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Association Between Screen Time, Digital Gaming Addiction, and Ocular Surface Parameters in School-Aged Children: A Cross-Sectional Study

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Abstract

Objective: This study aimed to evaluate whether screen exposure duration and the level of digital gaming addiction are associated with subjective ocular surface symptoms and objective tear film function tests in children.

Method: This cross-sectional study was conducted with 90 children aged between 8 and 14 years. Participants were divided into two groups: a symptomatic group (n = 45), consisting of children reporting ocular complaints such as burning, stinging, or itching, and a control group (n = 45) without such symptoms. All participants completed the Ocular Surface Disease Index (OSDI) questionnaire. Tear film function was assessed using tear break-up time (BUT) and non-anesthetized Schirmer tests. Screen time and digital gaming addiction levels were measured using structured questionnaires and the Digital Gaming Addiction Scale for Children (DGAS-C).

Results: Weekday and weekend screen exposure times were significantly longer in the symptomatic group compared to the control group ($p < 0.001$). OSDI scores were markedly higher in the symptomatic group ($p < 0.001$); however, no statistically significant differences were observed between groups in terms of BUT and Schirmer test results ($p > 0.05$). Total and subscale scores of the DGAS-C were also significantly higher in the symptomatic group ($p < 0.05$). Among participants with daily screen time exceeding two hours, no significant differences were detected in objective test results or addiction levels ($p > 0.05$).

Conclusion: This study demonstrated that increased screen time is significantly associated with the presence of ocular surface symptoms in children. However, the elevation in subjective symptom scores does not always correspond to changes in objective tear function tests. The findings indicate that digital screen exposure constitutes a relevant risk factor for pediatric ocular health and that such effects may initially manifest as subjective complaints. These findings highlight digital screen exposure as an emerging pediatric ophthalmic concern, underscoring the urgency of early behavioral interventions.

Keyword: Screen time; dry eye; OSDI; BUT; Schirmer; digital gaming addiction.

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INTRODUCTION

The rapid integration of digital technologies into daily life practices has led to a profound shift in media consumption patterns, particularly among children and adolescents, at cognitive, behavioral, and social levels. With the accelerating pace of technological advancement worldwide, the prevalence of digital tools in everyday routines has markedly increased. Exposure to digital media has been reported to be on the rise among younger populations, especially school-aged children, who now rely heavily on digital devices for various needs ranging from education and socialization to entertainment and information access. The educational processes, social interactions, leisure activities, and information acquisition methods of children and adolescents are increasingly being mediated through digital platforms in addition to traditional media like television.

The increasing daily exposure to screen-based devices such as smartphones, tablets, computers, and televisions not only affects cognitive and psychosocial development but also holds the potential to exert clinically significant effects on the ocular system (1). This intensive digital exposure poses risks not only to cognitive functions and psychosocial well-being but also to ocular health.

The integrity of the ocular surface and the physiology of the tear film are highly sensitive to both environmental and behavioral stimuli. The literature indicates that prolonged exposure to digital screens initiates a process characterized by reduced blink rate, increased tear film evaporation, and subsequent destabilization of the tear film (2,3). These physiological alterations are particularly impactful in the developing pediatric ocular system, potentially resulting in the early manifestation of subjective symptoms such as burning, stinging, dryness, and itching—early indicators of dry eye disease (4,5). Such symptoms have been reported to negatively affect school performance, attention span, and overall quality of life.

Furthermore, excessive and uncontrolled digital gaming may lead to behavioral addiction in children, consequently prolonging screen exposure time and exacerbating secondary effects on ocular health (6). Digital gaming addiction is associated with psychosocial outcomes such as sleep disturbances, social withdrawal, reduced academic performance, and impaired attention regulation. Additionally, prolonged engagement with screens can act as a physiological stressor affecting tear film dynamics (7). However, the literature remains limited regarding studies that elucidate a causal relationship between digital gaming addiction and ocular surface pathology.

The primary aim of this study is to comprehensively evaluate the relationship between screen exposure duration and digital gaming addiction levels with both subjective symptoms of dry eye and objective tear film parameters in children aged 8–14 years. Understanding the effects of digital media use on ocular physiology in pediatric populations may provide an important foundation for developing early intervention strategies to mitigate harmful digital behavior patterns that threaten eye health. Moreover, this study seeks to contribute original findings to the literature by exploring the interaction between behavioral addiction and ophthalmic pathophysiology in children.

