

# Effects of Virtual Teaching on Swedish Teachers' Voices During the COVID-19 Pandemic

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**Summary: Purpose.** Since the beginning of 2020, teachers all over the world have had to switch over to virtual teaching because of the COVID-19 pandemic. This change of teaching mode has unknown consequences on the vocal health of teachers who already experience voice disorders at a rate nearly double that of the general population. Therefore, the purpose of this study is to investigate teachers' self-reported voice problems during virtual teaching compared to face-to-face teaching and how they are associated to perceived risk factors in the work environment.

**Method.** Participants included 141 teachers (49 males, 92 females) in high schools and higher education in Sweden who responded to an internet-based survey. Information was collected about participants' self-reported voice handicap using a translated version of the Voice Handicap Index-10 (VHI-10). Information about self-reported VTD (Vocal Tract Discomfort) symptoms and dysphonia was collected in regard to both modes of teaching (virtual vs face-to-face). The survey also included questions on risk factors related to vocal health.

**Results.** Self-reported voice handicap and VTD symptoms were slightly lower during periods of virtual teaching compared to periods of face-to-face teaching. There was a lower frequency of dysphonia symptoms during virtual teaching compared to face-to-face teaching, however the difference was not statistically significant. In addition, 34% of teachers reported experiencing more voice problems when teaching face-to-face while 15% reported more voice problems when teaching virtually. The most reported VTD symptoms during both virtual and face-to-face teaching were having a dry and a tight throat. The dysphonia symptoms with the highest reported frequency were a tense voice and hoarseness in both modes of teaching. Risk factors associated with higher prevalence of voice symptoms and/or higher levels of voice handicap during virtual teaching were air quality and straining the voice while teaching face-to-face. In addition, those teachers who reported more voice problems while teaching virtually also reported feeling more stressed.

**Conclusion.** The results showed a slight decrease in voice symptoms and voice handicap during virtual teaching compared to face-to-face teaching. Although multifactorial, results suggest that a potential positive effect may be attributed to better air quality in the work environment and more favorable acoustic conditions preventing teachers from straining their voice.

**Key Words:** COVID-19—Distance learning—Dysphonia—Phonotrauma—Teachers—Voice—Work environment.

## INTRODUCTION

During the year of 2020, schools all over the world made a sudden shift from face-to-face teaching in the classroom to virtual teaching as one of many measures to prevent the spread of COVID-19. Using digital live-interaction tools such as Google Meet and Zoom, education could be maintained throughout the pandemic.<sup>2</sup> The way countries have handled the pandemic in terms of restrictions and recommendations have varied. In Sweden, high schools and institutions of higher education, such as universities, were recommended by the National Health Agency to switch to virtual teaching in March 2020.<sup>3</sup> Recommendations in high schools, for example, were changed several times following the waves of the pandemic and also differed greatly among

schools.<sup>4</sup> However, institutions of higher education were continuously recommended to conduct virtual teaching up until June 1, 2021.<sup>5</sup> Regardless, the COVID-19 pandemic has resulted in a widespread use of virtual platforms as a mode of delivering education which is likely to continue as part of an increasingly digital society.<sup>6</sup>

Arguably, the group most affected by the sudden shift to a virtual teaching platform is teachers. Clearly, teachers rely on their voice to deliver the educational content and the effects of shifting to a virtual platform on teachers' voices are unknown. What is known, however, is that prior to the pandemic, numerous studies have shown that teachers are at a higher risk of developing voice problems or voice disorders compared to other professions. The prevalence of having a current voice problem has been estimated to be 11-16% in teachers compared to 6-7.5% in the general population.<sup>7-10</sup> Approximately 60% of teachers report having experienced voice problems or voice disorders during their lifetime versus around 30% in the general population.<sup>7,11</sup> In Sweden, it has been estimated that 13% of teachers experience voice problems sometimes, often or always.<sup>12</sup> Further, teachers report a higher number of past and present voice symptoms compared to other professions and more often relate these voice

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symptoms to their occupation.<sup>7,10</sup> Teachers are also more likely to have consulted a professional for their voice problem or to have gone through voice rehabilitation/training in the past, compared to other professions.<sup>8,11,13</sup> Finally, research shows that teachers feel more limited in their work, miss more days of work and more often consider changing occupations because of their voice problems compared to non-teachers.<sup>7,10,12,14</sup> Needless to say, voice problems pose a significant problem to those working in the field of education.

### Vocal symptoms

In addition to constituting an obstacle in day-to-day life, voice problems observed by teachers often include physical symptoms. Commonly reported voice symptoms in teachers include hoarseness, dryness in the throat, vocal fatigue, throat discomfort, roughness and dysphonia.<sup>13,15-17</sup> To better elucidate the presence of these and other symptoms commonly associated with throat discomfort secondary to a voice disorder, Mathieson et al (2009)<sup>48</sup> developed the Vocal Tract Discomfort (VTD) Scale which aimed to “quantify the severity and frequency of an individual’s throat discomfort using qualitative descriptors” (p.354) with the authors stipulating that ‘discomfort’ is akin to low-level pain and reckoning that most people can reliably indicate if they are experiencing discomfort. Other research has shown a significant correlation between self-reported voice problems in teachers and frequency and intensity of VTD, with the most common VTD symptoms being irritable throat and dryness.<sup>17</sup> Korn et al<sup>18</sup> also found that 50.8% of university teachers experience pain or irritation in the throat. Self-reported voice symptoms in teachers are also correlated to a higher Voice Handicap Index (VHI), suggesting that these symptoms are associated with impairments in functional, physical, and emotional aspects of everyday life.<sup>15,19</sup> Thus, voice problems in teachers may present themselves in various ways.

