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# Vocal Self-Perception of Home Office Workers During the COVID-19 Pandemic

\*Larissa Thaís Donalsonso Siqueira, †Ana Paula dos Santos, †Rebeca Liaschi Floro Silva, †Pamela Aparecida Medeiros Moreira, †Jhonatan da Silva Vitor, and ‡,§,¶Vanessa Veis Ribeiro, \*†Bauru, ‡Lagarto, §São Paulo, and ¶João Pessoa, Brazil

**ABSTRACT: Objective.** To investigate the self-perception of vocal fatigue symptoms and musculoskeletal pain in home office workers before and during the coronavirus disease (COVID-19) pandemic.

**Materials and methods.** A total of 424 individuals participated in this cross-sectional, observational, and descriptive study; they were stratified into the experimental group (EG), consisting of 235 individuals working from home office during the COVID-19 pandemic; and the control group (CG), with 189 individuals who continued to work in person during this period. All participants answered the vocal fatigue index and the musculoskeletal pain investigation questionnaires. The data were analyzed in a descriptive and inferential manner.

**Results.** Participants in the EG reported more vocal fatigue symptoms and musculoskeletal pain than those in the CG before the pandemic. However, during the pandemic, the EG presented a higher frequency of pain in the posterior of the neck, shoulder, upper back, and temporal and masseter muscles, while the CG presented a higher frequency of pain in the larynx. With regard to vocal fatigue, during the pandemic, EG had an increase in scores to factors such as tiredness and voice impairment, avoidance of voice use, and total scores. No such differences were noted in the CG.

**Conclusion.** Workers who migrated to home offices during the COVID-19 pandemic are at risk of developing vocal disorders.

**Key Word:** Coronavirus—Fatigue—Pain—Signs and symptoms—Voice—Pandemic.

## INTRODUCTION

At the end of 2019, an epidemic began in China, caused by the severe acute respiratory syndrome coronavirus 2, that causes the coronavirus disease (COVID-19). The disease had a rapid spread globally and has been considered a public health emergency. As a result, in 2020, the World Health Organization (WHO) declared it a pandemic.<sup>1</sup> Since the first diagnosed case in Brazil in February 2020, more than five million confirmed cases and more than 150,000 deaths were reported nationwide.<sup>2</sup>

In view of the current scenario, individual and collective interventions are required to reduce disease transmissions, such as respiratory and hand hygiene, face mask use, and social distancing.<sup>2,3</sup> Social distancing is the recommended practice of maintaining at least 6-foot space between people to reduce the spread of COVID-19.<sup>4</sup> It was initially recommended by the WHO,<sup>2</sup> and among the possible measures is the closing of nonessential companies and implementation of remote work from home offices.<sup>4</sup> The employee can carry

out his professional activities remotely in his own home, using information processing technologies and resources.<sup>5</sup>

Thus, it is essential to highlight that workers who adapted to their home offices did not receive guidance or training to change their vocal use. In the remote working model, there is a greater demand for meetings vocally via digital platforms, using microphones and/or headphones. Since daily face-to-face contact is no longer a reality, it was necessary to find other means to enable interaction between employees, the company, and customers. In addition, many workers do not have suitable equipment and infrastructure at home for a professional practice that may provide adequate ergonomic conditions.

Vocal use in inadequate ergonomic conditions, without prior vocal training, can be performed through incorrect muscle adjustments. Such adjustments, associated with excessive tension of the laryngeal musculature and scapular girdle region, can trigger an inappropriate vocal behavior<sup>6–15</sup> resulting in vocal fatigue symptoms<sup>16</sup> and musculoskeletal pain in regions close to the larynx.<sup>17,18</sup> It is also known that an inadequate body posture during vocal use is a predictor for the development of vocal changes.<sup>19</sup> On the other hand, workers who kept their jobs in person in the usual places had to adopt the face mask as a mandatory accessory and are also subject to the vocal fatigue symptoms.<sup>20</sup> Thus, it is necessary to understand whether adaptations in professional activities resulting from the pandemic pose a risk to the voice since these new working conditions can be long-lasting, and these professionals may develop vocal disorders in the future.

