The Face Mask-Associated Dry Eye Symptoms in Workers Who Collecting Novel Coronavirus Nucleic Acid Sample During the Covid-19 Outbreak

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Research Article

Keywords: Mask-related Dry Eye, health and social workers, ocular surface disease index, Covid-19

Posted Date: November 4th, 2022

DOI: https://doi.org/10.21203/rs.3.rs-2208978/v1

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Abstract

Objectives
To evaluate the impact of face mask wearing on dry eye symptoms in health care professionals who collecting novel coronavirus nucleic acid sample during Omicron outbreak.

Methods
This cross-sectional online survey enrolled a total of 1135 health workers and social workers who were dispatched to the front line to participate in the fight against the epidemic. The ocular surface disease index (OSDI) questionnaire was also administered to quantify Mask-Associated Dry Eye (MADE) symptoms. The difference between wearing the face shield and safety-goggle was also investigated.

Results
In this study, the average score was 13.39 (3.39–23.39) and the prevalence of MADE symptoms including mild (23.62%), moderate (12.8%) and severe (4.09%) in Face Shield Group and mild (22.00%), moderate (11.67%) and severe (2.67%) in Safety-Goggles Group. The prevalence of MADE symptoms was higher in female (41.80%) and 50–65 age (64.65%).

Conclusions
A proportion of health and social workers suffer from dry eye symptoms related with wearing mask during the COVID-19 outbreak. MADE interventions should be implemented among health workers during the COVID-19 outbreak to reduce MADE symptoms effects and prevent long-term adverse outcomes.

1. Introduction
Dry eye disease(DED), one of the most prevalent ocular surface problem in daily ophthalmological practice[1], is a multifactorial disease of the ocular surface characterised by a loss of homoeostasis of the tear film, and accompanied by ocular symptoms, in which tear film instability and hyperosmolarity, ocular surface inflammation and damage, and neurosensory abnormalities have aetiological roles[2], which was a new definition from the second International Dry Eye workshop reported in the summer of 2017. The prevalence of DED was great differences worldwide range from 5–50%[3]. In China, the pooled prevalence of DED by symptoms and signs was 18.48% [4].

The symptoms of DED, such as foreign body sensation, grittiness, itchiness, fatigue, and visual disturbances[5], can severely impact vision-related quality of life and that it carries a considerable economic burden of disease [3]. There were a plethora of risk factors that can contribute to the disease, such as normal aging, inflammatory conditions, systemic medications, environmental factors, and lifestyle such as prolonged electric devices using. Most recently, a new factor that wearing face masks was considered to be related to DED during the Covid-19 outbreak. White DE purposed the term "mask associated dry eye (MADE)" to describe this condition [6] and increasingly concerned about mask-related dry eye research[7,8]. Fan Q et al’s study show that risk factors of MADE included longer mask wearing time, nonstandard wearing of face masks, dry environment, older age, female sex, higher education and less outdoor time. Pre-existing dry eyes and use of glasses and contact lens could worsen dry eye symptoms[9].

The Coronavirus (COVID-19) pandemic had an outbreak in December 2019 in Wuhan[10] and has lasted over three years. The Chinese government had taken a number of steps to avoid infection and to quickly screen positive cases throughout China[11]. So many medical staff were pulled out of hospitals to participate in community-level nucleic acid detection, many social workers, as partner of health workers, were employed on a temporary basis for using a mobile phone app to scan a QR code to register the information data. Their prolonged use of masks may cause dry eye symptoms.

Health workers and social workers were at risk of MADE due to the prolonged use of face masks. The aim of this study was to assess the relationship between the wearing of face masks and the presence of MADE among health professional workers and social workers in Shenyang of China during the COVID-19 pandemic.

2. Methods And Materials
This cross-sectional, observational study included the health professionals, including doctors and nurses collecting novel coronavirus nucleic acid sample and social workers as partner of health workers collecting information data in the community during the Omicron outbreak in Shenyang, China. Participants were also divided into a Face-Shield group and a Safety-Goggle Group for comparison based on the different environment caused by the facial protection device they wore.

This study adhered to the tenets of the Declaration of Helsinki, and was approved by the Forth People’s Hospital of Shenyang Ethics Committee. Participants having a history of systemic or ocular disorders (including dry eye diagnosis) or who were using systemic or topical therapies (such as lubricants or artificial tears) were excluded from the research, as were contact lens wearers. The subjects were asked to make a note of the duration they kept their masks on during the work-day.
All participants were also asked to fill in the Ocular Surface Disease Index (OSDI) questionnaire[12] at the end of the three consecutive work-day. Both eyes of all the subjects were included in the statistical analyses. The online questionnaire was created using "Wenjuan Xing," a widely used, open, web-based questionnaire platform and the invitation to participate in the study was posted on "Wechat" for file sharing and messaging, one of the main ways people communicate in China. The 12-item OSDI score range from 0 to 100, with a score of 0 indicating no ocular symptoms and higher scores indicating greater symptom severity. The minimal clinically meaningful change in score for an individual is 10 points.

