The Laryngoscope

Prevalence of Voice Disorders in Healthcare Workers in the Universal Masking COVID-19 Era

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Objectives/Hypothesis: To determine the prevalence and associated risk factors of voice disorders in healthcare workers of high-risk hospital care units during the 2019 coronavirus disease (COVID-19) pandemic.

Study Design: Cross-sectional study.

Methods: Questionnaire survey to healthcare personnel of COVID-19 high-risk hospital units was conducted, regarding demographic data, clinical activity, the pattern of usage of personal protective equipment, medical and vocal history, vocal symptoms, and Spanish validated Voice Handicap Index (VHI)-10 questionnaire.

Results: A total of 221 healthcare workers answered the survey. Nearly 33% of them reported having trouble with their voice during the last month, and 26.24% had an abnormal score in the Spanish validated VHI-10 questionnaire. The mean VHI-10 score was 7.92 (95% confidence interval 6.98–8.85). The number of working hours, the number of hours of mask daily use, simultaneous surgical and self-filtering mask use, and working in intermediate or intensive care units were independent variables significantly associated with a higher VHI-10 score.

Conclusions: Healthcare workers of high-risk hospital care units during the universal masking COVID-19 pandemic are at risk of voice disorders.

Key Words: Voice, universal masking, 2019 coronavirus disease, laryngology, otolaryngology.

Level of Evidence: 3

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INTRODUCTION

Novel 2019 coronavirus disease (COVID-19) was declared a pandemic by the World Health Organization on March 11, 2020.[1] This pandemic has changed our clinical practice, imposing the universal and protocolized use of personal protective equipment (PPE) in healthcare professionals. These new standards lead to an increase in the number of hours using face masks during the workday, and the use of more than one PPE simultaneously (surgical masks, self-filtering masks, and face shields) or the use of advanced facial protective equipment (air-purifying respirators).

Reports of adverse effects of prolonged use of PPE in healthcare professionals have been published,[2–5] including headaches, difficulty breathing, acne, skin reactions, and impaired cognition. Still, there are no published data regarding voice disorders as a side effect of prolonged PPE use in healthcare personnel.

Face masks function as an acoustic filter for speech, attenuating high frequencies spoken by the wearer by 3–12 dB,[6] depending on the type of mask (surgical vs. self-filtering). Besides, most COVID-19 hospitalized patients are older adults, with various degrees of hearing loss and consciousness, which added to the noisy environment of intensive care units, and the absence of visual cues because of the use of facial protective equipment renders oral communication very difficult between patients and healthcare professionals.[7]

It has been suggested that to obtain speech understanding of 90% accuracy, the signal must be presented at 10–15 dB above the noise source.[8] Thus, with an average background noise level of 65 dB sound pressure level (SPL), health personnel would have to speak at levels of 80 dB SPL to be understood with 90% accuracy.[8]

To the best of knowledge, the are no published data related to voice disorders in healthcare workers associated to universal masking in the COVID-19 era. We suspect that prolonged use of facial PPE in healthcare professionals poses an occupational health risk of vocal disorders due to the phonotrauma implicated in speaking counteracting the acoustic attenuation generated by them.

We aimed to determine the prevalence of voice disorders in healthcare workers of high-risk hospital care units during the COVID-19 pandemic in a tertiary center in Santiago, Chile, and determine the risk factors associated with these disorders.

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TABLE I.
Voice Handicap Index (VHI)-10 Overall Score Stratified by Self-Perceived Voice Problems.

