DOI: 10.4274/gulhane.galenos.2025.34711
Gulhane Med J 2026;68(2):87-93

Age-related effects of smartphone and tablet reading on ocular surface parameters

Selcan Ekicier Acar, Zennure Özdemir Yıldız

University of Health Sciences Türkiye, Atatürk Sanatorium Training and Research Hospital, Clinic of Ophthalmology, Ankara, Türkiye

Cite this article as: Ekicier Acar S, Özdemir Yıldız Z. Age-related effects of smartphone and tablet reading on ocular surface parameters. *Gulhane Med J.* 2026;68(2):87-93.

Date submitted:
07.07.2025
Date accepted:
02.12.2025
Epub:
08.06.2026
Publication Date:
16.06.2026

Corresponding Author:
Selcan Ekicier Acar, M.D., University of Health Sciences Türkiye, Atatürk Sanatorium Training and Research Hospital, Clinic of Ophthalmology, Ankara, Türkiye
selcanekicier@gmail.com

ORCID:
orcid.org/0000-0002-7025-380X

Keywords: Handheld devices, visual discomfort, blinking, ocular surface

ABSTRACT

Aims: The use of handheld devices has increased rapidly over the past decade. Smartphones and tablets are commonly used for reading and work-related tasks. This study aims to compare the effects of smartphone and tablet screen sizes on the ocular surface of adolescents and young adults.

Methods: This was a prospective observational study involving 90 healthy volunteers divided into three age-based groups: adolescents (n=30, 10-18 years), young adults (n=30, 18-24 years), and adults (n=30, 24-40 years, control). Participants read for 30 minutes using a smartphone, a tablet, and a printed book. The Ocular Surface Disease Index©, the ocular discomfort questionnaire, fluorescein break-up time (FBUT), corneal fluorescein staining, the Schirmer test, and the blink rate were assessed before and after each reading session.

Results: Ninety participants (mean age for adolescents: 13.33±1.33 years; young adults: 20.77±2.32 years; adults: 33.47±5.38 years; sex distribution: 56%, 56%, 53% female, respectively) were included. FBUT values decreased significantly after reading in all groups (p<0.01). In adolescents, corneal fluorescein staining significantly increased after smartphone reading, from 0 to 0.30±0.46 (p=0.001). Schirmer test values did not change significantly (p>0.05) among all groups. Blink rate decreased from 18.2±2.7 to 9.8±1.8 blinks/min and incomplete blinking increased from 1.8±0.9 to 4.9±1.6 blinks/min during smartphone reading (p<0.001). Discomfort scores were highest after smartphone use (34.8±13.8) compared with tablet (24.8±10.1) and print reading (21.0±12.4) (p<0.001).

Conclusions: Reading from smartphones and tablets causes measurable alterations in ocular surface integrity, tear film stability, and blinking patterns. Ocular discomfort scores were highest after smartphone use, particularly in adolescents and young adults.These findings highlight the ocular strain associated with handheld devices and the need for preventive strategies, especially for younger populations with extended screen exposure.

Introduction

Electronic devices are commonly used in daily life. The use of handheld devices has been increasing rapidly. Smartphones, computers, tablets, and electronic reading devices have become necessary to read books and conduct work-related tasks (1). Electronic screen use increased during the coronavirus disease 2020 pandemic (2). Extended screen time during childhood adversely affects health and well-being and is associated with ocular changes, such as myopic progression and ocular surface alterations (3). This increasing trend in screen usage has resulted in national and international efforts to control screen time among young people (4-6).

Electronic displays, including laptops, tablets, and smartphones, have substantially changed methods of accessing information and are an important factor in daily human life compared with printed displays. Instead of pen and paper, students use software and tools to create presentations and projects. How varying screen sizes influence ocular surface parameters and blinking dynamics is not well understood, particularly in younger populations increasingly exposed to these devices. Prolonged reading from electronic displays is central to the onset of ocular symptoms and affects quality of life. After prolonged reading, the symptoms experienced are not specific to patients with dry eye disease (DED). Healthy individuals without a DED diagnosis experience eye-related complaints after prolonged reading (7).