METHODS

This observational and cross-sectional study was conducted between May 2024 and December 2024 at the Department of Ophthalmology, Faculty of Medicine, Recep Tayyip Erdoğan University. Ethical approval for the study was obtained from the Non-Interventional Clinical Research Ethics Committee of the institution (Ethics Committee Approval No: [2024/83], Date: [18/04/2024]). The study population consisted of children aged 8 to 14 years who were in generally stable ocular health.

Inclusion criteria were defined as children with a best-corrected visual acuity of 1.0 in Snellen equivalent, and without any active infections or a history of systemic or ocular chronic diseases. Participants were divided into two groups based on their presenting complaints at the ophthalmology outpatient clinic. The symptomatic group included children presenting with ocular surface-related complaints such as stinging, burning, or itching, suggestive of dry eye symptoms. The control group consisted of asymptomatic individuals with no subjective ocular complaints and no remarkable pathological findings upon general ophthalmic examination. All participants underwent slit-lamp biomicroscopy, and only those with normal anterior segment findings were included in the study.

Exclusion criteria included the presence of any systemic or ocular pathology that could directly affect tear physiology or subjective symptom perception; history of any ocular surgery; systemic diseases such as diabetes, hypertension, or metabolic disorders; chronic ocular conditions such as glaucoma, uveitis, amblyopia, or retinal pathologies; prior referral to child psychiatry or current use of psychiatric medication. Additionally, individuals with a current or past history of allergic or viral conjunctivitis, contact lens wearers, those using systemic medications that may influence corneal integrity or tear production, and those with spherical equivalent myopic refractive errors exceeding -2.00 diopters were excluded from the study. This exclusion strategy was implemented to ensure a more reliable assessment of the relationship between screen time and dry eye-related symptoms.

Ocular Assessments

Ocular Surface Disease Index (OSDI)

To assess ocular surface symptoms, the Ocular Surface Disease Index (OSDI) questionnaire was administered. The OSDI is a validated 12-item instrument that evaluates visual function limitations, ocular discomfort, and symptoms triggered by environmental factors (8). All questionnaires were administered in the morning under standardized conditions by the same trained researcher, in the presence of the parent but without parental guidance or interference. The total score was calculated using the following formula and expressed on a scale of 0–100:

OSDI Score = (Total Score × 25) / Number of Questions Answered.

Higher scores indicate greater symptom severity. Scores were categorized as follows: 0–12 (normal), 13–22 (mild), 23–32 (moderate), and ≥33 (severe).

Tear Film Break-Up Time (BUT)

Tear film stability was evaluated using fluorescein-based BUT measurements. A sterile fluorescein strip (Fluorescein Sodium Strip, Haag-Streit) was applied to the inferior fornix. After several blinks, participants were asked to keep their eyes open. Using a slit-lamp with cobalt blue illumination, the interval between the last blink and the appearance of the first dark spot on the corneal surface was recorded in seconds. Three consecutive measurements were taken from each eye, and the mean value was used for analysis.

Measurements were performed under constant room conditions (22 ± 1°C, relative humidity 50 ± 5%) following a 10-minute screen-free rest period. To eliminate observer variability, all assessments were conducted by the same researcher. Values of <10 seconds were considered indicative of tear film instability.

Schirmer Test (Non-anesthetized)

Tear production was assessed using the Schirmer test without topical anesthesia. Standard Schirmer strips (Whatman no. 41, 5×35 mm) were placed in the lateral third of the lower eyelid. Participants were asked to keep their eyes closed for 5 minutes. The length of the moistened area was measured in millimeters for each eye. All measurements were conducted in the morning under consistent physical conditions by the same examiner. Values ≤10 mm were considered indicative of reduced tear production.