	Self-Perceived Voice Problems (n)	Proportion (95% CI)	VHI-10 Overall Score (95% CI)
Not reported	147	67.43 (60.90–73.35)	5.66 (4.78–6.53)
Mild	47	21.56 (16.57–27.55)	10.60 (8.40–12.79)
Moderate or severe	24	11.10 (7.47–15.93)	16.16 (13.47–18.86)

MATERIALS AND METHODS

A cross-sectional study was conducted at Universidad Católica Clinical Hospital and San Carlos de Apoquindo Hospital, both tertiary centers in Santiago de Chile. An anonymous, self-administered, 23 item questionnaire survey (available in Appendix S1) was applied between July 22 and August 9, 2020, in the middle of the COVID-19 outbreak in Chile, to healthcare staff who had direct contact with hospitalized patients in high-risk hospital areas who use universal and protocolized PPE: isolation general wards, intermediate and intensive care units. At our institution, the working hours are divided into three types of schedules: 44 hours/week shift with 8 hours daily, 22 hours/week shift with 4 hours daily, and fourth shift modality with 24 hours on-duty followed by 3 days off. All subjects participated in the study voluntarily and signed informed consent. This study was approved by the ethics committee in the Faculty of Medicine of Pontificia Universidad Católica de Chile (protocol number 200705001). Given that the prevalence of voice disorders in this population is unknown, corrected sample size in finite population calculation was performed considering a 50% prevalence, which determined a target sample size of 218 participants. The survey collected information about demographic data, clinical activity (occupation, unit, hours per shift), PPE usage pattern (type of PPE, hours of use, combined use), medical and vocal past history, tobacco use, personal view regarding the presence of vocal problems and severity during the last month, vocal symptoms during last month, own opinion regarding the existence of vocal symptoms the same period the previous year, and Spanish validated Voice Handicap Index (VHI)-10 questionnaire.[9]

Statistical Analyses

An exploratory data analysis was carried out, checking for atypical values and determining the distribution of the continuous quantitative variables. Descriptive statistics were estimated

TABLE II.
Univariate and Multivariate Linear Regression Analyses for the VHI-10 Overall Score (Dependent Variable) and the Independent Variables of Sociodemographic and Working Characteristics (n = 221)*,†,‡.

	Descriptive Statistics, n (%)	Univariate Models (95% CI)	*P* Value	Multivariate Model§ (95% CI)	*P* Value
Gender					
Females	167 (75.57)	Reference	.140		
Males	54 (24.43)	−1.56 (−3.52–0.64)			
Age (median, 25th–75th percentiles)	32 (28–39)	−0.04 (−0.132–0.08)	.444		
Healthcare personnel					
Nurses	89 (40.83)	Reference		Reference	
Physicians	21 (9.63)	**−4.59 (−8.03 to −1.16)**	**.009**	−3.82 (−8.74–1.08)	.126
Medical residents	14 (6.42)	**−3.40 (−5.64 to −1.17)**	**.003**	−2.38 (−6.27–1.51)	.229
Physical therapists	18 (8.26)	−1.04 (−5.21–3.14)	.627	−1.40 (−7.83–5.01)	.666
Speech language pathologists	12 (5.50)	**−5.59 (−8.12 to −3.07)**	**<.001**	−2.52 (−7.04–1.99)	.271
Nursing assistants	64 (29.36)	−0.64 (−2.90–1.63)	.582	−0.58 (−2.89–1.73)	.623
Number of working hours					
44 hours	64 (33.16)	Reference		Reference	
Fourth shift¶	126 (65.28)	**2.41 (0.11–4.42)**	**.025**	−0.64 (−2.70–3.98)	.705
22 hours	3 (1.55)	**−5.26 (−7.49 to −1.71)**	**<.001**	**−3.11 (−5.96 to −0.26)**	**.033**
Clinical unit					
Intensive care unit	118 (53.64)	Reference		Reference	
Intermediate care unit	66 (30.00)	−0.35 (−2.19–1.69)	.731	−1.59 (−3.75–0.58)	.187
General ward	33 (15.00)	**−3.86 (−6.00 to −1.40)**	**.001**	−2.34 (−5.72–1.04)	.105
Other unit	3 (1.36)	2.47 (−6.58–19.44)	.740	4.79 (−12.85–22.43)	.651
Type of patients					
Children	46 (20.91)	Reference			
Adults	171 (77.73)	−1.24 (−3.91–1.07)	.332		
Both	3 (1.36)	−1.93 (−9.34–11.68)	.736		

