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Original Article

Changes in Blink Rate, Reading Performance, and Ocular Discomfort During Print and Digital Reading Among Young Adults with Myopia: A Cross-Sectional Comparative Study.

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ABSTRACT

Background: Digital reading has become increasingly prevalent among students and young adults. Prolonged screen exposure has been associated with reduced blink activity, ocular discomfort, and symptoms of digital eye strain. However, evidence comparing blink behavior and reading performance between digital and print reading among myopic individuals remains limited.

Objective: To compare spontaneous blink activity, reading performance, and ocular discomfort during print and digital reading tasks among young adults with myopia.

Methods: This cross-sectional comparative study included 40 healthy myopic adults aged 18–30 years. Participants were allocated to either a soft-copy reading group (n = 20) or a hard-copy reading group (n = 20). Subjects read identical text for 15 minutes under standardized environmental conditions. Blink activity was recorded using video analysis. Reading performance was assessed by the total number of words completed during the reading task. Ocular discomfort was evaluated before and after reading using the Ocular Discomfort Analog Scale (ODAS). Data were analyzed using non-parametric statistical tests, with statistical significance established at $p < 0.05$.

Results: Participants in the hard-copy group demonstrated significantly greater blink activity than those in the soft-copy group (56.80 ± 1.99 vs. 25.80 ± 4.31 blinks during 15 minutes; $p < 0.001$). Reading performance was significantly higher during print reading (1953.85 ± 92.74 vs. 1620.00 ± 184.81 words completed; $p < 0.001$). Ocular discomfort symptoms increased following both reading conditions but were more frequent and severe after digital reading. Eye dryness and eye fatigue were the most commonly reported symptoms.

Conclusion: Digital reading was associated with significantly reduced blink activity, lower reading performance, and greater ocular discomfort compared with print reading among young adults with myopia. These findings suggest that prolonged digital reading may contribute to visual fatigue and symptoms of digital eye strain.

Keywords: Myopia; Blink rate; Digital eye strain; Reading performance; Ocular discomfort; Screen reading.

Introduction:

Myopia is one of the most common refractive errors worldwide and represents a growing public health concern because of its rapidly increasing prevalence and associated visual morbidity [10–12]. Recent epidemiological projections estimate that nearly half of the global population may be affected by myopia by the year 2050, resulting in substantial socioeconomic and healthcare burdens [12].

Blinking is an essential physiological mechanism that maintains ocular surface integrity through redistribution of the tear film, removal of debris, and protection of the corneal surface [1,16]. Adequate blinking contributes to tear-film stability and visual comfort. Alterations in blink frequency or blink completeness may disrupt tear-film homeostasis and contribute to ocular surface dryness, irritation, and visual fatigue [16].

The rapid adoption of digital technologies has transformed reading habits among students and working professionals. Reading activities that were traditionally performed using printed materials are now increasingly conducted using laptops, tablets, smartphones, and electronic readers. Although digital platforms offer convenience and accessibility, prolonged screen exposure has been associated with symptoms collectively referred to as digital eye strain or computer vision syndrome [16]. Common symptoms include eye dryness, burning sensation, blurred vision, headaches, eye fatigue, and difficulty focusing [16]. Previous investigations have demonstrated that blink activity decreases significantly during computer use and cognitively demanding visual tasks [1,6,16]. Reduced blink frequency and increased incomplete blinking during screen use have been proposed as mechanisms contributing to tear-film instability and ocular discomfort [16]. Furthermore, differences in blink behavior have been observed when reading from electronic displays compared with printed text [1]. Reading performance is another important component of visual function. Reading efficiency may be influenced by multiple factors, including accommodative demand, contrast sensitivity, luminance characteristics, visual comfort, and display modality [2,9,13–15]. Digital displays may impose additional visual demands due to glare, screen luminance, and reduced edge contrast, potentially affecting reading performance and visual comfort [9].

Young adults with myopia frequently engage in prolonged near-work activities and extensive digital device use. Consequently, understanding the influence of reading modality on blink behavior and ocular comfort in this population is clinically relevant. Therefore, the present study aimed to compare spontaneous blink activity, reading performance, and ocular discomfort during hard-copy and soft-copy reading tasks among young adults with myopia.

Materials and Methods:

Study Design and Setting: A cross-sectional comparative study was conducted over a six-month period at the Ahalia School of Optometry and Research Centre, Kerala, India. The study was designed to investigate the influence of reading modality on blink activity, reading performance, and ocular discomfort among young adults with myopia. The study protocol adhered to the tenets of the Declaration of Helsinki and received approval from the Institutional Ethics Committee of Ahalia School of Optometry and Research Centre. Written informed consent was obtained from all participants before enrollment.

