Graefe's Archive for Clinical and Experimental Ophthalmology (2022) 260:3313–3319
https://doi.org/10.1007/s00417-022-05709-3

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The effect of day-long mask wearing on non-invasive break-up time

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Received: 15 March 2022 / Revised: 1 May 2022 / Accepted: 14 May 2022 / Published online: 26 May 2022

Abstract

Purpose This study aimed to investigate the effect of day-long face mask wearing on non-invasive tear break-up time (NI-BUT) in health care staff due to working schedules.

Methods Seventy-four right eyes of 74 participants were included in the study. Participants completed the Ocular Surface Disease Index (OSDI) questionnaire, and NI-BUT measurements were performed between 08.30–09.00 and 16.30–17.00 h. Participants with an initial NI-BUT measurement below 17 s were classified as group-1, and those over 17 s were classified as group-2. NI-BUT changes during the day and correlation to age, gender, and OSDI results were evaluated.

Results Thirty-eight women and 36 men, with a mean age of 30.9 ± 8.5 years, were included in the study. The mean OSDI score of the participants was 28.6 ± 17.1. NI-BUT means of group-1 at baseline and 8th hour were 11.4 ± 3.3 and 7.9 ± 3.6 s, respectively, and the mean NI-BUT at the 8th hour was statistically significantly lower than the baseline ($p < 0.0001$). Also, 24.2% (8 people) of those in group-2 had the 8th-hour NI-BUT value fallen into the measurable range (below 17 s). No significant correlation was found between the decrease in NI-BUT value and age, gender, and OSDI ($p = 0.08$, $p = 0.3$, and $p = 0.2$, respectively).

Conclusion The use of face masks throughout the day leads to a significant reduction in NI-BUT, regardless of age, gender, and OSDI score. Prolonged use of face masks should be considered as a risk factor for evaporative dry eye disease.

Keywords COVID-19 · Evaporative dry eye · Face mask · Non-invasive tear break-up time · OSDI score

Key messages

What is known

- Use of face masks increases dry eye symptoms such as irritation, blurred vision, foreign body sensation, pain, and itching.

What is new

- The use of face masks throughout the day leads to a significant reduction in non-invasive tear break-up time.
- Reduction in tear break-up time has no correlation to age, gender or OSDI score.
- Prolonged use of face mask should be considered as a risk factor for evaporative dry eye disease.

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Introduction

One of the changes that the COVID-19 pandemic brought to our lives is the widespread use of masks, which is recommended as an important precaution against the spread of SARS-CoV-2 [1]. Using a face mask reduces the outward spread of air significantly. However, that exhaled air finds a leaking route which is likely upward especially if the mask is ill-fitting. This leaking air over the surface of the cornea

