

Original Article



Eye Health Risks and Use of Digital Devices Among Adolescents in Dhaka City

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Abstract

Background and objectives: The widespread use of digital devices among adolescents raises public health concerns, particularly regarding digital eye strain. Because localized data on eye health risks associated with device use among adolescents in urban Bangladesh remain limited, this study assessed eye health risks and digital device use among adolescents in Dhaka City.

Methods: A descriptive cross-sectional study was conducted among 220 adolescents aged 13–17 years at a single school in Dhaka City from September 2024 to October 2025 using convenience sampling. Data were collected using a structured, culturally adapted questionnaire assessing sociodemographic characteristics, digital device use patterns, and self-reported ocular and musculoskeletal symptoms recalled for the periods before and after digital device use. Descriptive statistics, t-tests, analysis of variance, and Pearson correlation were performed using SPSS version 29.

Results: Participants reported very early exposure to digital devices (mean age at onset, 4.29 ± 2.43 years). High-risk usage patterns were prevalent: 40% used devices for > 3 hours/day, 73.2% used them while lying down, and 61.4% used them at bedtime with the lights off. The prevalence of all reported symptoms was higher for the period recalled after device use, with headache (56.4%), neck pain (38.6%), tired eyes (33.6%), and blurred vision (33.2%) being the most common. A statistically significant but weak positive correlation was found between daily usage time (hours/day) and post-use eye health risk scores ($r = 0.155$, $P = 0.021$).

Conclusions: These exploratory findings from a single-school sample suggest the need for education on healthier digital device practices among adolescents, but confirmation in larger, representative studies with objective ophthalmic assessments is warranted.

Keywords: Digital eye strain; Eye health risk; Adolescents; Screen time; Ocular health; Bangladesh.

Introduction

The rapid advancement of information and communication technologies has transformed daily life, with digital devices becoming ubiquitous tools for work, education, and social interaction. This shift is particularly pronounced among younger generations, for whom laptops, tablets, smartphones, and institution-based computers are now common and integral to both social and academic activities.^{1,2} The use of personal electronic devices has increased dramatically in recent decades, embedding screen-based activities into childhood and adolescence.

Consequently, as the duration and proximity of engagement with these devices increase, concerns regarding their potential impact on physical health have grown, with ocular health emerging as a primary concern. Children and adolescents are especially vulnerable, and research indicates that their eyes may be more sensitive to the high-energy blue light emitted from digital screens than those of adults, potentially increasing the risk of visual disturbances.³

The constellation of visual and ocular symptoms associated

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with prolonged use of digital screens is clinically recognized as digital eye strain (DES) or computer vision syndrome. This condition includes eye tiredness, redness, dryness, discomfort, and blurred vision and is often accompanied by headaches and musculoskeletal pain related to poor posture and improper viewing angles.⁴ The prevalence of DES is high and appears to be increasing alongside device dependency. International studies underscore the scale of the problem; for instance, research in the United Kingdom suggests a significant prevalence of dry eye disease among computer users, with estimates potentially exceeding those in the general population.⁵ Similarly, an Indian study reported a DES prevalence of 89.9% among surveyed pupils and noted a strong association between excessive use, particularly beyond two hours daily, and symptom occurrence.⁶ These findings highlight a pervasive public health issue associated with digital screen exposure, with behavioral factors such as use while reclining or in poor cervical positions further aggravating the risks.⁷

Despite the global recognition of DES as a growing health concern, important gaps remain in the contextual understanding of its impact on specific demographic groups, particularly adolescents in urban settings in developing countries. The ocular effects of digital device use on teenagers have been studied, but many reports lack the granularity needed to inform localized public health strategies. This gap became even more pressing during and after the COVID-19 pandemic, as mandatory online learning and increased screen time for social connectivity substantially altered usage patterns, a shift widely discussed in the media but insufficiently documented in rigorous academic research.⁶ Furthermore, previous studies have documented high rates of myopia (26.87%) and asthenopia (10%) among Bangladeshi youth, but comprehensive investigations focusing specifically on adolescents in Dhaka remain scarce.² This study, therefore, sought to address this research gap by systematically assessing eye health risks and patterns of digital device use among adolescents in Dhaka City.