The OSDI score $\geq 13$ was marked as clinically significant presence of DES (Classification of severity: mild (13 to 22), moderate (23 to 32), and severe (33 to 100))[13].

Descriptive statistics were used to summarise the results, and an Odds Ratio was calculated to quantify the magnitude of association using 95% Confidence Interval (CI) and P-value (< 0.05). Statistical Program for Social Sciences(IBM SPSS Corp, SPSS Statistics ver. 25, USA) was used for statistical analyses, paired samples t test and logistic regression was used to analyse factors associated with dry eye disease.

3. Results

3.1 Geographic Characteristic

Of the 1135 participated in the survey, 68 (5.99%) did not complete questionnaires in the three consecutive work-day, 32 (2.82%) did not pass the consistency checks. Finally, a total of 935 (82.38%) participants were included in the analysis (shown in Table 1), with an effective response rate of 82.38%. Regarding the distribution of gender and age, 73.69% of health workers were female and 26.31% were male, and 45.45% were aged 20–34, 65.23% were married, 29.84% were unmarried and 4.81% were divorced/widowed. 635 (67.91%) were in Face-Shield Group, and 300 (32.09%) were in Safety-Goggles Group. The mean age of all participants was (34.89 ± 6.8) years. All of them spent more than average 10 hours of wearing face mask per day in the last two months.

3.2 Prevalence of Dry Eye Symptoms
In this study, a total of 363 (38.82%) of the respondents reported OSDI score greater than or equal to 13 points. Table 2 presents the prevalence of MADE symptoms including mild (23.62%), moderate (12.8%) and severe (4.09%) in Face Shield Group and mild (22.00%), moderate (11.67%) and severe (2.67%) in safety-Goggles Group. The prevalence of MADE symptoms was higher in female (41.80%) and 50–65 age (64.65).

<table>
<thead>
<tr>
<th>Face Shield Group</th>
<th>safety-Goggles Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non(%)</td>
<td>Mild(%)</td>
</tr>
<tr>
<td>935</td>
<td>635</td>
</tr>
</tbody>
</table>

**Gender**

- **Male**
  - Total: 246
  - Non(60.03%): 122
  - Mild(19.78%): 36
  - Moderate(12.09%): 22
  - Severe(1.10%): 2
  - Female: 497
  - Non(63.67%): 311
  - Mild(23.62%): 114
  - Moderate(12.36%): 56
  - Severe(3.33%): 3

**Age, years**

- 20–34
  - Non(60.59%): 207
  - Mild(20.67%): 62
  - Moderate(10.33%): 31
  - Severe(0.00%): 0
  - 35–49
  - Non(62.32%): 129
  - Mild(23.19%): 48
  - Moderate(11.59%): 24
  - Severe(2.20%): 6
  - 50–65
  - Non(35.16%): 45
  - Mild(17.97%): 23
  - Moderate(15.63%): 20
  - Severe(5.71%): 10

**Marital Status**

- Married
  - Total: 611
  - Non(57.78%): 358
  - Mild(23.33%): 98
  - Moderate(12.38%): 52
  - Severe(3.33%): 14
  - Unmarried
  - Total: 279
  - Non(57.82%): 104
  - Mild(24.44%): 44
  - Moderate(12.22%): 22
  - Severe(5.56%): 10
  - Divorced/Widowed
  - Total: 45
  - Non(57.58%): 26
  - Mild(23.00%): 10
  - Moderate(11.54%): 5
  - Severe(3.33%): 2