### Vocal load and fatigue

Not surprisingly, the amount of vocal load, or the perception of vocal effort,<sup>20</sup> together with the phonation technique used when teaching is highly related to the development of voice problems in teachers. For example, one of the most important contributing factors to vocal fatigue is extended periods of phonation.<sup>21</sup> In this sense, vocal fatigue is defined as a common voice symptom in professional voice users (eg, teachers) characterized by physical changes following excessive vocalization.<sup>20</sup> In addition, strategies used to compensate for the extensive vocal use, such as excessive muscular tension and unfavorable posturing of the vocal folds, also have deleterious effects on the voice.<sup>21</sup> Furthermore, a sub-optimal technique has been shown to be an important factor in occupational dysphonia, or those occupations in which people rely on their voice for their work.<sup>13</sup> Additionally, Kooijman et al<sup>22</sup> states that physical factors seem to play a large role in the development of voice problems in teachers, such as problems with the mucosa because of intensive vocal

use (eg, increase in vocal pitch during the workday) and problems with the neck, shoulders and lower back. Cardoso et al<sup>23</sup> also showed that efficient voice production can only be obtained by using good posture when speaking. While this may seem intuitive, it has been reported that over 40% of teachers hold their head in an undesirable posture while teaching or use other undesirable postures such as hunched upper back, raised shoulders and twisted torso.<sup>24</sup> In fact, Rantala et al<sup>24</sup> found that using a combination of three or more of these unfavorable postures while teaching was associated with a higher sound pressure level (SPL) and increased voice breaks. Considering the amount of vocal load the teaching profession entails, it is vital that teachers are informed and receive training regarding the importance of a proper voice technique and posture while working.

### Risk factors for voice disorders in teachers

Several other potential risk factors of teachers developing voice problems have been identified in the research. For example, factors related to classroom environment, such as a high number of students, noise level and temperature changes, have been identified as factors that may predispose teachers to a voice disorder.<sup>14</sup> In addition, Giannini et al<sup>25</sup> found that poor classroom acoustics were associated with voice disorders in teachers. This is congruent with previous results which showed that poor room acoustics and an unfavorable working environment, as perceived by the respondents, were more noticeable in teachers with voice problems compared to teachers without voice problems.<sup>12</sup> The number of known classroom-related risk factors in a teachers’ working environment, related to working culture, working posture and indoor air quality, has also been shown to correlate to a higher SPL in teachers.<sup>26</sup> This translates to increased vocal loading which may lead to increased vocal damage. Additionally, it has been shown that using a face mask is associated with vocal fatigue and perceived voice problems.<sup>27,28</sup> Clearly, this is an important factor to consider during the current pandemic as some teachers are obliged to wear masks while teaching. Furthermore, other research has found that psycho-emotional aspects such as high workload, stress and emotions are also important risk factors for teachers in developing voice problems.<sup>22</sup> Such psycho-emotional factors coupled with a noisy working environment, air pollution, and other personal habits have, in fact, been shown to be associated with increased throat pain or irritation in university teachers.<sup>18</sup> Lastly, hydration and access to water are also factors related to voice quality and the presence of pain and irritation in the throat.<sup>18,29</sup> In sum, the reason for teachers’ increased vulnerability to voice problems is certainly multifactorial.

### Impact of voice disorders on quality of life

There are a number of factors that affect teachers’ lives as a consequence of their voice disorders. For example, several studies have shown conclusive data regarding voice-related absenteeism in teachers, reporting that approximately 20-

30% of teachers have had to take sick leave at least once during their career because of their voice problems.<sup>10,14,30</sup> Furthermore, a survey in 2002 found that teachers with voice disorders reported higher sick leave, larger impact on job performance, reduced social activities, and increased negative emotions.<sup>31</sup> Kruschke et al<sup>32</sup> also concluded that patients with a voice disorder reported lower scores in their health-related quality of life (HRQOL). In a similar study, significant differences in HRQOL were seen between patients with dysphonia and healthy controls, especially regarding the variables of bodily pain, physical role and social functioning.<sup>33</sup> Additionally, Smith et al<sup>34</sup> found that 75% of treatment seeking adults with voice problems reported that their voice problems affected their social interactions leading to isolation, 65% described a moderate to high depression because of their voice problems and 61% reported a negative impact on their professional self-esteem. Finally, teachers' voice problems represent a financial load to society in that teachers take sick leave and time off to receive medical attention for their voice disorders, all resulting in possible need for replacement teachers.<sup>14,35</sup> Clearly, teachers can be widely affected by their voice problems in different ways, including professional, financial, emotional and social.

### Impact of voice disorders on listeners

Aside from the obvious impact on the teacher and their overall livelihood, voice disorders also have been shown to have a significant impact on the listener. Considering that the primary job of a teacher is to convey information through verbal means, the disordered voice signal can have significant deleterious consequences. For example, listening to dysphonic speakers requires greater processing time and yields a higher number of errors in intelligibility among adult listeners.<sup>36,37</sup> Additionally, children who listened to a dysphonic voice while receiving instructions showed lower scores in more difficult tasks and self-corrected more often during easier tasks.<sup>38</sup> The authors of that study concluded that listening to a dysphonic voice might force the child to devote more cognitive effort in processing the vocal signal at the cost of comprehension.<sup>38</sup>

### Virtual teaching

There are several ways in which switching to virtual teaching may have an impact on teachers' voices, especially regarding changes in the work environment and work habits. Online teaching typically involves the instructor sitting at a computer, possibly with an undesirable posture, for extended periods. As mentioned earlier, poor posture has been shown to have a negative effect on phonation technique which in turn could lead to more voice problems.<sup>23,24</sup> Using a virtual platform also entails large differences in the way teachers interact with students and in the teaching environment, including noise level, room acoustics, and air quality. All of which have been shown to have a negative influence on teachers' voices.<sup>25,39</sup> In addition, although

virtual instruction has been used in education for a long time, not all teachers have the same amount of experience and some have had trouble adapting to the new technology and ways of interacting with students on a virtual platform.<sup>40</sup> According to Penado Abilleira et al,<sup>41</sup> the term "techno-stress" or "techno-strain" has been used to describe negative feelings, such as stress, anxiety or fatigue, related to the use of technology. Feelings of inadequacy and a lack of confidence regarding the use of technology were found in university teachers as a result of teaching virtually during the pandemic, especially in older teachers and those with more years of experience.<sup>41</sup> Effectively, while some take technological skills for granted, some teachers might experience increased levels of stress and/or anxiety following the sudden switch to virtual teaching, both of which have been shown to relate to voice problems.<sup>18,22</sup> In sum, a change in mode of teaching could have an effect on multiple factors related to vocal health.