Adolescence is a critical period of physiological change, during which ocular health is important for development, quality of life, and social inclusion.^{8,9} The rationale for this investigation is rooted in the need to generate localized empirical data that can illuminate the specific risk profiles and behavioral patterns within this population. By examining the relationship between device use habits, such as duration, posture, and device type, and the manifestation of ocular symptoms, this study aimed to provide useful information for adolescents, families, and educators to support prevention and control. The findings may also provide healthcare leaders and policymakers with a preliminary evidence base to support targeted preventive measures, regular eye examinations, and healthier digital practices, thereby helping to safeguard the vision of the nation's youth.

Materials and methods

The study employed a descriptive cross-sectional design to assess patterns of digital device use and associated eye health risks among adolescents in Dhaka City. The research was conducted at the Institute of Public Health (IPH) School & College in Mohakhali, Banani, targeting adolescent students aged 13–17 years from both morning and day shifts. Due to practical constraints, a non-probability convenience

sampling method was used during the study period from September 2024 to October 2025. The sample size was determined using G*Power analysis, with an effect size of 0.25, a significance level (alpha) of 0.05, and a power (1-beta) of 0.80, which yielded a minimum sample size of 200. To account for potential attrition, an additional 10% of participants were included, resulting in a final sample size of 220 adolescents. The inclusion criteria encompassed adolescent students aged 13–17 years who used digital devices, were present at school during the data collection period, whose parents provided written informed consent, and who provided assent to participate.

Data were collected using a structured, self-administered questionnaire adapted from an instrument developed by a group of researchers.¹⁰ The tool was slightly modified based on an extensive literature review to ensure contextual relevance and was subsequently reviewed by three subject matter experts for content validity. However, no formal reliability statistics (e.g., Cronbach's alpha) were calculated for the adapted version, and the questionnaire did not undergo further cultural validation beyond expert review. The "eye health risk score" was computed as the mean of dichotomous (yes/no) responses across all ocular and musculoskeletal symptoms, with higher scores indicating greater symptom burden; this scoring method has not been independently validated. The finalized questionnaire comprised three sections. The first section gathered sociodemographic information, including age, gender, parental education and occupation, family income, and family structure. The second section focused on digital device use characteristics, such as type, duration, purpose, and frequency of use, as well as viewing distance, posture, and bedtime usage habits. The third section assessed self-reported eye health risks, capturing symptoms such as eye itching, eye pain, tiredness, redness, blurred vision, and associated musculoskeletal pain as recalled separately by participants for the periods "before using digital devices" and "after using digital devices". This represented retrospective cross-sectional recall rather than a prospective pre-post measurement. Responses were recorded on a dichotomous (yes/no) scale. Following approval from the Institutional Review Board (IRB) and formal permission from the school principal, the researcher introduced the study and explained its objectives, benefits, and participant rights. Written informed consent was obtained from parents, and assent was obtained from each participating adolescent, with strict measures to ensure confidentiality and anonymity throughout the process.

Upon completion of data collection, all questionnaires were checked, verified, and edited for consistency and accuracy to minimize errors. The data were then entered and analyzed using the Statistical Package for the Social Sciences (SPSS) version 29. Descriptive statistics, including frequencies, percentages, means, and standard deviations, were computed to summarize sociodemographic profiles, device use patterns, and the prevalence of ocular and physical symptoms. Inferential statistical analyses were conducted to explore relationships and differences among variables. Specifically, independent-samples t-tests and one-way analysis of variance were used to examine differences in eye health risk scores across demographic and device-use groups. Pearson correlation coefficient was used to assess the strength and direction of relationships between continuous variables, such as hours of device use and symptom severity scores. Given

Table 1. Sociodemographic characteristics of the participants (N=220)