High cognitive activity associated with reading can lead to dry eye symptoms caused by decreased and partial blinking (8). Similarly, prolonged screen time affects blinking dynamics, facilitating the onset and progression of ocular surface changes and causing dry eye symptoms. DED poses a substantial burden on patients' quality of life, productivity, learning, and economic well-being. Prolonged screen use from an early age and the inevitable role of screens in work environments predispose children, adolescents, and young adults to dry eyes and to an earlier, more rapid decline in quality of life (9,10).

Smartphones and tablets, as small handheld devices, typically feature larger, vertically oriented screens and lack external keyboards or mice, distinguishing them from traditional computers (11). Variations between computers and handheld devices in screen size, viewing distance and angle, usage modality, ambient light levels, screen reflection, and user posture may contribute to divergent ocular symptomatology. This study aims to elucidate these differences by investigating the effects of reading from handheld devices of varying screen sizes and from printed materials on ocular surface parameters and blink dynamics in adolescents and young adults. To the best of our knowledge, this is the first investigation to specifically assess the impact of screen size on the ocular surface in this population.

Methods

Study design and setting

This prospective, comparative study was conducted at the University of Health Sciences Türkiye, Atatürk Sanatorium Training and Research Hospitalfrom January to December 2024.

Participants were tested under standardized environmental conditions, including lighting. Screen brightness for all devices was adjusted to 50% of the maximum level. Font type and size were kept consistent across groups, and reading distance was set at 40 cm between the eyes and the screen. All participants undertook the reading test under comparable environmental conditions: temperatures ranged from 22 °C to 25 °C, without air conditioning, and testing occurred between 08.00 and 10.00 hours.

Participants

A total of adolescents (n=30), young adults (n=30), and adults (n=30) were included in the study. Volunteers underwent the following assessments: best-corrected visual acuity, tear break-up time, corneal fluorescein staining (assessed by the Oxford scale), Schirmer's test, Ocular Surface Disease Index© (OSDI©) questionnaire, and blink rate. A 15-minute interval was maintained between assessments. All volunteers had normal vision and were free of dry eye or significant accommodative or binocular vision abnormalities. Baseline readings served as controls.

Exclusion criteria included: (i) diminished near or distance visual acuity, (ii) use of multifocal spectacles, and (iii) use of contact lenses within 48 hours prior to the trial.

Ethical approval

The study protocol was approved by the Ankara Governorship Provincial Health Directorate, University of Health Sciences Türkiye, Atatürk Sanatorium Training and Research Hospital Ethics Committee (approval no: 2012-KAEK-15/2835, date: 27.12.2023). The study adhered to the tenets of the Declaration of Helsinki. All volunteers were informed about the purpose and procedures of the study and provided written informed consent.

Reading procedure

After the examination, volunteers read for 30 minutes in separate sessions from electronic devices with screen sizes of 6.1 inches (1) and 12.9 inches (2), and from A4-printed text (3). Blinking rates during the last 5 minutes of the reading sessions were recorded and analyzed.

OSDI©

The OSDI assesses dry eye symptoms through three subscales: (i) ocular symptoms, (ii) visual tasks, and (iii) environmental factors. The twelve items in the OSDI survey are evaluated on a scale from 0 to 4, with 0 indicating "never," 1 signifying "sometimes," 2 representing "half the time," 3 denoting "most of the time," and 4 meaning "always". The overall OSDI score is computed using the formula: OSDI=[(sum of all response scores)×100]/[(total number of answered questions)×4]. The Tear Film and Ocular Surface Society Dry Eye Workshop (DEWS) II Diagnostic Methodology Report categorizes OSDI scores for dry eye screening as follows: normal (0-12), mild (13-22), moderate (23-32), and severe (33-100).

Questionnaire about discomfort

During or after prolonged reading, ocular symptoms include blurred vision while reading and when looking away afterward, difficulty or slowness in refocusing from one distance to another, irritation, dry eyes, eye strain, headache, watery eyes, sensitivity to bright lights, and eye discomfort. Each symptom was rated from 1 to 10, and the total scores were recorded.

