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The effect of online education during the pandemic on ocular surface symptoms

Abdullah Beyoglu [1], Muhammed Mustafa Beyoglu [2]

[1] Sutcu Imam University, Faculty of Medicine, Department of Ophthalmology, Kahramanmaras, Turkey
[2] Onikisubat District Health Directorate, Kahramanmaras, Turkey

ORCID ID of the author(s)

AB: 0000-0003-1948-7755
MMB: 0000-0003-0367-5794

Corresponding Author
Muhammed Mustafa Beyoğlu
Onikisubat District Health Directore, Kahramanmaras, Turkey
E-mail: mstfbeyoglu@gmail.com

Ethics Committee Approval
Approval for the study was granted by the Clinical Research Ethics Committee of Kahramanmaras Sutcu Imam University Faculty of Medicine (Decision no:06, dated:12/04/21). Registered at Clinical Trial Registry (ClinicalTrials.gov Identifier: NCT04960696). All procedures in this study involving human participants were performed in accordance with the 1964 Helsinki Declaration and its later amendments.

Conflict of Interest
No conflict of interest was declared by the authors.

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Abstract

Background/Aim: During the pandemic, eye symptoms increased. This study aimed to investigate the effects of online education on ocular surface symptoms, which was a part of the distance learning model during the COVID-19 pandemic, to be able to prevent the formation of irreversible damage.
Methods: This cohort study included 315 students who were undertaking online education and presented at the Ophthalmology Department of a university hospital. The sociodemographic data, Schirmer test results, tear break-up time (TBUT) and Ocular Surface Disease Index (OSDI) scores of the students were noted. The data were analyzed using SPSS v. 22.0 software and a value of $P<0.05$ was considered statistically significant.
Results: Evaluation was made of 315 students with a mean age of 14.48 (5.86) years (range: 6-29 years). Of these, 159 were studying at a high school or university, and 267 had been participating in online education for ≥6 hours per week. New symptoms had developed in the eyes of 213. The Schirmer test results were 8.74 (3.76) mm in the right eye and 8.90 (3.86) mm in the left eye. TBUT was 9.95(3.60) seconds in the right eye and 10.15 (3.58) seconds in the left. The mean OSDI score was 26.39 (11.85). OSDI was significantly negatively correlated with the Schirmer results and TBUT (r= -0.883, $P<0.05$, r= -0.793, $P<0.05$, respectively), while Schirmer and TBUT were positively correlated (r=0.871, $P<0.05$).
Conclusion: With the continuation of education online during the COVID-19 pandemic, televisions, computers, and tablets were commonly used. This increased screen time led to the development of new symptoms causing significant changes in the OSDI, TBUT, and Schirmer tests.

Keywords: COVID-19, Online education, Tear break-up time, Schirmer, OSDI

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Introduction

At the end of 2019, a series of treatment-resistant cases of pneumonia of unknown cause was determined in Wuhan, China, by Dr. Wenliang Li. He warned that this could become an epidemic, and in March 2020, the novel coronavirus disease 2019 (COVID-19) caused by SARS-CoV-2 virus infection was declared a global pandemic by the World Health Organization (WHO) [1, 2]. This virus was one of the most rapidly spreading viruses in history. By 1 January 2021, 83.5 million cases had been diagnosed worldwide in 222 countries, with 1.82 million deaths [2].

With rapidly increasing numbers of cases from the beginning of the pandemic, national leaders and the WHO started to implement measures to protect public health. One of the most important was quarantine and the immediate temporary cessation of face-to-face education [3]. With these quarantine measures, 20 million students were no longer physically attending school, and in Turkey, as throughout the world, education was converted to a distance learning model [2, 4]. Televisions, computers, and tablets became an indispensable part of daily life as a part of the online education model. Exposure to digital screens is known to harm eye health [5, 6]. With the prolonged time spent using televisions, computers, and tablets for education during the pandemic, there was an increase in ocular complaints. The main reasons for these symptoms are ocular surface disorders and accommodation problems stimulated or exacerbated by digital screen exposure [7-9].

This study aimed to investigate the effects of online education on the ocular surface symptoms of the students, which was a part of the distance learning model during the COVID-19 pandemic, to be able to prevent irreversible damage with early diagnosis and treatment. With simple recommendations, it was aimed to protect ocular health.

