Original Article

# Mask-Associated Dry Eye (MADE) in Healthcare Professionals Working at COVID-19 Pandemic Clinics

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**Abstract**

**Background:** Healthcare professionals working at COVID-19 pandemic clinics have to work with masks during long hours. After the widespread use of masks in the community, many mask-related side effects were reported to clinics. The increase in the number of applicants with dry eye symptoms due to mask use in ophthalmology clinics has led to the emergence of the concept of mask-associated dry eye (MADE). We think that it would be valuable to evaluate ocular surface tests with a comparative study using healthcare professionals working in pandemic clinics, which we think is the right study group to examine the effects of long-term mask use. **Aims:** We aimed to evaluate the mask-associated dry eye (MADE) symptoms and findings in healthcare professionals who have to work prolonged time with face masks in coronavirus disease 2019 (COVID-19) pandemic clinics. **Patients and Methods:** In this prospective, observational comparative clinical study, healthcare professionals who use the mask for a long time and work in COVID-19 pandemic clinics were compared with an age and sex-matched control group consisting of short-term masks users, from April 2021 to November 2021. All participants underwent the Ocular Surface Disease Index (OSDI) questionnaire, tear film break-up time (T-BUT), Oxford staining score, Schirmer's test I, and meibography with infrared transillumination. **Results:** The long-term mask user group consisted of 64 people, while the short-term mask user group consisted of 66 people (260 eyes, total). The OSDI score and Schirmer I measurement were not statistically different between the two groups. T-BUT was statistically significantly shorter in the long-term group ($P$: 0.008); lid parallel-conjunctival fold, Oxford staining score, and upper and lower lid meibography score were found to be significantly higher in the long-term group ($P < 0.001$, $P$: 0.004, $P$: 0.049, $P$: 0.044, respectively). **Conclusion:** Healthcare professionals with longer mask-wearing times are at greater risk of ocular surface damage. It may be considered to prevent this damage by blocking airflow to the ocular surface, such as by wearing a face mask properly or fitting it over the nose with surgical tape. Those who have to work with a mask for a long time during the COVID-19 pandemic should keep in mind the ophthalmology follow-up for eye comfort and ocular surface health.

**Keywords:** *COVID-19, healthcare professional, mask-associated dry eye, ocular surface*

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## Introduction

Using a face mask for a long time during the day to reduce the spread of the 2019 Coronavirus disease (COVID-19) and prevent acquiring the disease has caused various problems that affect our daily lives. Irritation and rash in the skin area covered by the mask, auricular pain due to the mask rope, headache, difficulty in breathing, and ocular discomfort are some of the

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reported complaints.[1-3] The increase in patients with dry eye symptoms in ophthalmology clinics during the pandemic has led to the emergence of the concept of face mask-associated dry eye (MADE).[4] Although most of these patients had no previous signs or symptoms of dry eye, ocular discomfort occurred with mask use. There are some previous studies on the effects of face mask use on the ocular surface.[5-7] When the mask does not fit properly over the nose, inhaled air and exhaled hot air from the mouth and nose cause continuous air exposure to the ocular surface. It was claimed that there may be a retrograde airflow from the nose to the ocular surface through the nasolacrimal duct when the mask fits snugly over the nose. Likewise, the microorganisms in the air droplet are contaminated to the ocular surface by direct and retrograde air flows.[8,9] It has been stated that the prevention and treatment of the MADE is a necessity for public health since the use of masks causes instability of the tear film layer, which causes visual and symptomatic discomfort, and may damage the ocular surface.[4,10,11]

Healthcare professionals working in pandemic clinics must use face masks effectively during their working hours to protect themselves from COVID-19. The increase in dry eye disease (DED) signs and symptoms in this occupational group may negatively affect their quality of life. Evidence of the negative effects of airflow altered by mask used on the eye surface may enable us to develop recommendations to protect us from DED. To our knowledge, there is no previous study evaluating the effect of face mask wearing on the ocular surface in COVID-19 clinics where long-term mask use is required. In this comparative study, dry eye findings of healthcare professionals working in pandemic clinics who must wear a protective mask during long working hours were evaluated with Ocular Surface Disease Index (OSDI), Schirmer I test, tear film break-up time (T-BUT), ocular surface evaluation tests, and infrared transillumination meibography.