Structured Questionnaires

Sociodemographic and Screen Time Questionnaire: Parents were asked to complete a structured questionnaire prepared by the research team to obtain sociodemographic information and screen time data. The questionnaire collected data on participants' age, sex, and parental education level, as well as daily duration of exposure to televisions and screen-based devices (computers, tablets, and smartphones). Weekly screen time averages were calculated and expressed in hours per day. Total screen exposure was additionally evaluated in relation to the recommended maximum daily screen time of 2 hours for this age group.

Digital Gaming Addiction Scale for Children (DGAS-C)

To assess digital gaming addiction levels, the Digital Gaming Addiction Scale for Children (DGAS-C) was used. This scale was developed and psychometrically validated by Hazar and Hazar for use in children aged 10–14 years. The scale consists of 24 items rated on a 5-point Likert scale, where each item is scored from 1 (strongly disagree) to 5 (strongly agree). The total score ranges from 24 to 120, and scores are categorized as follows: 1–24 (normal), 25–48 (low-risk), 49–72 (at risk), 73–96 (addicted), and 97–120 (highly addicted). The scale includes four subdimensions: (1) excessive focus and conflict related to digital gaming, (2) development of tolerance and psychological value attributed to gaming, (3) postponement of individual and social responsibilities, and (4) psychological-physiological manifestations of withdrawal symptoms. The internal consistency of the scale is high, with a reported Cronbach's alpha coefficient of 0.90 (9).

Based on a power of 95% and a Type I error rate of 5%, the total sample size was determined to be 90 participants, with 45 in each group, for independent samples t-test analysis. This sample size yielded an effect size of d = 0.77, indicating a moderate effect according to Cohen's criteria (Cohen, 1988). The power analysis findings suggest that the sample size is sufficient to draw reliable inferences from the study (Gibson et al., 2017). The power analysis was conducted using the G*Power 3.1 software (Faul, Erdfelder, Buchner, & Lang, 2009).

Statistical Analysis

The assumption of normality was first evaluated using the Shapiro–Wilk test. For comparisons of normally distributed variables between two groups, the independent samples t-test was used. For non-normally distributed data, the Mann–Whitney U test was applied. Categorical variables were compared using the Pearson chi-square test when all expected cell counts were greater than 5; otherwise, Fisher's exact test was employed (Howell, 2011). Multiple comparisons of proportions were conducted using the Bonferroni-corrected Z test. Correlations between non-normally distributed quantitative variables within the patient group were assessed using Spearman's rho correlation coefficient. Results for quantitative data were reported as mean ± standard deviation (SD) or median with minimum and maximum values (median [min–max]). Categorical variables were presented as frequency (n) and percentage (%). A p-value of <0.05 was considered statistically significant. All statistical analyses were performed using IBM SPSS Statistics for Windows, Version 26.0 (IBM Corp., Armonk, NY, USA; released 2019).

RESULTS

A total of 90 children participated in this study, comprising 45 symptomatic participants (those reporting ocular symptoms such as stinging, burning, and itching) and 45 asymptomatic participants (control group). The mean age was 9.97 ± 1.34 years in the symptomatic group and 9.48 ± 1.21 years in the control group, with no statistically significant difference between the groups ($p > 0.05$). Similarly, there was no significant difference in gender distribution ($p > 0.05$).

Regarding screen exposure, the symptomatic group reported significantly longer durations of both television viewing and the use of other digital devices (computers, tablets, smartphones) on both weekdays and weekends compared to the control group ($p < 0.05$). Demographic characteristics and questionnaire results of the groups are summarized in Table 1.

Comparison of OSDI scores revealed that the mean OSDI score was significantly higher in the symptomatic group than in the control group ($p < 0.001$). However, no statistically significant differences were found between the groups in Schirmer test values or Break-Up Time (BUT) measurements ($p > 0.05$).

The total score of the Digital Gaming Addiction Scale for Children (DGAS-C) was significantly higher in the symptomatic group ($p < 0.05$). All subscales of the scale—including “excessive focus and conflict,” “development of tolerance,” “postponement of duties,” and “withdrawal and immersion in gaming”—also yielded significantly higher scores in the symptomatic group compared to the control group ($p < 0.05$). According to the classification of addiction risk, none of the participants in the control group met the criteria for addiction, while 48.9% of the symptomatic group were classified as “at risk” and 35.6% as “addicted” (Table 2).