Variable	Category	Frequency (n)	Percentage (%)	M ± SD
Age (in years)				14.47 ± 1.22
	≤15 years	171	77.7	
	>15 years	49	22.3	
Gender	Male	95	43.2	
	Female	125	56.8	
Religion	Muslim	196	89.1	
	Hindu	22	10.0	
	Christian	2	0.9	
Mother's education	Primary	72	32.7	
	Secondary	96	43.6	
	Higher Secondary	45	20.5	
	Graduate and above	7	3.2	
Father's education	Primary	62	28.2	
	Secondary	73	33.2	
	Higher Secondary	66	30.0	
	Graduate and above	19	8.6	
Mother's occupation	Government service	4	1.8	
	Private service	37	16.8	
	Business	6	2.7	
	Homemaker	155	70.5	
	Others	18	8.2	
Father's occupation	Government service	24	10.9	
	Private service	68	30.9	
	Business	68	30.9	
	Farmer	26	11.8	
	Others	34	15.5	
Monthly family income (Bangladeshi taka)				27,518 ± 15,218
	≤25,000	124	56.4	
	25,001–50,000	84	38.2	
	>50,000	12	5.5	
Type of family	Nuclear family	182	82.7	
	Joint family	38	17.3	

BDT, Bangladeshi taka; M, mean; SD, standard deviation.

the exploratory nature of the study and the number of comparisons performed, no adjustment for multiple testing (e.g., Bonferroni correction) was applied; thus, significant findings ($P < 0.05$) should be interpreted cautiously because they may be subject to type I error. For all inferential tests, a P value of less than 0.05 was considered statistically significant.

Results

Table 1 presents the socio-demographic characteristics of the 220 study participants. The mean age of the participants was 14.47 ± 1.22 years, with the majority being 15

years or younger (77.7%), indicating that the sample was predominantly composed of early adolescents. Females constituted a slightly higher proportion of the participants (56.8%) compared to males (43.2%). In terms of religion, the vast majority of participants were Muslim (89.1%), followed by Hindu (10.0%) and Christian (0.9%), reflecting the general religious distribution of the study population. Regarding parental education, most mothers had completed secondary education (43.6%), while 32.7% had primary education and only a small proportion (3.2%) had attained graduate-level education or above. Similarly, fathers' education was largely concentrated at the secondary (33.2%) and higher

Table 2. Distribution of digital device use among participants (N=220)

Variable	Category	Frequency (n)	Percentage (%)	M ± SD
Age at onset of use (years)				4.29 ± 2.43
	≤3 years	92	41.8	
	4–6 years	96	43.6	
	≥7 years	32	14.5	
Number of devices used	Single device	214	97.3	
	Multiple devices	6	2.7	
Purpose of use	Single purpose	173	78.6	
	Multiple purposes	47	21.4	
Frequency of use (times/day)				3.50 ± 2.07
	≤3 times	151	68.6	
	4–6 times	53	24.1	
	≥7 times	16	7.3	
Duration of use (hours/day)				3.31 ± 1.92
	≤3 hours	132	60.0	
	4–6 hours	69	31.4	
	≥7 hours	19	8.6	
Viewing distance	<25 cm	60	27.3	
	25–40 cm	75	34.1	
	At arm's length	85	38.6	
Typical posture	Sitting	27	12.3	
	Lying down	161	73.2	
	Both	32	14.5	
Required to use spectacles	Yes	15	6.8	
	No	205	93.2	
Required prescription changes (n = 15)	Yes	8	53.3	
	No	7	46.7	
Use at bedtime with lights off	Yes	135	61.4	
	No	85	38.6	

M, mean; SD, standard deviation.

secondary (30.0%) levels, with 8.6% having education at graduate level or higher. Occupational status showed that the majority of mothers were homemakers (70.5%), whereas fathers were mainly engaged in private service (30.9%) and business (30.9%), followed by farming (11.8%) and government service (10.9%). The mean monthly family income was Bangladeshi taka 27,518 ± 15,218, with over half of the families (56.4%) earning ≤ 25,000 Bangladeshi taka per month, indicating that most participants came from low- to middle-income households. Finally, family structure analysis revealed that a large majority of participants belonged to nuclear families (82.7%), while a smaller proportion lived in joint families (17.3%).