Slit lamp biomicroscopy

Tear breakup time

A fluorescent strip (Liaoning Meizilin Pharmaceutical, China) was moistened with saline, and a droplet was administered to the lower fornix. The corneal surface was examined using a slit lamp with a cobalt blue filter at 10x magnification. fluorescein break-up time (FBUT) was defined as the interval between the last complete blink and the appearance of the first black patch on the corneal surface. An FBUT greater than 10 seconds was considered typical.

Oxford grading system

The corneal staining test was performed using the Oxford grading method two minutes after the assessment of FBUT. The system was validated by DEWS in 2007. Staining is depicted by a dotted line across panels A-E.

Schirmer's test

A strip of filter paper was positioned on the conjunctival sac of the temporal lower eyelid without the application of topical anesthetic. The length of the wetted segment was measured after 5 minutes. To mitigate the impact of corneal staining on the Schirmer's test, the testing interval was established at a minimum of 15 minutes. Hyposecretion was suspected in cases when strip moistening was less than 10 mm.

Blinking rate and pattern

The blinking rate was documented using a high-resolution camera (SJCAM SJ4000 Camera) positioned on the headband for 5 minutes. Intervals of blinking, as well as complete and incomplete blinks, were documented.

Statistical Analysis

The data were documented in a database and analyzed with SPSS software (version 22.0; IBM, Armonk, NY, 2013). Continuous data were presented as mean ± standard deviation. Differences among the three age groups and among reading modalities (smartphone, tablet, hard copy) were evaluated using one-way ANOVA or repeated-measures ANOVA. Categorical data, including Oxford grading scores, were compared using the chi-square test. The relationships between blinking parameters and discomfort scores were assessed using Pearson's correlation analysis. A p-value of <0.05 was considered statistically significant.

Results

This study included 180 eyes from 90 volunteers. The mean age was 13.33±1.33 years in adolescents, 20.77±2.32 years in young adults, and 33.47±5.38 years in adults. Female participants constituted 56%, 56%, and 53% of the adolescens, young adults and adults groups, respectively). Table 1 summarizes their baseline characteristics.

Before reading, all volunteers had good vision: the Schirmer's test, FBUT, and Oxford scale results were normal. Across all age groups, FBUT decreased compared with baseline. Corneal staining, based on the Oxford grading system, increased in adolescents after smartphone reading and in young adults after both smartphone and tablet reading (p=0.047). No statistically significant changes were observed in other groups (Table 2).

At rest, the blinking rate (n=90) was 18.24±2.66 blink/min and incomplete blinking rate was 1.82±0.91 blink/min. For different reading items, the changes in blinking frequency were as follows: 9.84±1.78 blink/min for smartphones, 13.78±3.13 blink/min for tablets, and 14.64±2.31 blink/min for hardcopy. The incomplete blinking rates were 4.88±1.63 blink/min for smartphones, 3.13±1.42 blink/min for tablets, and 2.31±1.14 blink/min for hardcopy (n=90). Discomfort scores after reading were 34.77±13.75 for smartphones, followed by 24.84±10.05 for tablets and 20.99±12.40 for hardcopy. When groups were divided by age, the blinking rate decreased across all groups (p<0.001). Among adolescents, the resting incomplete blinking rate increased in all groups (p<0.001). The incomplete blinking during smartphone reading was higher than during tablet and hard-copy reading. The discomfort score was higher for

Table 1. Comparison of baseline characteristics of different age groups

	Adolescents	Young adults	Adults
Age, years, mean ± SD	13.33±1.33	20.77±2.32	33.47±5.38
Gender, female/male, n	17/13	17/13	16/14
OSDI total, 0-100, mean ± SD	3.50±2.01	2.97±2.2	4.0±1.41
FBUT, seconds, mean ± SD	11.70±0.87	11.13±0.72	11.40±1.14
Schirmer's test, mm, mean ± SD	12.73±1.53	12.23±1.43	13.53±3.21
Self reported screen time, hours, mean ± SD	6.16±1.56	5.18±1.47	4.55±1.39