### Impact of virtual teaching on teachers' voices

Currently, there is a nascent body of research on the effects of working virtually on people's voices. Using survey data from 1575 people in Ireland, Kenny<sup>42</sup> found an increased prevalence and incidence of dysphonia and VTD. The self-reported prevalence of dysphonia was 33%, out of which 85% had developed their voice problem after the beginning of the lockdown.<sup>42</sup> Results also showed that subjects who reportedly raised or strained their voice during telephone or video calls were the most likely to develop a new onset of dysphonia and VTD and that stress and poor air quality were also factors associated with reported new onsets of dysphonia and VTD.<sup>42</sup> Furthermore, research from Brazil that included 424 respondents who were interviewed while working from home during the pandemic showed that participants experienced more vocal fatigue and higher vocal impairment scores, as well as an increased musculoskeletal pain in the back of the neck, shoulders and upper back.<sup>43</sup> Conversely, the control group reported more pain in the laryngeal region while continuing to work in person during the pandemic, which the author attributes to a change in the ergonomics of the work environment.<sup>43</sup>

Other research suggests a positive effect on the voice as a consequence of changing mode of teaching. For example, one study found that 24.5% of the participants felt a change in their voice during the pandemic, of which 67.4% answered that their voices changed for the better and 32.6% reported that their voice changed for the worse.<sup>44</sup> Interestingly, only 17.6% of the participants reported vocal difficulties as a consequence of teaching virtually.<sup>44</sup> In addition, a study on Finnish teachers showed that 44% of teachers experienced voice symptoms during the period of virtual teaching compared to 71% experiencing voice symptoms when teaching in a classroom.<sup>45</sup> As a potential explanation, 73% of Finnish teachers also reported more favorable acoustic conditions and less background noise when teaching virtually. Based on these studies, there does not appear

to be a consensus on the impact of virtual teaching during the pandemic on teachers' voices.

The pandemic has accelerated the widespread use of virtual platforms as an alternative mode of teaching, which is likely to continue as society moves into a postpandemic mode. Given the amount of consequences of voice problems in teachers, for individuals as well as for society, it is of great importance to investigate how different modes of teaching affect teachers' voices.

### Purpose of the study

The purpose of this study is to further elucidate the impact of teaching virtually on the voices of teachers, particularly in Sweden. The hypothesis is that virtual teaching could be favorable to teachers' voices, depending on their virtual work environment. The elimination of background noise in addition to better vocal hygiene and more favorable acoustic conditions while working virtually should result in fewer self-reported voice problems.

Specific research questions are:

1. How do teachers' self-reported voice symptoms and measures of perceived voice handicap differ between virtual teaching and face-to-face teaching?
2. What are the common symptoms of voice disorders in teachers related to virtual teaching compared to face-to-face teaching?
3. How do self-reported risk factors related to work habits and environment while teaching virtually correlate with self-perceived voice handicap and symptoms of voice disorders in teachers?

## METHODS

### Participants

A purposive sampling method was used, where participants who fulfilled the inclusion criteria of the study were recruited. The focus of the recruiting process was primarily to reach university teachers who are themselves educating future teachers, as they might have a genuine interest in the subject and therefore could be willing to participate in the study. An internet search was conducted to contact departments of Education across the country. In some universities, this entailed reaching out to the head of other departments, such as the department of Social Sciences, where the employees taught at the teacher education program. An initial request to help spread the survey to teachers was sent via email to the head of 22 institutions at universities and colleges in Sweden. In order to achieve a larger and more diverse group of participants, requests were additionally sent to high schools through convenience sampling, selecting high schools in the proximity. Purposive sampling was then used to select high schools who were confirmed to have conducted virtual teaching during the pandemic. Following the approval of the request to distribute the survey, an information letter with a link to the survey was ultimately sent to

15 universities/colleges and three high schools. Institutions of higher education that received the invitation to the survey were located across Sweden, specifically five in the eastern region, four in the southern region, three in the central region, two in the western region and one in the northern region. The high schools were located in two cities in the east of Sweden (Uppsala and Nyköping). In addition, a physical invitation to participate in the study (using a QR-code as well as a web link to direct participants to the survey) was distributed to seven departments at Uppsala University by asking a department representative to share it with their teacher colleagues.

### Ethical aspects

The study was reviewed and approved by the departmental review board of the Study program of Speech and Language Pathology at Uppsala University. Information about the survey was available in the invitation letter, including the purpose of the study, information about the possibility to discontinue the survey, anonymity and a statement of implied consent if they entered the survey link.

### Survey

The General Data Protection Regulation-approved survey platform SurveyMonkey was used to conduct the survey. Data collection was from the September 29, 2021 to the October 25, 2021. The survey gathered demographic information such as gender, age, level of instruction, years of teaching experience and work hours. Respondents were also asked if they had taught with a facemask during the pandemic. A question at the beginning of the survey was used to assure that teachers who had not been teaching virtually during the desired 2020-2021 period were directed to the end of the survey. The estimated duration of the survey was 5-10 minutes. The survey was pilot tested by six volunteers of different age, gender and occupation. Minor adjustments were made accordingly before the survey was distributed (ie, added 'none of the above' to decrease potential confusion for multiple survey questions and highlighted/bolded which mode of delivery for questions related to discomfort and handicap scales).

The modified survey was based on Kenny<sup>42</sup> and included questions regarding voice history, voice use and work ergonomics. Participants were asked about vocal health history (such as previous voice diagnoses and/or treatment), voice use in leisure activities and amount of lecturing hours in each setting, as well as use of peripheral equipment (eg, headsets and microphone) and monitor placement. Participants also answered questions regarding possible risk factors for voice disorders related to work habits and environment. Participants were asked to rank their posture while lecturing on a 5-grade scale from 'unfavorable' to 'good' and if they felt like they raised or strained their voice when teaching virtually on a 5-grade scale from 'never' to 'very often/always'. Respondents were also asked whether they felt more or less stressed when teaching virtually on a

scale from 1 to 5 (where 1 is less stressed, 3 is no difference and 5 is more stressed) and whether they drink more, less or the same amount of water while teaching virtually compared to when teaching face-to-face. Water intake is included as a risk factor in the current study, as access to water is associated with VTD symptoms and a factor the authors deem likely to vary between teaching modes. Lastly, participants were asked to select which words they would use to describe the air quality in both work environments (virtual and face-to-face) from a list of poor air quality factors. Participants could also choose 'other', if they wanted to describe the air quality in other words, or 'none of the above'.

In order to access participants subjective experience of how mode of teaching affects their voice, participants were asked 'In which form of teaching do you experience more voice symptoms?' and rated their experience on a scale from 1 to 5 (1 = More symptoms in periods of virtual teaching, 3 = No difference and 5 = More symptoms in periods of face-to-face teaching). To assure the participants were answering based on the mode of teaching, the terms *virtual teaching* and *face-to-face teaching* were marked in bold letters in the appropriate questions.