Table 2 summarizes the pattern of digital device use among the 220 participants. The mean age at onset of digital device use was 4.29 ± 2.43 years, with most participants beginning use between 4–6 years (43.6%), followed closely

by those who started at ≤ 3 years (41.8%), indicating very early exposure to digital devices. Nearly all participants used a single device (97.3%), and the majority reported using devices for a single purpose (78.6%), suggesting limited multi-tasking behavior. The average frequency of device use was 3.50 ± 2.07 times per day, with over two-thirds of participants (68.6%) using devices three times or less per day, while a smaller proportion (7.3%) reported very frequent use (≥ 7 times/day). The mean daily duration of use was 3.31 ± 1.92 hours, and although 60.0% of participants used devices for ≤ 3 hours per day, a substantial minority (40.0%) exceeded this duration, including 8.6% who reported prolonged use of 7 hours or more per day. Regarding usage practices, most participants maintained a viewing distance of 25–40 cm (34.1%) or arm's length (38.6%), though more than one-quarter (27.3%) used devices at a close distance of < 25 cm. A notably high proportion reported using devices while lying

Table 3. Distribution of eye health risks recalled before and after using digital devices among participants (N=220)

Symptom/risk	Before device use			After device use		
	Yes, n (%)	No, n (%)	M ± SD	Yes, n (%)	No, n (%)	M ± SD
Watering eyes	25 (11.4)	195 (88.6)	1.11 ± 0.32	64 (29.1)	156 (70.9)	1.29 ± 0.46
Itching eyes	42 (19.1)	178 (80.9)	1.19 ± 0.39	58 (26.4)	162 (73.6)	1.26 ± 0.44
Pain in eyes	15 (6.8)	205 (93.2)	1.07 ± 0.25	61 (27.7)	159 (72.3)	1.28 ± 0.45
Tired eyes	28 (12.7)	192 (87.3)	1.13 ± 0.33	74 (33.6)	146 (66.4)	1.34 ± 0.47
Red eyes	19 (8.6)	201 (91.4)	1.09 ± 0.28	39 (17.7)	181 (82.3)	1.18 ± 0.38
Blurred vision	28 (12.7)	192 (87.3)	1.13 ± 0.33	73 (33.2)	147 (66.8)	1.33 ± 0.47
Double vision	11 (5.0)	209 (95.0)	1.05 ± 0.22	24 (10.9)	196 (89.1)	1.11 ± 0.31
Shoulder pain	35 (15.9)	185 (84.1)	1.16 ± 0.37	65 (29.5)	155 (70.5)	1.30 ± 0.45
Neck pain	47 (21.4)	173 (78.6)	1.21 ± 0.41	85 (38.6)	135 (61.4)	1.39 ± 0.49
Back pain	20 (9.1)	200 (90.9)	1.09 ± 0.29	52 (23.6)	168 (76.4)	1.24 ± 0.43
Headache	79 (35.9)	141 (64.1)	1.36 ± 0.48	124 (56.4)	96 (43.6)	1.56 ± 0.50
Total mean score		1.14 ± 0.18			1.30 ± 0.24	

M, mean; SD, standard deviation.

down (73.2%), and 14.5% alternated between sitting and lying postures. Only a small percentage of participants (6.8%) required spectacles; however, among those, more than half (53.3%) needed prescription changes. Finally, a majority of participants (61.4%) reported using digital devices at bedtime with lights off, highlighting potentially unfavorable usage behaviors that may have implications for visual health and sleep patterns.

This section presents the primary descriptive findings of the study. Table 3 illustrates the distribution of eye-related and musculoskeletal health risks among participants before and after digital device use. Overall, the prevalence of nearly all reported symptoms was higher for the period recalled after digital device use, as reflected by the total mean score of 1.14 ± 0.18 before use and 1.30 ± 0.24 after use. Eye-related symptoms such as watering eyes, itching, eye pain, tired eyes, red eyes, blurred vision, and double vision were relatively uncommon before device use, with prevalence ranging from 5.0% to 19.1%. Higher proportions were reported for these symptoms for the period after device use, particularly tired eyes (33.6%), blurred vision (33.2%), watering eyes (29.1%), and eye pain (27.7%). A similar pattern was observed for musculoskeletal complaints. Before device use, neck pain (21.4%), shoulder pain (15.9%), and back pain (9.1%) were reported by a minority of participants. For the period after device use, higher proportions of neck pain, shoulder pain, and back pain were reported, with neck pain rising to 38.6%, shoulder pain to 29.5%, and back pain to 23.6%, indicating a higher self-reported burden of musculoskeletal discomfort for the period after device use. Headache was the most commonly reported symptom both before and after device use, increasing from 35.9% to 56.4%. Collectively, this primary descriptive analysis showed a consistent higher self-reported symptom burden for the period after device use.