The objective of this study was to investigate the self-perception of vocal fatigue symptoms and musculoskeletal

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From the \*Speech Hearing and Language Disorders Department, Faculdade de Odontologia de Bauru/Universidade de São Paulo - FOB/USP, Bauru, São Paulo, Brazil; †Bauru School of Dentistry, São Paulo College, Bauru, São Paulo, Brazil; ‡-Speech-Language Pathology Department, Universidade Federal de Sergipe - UFS, Governador Marcelo Dedá Avenue, Lagarto, Sergipe, Brazil; §Centro de Estudos da Voz - CEV, São Paulo, São Paulo, Brazil; and the ¶Associate Postgraduate Program in Speech-Language Pathology, Universidade Federal da Paraíba - UFPB, Cidade Universitária, Conjunto Presidente Castelo Branco III, João Pessoa, Paraíba, Brazil.

Address correspondence and reprint requests to Larissa Thaís Donalsonso Siqueira, Speech Hearing and Language Disorders Department, Faculdade de Odontologia de Bauru/Universidade de São Paulo - FOB/USP, Al. Dr. Octávio Pinheiro Brisolla, 9-75; Bauru (SP), Brazil, Bauru, São Paulo 17012-901, Brazil.  
E-mail: larisqueira\_4@hotmail.com

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pain related to voice in home office workers before and during the COVID-19 pandemic.

## MATERIAL AND METHODS

### Design study

This research is a cross-sectional, observational, and descriptive study.

### Ethical aspects

The Research Ethics Committee of the Universidade Federal de Sergipe approved this study (4.071.175). Each participant signed an informed consent form before participation in the study.

### Sample

Participants were recruited by the dissemination of the study on social networks in Brazil. For this purpose, a post was prepared and shared with an access link to complete the survey questions and questionnaires. The data collection was conducted online through Google Forms in June 2020, during the COVID-19 pandemic.

Eligibility criteria were established to select the sample and applied based on responses to a sample questionnaire prepared by the authors and the Voice Disorders Screening Index protocol.<sup>21</sup> Brazilian individuals of both sexes, aged between 18 and 59 years, were invited to participate. Participants that reported an established diagnosis of dysphonia, undergoing otorhinolaryngological or treatments for voice or larynx at the time of the study, participants who reported hearing complaints, and/or diagnosis of COVID-19, who reported with diseases of the upper airway on the day the survey was completed, participants who already worked in home office before the pandemic, and participants who were classified in the risk range for developing dysphonia using the voice disorder screening index protocol<sup>21</sup> were excluded.

The sample size was calculated using hypothesis testing with the *t* test for two independent groups of different sizes from a pilot study with 100 participants. The main outcome variability was considered for the calculation (the total domain of the vocal fatigue index [VFI]). The parameters adopted for the test were  $\alpha = 5\%$ ,  $\beta = 20\%$ ,  $K = 80\%$ , difference from the mean of 2.5 points ( $\mu = 2.5$ ) and a combined standard deviation of 8.3 ( $\sigma = 8.3$ ). The calculated sample size was 169 participants per group.

A total of 514 volunteers participated in the selection process, of which 89 were excluded. The sample consisted of 424 participants (252 women and 172 men) with an average age of 32 years and three months, divided into the experimental group (EG) with 235 individuals working from home office during the COVID-19 pandemic; and the control group (CG) with 189 individuals who were working at their usual workplace.

### Outcomes

The self-assessed outcomes were vocal fatigue symptoms and the frequency of musculoskeletal pain. Both outcomes were assessed twice by considering the current period—March 2020 to June 2020 (during the pandemic) and that until February 2020 (before the pandemic). However, data collection was performed in a single moment, obtaining the present and retrospective data.

To analyze the self-perception of vocal fatigue symptoms, the VFI was used, translated, and validated in Brazilian Portuguese.<sup>22</sup> The frequency of 17 vocal fatigue symptoms was analyzed on a five-point Likert scale from zero (never) to four (forever). The factors of the VFI are tiredness and voice impairment; avoidance of voice use; physical discomfort; improvement of voice symptoms with rest, and, total. The calculation of the factors was performed according to the authors' instructions.

To investigate the frequency of pain, the "Musculoskeletal Pain Investigation Questionnaire" was used.<sup>17</sup> For the present study, only the larynx's proximal regions were used, and the frequency of pain was analyzed. The body parts investigated were the posterior and anterior neck, shoulders, upper and lower back, temporal region, masseter, submandibular region, and larynx. Participants rated the frequency of pain in each body region between zero and three (0 = never, 1 = rarely, 2 = sometimes, 3 = always).