SD: Standard deviation, OSDI©: Ocular Surface Disease Index©, FBUT: Fluorescein break-up time smartphones than for tablets and hard copy (p<0.001). Across all reading situations, young adults exhibited a lower blinking rate and a higher rate of incomplete blinking than at rest (p<0.001). The incomplete blinking rate was higher in smartphone reading (p<0.001); however, it did not differ between tablet and hardcopy reading. The discomfort score among young adults was higher for smartphone reading than for hardcopy reading (p<0.001) and for tablet reading (p=0.07). Among adults, the incomplete blinking rate was higher during tablet and smartphone reading than at rest (p<0.001); the rate did not differ from that during hardcopy reading. The discomfort score did not differ among the reading groups (Table 3).

When discomfort scores were compared across age groups, symptoms, including blurred vision, irritation, burning eyes, watery eyes, and eye discomfort, were more severe during smartphone reading. Among adolescents, the most prominent symptoms were: during smartphone reading, blurred vision and eye discomfort; during tablet reading, blurred vision, irritation, and burning eyes; and during hardcopy reading, blurred vision and watery eyes. In young adults, the prominent symptoms were watery and dry eyes during smartphone reading, dry eyes and eye strain during tablet reading, and blurred vision and eye strain during hard-copy reading. In adults, the prominent symptoms included blurred vision and eye discomfort during

Table 2. Changes in ocular surface and tear film parameters

		Smartphone		Tablet		Hardcopy	
	Baseline (mean ± SD)	After reading (mean ± SD)	p-value	After reading (mean ± SD)	p-value	After reading (mean ± SD)	p-value
Adolescents							
FBUT, seconds	11.70±0.87	9.07±0.96	**<0.01**	10.01±0.97	**<0.01**	10.22±1.04	**<0.01**
Schirmer's test, mm	12.73±1.53	12.40±1.61	0.33	12.63±2.37	0.76	12.80±2.32	0.89
Oxford grading system, 0-5	0	0.30±0.46	**0.001**	0.10±0.30	0.83	0.07±0.25	0.16
Young adults							
FBUT, seconds	11.13±0.72	9.55±0.90	**<0.01**	10.20±1.01	**<0.01**	10.24±0.61	**<0.01**
Schirmer's test, mm	12.23±1.43	12.40±1.99	0.68	12.56±2.44	0.41	12.83±2.42	0.19
Oxford grading system, 0-5	0	0.10±0.30	0.08	0.16±0.37	**0.02**	0.03±0.18	0.32
Adults							
FBUT, seconds	11.40±1.14	8.93±1.57	**<0.01**	9.86±1.16	**<0.01**	10.08±0.86	**<0.01**
Schirmer's test, mm	13.53±3.21	12.16±2.46	0.08	12.60±2.46	0.31	12.03±2.51	0.13
Oxford grading system, 0-5	0	0.16±0.37	0.23	0.1±0.30	0.83	0.23±0.43	0.06

SD: Standard deviation, FBUT: Fluorescein break-up time.

Table 3. Blinking rate, incomplete blinking rate, and discomfort scores during smartphone, tablet, and hardcopy reading across age groups

	Adolescents (mean ± SD)	Young adults (mean ± SD)	Adults (mean ± SD)
At rest			
Blinking rate, blinks/min	18.73±2.22	18.63±2.60	17.37±2.95
Incomplete blinking, blinks/min	1.70±0.98	1.67±0.80	2.10±0.88
Smartphone			
Blinking rate, blinks/min	9.57±1.81	9.83±1.51	10.13±2.01
Incomplete blinking, blinks/min	5.13±1.40	4.90±1.29	4.60±2.09
Discomfort score	38.40±10.50	29.63±9.13	36.27±18.53
Tablet			
Blinking rate, blinks/min	13.17±1.72	16.33±2.64	11.83±1.51
Incomplete blinking, blinks/min	3.30±1.31	2.53±1.07	3.57±1.63
Discomfort score 1-100	25.17±10.70	23.70±7.57	25.67±11.65
Hardcopy			
Blinking rate, blinks/min	14.97±2.91	16.73±2.87	12.23±2.60
Incomplete blinking, blinks/min	2.23±0.85	2.53±1.25	2.17±1.28
Discomfort score	11.87±6.98	21.17±8.25	29.93±13.65