The following analyses (Tables 4 and 5) are secondary and exploratory. They were conducted to identify potential variables of interest for future research. Therefore, findings

from these analyses and their associated *P* values should be interpreted cautiously as hypothesis-generating rather than confirmatory evidence. No adjustments for multiple testing were applied, as the aim was signal detection in an exploratory context.

Table 4 presents the exploratory analysis of the relationship between sociodemographic characteristics and eye health risk scores before and after digital device use. Age showed no significant correlation with eye health risks either before ($r = 0.035$, $P = 0.601$) or after device use ($r = 0.130$, $P = 0.054$), although a weak positive trend was observed after use. An exploratory bivariate analysis suggested a potential association between gender and baseline eye health risk scores, with females (1.17 ± 0.19) reporting higher mean scores than males (1.11 ± 0.17) ($t = 2.312$, $P = 0.022$); however, this difference was no longer significant after device use ($P = 0.092$), and given the exploratory nature of the analysis, this finding requires confirmation in future studies. No significant associations were found between religion, mothers' education, fathers' education, mothers' occupation, or fathers' occupation and eye health risk scores either before or after digital device use, as indicated by non-significant F-test results across categories. Exploratory analysis also suggested a negative correlation between monthly family income and eye health risk scores before digital device use ($r = -0.166$, $P = 0.014$), indicating a potential signal that participants from higher-income families had fewer baseline eye health risks. This association, however, was not maintained after device use ($P = 0.445$). Type of family (nuclear vs. joint) was not significantly associated with eye health risk scores either before or after device use.

Table 5 presents the exploratory analysis of the relationship between digital device use characteristics and eye health risk scores before and after device use. Overall, most device-related variables were not significantly associated with eye health risks before device use. Duration of device use (years), frequency of use per day, and daily usage time showed no significant correlations with eye health risk

Table 4. Relationship between sociodemographic characteristics and eye health risks before and after digital device use (N=220)

Variable	Category	Before device use		After device use	
		M ± SD	F/t/r (p)	M ± SD	F/t/r (p)
Age (in years)			$r = 0.035$ (0.601)		$r = 0.130$ (0.054)
Gender	Male	1.11 ± 0.17	$t = 2.312$ (0.022)*	1.27 ± 0.23	$t = 1.693$ (0.092)
	Female	1.17 ± 0.19		1.32 ± 0.25	
Religion	Muslim	1.15 ± 0.18	$F = 0.295$ (0.745)	1.30 ± 0.24	$F = 0.450$ (0.638)
	Hindu	1.14 ± 0.22		1.25 ± 0.25	
	Christian	1.05 ± 0.06		1.27 ± 0.26	
Mother's education	Primary	1.16 ± 0.20	$F = 1.866$ (0.136)	1.32 ± 0.22	$F = 1.606$ (0.189)
	Secondary	1.16 ± 0.18		1.32 ± 0.25	
	Higher Secondary	1.10 ± 0.16		1.35 ± 0.25	
	Graduate and above	1.05 ± 0.07		1.37 ± 0.11	
Father's education	Primary	1.16 ± 0.19	$F = 0.925$ (0.430)	1.29 ± 0.25	$F = 0.787$ (0.502)
	Secondary	1.16 ± 0.20		1.31 ± 0.25	
	Higher Secondary	1.12 ± 0.16		1.27 ± 0.24	
	Graduate and above	1.12 ± 0.15		1.35 ± 0.14	
Mother's occupation	Government service	1.14 ± 0.17	$F = 0.246$ (0.912)	1.33 ± 0.16	$F = 0.626$ (0.644)
	Private service	1.14 ± 0.18		1.32 ± 0.27	
	Business	1.17 ± 0.28		1.41 ± 0.24	
	Homemaker	1.14 ± 0.18		1.29 ± 0.24	
	Others	1.18 ± 0.15		1.25 ± 0.19	
Father's occupation	Government service	1.09 ± 0.16	$F = 1.146$ (0.336)	1.24 ± 0.21	$F = 1.262$ (0.286)
	Private service	1.13 ± 0.18		1.33 ± 0.26	
	Business	1.14 ± 0.18		1.26 ± 0.23	
	Farmer	1.19 ± 0.20		1.35 ± 0.22	
	Others	1.17 ± 0.18		1.31 ± 0.25	
Monthly family income			$r = -0.166$ (0.014)*		$r = 0.052$ (0.445)
Type of family	Nuclear family	1.14 ± 0.17	$t = 0.838$ (0.406)	1.29 ± 0.24	$t = 1.386$ (0.167)
	Joint family	1.17 ± 0.22		0.25	