Some data from the sample questionnaire were used to characterize the sample. The participants' profession was classified according to the classification of voice and speech professions according to the demands on voice quality and vocal loading from working ability.<sup>23</sup>

### Data analysis

Data analysis was performed using the SPSS 25.0 (IBM Corporation, Armonk, NY). The descriptive analysis of the nominal qualitative variables was performed by calculating the mean values of relative and absolute frequencies, and that of the qualitative ordinal variables and quantitative variables were performed by calculating the measures of variability, central tendency, and position. The quantitative variables were subjected to a normality analysis with the Shapiro Wilk test for inferential analysis. The independent groups were compared using the Mann-Whitney test, and the dependent groups were compared using the Wilcoxon test. Nominal qualitative variables were associated with the chi-squared test. A significance level of 5% was considered.

## RESULTS

EG was significantly older than CG ( $P < 0.001$ ). The groups were homogeneous in terms of daily working time (Table 1).

Table 2 shows that both groups were associated with moderate quality and high loading, and moderate quality and moderate loading ( $P = 0.019$ ).

EG showed scores significantly higher than CG for pain frequency in all regions, except submandibular (Table 3),

**TABLE 1.**  
**Characterization of Groups According to Age and Working Time**

Variable	Group	Mean	SD	1Q	Median	3Q	PValue
Age	CG	30.46	8.51	24.00	28.00	36.00	<0.001*
	EG	33.77	9.29	26.00	32.00	39.00	
Daily workload	CG	7.89	2.59	7.00	8.00	9.00	0.552
	EG	7.86	1.79	8.00	8.00	8.00	

\* Mann-Whitney test.

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

and vocal fatigue symptoms in all factors (Table 4), both before and during the COVID-19 pandemic.

When comparing the moments before and during a pandemic, the EG showed an increase in the frequency of pain in the posterior regions of the neck ( $P= 0.001$ ), shoulders ( $P< 0.001$ ), upper back ( $P< 0.001$ ), temporal ( $P= 0.027$ ) and masseter ( $P= 0.030$ ), and the CG in the larynx region ( $P= 0.023$ ) during the pandemic (Table 5). EG showed an increase in tiredness and voice impairment scores ( $P= 0.008$ ), avoid of voice use ( $P< 0.001$ ), and total ( $P = 0.027$ ) during the pandemic to the moment before the pandemic (Table 6).

## DISCUSSION

The COVID-19 pandemic has changed the style, leisure, routine of life, and work for people globally. WHO<sup>2</sup> recommended social detachment during the pandemic, which forced workers to discontinue visiting their usual workplaces in companies and adapt to perform their functions from their home offices<sup>24</sup> to maintain work activities. A recent study by the American company Deloitte, published in The Wall Street Journal,<sup>25</sup> showed that with the technological advancements, this could continue even after the pandemic ends. Thus, it is necessary to know the new vocal use profile in individuals working from remote modes and obtain evidence about the possible vocal fatigue symptoms and musculoskeletal pain related to vocal production before and during the

pandemic. This would help assess the risk to these workers' vocal health in the home office work modality.

In the present study, we observed that when comparisons were made before and during the pandemic, the EG presented more vocal fatigue symptoms and musculoskeletal pain than the CG, except in the submandibular region. However, when the workers switched to working from home offices during the pandemic, the EG showed an increase in the frequency of musculoskeletal pain in most regions, and the scores of most factors of vocal fatigue, while in the CG, whose participants maintained their activities in the usual place of work, there was only an increase in muscle pain in the laryngeal region.

It is believed that the increase in pain in the laryngeal region in the CG can be due to the use of face masks for professional activities, which is mandatory by law for all workers who keep working in the usual place. Such a measure seeks to prevent the spread and contamination by the new coronavirus.<sup>3,26</sup> The use of masks can attenuate the sound of the voice between 3 and 12 dB, mainly at frequencies between 2000 and 7000 Hz.<sup>27</sup> This can compromise communication, as the interlocutor cannot hear the message clearly and accurately. In addition, the listener's visual feedback for orofacial reading becomes difficult, along with the limitation of articulatory movements in some cases. The use of the face mask can also decrease the inspiratory flow and impact the expiratory flow, which can further lead to pneumophonic incoordination.<sup>20</sup> Thus, compensatory adjustment is made by

**TABLE 2.**  
**Association Between Groups and Classification of Voice and Speech Professions According to the Demands on Voice Quality and Vocal Loading From the Working Ability**

Classification		n	Group		PValue
			CG	EG	
High quality and high loading	n	1	3	0.019*	
	%	0.5%	1.3%		
Moderate quality and high loading	n	76	128	54.5%	
	%	40.2%	54.5%		
Moderate quality and moderate loading	n	110	101	43.0%	
	%	58.2%	43.0%		
Low quality and high loading	n	2	3	1.3%	
	%	1.1%	1.3%		

\* Chi-squared test.