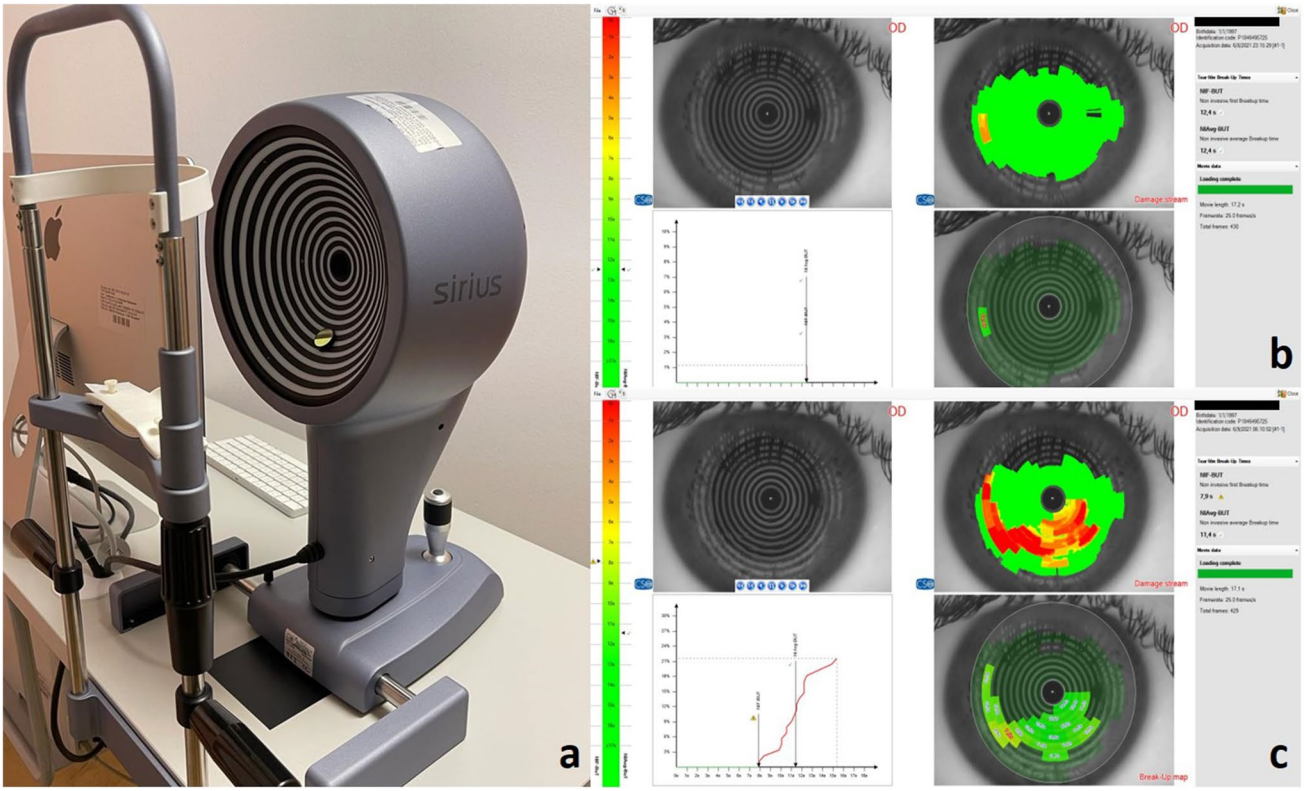

Fig. 1 **a** NI-BUT with Sirius topography. **b** Initial NI-BUT of a participant with 12,4 s. **c** 8th-h NI-BUT of the same patient with 7.9 s

has introduced us to a novel cause of evaporative dry eye: mask-associated dry eye (MADE) [2].

After the first anecdotal description of MADE, there have been increasing reports of dry eye symptoms such as irritation, blurred vision, foreign body sensation, pain, and itching due to loosely sitting masks against the face and leakage of air [3, 4]. However, the evaporative effect of long-term mask use has not been adequately discussed in the literature. In this study, we aimed to reflect the association between prolonged mask-wearing and non-invasive tear break-up time (NI-BUT) in a cohort of health care professionals who use face masks day-long because of their intensive work schedules.

Material-methods

This cross-sectional study was conducted in accordance with the Declaration of Helsinki. Written consent was obtained from all participants for the use of their data for research purposes. Ethical approval was received from the Ethical Committee of Zonguldak Bülent Ecevit University (2022/04–18).

Health care staff working at Bülent Ecevit University Practice and Research Hospital, who used face masks during the day, was included in the study. Participants were allowed to take their masks off only during lunch time due to work schedules. Those who had ocular surface disease or irregularity, acute corneal or conjunctival infection, glaucoma, or thyroid eye disease, had a history of ocular trauma or ocular surgery, were using contact lens, any topical medication, or receiving continuous positive airway pressure (CPAP) therapy, smoking, and those who cannot adequately comply with the examination are excluded from the study. The

Table 1 Demographical data, non-invasive tear break-up time, and OSDI score distribution of participants

Age (Mean ± SD)	30.9 ± 8.5
Gender	
Female	38 (51.3%)
Male	36 (48.7%)
NI-BUT > 17 s (group-1)	33 (44.6%)
NI-BUT < 17 s (group-2)	41 (55.4%)
Ocular surface according to OSDI	
Normal	13 (17.6%)
Mild dry eye	18 (24.3%)
Moderate dry eye	13 (17.6%)
Severe dry eye	30 (40.5%)

participants completed the Ocular Surface Disease Index (OSDI) questionnaire for subjective evaluation of symptoms [5]. The Turkish adaptation of OSDI was used to quantitatively evaluate the subjective condition of the ocular surface. The overall and subscale scores of OSDI range from 0 to 100, classifying the ocular surface as normal (0–12 points), mild (13–22 points), moderate (23–32 points), or severe (33–100 points) dry eye syndrome [6].