Asterisk (*) denotes statistical significance at $P < 0.05$. F , F-test value from analysis of variance; M , mean; P , P value; r , Pearson correlation coefficient; SD , standard deviation; t , t-test value.

scores at baseline. Similarly, no significant differences were observed based on the number of devices used, purpose of use, viewing distance, typical posture, or use of devices at bedtime with the lights off before device use. After digital device use, a different pattern emerged. A weak but statistically significant positive correlation was found between daily usage time (hours/day) and eye health risk scores ($r = 0.155$, $P = 0.021$), suggesting that longer daily screen exposure was associated with higher eye health risks in this exploratory analysis. However, the low correlation strength ($r < 0.2$) indicates that daily duration explains only a small proportion of the variance in symptom scores, and this finding should be considered preliminary. Participants who required prescription changes also demonstrated significantly higher eye health risk scores after device use compared with those who did not ($t = 3.382$, $P = 0.005$); however, this finding is

based on a very small subsample ($n = 15$) and should be interpreted with particular caution. In contrast, the number of devices used, purpose of use, frequency of use, viewing distance, posture, and bedtime use with the lights off were not significantly associated with post-use eye health risks, although bedtime use showed a borderline association ($P = 0.059$). Notably, participants who required spectacles had significantly higher eye health risk scores before device use ($t = 2.059$, $P = 0.032$); however, this difference was no longer evident after device use.

Discussion

Eye health plays a crucial role in maintaining optimal vision and preventing ocular conditions that may ultimately lead to visual impairment. Good eye health depends on appropri-

Table 5. Relationship between digital device use characteristics and eye health risks before and after device use (N=220)

Variable	Category	Before device use		After device use	
		M ± SD	Test statistic (P value)	M ± SD	Test statistic (P value)
Duration of use (years)			$r = 0.065$ (0.337)		$r = 0.016$ (0.815)
Number of devices used	Single device	1.14 ± 0.18	$t = 0.107$ (0.915)	1.30 ± 0.24	$t = 0.219$ (0.827)
	Multiple devices	1.14 ± 0.14		1.31 ± 0.16	
Purpose of use	Single purpose	1.15 ± 0.18	$t = 0.702$ (0.484)	1.30 ± 0.24	$t = 0.916$ (0.361)
	Multiple purposes	1.13 ± 0.21		1.27 ± 0.25	
Frequency of use (times/day)			$r = -0.048$ (0.480)		$r = -0.029$ (0.668)
Daily usage time (hours/day)			$r = 0.042$ (0.535)		$r = 0.155$ (0.021)*
Viewing distance	<25 cm	1.14 ± 0.19	$F = 0.029$ (0.971)	1.34 ± 0.25	$F = 1.587$ (0.207)
	25–40 cm	1.14 ± 0.18		1.29 ± 0.24	
	At arm's length	1.15 ± 0.15		1.22 ± 0.22	
Typical posture	Sitting	1.12 ± 0.17	$F = 1.059$ (0.349)	1.23 ± 0.23	$F = 1.140$ (0.322)
	Lying down	1.15 ± 0.18		1.31 ± 0.25	
	Both	1.11 ± 0.20		1.30 ± 0.20	
Required to use spectacles	Yes	1.23 ± 0.22	$t = 2.059$ (0.032)*	1.27 ± 0.22	$t = -0.452$ (0.652)
	No	1.14 ± 0.18		1.30 ± 0.24	
Required prescription changes (n = 15)	Yes	1.27 ± 0.20	$t = 0.107$ (0.917)	1.43 ± 0.22	$t = 3.382$ (0.005)*
	No	1.26 ± 0.27		1.12 ± 0.13	
Use at bedtime with lights off	Yes	1.15 ± 0.19	$t = 1.026$ (0.306)	1.32 ± 0.25	$t = 1.902$ (0.059)
	No	1.13 ± 0.16		1.26 ± 0.21	