Abbreviations: %, relative frequency; n, absolute frequency.

**TABLE 3.**  
**Analysis of the Self-Perceived Frequency of Pain Before and During the Pandemic Among Individuals Who Are Working in the Home Office and Individuals Who Are Working in the Usual Workplace During the COVID-19 Pandemic**

Variable	Group	Mean	SD	1Q	Median	3Q	P Value
Posterior neck (prepandemic)	CG	0.70	0.87	0.00	0.00	1.00	<0.001*
	EG	1.05	0.91	0.00	1.00	2.00	
Posterior neck (during pandemic)	CG	0.75	0.92	0.00	0.00	1.00	<0.001*
	EG	1.23	1.03	0.00	1.00	2.00	
Shoulders (prepandemic)	CG	0.79	0.93	0.00	1.00	1.00	<0.001*
	EG	1.13	0.96	0.00	1.00	2.00	
Shoulders (during pandemic)	CG	0.88	1.00	0.00	1.00	2.00	<0.001*
	EG	1.33	1.06	0.00	1.00	2.00	
Upper back (prepandemic)	CG	0.81	0.95	0.00	1.00	1.00	<0.001*
	EG	1.20	0.97	0.00	1.00	2.00	
Upper back (during pandemic)	CG	0.86	0.95	0.00	1.00	1.50	<0.001*
	EG	1.41	1.05	0.00	1.00	2.00	
Lower back (prepandemic)	CG	0.93	1.00	0.00	1.00	2.00	<0.001*
	EG	1.26	0.99	0.00	1.00	2.00	
Lower back (during pandemic)	CG	0.94	1.03	0.00	1.00	2.00	<0.001*
	EG	1.37	1.04	0.00	1.00	2.00	
Temporal region (prepandemic)	CG	0.60	0.85	0.00	0.00	1.00	0.024*
	EG	0.78	0.91	0.00	1.00	1.00	
Temporal region (during pandemic)	CG	0.64	0.93	0.00	0.00	1.00	0.005*
	EG	0.88	0.96	0.00	1.00	2.00	
Masseter (prepandemic)	CG	0.23	0.53	0.00	0.00	0.00	0.025*
	EG	0.39	0.73	0.00	0.00	1.00	
Masseter (during pandemic)	CG	0.23	0.52	0.00	0.00	0.00	0.006*
	EG	0.47	0.82	0.00	0.00	1.00	
Submandibular region (prepandemic)	CG	0.13	0.38	0.00	0.00	0.00	0.138
	EG	0.21	0.52	0.00	0.00	0.00	
Submandibular region (during pandemic)	CG	0.14	0.40	0.00	0.00	0.00	0.095
	EG	0.24	0.59	0.00	0.00	0.00	
Larynx (Prepandemic)	CG	0.15	0.38	0.00	0.00	0.00	<0.001*
	EG	0.39	0.70	0.00	0.00	1.00	
Larynx (during pandemic)	CG	0.21	0.52	0.00	0.00	0.00	0.004*
	EG	0.41	0.74	0.00	0.00	1.00	
Anterior neck (prepandemic)	CG	0.22	0.51	0.00	0.00	0.00	<0.001*
	EG	0.48	0.78	0.00	0.00	1.00	
Anterior neck (during pandemic)	CG	0.28	0.62	0.00	0.00	0.00	<0.001*
	EG	0.55	0.86	0.00	0.00	1.00	

Note: Mann-Whitney test.

\* Mann-Whitney test.

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

increasing vocal intensity, which can generate overload at the glottic level,<sup>20</sup> increasing the muscle tension and causing pain perception in the laryngeal region.

The EG showed an increase in the frequency of pain in the posterior regions of the neck, shoulders, upper back, and temporal regions during professional practice in the home office in the pandemic. These findings can be attributed to work ergonomics implemented at home, which may not be the most appropriate, and maintain the same inadequate physical body position for long periods. Posture imbalances associated with vocal use are considered predictors of vocal disorders.<sup>19</sup> In addition to muscle fatigue, the effects of inadequate body posture, in the long run, can cause overload to the respiratory system, edema, varicose

veins, and joint disorders, osteoarthritis, deformities in the spine, among others,<sup>28</sup> also manifesting through the body pain, as seen in this study.