### Voice handicap index-10 (VHI-10)

A translated version of the VHI-10 questionnaire<sup>1</sup> was used to gather information about teachers' perceived voice handicap in both modes of teaching. The VHI-10 is an abbreviated and validated version of the Voice Handicap Index (VHI) which measures psychosocial consequences of a voice disorder in an individual.<sup>46</sup> In the current study, the VHI-10 was used instead of the original 30-item questionnaire to ensure that participants would not perceive the survey as too extensive and time consuming. A modified version of the Swedish validated translation of the VHI-10, the VHI-11-Lund was used in the survey.<sup>47</sup> Modifications included exclusion of the final/additional question in the VHI-11-Lund in order to facilitate comparison to other studies which used the VHI-10 as well as changes necessary while translating the original from Swedish to English. Additional minor modifications were made to suit the targeted population (ie, teachers) of the study, while ensuring that the questions remain as close as possible to the original questionnaire.

Participants were asked to rate how often they experience each statement when teaching virtually and when teaching face-to-face respectively. For instance, participants were given the statement 'My voice makes it difficult for people to hear me', followed by the options 'never', 'almost never', 'sometimes', 'almost always' and 'always' regarding periods of virtual teaching, directly followed by the same options for periods of face-to-face teaching. The scale "never-always" was translated to an ordinal scale from 0 to 4, as consistent with the VHI-10 questionnaire. A total score of all 10 questions was calculated for all participants, one for each mode of teaching (virtual or face-to-face).

### Vocal tract discomfort (VTD)

Questions regarding participants' VTD symptoms were asked for each mode of teaching (eg, virtual and face-to-face). The symptoms from the self-rating instrument the VTD-scale were used.<sup>48</sup> The VTD-scale uses a 7-point Likert scale to quantify the severity and frequency of a person's perceived throat discomfort. The list of symptoms from the VTD-scale include 'burning', 'tight', 'dry', 'aching', 'tickling', 'sore', 'irritable' and 'lump in the throat'.<sup>48</sup> The alternative 'none of the above' was added as well as the option to choose 'other', to facilitate further explanation. In the current study, only the prevalence of VTD symptoms was asked. For example, 'Based on your experience of teaching, which of the following physical sensations do you experience in your throat while teaching virtually? Select all that apply'. In the data analysis, VTD prevalence entailed reporting at least one VTD symptom.

### Dysphonia symptoms

The survey also included questions about perceived dysphonia symptoms. The symptoms were the same as in the study by Kenny<sup>42</sup> and included 'hoarse', 'rough or gravelly', 'weak', 'tense' and 'creaky'. The option 'other' was added to ensure that participants could answer freely and/or add other symptoms. Participants were asked to rate their experienced symptoms in each mode of teaching using the same scale as in the VHI-10 questions (ie, never-always). For example, 'During periods of virtual teaching, to which extent do the following alternate terms describe the sound of your voice?'

### Data analysis

Data processing and analysis was performed using Excel version 2102/2110 and Jamovi version 1.6.23.0. Student's *t* test for paired samples was used to compare the mean number of VTD symptoms, frequency of dysphonia symptoms, VHI-10 scores and individual questions in the VHI-10 questionnaire, in both modes of teaching.<sup>49</sup> Although the answers were mostly collected using ordinal Likert-scales, the data can be viewed as parametric because of the large sample size.<sup>50</sup> Cohen's *d* was used to show the effect sizes.<sup>51</sup>

Prevalence of individual VTD symptoms in both modes of teaching was collected as paired binominal data, therefore the McNemar test was used to compare the number of participants reporting each symptom.<sup>52</sup> Pearson's correlation coefficient was used to analyse the correlation between risk factors and data on participants reported voice symptoms/voice handicap.<sup>49</sup>

## RESULTS

### Demographics and participant characteristics

In sum, 175 participants originally completed the survey. From this, 14 participants were excluded because they did not meet the inclusion criteria of having taught virtually ( $n = 11$ ) or for more than one year ( $n = 3$ ). An additional 20

participants were excluded due to only partial completion of the survey. The final dataset included 141 participants (49 male, 92 female) in the following age brackets: 18-29 years = 3%, 30-39 years = 14%, 40-49 years = 36%, 50-59 years = 30%, and +60 years = 17%. Out of these, three participants did not complete the VHI-10, however the data collected previous to the VHI-10 was still used in analyses. As the authors did not send the survey directly to each participant, the number of teachers who received the survey link could not be estimated and the response rate was therefore not calculated.

The majority of participants were university teachers in the ages 40-60 years and had more than 10 years of teaching experience. Of the respondents, 46% (65/141) were still teaching virtually at the time of answering the survey, while 38% (53/141) were not teaching virtually anymore and 16% (23/141) were mixing mode of teaching or soon going back to face-to-face teaching. During periods of virtual teaching, 60% (85/141) of participants taught exclusively virtually and 27% (38/141) taught mostly virtually, while 12% (17/141) had an equal amount of face-to-face teaching or more during periods of virtual teaching. More data on participants' characteristics, vocal health history and voice use during leisure activities is shown in [Tables 1–3](#).

The limited time of the present research project did not allow for further analysis regarding the influence of factors such as amount of lecture hours, level of instruction and length of practice on teachers' vocal health while working virtually compared to face-to-face. This information is therefore only presented as descriptive data.

### Work habits and environment during virtual teaching

During virtual teaching, nearly all the participants (92%, 130/141) reported generally teaching from home, 37% (53/141) reported usually teaching from an office and 6%, (8/140) from another setting (eg, an empty classroom). The most common equipment used while having video-calls (eg, Zoom or Teams) was a headset or earphones with microphone 69% (96/141), followed by the use of the internal computer microphone 59% (83/141). A smaller group of 4% (6/141) used the speaker on a mobile phone and 9% (12/141) answered 'other'. The majority of responses in this category mentioned using an external microphone or speaker. In both of these questions (workplace and equipment), participants could select more than one option. When asked "Have you during the pandemic (2020/2021) used a face-mask while teaching?", only 8 participants answered 'yes'. When asked about air quality in their work environment, the options most frequently chosen (>20% of participants) were 'dry', 'cold' and 'hot' for both modes of teaching. There was a higher frequency of all factors (*dry, cold, hot, dusty, damp, moldy* and *chemical smell*) during face-to-face teaching compared to virtual teaching and a lower frequency of respondents choosing 'none of the above'. Several respondents mentioned a difference in air quality depending on the classroom.