**Education**

- College degree and below
  - Total: 236
  - Non(61.33%): 92
  - Mild(22.67%): 34
  - Moderate(12.00%): 18
  - Severe(4.00%): 6
  - Bachelor’s degree
  - Total: 458
  - Non(58.52%): 182
  - Mild(24.44%): 76
  - Moderate(12.86%): 40
  - Severe(4.18%): 13
  - Master’s degree
  - Total: 217
  - Non(61.54%): 80
  - Mild(23.08%): 30
  - Moderate(11.54%): 15
  - Severe(3.85%): 8
  - Doctor’s degree
  - Total: 44
  - Non(61.36%): 27
  - Mild(22.73%): 10
  - Moderate(11.36%): 5
  - Severe(4.55%): 2
  - Post of duty
    - Information Collection
      - Total: 448
      - Non(62.09%): 224
      - Mild(22.88%): 70
      - Moderate(11.76%): 36
      - Severe(3.27%): 10
    - Nucleic Acid Collection
      - Total: 487
      - Non(62.09%): 191
      - Mild(23.32%): 80
      - Moderate(12.77%): 42
      - Severe(4.86%): 16
    - Occupation
      - Doctor
        - Total: 187
        - Non(58.91%): 76
        - Mild(25.58%): 33
        - Moderate(10.85%): 14
        - Severe(4.65%): 6
        - Nurse
          - Total: 300
          - Non(57.50%): 115
          - Mild(23.50%): 47
          - Moderate(14.00%): 28
          - Severe(5.00%): 10
          - Social Worker
            - Total: 448
            - Non(62.09%): 190
            - Mild(22.88%): 70
            - Moderate(11.76%): 36
            - Severe(3.27%): 10

### 3.3 Severity of Dry Eye Symptoms

As shown in Table 3, the average score on the OSDI for MADE symptoms for all respondents were 13.39 (3.39–23.39) and 13.75 (4.89–22.61), 12.64 (4.44–20.84), respectively in Face Shield group and safety-Goggles group. Score in female 14.75 (4.11–25.39) was significantly higher than male (9.59 (3.42–15.76), p < 0.05). There were significant differences of MADE scores between 50–65 ages 20.39 (5.65–14.74) and the other two groups 10.82 (3.21–18.43) and 12.47 (4.21–20.73). The nucleic acid collection group 14.14 (4.17–24.11) including doctor 14.53 (4.07–10.46) and nurse 13.59 (4.11–23.07) was higher than information collection group 12.55 (4.08–21.02) made up of social workers 12.52 (4.06–20.98, p < 0.05). There were significant differences of MADE scores
between Face Shield group and safety Goggles group only related with gender 7.83 (4.12–10.64) vs 13.94 (4.89–22.99, \( p < 0.05 \)) and age (9.13 (4.25–14.01) vs 11.75 (4.44–19.06) vs 20.22 (6.25–34.19), \( p < 0.05 \)).

### Table 3

**Severity of Dry eye symptoms**

<table>
<thead>
<tr>
<th></th>
<th>Total</th>
<th></th>
<th>Face Shield Group</th>
<th></th>
<th>safety-Goggles Group</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>OSDI Score(95%CI)</td>
<td>( p )</td>
<td>OSDI Score(95%CI)</td>
<td></td>
<td>OSDI Score(95%CI)</td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>13.39 (3.39–23.39)</td>
<td>0.065</td>
<td>13.75 (4.89–22.61)</td>
<td>0.015*</td>
<td>12.64 (4.44–20.84)</td>
<td>0.0125*</td>
</tr>
<tr>
<td>Female</td>
<td>14.75 (4.11–25.39)</td>
<td>0.0487*</td>
<td>15.18 (5.12–25.24)</td>
<td></td>
<td>13.94 (4.89–22.99)</td>
<td></td>
</tr>
<tr>
<td>Age, years</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>20–34</td>
<td>10.82 (3.21–18.43)</td>
<td>0.0342*</td>
<td>11.52 (4.25–18.79)</td>
<td>0.0487*</td>
<td>9.13 (4.25–14.01)</td>
<td>0.0125*</td>
</tr>
<tr>
<td>35–49</td>
<td>12.47 (4.21–20.73)</td>
<td>0.015*</td>
<td>12.83 (4.38–21.28)</td>
<td></td>
<td>11.75 (4.44–19.06)</td>
<td></td>
</tr>
<tr>
<td>50–65</td>
<td>20.39 (5.65–14.74)</td>
<td>0.0487*</td>
<td>20.48 (6.64–34.32)</td>
<td></td>
<td>20.22 (6.25–34.19)</td>
<td></td>
</tr>
<tr>
<td>Marital Status</td>
<td></td>
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</tr>
<tr>
<td>Married</td>
<td>13.2 (4.23–22.17)</td>
<td>0.698</td>
<td>13.42 (4.56–22.28)</td>
<td>0.015*</td>
<td>12.71 (4.32–21.1)</td>
<td>0.523</td>
</tr>
<tr>
<td>Unmarried</td>
<td>13.79 (4.11–23.47)</td>
<td>0.0487*</td>
<td>14.46 (4.78–24.14)</td>
<td></td>
<td>12.59 (4.35–20.83)</td>
<td></td>
</tr>
<tr>
<td>Divorced/Widowed</td>
<td>13.56 (4.16–22.96)</td>
<td>0.0487*</td>
<td>14.13 (4.35–23.91)</td>
<td></td>
<td>11.56 (4.11–19.01)</td>
<td></td>
</tr>
<tr>
<td>Education</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>College degree and below</td>
<td>13.12 (4.05–22.19)</td>
<td>1.254</td>
<td>13.59 (4.25–22.93)</td>
<td>0.015*</td>
<td>12.34 (4.09–20.59)</td>
<td>0.123</td>
</tr>
<tr>
<td>Bachelor's degree</td>
<td>13.55 (4.11–22.99)</td>
<td>0.015*</td>
<td>13.93 (4.44–23.42)</td>
<td></td>
<td>12.59 (4.44–20.74)</td>
<td></td>
</tr>
<tr>
<td>Master's degree</td>
<td>13.3 (4.12–22.48)</td>
<td>0.015*</td>
<td>13.51 (4.65–22.37)</td>
<td></td>
<td>12.99 (4.52–21.46)</td>
<td></td>
</tr>
<tr>
<td>Doctor's degree</td>
<td>13.82 (4.23–23.41)</td>
<td>0.015*</td>
<td>13.82 (4.89–22.75)</td>
<td></td>
<td>0.00 (0.00–0.00)</td>
<td></td>
</tr>
<tr>
<td>Post of duty</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Information Collection</td>
<td>12.55 (4.08–21.02)</td>
<td>0.022*</td>
<td>12.94 (4.27–21.61)</td>
<td>0.015*</td>
<td>11.72 (4.21–19.23)</td>
<td>0.548</td>
</tr>
<tr>
<td>Occupation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Doctor</td>
<td>13.59 (4.11–23.07)</td>
<td>0.035*</td>
<td>13.98 (4.68–23.10)</td>
<td>0.035*</td>
<td>12.71 (4.44–20.98)</td>
<td>0.621</td>
</tr>
<tr>
<td>Social Worker</td>
<td>12.52 (4.06–20.98)</td>
<td>0.015*</td>
<td>12.94 (4.22–21.66)</td>
<td></td>
<td>11.61 (4.08–19.14)</td>
<td></td>
</tr>
</tbody>
</table>