There was also an increase in vocal fatigue in EG, comparing the time before and during the pandemic. Vocal fatigue is defined as a self-reported sensation of phonatory effort due to increased vocal load,<sup>29–31</sup> which generates symptoms of vocal, laryngopharyngeal, and bodily discomfort, such as the presence of musculoskeletal pain.<sup>32</sup> However, it is possible that there are no vocal changes audible or measured acoustically or physically.<sup>29</sup> Several factors favor the appearance of vocal fatigue, including physical, psychological, organizational, and environmental factors.<sup>33</sup>

**TABLE 4.**  
**Analysis of Self-Perceived Vocal Fatigue Symptoms Before and During the Pandemic Among Individuals Who Are Working in the Home Office and Individuals Who Are Working in the Usual Workplace During the COVID-19 Pandemic**

Variable	Group	Mean	SD	1Q	Median	3Q	PValue
Tiredness and voice impairment (prepandemic)	CG	3.49	4.64	0.00	1.00	6.50	<0.001*
	EG	5.69	6.13	0.00	4.00	8.00	
Tiredness and voice impairment (during pandemic)	CG	3.63	4.67	0.00	2.00	6.00	<0.001*
	EG	6.59	6.05	1.00	5.00	9.00	
Avoidance of voice use (prepandemic)	CG	1.83	2.36	0.00	1.00	3.00	<0.001*
	EG	2.77	2.91	0.00	2.00	4.00	
Avoidance of voice use (during pandemic)	CG	1.94	2.28	0.00	1.00	3.00	<0.001*
	EG	3.30	2.79	1.00	3.00	5.00	
Physical discomfort (prepandemic)	CG	1.00	1.77	0.00	0.00	2.00	<0.001*
	EG	2.30	3.53	0.00	0.00	4.00	
Physical discomfort (during pandemic)	CG	0.94	1.95	0.00	0.00	1.00	<0.001*
	EG	2.36	3.19	0.00	1.00	4.00	
Improvement of voice symptoms with rest (prepandemic)	CG	2.29	3.53	0.00	0.00	3.50	<0.001*
	EG	4.20	4.42	0.00	3.00	8.00	
Improvement of voice symptoms with rest (during pandemic)	CG	2.36	3.32	0.00	0.00	4.00	<0.001*
	EG	4.39	4.08	0.00	3.00	7.00	
Total (Prepandemic)	CG	16.03	6.54	12.00	13.00	19.00	0.003*
	EG	18.57	9.42	12.00	16.00	23.00	
Total (during pandemic)	CG	16.15	6.28	12.00	14.00	19.00	<0.001*
	EG	19.86	9.28	13.00	18.00	24.00	

Note: Mann-Whitney test.

\* Mann-Whitney test.

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

**TABLE 5.**  
**Analysis of the Self-Perceived Frequency of Pain in Individuals Who Are Working in the Home Office and Individuals Who Are Working in the Usual Workplace During the COVID-19 Pandemic Between the Moments Before and During the Pandemic**