The improved tear analysis program of Sirius topography (Costruzione Strumenti Ophthalmici, Florence, Italy) was used to measure NI-BUT values of the participants. Tear break-up is examined by video recording by the projection of the Placido disc. The breakage of the disc rings reflects tear film deformation. The received video image is evaluated by the system, and break-up time is measured without user intervention. According to break-up time, a colored map is formed in which the yellow color indicates a slight separation that is not visible or difficult to see with the naked eye, while the red tones indicate a more severe separation (Fig. 1). NI-BUT measurements of the participants' right eye were performed between 08.30–09.00 and 16.30–17.00 h. Since the measurement interval of the device is up to 17 s, those with an initial NI-BUT measurement below 17 s were classified as group-1, and those over 17 s were classified as group-2. Participants' NI-BUT changes during the day and correlation to age, gender, and OSDI results were evaluated. Due to that NI-BUT values of group-2 are out of measurable range, this group was not included in the correlation analysis.

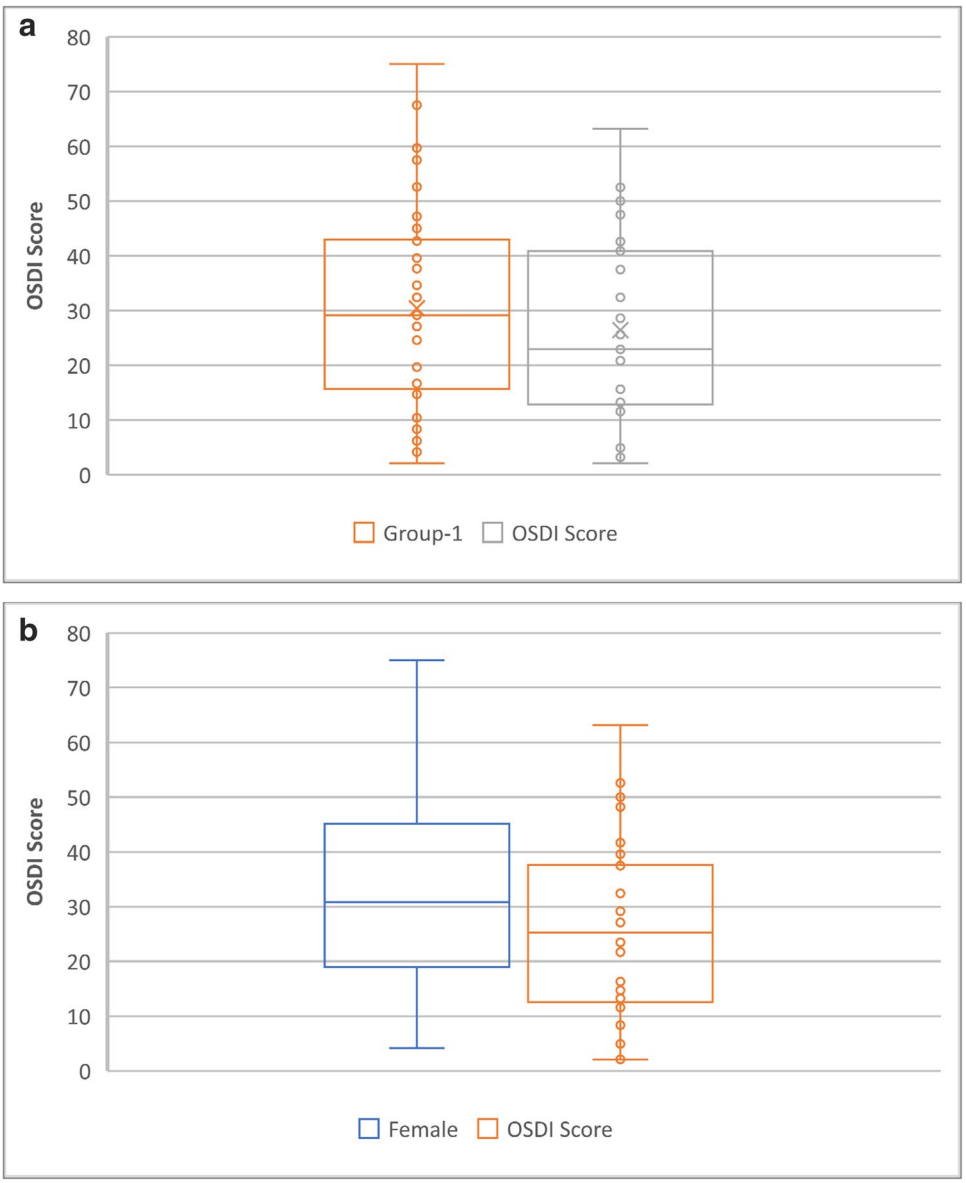

Fig. 2 **a** The mean OSDI score of the participants was 28.6 ± 17.1, 30.4 ± 17.7 in group-1 and 26.4 ± 16.2 in group-2. There was no statistically significant difference between the two groups in terms of OSDI score ($p = 0.32$). **b** The mean OSDI score was 31.8 ± 17.4 in females and 25.2 ± 16.2 in males. The difference between genders was not statistically significant ($p = 0.09$)