*The standard error of linear models was estimated with bootstrapping (10,000 replications). The 95% CI was calculated using a bias-corrected and accelerated method.
†Variables significantly associated with VHI-10 overall score in bold.
‡Missing data were not incorporated into the analyses.
§The multivariate model only included variables that were associated with the VHI-10 overall score in the univariate models.
¶Corresponds to 24 working hours followed by 3 days free.

using the mean and standard deviation (SD) for continuous variables with a normal distribution and the median and interquartile range (IQR) (25th and 75th percentiles) for variables with a biased distribution. In the case of categorical variables, the relative and absolute frequencies were obtained.

Univariate regression models were built to assess the association between the VHI-10 overall score (dependent variable) and each of the independent variables of interest: sociodemographic variables (gender and age), working characteristics (healthcare personnel, number of working hours, clinical unit, and type of patients), and mask and face shield use characteristics (frequency of daily mask use, mask type, simultaneous mask use, face shield use, frequency of mask along with face shield use). Then a multivariate regression model was constructed with the factors significantly associated with the VHI-10 overall score in the univariate models. Wald's test was applied to assess the linear trend of increase VHI-10 scores across daily mask use frequency, considering this variable (ordinal) as a continuous variable. As the distribution of the dependent variable was non-normal, the standard error of linear regression models was estimated through bootstrapping (10,000 replications). The 95% confidence intervals (CIs) were calculated using the bias-corrected and accelerated method.[10,11] Collinearity was explored among the independent variables included in the models, and it was evaluated using a variance inflation factors test.

Then, the VHI-10 questionnaire's overall score was dichotomized, considering its cut-off is 11 points. Univariate and multivariate logistic regression models were built to assess the association between scores over the cut-off of 11 points (dependent variable), and the independent variables of sociodemographic, working characteristics, and mask and face shield characteristics were constructed. Odds ratios with 95% CI were calculated. The Hosmer-Lemeshow test was used to assess the goodness-of-fit of the multivariate logistic regression models. A good model fit as measured by Hosmer and Lemeshow's test will yield a *P*-value >.05.

RESULTS

Approximately 500 high-risk healthcare workers were invited to participate in the study, with 221 agreeing, giving an overall response rate of approximately 44%. One hundred and sixty-seven (75.57%) subjects were females. The mean age of the respondents was 32 years (IQR: 28–39 years). Eighty-nine (40.83%) respondents were nurses, 64 (29.36%) were nursing assistants, 21 (9.63%) physicians, 18 (8.26%) physical therapists, 12 (5.50%) speech pathologists, and 14 (6.42) were medical residents. The majority of participants (n = 201, 90.95%) reported using face masks between 8 and 12 hours per work day, 17 (7.69%) between 4 and 8 hours, and 3 (1.36%) between 1 and 4 hours per work day. The use of surgical mask and self-filtering mask simultaneously was reported by 139 (62.98%) of respondents, while 44 (19.91%) used a self-filtering mask only, 36 (16.29%) used a surgical mask only. Of those who used both masks simultaneously, 77.36% reported using the surgical mask over self-filtering mask,

TABLE III.
Univariate and Multivariate Linear Regression Analyses for the VHI-10 Overall Score (Dependent Variable) and the Independent Variables of Mask and Face Shield Use Characteristics (n = 221)*,†,‡.

