**Vocal problems of healthcare workers in China during the pandemic**

Song Ziweia; Pyoung-Jik Lee a

a Acoustics Research Unit, School of Architecture, University of Liverpool, Liverpool, L69 7ZN, UK2

ABSTRACT

This study explored the vocal problems of healthcare workers in China during the pandemic. Firstly, online questionnaire surveys were conducted in three hospitals in China. Healthcare workers from different departments in hospitals completed the questionnaires. A total of 411 healthcare workers took part in the survey with different face mask requirements (N95 masks with face shields or surgical masks without face shield). Second, semi-structured interviews were carried out with critical care nurses as a qualitative approach. A total of 15 nurses have finished this survey so far. Lastly, voice-related parameters of the nurses from three ICUs were measured. For this, a non-invasive accelerometer was attached to a participant’s neck during working hours. Healthcare workers in the fever clinic showed the most serious voice problem during the pandemic, followed by intensive care units. The most frequent voice symptom was ‘voice tiredness’ and followed by the ‘difficulty in being heard’.

Keywords: healthcare workers, vocal problems, Noise in hospitals, Pandemic

# INTRODUCTION

Interpersonal communication has been severely affected during the COVID-19 pandemic. Protective measures, such as social distancing and face masks, are essential to mitigate efforts against the coronavirus [1] and pose challenges to daily face-to-face communication. Face masks muffle sounds and cover facial expressions that ease comprehension during live communication [2]. For example, successful communications between healthcare workers and patients are essential in hospitals; however, the presence of face masks may reduce speech intelligibility and cause vocal problems.

Several studies have highlighted the vocal problems of healthcare workers. For example, Heider et al. [3] conducted a questionnaire survey and reported that healthcare workers of high-risk hospital care units are at risk of voice disorders. However, most studies were carried out in developed countries and there was no attempt to explore the voice problems of the healthcare workers in developing countries. In addition, the majority of previous studies performed questionnaire surveys and a qualitative approach was not adopted.

Therefore, this research aims to understand whether personal protective equipment such as face masks affects vocal problems in hospitals during the pandemic in Chinese hospitals. First, a questionnaire survey was conducted in three hospitals to investigate the vocal problems of the healthcare workers. Second, semi-structured interviews were conducted to explore how healthcare workers react to noise in hospitals. Lastly, voice monitoring was performed with the nurses in intensive care units.

# METHODOLOGY

## Sites

The online questionnaires were conducted in three hospitals (Sites A, B, and C) in China from December 2021 to April 2022. Site A is the smallest and was recently rebuilt from the old factory. Site B is the largest, while Site C is a part of the local university in Chongqing, China. The semi-structured interviews were also carried out in August 2022 in the intensive care units (ICUs) of these three hospitals.

## Participants

A total of 411 healthcare workers (162 from Site A, 133 from Site B, and 116 from Site C) were recruited from three hospitals for online surveys. Table 1 shows the socio-demographic and professional characteristics of the participants. The participants were aged between 20-57 (mean 37.5, SD 10.7) with different educational levels. Among them, 307 healthcare workers have worked in the hospitals for more than ten years and thirteen participants have worked for less than one year. Seventy-nine healthcare workers are from the fever clinic departments, including 56 volunteers from medical universities or other out-of-town hospitals during the pandemic, while 77 participants worked in the intensive care units. During working hours, all the participants at the fever clinic departments wore both N95 face masks (named for their ability to filter 95% or more of tiny 0.3-μm particles) and face shields for more than 12 hours, whereas others wore surgical masks for about 8 hours (see Figure 1). For the semi-structured interviews, 14 nurses from the ICU were recruited later.

