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Effect of Wearing a Face Mask on Vocal Self-Perception during a Pandemic

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Summary: Objective. To analyze the vocal self-perception of individuals who wore face masks for essential activities and those who wore them for professional and essential activities during the coronavirus disease pandemic.

Materials and Methods. This was an observational, descriptive, cross-sectional study. The study included 468 individuals who were stratified into two groups: the Working Group, comprising individuals who wore face masks for professional and essential activities during the pandemic; and the Essential Activities Group, with individuals who wore face masks only for essential activities during the pandemic. The outcome measures tested were self-perception of vocal fatigue, vocal tract discomfort, vocal effort, speech intelligibility, auditory feedback, and coordination between speech and breathing. Descriptive and inferential statistics were performed.

Results. Face masks increased the perception of vocal effort, difficulty in speech intelligibility, auditory feedback, and difficulty in coordinating speech and breathing, irrespective of usage. Individuals who wore face masks for professional and essential activities had a greater perception of symptoms of vocal fatigue and discomfort, vocal effort, difficulties in speech intelligibility, and in coordinating speech and breathing.

Conclusion. Use of face masks increases the perception of vocal symptoms and discomfort, especially in individuals who wore it for professional and essential activities.

Key Words: Coronavirus—Fatigue—Masks—Pandemics—Self-assessment—Signs and symptoms—Voice disorders—Voice.

INTRODUCTION

In 2020, the World Health Organization declared a pandemic caused by the severe acute respiratory syndrome coronavirus 2¹ that causes a disease in humans called coronavirus disease (COVID-19). To contain the transmission of the disease, several nonpharmacological interventions at the individual, environmental, and community level have been recommended.² These include social distancing and prohibiting agglomerations of people, keeping rooms well-ventilated and exposed to the sun, cleaning objects and surfaces, and using personal protective devices, such as face masks, and regular hand washing.^{2–4}

China was the first country to use face masks as a complementary comprehensive strategy against COVID-19.^{5,6} Since May 2020, the use of face masks has been made mandatory in Brazil, for professional and essential activities. Noncompliance to this guideline is liable to be penalized by the health surveillance team and the penalty varies according to the state regulations. Snugly fitted face masks interrupt the dispersion of particles expelled through coughing

or sneezing, preventing the transmission of respiratory diseases. Even face masks that do not fit snugly, for example home-made masks, though inferior to surgical and N95 masks, can prevent the transmission of airborne particles and viruses in the vicinity.^{2,7,8} The most recommended facial masks are the surgical mask for professional use or the N95 while performing potentially aerosol-generating procedures, and the three-layer cloth mask for professional activities in order to protect from the contagion and the proliferation of the virus.⁹

It is known that wearing a face mask causes voice attenuation,¹⁰ which can further lead to increased loudness or vocal intensity. In addition, it can influence other levels of vocal production, generate pneumo-phono-articulatory incoordination, and prevent the visualization of articulation. Vocal misuse and abuse associated with inadequate vocal adjustments and excessive muscle tension may increase the perception of symptoms, discomfort, and even trigger behavioral dysphonia.^{11–14} Thus, the hypothesis of the present study was that the incorrect use of voice associated with wearing a face mask may also be associated with these consequences.

Given the scarcity of scientific evidence, it is necessary to conduct research to identify the potential vocal risks of wearing face masks. Such data will allow clinical practitioners to reflect on guidelines and strategies in voice management while wearing the face mask during the COVID-19 pandemic.

Thus, the aim of the study was to analyze the vocal self-perception of individuals who wore the face mask for essential activities and those who wore it for both professional and essential activities during the COVID-19 pandemic in Brazil.

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MATERIAL AND METHODS

Design

This was the first phase of an observational descriptive cross-sectional hybrid study.

Ethical aspects

This research project was approved by the Research Ethics Committee of the Federal University of Sergipe and followed resolution 466/12 of the National Council of Ethics in Research. All participants were volunteers and digitally signed the Free and Informed Consent Form.

Study participants

Participants were recruited through announcements of the research on media and social networking platforms in Brazil. The collection of data was performed online during the COVID-19 pandemic (April 2020) through Google Forms.

