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Research Article

Association Between Digital Screen Exposure and Severity of Myopia in Young Adults

Rameesha Rasheed[1], Nabeel Akram[2], Asma Aftab[3], Ayesha Afzal[4], Marrium Shafi[5], Asad Ali Khan[6]

1. FCPS, Ophthalmologist, Sir Ganga Ram Hospital, Lahore, Pakistan.
2. Consultant Ophthalmologist, Lahore General Hospital, Lahore, Pakistan.
3. Assistant Professor, Ophthalmology, Wah Medical College, Wah Cantt, affiliated with National University of Medical Sciences (NUMS), Pakistan.
4. Medical Officer, Ophthalmology, P.I.M.S Islamabad, Pakistan.
5. Assistant Professor, Ophthalmology, Wah Medical College, National University of Medical Sciences (NUMS), Rawalpindi, Pakistan.
6. Senior Registrar, Ophthalmology, Wah Medical College (NUMS), Pakistan

Rameesha Rasheed: Corresponding author

Abstract

The rapid proliferation of digital technology has significantly increased daily screen time among young adults, coinciding with a global rise in myopia prevalence and severity. This cross-sectional study evaluated the association between daily digital screen exposure, specific viewing behaviors, and the severity of myopia in young adults. A total of 420 young adults (aged 18 to 25 years) with refractive errors were evaluated. Daily screen time, viewing distance, continuous viewing duration, and outdoor activity were assessed using validated self-report questionnaires and digital usage logs. Cycloplegic autorefraction and axial length measurements were performed to classify myopia severity (mild: -0.50 to -3.00 D; moderate: -3.25 to -6.00 D; severe: > -6.00 D). High daily digital screen exposure (ge 6 hours/day) was significantly associated with higher myopia severity (aOR: 3.82, 95% CI: 2.15–6.78, p < 0.001) and longer axial length (mean axial length: 25.42 mm vs. 23.85 mm, p < 0.001). A close working distance (< 20 cm) and prolonged continuous screen use without breaks (> 45 minutes) were independent predictors of severe myopia. Conversely, higher outdoor activity (age 12 hours/week) demonstrated a protective effect against myopia progression (aOR: 0.42, 95% CI: 0.23–0.76, p = 0.004). Digital screen exposure and poor visual ergonomics are strongly linked to increased myopia severity and axial elongation in young adults, emphasizing the need for targeted lifestyle interventions and ergonomic guidelines.

Keywords: Myopia severity, axial length, digital screen exposure, young adults, near work, visual ergonomics.

Introduction

Myopia (nearsightedness) has emerged as a major global public health concern, with estimates suggesting that nearly 50% of the world's population could be myopic by 2050. While myopia typically develops during school-age childhood, recent epidemiological evidence indicates an increasing rate of myopic progression and late-onset myopia among young adults, particularly those in higher education or computer-intensive occupations. [1–3]

The widespread adoption of digital devices—including smartphones, tablets, laptops, and desktop monitors—has drastically shifted visual habits. Young adults routinely engage in extended near-work activities characterized by high spatial frequency content, continuous accommodation, hyper-accommodative lag, and reduced blink rates. Prolonged peripheral hyperopic defocus induced during sustained near visual tasks is hypothesized to stimulate axial elongation of the globe, directly driving myopia progression. [4–6]

While environmental factors such as outdoor light exposure have been widely established as protective against childhood myopia, the specific contribution of digital screen parameters—such as screen type, viewing distance, break frequency, and cumulative daily exposure—to myopia severity in young adults remains under investigation. High myopia (> -6.00. D) carries substantial clinical risks, including myopic maculopathy, retinal detachment, open-angle glaucoma, and early cataract formation. [7–10]

Understanding the operational relationship between digital device usage parameters and ocular biometry in young adults is essential to formulate evidence-based visual ergonomic recommendations and prevent sight-threatening high myopia.

This study aimed to investigate the association between daily digital screen exposure duration, visual ergonomic habits, and the severity of myopia and axial length in a cohort of young adults.

Methodology

A cross-sectional observational study was conducted over a 12-month period involving 420 young adult university students and professionals aged 18 to 25 years at Ganga Ram Hospital. Participants provided written informed consent prior to enrollment, and the study was approved by the institutional review board.

Inclusion criteria comprised young adults with spherical equivalent refraction (SER) .\le -0.50. D under cycloplegia and best-corrected visual acuity (BCVA) of 20/20 or better in both eyes. Exclusion criteria included previous corneal refractive surgery, orthokeratology treatment, strabismus, amblyopia, systemic diseases affecting ocular health, or active ocular surface disease.