Asterisk (*) denotes statistical significance at $P < 0.05$. F , F-test value from analysis of variance; M, mean; r , Pearson correlation coefficient; SD, standard deviation; t , t-test value.

ate lifestyle practices, regular eye examinations, and early recognition of visual changes. In recent years, the rapid expansion of digital device use among adolescents has raised concerns regarding its potential impact on eye health. The present descriptive cross-sectional study was conducted among 220 adolescents from a single school in Dhaka City to assess eye health problems associated with digital device use. As stated in the statistical analysis section, this study is primarily descriptive and exploratory. The core descriptive finding is the comparison of symptom prevalence before and after device use (Table 3), while all other analyses examining associations with demographic and device-use characteristics (Tables 4 and 5) are secondary and hypothesis-generating. Therefore, findings from these exploratory analyses should be interpreted cautiously and are intended to inform future confirmatory research rather than provide definitive evidence. Because of the cross-sectional, convenience-sampling design, the findings should be interpreted as exploratory and hypothesis-generating rather than confirmatory or generalizable to all adolescents in Dhaka City.

The mean age of the participants was 14.47 ± 1.22 years, ranging from 13 to 17 years, and more than half were female. The age range was broadly comparable with previous school-based studies in similar populations, and the female predominance was consistent with one prior report,^{11,12} al-

though it contrasts with the study by Ichhpujani *et al.*,¹⁰ which reported a male predominance. In our exploratory bivariate analyses, females had higher pre-use symptom scores, but this difference was not significant after device use, and the overall pattern does not consistently support a robust gender effect in this study. This finding contrasts with earlier studies suggesting consistently higher eye health risks among females,¹³ though the inconsistency may reflect differences in study design, sample characteristics, or the exploratory nature of our subgroup analyses.

Regarding digital device use characteristics, the mean age at onset was 4.29 years, indicating very early exposure, a finding consistent with regional trends.⁶ High-risk behaviors were prevalent: 73.2% of participants used devices while lying down, and 61.4% used them at bedtime with the lights off. These behavioral patterns are concerning from a public health perspective, even though our analysis did not find statistically significant associations between these behaviors and symptom scores (possibly due to limited sample size, the homogeneity of high-risk behaviors in our sample, or the retrospective recall method). It is important to note that the absence of a statistically significant association in these exploratory analyses does not rule out a clinically meaningful relationship, and these behaviors warrant further investigation in larger prospective studies.

The main descriptive finding was that participants reported a higher prevalence of symptoms for the period after digital device use than for the period before use. Within the secondary exploratory analyses, a weak but statistically significant positive correlation was observed between daily screen time (hours/day) and post-use eye health risk scores ($r = 0.155$, $P = 0.021$). This is broadly consistent with previous research linking longer computer or smartphone use with musculoskeletal or DES symptoms among adolescents.^{14,15} However, the correlation strength is low ($r < 0.2$), indicating that daily duration explains only about 2.4% of the variance in symptom scores. Therefore, while prolonged use may contribute to eye strain, other unmeasured factors (e.g., screen brightness, content type, blinking frequency, and pre-existing refractive error) likely play substantial roles. Given the exploratory nature of this analysis and the modest effect size, this finding should not be overstated in public health messaging but rather viewed as a preliminary signal requiring confirmation.

The higher self-reported symptom prevalence for the period after device use, particularly headache (from 35.9% to 56.4%), neck pain (from 21.4% to 38.6%), tired eyes (from 12.7% to 33.6%), and blurred vision (from 12.7% to 33.2%), is consistent with numerous cross-sectional studies on DES.^{4,6,13} This descriptive before-and-after comparison represents the primary evidence from our study and shows a consistent pattern across all symptoms. Nevertheless, because symptom reports for “before” and “after” were collected retrospectively at a single time point, the apparent increase may be influenced by recall bias and the tendency to attribute contemporaneous symptoms to recent device use. Causal language such as “caused by” or “resulted from” should be avoided.