SD: Standard deviation

smartphone reading, dry and watery eyes during tablet reading, and irritation, burning sensations, and eye discomfort during hardcopy reading. In adolescents, the most prominent symptom when looking away after smartphone reading was blurred vision (Figure 1). The blinking rate was not correlated with the incomplete blinking or discomfort scores.

Discussion

This study demonstrated that reading on different handheld devices and from hard copies significantly altered the ocular surface and blinking patterns in healthy adolescents, young adults, and adults.

Across all age groups, FBUT decreased after reading compared with baseline. Reading on smartphones affected corneal staining in adolescents and young adults. However, no significant changes were observed in the Schirmer's test scores.

Tablets and smartphones have gained popularity in daily life; nonetheless, their long-term effects on the ocular surface are unclear (12-14). Studies examining tear film secretion and amount have reported no change in tear meniscus levels 1 hour after smartphone or tablet reading (15). Another study reported an increase in Schirmer's test scores after watching a movie and playing a game on a smartphone; however, this increase could be attributed to reflex tear secretion (16). In contrast, studies conducted using computers reported a decrease in the tear volume (17,18). The tear volume appears to decrease with computer use; however, studies investigating the effects of handheld digital devices have generated contradictory results.

Studies evaluating tear film stability have demonstrated that FBUT decreases after 60 minutes of gaming on a tablet; however, no changes were recorded after smartphone reading (13,15). This study reported that, across all age groups, a decrease in FBUT was associated with corneal staining in children and adolescents. Children who used smartphones for an average of 3 hours per day demonstrated an FBUT <10 seconds and corneal punctate erosions. Conversely, children who used smartphones for <1 hour per day exhibited FBUT >10 seconds. Additionally, the group that used smartphones for 3 hours per day was 13 times more likely to have DED (12). In our study, the self-reported screen time among children and adolescents was 5 to 6 hours. Another study reported that screen time >4 hours per day negatively affected the quality of meibum expression (19). We did not evaluate meibomian gland function. FBUT decreased with computer use.

The observed reduction in FBUT after reading across all age groups underscores a common deleterious effect of digital screen exposure on tear film stability, an essential factor in maintaining ocular surface health. Notably, smartphone reading induced more pronounced corneal fluorescein staining in adolescents and young adults, whereas Schirmer's test results remained statistically unchanged. This suggests that short-term device use predominantly affects tear film quality and distribution rather than tear quantity, which aligns with the literature indicating that reflex tearing may mask basal tear film deficits in such scenarios.

Across all age groups, participants reported a lower blink rate and a higher rate of incomplete blinks when reading on a smartphone than when reading on a tablet or in hardcopy. The discomfort score was higher for smartphone reading, with blurred vision, irritation, burning eyes, watery eyes, and eye discomfort were the most prominent symptoms. Children predominantly reported visual symptoms, such as blurred vision; in contrast, young adults and adults most frequently reported dry eyes and eye discomfort. Short-term studies have reported symptoms related to the ocular surface and vision, such as blurred vision,