In subgroup analyses within the symptomatic group, no statistically significant differences were observed in OSDI, Schirmer, or BUT values between participants with less than 2 hours and those with more than 2 hours of daily screen time ($p > 0.05$). Similarly, the DGAS-C total and subscale scores did not differ significantly by screen time duration ($p > 0.05$) (Table 3).

Table 1. Comparison of Demographic and Clinical Characteristics Between Groups

	Control (n=45)	Patient (n=45)	p
Age	9.48 ± 1.21	9.97 ± 1.34	0.077[t]
Gender			
Male	30 (66.7)	22 (48.9)	0.088[x]
Female	15 (33.3)	23 (51.1)	
Number of Siblings			
1	1 (2.2)	1 (2.2)	0.286[f]
2	11 (24.4)	17 (37.8)	
3	27 (60)	18 (40)	
4	6 (13.3)	8 (17.8)	
5	0 (0)	1 (2.2)	
Birth Order			
1	14 (31.1)	14 (31.1)	0.155[f]
2	28 (62.2)	21 (46.7)	
3	3 (6.7)	8 (17.8)	
4	0 (0)	2 (4.4)	
Parental Status			
Father deceased	0 (0)	1 (2.2)	1.000[f]
Living together	45 (100)	44 (97.8)	
Mother's Education			
Primary school	4 (8.9)[a]	10 (22.2)[a]	**0.005[f]**
High school	37 (82.2)[a]	22 (48.9)[b]	
Vocational school	0 (0)[a]	3 (6.7)[a]	
University	4 (8.9)[a]	10 (22.2)[a]	
Father's Education			
Primary school	0 (0)[a]	5 (11.1)[b]	**<0.001[f]**
High school	37 (82.2)[a]	23 (51.1)[b]	
Vocational school	0 (0)[a]	6 (13.3)[b]	
University	8 (17.8)[a]	11 (24.4)[a]	
Mother's Employment			
Not working	17 (37.8)	23 (51.1)	0.289[f]
Working	28 (62.2)	22 (48.9)	
Father's Employment			
Not working	0 (0)	1 (2.2)	1.000[f]
Working	45 (100)	44 (97.8)	
Weekday TV time	45 (0 - 180)	120 (0 - 360)	**<0.001[m]**
Weekday screen device	30 (0 - 180)	180 (0 - 360)	**<0.001[m]**
Weekend TV time	60 (0 - 240)	120 (0 - 600)	**<0.001[m]**
Weekend screen device	90 (0 - 300)	240 (30 - 600)	**<0.001[m]**
BUT	17.1 (3.9 - 17.6)	13.3 (3.8 - 17.6)	0.148[m]
Schirmer	16 (2 - 25)	16 (4 - 30)	0.710[m]
OSDI	7.5 (0 - 55)	30 (2.5 - 77.5)	**<0.001[m]**

t: Independent samples t-test, m: Mann–Whitney U test, x: Pearson chi-square test, f: Fisher's exact test, mean ± standard deviation, median (min.–max.), n (%), Test stat: Test statistic, a-b: Groups sharing the same letter do not significantly differ.
BUT:Break-up Time , OSDI: Ocular Surface Disease Index.

Table 2. Examination of digital game scale scores according to groups

	Control (n=45)	Patient (n=45)	p
Over-focus and Procrastination	22 (11 - 26)	30 (11 - 44)	**<0.001[m]**
Conflict, Deprivation and Seeking	11 (6 - 16)	16 (6 - 22)	**<0.001[m]**
Emotion Exchange and Immersion	8 (4 - 14)	13 (4 - 18)	**<0.001[m]**
Digital Game Addiction	40 (21 - 56)	59 (23 - 80)	**<0.001[m]**
Digital Game Addiction Evaluation			
Normal	1 (2.2)[a]	0 (0)[b]	**<0.001[f]**
Little risk	29 (64.4)[a]	7 (15.6)[b]	
At risk	15 (33.3)[a]	22 (48.9)[a]	
Addicted	0 (0)[a]	16 (35.6)[b]	

m: Mann Whitney U test, f: Fisher's exact test, median (min.-max.), n (%), Test ist: Test statistic, a-b: No difference between groups with the same letter.