## Materials and Methods

In this prospective randomized comparative study, a long-term mask user group was compared to an age and sex-matched, short-term mask user control group. Healthcare professionals working at tertiary hospital pandemic clinics, which have almost continuous use of face masks during the 12-hour working period of intensive care unit work schedule due to the COVID-19 pandemic, were included in the study group. An ophthalmological examination was performed on the study group participants at the end of the work schedule. The control group was selected from healthy volunteers who did not wear masks for more than 2 hours a day during the COVID-19 pandemic. The study was carried out between April and December 2021. The exclusion criteria were a history of ocular surgery, a systemic disease that may affect the measurements (rheumatoid arthritis, Sjögren's disease, etc.), cataract, uveitis, glaucoma, retinal pathologies, spherical refraction outside the range of +2.00 and -3.00, or with a cylindrical value exceeding 2.00, the best-corrected visual acuity less than 10/10 in each eye were excluded from the study. Fully vaccinated status was defined as having at least two doses of the Pfizer/BioNTech or Sinovac vaccine.[12]

The study protocol was approved by the local ethics committee of the Tekirdag Namik Kemal University Hospital (04.2021/2021.103.04.21). Written informed consent was obtained from all participants by giving detailed information about the purpose of the study and the procedures to be performed. The criteria specified in the Declaration of Helsinki were complied with. An OSDI questionnaire was administered to the subjects. T-BUT, Schirmer's test I, Oxford staining score, and meibography were performed and lid parallel-conjunctival fold status was recorded. The symptoms of the patient and the effects of these complaints on daily activities were scored with the OSDI questionnaire consisting of twelve questions and questioning the complaints of the patient about dry eye in the last two weeks. Answers to questions were; 0: never 1: sometimes 2: half of the day 3: most of the time 4: always. The total OSDI score was calculated with the formula OSDI = [(sum of scores of all questions answered) × 25]/[(total number of questions answered). Results were evaluated on a scale of 0-100.[13] While performing Schirmer's test I, a 35 mm Schirmer test paper was placed on the outer 1/3 of the lower eyelid without using ocular topical anesthesia, and was told to stay in an upright position for 5 minutes without blinking frequently. T-BUT was measured with a slit lamp microscope by touching a sterile fluorescein sodium ophthalmic strip (1 mg, USP BioGlo Sterile Strips, HUB Pharmaceutics LLC, Rancho Cucamonga, CA) to the tear meniscus. After dyeing, the eyes were asked to blink. The slit lamp was set to 10x magnification using a blue cobalt filter, and the seconds counted until the first tear film break-up time. In the Oxford staining test, ocular surface damage was assessed using a fluorescent strip, according to DEWS 2007 recommendations.[10] By lifting the upper eyelid, staining on the corneal surface was graded in six stages (0-5).

The lid parallel-conjunctival fold was evaluated according to the conjunctival folds parallel to the nasal and temporal lower lid when looking ahead.

Lid parallel-conjunctival fold grading evaluated as grade 0: no permanently present folds; grade 1: a conjunctival fold that appears smaller than the normal tear meniscus; grade 2: multiple folds up to normal tear meniscus; grade 3: multiple folds higher than normal tear meniscus. In meibography, images of the meibomian gland lying on the tarsal plate were obtained with infrared transillumination by turning the upper and lower eyelids. Quantification of meibomian gland loss was assessed by a whiter bright image on black of the meibomian gland (SL-D701; Topcon, IJssel, The Netherlands) [Figure 1].

Meibomian gland loss was in the upper and lower lids graded as; 0: no meibomian gland loss; 1: loss of less than one-third of the total meibomian gland area; 2: loss of more than one-third, less than two-thirds; 3: loss of more than two-thirds.[14] Image J software was used to calculate these ratios of meibomian gland loss relative objectively in meibography images by a masked observer (E.C.) [Figure 2].

