J Pediatr Res 2022;9(3):292-6
DOI: 10.4274/jpr.galenos.2022.60243

Original Article

The Effects of Face Mask Usage on Ocular Structures in Children During the COVID-19 Pandemic

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ABSTRACT

Aim: To determine the effects of face mask usage on ocular structures in children during the coronavirus disease-2019 (COVID-19) pandemic.

Materials and Methods: Forty-two children's ocular data from the pandemic period were compared with the same children's ocular data from the pre-pandemic period.

Results: Their mean age was 14.6±2.1 (9-18) years initially. The tear film break-up time values of the children with a mask in the pandemic period were significantly shorter than those of the children without a mask in the pre-pandemic period (9.35±1.40 vs. 12.10±1.05 seconds, p=0.033). There was no staining in any case in the pre-pandemic period, while minimal punctate epithelial corneal staining pattern was determined in 4 (9.5%) children in the pandemic period. The Schirmer test 1 value detected in the pandemic period was similar to the value detected in the pre-pandemic period (11.14±2.07 vs. 12.03±1.01 mm, p=0.127). Additionally, there were no significant changes in visual acuities, central corneal thicknesses, anterior chamber depths, lens thicknesses, and axial lengths between the pre-pandemic and pandemic periods (p>0.05).

Conclusion: To the best of our knowledge, this is the first study to date to evaluate the effects of face mask usage on ocular structures in just children. The use of face masks may cause increased tear evaporation and dry eye in pediatric cases. Educating children about the correct use of face masks can be important. Thus, possible ocular surface changes which may occur relating to masks can be prevented, and children may be more willing to use masks. Increased mask compliance may also indirectly help protect children from the virus.

Keywords: Children, COVID-19, dry eye, mask, ocular surface

Introduction

The use of face masks during the pandemic is one of the most important personal protection methods against the coronavirus disease-2019 (COVID-19) (1,2). Wearing a mask can prevent the spread of virus-containing droplets, and thus it can protect the person (3). Mask use is more effective if it fits well on the wearer's face and shows as little leakage as possible while breathing (3). In children, this situation may gain more importance during the pandemic, especially during the face-to-face education period. However, compared to adults, children may be more reluctant to use masks and may not wear them properly (4). In line with this, we observed that the masks mostly did not fit the face properly in those children who came for eye examinations during the pandemic period. Inappropriate face mask usage in children may have some effects on ocular structures. In the literature, although there were some studies about the effects on the eye of mask usage in adults (5-8), to the best of our knowledge,

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Received: 26.05.2022 **Accepted:** 02.06.2022

this subject had not been investigated in children until our study. Therefore, we planned this study.

Materials and Methods

This study was carried out with the approval of the University of Health Sciences Turkey, İzmir Tepecik Training and Research Hospital's Medical Research Ethical Committee (approval number: 2022/04-10) and in line with the ethical principles of the Declaration of Helsinki. The children and their parents were informed in detail about the study, and risks were explained. Written consent forms were obtained from the participants and their parents.

In the cornea department of our hospital, a total of 58 children aged 9-18 years who had been under follow-up in the pre-pandemic period due to ocular injury in just one eye and who had check-up examinations in the face-to-face education period of the pandemic were initially determined. The ocular data from the non-traumatic (healthy) eyes of 42 cases whose examination findings were fully written up in the file and system records and who met the inclusion criteria were evaluated. The children's age, gender, medical personal history (such as medications, ocular surgery, contact lens usage, ocular and/or systemic diseases), visual acuity, intraocular pressure level, anterior-posterior segment examinations and ocular data [tear film break-up time (TBUT), Schirmer test 1, central corneal thickness, anterior chamber depth, lens thickness and axial length values] were noted from the file and system records. If more than one ocular parameter value had been recorded for the same individual during the pre-pandemic or pandemic period, the average of them was used. If the eye in which the data were evaluated in this study had an acute or chronic ocular disease such as blepharitis, conjunctivitis, keratitis, uveitis, glaucoma and/or a history of ocular trauma or surgery, these eyes were not included in this study. Those children wearing a contact lens for that eye, those individuals having a systemic disease capable of affecting the ocular structures, those cases with a diagnosis of dry eye in the pre-pandemic period, and those children diagnosed with COVID-19 in file and system records were excluded from this study. Those cases who reported wearing a face mask for 2-6 hours a day for at least 3 months in the family and child statements were included in this study.