Statistical analyses

Statistical analysis was performed using IBM SPSS Statistics 22.0 (SPSS Inc, Chicago IL). Descriptive data were presented as mean values and SD. *T*-test was used to compare NI-BUT values of 0th-8th h. The Mann–Whitney *U* test and Spearman correlation analysis were used to reflect the correlation of NI-BUT change with gender, age, and OSDI score. Results were within a 95% confidence interval, and the *p* value of less than 0.05 was considered statistically significant.

Results

A total of 74 people, 38 women and 36 men, were included in the study. The mean age of the participants was 30.9 ± 8.5 years. According to the OSDI score of the participants, 13 had normal ocular surface and 18 had mild, 13 moderate, and 30 severe dry eye syndrome. Of the participants, 41 were in group-1 and 33 were in group-2 (Table 1).

The mean OSDI score of the participants was 28.6 ± 17.1 and 30.4 ± 17.7 in group-1 and 26.4 ± 16.2 in group-2 (Fig. 2a). There was no statistically significant difference between the two groups ($p = 0.32$). The mean OSDI score was 31.8 ± 17.4 in females and 25.2 ± 16.2 in males. Although the mean OSDI score was higher in women than in men, this difference was not statistically significant. ($p = 0.09$) (Fig. 2b).

In group-1, the mean NI-BUT at baseline was 11.4 ± 3.3 s, the mean of the 8th h NI-BUT was 7.9 ± 3.6 s, and the mean NI-BUT at the 8th h was statistically significantly lower than the baseline ($p < 0.0001$) (Fig. 3). No significant correlation was found between the decrease in NI-BUT value and age, gender, and OSDI ($p = 0.08$, $p = 0.3$, and $p = 0.2$, respectively) (Fig. 4a, b, c). Also, 24.2% (8 people) of those in group-2 had the 8th h NI-BUT value fallen into the measurable range (below 17 s).

Discussion

The non-invasive assessment of pre-corneal tear film stability was introduced by Mengher et al. in 1985, but it required a subjective measurement by an examiner [7]. The inter-grader variability observed with subjective examiner assessment had been eliminated by the development of new devices with automated software for NI-BUT quantification [8–10]. Significant correlations between NI-BUT and the standard biomicroscopic tear break-up time (TBUT) have been reported [10–12]. In addition, it is stated that NI-BUT measurement obtained with a topography device is more advantageous than TBUT measurement because it is objective, more practical, and does not require fluorescein paper and topical anesthesia [12]. Recently, NI-BUT with a cut-off value less than or equal to 10 s had been identified by the Dry Eye Workshop II (DEWS II) as an indicator for DED diagnosis with 82–84% sensitivity and 76–94% specificity [13].