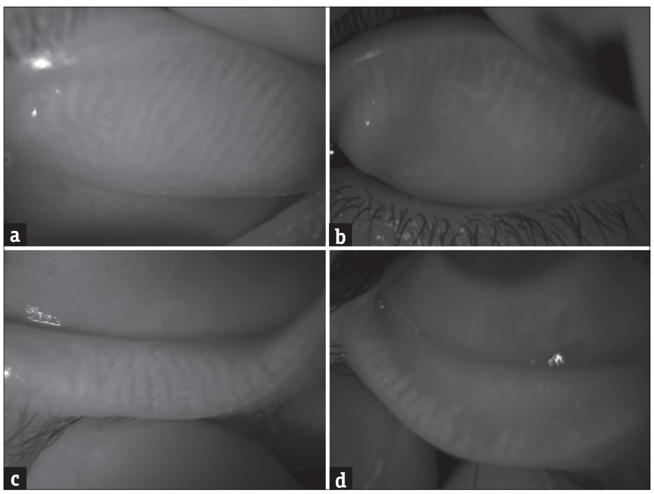


**Figure 1:** The appearance of the meibomian glands using infrared transillumination meibography. (a) Showing images of the no loss of meibomian gland on the upper eyelid; (b) No loss on the lower eyelid; (c) The loss of more than two-thirds on the upper eyelid; (d) The loss of more than two-thirds on the lower eyelid

### Statistical analysis

Data were collected and analyzed in the database of SPSS software for Windows (version 26, IBM SPSS Statistics, Chicago, Illinois, USA). The confidence interval was determined as 95% for the independent outcome variables obtained and a *P* value <.05 was considered statistically significant. Pearson's Chi-square test was used for categorical variables and the Independent-samples *t*-test was used for quantitative variables. All examinations and measurements were performed by the same experienced practitioner.

## Results

Sixty-four long-term mask users and 66 short-term mask users (260 eyes, total) were included in the study. The mean age in the long-term group was 36.34 ± 8.07 (range, 21-53), and in the short-term group was 35.93 ± 9.57 (range, 21-51). The female ratio was 62.5% (40) in the long-term group and 66.6% (44) in


**Figure 2:** Calculation of the ratio of meibomian gland loss to total lid area using ImageJ software. (a) Upper eyelid total area; (b) Upper eyelid meibomian gland area

**Table 1: Demographics and clinic characteristics of long-term and short-term mask use groups**

| | Groups | | | | *P* |
|---|---|---|---|---|---|
| | Long-term mask use | | Short-term mask use | | |
| Sex-female% (n) | 62.5% (40) | | 66.6% (44) | | 0.623 |
| Had Covid-19% (n) | 18.7% (10) | | 18.1% (12) | | 0.934 |
| Fully vaccinated % (*n*) | 98.4% (63) | | 86.3% (57) | | 0.000 |
| | Mean±SD | Range | Mean±SD | Range | *P* |
| Masked time (hour) | 8.10±2.52 | 6, 12 | 1.60±0.49 | 1, 2 | 0.000 |
| Age | 36.34±8.07 | 21, 53 | 35.93±9.57 | 21, 51 | 0.795 |
| OSDI | 36.62±22.72 | 0, 82.50 | 36.41±20.60 | 4.16, 81.81 | 0.957 |
| Schirmer-I (mm) | 19.59±8,44 | 5, 35 | 19.07±9.68 | 3, 35 | 0.647 |
| T-BUT (second) | 8.42±3.64 | 2, 15 | 9.51±2.97 | 2, 15 | 0.008 |
| Lid-parallel conjunctival fold | 0.21±0.54 | 0, 2 | 0.03±0.17 | 0, 1 | 0.000 |
| Oxford staining score | 0.57±0.78 | 0, 3 | 0.33±0.56 | 0, 2 | 0.004 |
| Upper meibography score | 0.60±0.83 | 0, 3 | 0.43±0.63 | 0, 3 | 0.065 |
| Lower meibography score | 0.69±0.89 | 0, 3 | 0.48±0.63 | 0, 3 | 0.029 |
| Total meibography score | 0.67±0.85 | 0, 3 | 0.46±0.63 | 0, 3 | 0.026 |

OSDI: Ocular Surface Disease Index, T-BUT: Tear film break-up time the short-term group. The fully vaccinated rate was higher in the long-term group than in the short-term group (98.4%, and 86.3%, respectively, $P < 0.001$). On the contrary, there was no statistically significant difference between the two groups with a history of at least one COVID-19 disease ($P = 0.934$). The mean duration of masking was 8.10 ± 2.52 (6, 12, range) for the long-term group, while it was 1.60 ± 0.49 (1, 2, range) for the short-term group. OSDI score and Schirmer I test were not statistically different between the two groups. T-BUT was found to be statistically significantly shorter in the long-term group ($P = 0.008$). Lid parallel-conjunctival fold and Oxford staining scores were significantly higher in the long-term group ($P < 0.001$). While the mean upper and lower lid meibography score was found to be significantly higher in the long-term group ($P = 0.049$, $P = 0.044$, respectively), there was no significant difference in the total meibography score ($P = 0.216$) [Table 1].