The best corrected visual acuity of the children was determined with a Snellen chart. Anterior and posterior segment examinations were carried out using a slit-lamp biomicroscope and a 90 D lens. An intraocular pressure measurement was made with a Goldmann applanation tonometer. The TBUT test shows the tear film stability (9,10). In this test, a fluorescein strip (fluorescein paper) is moistened with a saline solution and touched against the lower fornix. Individuals are instructed to keep their eyes open until the first dry spots are observed on the tear film on the cornea illuminated by cobalt blue light under a biomicroscope. The time elapsing between the last blink and the first formation of dry spots is measured. Precorneal tear evaporation is evaluated with this measurement (9,10). The ocular surface staining pattern is also examined at the same time. In the Schirmer test 1 with anesthesia, 0.5% proparacaine HCl is applied, followed by a 5-minute wait. Standard Schirmer test paper is attached to the outer 1/3 of the lower eyelid. The amount of wetting on the paper is noted after 5 minutes. Basal tear secretion is assessed using this test (9,10). Central corneal thickness, anterior chamber depth, lens thickness and axial length was measured using optical biometry device (LenStar LS900, Haag-Streit Diagnostic, Switzerland). The children's ocular data in the pandemic period were compared with the same children's ocular data in the pre-pandemic period.

Statistical Analysis

Statistical Package for the Social Sciences (SPSS Version 20.0) software was used for the statistical analysis. Continuous variables were given as mean ± standard deviation (minimum-maximum) values, while count data was given as case number and percentage. The assumption of normality was tested by the Kolmogorov-Smirnov test. Comparisons were made by the chi-squared test and paired sample t-test. Statistical significance was set at $p<0.05$.

Results

The data of 42 children were evaluated in this study. Eighteen (42.9%) of the cases were female and 24 (57.1%) were male (p=0.523). Their mean age was 14.6±2.1 (9-18) years initially. Fundus examinations of the eyes, in which the data were evaluated in our study, were normal in both the pre-pandemic and pandemic periods. The TBUT values of the children with a mask in the pandemic period were significantly shorter than those of the children without a mask in the pre-pandemic period (9.35±1.40 vs. 12.10±1.05 second, p=0.033). When ocular surface staining was examined, there was no staining in any case in the pre-pandemic period, while a few scattered (minimal) punctate epithelial corneal staining patterns were determined in 4 (9.5%) children in the pandemic period. The Schirmer test 1 value detected in the pandemic period was similar to the value detected in pre-pandemic period (11.14±2.07

vs. 12.03±1.01 mm, p=0.127). Additionally, there were no significant changes in the best corrected visual acuities, central corneal thicknesses, anterior chamber depths, lens thicknesses, and axial lengths between the pre-pandemic and pandemic periods (p>0.05). The clinical findings in the pre-pandemic and pandemic periods are given in Table I.

Discussion

The use of face masks may affect some ocular structures. In the literature, although there have been some studies relating to this subject in healthcare workers and other adult cases (5-8), as far as we know, this subject had not been investigated in children alone to date.

In an online survey administered to medical students, Al-Dolat et al. (11) found no significant association between wearing a face mask and dry eye in the pandemic period. On the other hand, some authors observed an increase in symptoms such as foreign body sensation, light sensitivity, itching, burning and stinging in face mask users (2,12). Additionally, in adults with a previous diagnosis of dry eye, Scalinci et al. (13) reported that the prolonged use of face masks in the pandemic might worsen dry eye symptoms. Nair et al. (14) stated that TBUT was a reliable test to evaluate ocular surface stability in individuals using a face mask. In adults with a previous diagnosis of moderate to severe dry eye, Arriola-Villalobos et al. (7) investigated tear film stability after mask usage. The authors determined that the TBUT value with a mask was significantly shorter than the TBUT value without a mask. They detected that the use of a face mask reduced tear film stability. Similarly, face mask usage was reported to worsen the clinical indicators of ocular surface diseases, such as TBUT and ocular surface staining in adults with dry eye disease (15).

In healthcare workers, TBUT values measured after wearing a mask were shown to be significantly lower than those measured without a mask (5,6). In addition, Esen Baris et al. (6) stated that health-care professionals who wore a face mask for the entire work-day had increased dry eye symptoms. Similarly, in adults, Aksoy and Simsek (8) found that the daily use of a face mask significantly decreased TBUT and increased ocular surface staining.

In our study, the TBUT values of those children with a mask in the pandemic period were significantly shorter than those of children without a mask in the pre-pandemic period. Additionally, we determined minimal punctate epithelial staining pattern in some cases in the pandemic period. We thought that the reason for this significant change in TBUT might be related to increased tear evaporation as a result of the mask. The outermost layer of the tear film is the lipid layer. This layer plays an important role in preventing tear evaporation, and the lipid layer is directly affected by exhaled air (16,17). The temperature of the air inside a face mask was reported to be likely higher than that of the outside air (13). Additionally, air leakage from face masks was shown to be mostly through the gaps at the upper edge of the mask (18). When a face mask does not properly fit on the face, exhaled air may pass through the gaps and move towards the eye (2,5,13,18). This air circulation may