Variable	Group	Prepandemic					During Pandemic					PValue
		Mean	SD	1Q	Median	3Q	Mean	SD	1Q	Median	3Q	
Posterior neck	CG	0.70	0.87	0.00	0.00	1.00	0.75	0.92	0.00	0.00	1.00	0.326
	EG	1.05	0.91	0.00	1.00	2.00	1.23	1.03	0.00	1.00	2.00	
Shoulders	CG	0.79	0.93	0.00	1.00	1.00	0.88	1.00	0.00	1.00	2.00	0.062
	EG	1.13	0.96	0.00	1.00	2.00	1.33	1.06	0.00	1.00	2.00	
Upper back	CG	0.81	0.95	0.00	1.00	1.00	0.86	0.95	0.00	1.00	1.50	0.321
	EG	1.20	0.97	0.00	1.00	2.00	1.41	1.05	0.00	1.00	2.00	
Lower back	CG	0.93	1.00	0.00	1.00	2.00	0.94	1.03	0.00	1.00	2.00	0.721
	EG	1.26	0.99	0.00	1.00	2.00	1.37	1.04	0.00	1.00	2.00	
Temporal region	CG	0.60	0.85	0.00	0.00	1.00	0.64	0.93	0.00	0.00	1.00	0.387
	EG	0.78	0.91	0.00	1.00	1.00	0.88	0.96	0.00	1.00	2.00	
Masseter	CG	0.23	0.53	0.00	0.00	0.00	0.23	0.52	0.00	0.00	0.00	0.960
	EG	0.39	0.73	0.00	0.00	1.00	0.47	0.82	0.00	0.00	1.00	
Submandibular region	CG	0.13	0.38	0.00	0.00	0.00	0.14	0.40	0.00	0.00	0.00	0.835
	EG	0.21	0.52	0.00	0.00	0.00	0.24	0.59	0.00	0.00	0.00	
Larynx	CG	0.15	0.38	0.00	0.00	0.00	0.21	0.52	0.00	0.00	0.00	0.023*
	EG	0.39	0.70	0.00	0.00	1.00	0.41	0.74	0.00	0.00	1.00	
Anterior neck	CG	0.22	0.51	0.00	0.00	0.00	0.28	0.62	0.00	0.00	0.00	0.060
	EG	0.48	0.78	0.00	0.00	1.00	0.55	0.86	0.00	0.00	1.00	

Note: Wilcoxon test.

\* Wilcoxon test.

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

**TABLE 6.**  
**Analysis of Self-Perceived Vocal Fatigue Symptoms in Individuals Who Are Working in the Home Office and Individuals Who Are Working in the Usual Workplace During the COVID-19 Pandemic Between the Moments Before and During the Pandemic**

Variable	Group	Prepandemic					During Pandemic					P Value
		Mean	SD	1Q	Median	3Q	Mean	SD	1Q	Median	3Q	
Tiredness and voice impairment	CG	3.49	4.64	0.00	1.00	6.50	3.63	4.67	0.00	2.00	6.00	0.144
	EG	5.69	6.13	0.00	4.00	8.00	6.59	6.05	1.00	5.00	9.00	0.008*
Avoidance of voice use	CG	1.83	2.36	0.00	1.00	3.00	1.94	2.28	0.00	1.00	3.00	0.301
	EG	2.77	2.91	0.00	2.00	4.00	3.30	2.79	1.00	3.00	5.00	<0.001*
Physical discomfort	CG	1.00	1.77	0.00	0.00	2.00	0.94	1.95	0.00	0.00	1.00	0.298
	EG	2.30	3.53	0.00	0.00	4.00	2.36	3.19	0.00	1.00	4.00	0.845
Improvement of voice symptoms with rest	CG	2.29	3.53	0.00	0.00	3.50	2.36	3.32	0.00	0.00	4.00	0.280
	EG	4.20	4.42	0.00	3.00	8.00	4.39	4.08	0.00	3.00	7.00	0.375
Total	CG	16.03	6.54	12.00	13.00	19.00	16.15	6.28	12.00	14.00	19.00	0.478
	EG	18.57	9.42	12.00	16.00	23.00	19.86	9.28	13.00	18.00	24.00	0.027*

Note: Wilcoxon test.

\* Wilcoxon test.

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

The literature states that three mechanisms influence the development of vocal fatigue: muscular, mucous, and mental fatigue.<sup>29</sup> These mechanisms can explain the findings of the present study. Muscle fatigue, which affects the vocal muscles, corresponds to neuromuscular adjustments, both in the cervical musculature and the extrinsic and intrinsic muscles of the larynx. This can be due to a series of adjustments or compensations for postural deviations of the head, neck, and trunk.<sup>29</sup> These modifications allow bodily adaptations that cause morphophysiological and postural changes in the larynx and excessive use of the entire body musculature, emphasizing the extrinsic musculature of the larynx and the cervix, with the appearance of symptoms of discomfort and musculoskeletal pain.<sup>17,34–38</sup> In addition, poor postural and muscular adaptations of these regions can promote excessive tension of the intrinsic muscles of the larynx. The adductor muscles are utilized excessively, simultaneously exerting adduction and abduction forces or stretching and shortening the vocal folds. Thus, the inefficient and excessive use of intrinsic musculature associated with phonatory effort leads to vocal fatigue.<sup>29</sup>

