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# Vocal Signs and Symptoms Related to COVID-19 and Risk Factors for their Persistence

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**Abstract: Objective.** To compare the occurrence of vocal signs and symptoms before, during, and after coronavirus disease (COVID-19) and analyze possible risk factors for the persistence of these signs and symptoms after disease resolution.

**Methods.** This was an observational, analytical, and cross-sectional study. The participants were 45 individuals of both sexes, with a mean age of 44 years, who were previously affected by COVID-19. All participants answered a questionnaire about sociodemographic data, smoking history, disease course, vocal complaints, and the vocal signs and symptoms list (SSL), referring to three timepoints (before, during, and after COVID-19).

**Results.** The most commonly reported vocal signs and symptoms before COVID-19 were phlegm (26.67%; n=12) and dry throat (24.44%; n=11). During COVID-19, the most frequent vocal signs and symptoms were tired voice after short-term use (73.33%; n=33) and dry throat (71.11%; n=32). After the disease, the most reported vocal signs and symptoms were dry throat (57.78%; n=26) and phlegm (53.33; n=24). The self-perception of vocal signs and symptoms before COVID-19 was lower than that during and after COVID-19 ( $P < 0.001$ ). Vocal complaints after COVID-19 and oxygen therapy were predictors of self-perception of vocal signs and symptoms after COVID-19.

**Conclusions.** Individuals affected by COVID-19 had a higher frequency of vocal signs and symptoms during the disease. However, after remission, the frequency of vocal signs and symptoms was higher than that at baseline. The need for oxygen therapy may indicate a risk for a higher occurrence of vocal signs and symptoms after COVID-19.

**Key Words:** COVID-19—Dysphonia—Signs and symptoms—Voice.

## INTRODUCTION

COVID-19 is caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). The virus has a clinical spectrum ranging from asymptomatic infections to deaths.<sup>1</sup>

Approximately 80% of COVID-19 patients may be asymptomatic or oligosymptomatic (few symptoms). Of the 20% who require hospital care because they have difficulty breathing, approximately 5% may require oxygen therapy due to hypoxemia.<sup>1</sup>

Acute symptoms of COVID-19 include cough, fever, dyspnea, musculoskeletal symptoms (myalgia, joint pain, fatigue), gastrointestinal symptoms, anosmia, and dysgeusia.<sup>2–4</sup> COVID-19 can lead to respiratory complications, which in turn may result in cardiac (arrhythmias and

myocardial), renal (acute kidney injury), gastrointestinal, neurological (neuropathy, encephalopathy), endocrine, and musculoskeletal consequences (weakness, pain, and fatigue).<sup>5,6</sup>

Despite numerous studies on the acute form of COVID-19, to date, there is no established deadline to describe the slow and persistent condition in individuals with long-term sequelae of COVID-19.<sup>7</sup> Abnormal signs and symptoms or parameters that persist for more than 2 weeks after the onset of COVID-19 and do not resolve (baseline values) may have potential long-term effects.<sup>8</sup> These symptoms occur mainly in survivors of severe and critical COVID-19, and long-lasting effects also occur in individuals with mild infection and those who require no hospitalization.<sup>9</sup>

Patients who had COVID-19 and required medical hospitalization often have symptoms after approximately 2 months,<sup>10,11</sup> especially those who needed intensive care unit (ICU) care.<sup>11</sup> The main symptoms are fatigue,<sup>10,11</sup> dyspnea,<sup>10,11</sup> joint pain,<sup>10</sup> chest pain,<sup>10</sup> and psychological distress.<sup>11</sup> Voice-related symptoms, more specifically related to laryngeal sensitivity and vocal changes, have also been described.<sup>11</sup>

Regarding vocal symptoms, a single study specifically on this topic analyzed the prevalence of dysphonia in 702 European patients with mild to moderate COVID-19. The data showed that 27% of the patients had dysphonia. Dysphonic patients had a higher occurrence of cough, chest pain, sticky sputum, arthralgia, diarrhea, headache, fatigue, nausea, and vomiting. The severity of dyspnea, dysphagia, ear pain,

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facial pain, sore throat, and nasal obstruction was higher in the dysphonic group than in the non-dysphonic group.<sup>12</sup>

It is believed that the vocal symptoms present after COVID-19 may not only be related to orotracheal intubation<sup>13</sup> but also to respiratory sequelae. In clinical practice, vocal complaints associated with respiratory complaints have been observed. This is because the integrity of the respiratory system is fundamental for proper voice production with respect to providing the air pressure necessary for phonation.<sup>14–17</sup> Moreover, in the new scenario imposed by COVID-19, some laryngeal occurrences have been described, with scarcely known causes, as paradoxical movement of the vocal fold.<sup>12</sup>

It is necessary to understand more deeply the occurrence of vocal signs and symptoms before, during, and after COVID-19. Thus, it is possible to contribute to the management of symptoms and maximize the functional recovery of patients.<sup>11</sup>

Therefore, this study aimed to compare the occurrence of vocal signs and symptoms before, during, and after coronavirus disease (COVID-19) and analyze possible risk factors for the persistence of these symptoms after disease resolution.