**TABLE 1.**  
Participant Characteristics

	<i>n</i>	%
Age		
18-29	4	2.8%
30-39	20	14.2%
40-49	50	35.5%
50-59	43	30.5%
60+	24	17.0%
Gender		
Female	92	65.2%
Male	48	34.0%
Other	1	0.7%
Length of practice		
1-4 yrs	18	12.8%
5-10 yrs	18	12.8%
More than 10 yrs	105	74.5%
Level of instruction		
High school	30	21.3%
University/college	110	78.0%
Other	1	0.7%
Max amount of lecture hours per week (regardless mode of teaching)		
1-4 h	37	26.2%
11-20 h	45	31.9%
5-10 h	50	35.5%
More than 20 h	9	6.4%
Max amount of lecture hours per week (virtually)		
1-4 h	41	29.1%
11-20 h	40	28.4%
5-10 h	56	39.7%
More than 20 h	4	2.8%
Max amount of lecture hours per day (virtually)		
0-2 h	40	28.4%
3-5 h	80	56.7%
More than 5 h	21	14.9%

**TABLE 2.**  
Vocal Health History

Voice Disorders	<i>n</i>	%
Yes	9	6.4%
No	130	92.2%
Unsure	2	1.4%
Diagnoses		
Nodules	3	2.1%
Polyps	0	0%
Muscle tension dysphonia	5	3.6%
Unsure	0	0%
Other	3	2.1%
Previous voice therapy from an SLP		
Yes	10	7.1%
No	128	90.8%
Unsure	3	2.1%

Note. Participants were asked if they had been diagnosed with a voice disorder by a healthcare professional in the past. Respondents choosing 'yes' or 'unsure' then selected the diagnosis given (n=11).

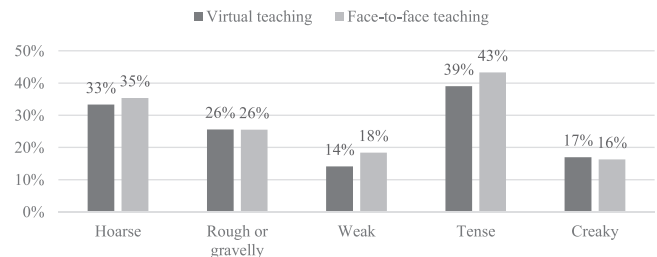
**TABLE 3.**  
**Voice Use During Leisure Activities**

Participation in Voice Demanding Activities Prior to the Pandemic	<i>n</i>	%
Multiple times per week	14	9.9%
Once a week	19	13.5%
Once/a few times a month	12	8.5%
Once/a few times a year	12	8.5%
Never	84	59.6%
Participation in activities during the pandemic		
Not at all	91	64.5%
As often as before	29	20.6%
Less often than before	21	14.9%

When comparing stress levels during virtual teaching to when teaching face-to-face on a scale from 1 to 5 (1 = *less stressed during virtual teaching*, 3 = *no difference* and 5 = *more stressed during virtual teaching*), the mean was 2.82 and the mode response (36%) was 3, which indicated that participants overall do not experience a large difference in stress levels. When rating their posture during virtual teaching from 1 to 5 (1 = *unfavorable* and 5 = *good*), the resulting mean was 2.64 and the mode response (35%) was 2.0 which would indicate a slightly unfavorable posture. Participants also rated how much they perceive themselves raising or straining their voice during virtual teaching on a scale from 1 to 5 (1 = *never* and 5 = *very often*). The mean response was 2.47 and the mode response (31%) was 3.0, which translates to '*sometimes*'. Regarding self-perceived water intake during virtual teaching in comparison to face-to-face teaching, 46% (65/141) did not report a difference in their perceived water intake, 32% (45/141) reported drinking more water during virtual teaching and 14% (19/141) reported drinking less water.

### Research question 1: self-reported voice symptoms and measures of perceived voice handicap during virtual teaching and face-to-face teaching

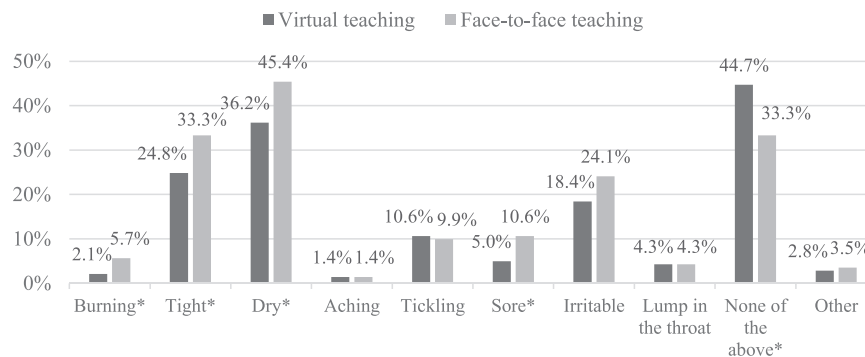
The prevalence of VTD was 55% (77/141) during virtual teaching and 65% (92/141) during face-to-face teaching, indicating a 15% decrease in VTD prevalence when

**FIGURE 2.** Prevalence of dysphonia symptoms across modes of delivery. Note. \* =  $P < 0.05$ .

switching from face-to-face teaching to virtual teaching. The mean number of reported VTD symptoms during virtual and face-to-face teaching was 1.03 (SD = 1.18) and 1.35 (SD = 1.36), respectively. A *t* test showed that there were significantly fewer VTD symptoms (Student's  $t = -2.82$ ,  $P = 0.005$ ) during virtual teaching compared to face-to-face teaching, with a difference of 0.32, although with a small effect size (Cohen's  $d = -0.24$ ). When comparing the prevalence of each symptom during virtual and face-to-face teaching, a higher prevalence was found during face-to-face teaching in the majority of VTD symptoms (Figure 1). Significant differences ( $P < 0.05$ ) were found regarding '*burning*', '*tight*', '*dry*', '*sore*' and '*none of the above*'.

Furthermore, a slight decrease in the frequency of dysphonia symptoms was seen in virtual teaching compared to face-to-face teaching, however there were no significant differences when comparing the reported frequency of each symptom during virtual teaching and face-to-face teaching (Figure 2).

