyngeal globus is the symptom that most frequently leads men to undergo specialist examination for dysphonia, while women often present for alterations of the quality of the voice, breath, or cough [11].

Studies on dysphonia consider sex as a risk factor for the development of the disease from a purely epidemiological point of view. To date, there are no studies evaluating the role of gender in the diagnostic or treatment phase of dysphonia.

Considering the perspective to apply personalised medicine and the increasing attention given to gender-specific medicine as a milestone in the progress of patient-centred care, the purpose of this work is to describe sex-related differences in the prevalence of unilateral vocal fold paralysis (UVFP), benign vocal folds lesions and functional dysphonia, patients' awareness of dysphonia, voice quality and outcomes using a multidimensional (subjective, auditory perceptual and acoustic) voice assessment before and after voice therapy (VT).

Materials and methods

We retrospectively collected data on patients affected from dysphonia who referred to the Phoniatric Unit of the "A. Gemelli" IRCCS University Hospital Foundation of Rome. We excluded patients with diagnosis of psychogenic dysphonia or previous laryngeal surgery. Patients with a history of psychiatric disorders, depression and use of antidepressant medication, patients affected by neurological disorders other than unilateral vocal fold paralysis, especially neurodegenerative disease as Alzheimer's and Parkinson's disease, were also excluded. The study sample was selected according to the following criteria: age between 18 and 65 years; diagnosis of functional dysphonia (as voice disturbance that occurs in the absence of structural or neurologic laryngeal pathological characteristics) or organic dysphonia caused by iatrogenic unilateral vocal fold paralysis or benign vocal fold lesions as Reinke's oedema, polyp, cyst, or nodules; prescription of voice therapy (VT) as only treatment.

Patients underwent a complete multidimensional (subjective, auditory perceptual and acoustic) assessment of voice. This latter included:

a) the Italian version of Voice Handicap Index (VHI) [13] to evaluate patient's subjective perception of the impact of the dysphonia on the quality of life. It is a questionnaire composed of 30 items equally divided between functional, physical and emotional domains, that analyses the biopsychosocial impact of voice problems. Each question has 5 quantifiable answers (0-4); the final total score (0-120) defines the degree of subjective perception of the voice disorder. VHI was administered before and after VT;

b) auditory perceptual evaluation of voice quality carried out by a single rater (an expert otolaryngologist (DL) with more than 10 years of experience in the diagnosis and treatment of voice disorders), blind to the diagnosis, using the Grade-Roughness-Breathiness-Asthenia-Strain (GRBAS) scale on recorded voice samples. Voice recordings were directly stored in the host computer using the Computerized Speech Lab (CSL) Model 4500 (Kay Elemetrics, Lincoln Park, NJ). All recordings were made in a quiet room (environmental noise < 30 dB SPL). Voice samples consisted of reading the first three sentences (53 words, 107 syllables) of the passage "Il deserto" (DCA n. U00226, 5 June 2018) at a conversation loudness level and comfortable pitch. For perceptual assessment only the "G" parameter of the GRBAS scale was rated since it reflects the severity of dysphonia integrating all deviant components. The R, B, A and S parameters were not rated because of the wide variability of voice features between the subjects included in the study. The "G" parameter was measured in each patient before and after VT;

c) acoustic analysis routinely carried out with the Multidimensional Voice Program (MDVP) (model 5105) (Kay Elemetrics, Lincoln Park, NJ). We considered jitter percentage (Jitt%), shimmer percentage (Shim%) and noise to harmonics ratio (NHR). Our normal values were obtained from 100 adult subjects (50 females, 50 males), euphonic, without any previous vocal pathology, aged between 18 and 70 years. In this normative voice parameters vary little according to gender (Tab. I).

The acoustic parameters were evaluated before and after VT on the sustained vowel /a/ produced at a comfortable pitch and loudness level for at least four seconds.

The enrolled subjects were divided in group M (males) and group F (females). For all the cases and for each group we analysed: the prevalence of each voice disorder; patients' awareness of dysphonia by calculating both "time-to-diagnosis" (the time interval between the onset of symptoms and the first medical consultation) and the "VT adherence" (percentage of refusal of VT, mean number of absences to the therapy sessions and premature therapy dropout); mean VHI and "G" parameter improvement after therapy; the number of subjects with abnormal values of the selected acoustic parameters before and after VT.