Individuals aged between 18 and 59 years, irrespective of their gender, were invited to participate. The individuals who did not adhere to the informed consent, had an established diagnosis of dysphonia or laryngeal alterations, was diagnosed with COVID-19, and foreigners or non-residents of Brazil were excluded. To meet the selection criteria, the participants answered a sample questionnaire.

There were 561 volunteers who participated in the selection stage, of which 468 met the eligibility criteria. There were 346 women and 122 men (mean age, 36 years and eight months; standard deviation [SD], 10.21). The participants were divided into two groups according to the purpose of wearing the face mask: the Working Group (WG), with 289 individuals who wore the face masks for professional and essential activities during the pandemic; and the Essential Activities Group (EAG), which comprised of 179 individuals who wore the face masks only to perform essential activities during the pandemic. In the present study, visits to health services, purchase of medicines, food and beverages were considered essential activities, and any activity for occupational purposes, including the provision of essential services, was considered professional activities.¹⁵

Outcomes

The outcomes evaluated were self-perception of vocal fatigue; vocal tract discomfort; and vocal effort, speech intelligibility, auditory feedback, and coordination between speech and breathing.

To verify the perception of vocal fatigue while wearing the face mask, all participants answered the Vocal Fatigue Index (VFI), which had been translated to Brazilian Portuguese.¹⁶ The VFI is composed of 17 questions on the frequency of occurrence on a 5-point Likert Scale between zero (never) and four (always) and which must be answered individually. The questions are subdivided into five factors: tiredness and vocal impairment, avoiding use of voice, physical discomfort, improvement of vocal symptoms with rest,

and total. The calculation was performed according to the orientation of the authors.

To verify the perception of vocal tract discomfort while wearing the face mask, all participants responded to the Vocal Tract Discomfort Scale translated into Brazilian Portuguese.¹⁷ The Vocal Tract Discomfort Scale is composed of eight symptoms that should be evaluated individually to assess the frequency and intensity on a 6-point Likert Scale between zero (never) and six (always and/or extreme). The calculation was performed by adding the frequency and intensity of discomfort.

To analyze the self-perception of vocal effort, speech intelligibility, auditory feedback, and coordination between speech and breathing, with and without wearing the face mask, a questionnaire elaborated by the authors was used. The participants evaluated self-perception of the frequency of difficulty in each parameter on a 5-point Likert Scale between zero (never) and five (always).

Participants also answered a characterization questionnaire with questions about: age (years), profession time (years), daily workload (hours), gender (female and/or male), educational level (elementary school and/or high school and/or university education and/or postgraduate studies), workplace during the pandemic (at home and/or regular workplace and/or both), mask type most often used (N95 mask and/or disposable mask and/or cloth mask), adaptation of the mask on the face (loose and/or comfortable/tight).

Data analysis

The data were analyzed with the SPSS version 25.0 (IBM Corporation, Armonk, NY). Descriptive and inferential statistics were used for analysis. The description of the nominal qualitative variables was determined by means of relative and absolute frequency. The description of the quantitative variables was determined by measures of variability (SD), central tendency (mean and median), and position (first and third quartile).

The normality of quantitative variables was analyzed with the Shapiro-Wilk test. The comparison of qualitative and quantitative ordinal variables between the groups was performed with the Mann-Whitney *U* test. The comparison of ordinal qualitative variables with and without wearing the mask in each group was performed with the Wilcoxon Test. The association between the groups and the nominal qualitative variables was performed with the Pearson's chi-squared test. A significance level of 5% was considered in all inferential analyses.

RESULTS

There were 468 Brazilian participants in this study, of which 346 were women and 122 were men, with a mean age of 36 years and 8 months (SD = 10.21). The WG had 289 individuals, with 221 (76.5%) women and 68 (23.5%) men. The EAG comprised of 179 individuals, with 125 (69.8%) women and 54 (30.2%) men.