In total, 138 respondents answered the VHI-10 questionnaire regarding periods of virtual teaching and face-to-face teaching. The mean VHI-10 score for virtual and face-to-face teaching was 3.51 (SD = 4.02) and 4.16 (SD = 4.35), respectively, showing a difference of 0.66 between the two modes of teaching. This indicates a significant decrease (Student's  $t = -3.94$ ,  $P < 0.001$ ) in reported voice handicap during virtual teaching compared to face-to-face teaching with a small effect size (Cohen's  $d = -.34$ ). When comparing responses in both modes of teaching in each question using Student's *t* test for paired samples, significant differences ( $P < 0.05$ ) were seen in questions #2 (*People have difficulty*

**FIGURE 1.** Prevalence of VTD symptoms across modes of delivery. Note. \* =  $P < 0.05$ .

**TABLE 4.**  
Correlations of Environmental Risk Factors With VTD Symptoms and VHI-10 Scores

	Posture	Use of Headset	Strain Voice	Air Quality Virtual	Air Quality F-T-F
VHI, virtual	-.166	.181*	.234*	.294*	-
VTD, virtual	-.119	.146	.398*	.345*	-
VHI, F-T-F	-	-	-	-	.213*
VTD, F-T-F	-	-	-	-	.271*

Note. The term "air quality" refers to the number of reported factors related to poor air quality in the work environment (eg, dry or moldy). Concerning posture, use of headset and voice strain while teaching, data was only collected in regard to virtual teaching. The abbreviation F-T-F means "face-to-face".

\* =  $P < 0.05$ .

understanding me in a noisy room), #6 (I feel as though I have to strain to produce voice), #8 (My voice problem upsets me), #9 (My voice makes me feel handicapped), and #10 (People ask, 'What's wrong with your voice'). When explicitly asked 'In which form of teaching do you experience more voice symptoms?', 51% (72/141) reported 'no difference', 34% (48/141) reported experiencing more problems when teaching face-to-face and 15% (21/141) experienced more problems when teaching virtually.

### Research question 2: common symptoms of voice disorder related to mode of teaching

Based on Figure 1, the most common VTD symptoms reported by teachers during virtual teaching were 'none of the above' (45%), 'dry' (36%), and 'tight' (33%). The most common VTD symptoms reported during face-to-face teaching were 'dry' (45%), 'tight' (33%), and 'none of the above' (33%). Other symptoms reported by respondents were mainly vocal fatigue and hoarseness. Figure 2 shows that the dysphonia symptoms with the highest reported frequency were 'tense', 'hoarse', and 'rough or gravelly' in both modes of teaching.

### Research question 3: correlation between risk factors and self-reported voice problems

Risk factors for voice disorders considered in the survey were posture while lecturing, air quality, raising or straining the voice, stress levels, water intake and the use of headset while teaching virtually.<sup>12,18,21,22,24,25,42</sup> To determine the correlation between VHI-10 scores, VTD symptoms and frequency of individual dysphonia symptoms to risk factors during virtual teaching, correlation analyses were

calculated. For virtual teaching, higher levels of straining or raising the voice and more air quality risk factors in the workplace showed a small correlation to a higher number of VTD symptoms and higher VHI-10 scores during virtual teaching (Table 4). A weak correlation ( $r = .181$ ) was found between using a headset and having a higher VHI-10 score. No significant correlation was found between posture and measures of voice handicap/VTD symptoms.

Additionally, the correlation between individual dysphonia symptoms and risk factors was calculated. The risk factors that were most associated with a higher frequency of dysphonia symptoms during virtual teaching were raising or straining the voice when lecturing and a higher number of poor air quality factors.

Correlational analyses were also calculated regarding face-to-face teaching between air quality and VHI-10 scores, VTD symptoms and individual dysphonia symptoms. VTD symptoms and VHI-10 scores while teaching face-to-face show a small correlation with number of poor air quality factors (Table 5). As for dysphonia symptoms during face-to-face teaching, the results show a small significant correlation between a higher number of poor air quality factors and a higher frequency of hoarseness ( $r = .317$ ) and rough/gravelly voice ( $r = .161$ ) (Table 5).

Questions about water intake and stress levels were not included in the previous correlation analysis as they only addressed the perceived change in these factors when switching mode of teaching and thus did not include any measures of water intake or stress. Instead, an additional correlation analysis was calculated between these variables and participants responses to the question 'In which mode of teaching do you experience more voice symptoms?'. No significant correlation was found between which mode of teaching

**TABLE 5.**  
Correlations of Dysphonia Symptoms With Risk Factors During Virtual Teaching

	Hoarse	Rough/ gravelly	Weak	Tense	Creaky
Posture	-.121	-.136	.170*	-.149	-.147
Air quality	.317*	.161	.221*	.258*	.189*
Strain the voice	.464*	.407*	.250*	.374*	.256*
Use of headset	.210*	.132	.150	.202*	.183*

\* =  $P < 0.05$ .



entails more voice problems and perceived change in water intake ( $r = .01$ ,  $P = 0.90$ ), however there was a moderate negative correlation with perceived change in stress levels ( $r = .42$ ,  $P = < 0.001$ ). This result suggests that participants who reported feeling more stressed during virtual teaching also experienced more voice problems during virtual teaching.

## DISCUSSION

The onset of the COVID-19 pandemic during 2020 has resulted in teachers having to rapidly switch mode of teaching from face-to-face to virtual teaching. This in turn has caused numerous teachers to change their routines, work environment and vocal habits as the demands of their job have changed. This study sought to investigate self-reported voice symptoms and VHI-10 scores during both virtual teaching and face-to-face teaching in order to investigate potential changes in teachers' voices following the switch to virtual teaching. Data about various known risk factors in teachers' working environment and work habits, in which the switch to virtual teaching may have brought tangible changes, was collected to determine their relationship to teachers' self-reports of voice problems. Results are discussed as they pertain to each research question with impact of mode of teaching delivery first, followed by symptoms of voice disorders, and concluding with work-related risk factors.

### Mode of delivery and voice problems

Overall results show that teachers in this study experienced a slight decrease in voice problems when switching to virtual teaching. Regarding the first research question, '*How do teachers' self-reported voice symptoms and measures of perceived voice handicap differ between virtual teaching and face-to-face teaching?*' both VTD prevalence and VHI-10 scores were lower during virtual teaching compared to face-to-face teaching. Additionally, 34% of participants reported experiencing more voice problems when teaching face-to-face compared to 15% who experienced more voice problems during virtual teaching. Although the differences in mean VHI-10 scores and number of VTD symptoms were statistically significant, the effect sizes were small. However, when calculating the combined mean of VTD symptoms, the difference in mean number of symptoms represents a 26% difference between the mean values.