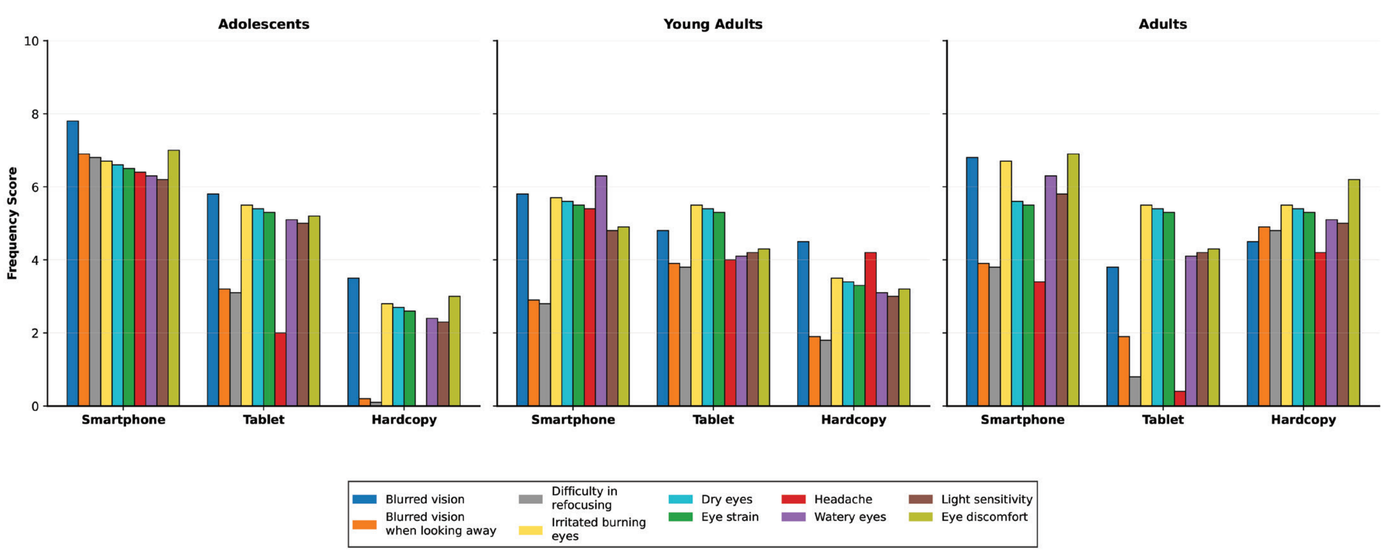

Figure 1. Comparison of digital device-related discomfort symtproms across age groups

headache, pain in the eyes, burning, and stinging (12,14). Dry eye symptoms improve after discontinuing phone use and double upon extending the screen time for 2 hours in adolescents (20). One hour of tablet or smartphone use increases eye fatigue and blurring up to five times in young adults (21). Among adolescents, blurred vision when looking away after reading is a prominent symptom in the smartphone-reading group. However, we did not evaluate the accommodation-vergence reflex or ocular deviation.

The mechanism by which smartphones and tablets disrupt accommodative flexibility is unclear. Additional cognitive demands from the multifunctionality of these devices may adversely affect accommodation, consequently affecting the ability to rapidly change focus (22). In our study, more adolescents with blurred vision looked away after reading in the smartphone-reading group. Smartphone use among adolescents results in dry eye symptoms and both immediate and sustained slowing of blinking, without changes in tear function for up to 1 hour. Considering the ubiquitous use of smartphones by adolescents, future studies should describe whether the mentioned effects persist or worsen over the long term, causing cumulative damage to the ocular surface (23). Our observation of frequent episodes of blurred vision in adolescents while reading on smartphones supports this hypothesis and highlights the need for detailed evaluations of accommodative and binocular visual function in this population.

Although adults demonstrated increased incomplete blinking with smartphone and tablet use, discomfort scores did not differ significantly across reading modalities. This may reflect greater ocular surface resilience and adaptive blinking patterns developed with age and prolonged exposure to digital devices, potentially mitigating subjective discomfort despite measurable ocular surface alterations. Nonetheless, these changes in blinking and tear film dynamics may still predispose adults to long-term ocular surface compromise if exposure continues unchecked.

Visual symptoms are the most common reading-related issues in patients without DED. Symptoms caused by dry eye substantially affect individuals' daily functioning and reduce their quality of life. In our study, adolescents and young adults demonstrated higher discomfort scores while reading on a smartphone. Healthy individuals without a DED diagnosis experience visual symptoms after prolonged reading (24). Given that incomplete blinking hinders the uniform spread of the tear film and exposes the ocular surface to desiccation, these results provide a mechanistic explanation for the increased ocular discomfort and visual symptoms reported, including blurred vision, irritation, and burning sensations. The higher discomfort scores associated with smartphone use reinforce the hypothesis that a smaller screen size and increased visual demands impose greater ocular strain than tablets or printed materials.