A study conducted in telemarketers to assess the relationship between musculoskeletal pain and vocal fatigue symptoms found that the greater the sensation of pain, the more vocal fatigue symptoms.<sup>32</sup> In the present study, the correlation of these variables was not investigated, but it was observed that both fatigue and muscle pain symptoms increased with the new work modality, corroborating the relationship found in the study mentioned above. Thus, it is believed that muscle fatigue also favors the appearance of fatigue of the vocal fold mucosa. This can occur because of the prolonged use of the voice, in which each glottic cycle during phonation increases the friction of the vibrating portion, generating increased heat dissipation and increased tissue viscosity,<sup>29</sup> which creates biomechanical tension and

stress. Therefore, this fatigue of nonmuscular tissue can cause long-term damage to the laryngeal mucosa.<sup>39</sup>

In the present study, it was observed that in the new occupational scenario in times of pandemic, professionals had to adapt to the workplace within their homes. Such a fact may have produced an increase in local noise and, consequently, when communicating, professionals end up being loud. The literature reports that vocal overload or increased phonation in relation to the intensity and frequency of the voice for long periods are aspects that influence vocal fatigue.<sup>23</sup> However, these workers were not vocally prepared and conditioned to use their voices for long periods. In addition, they did not have any guidance and training on how to communicate in front of the cameras and how to use vocal, gestural, and facial expressions and resources.

Muscle fatigue and mucosal fatigue<sup>29,39</sup> are mediated by peripheral nerves and the muscles interface. However, the other factors are centrally mediated, which would fall into "mental" fatigue. Mental fatigue involves increased self-perceived effort that can occur with prolonged activity.<sup>29</sup> Therefore, in the current situation in which remote workers find themselves, mental fatigue is even more prominent. Home office work requires greater concentration during communication, more time looking at the computer screen,<sup>40</sup> and the use of headphones (may favor an increase in loudness), which generates visual, auditory, vocal, and mainly mental overload, as there are many elements simultaneously composing online communication. In addition, factors such as distortions and interruptions of videos and/or audio, connection failures, and interference from electronic equipment can recruit more cognitive resources to concentrate and understand information, generating greater auditory and mental effort.<sup>41,42</sup> It is important to consider that several factors related to the current GE work modality, such as the maintenance of the same body position for

an extended period, with consecutive virtual meetings, in a closed environment, and with insufficient infrastructure, without face-to-face social communication, can generate mental tiredness.<sup>40</sup>

Vocal fatigue symptoms commonly decrease with adequate vocal rest,<sup>29,43,44</sup> as happened in the present study. This finding shows that although vocal fatigue increased during the pandemic, it still shows acute symptoms. Despite this, as there is no forecast for the "new normal" return, it is necessary to carry out long-term follow-ups to verify whether chronic vocal fatigue cannot be installed during the pandemic.

As limitations of the present study, the absences of assessment of vocal quality and larynx stands out, which was not possible, given the restrictions on the collection of face-to-face data resulting from the pandemic, and it was not possible to collect workers in the CG who did not use a face mask, since its use is mandatory by law. In addition, there was a risk of reporting bias as participants were asked to respond to data before the pandemic. Another limiting factor was the scarcity of studies in the literature that have investigated vocal conditions in this population of workers, which made it difficult to discuss our findings. It is suggested to carry out future studies that can raise the sociodemographic and occupational characteristics of professionals working in the home office during the pandemic and investigate possible relationships with fatigue and vocal self-perception.

In summary, it can be considered from the above results that workers who are working from home offices during the pandemic are performing their professional activities with the risk of developing vocal changes in the future if they continue using their voice without adequate preparation. In addition, it is known that many professionals, after the pandemic, will continue to exercise their professional/position in this modality or that many occupational activities will be carried out remotely. Therefore, the evidence about the presence of vocal fatigue symptoms and musculoskeletal pain associated with voice alerts to the importance of early intervention with educational and vocal conditioning programs as well as improving communicative competence as a necessity for this population, in order to promote the optimization of vocal use and prevent future vocal disorders.<sup>45</sup>

### CONCLUSION

Individuals who started to work from their home offices during the COVID-19 pandemic showed increased vocal fatigue symptoms and musculoskeletal pain in the cervical region during the pandemic. In contrast, individuals who continued to work in their usual location showed increased pain in the laryngeal region during the pandemic. Thus, workers who migrated to their home offices during the COVID-19 pandemic are at risk of developing vocal disorders.

### CONFLICT OF INTEREST

There are no conflicts of interest to declare.

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