Moreover, all cases and each group were divided according to diagnosis into "Unilateral Vocal Fold Paralysis" (UVFP), "Organic Dysphonia" (benign vocal fold lesions as Reinke's oedema, polyp, cyst or nodules) and "Functional Dysphonia". For each type of vocal disorder, data were compared and any differences between group M and group F were analysed.

The data were collected and managed anonymously, and statistical analysis was performed with the Excel program (Microsoft Corporation, Redmond, Washington, USA). Continuously distributed data were summarised as mean and categorical variables by absolute frequency and percentages. Differences between the two groups were analysed with Student's test for continuous and normally distributed variables and with Mann-Whitney's test and Fisher's exact test for categorical variables. For all tests the significance level was set at $p < 0.05$.

Table I. Normative values of voice parameter for adults (m/f = male/female).

Voice parameter	Normal values
Jitter (M ± SD) m/f	0.58 ± 0.65/0.63 ± 0.62
Shimmer (M ± SD) m/f	3.52 ± 0.60/2.99 ± 0.54
NHR (M ± SD) m/f	0.12 ± 0.05/0.11 ± 0.12

NHR: noise to harmonics ratio.

Results

One hundred and seventy-one of 212 (85.5%) cases were eligible for our study. Forty-one patients were excluded from the analysis due to lack of information in medical records. The females (group F) were 129/171 (75.44%) with a mean age of 48 years (range 28-80); the males (group M) were 42/171 (24.56%) with a mean age of 54 years (range 18-79). For each type of dysphonia, the percentage of females was significantly higher ($p < 0.05$) confirming the higher prevalence of voice disorders in female gender (Fig. 1). As reported in Figure 1, the prevalence of each voice disorder was not significantly different between the two groups ($p > 0.05$). Within each group (M/F), the preva-

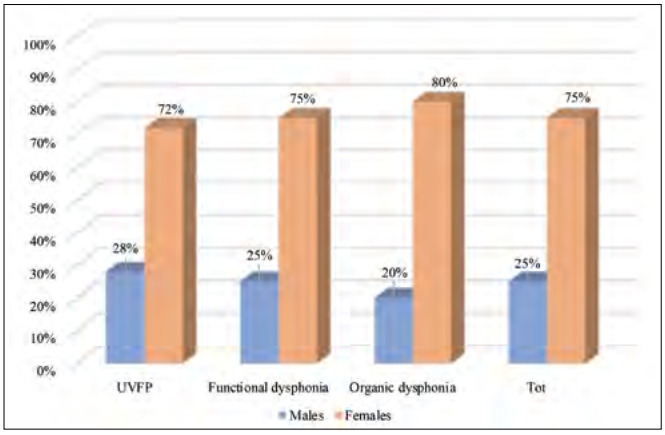

Figure 1. Percentage of males and females by each voice disorder. UVFP: Unilateral Vocal Fold Paralysis; Tot: Total.

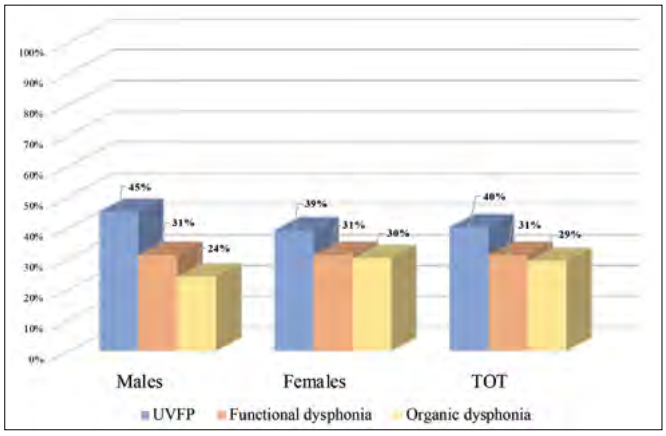

Figure 2. Percentage of unilateral vocal fold paralysis, functional dysphonia and organic dysphonia by male and female.
UVFP: Unilateral Vocal Fold Paralysis; Tot: Total.

lence of UVFP, functional dysphonia and the organic ones did not significantly differ ($p > 0.05$). In both groups the most frequent diagnosis was the UVFP, followed by functional dysphonia and organic dysphonia (Fig. 2).