## MATERIAL AND METHODS

This study has an observational, analytical, cross-sectional, and hybrid design. The study was approved by the Ethics Committee on Research with Human Beings of the institution of origin, under number 4.319.245.

Individuals referred by the health department of a Brazilian municipality to the evaluation and rehabilitation service after COVID-19 developed by the home institution participated in the study. The service is composed of speech therapists and physiotherapists.

The inclusion criteria were as follows: both sexes, age  $\geq 18$  years, a diagnosis of COVID-19 confirmed by reverse transcription polymerase chain reaction (RT-PCR), and referral from the public health service of the city where the institution proposing this research is located. Exclusion criteria were: asymptomatic persons; invasive mechanical ventilation; history of respiratory disorders or other health changes that impacted voice and communication before COVID. The eligibility criteria were applied using direct questions.

All participants answered a questionnaire about sociodemographic data (sex, age, weight, and height), smoking

history, course of the disease (date of diagnosis, need for hospitalization, type and duration of hospitalization, noninvasive mechanical ventilation, oxygen therapy), and vocal complaints (before, during, and after COVID-19).

Following this, the individuals answered the vocal signs and symptoms list (SSL), which investigates the presence or absence of 14 vocal signs or symptoms.<sup>18</sup> A Brazilian Portuguese translation of the instrument was used.<sup>19</sup> Each symptom was addressed with respect to three distinct timepoints: before, during, and after COVID-19. According to the authors' instructions, the total score of the questionnaire was calculated using a simple sum. Moreover, a descriptive analysis of individual symptoms was conducted.

The vocal symptoms were self-reported based on the following questions: Vocal signs and symptoms before COVID-19 - participant should answer considering whether the sign/symptom was recurrent or persistent in his/her day-to-day before the diagnosis of the disease; Vocal signs and symptoms during COVID-19 - participant should respond considering if the sign/symptom questioned occurred during the active period of the disease, which comprised the interval between the 3rd and 11th day; Vocal signs and symptoms after a COVID-19 - participant should respond considering whether the sign/symptom was recurrent or persistent from the day of remission of the disease to the current day (day of data collection).

Data were tabulated and statistically analyzed using SPSS 25.0. The inferential analysis was performed using the Friedman test to compare the results obtained with the SSL before, during, and after COVID-19. Multiple pairwise comparisons with Bonferroni corrections were performed for cases of significance. Multiple linear regression with the selection of variables by the stepwise method was performed to analyze the factors related to the maintenance of symptoms after COVID-19. For all inferential analyses, a significance level of 5% was adopted.

## RESULTS

Forty-five individuals participated in this study, with a mean age of 44 years and 10 months, 24 females and 21 males. The descriptions of the other variables independent of sociodemographic data, disease course, and vocal complaints are shown in [Tables 1 and 2](#).

**TABLE 1.**  
Descriptive Analysis of Independent Quantitative Variables

| Variable                                | Mean  | SD    | Minimum | Maximum | 1Q    | Median | 3Q    |
|---|-------|-------|---------|---------|-------|--------|-------|
| Age                                     | 44.89 | 13.15 | 19.00   | 78.00   | 35.50 | 45.00  | 55.50 |
| Body mass index                         | 29.76 | 5.26  | 20.28   | 42.27   | 25.90 | 30.61  | 33.53 |
| Time since COVID-19 diagnosis (in days) | 41.91 | 17.19 | 19.00   | 107.00  | 30.00 | 38.00  | 47.50 |
| Days of hospitalization                 | 1.29  | 2.77  | 0.00    | 13.00   | 0.00  | 0.00   | 0.50  |
| Days of ICU stay                        | 0.51  | 1.84  | 0.00    | 10.00   | 0.00  | 0.00   | 0.00  |

Descriptive analysis.

SD, standard deviation; 1Q, first quartile; 3Q, third quartile.