	Descriptive Statistics, n (%)	Univariate Models (95% CI)	*P* Value	Multivariate Model§ (95% CI)	*P* Value
Frequency of mask daily use					
1–4 hours	3 (1.36)	Reference		Reference	
4–8 hours	17 (7.69)	**4.02 (1.14–6.91)**	**.008**	**5.83 (2.38–10.37)**	**.003**
8–12 hours	201 (90.95)	**5.80 (3.59–7.32)**	**<.001**	**7.51 (5.33–11.43)**	**<.001**
Mask type					
Self-filtering and surgical used simultaneously	139 (63.47)	Reference		Reference	
Only self-filtering	44 (20.09)	−0.75 (−3.18–2.10)	.579	−0.17 (−3.62–4.37)	.936
Only surgical	36 (16.44)	**−2.77 (−4.52 to −0.79)**	**.004**	−1.79 (−5.52–2.63)	.384
Simultaneous mask use					
Not simultaneous use	82 (37.10)	Reference		Reference	
Over self-filtering	122 (55.45)	1.51 (−0.72–3.50)	.152	1.08 (−2.64–5.72)	.597
Over surgical	36 (16.36)	**3.43 (0.49–6.25)**	**.024**	3.35 (−0.97–7.65)	.121
Face shield use					
Not used	28 (12.67)	Reference			
Used	193 (87.33)	0.37 (−2.87–2.77)	.790		
Frequency of mask along with face shield use					
<1 hours	15 (7.61)	Reference			
1–4 hours	43 (21.83)	−1.94 (−6.49–1.82)	.352		
4–8 hours	69 (35.03)	−0.29 (−4.40–3.46)	.885		
8–12 hours	70 (35.53)	0.41 (−3.64–4.11)	.841		

*The standard error of linear models was estimated with bootstrapping (10,000 replications). The 95% CI was calculated using a bias-corrected and accelerated method.

†Variables significantly associated with VHI-10 overall score in bold.

‡Missing data were not incorporated into the analyses.

§The multivariate model only included variables that were associated with the VHI-10 overall score in the univariate models.

and 22.64% used self-filtering masks over surgical mask. One hundred and ninety-three (87.33%) declared the use of a face shield. Eleven (4.98%) of the surveyed subjects reported a previous vocal diagnosis (four subjects with vocal nodules, one with muscle tension dysphonia, one vocal polyp, and one vocal cord paralysis; the rest did not specify the diagnosis), and nine (4.07%) reported recalling having voice problems the same period last year.

Self-Perceived Voice Symptoms and VHI-10 Scores

When asked if they have noticed any trouble with their voice during the last month, 147 (67.43%) responded negatively, 47 (21.56%) reported mild symptoms, and 24 (11.10%) moderate or severe symptoms (Table I). Participants were asked four questions about vocal symptoms and severity during last month: "I feel my voice more hoarse," "I run out of my voice during the workday," "I experience pain when I talk," and "I make more effort to speak." The statements related to vocal fatigue ("I run out of my voice during the work day") and vocal effort ("I make more effort to speak") had the highest scores.

All subjects responded the Spanish validated VHI-10 questionnaire,[9] and 58 (26.24%) had an abnormal score (>11) according to normative data.[12] The mean VHI-10 score was 7.92 (95% CI 6.98–8.85). The VHI-10 overall score for those who did not report a voice problem was 5.66 (95% CI 4.78–6.53), increasing to 12.48 (95% CI 10.68–14.28) for the group with self-perceived voice problems (Table I). The individual statements with the higher scores were "People have difficulty understanding me in a noisy room" and "My voice makes it difficult for people to hear me." Only four (6.89%) of the participants with an abnormal VHI-10 score had a previous vocal diagnosis, and three (5.17%) recalled having trouble with their voice the same period last year.

Sociodemographic and Working Characteristics Associated With the VHI-10 Overall Score

In the univariate linear models, the number of working hours was significantly associated with the VHI-10

TABLE IV.
Univariate and Multivariate Logistic Regression Analyses for Scores Over the Cut-Off (Dependent Variable) and the Independent Variables of Sociodemographic and Working Characteristics (n = 221)*,†.