Although results in the current study showed that numerous teachers reported voice problems in both modes of delivery, it should be noted that the majority of participants in the current study were within the normal range (with mean VHI-10 scores of 4.16 and 3.51 during virtual teaching and face-to-face teaching respectively). This is based on the mean VHI-10 score in healthy controls found by Rosen<sup>1</sup> to be 3.38 and data by Arffa *et al*<sup>56</sup> which showed values greater than 11 were associated with voice disorders. Thus, the differences, while statistically significant, perhaps are not meaningful from a clinical perspective. Additional

research is warranted to determine if such differences represent a minimal clinically important difference. Furthermore, the results of this study show a lower number of VTD symptoms in teachers (1.03 during virtual teaching and 1.35 during face-to-face teaching) when compared to teachers without self-reported voice problems with a mean of 2.8 symptoms.<sup>17</sup> The clinical relevance of these results should therefore be interpreted cautiously.

Nonetheless, these results are congruent with previous research which also found an decrease in vocal symptoms when switching from face-to-face teaching to virtual teaching.<sup>44,45</sup> More specifically, Patjas *et al*<sup>45</sup> found a larger difference in mean VHI-10 scores between virtual teaching and face-to-face teaching compared to the current results (3.2 vs 0.66). However, participants VHI-10 scores were lower in the current study compared to Patjas *et al*,<sup>45</sup> where the mean VHI-10 score was 7.88 during face-to-face teaching and 4.58 during virtual teaching. The difference could, among other things, be caused by the fact that the participants in Patjas<sup>45</sup> study taught at primary and secondary level. Teachers in lower levels of education have been shown to have significantly more voice problems compared to high school teachers.<sup>53</sup>

There could be multiple explanations as to why a decrease in perceived voice handicap and self-reported VTD symptoms is reported by teachers when switching to virtual teaching. Besides the known risk factors for voice problems, such as work ergonomics and air quality, there are other aspects not as strictly related to work habits and environment that could possibly be beneficial for teachers' voices during periods of virtual teaching. One factor could be a potential decrease in overall respiratory infections. As the pandemic, and the restrictions put in place as a result, make people more isolated there is a chance that teachers were less exposed to viral infections and therefore had less voice symptoms during the period of virtual teaching, as respiratory infections can trigger vocal problems such as dysphonia.<sup>54</sup> Another factor to consider is the decrease in social activities with high vocal load, such as singing in a choir or going to sports events. This is supported by the fact that 23% of participants in this study reported participating in voice demanding activities once or multiple times per week, and out of those, 61% reported attending these events less often than before or not at all during the pandemic.

### Symptoms of voice disorders

The second research question addressed the common symptoms of voice disorders across both modes of teaching delivery. The symptoms *tight*, *dry* and *irritable* throat were the most commonly reported VTD symptoms in both modes of teaching. These results are similar to the findings of Kenny<sup>42</sup> where dry, irritable, and tight throat were also cited as the most common symptoms reported during the period of working virtually. In contrast to the current results, the symptom *tickling* was in third place (27%) for the Kenny<sup>42</sup> study, whereas in the current study it was in fourth place

with only 10% of the respondents reporting that symptom. Similarly, Rodrigues et al<sup>17</sup> found that dryness and irritable throat were also the most common VTD symptoms in teachers with and without self-reported voice problems. Current results show that virtual teaching did not result in an increase of any specific symptom. Instead, there was a consistent decrease in frequency in most VTD symptoms during virtual teaching compared to face-to-face teaching. Similarly, the results regarding the prevalence of dysphonia symptoms showed a slight decline in virtual teaching compared to face-to-face teaching, while no discrepancy was found regarding the most common symptoms between modes of teaching. In this study, the symptoms *tense*, *hoarse*, and *rough/gravelly* voice showed the highest prevalence in both modes of teaching. Previous studies have also reported hoarseness to be a common vocal symptom while working virtually.<sup>42,44</sup>

### Work-related risk factors

The third research question focused on how work-related risk factors for voice problems in teachers correlate with self-reported voice problems. Overall, the results suggest that factors related to air quality and straining or raising ones' voice while teaching virtually are the risk factors most associated with VTD symptoms and perceived voice handicap out of those included in this study. These factors were also associated with the frequency of dysphonia symptoms. Although the correlations were weak, air quality and perceived vocal load appear to be particularly important factors to consider while teaching virtually. These results are congruent to Kenny's<sup>42</sup> findings suggesting poor air quality and straining or raising the voice during video calls as predictive factors for dysphonia and VTD symptoms in subjects working from home. It should be noted, however, much variability may exist across participants with regard to the perception of air quality in their working environment. Although this finding was consistent with Kenny,<sup>42</sup> future research should include more objective measures to better delineate the effect of air quality on vocal health in the home and work environment.

In addition to these results regarding work-related risk factors, correlation analysis suggests that participants who experience more voice problems when teaching virtually may also feel more stressed when teaching virtually. Stress has been shown to have an impact on the voice, as it has been associated with an increase in both fundamental frequency and SPL, as well as muscle tone.<sup>55</sup> A relationship between stress levels and increased voice problems in teachers has been shown in both modes of teaching.<sup>18,45</sup> Previous studies have found that stress is one of the main factors reported by teachers to have had a negative effect on the voice, while reduced stress was reported to have had a positive effect on the voice.<sup>22,44</sup> Clearly, there is a strong and intuitive relationship between stress and voice problems. However, it should be noted that the opposite causality is also possible, as an increase in voice problems can lead to

teachers feeling more stressed since they rely on their voice to be able to work. Regarding water intake, no significant correlation to perceived voice problems was found. Nonetheless, one-third of the participants (32%) in the current study reported drinking more water while teaching virtually compared to when teaching face-to-face, as opposed to 14% who reported drinking less water when teaching virtually. Such findings are consistent with Nemr et al<sup>44</sup> who found that 42% of respondents reported drinking water more frequently during the pandemic.

When comparing this study to similar studies conducted during the pandemic, it is important to emphasize the circumstances during which the switch to virtual teaching has taken place. In Sweden, there were no periods of total lockdown in society during 2020-2021. This allowed teachers to choose their work environment which could entail, for example, more favorable work ergonomics. That being said, 92% of teachers in this study reported working from home when teaching virtually, which might indicate that many chose to work from home when given the option.