**TABLE 2.**  
**Descriptive Analysis of Independent Binary Nominal Binary Variables**

| Variable                         | No |       | Yes |       |
|----------------------------------|----|-------|-----|-------|
|                                  | n  | %     | n   | %     |
| Hospitalization                  | 31 | 68.89 | 14  | 31.11 |
| Noninvasive ventilation          | 44 | 97.78 | 1   | 2.22  |
| Oxygen therapy                   | 36 | 80.00 | 9   | 20.00 |
| Smoking history                  | 35 | 77.78 | 10  | 22.22 |
| Vocal complaints before COVID-19 | 40 | 88.89 | 5   | 11.11 |
| Vocal complaints during COVID-19 | 21 | 46.67 | 24  | 53.33 |
| Vocal complaints after COVID-19  | 31 | 68.89 | 14  | 31.11 |

Descriptive analysis.  
n, absolute frequency; %, relative frequency.

Table 3 shows descriptive analysis regarding the presence or absence of the 14 vocal signs and symptoms investigated in the SSL. The vocal signs and symptoms most commonly reported before COVID-19 were phlegm (26.67%; n=12) and dry throat (24.44%; n=11). During COVID-19, the most frequent vocal signs and symptoms were tired or changed voice after use for a short time (73.33%; n=33) and dry throat (71.11%; n=32). After COVID-19, the most reported vocal signs and symptoms were dry throat (57.78%; n=26) and phlegm (53.33; n=24).

Table 4 indicates a significant difference in self-perception of vocal signs and symptoms before, during, and after COVID-19 ( $P < 0.001$ ). The self-perception of vocal signs and symptoms before COVID-19 was lower than during ( $P < 0.001$ ) and post-disease ( $P < 0.001$ ). Moreover, the self-perception of vocal signs and symptoms after COVID-19 was lower than during the disease ( $P < 0.001$ ).

Regression to verify whether the variables (age, body mass index, time since COVID diagnosis, days of hospitalization, days of intensive care unit (ICU) stay, hospitalization, noninvasive ventilation, oxygen therapy, smoking history, vocal complaints before, during, and after COVID-19), were related to self-perception of vocal signs and symptoms after COVID-19 resulted in a statistically significant model ( $F(2,43) = 18.076$ ;  $P < 0.001$ ;  $R^2 = 0.422$ ). Vocal complaint after COVID-19 ( $\beta = 0.549$ ;  $t = 4.508$ ;  $P < 0.001$ ) and oxygen therapy ( $\beta = 0.333$ ;  $t = 2.737$ ;  $P = 0.009$ ) were predictors of self-perception of vocal signs and symptoms after having COVID-19 (Table 5).

**DISCUSSION**

Understanding the impact of COVID-19 on voice and communication is extremely important for speech therapists to develop appropriate and resolute actions for the population.

The types of signs and symptoms most reported during and after COVID-19 are related to pulmonary and

**TABLE 3.**  
**Descriptive Analysis of Binary Nominal Qualitative Variables Related to SSL, in the Pre, During, and After COVID-19 Timepoints**