TABLE 1.
Comparison of the Quantitative Variables of Sample Characterization According to the Group

Variable	Group	Mean	SD	1Q	Median	3Q	P Value
Age (years)	EAG	36.97	10.67	28.00	37.00	46.00	0.576
	WG	36.51	9.92	29.00	35.00	43.00	
Profession time (years)	EAG	12.07	9.56	3.00	10.00	19.00	0.742
	WG	11.62	9.23	4.00	10.00	17.50	
Daily workload (hours)	EAG	6.45	3.32	4.00	6.00	8.00	0.101
	WG	7.77	2.28	6.00	8.00	8.00	

Abbreviations: 1Q, first quartile; 3Q, third quartile; EAG, Essential Activities Group; SD, standard deviation; WG, Work Group. Mann-whitney *U* test.

The groups were homogeneous with regard to age, sex, education, profession time, daily workload, and adaptation to face masks. There was a higher frequency of usage of cloth masks in the EAG ($P < 0.001$), especially by participants who were working from home ($P < 0.001$) (Tables 1 and 2).

As shown in Table 3, there were significantly higher scores of vocal fatigue symptoms in the domains of tiredness and voice impairment ($P = 0.001$), avoidance of voice use ($P = 0.046$), and total ($P = 0.016$) in the WG as compared with the EAG.

There was a significantly higher frequency ($P < 0.001$) and intensity ($P < 0.001$) of vocal tract discomfort in the WG relative to the EAG (Table 4).

There was an increase in vocal effort, difficulty in speech intelligibility, difficulty in coordinating speech, and breathing in both groups, and reduction of auditory feedback when the conditions with and without face masks were compared ($P < 0.001$; Table 5). Higher frequencies of vocal effort ($P = 0.017$), difficulty with speech intelligibility ($P = 0.003$), and difficulty in coordinating speech and breathing ($P = 0.003$) were observed in those wearing the face mask in the WG when compared to the EAG, as shown in Table 6.

DISCUSSION

Using face masks in Brazil, during the existing COVID-19 pandemic, has become mandatory for both essential and professional activities, and it is assumed to continue for a long time. Therefore, it becomes important to identify the consequences of their use for vocal health to provide evidence for the development of strategic measures to optimize vocal use with the face mask.

The results showed more use of the cloth mask by the EAG, during the pandemic. As the market is unable to fulfill the increased demand for masks,⁸ due to its mandatory use, there are recommendations for its home manufacture. For essential activities, World Health Organization recommends the use of a three-layer cloth mask to protect against contagion and virus proliferation.¹

Most of the participants in the EAG reported to be working from home during the pandemic. Several non-essential

sectors have shifted their professional activities to home offices, which has contributed to social distancing measures, and does not require the use of face masks for occupational purposes.¹⁸

The WG had significantly higher scores for symptoms of vocal fatigue for tiredness and voice impairment, avoidance of voice use and total in the WG, in comparison to the EAG. Vocal fatigue is the primary perception of increased vocal effort, which increases with use and improves with rest.¹⁹ It is usually due to increased demand for use or vocal load, leading to the perception of vocal effort or discomfort, decreased flexibility and pitch range, and vocal projection.²⁰ Vocal fatigue is defined as a set of symptoms of self-perception,^{19,21–24} a negative physiological consequence for a vocal load of task¹⁹; a perceived progressive increase in phonatory effort and loss of phonatory skills^{25,26}; and a quantifiable decrease in both in functional performance and voice perception, which influences the vocal task performance.²⁷

Although vocal fatigue can improve with adequate vocal rest,¹⁹ in the present study, there was no improvement of symptoms after rest. Vocal fatigue has three mechanisms: mucosal fatigue, muscle fatigue, and mental fatigue.¹⁹ Mental or central fatigue is related to tiredness and the feeling of effort. Thus, it is believed that during the COVID-19 pandemic, symptoms of vocal fatigue are associated with mental fatigue. There have been several effects of social isolation in the COVID-19 pandemic. The psychological symptoms of depression and anxiety has affected previously healthy people.²⁸ A recent study reported on the influence of stress on vocal health.²⁹ Accordingly, in the present study, there was no difference between the groups regarding the physical discomfort related to fatigue resulting from the use of face masks. However, this information is an extrapolation and cannot be confirmed from the analysis of the present study. Other studies need to investigate the duration of rest and perform a causal analysis to confirm this information.