Awareness of dysphonia

The time-to-diagnosis was a mean of 23.6 (range 1-120) months, 22.7 months in the group M *vs* 23.9 months in the group F ($p > 0.05$). Eighty of 129 (62.01%) females and 29/42 (69.04%) males consented to undergo VT ($p > 0.05$). A total of 62/171 (36.25%) cases refused, 49/129 (37.98%) F *vs* 13/42 (30.95%) M ($p > 0.05$). The mean number of therapy sessions was 6.1 (range 4-12) in group M and 6.1 (range 4-8) in group F ($p > 0.05$). The number of patients who dropped out therapy (15/80 -18.75% F *vs* 8/29 - 27.58% M) and the mean number of absences to therapy sessions (1.3 F *vs* 1.5 M) did not significantly differ between the two groups ($p > 0.05$).

Pre-VT subjective, perceptual and acoustic assessment

The mean VHI total score and the mean partial scores of each domain were significantly higher in the group F ($p < 0.05$) (Tab. II), especially for the emotional one (11.6 *vs* 7.1). Comparing VHI results basing on the aetiology of dysphonia, a significant difference between groups was found for UVFP and organic voice disorders. Table III shows auditory perceptual results in each group of subjects. The "G" parameter of GRBAS score was significantly worse in group F (2.1 *vs* 1.5) ($p < 0.05$). The greatest difference between groups was found in subjects affected by organic dysphonia (2.2 F *vs* 1.3 M) ($p < 0.05$). Moreover, the percentages of patients with abnormal Jitter% and NHR values in group F were significantly higher than in group M (Tab. IV).

Table II. Mean pre-therapy and post-therapy VHI scores in each group of subjects and percentage of improvement.

	VHI score					
	Pre-VT		Post-VT		Gain	
Type of dysphonia (N)	**M**	**F**	**M**	**F**	**M**	**F**
			Functional score			
UVFP (N 69)	14.2	19.2*	10.7	5.6	3.5	13.6*
Functional dysphonia (N 53)	6.9	10.5*	7	7.8	-0.1	2.7
Organic dysphonia (N 49)	6.3	11.2*	5.8	9.2	0.5	2
Total (N 171)	**10.1**	**14.1***	**8.3**	**6.9**	**1.8**	**7.2**
			Emotional score			
UVFP (N 69)	7.1	14.4*	4.3	5.8	2.8	8.6
Functional dysphonia (N 53)	8.3	11.3	5.2	5.3	3.1	6
Organic dysphonia (N 49)	5.4	8.2	4.5	5.5	0.9	2.7
Total (N 171)	**7.1**	**11.6***	**4.6**	**5.7**	**2.5**	**5.9**
			Physical score			
UVFP (N 69)	20.5	25.4*	18.5*	9.9	2	15.5*
Functional dysphonia (N 53)	19.5	19.7	9.5	12.2	10	7.5
Organic dysphonia (N 49)	13.9	21.2*	14	16.9	-0.1	4.3
Total (N 171)	**18.6**	**22.3***	**15**	**12.1**	**3.6**	**10.2***
			TOTAL score			
UVFP (N 69)	41.9	59.0*	33.6	21.4	8.3	37.6*
Functional dysphonia (N 53)	34.8	41.6	21.8	25.3	13	16.3
Organic dysphonia (N 49)	25.6	40.7*	24.3	31.7	1.3	9*
Total (N 171)	**35.8**	**47.9***	**27.9**	**24.7**	**7.9**	**23.2***

*VHI: Voice Handicap Index; VT: Voice Therapy; UVFP: Unilateral Vocal Fold Paralysis; * males vs females: $p < 0.05$.*

Post-VT subjective, perceptual and acoustic assessment

The post-VT VHI total score of group M did not differ compared to the one of group F (Tab. II). Moreover, the post-VT VHI score of each group did not differ based on diagnosis except for the UVFP. Males affected by UVFP scored significantly higher than females in the VHI physical domain (18.5 *vs* 9.9) ($p < 0.05$) (Tab. II).

Table III. Auditory-perceptual results. The mean scores of the "G" parameter of GRBAS scale obtained before and after voice therapy (VT) in each group and the gain score.