Study Limitations

Several limitations should be acknowledged. First, the sample size, although sufficient for detecting significant changes in blink rate and ocular surface parameters, was relatively small and limited to a single center, which may limit generalizability. Second, the study focused on short-term, 30 minute reading sessions; the long-term effects of chronic digital device use were not assessed. Third, only healthy participants without pre-existing ocular surface disease were included, which limits the extrapolation of these findings to populations with dry eye or other ocular conditions. Fourth, environmental factors, such as ambient light and screen reflection, were standardized; however, subtle variations could still influence ocular responses. Finally, subjective discomfort scores rely on self-reporting and may be influenced by individual perception, attention, or mood, thereby introducing potential bias. Future studies with larger, multi-center cohorts and extended monitoring periods are warranted to confirm and expand upon these findings.

Conclusion

These results emphasize that digital device use, particularly smartphone reading, constitutes a significant risk factor for ocular surface disruption and discomfort, with adolescents and young adults exhibiting greater susceptibility. Given the rising global prevalence of DED and its documented negative impact on quality of life, these findings underscore an urgent need for targeted clinical guidelines and public health strategies to minimize digital eye strain. Preventive interventions in vulnerable populations should include education on the importance of regular blinking, ergonomic optimization of screen use (e.g., viewing distance, screen angle), limiting continuous screen exposure, and possibly the use of artificial tears or other ocular surface therapies.

Future longitudinal studies are warranted to elucidate the cumulative effects of prolonged handheld device use on ocular surface health, accommodative function, and visual performance. Additionally, investigations into the interplay between device characteristics, user behavior, and individual ocular physiology will be critical to developing tailored recommendations to safeguard ocular health in the digital era.

Ethics

Ethics Committee Approval: The study protocol was approved by the Ankara Governorship Provincial Health Directorate, University of Health Sciences Türkiye, Atatürk Sanatorium Training and Research Hospital Ethics Committee (approval no: 2012-KAEK-15/2835, date: 27.12.2023).

Informed Consent: All volunteers were informed about the purpose and procedures of the study and provided written informed consent.

Footnotes

Authorship Contributions

Surgical and Medical Practices: Z.Ö.Y., Concept: S.E.A., Design: S.E.A., Data Collection or Processing: S.E.A., Analysis or Interpretation: Z.Ö.Y., Literature Search: Z.Ö.Y., Writing: S.E.A., Z.Ö.Y.

Conflict of Interest: The authors declared no conflict of interest.