The use of face masks for professional and essential activities by the participants of the WG increased the tiredness and voice impairment, avoidance of voice used, and total vocal fatigue. However, except for the avoidance of voice used, in which those in the EAG presented borderline values, both groups had scores above the cutoff point in the

TABLE 2.
Comparison of the Qualitative Variables of Sample Characterization According to the Group

Variable			Group		P Value
			EAG	WG	
Gender	Female	n	125	221	0.129
		%	69.8%	76.5%	
	Male	n	54	68	0.217
		%	30.2%	23.5%	
Educational level	Elementary School	n	0	1	0.217
		%	0.0%	0.3%	
	High School	n	18	19	
		%	10.1%	6.6%	
	University Education	n	53	107	
		%	29.6%	37.0%	<0.001*
	Postgraduate Studies	n	108	162	
		%	60.3%	56.1%	
Workplace during the pandemic	At home	n	168	17	<0.001*
		%	93.9%	5.9%	
	Regular workplace	n	6	182	
		%	3.4%	63.0%	<0.001*
	Both	n	5	90	
Mask type		%	2.8%	31.1%	<0.001*
	N95 mask	n	3	41	
		%	1.7%	14.3%	<0.001*
	Disposable mask	n	15	50	
		%	8.4%	17.5%	
Adaptation of the mask on the face	Cloth mask	n	160	195	0.069
		%	89.8%	68.2%	
	Loose	n	11	23	0.069
		%	6.1%	8.0%	
	Comfortable	n	139	196	
		%	77.7%	67.8%	0.069
	Tight	n	29	70	
		%	16.2%	24.2%	

Abbreviations: %, percent; EAG, Essential Activities Group; n, number; WG, Work Group.

Pearson's chi-squared test.

*p<0.05

TABLE 3.
Comparison of Self-Perception of Vocal Fatigue Symptoms According to the Group

Variable	Group	Mean	SD	1Q	Median	3Q	P Value
Tiredness and voice impairment	EAG	7.41	5.74	2.00	7.00	11.00	0.001*
	WG	9.38	6.34	4.00	9.00	14.00	
Avoidance of voice use	EAG	3.54	2.77	1.00	3.00	5.00	0.046*
	WG	4.07	2.89	2.00	4.00	6.00	
Physical discomfort	EAG	1.96	2.59	0.00	1.00	3.00	0.316
	WG	2.28	2.75	0.00	1.00	4.00	
Improvement of voice symptoms with rest	EAG	5.30	4.56	0.00	5.00	10.00	0.079
	WG	6.07	4.42	2.00	6.00	9.50	
Total	EAG	19.61	7.96	13.00	18.00	25.00	0.016*
	WG	21.66	8.99	15.00	21.00	27.00	

Abbreviations: 1Q, first quartile; 3Q, third quartile; EAG, Essential Activities Group; SD, standard deviation; WG, Work Group.

Mann-Whitney U test.

*p<0.05

TABLE 4.
Comparison of Self-Perception of Vocal Tract Discomfort According to the Group

Variable	Group	Mean	SD	1Q	Median	3Q	PValue
VTDS frequency	EAG	4.98	6.18	0.00	3.00	7.00	<0.001*
	WG	7.87	8.36	1.00	6.00	12.00	
VTDS intensity	EAG	9.44	12.35	0.00	5.00	13.00	<0.001*
	WG	14.72	15.70	2.00	10.00	22.00	

Abbreviations: 1Q, first quartile; 3Q, third quartile; EAG, Essential Activities Group; SD, standard deviation; WG, Work Group.

Mann-Whitney *U* test.