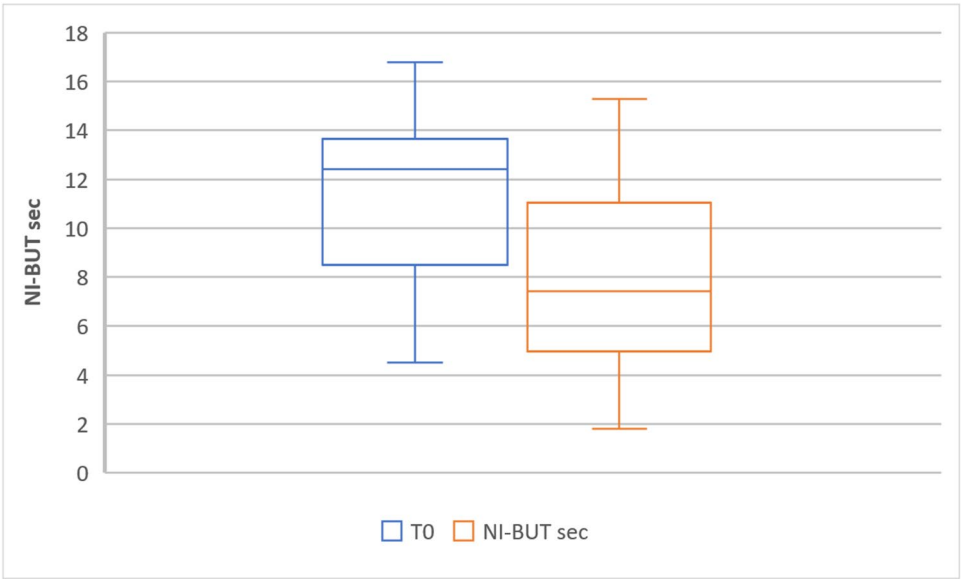

Fig. 3 The mean NI-BUT at baseline was 11.4 ± 3.3 s, the mean of the 8th h NI-BUT was 7.9 ± 3.6 s, and the mean NI-BUT at the 8th hour was statistically significantly lower than the baseline ($p < 0.0001$)

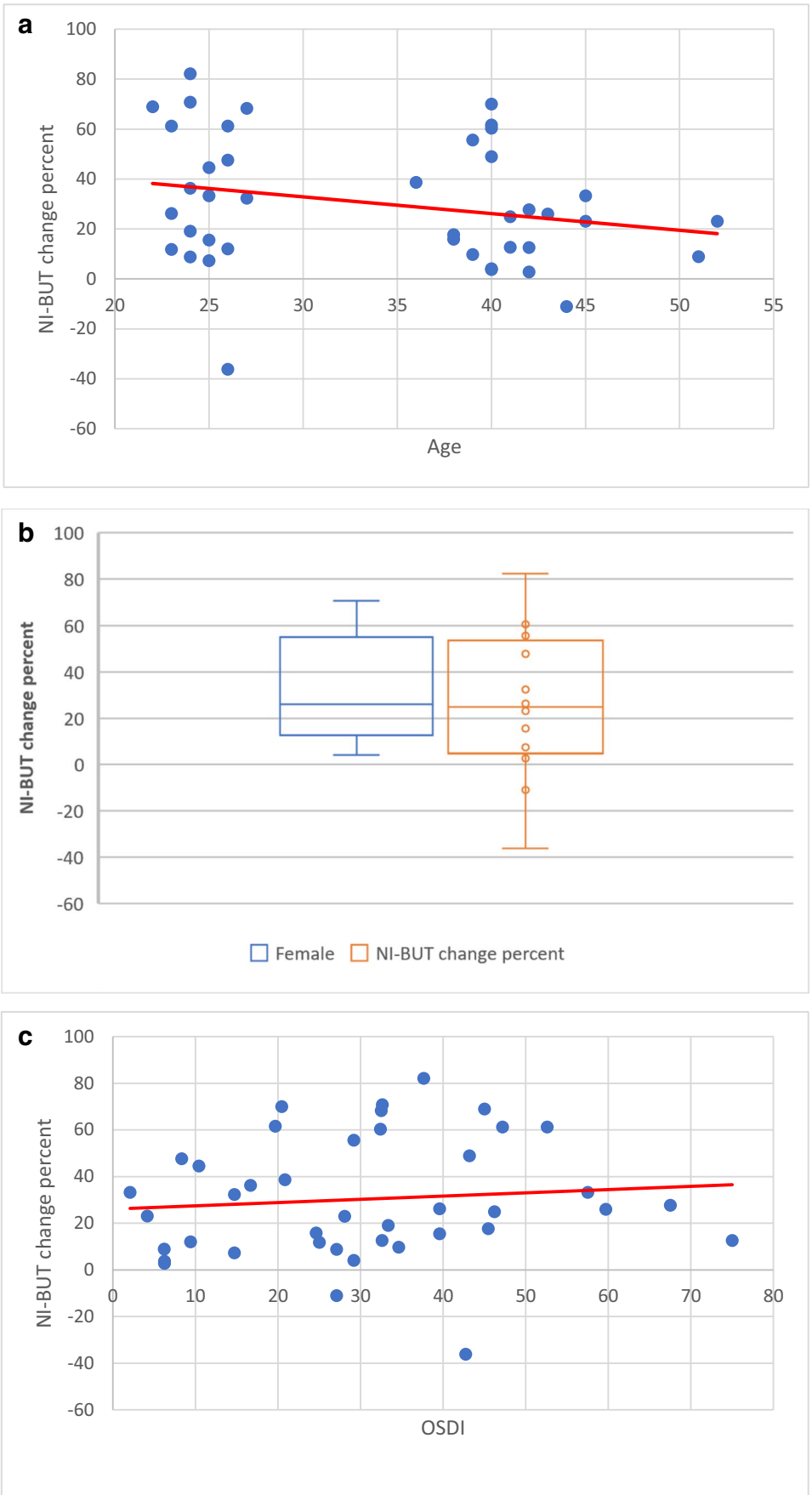

Fig. 4 **a**, **b**, **c** No significant correlation was found between NI-BUT change percentage and age, gender, or OSDI ($p=0.08$, $p=0.3$, and $p=0.2$, respectively)