Materials and methods

This cohort study was conducted in the Ophthalmology Department of a tertiary level university hospital. Approval for the study was granted by the Clinical Research Ethics Committee of Kahramanmaras Sutcu Imam University Faculty of Medicine (Decision no:06, dated:12/04/21). This study is registered in the Clinical Trial Registry (ClinicalTrials.gov Identifier: NCT04960696). All procedures followed the principles of the Helsinki Declaration. The study sample consisted of 315 students, aged 6-30 years, participating in online education who presented at the Ophthalmology Polyclinic within 2 months. Patients were excluded from the study if they were aged <6 years or >30 years, had communication difficulties, were not students, or were not continuing education online.

All patients underwent the Schirmer test, the Tear Break-Up Time (TBUT) test, and the Ocular Surface Disease Index (OSDI) scoring, and filled a sociodemographic form created by literature review. The sociodemographic data were collected by face-to-face interviews. The OSDI scoring was performed face-to-face with a questionnaire consisting of 12 items in 3 sections regarding ocular symptoms, sight-related functions, and environmental factors. Each item is scored between 0-4 points, and the final score is calculated by multiplying the total points by 25 and dividing the result by the number of items. Thus, the total points range between 0-100 and are evaluated as follows: 0-12 points: Normal, 13-22 points: Mild, 23-32 points: Moderate, and 33-100 points: Severe ocular surface damage.

In the TBUT test, fluorescein is dropped into both eyes, and after several blinks, the cornea is examined biomicroscopically under cobalt blue. The time of the formation of two black dots is considered the tear break-up time. A time of >10 secs is normal.

In the Schirmer test, the results are obtained from a special filter paper placed between the eye and the lower eyelid outer third. The cut-off value is 10mm and values >10mm are considered normal.

Statistical analysis

Data obtained in the study were analyzed using SPSS v. 22.0 software. Conformity of the data to normal distribution was assessed with the Shapiro-Wilk test. Categorical data were analyzed with the Chi-square test. The ANOVA test was used for comparisons between the groups. Spearman correlation analysis was utilized for group correlations. Continuous data were presented as mean (standard deviation (SD)), and categorical data, as number (n) and percentage (%). A value of $P<0.05$ was considered statistically significant.

Results

An evaluation was made of a total of 315 students with a mean age of 14.48 (5.86) years. The sociodemographic data and responses to the questionnaire are shown in Table 1.

Table 1: Sociodemographic and survey data of the students included in the study

	Groups	n	Percent (%)
Gender	Male	153	48.6
	Female	162	51.4
Education status	Primary school	78	24.8
	Middle school	78	24.8
	High school	78	24.8
	University	81	25.7
Weekly Online Education Period	<6 hours	48	15.2
	6-12 hours	117	37.1
	>12 hours	150	47.6
Online Education-related Screen Exposure	<30 minutes	51	16.2
	30-60 minutes	60	19.0
	61-120 minutes	99	31.4
	>120 minutes	105	33.3
Developed New Symptoms	Yes	213	67.6
	No	102	32.4
What Symptoms Have Developed	Sensitivity	156	49.5
	Itching	123	39.0
	Redness	135	42.8
	Sting-Burning	74	23.5
	Watering	75	23.8
	Blurred vision	90	28.5

N: Numbers of subjects

The data showing the quality, amount, and evaluations of the tears of the students are shown in Table 2. The overall mean Schirmer test results were 8.74 (3.76) mm in the right eye and 8.90 (3.86) mm in the left eye. Mean TBUT was 9.95 (3.60) secs in the right eye and 10.15 (3.58) secs in the left eye. According to the OSDI grading, 86 (27.3%) students were within normal limits, 95 (30.1%) had mild, 54 (17.1%) had moderate, and 80 (25.3%) had severe ocular surface damage. The mean OSDI score of the whole sample indicated moderate ocular surface damage.

The subgroup examinations (education status, duration of online education per week, education-related screen exposure) of the OSDI, Schirmer, and TBUT results and the post-hoc analyses are shown in Table 3.