* $p < 0.05$

TABLE 5.
Comparison of Self-Perception of Vocal Effort, Difficulty with Speech Intelligibility, Auditory Feedback, and Difficulty to Coordinate Speech and Breathing According to the Use of the Mask

Variable	Group	With Mask					Without Mask					PValue
		Mean	SD	1Q	Median	3Q	Mean	SD	1Q	Median	3Q	
Vocal effort	EAG	1.99	1.21	1.00	2.00	3.00	0.57	0.72	0.00	0.00	1.00	<0.001*
	WG	2.28	1.24	1.00	2.00	3.00	0.66	0.90	0.00	0.00	1.00	<0.001*
Difficulty with speech intelligibility	EAG	1.65	1.12	1.00	2.00	2.00	0.71	0.84	0.00	1.00	1.00	<0.001*
	WG	1.97	1.09	1.00	2.00	3.00	0.83	0.95	0.00	1.00	1.00	<0.001*
Auditory feedback	EAG	2.73	1.35	2.00	3.00	4.00	3.24	1.34	3.00	4.00	4.00	<0.001*
	WG	2.68	1.26	2.00	3.00	4.00	3.24	1.28	3.00	4.00	4.00	<0.001*
Difficulty to coordinate speech and breathing	EAG	1.50	1.27	0.00	1.00	2.00	0.52	0.84	0.00	0.00	1.00	<0.001*
	WG	2.04	1.46	1.00	2.00	3.00	0.74	1.14	0.00	0.00	1.00	<0.001*

Abbreviations: 1Q, first quartile; 3Q, third quartile; EAG, Essential Activities Group; SD, standard deviation; WG, Work Group.

Wilcoxon test.

* $p < 0.05$

TABLE 6.
Comparison of Self-Perception of Vocal Effort, Difficulty with Speech Intelligibility, Auditory Feedback and, Difficulty to Coordinate Speech and Breathing According to the Group

Variable	Group	Mean	SD	1Q	Median	3Q	PValue
Vocal effort (with mask)	EAG	1.99	1.21	1.00	2.00	3.00	0.017*
	WG	2.28	1.24	1.00	2.00	3.00	
Vocal effort (without mask)	EAG	0.57	0.72	0.00	0.00	1.00	0.581
	WG	0.66	0.90	0.00	0.00	1.00	
Difficulty with speech intelligibility (with a mask)	EAG	1.65	1.12	1.00	2.00	2.00	0.003*
	WG	1.97	1.09	1.00	2.00	3.00	
Difficulty with speech intelligibility (without a mask)	EAG	0.71	0.84	0.00	1.00	1.00	0.263
	WG	0.83	0.95	0.00	1.00	1.00	
Auditory feedback (with mask)	EAG	2.73	1.35	2.00	3.00	4.00	0.516
	WG	2.68	1.26	2.00	3.00	4.00	
Auditory feedback (without mask)	EAG	3.24	1.34	3.00	4.00	4.00	0.905
	WG	3.24	1.28	3.00	4.00	4.00	
Difficulty to coordinate speech and breathing (with a mask)	EAG	1.50	1.27	0.00	1.00	2.00	0.003*
	WG	2.04	1.46	1.00	2.00	3.00	
Difficulty to coordinate speech and breathing (without a mask)	EAG	0.52	0.84	0.00	0.00	1.00	0.346
	WG	0.74	1.14	0.00	0.00	1.00	

Abbreviations: 1Q, first quartile; 3Q, third quartile; EAG, Essential Activities Group; SD, standard deviation; WG, Work Group.

Mann-Whitney *U* test.

* $p < 0.05$

other domains of the VFI instrument validated in Brazilian Portuguese.¹⁶ Nevertheless, the WG showed significantly higher values than the EAG, which indicates that the use of the voice associated with the face masks could produce more symptoms of tiredness and restriction related to the vocal use during professional activities. It is hypothesized that these findings may be related to muscle fatigue due to difficulties in the respiratory level, resulting from a reduction in the inspiratory flow. These may also be due to a physical obstacle to the projection in the resonant and/or articulatory level, and the loss of visual feedback and articulatory movements, which can attenuate the sound of the voice with the use of the face mask.¹⁰ As a result, there may be overload at the glottic level, which can increase the effort.