Table I. The clinical findings in the pre-pandemic and pandemic periods

Clinical findings	**Pre-pandemic period (value without a mask) Mean ± SD (range)**	**Pandemic period (value with a mask) Mean ± SD (range)**	**p[a]**
BCVA (Snellen chart/decimal)	0.92±0.07 (0.80-1.00)	0.91±0.08 (0.80-1.00)	0.872
TBUT (second)	12.10±1.05 (11-15)	9.35±1.40 (7-12)	**0.033**
Schirmer test 1 (millimeter)	12.03±1.01 (11-15)	11.14±2.07 (9-14)	0.127
Central corneal thickness (micrometer)	539.07±16.81 (510-572)	538.64±21.35 (506-578)	0.861
Anterior chamber depth (millimeter)	3.53±0.19 (3.28-3.85)	3.54±0.17 (3.32-3.79)	0.792
Lens thickness (millimeter)	3.42±0.29 (3.09±3.78)	3.40±0.36 (3.01-3.92)	0.504
Axial length (millimeter)	22.57±0.28 (22.13-22.89)	22.61±0.36 (22.01-22.99)	0.716

[a]Paired sample t-test, p<0.05 statistically significant.
SD: Standard deviation, BCVA: Best corrected visual acuity, TBUT: Tear film break-up time

accelerate tear evaporation from the ocular surface (2,5,19). Increased tear evaporation may cause ocular irritation and adversely affect ocular surface health (20). In addition, it may increase the risk of ocular surface damage and virus transmission by inducing people to touch their eyes more frequently (20,21). Increased tear evaporation and/or decreased tear secretion were also stated to be among the causes of dry eye (22,23).

In our study, the reasons for the significantly shorter TBUT values in children wearing a mask in the pandemic period may be associated with the above-mentioned mechanisms. In our opinion, another finding which supports these mechanisms may be that taping the upper mask edge has been reported to significantly improve TBUT values (8,14). Sealing the upper edge of the face mask with an adhesive tape was found to significantly decrease air leakage from the face mask (18). Nair et al. (14) detected that taping the upper mask edge resulted in a reduction in dry eye symptoms and a significant increase in TBUT values in healthcare workers. Aksoy and Simsek (8) observed an improvement in TBUT and a significant decrease in ocular surface staining after appropriate taping.

In one study, daily use of a face mask was stated to reduce the Schirmer test values in adults (8). However, Azzam et al. (20) determined that healthcare workers using a mask had normal Schirmer test scores. Similarly, in our study, there was no significant change in the Schirmer test values between the pre-pandemic and pandemic periods. The reason why there was no significant difference in the anesthetized Schirmer test scores in our study may be related to the fact that this test shows the basal tear secretion, not tear evaporation (9,10). We also found no significant changes in the best corrected visual acuities, central corneal thicknesses, anterior chamber depths, lens thicknesses or axial lengths between the pre-pandemic and pandemic periods.

Study Limitations

There were some limitations in our study. The ocular surface disease index questionnaire could not be evaluated in this study. Additionally, daily screen time during the pandemic might have contributed to these results. In the pandemic period, there might be other undetectable causes predisposing to dry eye in children. Another limitation was that this study might have included patients with asymptomatic COVID-19 infection, who were unaware of their condition. Further studies with larger populations may provide more comprehensive data about the effects of mask usage on the ocular surface in children.

Conclusion

In conclusion, to the best of our knowledge, this is the first study to date to evaluate the effects of face mask usage on ocular structures in children alone. The use of face masks may cause increased tear evaporation and dry eye in pediatric cases. Educating children about the correct use of face masks is important. In order to prevent upward airflow, the wire should be shaped appropriately (if bendable nose-wire masks are used) or the upper mask edge should be taped properly. However, it should be ensured that taping does not disrupt lower eyelid function. Regular blink exercises may also be beneficial in protecting the ocular surface. Thus, possible mask related ocular surface changes can be prevented, and children may be more willing to use masks. Increased mask compliance may also indirectly help to protect children from the virus.

Ethics

Ethics Committee Approval: This study was carried out with the approval of the University of Health Sciences Turkey, İzmir Tepecik Training and Research Hospital's Medical Research Ethical Committee (approval number: 2022/04-10).

Informed Consent: Written consent forms were obtained from the participants and their parents.

Peer-review: Externally peer-reviewed.

Authorship Contributions

Concept: B.Ö., H.Ö., Design: B.Ö., H.Ö., Data Collection or Processing: H.Ö., Analysis or Interpretation: B.Ö., H.Ö., Writing: B.Ö.

Conflict of Interest: No conflict of interest is declared by the authors.

Financial Disclosure: The authors declared that this study received no financial support.

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