| Symptoms  | Before |        | During |       | After |       |
|---|--------|--------|--------|-------|-------|-------|
|   | n      | %      | n      | %     | n     | %     |
| Hoarseness  |        |        |        |       |       |       |
| No  | 39     | 86.67  | 23     | 51.11 | 33    | 73.33 |
| Yes   | 6      | 13.33  | 22     | 48.89 | 12    | 26.67 |
| Voice becoming tired or change after use for a short time |        |        |        |       |       |       |
| No  | 43     | 95.56  | 12     | 26.67 | 30    | 66.67 |
| Yes   | 2      | 4.44   | 33     | 73.33 | 15    | 33.33 |
| Trouble singing or speaking low                           |        |        |        |       |       |       |
| No  | 44     | 97.78  | 34     | 75.56 | 38    | 84.44 |
| Yes   | 1      | 2.22   | 11     | 24.44 | 7     | 15.56 |
| Difficulty in projecting your voice                       |        |        |        |       |       |       |
| No  | 42     | 93.33  | 25     | 55.56 | 36    | 80.00 |
| Yes   | 3      | 6.67   | 20     | 44.44 | 9     | 20.00 |
| Difficulty singing high                                   |        |        |        |       |       |       |
| No  | 45     | 100.00 | 34     | 75.56 | 39    | 86.67 |
| Yes   | 0      | 0.00   | 11     | 24.44 | 6     | 13.33 |
| Discomfort when speaking                                  |        |        |        |       |       |       |
| No  | 45     | 100.00 | 26     | 57.78 | 40    | 88.89 |
| Yes   | 0      | 0.00   | 19     | 42.22 | 5     | 11.11 |
| Monotone voice  |        |        |        |       |       |       |
| No  | 43     | 95.56  | 31     | 68.89 | 41    | 91.11 |
| Yes   | 2      | 4.44   | 14     | 31.11 | 4     | 8.89  |
| Effort to speak   |        |        |        |       |       |       |
| No  | 45     | 100.00 | 23     | 51.11 | 39    | 86.67 |
| Yes   | 0      | 0.00   | 22     | 48.89 | 6     | 13.33 |
| Dry throat  |        |        |        |       |       |       |
| No  | 34     | 75.56  | 13     | 28.89 | 19    | 42.22 |
| Yes   | 11     | 24.44  | 32     | 71.11 | 26    | 57.78 |
| Sore throat   |        |        |        |       |       |       |
| No  | 40     | 88.89  | 25     | 55.56 | 38    | 84.44 |
| Yes   | 5      | 11.11  | 20     | 44.44 | 7     | 15.56 |
| Phlegm  |        |        |        |       |       |       |
| No  | 33     | 73.33  | 16     | 35.56 | 21    | 46.67 |
| Yes   | 12     | 26.67  | 29     | 64.44 | 24    | 53.33 |
| Acidic or bitter taste in the mouth                       |        |        |        |       |       |       |
| No  | 40     | 88.89  | 18     | 40.00 | 28    | 62.22 |
| Yes   | 5      | 11.11  | 27     | 60.00 | 17    | 37.78 |
| Difficulty swallowing                                     |        |        |        |       |       |       |
| No  | 44     | 97.78  | 35     | 77.78 | 43    | 95.56 |
| Yes   | 1      | 2.22   | 10     | 22.22 | 2     | 4.44  |

(Continued)

**TABLE 3. (Continued)**

| Symptoms                    | Before |        | During |       | After |       |
|-----------------------------|--------|--------|--------|-------|-------|-------|
|                             | n      | %      | n      | %     | n     | %     |
| Voice instability or tremor |        |        |        |       |       |       |
| No                          | 45     | 100.00 | 35     | 77.78 | 39    | 86.67 |
| Yes                         | 0      | 0.00   | 10     | 22.22 | 6     | 13.33 |

Descriptive analysis.

n, absolute frequency; %, relative frequency.

laryngeal aspects. The most common symptom reported during the pandemic was tired or changed voice after use for a short time (73.33%; n=33). This symptom persisted in 33.3% of individuals after COVID-19, and only 4.4% of patients reported it before COVID-19. This symptom is directly associated with respiratory sequelae related to the disease, and its persistence refers to the maintenance of fatigue symptoms, pointed out in the literature as the most frequent symptom type after COVID-19.<sup>20</sup> Pulmonary function is directly related to subglottic airflow, which is fundamental for phonation and pneumo-phono-articulatory coordination.<sup>21–25</sup>

The dry throat and phlegm symptoms are related to dehydration and inflammatory processes in the upper airways and vocal folds.<sup>26,27</sup> In general, symptoms related to vocal tract sensations have been observed in other studies investigating patients with COVID-19 at varying frequencies.<sup>28–31</sup> Otorhinolaryngological symptoms, in general, may be present in almost 60% of patients during the disease.<sup>30</sup> Cough is one of the most common symptoms of the disease and may be present in approximately 76% of cases,<sup>29</sup> causing irritation, edema, and even phonotrauma in the vocal folds. Regarding the period after COVID-19, there is a possibility that 25% of individuals will continue experiencing laryngeal sensitivity.<sup>11</sup>

This study hypothesized that respiratory sequelae and vocal tract symptoms related to COVID-19 might be risk factors for the development of dysphonia. This study

**TABLE 5.**

**Multiple Linear Regression Model of Independent Variables as Predictors of Self-Perception of Vocal Signs and Symptoms After Having COVID-19**

| Model                           | B     | $\beta$ | t     | P-value | VIF   |
|---------------------------------|-------|---------|-------|---------|-------|
| (Constant)                      | 1.622 |         | 3.323 | 0.002   |       |
| Vocal complaints after COVID-19 | 3.649 | 0.549   | 4.508 | <0.001  | 1.001 |
| Oxygen therapy                  | 2.495 | 0.333   | 2.737 | 0.009   | 1.001 |

Multiple linear regression, stepwise method.

 $r^2 = 0.422$ .