Daily screen time (hours/day across all devices) was quantified using device-integrated screen time applications verified over a 14-day tracking period, supplemented by a structured visual ergonomics questionnaire. Visual ergonomic parameters assessed included average working distance (< 20 cm, 20–40 cm, > 40 cm), duration of continuous viewing sessions before taking a break (< 20 min, 20–45 min, > 45 min), and self-reported weekly outdoor activity (hours/week).

Comprehensive ophthalmic evaluations were conducted for all participants. Cycloplegia was induced using two drops of 1% cyclopentolate administered 10 minutes apart. Cycloplegic autorefraction was measured using an automated refractometer, and spherical equivalent refraction (SER = Spherical Power + [Cylindrical Power / 2]) was recorded. Myopia severity was categorized as Mild (-0.50 to -3.00 D), Moderate (-3.25 to -6.00 D), or Severe (> -6.00 D). Ocular biometry, including axial length (AL), anterior chamber depth (ACD), and corneal curvature, was measured using optical biometry (IOLMaster 700).

Statistical analysis was conducted using SPSS version 26. One-way ANOVA and Chi-square tests were used for univariate comparisons. Multivariable ordinal logistic regression was applied to determine independent associations between digital screen habits and myopia severity, adjusting for age, gender, parental history of myopia, and outdoor activity.

Results

Table 1: Baseline Demographic and Clinical Characteristics Stratified by Myopia Severity

Parameter	**Mild Myopia (-0.50 to -3.00 D) (n=180)**	**Moderate Myopia (-3.25 to -6.00 D) (n=165)**	**Severe Myopia (> -6.00 D) (n=75)**	**p-value**
Age (Years pm SD)	21.2 ± 2.1	21.8 ± 2.3	22.1 ± 2.0	0.082
Gender (Male / Female)	82 / 98	74 / 91	33 / 42	0.912
Spherical Equivalent (Diopters ± SD)	-1.75 ± 0.65	-4.50 ± 0.82	-7.25 ± 1.15	< 0.001
Axial Length (mm ± SD)	23.85 ± 0.62	24.78 ± 0.71	26.12 ± 0.85	< 0.001
Parental Myopia (At least one parent) (%)	72 (40.0%)	98 (59.4%)	58 (77.3%)	< 0.001
Daily Digital Screen Time (Hours ± SD)	4.2 ± 1.5	6.5 ± 1.8	8.8 ± 2.1	< 0.001

Note: Higher myopia severity was significantly associated with longer axial length, a history of parental myopia, and increased daily screen exposure.

Table 2: Visual Ergonomic Habits and Digital Screen Behaviors Across Myopia Severity Groups

Screen Parameter / Behavior	Mild Myopia (n=180)	Moderate Myopia (n=165)	Severe Myopia (n=75)	p-value
Daily Screen Time Category				< 0.001
< 4 Hours / Day (%)	88 (48.9%)	22 (13.3%)	4 (5.3%)	
4 to 6 Hours / Day (%)	68 (37.8%)	65 (39.4%)	15 (20.0%)	
> 6 Hours / Day (%)	24 (13.3%)	78 (47.3%)	56 (74.7%)	
Working Distance				< 0.001
> 40 cm (%)	95 (52.8%)	42 (25.5%)	8 (10.7%)	
20 to 40 cm (%)	71 (39.4%)	93 (56.4%)	38 (50.7%)	
< 20 cm (%)	14 (7.8%)	30 (18.2%)	29 (38.7%)	
Continuous Screen Session Before Break				< 0.001
< 20 minutes (%)	62 (34.4%)	28 (17.0%)	5 (6.7%)	
20 to 45 minutes (%)	86 (47.8%)	74 (44.8%)	22 (29.3%)	
> 45 minutes (%)	32 (17.8%)	63 (38.2%)	48 (64.0%)	

Screen Parameter / Behavior	Mild Myopia (n=180)	Moderate Myopia (n=165)	Severe Myopia (n=75)	p-value
Outdoor Time (.\ge. 12 Hours / Week) (%)	82 (45.6%)	48 (29.1%)	14 (18.7%)	< 0.001

Note: Patients with severe myopia engaged in significantly higher daily screen exposure, closer working distances, longer continuous sessions, and less outdoor activity.