Table 1 – Socio-demographic and professional characteristics of the participants

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Site A | Site B | Site C | Total |
| Gender |  |  |  |  |
| Male | 29 | 36 | 35 | 100 |
| Female | 133 | 97 | 81 | 311 |
| Age (yrs.) |  |  |  |  |
| 20-25 | 12 | 5 | 3 | 20 |
| 25-30 | 18 | 47 | 33 | 98 |
| 30-35 | 104 | 76 | 67 | 247 |
| >35 | 27 | 5 | 13 | 45 |
| Role |  |  |  |  |
| Nurse | 113 | 87 | 74 | 274 |
| Medical doctor | 17 | 23 | 8 | 48 |
| Technician | 5 | 9 | 27 | 41 |
| Therapist | 7 | 3 | 2 | 12 |
| Volunteer | 20 | 11 | 6 | 37 |
| Years of working in hospitals |  |  |  |  |
| <1 | 8 | 3 | 2 | 13 |
| 1-2 | 4 | 2 | 2 | 8 |
| 2-5 | 4 | 7 | 10 | 21 |
| 5-10 | 17 | 27 | 19 | 63 |
| >10 | 130 | 94 | 83 | 307 |
| Departments |  |  |  |  |
| Fever clinic | 37 | 25 | 17 | 79 |
| Intensive care unit (ICU) | 35 | 19 | 23 | 77 |
| Obstetrics and Gynaecology | 7 | 6 | 3 | 16 |
| Medical technology department | 15 | 32 | 44 | 91 |
| Clinical departments | 75 | 50 | 21 | 146 |
| Administration department | 5 | 3 | 8 | 16 |
| Personal protective equipment (PPE) |  |  |  |  |
| Surgical mask | 137 | 108 | 96 | 341 |
| N95+face shields | 37 | 25 | 17 | 79 |

穿着蓝色衣服的男人站在墙边

描述已自动生成

Figure 1 – Healthcare workers who wear personal protective equipment (PPE) in the fever clinic (left) and ICU (right)

## Questionnaire survey and interview

The questionnaire consists of three major parts: 1) basic information such as age and gender, 2) vocal problems in hospitals, and 3) perception of the acoustic environment. The participants were asked to rate the experience of the vocal symptoms using a 5-point scale (1: never and 5: always). The Voice Handicap Index (VHI-30) was also used to measure the self-perception of voice handicaps. In addition, the participants were asked about noise sources, and they rated their perception of acoustic environments using a semantic scale. Second, semi-structured interviews were carried out with ICU nurses as a qualitative approach. The interview aimed to investigate 1) how the ICU nurses perceive and react to the noise sources and 2) the effects of acoustic environments on nurses’ voices, job satisfaction, and well-being. During the interviews, the participants were encouraged to freely express their thoughts and experiences concerning vocal problems and acoustic environments in hospitals.

## Voice monitoring

The voice monitoring was carried out for 4 hours during working hours using the Voice-Care device (PR.O. VOICE S.r.l, Turin, Italy). The Voice-Care device provides information on the fundamental frequency (Hz), phonation time percentage (Dt%), and vocal sound pressure level (dB SPL). Phonation time percentage is defined as the percentage of time spent phonating over the total recording time. Before the monitoring, the device was calibrated in a quiet room in each hospital using a reference microphone. In addition, the participants will be asked to perform a conversational task (pre-monitoring). For this task, the nurses will be asked to speak to a listener, positioned at 1 m, about a topic that is well known to them.

# RESULTS

## Questionnaire survey

Table 2 shows the types of face masks in different departments and the hours of wearing. The fever clinic has the longest hours of wearing the strictest mask (N95 with face shields). The experiences of vocal-related symptoms are summarised in Table 3. The percentage in the table indicates the percentage of respondents whose answers are greater than 3 on a 5-point scale. ‘voice tiredness’ is the most common symptom across all departments during the pandemic with 119 participants (29.3%). The fever clinic showed more symptoms than others, followed by ICUs. Specifically, 44.3% of participants in the fever clinic department reported ‘voice tiredness’ and 43.0% answered that they had experienced ‘difficulty in heard’. Similarly, in ICUs, ‘voice tiredness’ and ‘difficulty in heard’ are the most frequent symptoms, followed by ‘voiceless. On the other hand, in general departments, only ‘voice tiredness’ exceeded 23.4% and other symptoms were rarely reported.