	Score of "G" parameter of GRBAS scale					
	Pre-VT		Post-VT		Gain	
Type of dysphonia (N)	**M**	**F**	**M**	**F**	**M**	**F**
UVFP (N 69)	2.0	2.3	1.3	1.4	0.7	0.9
Functional dysphonia (N 53)	1.8	1.9	1.1	1.2	0.8	0.7
Organic dysphonia (N 49)	1.3	2.2*	0.4	1.5	0.9	0.7
Total (N 171)	**1.5**	**2.1***	**0.8**	**1.4**	**0.7**	**0.7**

*UVFP: Unilateral Vocal Fold Paralysis; *males vs females p < 0.05.*

As shown in Table II, the mean total and sub-total VHI scores decreased after VT in both groups, especially for the physical domain. The mean total VHI gain was significantly higher in group F (23.2 *vs* 7.9) ($p < 0.05$) demonstrating a major improvement of subjective perception of the quality of voice in women than in men after VT. The improvement of Physical score was significantly higher in group F (10.2 *vs* 3.6) ($p < 0.05$). Post-therapy "G" parameter of the GRBAS scale score did not differ between males and females (Tab. III). The results of acoustic analysis are shown in Table IV.

Discussion

The importance of epidemiologic studies on treatment-seeking population with dysphonia to understand its impact, evaluation and management is known. Thanks to these studies, in fact, we know that functional disorders represent the most common cause of voice disorders (except in childhood) and that "voice professionals" (actors, singers, voice actors, teachers, etc.) represent almost half of the dysphonic population with a higher prevalence of organic dysphonia [14,15]. Other frequently detected pathologies are vocal

Table IV. Number and percentage of the cases with abnormal values of the acoustic parameters for each group Pre- and Post-Voice Therapy (VT).

	Pre-VT		Post-VT	
Type of dysphonia (N)	**Males**	**Females**	**Males**	**Females**
		Jitter%		
UVFP (N 69)	10/12 (52.6%)	46/50 (92%)*	2/9 (22.2%)	4/34 (11.76%)
Functional dysphonia (N 53)	6/13 (46.2%)*	3/40 (7.5%)	1/5 (20%)	0/11 (0%)
Organic dysphonia (N 49)	0/10 (0%)	20/39 (51.3%)*	0/7 (0%)	5/20 (25%)
Total (N 171)	**16/42 (38.1%)**	**69/129 (53.5%)***	**3/21 (14.3%)**	**9/65 (13.8%)**
		Shimmer%		
UVFP (N 69)	19/19 (100%)	47/50 (94%)	2/9 (22.2%)	6/34 (17.6%)
Functional dysphonia (N 53)	13/13 (100%)*	20/40 (50%)	1/5 (20%)	0/11 (0%)
Organic dysphonia (N 49)	10/10 (100%)*	21/39 (53.8%)	4/7 (57.14%)	10/20 (50%)
Total (N 171)	**42/42 (100%)***	**88/129 (68.2%)**	**8/2 (38.0%)**	**16/65 (24,6%)**
		NHR		
UVFP (N 69)	0/19 (0%)	11/50 (22%)*	0/9 (0%)	0/34 (0%)
Functional dysphonia (N 53)	0/13 (0%)	7/40 (17.5%)	0/5 (0%)	0/11 (0%)
Organic dysphonia (N 49)	0/10 (0%)	4/39 (10.3%)	0/7 (0%)	0/20 (0%)
Total (N 171)	**0/42 (0%)**	**22/129 (17.1%)***	**0/21 (0%)**	**0/6 (0%)**

*UVFP: Unilateral Vocal Fold Paralysis; *males vs females: p < 0.05.*

fold nodules, pharyngolaryngeal reflux dysphonia [15], vocal fold paralysis and vocal fold oedema. Furthermore, some Authors report that in the dysphonic population there are more females than males and that children and adolescents represent a minority of the sample [14,16].

In agreement with these data, our dysphonic population was mainly female. Moreover, females had a higher prevalence of all-cause dysphonia probably because, as is known, they use more healthcare resources than males. Nevertheless, the distribution of a dysphonia diagnosis did not differ between the two genders and reflected that in the general population [16].