Table 3: Ocular Biometric Correlation with Daily Screen Time

Ocular Biometric Parameter	Mean in Low Screen Time (<4 hrs/day)	Mean in Moderate Screen Time (4–6 hrs/day)	Mean in High Screen Time (>6 hrs/day)	p-value
Axial Length (mm)	23.78 ± 0.58	24.45 ± 0.68	25.42 ± 0.88	< 0.001
Anterior Chamber Depth (mm)	3.52 ± 0.24	3.58 ± 0.28	3.65 ± 0.31	0.004
Mean Corneal Curvature (K, Diopters)	43.12 ± 1.25	43.20 ± 1.30	43.28 ± 1.35	0.542
Axial Length / Corneal Radius Ratio	3.02 ± 0.08	3.10 ± 0.10	3.22 ± 0.14	< 0.001

Note: Axial length and the axial length-to-corneal radius ratio increased significantly with higher levels of daily screen exposure.

Table 4: Multivariable Ordinal Logistic Regression Analysis for Factors Associated with Myopia Severity

Variable	Unadjusted Odds Ratio (95% CI)	Adjusted Odds Ratio (aOR) (95% CI)	p-value
Daily Screen Time > 6 Hours	4.85 (3.10–7.58)	3.82 (2.15–6.78)	< 0.001
Working Distance < 20 cm	3.65 (2.12–6.28)	2.95 (1.58–5.51)	0.001
Continuous Screen Use > 45 minutes	3.12 (1.98–4.92)	2.24 (1.32–3.80)	0.003
Parental Myopia History	2.85 (1.82–4.46)	2.18 (1.35–3.52)	0.001
Outdoor Time .\ge. 12 Hours / Week	0.35 (0.21–0.58)	0.42 (0.23–0.76)	0.004

Note: High daily screen exposure, close working distance, sustained viewing sessions, and parental myopia were independent risk factors for greater myopia severity, whereas outdoor time had a protective association.

Discussion

This study demonstrates a strong, dose-dependent association between daily digital screen exposure and the severity of myopia in young adults. High screen time (> 6 hours/day), close working distances (< 20 cm), and continuous screen viewing without breaks (> 45 minutes) were significant independent risk factors for higher myopic refractive error and longer axial lengths.

The biological plausibility linking digital screen exposure to myopic axial elongation involves sustained accommodative demand and hyperopic retinal defocus. During prolonged near visual tasks on backlit digital displays, lagging accommodation leads to peripheral hyperopic defocus, which triggers signaling cascades that alter scleral extracellular matrix remodeling, promoting axial elongation. Furthermore, intense visual concentration during screen use significantly reduces spontaneous blink rates, inducing transient corneal optical aberrations and eye strain that may further exacerbate visual fatigue and accommodative stress. [11–14]

Our findings align with ocular biometric data showing that axial length was significantly higher among young adults reporting > 6 hours of daily screen time (mean 25.42 mm) compared to those with < 4 hours (mean 23.78 mm). The axial length-to-corneal radius ratio—a sensitive marker of structural myopia progression—also exhibited a linear increase alongside daily digital device usage. [15–17]

Importantly, visual ergonomics played a critical role in mediating myopia severity. A working distance closer than 20 cm nearly tripled the odds of severe myopia (aOR: 2.95). Holding smartphones or handheld devices at short distances dramatically increases accommodative and vergence demands compared to reading printed media at standard distances (~33–40 cm). Likewise, taking regular visual breaks (following ergonomic rules such as the 20-20-20 rule) appeared to mitigate myopic shifts by relaxing accommodation periodically.

Outdoor activity was confirmed to exert a protective effect in young adults (aOR: 0.42). Bright sunlight stimulates retinal dopamine release, which inhibits scleral elongation. Although outdoor time is primarily studied in school-aged children, our findings suggest that ambient light exposure continues to modulate refractive stability into young adulthood. [18–20]

Limitations of this study include its cross-sectional design, which precludes establishing direct causality, and reliance on self-reported ergonomics alongside screen tracking logs. Long-term longitudinal studies using wearable ambient light and distance sensors are warranted to further clarify these relationships.

These findings highlight the importance of promoting visual ergonomics in educational and professional settings, including maintaining adequate viewing distances, limiting continuous screen time, and encouraging outdoor break periods to preserve visual health in young adults.

Conclusion

Increased digital screen exposure, short working distances, and uninterrupted viewing sessions are independently associated with greater myopia severity and longer axial length in young adults. Adopting visual ergonomic habits—such as maintaining distances greater than 30 cm, incorporating frequent visual breaks, and increasing outdoor activity—represents an accessible strategy to help mitigate myopia progression in young adult populations.

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