## Discussion

Since the beginning of the COVID-19 pandemic, many people have been exposed to the long-term use of masks. Healthcare professionals working in pandemic clinics were considered long-term mask users in this study because they used masks for more than 8 hours on average, as they were thought to be an effective group in this study. In the examinations performed for this group, it was observed that the findings of ocular surface damage increased.

In our study, 98.4% of the long-term group received at least 2 doses of vaccination, while this rate was 86.3% in the control group. Although the rate of full vaccination was higher in the long-term mask user group, there was no statistically significant difference in the rate of having COVID-19 disease between groups ($P = 0.934$). It was thought that healthcare professionals working in pandemic clinics were more likely to be in contact with infected people, increasing the likelihood of contracting COVID-19 disease.

DED is a disorder of the tear film due to the underproduction of tears or excessive tear evaporation that damages the ocular surface and is evaluated in two categories as aqueous-deficient and evaporative.[10] While lacrimal gland secretion is decreased in aqueous-deficient, there is meibomian gland dysfunction in the evaporative-type. While evaporative type DED is more common, most patients have both aqueous insufficiency and dry eye.

The OSDI test is widely used to evaluate DED symptoms. The OSDI test allows us to quickly evaluate the signs of ocular irritation, discomfort, and its effect on visual function due to DED. In our study, no statistically significant difference was observed in the OSDI score in both group. The Schirmer I test, a specific test for tear production, was also statistically similar between the two groups. This result is a valuable DED finding indicating tear film instability. In the reference study evaluating the reliability and validity of the OSDI, it was reported that it may have a low correlation with other dry eye findings.[13] No difference was found for Schirmer I, which is an important finding of aqueous insufficiency.

Ocular surface findings difference is significantly meaningful in our study, indicating evaporative DED in the long-term group. T-BUT, a valuable finding of tear film instability, was found earlier in the long-term group and the difference was statistically significant. Oxford staining score, which is a test showing corneal epithelial damage, was statistically higher in the long-term group. The lid parallel-conjunctival fold is the result of increased friction of the conjunctiva due to DED. It is evaluated with one or multiple conjunctival folds parallel to the lid, in the temporal or nasal of the conjunctiva when looking throughout ahead. The incidence of lid parallel-conjunctival fold is statistically significantly higher in the long-term group.

The meibomian glands lie vertically from the bottom of the tarsal plate to behind the lashes on the lower and upper eyelids. It functions to form the outermost surface of the tear film layer by secreting lipids to the ocular surface. The glands have a distal blunt end and a proximal open end that secretes lipids anterior to the mucocutaneous junction. Meibomian gland dysfunction (MGD) is a chronic and diffuse anomaly characterized by an obstruction in the terminal ducts of these glands and/or a quantitative or qualitative secretory change in their glandular secretion.[15,16] We performed meibography using an infrared filter while imaging the meibomian gland. In these images, the white bands on the tarsal plate and a darker space between these bands are visible.[14,17] In our study, the meibomian loss was more common in the long-term group, and lower lid and total meiboscore were found to be statistically higher.

We thought that healthcare professionals working in the pandemic clinics are a standardized and ideal study group for long-term mask use. One of the limitations of the study is the presence of other environmental factors that may affect the dry eye findings in the occupational group. These participants had systematic air conditioning, artificial lighting, positive pressure, and mask used in the working environment for many years, before the COVID-19 pandemic.[18] This may suggest that the findings of the participants were not only due to the use of masks. Supportive studies can be conducted where only the use of mask duration is variable. Due to the different mask characteristics, studies evaluating the frequency of DED using the standard face mask model are needed.

Wearing a mask for a long time increases the frequency of MADE and requires us to take some precautions in our daily routine. Wearing the face mask properly or fixing it over the nose by sticking surgical tape on the top can prevent airflow to the ocular surface. Wearing the mask with rest intervals rather than using it continuously can reduce discomfort. We think that more frequent ophthalmology follow-ups and earlier use of eye lubricants should be on the agenda of long-term mask users.

## Ethics committee approval

The study protocol was approved by the Local Ethics Committee of Tekirdag Namik Kemal University Hospital (2021.103.04.21). This study was performed in line with the principles of the Declaration of Helsinki.

## Patient consent for publication

Informed consent was obtained from the patients.


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Nil.


## Conflicts of interest

There are no conflicts of interest.

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