Table 2 – Usage of face masks in different departments

|  |  |  |  |
| --- | --- | --- | --- |
| Departments | N95 | Face shields | Surgical mask |
| Fever clinic | >12hrs | >12hrs | N/A |
| ICU | N/A | N/A | 8-12hours |
| Obstetrics and Gynecology | N/A | N/A | 8-12hours |
| Medical technology department | N/A | N/A | 8-12hours |
| Clinical departments | N/A | N/A | 8-12hours |
| Administration department | N/A | N/A | 8-12hours |

Table 3 – Voice-related symptoms in different departments

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Fever clinic departments | | General department | | ICU | |
|  | % | Mean | % | Mean | % | Mean |
| Hoarseness | 26.6% | 1.9 | 10.9% | 6.3 | 19.5% | 1.8 |
| Voice tiredness | 44.3% | 2.4 | **23.4%** | 13.7 | **28.6%** | 2.1 |
| Voiceless | 32.9% | 2.0 | 13.7% | 8.0 | **23.4%** | 2.0 |
| Dryness in the throat | 35.4% | 2.1 | 9.7% | 5.7 | 15.6% | 1.8 |
| Sore throat when speaking | 17.7% | 1.8 | 16.6% | 9.7 | 27.3% | 2.1 |
| Aphonia | 32.9% | 1.9 | 14.3% | 8.3 | 11.7% | 1.8 |
| Clearing the throat | 25.3% | 1.7 | 18.3% | 10.7 | 18.2% | 1.9 |
| Difficulty in being heard | 43.0% | 2.3 | 13.1% | 7.7 | **26.0%** | 2.0 |
| Persistent dry cough | 16.5% | 1.6 | 18.3% | 10.7 | 10.4% | 1.8 |
| Lump in the throat | 17.7% | 1.6 | 12.0% | 7.0 | 14.3% | 1.8 |

Results of VHI-30 are listed in Table 4. The median values of the total VHI-30 in all departments were 26.8 (less than 30); however, the score of the fever clinic was 42 due to the wearing of N95 face masks with face shields.

Table 4 – Median scores for the total VHI-30 and VHI subscales

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Total | Fever clinic | ICU | Others |
| Total VHI-30 | 26.8 | 42.0 | 28.8 | 24.7 |
| Functional subscale | 9.7 | 17.3 | 11.7 | 8.0 |
| Emotional subscale | 6.3 | 10.3 | 6.3 | 6.0 |
| Physical subscale | 11.0 | 12.0 | 11.7 | 10.0 |

## Semi-structured Interview

Fourteen ICU nurses have been interviewed so far and 14 will be more recruited. All the nurses were females, and the average age was 32 years old (SD 7.1). The length of working in the ICU ranged between 1 and 15 years with a mean of 7.9 years. Table 5 shows the demographic information of the participants and the questions raised in the interviews are listed in Table 6.

Table 5 - Demographic Information of the participants (*N*=14)

|  |  |
| --- | --- |
| Characteristics | ICU |
| Age (mean ± SD) | 32 ± 7.1 |
| Gender (*N*)  Female | 14 |
| Male | 0 |
| Length of working (in years; mean ± SD) | 10.6 ±7.7 |
| Length of working in ICU (in years; mean ± SD) | 7.9 ±4.8 |
| 12-hour shift roster (*N*) | 9 |
| 8-hour shift roster (*N*) | 5 |

Table 6 – A list of interview questions

|  |
| --- |
| Can you tell me what kind of noise you have heard in ICU? |
| How did you feel when you exposed (or heard) the noise? |
| Did any specific noises disturb you? |
| Have you had any issues with your voice while working in ICU? |
| Have you experienced any difficulties in understanding others’ voices? |
| How did you react to noise? |
| Do you think the noise in ICU affects your job satisfaction? |
| Do you think noises in ICU affect psychological well-being? |

## 3.2.1 Noise sources

The participants listed several noise sources such as equipment, patients, other nurses, and noise from outside. Most participants mentioned the noise from equipment (e.g., life monitor).

P10: “In ICU, most noises come from the equipment. The breathing machine and life monitor make me unwell.”

P7: “When we are working in the nurse station, the nurses in patient wards usually shout out to let us clearly hear the situation.”