Our findings are consistent with some previous studies that reported a DES prevalence of 89.9% among Indian children using online learning,⁶ and with studies that found significant associations between screen time and ocular symptoms.¹⁰ The prevalence of bedtime device use in darkness (61.4%) was substantially higher than the 19.3% reported in a prior study.¹⁰ However, unlike some earlier studies,¹⁶ we did not find significant associations for viewing distance or posture in our exploratory analyses, which may be due to the homogeneity of our sample (most participants used poor postures), the lack of objective posture measurement, or the limited statistical power for detecting differences in subgroup analyses.

In the exploratory analyses, participants who required prescription changes had higher post-use symptom scores. However, this finding was based on a very small subsample ($n = 15$) and should be interpreted cautiously. Future studies with larger clinical samples and objective ophthalmic assessments are needed to examine whether uncorrected or under-corrected refractive errors contribute to digital eye strain symptoms in adolescents.

Limitations

1. Cross-sectional design: This design precludes causal inference. The “before/after” symptom reporting was retrospective and was not a true pre-post assessment.
2. Convenience sampling from a single school: The results are not generalizable to all adolescents in Dhaka or Bangladesh.

3. Self-reported data: These data are subject to recall bias, social desirability bias, and inaccurate estimation of screen time.
4. No objective ophthalmic examination: The absence of visual acuity testing, refraction, tear film analysis, or assessment of myopia/refractive error limits clinical validity.
5. Unmeasured confounders: Screen brightness, ambient lighting, type of digital content, blinking frequency, and pre-existing ocular conditions were not assessed.
6. Multiple comparisons: Because many statistical tests were performed, some significant findings (e.g., gender difference before use and income correlation) may have occurred by chance (type I error). No correction (e.g., Bonferroni) was applied.
7. Questionnaire reliability: Cronbach's alpha was not calculated, and the “eye health risk score” has not been externally validated.

Future directions

Based on the findings of this study and existing general recommendations for digital wellness, several practical suggestions may be considered. For adolescents and families, education on regular screen breaks, appropriate viewing distance, upright posture, and avoidance of bedtime device use may be useful. For educational institutions, incorporating digital wellness into curricula and training teachers to recognize DES symptoms are recommended. At the policy level, future evidence from larger and more representative studies may help inform guidance on safe screen time for children and adolescents. Future research should use longitudinal designs with random sampling, objective ophthalmic assessments (including cycloplegic refraction), and adjustment for multiple comparisons to establish causal relationships and evaluate long-term ocular outcomes.

Conclusions

This study concludes that adolescents in this single-school sample in Dhaka City were exposed to digital devices from a very young age and engaged in several high-risk behaviors, including prolonged daily use, predominantly lying-down postures, and frequent use in dark environments at bedtime. A weak but statistically significant exploratory correlation between longer daily screen time and higher symptom scores suggests that duration of use may warrant further investigation as a potentially modifiable factor. The marked increase in self-reported symptoms after device use highlights a potential burden, but causal inferences are limited by the cross-sectional, retrospective design. Education to raise awareness and promote healthier digital practices may be useful, but the findings must be confirmed in larger, more representative studies with objective clinical measures.

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Conflict of interest

The authors declare no conflicts of interest.

Author contributions

Conceptualization (RP, MMH), study design (RP), data curation (RP, RK, SM, HA), formal analysis (RP, MH, MUH, MMH), methodology (MH, MUH, HA), software (MH, SM), validation (MH, SM, MMH), investigation (MH, RK, NS), visualization (RK, NS), resources (MUH, HA), supervision (HA), writing – original draft (RP), writing – review and editing (RP, MH, HA, MMH), final approval of the manuscript (MMH).

Ethical statement

This study was approved by the Institutional Review Board of Bangladesh Medical University (formerly known as Bangabandhu Sheikh Mujib Medical University; registration no. 5036; memo no. BSMMU/2024/6724; July 11, 2024). Following approval from the Institutional Review Board and formal permission from the school principal, the researcher introduced the study and explained its objectives, benefits, and participant rights. Written informed consent was obtained from parents, and assent was obtained from each participating adolescent, with strict measures to ensure confidentiality and anonymity throughout the process. The study was conducted in accordance with institutional guidelines, Good Clinical Practice guidelines, and the Declaration of Helsinki (as revised in 2024).

Data sharing statement

Data are available from the corresponding author upon reasonable request.

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