	VHI >11 Points, n (%)	Univariate Models, OR (95% CI)	*P* Value	Multivariate Model‡,§, OR (95% CI)	*P* Value
Gender					
Females	46/164 (28.05)	Reference	.402		
Males	12/54 (22.22)	0.73 (0.35–1.51)			
Age	–	0.99 (0.96–1.02)	.523		
Healthcare personnel					
Nurses	33/89 (37.08)	Reference			
Physicians	3/21 (14.29)	0.28 (0.08–1.03)	.056		
Medical residents	2/14 (14.29)	0.28 (0.06–1.34)	.112		
Physical therapists	5/18 (27.78)	0.65 (0.21–2.00)	.454		
Speech language pathologists	Without observations	–	–		
Nursing assistants	15/61 (24.59)	0.55 (0.27–1.14)	.109		
Number of working hours					
44 hours	12/64 (18.75)	Reference		Reference	
Fourth shift¶	40/123 (32.52)	**2.09 (1.01–4.34)**	**.049**	1.53 (0.75–3.13)	.241
22 hours	Without observations	–	–	–	–
Clinical unit					
Intensive care unit	36/115 (31.30)	Reference		Reference	
Intermediate care unit	17/66 (25.76)	0.76 (0.39–1.50)	.431	0.63 (0.30–1.35)	.236
General ward	3/33 (9.09)	**0.22 (0.06–0.77)**	**.017**	**0.21 (0.05–0.93)**	**.040**
Other unit	1/3 (33.33)	1.10 (0.96–12.50)	.940	2.27 (0.18–29.06)	.529
Type of patients					
Children	14/44 (31.82)	Reference			
Adults	43/170 (25.29)	0.73 (0.35–1.49)	.384		
Both	1/3 (33.33)	1.07 (0.09–12.83)	.957		

*Variables significantly associated with scores over the cut-off in bold.
†Missing data were not incorporated into the analyses.
‡The multivariate model included variables that were associated with scores over the cut-off in the univariate models.
§The Hosmer-Lemeshow goodness-of-fit test was non-significant (*P* = .3168).
¶Corresponds to 24 working hours followed by 3 days free.

overall score (Table II). Healthcare personnel who worked 22 hours per week obtained significantly lower scores (mean −5.26; 95% CI −7.49 to −1.71) than those who worked 44 hours per week. Also, those who worked 24 hours, followed by 3-day free ("fourth shift"), had 2.41 (95% CI 0.11–4.42) more points than their counterparts who worked 44 hours per week. Other variables with a significant association with the VHI-10 overall score in the univariate linear models included the healthcare personnel –physicians, medical residents, and speech-language pathologists showing significantly lower scores than nurses – and the clinical units – working in general ward showing significantly lower scores than those in intermediate and intensive care units-.

In the multivariate linear model, the difference between 22 and 44 hours worked per week remained statistically significant (mean −3.25; 95% CI −6.19 to −0.30).

Mask and Face Shield Characteristics Associated With the VHI-10 Overall Score

In the univariate linear models, hours of mask daily use were positively and significantly associated with the VHI-10 overall scores (*P*-trend = .012). Both 4–8 (mean 4.02; 95% CI 1.14–6.91) and 8–12 hours (mean 5.80; 95% CI 3.59–7.32) of mask daily use showed highest scores than those who used it for 1–4 hours (Table III). Other variables significantly associated with the VHI-10 overall score in the univariate models were the mask type and the simultaneous mask use (self-filtering mask over surgical mask with significantly highest scores). The use of only a surgical mask showed 2.77 (95% CI −4.52 to −0.79) fewer points than simultaneous mask use.

In the multivariate linear model, the differences between hours of daily mask use remained statistically significant. Daily mask use of 8–12 hours represented an increment of 7.51 (95% CI 5.33–11.43) points compared to healthcare personnel that used it for 1 to 4 hours.

Sociodemographic and Working Characteristics Associated With a VHI-10 Score Over the Cut-Off

In the univariate logistic models, the number of working hours was significantly associated with the VHI-10 score over the cut-off (Table IV). Healthcare personnel who worked in a "fourth shift" showed an odds ratio (OR) of 2.09 (95% CI 1.01–4.34) to have a score over the cut-off, compared to those who worked 44 hours per week. Also, working in a general ward had 80% fewer odds (OR = 0.22; 95% CI 0.06–0.77) of having a score over the cut-off. In the multivariate logistic model, this difference related to the clinical unit remained statistically significant.