## 3.2.2 Perception

Most perceptions of noise sources were negative, and they made the participants feel annoyed and anxious; however, several nurses said that they were used to the noise sources.

P10: “Sometimes you need to concentrate on a problem, but the noise always makes you anxious.”

P3: “Although we can hear a lot of noise such as the life monitor and patients’ voices, we are not feeling annoyed. Maybe we are used to it, or maybe we do not have many patients.”

## 3.2.3 Disturbance

The noise in ICU made them speak louder so it affects their communications with the patients and other staff. Also, the noise led to sleep disturbance when they wanted to have a break.

P2: “The noise of equipment everywhere still affects our communication.”

P4: “Sometimes we are tired and want to have a break. However, the noise around us made us very hard to fall asleep.”

## 3.2.4 Intervening conditions

It was found that business and the seriousness of the patients affect the perception of noise sources and stress.

P10: “But it's especially bad when you're busy. Too much work makes me feel annoyed by the noise. Sometimes you need to concentrate on a problem, but the noise always makes you anxious.”

P8: “But when we are busy, noise from equipment and patient complaints makes me crazy.”

## Vocal monitoring

As listed in Table 7, the nurses in Site B showed higher mean values of the vocal sound pressure level throughout the entire monitoring session than those of site A and C. Across the sites, the mean voice levels of the nurses during the monitoring were significantly higher than those in the pre-monitoring session. For instance, the increase in mean sound pressure levels in Site A was 4.7 dB.

Table 7 - Mean Values of voice-related parameters across three hospitals. Numbers in parentheses represent standard error. F0 and Dt represent fundamental frequency and phonation time percentage, respectively

|  |  |  |  |
| --- | --- | --- | --- |
|  | Site A  *N*=15 | Site B  *N*=15 | Site C  *N*=15 |
|  |
| EM (Entire monitoring) | Mean (SE) | Mean (SE) | Mean (SE) |
| SPL\_median(dB) | 76.7 | 80.0 | 78.5 |
| SPL, mean(dB) | 74.5 | 77.6 | 76.7 |
| SPL, SD (dB) | 2.6 | 3.8 | 3.4 |
| F0, mean (Hz) | 246.9 | 280.3 | 266.7 |
| F0, SD(Hz) | 60.0 | 62.7 | 61.3 |
| Dt [%] | 7.1 | 11.6 | 9.3 |
| Pre-monitoring (PM) | Mean (SE) | Mean (SE) | Mean (SE) |
| SPL\_median(dB) | 74.8 | 73.0 | 75.2 |
| SPL, mean(dB) | 70.1 | 72.9 | 72.0 |
| SPL, SD(dB) | 3.7 | 3.2 | 2.60 |
| F0, mean (Hz) | 226.5 | 233.2 | 195.5 |
| F0, SD(Hz) | 25.8 | 24.2 | 39.4 |
| Dt [%] | 37.5 | 40.3 | 42.2 |
| EM-PM | Difference | Difference | Difference |
| SPL\_median(dB) | 1.9 | 4.6 | 2.5 |
| SPL, mean(dB) | 0.9 | 4.0 | 2.0 |
| SPL, SD (dB) | -0.3 | 0.6 | 0.0 |
| F0, mean (Hz) | 20.4 | 47.1 | 79.0 |
| F0, SD(Hz) | 34.2 | 38.5 | 34.9 |
| Dt [%] | -30.5 | -28.7 | -28.8 |

Summary

The present study explored the vocal problems of healthcare workers in three different hospitals in China during the pandemic. Questionnaires revealed that the healthcare workers in the fever clinic have the most serious voice problem during the pandemic, followed by ICUs. The most frequent voice symptom was ‘voice tiredness’ and ‘difficulty in being heard’. Vocal problems in hospitals are significantly affected by the type of masks during the pandemic. The median value of the total VHI-30 score indicated that the voice handicap associated with voice disorder was most significant in the fever clinic department, followed by ICU. The VHI-30 score in the general department was minimal during this research. It was also found that the mean values of voice SPLs were much affected by the type of face mask and the nurses increased their voice levels while they are working in the ICUs.

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