Sample Size Estimation: The study included 40 participants, with 20 participants allocated to each reading condition. The sample size was determined based on feasibility and the availability of eligible participants during the study period. Similar experimental studies investigating blink behavior and ocular discomfort during reading tasks have employed comparable sample sizes.

Study Population: A total of 40 healthy myopic participants aged between 18 and 30 years were recruited using simple random sampling. The study population consisted of 33 females and 7 males. All participants were students affiliated with the institution. Participants were included if they were aged between 18 and 30 years, had a confirmed diagnosis of myopia, were actively enrolled students, and were in good general health. Participants with hypermetropia, astigmatism, clinically diagnosed dry eye disease, blink abnormalities, eyelid disorders, previous ocular surgery, or active ocular infection and inflammation were excluded from the study.

Visual Assessment:

Prior to the reading task, all participants underwent a comprehensive visual assessment. Objective refractive status was determined using streak retinoscopy (Welch Allyn, USA) to confirm the presence of myopia and determine the best refractive correction.

Best-corrected visual acuity (BCVA) was measured monocularly and binocularly using a standard Snellen visual acuity chart positioned at a distance of 6 meters under ambient room illumination of approximately 158 lux. Visual acuity measurements were subsequently converted to LogMAR notation for documentation and analysis.

Reading Protocol: Participants were allocated into one of two reading conditions:

Group I: Soft-copy reading (digital display; n = 20)

Group II: Hard-copy reading (printed material; n = 20)

The soft-copy reading task was performed using a 15.6-inch laptop computer with a screen resolution of 1366 × 768 pixels and a refresh rate of 60 Hz. Participants in the hard-copy group received a printed version of the identical reading material.

Both reading formats contained the same prose passage entitled *"The Watchmaker of Caldera Street"*. The text was standardized in Times New Roman font, size 12, with double-line spacing and black text on a white background.

Reading was performed under standardized ambient illumination of 350 lux. Participants were instructed to maintain a viewing distance of approximately 100 cm from the reading material and to read continuously and silently for 15 minutes without interruption.

Outcome Measures

Blink Activity: Spontaneous blink activity was assessed throughout the 15-minute reading session using a digital video recording system positioned to unobtrusively capture ocular and facial movements. All recordings were reviewed manually by the investigator following completion of the experiment. The total number of spontaneous blinks occurring during the reading session was recorded for each participant and used for statistical analysis. To improve measurement reliability, blink counts were reviewed independently on two occasions, and discrepancies were re-evaluated before final data entry.

Reading Performance: Reading performance was quantified by calculating the total number of words completed during the 15-minute reading task. The reading material consisted of a maximum of 4,060 words. Participant progress within the text was assessed at the conclusion of the reading period, and the total number of words completed served as the primary indicator of reading performance.

Ocular Discomfort Assessment: Subjective ocular discomfort was evaluated using the Ocular Discomfort Analog Scale (ODAS). The questionnaire assessed seven symptom domains:

1. Photophobia
2. Eye dryness
3. Foreign-body sensation
4. Burning or stinging sensation
5. Blurred vision
6. Eye fatigue
7. Ocular pressure or tightness sensation

Each symptom was graded using a visual analog scale ranging from 0 to 10, where 0 represented no discomfort and 10 represented the maximum possible discomfort. Participants completed the questionnaire immediately before commencing the reading task and immediately after completion of the 15-minute reading session.

In addition to symptom severity, participants were asked to indicate the approximate time of symptom onset during the reading task.

Environmental Conditions:

All experimental procedures were conducted in a controlled indoor environment. Ambient room illumination was maintained at approximately 350 lux during the reading task. Participants completed the experiment individually to minimize distractions and maintain uniform testing conditions.

Statistical Analysis

Statistical analysis was performed using IBM SPSS Statistics version 20.0 (IBM Corp., Armonk, NY, USA). Data normality was assessed using the Shapiro–Wilk test, which demonstrated a non-normal distribution of study variables ($p < 0.05$). Therefore, non-parametric statistical methods were employed.

Descriptive statistics were calculated and expressed as mean ± standard deviation (SD). Intergroup comparisons between the soft-copy and hard-copy reading conditions were performed using the Mann–Whitney U test. Changes in ocular discomfort symptoms before and after reading were analyzed using the Wilcoxon signed-rank test where appropriate. Statistical significance was established at a two-tailed p-value of less than 0.05.

Results

Baseline Characteristics of Study Population:

A total of 40 myopic participants completed the study. The mean age of participants in the soft-copy group was 20.50 ± 1.32 years, while the mean age of participants in the hard-copy group was 20.80 ± 2.61 years. No statistically significant difference in age distribution was observed between groups ($p = 0.083$) (Table-1).