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

References

1. Uchino M, Uchino Y, Dogru M, Kawashima M, Yokoi N, Komuro A, et al. Dry eye disease and work productivity loss in visual display users: the Osaka study. *Am J Ophthalmol.* 2014;157(2):294-300.
2. Wong CW, Tsai A, Jonas JB, Ohno-Matsui K, Chen J, Ang M, et al. Digital screen time during the covıd-19 pandemic: risk for a further myopia boom? *Am J Ophthalmol.* 2021;223:333-337.
3. Wang J, Li Y, Musch DC, Wei N, Qi X, Ding G, et al. Progression of myopia in school-aged children after covid-19 home confinement. *JAMA Ophthalmol.* 2021;139(3):293-300.
4. World Health Organization. WHO Guidelines Approved by the Guidelines Review Committee. Guidelines on physical activity, sedentary behaviour and sleep for children under 5 years of age. Geneva: WHO; [cited 2019; 2019]. Available from: https://www.who.int/publications/i/item/9789241550536
5. Ishii K, Shibata A, Adachi M, Mano Y, Oka K. School grade and sex differences in domain-specific sedentary behaviors among Japanese elementary school children: a cross-sectional study. *BMC Public Health.* 2017;17(1):318.
6. Republic of Turkey Ministry of Health. Technology addiction parent guide. Ankara: Ministry of Health; 2023. Available from: https://sggm.saglik.gov.tr/TR-101322/teknoloji-bagimliligi-ebeveyn-rehberi-2023.html
7. Chu CA, Rosenfield M, Portello JK. Blink patterns: reading from a computer screen versus hard copy. *Optom Vis Sci.* 2014;91(3):297-302.
8. Altalhi A, Khayyat W, Khojah O, Alsalmi M, Almarzouki H. Computer vision syndrome among health sciences students in Saudi Arabia: prevalence and risk factors. *Cureus.* 2020;12(2):e7060.
9. Cremers SL, Khan ARG, Ahn J, Cremers L, Weber J, Kossler AL, et al. New Indicator of children's excessive electronic screen use and factors in meibomian gland atrophy. *Am J Ophthalmol.* 2021;229:63-70.
10. Wang MT, Muntz A, Wolffsohn JS, Craig JP. Association between dry eye disease, self-perceived health status, and self-reported psychological stress burden. *Clin Exp Optom.* 2021;104(8):835-840.
11. Jaiswal S, Asper L, Long J, Lee A, Harrison K, Golebiowski B. Ocular and visual discomfort associated with smartphones, tablets and computers: what we do and do not know. *Clin Exp Optom.* 2019;102(5):463-477.
12. Moon JH, Kim KW, Moon NJ. Smartphone use is a risk factor for pediatric dry eye disease according to region and age: a case control study. *BMC Ophthalmol.* 2016;16(1):188.
13. Kim DJ, Lim CY, Gu N, Park CY. Visual fatigue induced by viewing a tablet computer with a high-resolution display. *Korean J Ophthalmol.* 2017;31(5):388-393.
14. Long J, Cheung R, Duong S, Paynter R, Asper L. Viewing distance and eyestrain symptoms with prolonged viewing of smartphones. *Clin Exp Optom.* 2017;100(2):133-137.
15. Golebiowski B, Long J, Harrison K, Lee A, Chidi-Egboka N, Asper L. Smartphone use and effects on tear film, blinking and binocular vision. *Curr Eye Res.* 2020;45(4):428-434.
16. Park JS CM, Ma JE, Choi J, Ma JE, Moon JH, Moon HJ. Influence of cellular phone videos and games on dry eye syndrome in university students. *J Korean Acad Nurs.* 2014;25:12-23.
17. Ribelles A, Galbis-Estrada C, Parras MA, Vivar-Llopis B, Marco-Ramírez C, Diaz-Llopis M. Ocular surface and tear film changes in older women working with computers. *Biomed Res Int.* 2015;2015:467039.
18. Yazici A, Sari ES, Sahin G, Kilic A, Cakmak H, Ayar O, et al. Change in tear film characteristics in visual display terminal users. *Eur J Ophthalmol*. 2015;25(2):85-89.
19. Wu H, Wang Y, Dong N, Yang F, Lin Z, Shang X, Li C. Meibomian gland dysfunction determines the severity of the dry eye conditions in visual display terminal workers. *PLoS One.* 2014;9(8):e105575.
20. Kim J, Hwang Y, Kang S, Kim M, Kim TS, Kim J, et al. Association between exposure to smartphones and ocular health in adolescents. *Ophthalmic Epidemiol.* 2016;23(4):269-276.
21. Maducdoc MM, Haider A, Nalbandian A, Youm JH, Morgan PV, Crow RW. Visual consequences of electronic reader use: a pilot study. *Int Ophthalmol.* 2017;37(2):433-439.
22. Park M, Ahn YJ, Kim SJ, You J, Park KE, Kim SR. Changes in accommodative function of young adults in their twenties following smartphone use. *J Korean Ophthalmic Opt Soc.* 2014;19:253-260.
23. Chidi-Egboka NC, Jalbert I, Golebiowski B. Smartphone gaming induces dry eye symptoms and reduces blinking in school-aged children. *Eye (Lond).* 2023;37(7):1342-1349.
24. Blehm C, Vishnu S, Khattak A, Mitra S, Yee RW. Computer vision syndrome: a review. *Surv Ophthalmol*. 2005;50(3):253-262.