Table 1. Associations Between Screen Time and Ocular Surface Parameters

	BUT	p^t	Schirmer	pt	OSDI	p^t
Weekday TV time						
≤ 120 minutes	13.58 ± 3.31	0.105	15.14 ± 6.95	0.537	35.84 ± 18.73	0.657
> 120 minutes	11.07 ± 5.41		16.44 ± 6.22		33.28 ± 17.72	
Weekday screen device						
≤ 120 minutes	13.64 ± 3.28	0.156	16.33 ± 6.13	0.496	30.45 ± 17.45	0.124
> 120 minutes	11.85 ± 4.93		14.96 ± 7.15		38.85 ± 18.33	
Weekend TV time						
≤ 120 minutes	13.58 ± 3.46	0.156	14.35 ± 6.93	0.200	33.46 ± 16.47	0.584
> 120 minutes	11.75 ± 4.92		16.91 ± 6.24		36.48 ± 20.16	
Weekend screen device						
≤ 120 minutes	13.64 ± 2.55	0.338	17.13 ± 7.38	0.481	31.25 ± 23.07	0.534
> 120 minutes	12.48 ± 4.58		15.27 ± 6.55		35.73 ± 17.28	

t: Independent two sample t test, mean ± s.deviation

Table 4. Investigation of the relationship between total screen exposure times during the week, eye measurements and digital game scale scores in the patient group

	Screen Exposure on Weekdays		p
	≤ 120 (n=6)	**> 120 (n=39)**	
BUT	11.9 (11.2 - 13.3)	13.9 (3.8 - 17.6)	0.376^m
Schirmer	17.5 (5 - 18)	15 (4 - 30)	0.920^m
OSDI	40.83 ± 23.96	34.03 ± 17.39	0.400^t
Over-focus and Procrastination	26.17 ± 8.5	29.77 ± 8.42	0.335^t
Conflict, Deprivation and Seeking	15.33 ± 5.09	15.69 ± 4.22	0.851^t
Emotion Exchange and Immersion	13 (9 - 18)	13 (4 - 18)	0.736^m
Digital Game Addiction	55 ± 12.66	57.77 ± 14.47	0.660^t

t: Independent two sample t test, m: Mann Whitney U test, mean ± s.deviation, median (min.-max.) BUT:Break-up Time , OSDI: Ocular Surface Disease Index.

No significant associations were found between weekday screen exposure exceeding 2 hours and participants' BUT, Schirmer, or OSDI scores ($p > 0.05$). Likewise, no significant relationship was observed between weekday screen time over 2 hours and DGAS-C total or subscale scores ($p > 0.05$) (Table 4). Due to only one participant reporting less than 120 minutes of weekend screen exposure, statistical comparisons could not be performed for that subgroup.

DISCUSSION

This study investigated the effects of screen time and digital gaming addiction levels on dry eye symptoms and tear film parameters in school-aged children, contributing original findings to a topic that has been only sparsely addressed in the literature.

In our findings, symptomatic children spent significantly more time in front of screens, including both television and other digital devices, on weekdays and weekends compared to their asymptomatic peers. This observation supports the hypothesis that screen-based activities—particularly in school-aged children—may be associated with ocular surface symptoms. Prolonged use of digital devices is thought to reduce blink frequency, increase tear evaporation, and ultimately disrupt tear film stability. Lotfy et al. demonstrated that extended mobile gaming significantly decreased blink frequency and increased inter-blink intervals, which in turn led to ocular surface irritation due to tear film instability (10). Similarly, Müntz et al. investigated the impact of prolonged screen exposure on dry eye in adolescents and reported that decreased blink rates and tear film instability due to digital device use exacerbate ocular discomfort. Their findings indicate that screen-related activities may significantly disrupt blink dynamics that are essential for ocular surface health (5).

Moreover, our study revealed significantly higher OSDI scores among symptomatic participants, suggesting that digital exposure contributes to increased subjective ocular discomfort. The Ocular Surface Disease Index is a validated and widely used tool that evaluates the impact of ocular symptoms on daily visual function. Developed by Schiffman et al., the OSDI assesses multidimensional components including environmental triggers, visual disturbances, and symptom frequency, thereby offering a comprehensive assessment of perceived symptom burden (11).