### 4. Discussion

- To our knowledge, this is the first study evaluating the relationship of MADE prevalence in the health workers and social workers supported fighting Covid-19 in China. The results show that all participants had high prevalence of dry eye symptoms, which could have been related with long-time wearing mask.
- Before, a survey identified significant relationships between face mask wearing and increased mask wearing time and MADE incidence. The increased incidence of MADE due to the use of masks. This novel finding suggests that frequent wearing of face masks and longer daily mask wearing time are risk factors for MADE in China general population by MADE-Q[9].
- In a survey of Face Mask-Related Ocular Surface Modifications, the Ocular Surface Disease Index (OSDI) score was abnormal in more than half of the cases[14].
- When compared with non-mask related epidemiological studies, such as Caffery B et al. ’s, which study occurred before the COVID-19 outbreak ,resulting in an unadjusted prevalence of 22.0% (95% CI, 20.8–23.1%), the highest was aged 55–64 years (24.7%; 95% CI, 22.1–27.3%), and women was statistically higher(24.7%; 95% CI, 23.2–26.2%) than men (18.0%; 95% CI, 16.4–19.7%)[15].
- Another meta-analysis indicated the prevalence of DED by symptoms and signs was 13.55% (95% CI = 10.00–18.05) and that of DED by symptoms was 31.40% (95% CI = 23.02–41.13) in Chinese people aged 5–89 years. Even considering the region, our study occurred in Northeast China, while in Song’s study, the prevalence of DED by symptoms and signs in Northeast China was 26.42% [4]. So there has been an increase in mask-related dry eye symptoms since the Covid-19 outbreak.
Our results demonstrate that female has a statistically higher OSDI score than male, which concurs with previously reported papers on DED epidemiology [16]. For female, the prevalence of DED symptoms starts increasing from 14% at 50 years of age to 22% for those 80+ years of age [17]. Some previous studies have also reported age-specific sex differences, which may be the result of a combination of different hormones acting on the eye surface, lacrimal glands and so on[18,19].

The highest average OSDI score was found in the group over 50–65 years of age, which result was similar to that aged 40–64 years had the highest mean SD DEQ-5 score[16]. Since we haven’t included participants above the age of 65, and there were very few participants over the age of 60, affecting the overall prevalence and making it unrepresentative of all age groups.