VIF, Variance inflation factor.

indicates that hoarseness was present in 48.89% of the cases during the disease, higher rates than those described in the literature regarding dysphonia, which is 27%.<sup>12</sup> In this study, 26.67% of patients presented with symptoms of hoarseness after the disease. No specific studies on this symptom were found, but the results are compatible with those of a study that showed that approximately 25% of patients reported persistent vocal changes after the disease.<sup>11</sup>

Some atypical cases of dysphonia during or after COVID-19 have been reported, including vocal fold immobility, paradoxical movement of vocal folds, and psychogenic dysphonia.<sup>12,28,32</sup> For this reason, in addition to the possibility of vocal disorders due to respiratory sequelae or vocal tract symptoms commonly related to the disease, each case must be analyzed individually according to clinical history and vocal manifestations.

The highest frequency of vocal signs and symptoms was observed during COVID-19, with differences compared to those before and during the disease. The frequency of vocal signs and symptoms after COVID-19, although lower than during COVID-19, was higher than that before COVID-19. Thus, it was confirmed that many signs and symptoms persisted even after curing the disease. A median of one symptom was noted before COVID-19, which is compatible with

**TABLE 4.**

**Comparison of Self-Perception of Vocal Signs and Symptoms Before, During and After Having COVID-19**

| Variables                                 | Mean | SD   | Minimum | Maximum | 1Q   | Median | 3Q   | $X^2$ | P-value | Pairwise  |
|---|------|------|---------|---------|------|--------|------|-------|---------|---|
| Vocal signs and symptoms before COVID-19  | 1.09 | 1.39 | 0       | 6.00    | 0.00 | 1.00   | 1.00 | 66.53 | <0.001  | Before < During ( $P < 0.001$ )<br>= After ( $P < 0.001$ );<br>After < During ( $P < 0.001$ ) |
| Vocal signs and symptoms during COVID-19  | 6.22 | 3.63 | 0       | 14.00   | 3.00 | 7.00   | 8.50 |       |         |   |
| Vocal signs and symptoms after a COVID-19 | 3.24 | 3.00 | 0       | 12.00   | 1.00 | 3.00   | 4.00 |       |         |   |

Friedman test; multiple comparisons by pairwise with Bonferroni correction. SD, standard deviation; 1Q, first quartile; 3Q, third quartile.

that in the general population.<sup>18</sup> The median of seven vocal signs and symptoms during COVID-19 was compatible with the numbers presented for individuals with dysphonia in general.<sup>18</sup> After COVID-19, the median of three symptoms, although lower than that commonly presented by individuals with vocal disorders,<sup>18</sup> is similar to that presented by Brazilian teachers, a group whose profession historically indicates the presence of great symptomatology and vocal risk.<sup>19</sup>

Individuals who used oxygen therapy had a higher frequency of vocal signs and symptoms after COVID-19. The prescription of oxygen therapy is widely described in the literature to treat respiratory failure as it improves O<sub>2</sub> supply to cells by increasing the partial pressure of oxygen in the arterial blood through a higher oxygen concentration in the inspired air.<sup>33–36</sup> In cases of COVID-19, it is a frequently used and important procedure for recovery.<sup>37,38</sup> One of the side effects of this type of therapy is the dryness due to inadequate humidification.<sup>39</sup> Dryness of the mucous membranes of the vocal tract can be hypothesized as a cause, and dehydration may increase vocal symptomatology.

Individuals with vocal complaints after COVID-19 also had a higher frequency of vocal signs and symptoms. This result was expected, and there is already a consensus on this aspect in the literature.<sup>40–42</sup>

This study presented a risk of memory bias due to data collection performed after COVID-19 from the moments before and during the disease. For a better understanding of the theme, studies with longitudinal follow-up of patients after COVID-19 in monitoring vocal symptoms and clinical data of auditory-perceptual, acoustic, aerodynamic, and laryngological evaluations are suggested; analysis of vocal data of COVID-19 patients submitted to invasive mechanical ventilation; and investigation of the effects of speech therapy and its association with respiratory physiotherapy on patients' vocal rehabilitation after COVID-19.

## CONCLUSION

Individuals affected by COVID-19 have a higher frequency of signs and symptoms during the disease; however, they still maintain a higher frequency than baseline after remission. The most reported vocal signs and symptoms during and after COVID-19 indicate a relationship with pulmonary sequelae and upper airway, and vocal symptoms commonly present in the acute phase of the disease. The need for oxygen therapy may indicate a risk for a higher occurrence of after COVID-19 vocal signs and symptoms.

## DECLARATION OF COMPETING INTEREST

There are no conflicts of interest to declare.

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