Furthermore, the absence of a strict lockdown has also allowed teachers in high schools to teach both virtually and face-to-face simultaneously during the pandemic. Because of this, and the fact that recommendations have varied throughout the pandemic, responding to the survey in terms of switching to virtual teaching might have been difficult. Lastly, regulations regarding face masks have differed between countries. In Sweden, face masks have not been a common sight in society during the COVID-19 pandemic and were not required in schools and universities during the period of data collection. This however was the case in, for example, the United States.<sup>28</sup> In the current study, only eight participants responded 'yes' to the question '*Have you during the pandemic (2020-2021) used a face mask while teaching?*'. It can therefore be assumed that potential changes in Swedish teachers' voices due to the pandemic cannot be attributed to wearing a face mask while teaching which could be the case in other countries.

Finally, it is important to consider the time during which the studies have taken place when making comparisons. Several other studies (e.g., Kenny<sup>42</sup>; Nemr et al<sup>44</sup>; Patjas et al<sup>45</sup>) collected data in 2020 when the pandemic and its effects on everyone's lives were still relatively novel. This might entail differences in teachers' experiences of teaching remotely across the studies. For example, the beginning of the pandemic was marked by stress and uncertainty for teachers regarding the new mode of teaching.<sup>41</sup> In contrast, data collection in this study was completed a year later, towards the end of 2021, which was past the initial phase of the pandemic. Intuitively, people had become somewhat accustomed to living in a pandemic and teachers might have adapted to teaching virtually and become more familiar with the new work environment. Participants in this study might have therefore been less stressed at the time of responding to the survey as compared to earlier stages of the pandemic when a lot of changes occurred rapidly and

teachers had to readapt and learn how to use technology and teaching systems.

The relatively large sample size of 141 teachers and the fact that participants were recruited in various parts of Sweden facilitate generalization of the results to the targeted population of this study, which is Swedish teachers lecturing in university/college and high school levels.

### Limitations of the study

The first limitation of the study involved the survey design. Specifically, nearly all questions in the survey were made compulsory in order to avoid that participants unintentionally skip or forget to answer some of them. Some comments were made by participants who did not know how to answer some of the questions, as they did not have the option 'unsure'. Efforts were made by the authors to ensure that all participants would have a way to respond, therefore the options 'unsure' and/or 'other' were included in most questions. However, the questions in the VHI-10 did not include this option and was not added as it is a validated instrument. Neither did the dysphonia questions have the option 'unsure' as the same Likert-type scale as in the VHI-10 was used. Because of this, there is the risk that participants had to choose an option that did not correlate to their experience.

Furthermore, the variability across participants' equipment, teaching style, activities, etc., cannot be understated and must be taken into consideration when attempting to generalize results of the current study. Such variability is, however, inherent to survey-based research. While results should be interpreted with caution based on this as well as other limitations noted in this section, they hopefully provide a launching point for additional research to be conducted.

Second, as a large part of participants in this study did not experience voice problems, some questions in the survey may have been confusing or misunderstood. Although not identified as an issue during the pilot stage, several respondents reported that the questions included assumptions of the presence of a voice disorder that they did not recognize and felt as though the questions were not applicable. For that reason, future research may consider only including participants with self-reported voice difficulties in parts of the survey (particularly the VHI-10) or revising similar questions in an effort to reduce potential confusion.

The third limitation involves not asking participants if they had experience of face-to-face teaching. This was assumed as the inclusion criteria of having at least one year of teaching experience was applied, but this could not be assured since respondents who had never taught in a classroom would not have been automatically excluded. This was the case for one participant who mentioned in a comment not having taught in a classroom before (this participant was excluded nonetheless, since the exclusion criterion of having taught less than one year was met). Because the study is based on teachers' experience of both face-to-face

and virtual teaching, having experience of both modes of teaching would have been a more accurate inclusion criterion. Considering this, it would have been appropriate to also include the exclusionary question: 'Have you ever taught in a classroom?' to assure the participants had experience of both modes of teaching before answering the survey. It can be assumed that the final group of participants had experience of face-to-face teaching as well as virtual teaching, as they otherwise would not have been able to answer questions related to face-to-face teaching and therefore would presumably either drop out or mention it in one of the open-ended questions throughout the survey.

The fourth limitation involves teachers being asked to compare experiences in both face-to-face and virtual delivery modes, thus relying on teachers' memories to do so. Clearly, there is a chance that their current work mode and voice symptoms influenced their answers regarding previous teaching experiences in the classroom. Nevertheless, most participants (75%) had more than 10 years of teaching experience, thereby it can be assumed that they have established a robust reference to make as a comparison.

Finally, some selection bias is to be expected when conducting a survey where participants voluntarily choose to participate. It is likely that, for example, teachers who choose to participate in a study regarding voice problems might already be familiar with voice symptoms and therefore have an interest in the subject, whereas teachers who never thought about their voice might be more unlikely to participate the study. It does not seem, however, that this possible bias has largely affected the outcome of the study since many of the participants did not experience voice problems.

### Further research

This study included only teachers at high schools and university/college level, as they have been most affected by the recommendations of virtual education in Sweden during the pandemic. However, in the case that virtual teaching becomes more integrated in lower levels of education, which is already the case in other countries,<sup>44,45</sup> more research is warranted into the effects of virtual teaching for this group of teachers. When discussing changes in teachers working environment when switching to virtual teaching, it is important to consider that face-to-face teaching differs between levels of education. In addition, further research investigating what kind of acoustic equipment is the most appropriate for teachers to use while teaching virtually, in order to prevent new onsets of dysphonia and VTD, is encouraged by the authors of this study since there is still a lack of literature in the subject.

### CONCLUSION

Overall, the results of this study show that teachers report a slight decrease in vocal symptoms and voice-related handicap during periods of virtual teaching compared to face-to-face teaching. Although teachers reported the presence of

similar VTD symptoms (dry, tight, and irritable throat) and dysphonia symptoms (hoarse, rough/gravelly and tense voice) across both modes of teaching, the prevalence and frequency of these symptoms were lower when teaching virtually. Results also show that the presence of VTD symptoms, dysphonia symptoms and perceived voice handicap is associated with poor air quality and vocal strain when teaching virtually. Finally, participants who reported feeling more stressed when teaching virtually also reported more voice problems during virtual teaching. However, the correlations found in this study were weak. These results contribute to the existing body of research regarding virtual teaching and its' potential effects on teachers' voices. Despite the fact that most teachers reported somewhat fewer vocal symptoms and less voice handicap during virtual teaching, many teachers still experience voice problems to some degree. Therefore, information about vocal hygiene and how different aspects of their work environment affect the voice, such as work equipment and air quality, is still essential in order to improve teachers' vocal health.

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