A small sample study measured respirator related OSDI scores for health workers that were higher than our average, the mean OSDI score in the morning was 20.1 ± 8.3 (0–68.75), which increase significantly to 27.4 ± 10.4 at the end of the work-day (0–81.25)[20]. Scalinci SZ’s Research has shown that healthy workers and people who need to wear masks for at least 6 hours a day (At least 5 days a week during the 60 days prior) the highest absolute increase was: +12.50.) and thought it was related to wearing masks for a long time [21]. Moshifar et al.(2020) and Giannaccare G et al(2020) reported that mask wear can accelerate the evaporation of tears and exacerbate the symptoms of dry eye and harm the ocular surface[22,23].

Despite studies showing that wearing sealed goggles in healthcare workers will result in dehydration on ocular surface[24]. The safety-goggles group showed a partial statistically significant decrease in OSDI score relative to those for the face shield group, suggesting wearing safety-goggles maybe a little bit better than wearing face shield.

The study found that the exposure of the ocular surface to high speed air flow (1.5 m/s) reduces the lower tear meniscus height and area and increases the blink frequency[25]. One possible explanation for the worsening of DED symptoms might be related to loose fitting of masks around the nose. Without a proper seal, respiratory gas might be diverted upwards towards the eyes[21]. This is similar to our Face Shield group, but the safety-Goggles protect the air flow of the mask, so the score of this group is generally lower than that of the Face Shield group, but we do not see a significant difference. This could also be due to safety Goggles providing an alternative environment, or it could be related to dry eyes.

For example, the surrounding temperature and humidity of wearing safety goggles was different with wearing face shield. Previous research has revealed that the temperature and humidity of gases inside a face mask that travels through the upper edge of the mask towards the ocular surface can be higher. This hot air current produces instability, increased evaporation, hyperosmolarity, and a decrease in tear film renewal, all of which contribute to the development of dry eye symptoms. In turn, the severity of the symptoms is linked to the tear lipid layer’s thickness[26]. Alternatively, as a result of exhaled air, oxygen levels decline, and the air contains more carbon dioxide, causing degeneration of the lacrimal and ocular surfaces, which lowers pH and lowers stromal pH, resulting in corneal issues [27,28]. Silkiss RZ proposed that the use of adhesive tape over one’s mask on the bridge of the nose to minimize the upward direction of air towards the eyes may improve surroundings of the eye.[29].

We also saw higher rates and scores in the nucleic acid sampling group, which included medical staff, than in the information collection group, which included social workers, despite the fact that information collection is typically done by scanning a code using a mobile phone App, which may lead to confusion about whether time spent on a mobile phone is a factor affecting dry eye [30]. However, there was no evidence that this group was more numerous than those who did not use cell phones. However, even if health-care employees do not use mobile phones for work, they may spend a significant amount of time on terminal electronic devices in their other jobs or personal lives, thus this does not eliminate the dry eye disease induced by this factor.

It is recommended that we do not remove the mask, and certainly not remove Face Shield and safety Goggles, and we do not know if wetting the sampled environment increases the possibility of viral aerosol formation. However, using necessary interventions such as sodium glass cellulose eye drops when convenient may reduce and prevent dry eye.

**Limitations**

These participants didn't undergo a complete ophthalmological examination including a best corrected visual acuity (BCVA), intraocular pressure (IOP) measurement, biomicroscopic anterior segment examination and fundus examination with 90 D lens. We used a personal commitment to the above instead. The OSDI score only represents symptoms, but can't represent diagnosis of DE, therefore, a variety of other objective methods should be employed to evaluate DES.

**Conclusion**

A proportion of health workers suffer from dry eye symptoms related with wearing mask during the COVID-19 outbreak. High-risk health workers and social workers for DE symptoms were those female, older, and with face shield. DE interventions should be implemented among health workers during the COVID-19 outbreak to reduce DE symptoms effects and prevent long-term adverse outcomes.

**Declarations**

**Ethical approval**

The study was approved by The Fourth People’s Hospital of Shenyang Ethics Committee and in line with the principles of the Declaration of Helsinki.

**Competing Interests**
All of our authors participated in the study and agreed to the publication of the results. The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Contributions:

Jintao Ren contributed to the conception of the study; Jie Yu and Jintao Ren performed the experiment; Jie Yu Liang Zhang Chunguang Lu contributed significantly to analysis and manuscript preparation, Jie Yu and Dongning Liu performed the data analyses and wrote the manuscript; Jintao Ren and Dongning Liu helped perform the analysis with constructive discussions.

Funding:

Our study have no received any Funding.

Availability of data and materials

Not applicable

Informed consent

We gave an informed consent form at the top of the questionnaire, and only with consent can we continue to answer the OSDI content, so all participants in our study knew and agreed to participate in this study.

References