TABLE V.
Univariate and Multivariate Logistic Regression Analyses for Scores Over the Cut-Off (Dependent Variable) and the Independent Variables of Mask and Face Shield Use Characteristics (n = 221).*,†

	VHI >11 Points, n (%)	Univariate Models, OR (95% CI)	*P* Value	Multivariate Model‡,§, OR (95% CI)	*P* Value
Frequency of mask daily use					
1–4 hours	Without observations				
4–8 hours	3/17 (17.65)	Reference			
8–12 hours	55/198 (27.78)	2.19	.187		
Mask type					
Self-filtering and surgical used simultaneously	41/137 (29.93)	Reference		Reference	
Only self-filtering	5/43(11.63)	0.90 (0.40–2.04)	.801	1.32 (0.45–3.87)	.610
Only surgical	10/36 (27.78)	**0.31 (0.11–0.84)**	**.021**	0.59 (0.15–2.39)	.461
Simultaneous mask use					
Not simultaneous use	10/61 (16.39)	Reference		Reference	
Over self-filtering	33/122 (27.05)	1.89 (0.86–4.15)	.112	1.99 (0.54–7.28)	.301
Over surgical	15/34 (44.12)	**4.03 (1.54–10.49)**	**.004**	**4.16 (1.11–15.64)**	**.035**
Face shield use					
Not used	4/27 (14.81)	Reference			
Used	54/191 (28.27)	2.27 (0.75–6.86)	.148		
Frequency of mask along with face shield use					
<1 hours	5/15 (33.33)	Reference			
1–4 hours	9/43 (20.93)	0.53 (0.14–1.94)	.338		
4–8 hours	19/67 (28.36)	0.79 (0.24–2.62)	.702		
8–12 hours	22/70 (31.43)	0.92 (0.28–3.00)	.886		

*Variables significantly associated with scores over the cut-off in bold.
†Missing data were not incorporated into the analyses.
‡The multivariate model included variables that were associated with scores over the cut-off in the univariate models.
§The Hosmer-Lemeshow goodness-of-fit test was non-significant (*P* = .3168).

Mask and Face Shield Characteristics Associated With a VHI-10 Score Over the Cut-Off

In the univariate logistic models, the mask type and simultaneous mask use were significantly associated with the VHI-10 score over the cut-off (Table V). The use of a surgical mask had 69% fewer odds (OR = 0.22; 95% CI 0.06–0.77) of having a score over the cut-off, compared to simultaneous mask use. And those that used a self-filtering mask over a surgical mask showed an odds ratio of 4.03 (95% CI 1.54–10.49) to have a score over the cut-off, compared to no simultaneous mask use. In the multivariate logistic model, only this difference related to simultaneous mask use remained statistically significant.

DISCUSSION

Our study presents the first epidemiological investigation of the prevalence of voice disorders in healthcare workers in the COVID-19 pandemic universal-masking era. Our sample size is representative of healthcare workers of high-risk hospital care units during the COVID-19 pandemic in a tertiary center in Santiago, Chile. However, a volunteer bias may exist because of the voluntary questionnaire methodology, meaning that the proportion of participants who have had voice symptoms during the last month is likely to be higher. Another limitation is the lack of a control group of healthcare workers without face mask use; this was not possible due to PPE's sanitary requirement of during the pandemic. Unfortunately, the baseline prevalence of voice disorders in healthcare workers has not been reported previously to the COVID-19 arrival.

Prevalence

Nearly 33% of healthcare personnel reported trouble with their voice during the last month, which is higher than the prevalence of voice disorders in the general population reported in the literature. Bhattacharyya reported a 7.6% prevalence of voice problems in adult population surveyed in the United States.[13] Another epidemiologic telephone-survey study conducted by Roy et al. in 2005 reported that almost 30% of the adult population in Utah has experienced a voice disorder during their lifetime, and nearly 7% reported a current voice problem.[14] Smith et al. compared the frequency of reported voice symptoms in teachers to a control group, showing that teachers were more likely to report having voice problems (15% vs. 6% in the control group).[15] This results are similar to those published by Roy et al. in 2004, reporting a prevalence of current voice problems in teachers of 11%, versus a 6.2% in nonteachers.[16] There are no published data on prevalence of reported voice disorders in the general adult population in Chile, and there are no reports of the prevalence of voice disorders in healthcare workers in the literature.