Table 2: The results of the Shirmer test, tear break-up time and OSDI score of the students participating in the study

	Minimum	Maximum	Mean
Shirmer Test			
Right eye(mm)	2	15	8.74 (3.76)
Left eye(mm)	3	12	8.90 (3.86)
Total(mm)	2	15	8.82 (3.66)
TBUT			
Right eye(sn)	4	18	9.95 (3.60)
Left eye(sn)	6	15	10.15 (3.58)
Total(sn)	4	18	10.15 (3.58)
OSDI scores	4.5	61.6	26.39 (11.85)

TBUT: Tear Break Up Time, OSDI: Ocular Surface Disease Index

Table 3: Group comparisons of the test results measured by the questionnaire answers of the students participating in the study

		OSDI scores			Shirmer test		TBUT	
		N	Mean	*P*-value*	Mean	*P*-value*	Mean	*P*-value*
Education status	Primary school[a]	78	14.00 (15.46)[b,c,d]	<0.05	11.54 (3.25)[b,c,d]	<0.05	12.08 (3.21)[b,c,d]	<0.05
	Middle school[b]	78	27.47 (21.75)[a,d]		8.69 (3.99)[a,d]		10.00 (4.00)[a,d]	
	High school[c]	78	22.33 (21.29)[a,d]		8.35 (2.90)[a,d]		9.96 (3.30)[a,d]	
	University[d]	81	41.19 (18.73)[a,b,c]		6.78 (2.66)[a,b,c]		8.22 (2.63)[a,b,c]	
Weekly online education period	<6 hours[a]	48	13.47 (23.37)[b,c]	<0.05	11.06 (3.88)[b,c]	<0.05	12.38 (3.38)[b,c]	<0.05
	6-12 hours[b]	117	28.30(19.19)[a]		8.46 (3.50)[a]		9.38 (3.26)[a]	
	>12 hours[c]	150	29.04 (21.84)[a]		8.38 (3.44)[a]		9.82 (3.59)[a]	
Online education-related screen exposure	<30 minutes[a]	51	8.01 (16.42)[b,c,d]	<0.05	10.41 (2.40)[d]	<0.05	12.35 (3.09)[c,d]	<0.05
	30-60 minutes[b]	60	20.07 (20.91)[a,d]		10.35 (4.29)[d]		11.35 (3.66)[c,d]	
	61-120 minutes[c]	99	25.29 (18.61)[a,d]		9.27 (3.58)[d]		9.88 (3.31)[a,b,d]	
	>120 minutes[d]	105	39.98 (18.75)[a,b,c]		6.74 (2.79)[a,b,c]		8.34 (3.08)[a,b,c]	
Developed new symptoms	Yes	213	31.10 (18.06)	<0.05	7.63 (3.19)	<0.05	8.79 (2.97)	<0.05
	No	102	7.93 (12.51)		11.88 (2.92)		13.28 (2.92)	

TBUT: Tear Break Up Time, OSDI: Ocular Surface Disease Index, *ANOVA, **Groups that were significant in the post-hoc analysis were given as superscript.

OSDI was significantly negatively correlated with the Schirmer results and TBUT (r= -0.883, $P<0.05$, r= -0.793, $P<0.05$, respectively), while Schirmer and TBUT were positively correlated (r=0.871, $P<0.05$).

Discussion

One of the main precautions taken during the COVID-19 pandemic was the conversion of education to an online model. This model was of great importance concerning the quarantine and lockdown but resulted in students spending more time using televisions, computers, and tablets. The longer digital screen exposure increased the ocular complaints of the students. Ocular surface disorders and accommodation problems stimulated or exacerbated by digital screen exposure are the main reasons for these symptoms.

Of the total 315 study participants, 162 were female and 50.4% were studying at a high school or university. Among all, 52.3% undertook an online education of ≤12 hours per week, and a screen time exposure of >1 hour before and/or after online education was reported by 64.8%. In the study by Bostanci in 2016 [10], ocular symptoms increased with digital screen exposure, and in a study on computer use and sight, Shantakuri [11] reported that as digital screen time use increased, new symptoms were developing in the eyes, the most common being redness and burning. In the current study, new ocular symptoms were had developed after the introduction of online education in 213 students. The most common included sensitivity in the eyes in 49.5%, redness in 42.8%, and itching in 39%. It is thought that as a result of increased digital screen exposure, the amplitude of blinking is disrupted, and with the development of epithelial damage, more sensitivity, redness, and secondary itching develop.