This cross-sectional study aimed to reflect the evaporative effect of using the day-long face mask. A cohort of health care staff was specifically included in the study to better see the effect of uninterrupted mask use. Results revealed that 8 h of continuous face mask use reduced NI-BUT in all subjects having measurable NI-BUT.

It is revealed that the use of face masks may worsen dry eye symptoms. Boccardo revealed that 26% of dry eye symptoms having subjects had increased symptoms with mask wear [14]. Moshifar et al. indicated a marked increase in dry eye symptoms among regular mask users. This was attributed to air blowing from the upper portion of the mask toward the ocular surface, resulting in increased airflow and accelerated evaporation of the tear film, causing irritation or inflammation of the ocular surface when this continues for hours or days [3]. This scenario is similar to worsening dry eye symptoms in patients having CPAP therapy which increases ocular irritation and tear evaporation especially if the mask is improperly fitted [15, 16].

The impact of face masks on dry eye symptoms has been previously discussed in the literature; however, its evaporative aspect has not been adequately discussed quantitatively. Aksoy et al. revealed that 8 h of mask-wearing decreased TBUT and Schirmer test results [17]. However, they evaluated the subjects on different days, and continuous mask wear is based on subjects' statements. This is the first study, which investigates the impact of 8 h of continuous mask wear on non-invasive dry eye assessment, conducted on the same day. Although this study lacks a non-mask-wearing control group due to the COVID-19 precautions, it is shown before that no significant day-long change in TBUT values occurs in healthy subjects [18, 19].

Based on the OSDI values of subjects, Krolo et al. revealed that a history of prior dry eye disease, female sex, and wearing a face mask longer than 3 h per day could contribute to or worsen dry eye symptoms during face mask-wear [20]. In the current study, OSDI scores of females were slightly higher than males; however, no significant correlation was found between the decrease in NI-BUT value and age, gender, and OSDI score.

Jahanbani-Ardakani et al. stated that OSDI scores of health care staff were greater than the control group (27.2 vs 7.3), and this was attributed to face mask wearing time (10.1 vs 1.2 h) [21]. Our results showed similar OSDI scores (28.6) in a similar health care staff cohort who were wearing face masks for approximately 8 h that OSDI level may reflect evaporative effect of face mask usage, even though we had not a control group of non-mask wearers. Aksoy et al. also reported that 8-h mask use increased the OSDI score, and taping the upper part of the mask decreased the OSDI score [17].

Another entity described in 1986 as an evaporative dry eye reason is "office eye syndrome": in which air conditioning in the office environment causes a decrease in TBUT time, causing eye irritation and an increase in dry eye symptoms [22]. This entity may have an additional effect on the decrease in TBUT time in this health care staff cohort working in an air-conditioned hospital. However, the likely cause of this situation is that the poor-quality air generated by breathing is blown directly to the ocular surface from underneath the mask which is a closer and continuous source rather than an air conditioning system.

The main limitation of this study is the lack of a non-mask wearer control group. However, the arrangement of this control group is impossible nowadays due to the COVID-19 regulation. Another limitation is the subjective nature of the OSDI score. We believe this study will support further studies with larger study populations that may be planned to compare results during routine use of face masks to a period without face mask usage.

In conclusion, the use of surgical masks throughout the day leads to a significant reduction in NI-BUT, regardless of age, gender, and OSDI score. Prolonged use of surgical masks should be considered as a risk factor for evaporative dry eye disease.

Declarations

Ethics approval and consent to participate The tenets of Helsinki were followed by all the participant researchers, and the present study protocol was approved by the Ethical Committee of the Zonguldak Bulent Ecevit University 2022/04–18. Informed consent was obtained from every patient before starting the treatment.

Consent for publication The authors approved the final manuscript for submission.

Conflict of interest The authors declare no competing interests.

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