Characteristic	Soft Copy (n=20)	Hard Copy (n=20)	p-value
Age (years)	20.50 ± 1.32	20.80 ± 2.61	0.083

Table 1. Baseline Characteristics of Participants

Blink Activity and Reading Performance

Participants reading printed text demonstrated significantly greater blink activity than those reading digital text. The mean total blink count during the 15-minute reading task was 56.80 ± 1.99 blinks in the hard-copy group compared with 25.80 ± 4.31 blinks in the soft-copy group ($p < 0.001$). Similarly, reading performance was significantly greater during print reading. Participants in the hard-copy group completed an average of 1953.85 ± 92.74 words during the reading session, whereas participants in the soft-copy group completed 1620.00 ± 184.81 words ($p < 0.001$) (Table-2).

Variable	Soft Copy (n=20)	Hard Copy (n=20)	p-value
Total Blink Count (15 min)	25.80 ± 4.31	56.80 ± 1.99	<0.001
Total Words Completed (15 min)	1620.00 ± 184.81	1953.85 ± 92.74	<0.001

Table 2. Comparison of Blink Activity and Reading Performance

Ocular Discomfort

At baseline, ocular discomfort symptoms were negligible in both groups. Following completion of the reading task, symptoms increased in both groups, although symptom severity was substantially greater among participants reading digital text. The mean onset of ocular discomfort occurred approximately 11 minutes after commencement of reading (Table-3).

Symptom	Hard Copy n (%)	Soft Copy n (%)
Moderate Photophobia	4 (20.0)	2 (10.0)
Moderate Eye Dryness	4 (20.0)	7 (35.0)
Severe Eye Dryness	2 (10.0)	3 (15.0)
Moderate Eye Fatigue	2 (10.0)	3 (15.0)
Severe Eye Fatigue	0 (0.0)	1 (5.0)
Moderate Blurred Vision	0 (0.0)	2 (10.0)

Table 3. Post-Reading Ocular Discomfort Symptoms

Discussion

The present study investigated the influence of reading modality on blink activity, reading performance, and ocular discomfort among young adults with myopia. The findings demonstrated that digital reading was associated with significantly reduced blink activity, poorer reading performance, and greater ocular discomfort compared with print reading.

Blinking plays a crucial role in maintaining ocular surface health by ensuring tear-film redistribution and preventing excessive evaporation [1,16]. The present findings are consistent with previous studies demonstrating significant reductions in blink frequency during computer use and visually demanding cognitive tasks [1,6,16]. Reduced blink activity during digital reading may result from increased visual concentration and sustained attention, which suppress spontaneous blinking. Participants reading printed text demonstrated significantly greater blink activity than those reading from digital displays. This finding may be attributed to differences in accommodative demand, screen luminance, glare, and cognitive processing associated with electronic displays. Reduced blink activity during screen viewing may contribute to increased tear evaporation and ocular surface exposure, thereby increasing the risk of digital eye strain.

Reading performance was significantly greater during print reading. Participants reading printed material completed approximately 20% more words during the reading session than those reading digital text.

Similar findings have been reported in previous studies investigating reading efficiency across different display modalities [9]. Digital screens may reduce reading efficiency because of visual discomfort, screen glare, accommodative stress, and luminance-related factors. Ocular discomfort symptoms increased following both reading modalities but were more frequent and severe among participants reading digital text. Eye dryness and eye fatigue represented the most commonly reported symptoms. These findings support previous evidence linking prolonged digital device use with increased ocular surface symptoms and digital eye strain [16]. The present study highlights the importance of considering reading modality when evaluating visual comfort among individuals with myopia. Given the widespread use of digital devices for educational and occupational activities, strategies aimed at minimizing digital eye strain may be beneficial. Such strategies include regular visual breaks, optimization of screen ergonomics, appropriate viewing distances, and conscious blinking exercises.

Limitations: This study has several limitations. First, the sample size was relatively small, limiting the generalizability of the findings. Second, the study population was restricted to young adults with myopia, preventing extrapolation to other age groups or refractive conditions. Third, reading comprehension was not assessed and may have influenced reading performance outcomes. Finally, the cross-sectional design precludes causal inference.

Conclusion: Digital reading was associated with significantly reduced blink activity, lower reading performance, and greater ocular discomfort compared with print reading among young adults with myopia. Participants reading digital text demonstrated fewer spontaneous blinks, completed fewer words during the reading task, and reported more severe ocular symptoms, particularly eye dryness and eye fatigue. These findings suggest that prolonged digital reading may contribute to visual fatigue and symptoms of digital eye strain. Encouraging appropriate reading ergonomics and periodic visual breaks may help reduce ocular discomfort associated with prolonged screen use.

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