According to the VHI-10, there is a 26.24% prevalence of voice disorders in our population of healthcare workers. This result is comparable to other studies evaluating occupational voice users with VHI-10, like US 911 emergency telecommunicators[17] (24.64%), French tour guides[18] (21.29%), and Brazilian teachers (21.30%).[19] Our study was conducted in the middle of the COVID-19 outbreak in Chile under national universal masking regulations, so we could not establish a control group of healthcare workers who did not use PPE. In the absence of a control group in our study, we compared our results with the control group used in the Spanish validation of VHI-10 questionnaire[9] study, reporting a mean VHI-10 of 2.2 (SD 2.6), which is 5.72 points lower than the mean VHI-10 reported in our study (95% CI 3.45–7.98; $P < .001$). Besides, the vast majority of participants who reported trouble with their voice during the last month, or had an abnormal VHI-10 score, did not have a previous vocal diagnosis or recalled having trouble with their voice the same period last year, suggesting de novo PPE-associated vocal disorders in this population.

These results tend toward our hypothesis that healthcare workers of high-risk hospital care units with prolonged used of PPE have a higher risk of suffering from voice disorders than the general population, and are comparable to other occupational voice users. This observation is consistent with the main vocal symptoms reported by participants being related to vocal fatigue and vocal effort, and in the VHI-10 questionnaire the statements with the higher scores being "People have difficulty understanding me in a noisy room" and "My voice makes it difficult for people to hear me," both functional domains.

Risk Factors

The number of working hours, the hours of mask daily use and simultaneous mask use were independent variables significantly associated with higher VHI-10 overall and over the cut-off scores, and thus on patients' vocal handicap perception. These findings are in agreement with a dose–response voice handicap associated with face mask use in this population, which supports our hypothesis of an occupational health risk of vocal disorders.

With simultaneous mask use, using a self-filtering mask over a surgical mask had significantly higher scores than those who used them the other way. The rationality of using a surgical mask over a self-filtering mask is to extend the lifetime of the self-filtering mask resource by discarding the surgical mask after a high-risk contact with a patient. However, the use a self-filtering mask over a surgical mask (reported by 22.64% of those with simultaneous mask use), has no known rationality regarding the effectiveness of protection or resource considerations, and was associated with higher VHI-10 scores. Besides acting as an acoustic filter attenuating the volume of the voice, we hypothesize that face masks may also affect voice emission by altering the phono-respiratory coordination in the user. Studies of face-masks aerodynamics have demonstrated that inhaling with these devices generates a pressure drop across the mask,[20,21] requiring a more considerable inhalation effort by the wearer.[22] Furthermore, this phenomenon could be exacerbated when combining two face masks, in agreement with our findings, with the highest VHI-10 scores seen when the more collapsible surgical mask is used below the more rigid self-filtering mask, versus using them in the other way. These findings could imply generating a recommendation against using a self-filtering mask over surgical mask when combined mask use.

Our study highlights the lack of evidence regarding the voice health of personnel subject to working with face masks in general, and in particular of healthcare workers. It also raises the question of whether this population should be considered occupational voice users since it is very likely that the universal and protocolized masking era will be the standard in the clinical practice of healthcare workers in the future. Further studies are needed to gather more evidence of the vocal disorders associated to the use of masks, and raise the awareness of the potential professional vocal risks in healthcare workers.

CONCLUSIONS

We describe the first series of voice disorders prevalence in healthcare professionals during the universal masking COVID-19 pandemic. In our study, the prevalence of voice disorders in healthcare personnel was higher than the previously reported in the general population. Attention should be taken regarding the possible occupational association between voice problems and face mask use.

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