The literature reports few papers about the sex-related differences of the time between the onset of symptoms and initiation of therapy in cancer patients [17], but no study to date has examined the time-to-diagnosis of benign voice disorders. As such, the current study specifically focused on the time lag to diagnosis basing on the sex/gender related differences. Most research has described disparities about the timely recognition of symptoms by patients. The onset of symptoms may not only be different among men and women, but acknowledgment and validation of symptoms by healthcare providers may be susceptible to sex-based differences. One study noted that when physicians review cases in which patients present significant symptoms, as well as a recent emotionally upsetting event, they are much more likely to consider a man's symptoms as disease-related and that of a woman due to an "emotional upset" [18]. Interestingly, in the current study we demonstrated that women were not different in the time-to-diagnosis compared to men. On the other hand, women came to the diagnosis with a subjectively, auditory-perceptually and acoustically significantly poorer quality of voice than men. Therefore, considering both results, it would seem that males may be more sensitive to voice changes or that females have a "wait-and-see" approach; however, the impact of voice disorders on the quality of life is worse in females. In this regard, we assume that the association of two factors may explain the difference: if on one hand the well-known high male to female ratio of laryngeal cancer may alert the subject themself or the general practitioner, on the other the opposite ratio of the functional dysphonia and benign lesions [1] may delay the diagnosis in women. On the other hand, women in our society are generally expected to occupy a nurturant role, both performing daily essential household tasks and taking on the major responsibility for the care of children, spouses and aged relatives [19]. Therefore, as a consequence of social obligations towards others and the corresponding demands of others, women are often unable to successfully assume the role of "sick", thus ending up neglecting their health and lengthening the time-to-diagnosis despite perceptually more severe symptoms. Females demonstrate a higher emotional impact of dysphonia, especially in unilateral recurrent nerve laryngeal palsy diagnosis and organic voice disorders, probably because of women being more willing to admit psychological distress.

The literature has assessed sex variability in treatment adherence; Rangabashyam et al. [20] found that gender was an independent factor for the nonadherence to the head and neck tumour board recommendations. A systematic study on voice therapy adherence and influencing factors was first outlined by Van Leer et al. [21]. Age, distance to the clinic, marital status, insurance status, medical diagnosis and auditory-perceptual rating of dysphonia did not demonstrate a relationship to voice therapy adherence in previous quantitative studies [22-25]. On the contrary, it was demonstrated that patients who underwent evaluation by a otolaryngologist and speech-language pathologist not in the same day showed lower adherence to voice therapy [26]. Moreover, Pasternak et al. [27] highlighted the negative impact of having fewer school-aged children in the household. The voice therapy initiation rate obtained in our study did not differ between males and females. In our division, we routinely perform double assessment (speech-therapist and physician) in the same day in all cases. The number of patients who refused voice therapy, attendance at therapy sessions and prevalence of premature end of therapy did not differ by sex, demonstrating a similar awareness of dysphonia. This result is consistent with recent studies that ruled out the role of gender in voice therapy adherence [22,23] and reinforced the prospective of the absent relationship between voice therapy initiation and most patient- and disease-related factors. Finally, voice therapy was effective in both males and females. Our results showed that, despite a similar improvement of the auditory perceptual score, the subjective perception of the biopsychosocial impact of the voice disorder decreased more in women probably because of the worse subjective perception of dysphonia before VT.

Conclusions

Our study showed a higher prevalence of voice disorders in females. Awareness of dysphonia was not gender related. Females started with worse voice subjective perception and acoustic analysis, but they perceived greater improvement after therapy.

Conflict of interest statement

The authors declare no conflict of interest.

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Author contributions
Conceptualisation: LD and MRM. Methodology: MRM and YL. Investigation: TDC, GM and VT. Data curation: MRM, YL and TDC. Writing – original draft preparation: MRM, YL and TDC. Writing – review and editing: MRM, LD, JG. Supervision: JG and LD. All authors have read and agreed to the published version of the manuscript.

Ethical consideration
This study was approved by the Institutional Ethics Committee of A. Gemelli IRCCS University Hospital Foundation as retrospective case series study.
The research was conducted ethically, with all study procedures being performed in accordance with the requirements of the World Medical Association's Declaration of Helsinki.
Written informed consent was obtained from each participant/patient for study participation and data publication.

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