Interestingly, no significant differences were found between symptomatic and control groups in objective measures such as BUT and Schirmer test values. This discrepancy highlights the known limitation that subjective symptoms may not always align with objective tear film parameters. Previous studies have noted that tear film tests may demonstrate limited sensitivity and reliability in pediatric populations and may show weak correlations with reported symptoms (12). These findings underscore the need for cautious and multidimensional interpretation of test results in clinical practice.

OSDI is a validated, multidimensional tool designed to assess the severity of dry eye-related symptoms and their impact on daily functioning (13). Comprising 12 items, the scale evaluates visual symptoms (e.g., burning, stinging, dryness, itching), functional limitations (e.g., reading, screen use, night driving), and environmental triggers (e.g., wind, low humidity, air conditioning). This comprehensive structure allows OSDI to capture not only physiological signs but also the subjective symptom burden as perceived by the patient (14).

Particularly in the presence of behavioral stressors such as prolonged screen exposure, cognitive overload, and environmental stimuli (e.g., light, wind, or dust), subjective ocular symptoms may become apparent earlier and more prominently than objective clinical findings (14,15). Accordingly, the OSDI is considered a sensitive instrument for identifying early ocular surface dysfunction in cases where physiological changes have yet to be reflected in conventional diagnostic tests. Indeed, several studies report that OSDI scores do not always show strong correlations with objective tear film parameters such as osmolarity, BUT, or Schirmer test results, reinforcing the subjective nature of symptom reporting captured by this scale (17).

The application of conventional tests such as BUT and Schirmer in pediatric populations presents inherent limitations. It has been previously documented that these tests may suffer from poor reproducibility in children, are heavily dependent on patient cooperation, and can be influenced by external environmental factors (18). The TFOS DEWS II reports have particularly emphasized the low test-retest reliability of these conventional diagnostic methods in pediatric populations, highlighting their limited sensitivity in detecting early ocular surface dysfunction (17,18,20). Non-invasive tear film assessment techniques, such as non-invasive BUT measurements, have shown superior reproducibility and patient comfort compared to fluorescein-based methods, particularly in children where cooperation may be challenging (21,22,23). Moreover, they may not adequately reflect dynamic changes on the ocular surface, particularly in early evaporative dry eye, where subjective discomfort may be pronounced despite normal tear volume or stability. Thus, our findings suggest that digital screen exposure primarily impacts the ocular surface at a symptomatic level, preceding detectable physiological impairment. These results emphasize the potential superiority of symptom-based assessment tools in detecting early digital media-related visual complaints in children and highlight the clinical value of incorporating subjective scales in pediatric ophthalmologic evaluations.

In our study, digital gaming addiction scores were significantly higher in the symptomatic group compared to the control group. Total and subscale scores of the Children's Digital Game Addiction Scale (DGAS-C) were consistently elevated among symptomatic participants. These results imply that digital gaming behavior in symptomatic children is characterized not only by extended use but also by patterns suggestive of addictive tendencies. In a prior study by Hazar, digital game addiction in children was associated with social withdrawal, impaired impulse control, and reduced academic functioning, with behavioral and neuropsychological features of addiction prominently observed (19).

The observed link between digital gaming addiction and dry eye symptoms may be mediated by prolonged screen exposure, suppression of the blink reflex due to sustained visual attention, and reduced oculomotor activity. Floros et al. found that higher digital game addiction scores were significantly associated with symptoms of digital eye strain and suggested that such addiction constitutes a risk factor for the development of visual fatigue (16). These findings underscore the dual impact of digital game addiction—not only on mental health but also as a contributing factor to ocular surface dysfunction.

One of the novel aspects of this study lies in its multidimensional assessment of the association between digital screen exposure, digital gaming addiction behaviors, and ocular surface symptoms among school-aged children. By incorporating both subjective (OSDI) and objective (BUT and Schirmer) parameters, this investigation offers a comprehensive evaluation of digital media's potential impact on pediatric ocular health. Notably, the current literature lacks sufficient research directly addressing the ocular consequences of digital gaming addiction, thus underscoring the potential contribution of these findings to the field. Moreover, the assessment of digital game addiction through its subcomponents—encompassing cognitive, emotional, and social orientations—rather than reducing it solely to screen time, enhances the analytical depth of this study and distinguishes it from prior investigations.

