Voice Acoustics and Vocal Effort in Mask-Wearing Healthcare Professionals: A comparison pre- and post-workday

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Introduction

- Since the start of COVID-19, healthcare professionals have been required to wear face masks (simple surgical, N95, etc.)
- Masks negatively impact acoustic (spectral information) [1] and visual information (facial expressions and lip-reading) conveyed during speech.
- Little information is available on how face masks add to the communication challenges of the speaker, especially in those with high occupational vocal demands.

Purpose: (1) Summarize frequency of self-perceived communication problems and vocal symptoms; (2) Compare voice acoustics before and after occupational voice loading; (3) Assess self-perceptual ratings of dyspnea and vocal effort before and after occupational vocal loading.

Hypothesis: Mask-wearing occupational voice users would show evidence of vocal fatigue – quantified as acoustic manifestations of increased vocal effort and laryngeal muscle tension – over a single work-day.

Mask-wearing healthcare professionals report *greater* vocal symptoms during masked speech and increased vocal effort at the end of their workday compared to pre-workday. Vocal symptoms coincided with acoustic changes previously related to vocal effort; acoustic changes were considered mild.

Methods

Participants: 18 adult English speaking healthcare workers (11 cisgender female, 7 cisgender male, M= 33.72 years, SD = 8.30) wearing face masks > 6 hours/day. On the day of the evaluation, participants reported working an average of 9.1 hours/day using verbal communication throughout the day.

Protocol: Participants completed two sessions during the study. One session occurred prior to the beginning of the work-day ("pre-workday") and the second session occurred immediately following the work-day ("post-workday").
During each session, acoustic and perceptual data were collected from participants. During the first session, participants answered Likert rating scale questions to assess their speech, voice, and communication while wearing a face mask. Acoustic data were collected via a headset microphone and handheld recorder with the participant's mask off. Following recordings, perceptual ratings of vocal effort (100-mm visual analog scale) and dyspnea (modified Borg rating scale for dyspnea) [2] were made.

Speech Stimuli
1. Sustained vowels x 5 seconds in duration: /i/
2. Rainbow Passage
3. Single words and sentences: Heed Heed Heed I wish he would heed my advice. Hod Hod Hod A brick hod is a three-sided box. Who'd Who'd Who'd I asked myself, "Who'd do that?" My father hid food to feed the cat on Tuesday morning. The cat happened to see the food my father had hid in her pod at noon time. The fat cat was hot from her sleep in the noon sun beams.

Data Processing: The measurements extracted from the acoustic signal included: spectral and cepstral measurements, relative fundamental frequency (RFF) offset cycle 10 and onset cycle 1, vowel acoustics (HNR (dB), vocal intensity (dB SPL)), and formant-based estimates of vocal tract length (VTL). Perceptual measures were degree of vocal effort and dyspnea following speech readings.

Statistical Analysis: Mixed-effect models were performed to analyze each acoustic and perceptual measure separately. Two-way interactions were examined between fixed effects (session, sex, and mask type).

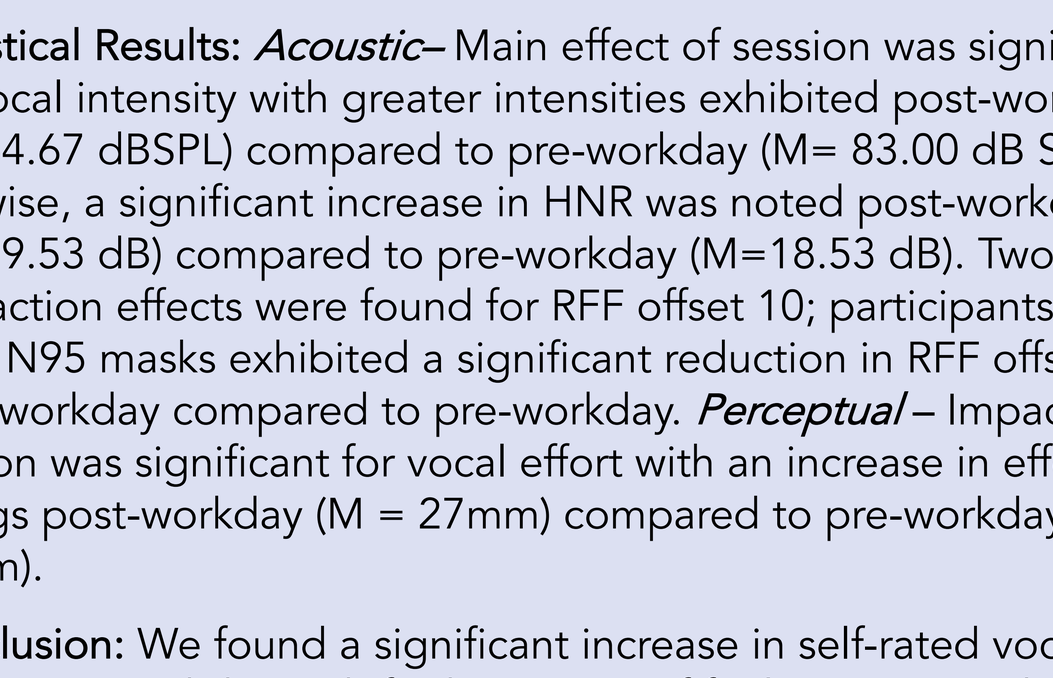
Results

Summary Statistics: Participants rated their experiences of mask-based communication and voice. Overall, participants rated questions pertaining to their personal communication and vocal health a 3 ("Sometimes") on a Likert Rating Scale from 1 ("Never") to 5 ("Always").

Statement	Rating Mean (SD)	Mdn.	Min	Max
Wearing a mask makes it difficult for people to hear me	3.39(0.70)	3	2	5
Wearing a mask causes me to need to repeat myself more	3.33(0.69)	3	2	5
I have trouble understanding people when they are wearing a mask	2.89(0.68)	3	2	4
I find I have to use more effort to talk while wearing a mask	4.06(1.00)	4	2	5
Wearing a mask is negatively impacting my communication with others at my job	2.89(1.18)	3	1	5
I feel that my voice is more tired at the end of the day when I wear a mask	2.94(1.35)	2	1	5

Statistical Results: *Acoustic*– Main effect of session was significant for vocal intensity with greater intensities exhibited post-workday (M=84.67 dBSPL) compared to pre-workday (M= 83.00 dB SPL). Likewise, a significant increase in HNR was noted post-workday (M=19.53 dB) compared to pre-workday (M=18.53 dB). Two-way interaction effects were found for RFF offset 10; participants who wore N95 masks exhibited a significant reduction in RFF offset 10 post-workday compared to pre-workday. *Perceptual* – Impact of session was significant for vocal effort with an increase in effort ratings post-workday (M = 27mm) compared to pre-workday (M = 10mm).

Conclusion: We found a significant increase in self-rated vocal effort post-workday with further report of feeling increased vocal effort at a frequency of "almost always." Self-reports were consistent with post-workday acoustic changes, including a significant reduction in RFF offset 10, increase in HNR, and increase in vocal intensity.



Citations
1. Titze IR, Lemke J, Montequin D. Populations in the U.S. workforce who rely on voice as a primary tool of trade: a preliminary report. *J Voice*. 1997;11:254–259.
2. Borg G. Psychophysical bases of perceived exertion. Med Sci Sports Exerc. 1982;14:377–381.

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