The OSDI results of the middle school and high school students were similar according to the post-hoc test, while the other subgroups showed significant differences. In a study by Schiffman [12] and Simavli [7], the OSDI score was correlated with screen exposure. In the current study, the highest mean points were found among university students, and these were classified as severe ocular surface damage. There may be several effective factors, such as the longer lesson hours of university students, weaker family, and social ties, and auto-control mechanisms, and spending a longer time on extra-curricular projects, thesis preparation, social media, and digital gaming platforms.

The OSDI score was significantly high in those who were studying ≥6 hours per week online, but there was no significant difference between the groups who undertook 6-12 hours and >12 hours of online education. OSDI scores were highest in the group who received more than 2 hours of online education per week, who were considered to have severe ocular surface damage. Students who developed new symptoms after online education were determined to have a moderate level of ocular surface damage. In a study of young adults by Pang in 2020 [13], screen time was reported to affect dry eye symptoms, and in another study by Mishra [14], entitled, "The effect of digital screen exposure on the ocular surface", it was reported that as digital screen time exposure increased, so did the OSDI score and dry eye symptoms. Associated with the decrease in blink reflex in digital screen-focused education, there is thought to be insufficient irrigation of the corneal surface epithelium and impaired tear functions. It must also not be forgotten that another main factor is that the screen light is not at an equal level to that of the environment.

The Schirmer test results were examined within the sub-groups. The lowest measurement was obtained among the university students, who were considered to have dry eyes. The results of the middle school and high school students were similar, and there was a statistically significant difference between the other groups. In the group receiving ≥6 hours per week online education, dry eye was determined at a significantly higher rate. The results of the groups receiving 6-12 hours and >12 hours online education were similar. A significant difference was found between the group with >2 hours of education-related screen exposure and the other groups concerning dry eye classification. The results of the groups with ≤2 hours of exposure were similar. Dry eye was significantly more common in the group that developed new symptoms after online education. Similar results were reported in a study by Mehra et al. [15], as an increase in the rate of dry eye in parallel with an increase in digital screen exposure. In a study of office workers by Uchino et al. [16], the extent of dry eye disease was determined at a high rate associated with the duration of screen exposure. Kawashima et al. [17] also investigated office workers and determined an increase in tired eyes and the diagnosis of dry eye with increased screen exposure. With a series of simple precautions, these diagnoses were reduced by 75%.

In the current study, the Schirmer test results were negatively affected in parallel with screen exposure. The high Schirmer test values measured in primary school students, those with few online lesson hours, and those with low education-related screen time were an indicator of this finding. Unlike the previous studies in literature, the reason that this study was conducted on a sample of students with no known systemic ocular disease was to be able to determine ocular surface problems which may develop associated with the use of televisions, computers, and tablets in online education during the pandemic.

The TBUT measurements were low (below the cut-off value) in university students, those with ≥6 hours per week online education, and those with > 1-hour education-related screen exposure, with significant differences between these and the other groups. The TBUT was affected in the group that developed new ocular symptoms after the onset of online education. In a study of dry eye patients, Yiğit et al. [18] showed that the TBUT value decreased as screen exposure increased. Gümüş et al. [19] examined the effect of computer use on ocular parameters and determined a negative relationship between TBUT and increased periods of computer work. In the workplaces and social life of the modern technological age, digital screen use has increased even more with the pandemic. The mandatory increase of screen exposure for students can be considered the reason for the decrease in TBUT values. In the current study, OSDI was significantly negatively correlated with Schirmer and TBUT, and a significant positive correlation was found between Schirmer and TBUT.

Similar results were seen in the study of Gümüş et al. [19]. In a study of the relationship between OSDI and ocular parameters by Balyen [20], OSDI was significantly correlated with Schirmer and TBUT. These results in the literature and those of the current study demonstrate that increased digital screen exposure due to online education harms ocular health.

The limitations of this study include the small sample size, limited follow-up time, and differences in the digital materials used.

Conclusion

The continuation of education online during the COVID-19 pandemic significantly increased the use of televisions, computers, and tablets. In addition to the development of new symptoms, this increase caused significant changes in the OSDI, TBUT, and Schirmer tests. It can be recommended that easily applicable measures be conveyed to students before, during, and after online education, and information given in various ways can draw the attention of the families.

The development of eye symptoms in students should be noticed by the family, and the student should immediately be taken to a primary level family healthcare center and/or an ophthalmologist for early diagnosis and treatment. Eye symptoms that initially seem unimportant may cause irreversible eye diseases in the future. The results of this study suggest that there is a need for studies of more extensive series at the national level.

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