Nevertheless, several methodological limitations should be acknowledged. The cross-sectional design precludes any inference of causality between variables. Additionally, tear function tests such as Schirmer and BUT are operator-dependent and susceptible to environmental influences, particularly in pediatric populations, thereby introducing a potential for inter-measurement variability. Self-reported data on digital device use and gaming behaviors may be subject to recall bias or social desirability bias, limiting the accuracy of these responses. The relatively small sample size and the single-center nature of the study may also restrict the generalizability of the findings to broader pediatric populations. Although the DGAS-C is validated for use in children aged 10–14 years, the inclusion of participants as young as 8 years may introduce a degree of measurement variability. However, item comprehension was confirmed by the research team during administration, and responses were carefully monitored for consistency.

Despite these limitations, the present study highlights the necessity of evaluating digital screen use and gaming behaviors not only in terms of their psychological consequences but also with regard to their physiological effects on ocular health. The results underscore the importance of structuring digital media habits in childhood and emphasize the need for awareness programs targeting screen duration and digital content quality. Ophthalmic evaluations in children should routinely include structured assessments of digital behavior. Future prospective, multicenter studies with larger cohorts are warranted to more precisely elucidate the long-term effects of digital exposure on ocular health and to provide stronger evidence to guide clinical and preventive interventions.

CONCLUSION

This cross-sectional study provides compelling evidence that increased screen time exposure is significantly associated with ocular surface symptoms in school-aged children, representing an emerging concern in pediatric ophthalmology. Our findings demonstrate that symptomatic children exhibited substantially longer screen exposure durations across all digital devices compared to their asymptomatic counterparts, with concomitantly elevated OSDI scores reflecting greater subjective ocular discomfort. Notably, digital gaming addiction scores were consistently higher in the symptomatic group, suggesting that problematic digital behaviors may constitute an additional risk factor for pediatric dry eye symptoms beyond mere exposure duration.

The dissociation between subjective symptom severity and objective tear film parameters observed in this study underscores the complexity of digital screen-related ocular surface dysfunction in children. While conventional diagnostic tests such as BUT and Schirmer measurements failed to demonstrate significant between-group differences, the pronounced elevation in OSDI scores among symptomatic participants suggests that digital exposure primarily manifests as symptomatic dysfunction in the early stages, preceding detectable physiological impairment. This finding has important clinical implications, emphasizing the potential superiority of validated symptom-based assessment tools in detecting early digital media-related visual complaints in pediatric populations.

The multidimensional nature of digital gaming addiction, encompassing cognitive, emotional, and behavioral components, appears to be intricately linked with ocular surface symptomatology. The significant associations observed across all DGAS-C subscales suggest that addictive gaming behaviors may amplify the deleterious effects of screen exposure through mechanisms involving sustained visual attention, suppressed blink dynamics, and prolonged accommodative stress.

These findings have significant implications for clinical practice and public health policy. Healthcare providers should incorporate structured assessments of digital behavior and screen time exposure into routine pediatric ophthalmologic evaluations. The implementation of evidence-based screen time guidelines, coupled with educational interventions targeting optimal digital hygiene practices, may serve as preventive measures against the development of digital eye strain in children.

Clinical Recommendations: Based on our findings, we recommend that clinicians routinely inquire about screen time exposure and digital gaming behaviors when evaluating children with ocular surface complaints. The OSDI questionnaire may serve as a sensitive screening tool for detecting early digital media-related visual symptoms, particularly when objective tests remain within normal limits. Furthermore, behavioral interventions focusing on proper screen viewing habits, scheduled digital breaks, and environmental modifications should be integrated into comprehensive pediatric eye care protocols.

Future research should focus on longitudinal studies to establish causal relationships and investigate the long-term consequences of digital exposure on pediatric ocular health. Additionally, the development of age-appropriate diagnostic tools specifically designed for children, along with standardized treatment protocols for digital eye strain, remains a priority for advancing pediatric ophthalmologic care in the digital age.

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