In the present study, WG participants had a higher frequency and intensity of discomfort in the vocal tract than those in the EAG. Discomfort is a subjective and sensory perception, which represents condition that compromises the standard of functionality.³⁰ It can be related to discomfort in the laryngopharyngeal region, or musculoskeletal discomfort.³¹ The discomfort in the vocal tract seems to be less related to the vocal quality and more related to the physical sensations associated with the production of the voice, such as fatigue and effort.¹⁷ The symptoms, evidenced in this research, may be related to the need to increase vocal intensity and inefficient respiratory support during the mask use, in addition to the general body factors. Voice intensity is related to respiratory support and efficiency in glottal closure.³² In the absence of adequate aerial support, excess glottic coaptation is common, generating effort to the emission. Thus, the participants of this research, to compensate for the sound attenuation of their voice because of the mask, used their voice at a higher intensity.

Other aspects were those related to the outcomes of vocal effort, speech intelligibility, auditory feedback, and pneumo-phono-articulatory coordination. Participants from both the groups reported a greater perception of difficulties related to these aspects with face masks. The decrease in auditory feedback may be related to the sound attenuation as previously described. Simple face masks attenuate the sound by 3–4 dB and N95 masks attenuate the sound up to 12 dB. The frequencies most affected are between 2000 and 7000 Hz, which are important for speech intelligibility.¹⁰ The lack of adequate auditory feedback can, therefore, be responsible for changes in vocal quality by reduced vocal monitoring ability.³³

In this research, it was found that the WG had more difficulty in coordinating breathing and speech with the use of the face mask, in comparison to the EAG, perhaps because of the greater amount of voice used and not the vocal demand itself, since the groups did not differ in relation to this variable. The findings infer that the use of the equipment alters the pneumo-phono-articulatory coordination, which results from the harmonic interrelation of the aerodynamic forces of breathing, myoelastic

forces of the larynx and muscle forces of the articulation. The pneumo-phono-articulatory incoordination can markedly compromise speech intelligibility, even when there is discrete deviation.³² In this context, the present study found greater difficulties in speech intelligibility in the WG.

Speech intelligibility is the result of the complex phono-articulatory processes. The face mask is responsible for the decrease of speech intelligibility, since it hinders inspiration, adequate control of breathing and its articulatory pauses, besides attenuating the vocal intensity, restricting the projection of sound in space; and limiting articulatory movements. It also prevents the support of visual articulatory feedback among speakers. The decrease in auditory feedback, the difficulty in speech intelligibility, and the difficulty in coordinating speech and breathing can generate compensatory vocal effort. The concept of vocal effort is multidimensional and is related to individual experience, association of a physiological component with external perception, level of efforts for vocal production, conditions of the communicating environment, and increased vocal load.²⁷

The findings of the present study reflect that the participants who wore a face mask for professional and essential activities, had a higher discomfort in the vocal tract, showed effort when using their voice, had difficulty with speech intelligibility, and coordination of speech and breathing, which was directly related to the vocal fatigue presented. Based on the results of the study, the participants refuted the null hypothesis and accepted the research hypothesis.

The present study has limitations regarding the lack of vocal assessment of the participants, considering the restrictions to the development of research and individual data collection during the pandemic, and regarding the control of the vocal dose. Further research on the topic should be carried out, considering aspects such as influence of sociodemographic, occupational variables and previous vocal characteristics, such as vocal complaints and (or) dysphonia on the impact of wearing a face mask for communication, effects of communication training for vocal improvement with the use of face masks, and longitudinal impact of wearing a face mask on communication, especially after professionals resume work in their usual environments. Such investigations become necessary in view of the current scenario, indicating that the mandatory use of a face mask can last for a long time.

CONCLUSION

The face mask increases the perception of vocal effort, difficulties in speech intelligibility, auditory feedback, and difficulty in coordinating speech and breathing, regardless of the purpose of use. There is a greater perception of symptoms of vocal fatigue and discomfort, effort, difficulties in speech intelligibility, and coordination of speech and breathing in individuals who use the face masks for professional and essential activities.

CONFLICT OF INTEREST

There are no conflicts of interest to declare.

SUPPLEMENTARY DATA

Supplementary data related to this article can be found online at [doi:10.1016/j.jvoice.2020.09.006](https://doi.org/10.1016/j.jvoice.2020.09.006).

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