



MODERN ASPECTS OF EYE PHYSIOLOGY UNDER THE INFLUENCE OF DIGITAL TECHNOLOGIES

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Abstract

The rapid development of digital technologies has significantly increased the visual load on the human eye. Prolonged use of computers, smartphones, tablets, and other electronic devices contributes to visual fatigue, dry eye syndrome, decreased visual acuity, and disorders of accommodation. The purpose of this study was to investigate the physiological changes of the visual organ associated with prolonged exposure to digital devices. A total of 113 patients participated in the study. Clinical and functional methods of ophthalmological examination were used, including visual acuity assessment, Schirmer test, accommodation evaluation, and questionnaire analysis. The study revealed that prolonged screen exposure negatively affects the physiological functions of the eye, especially among students and office workers. The obtained results emphasize the importance of preventive measures and rational use of digital technologies.

Keywords

Eye physiology, digital technologies, visual fatigue, dry eye syndrome, accommodation disorder, computer vision syndrome, visual analyzer, ophthalmology, screen exposure, digital eye strain.

Introduction

In recent decades, digital technologies have become an integral part of everyday life. Computers, smartphones, tablets, and other electronic devices are actively used in education, medicine, business, and social communication. Despite the undeniable benefits of technological progress, prolonged use of digital devices has led to an increase in ophthalmological complaints among people of different age groups.

Continuous visual concentration on screens causes excessive strain on the accommodative apparatus of the eye and affects the physiological functioning of the visual analyzer. Reduced blinking frequency, exposure to blue light, and prolonged near work contribute to the development of dry eye syndrome, visual fatigue, headaches, blurred vision, and discomfort.

According to modern studies, digital eye strain has become one of the most common functional disorders among students, office employees, and medical workers. The issue is especially relevant due to the increasing duration of screen time in both professional and educational environments.

The physiology of the eye under digital load involves complex neurophysiological and biochemical processes. Functional disturbances may affect accommodation, convergence, tear production, retinal sensitivity, and visual adaptation mechanisms. Therefore, studying the impact of digital technologies on eye physiology is important for the development of preventive and therapeutic strategies.



Aim of the Study

The aim of this research was to evaluate the modern aspects of eye physiology under the influence of digital technologies and identify the most common functional changes in patients exposed to prolonged screen time.

Materials and Methods of Research

The study included 113 patients aged between 18 and 45 years who regularly used digital devices for educational or professional purposes. The research was conducted in an ophthalmological clinic during 2025–2026.

The participants were divided into three groups according to daily screen exposure duration:

- Group 1 — less than 4 hours per day;
- Group 2 — 4–8 hours per day;
- Group 3 — more than 8 hours per day.

Among the examined individuals, there were students, office employees, teachers, and healthcare workers. All participants provided informed consent before inclusion in the study.

Methods

The following ophthalmological and functional examination methods were used:

- Assessment of visual acuity;
- Biomicroscopy of the anterior segment of the eye;
- Measurement of intraocular pressure;
- Schirmer test for tear production evaluation;
- Accommodation function assessment;
- Evaluation of blink frequency;
- Questionnaire survey regarding visual complaints and duration of digital device use.

Statistical analysis was performed using standard biomedical statistical methods. Quantitative indicators were expressed as mean values with standard deviation.

Results of the Study

Results of the Study

The study demonstrated that prolonged exposure to digital technologies had a considerable negative effect on the physiological functions of the eye. Functional ophthalmological disturbances were detected in the majority of examined patients, especially among individuals using digital devices for more than 6–8 hours daily.

Out of 113 examined patients, 87 individuals (76.9%) reported symptoms associated with digital eye strain. The severity of complaints increased proportionally with the duration of screen exposure.

The most frequently reported symptoms included:

- Eye dryness — 71 patients (62.8%);
- Ocular fatigue and heaviness — 69 patients (61.1%);
- Headaches — 54 patients (47.8%);
- Burning sensation and irritation — 46 patients (40.7%);
- Temporary blurred vision — 49 patients (43.3%);
- Redness of the eyes — 37 patients (32.7%);
- Increased sensitivity to light — 28 patients (24.8%);
- Difficulty focusing on distant objects after prolonged near work — 38 patients (33.6%).

Clinical examination showed that patients from Group 3 (screen exposure more than 8 hours per day) demonstrated the most pronounced physiological changes. Accommodation



disorders were observed in 41 patients (36.2%), while mild convergence insufficiency was identified in 19 patients (16.8%).

The analysis of blinking activity revealed a significant decrease in spontaneous blinking frequency during intensive digital work. In normal physiological conditions, blinking frequency averaged 15–20 blinks per minute; however, during prolonged screen use, the average frequency decreased to 6–8 blinks per minute in many participants.

The Schirmer test results indicated reduced tear production in 58 patients (51.3%). Among them:

- Mild dry eye syndrome was diagnosed in 39 patients (34.5%);
- Moderate dry eye syndrome — in 14 patients (12.4%);
- Severe symptoms — in 5 patients (4.4%).

Visual acuity remained relatively stable in most participants; however, transient fluctuations in refraction and focusing ability after prolonged screen exposure were commonly observed. Patients frequently experienced temporary pseudomyopia and accommodative spasm after intensive near work.

Statistical analysis demonstrated a positive correlation between daily screen time and the severity of ophthalmological symptoms ($p < 0.05$). Participants using smartphones and computers simultaneously for occupational and recreational purposes showed higher rates of visual fatigue compared to individuals with limited digital exposure.

Additionally, poor workplace ergonomics, inadequate lighting conditions, short viewing distance, and absence of regular visual breaks significantly aggravated symptoms of digital eye strain.

The obtained findings confirm that prolonged use of digital technologies contributes to functional disturbances of the visual analyzer and negatively affects the physiological adaptive mechanisms of the eye.

Discussion

The obtained results confirm that digital technologies have a significant impact on eye physiology. Continuous screen exposure contributes to excessive tension of the accommodative system and disrupts the normal functioning of tear film production.

One of the important physiological mechanisms involved is the reduction of blinking frequency during concentration on digital screens. Under normal conditions, a person blinks approximately 15–20 times per minute; however, during intensive screen work, the frequency may decrease by up to 50%. This leads to instability of the tear film and development of dry eye symptoms.

Blue light emitted from digital screens may also influence retinal metabolism and visual adaptation processes. Although the exact long-term consequences remain under investigation, prolonged exposure is associated with increased visual discomfort and fatigue.

The prevalence of computer vision syndrome among young adults is continuously increasing due to modern educational and occupational demands. Preventive strategies such as regular visual breaks, ergonomic workplace organization, adequate lighting, artificial tears, and limitation of unnecessary screen time are essential for preserving visual health.

The findings of this study are consistent with contemporary international ophthalmological research emphasizing the growing importance of digital hygiene and preventive ophthalmology.

Conclusion

Conclusion

The present study demonstrated that prolonged exposure to digital technologies has a substantial impact on the physiological condition of the visual system. Continuous use of



computers, smartphones, tablets, and other electronic devices contributes to the development of functional ophthalmological disturbances and negatively affects the adaptive mechanisms of the eye.

The analysis of 113 patients revealed that the most common manifestations associated with prolonged screen exposure included visual fatigue, dry eye syndrome, accommodative dysfunction, decreased blinking frequency, headaches, and temporary blurred vision. The severity of symptoms increased significantly in individuals spending more than 8 hours daily using digital devices.

The findings indicate that digital eye strain has become an important medical and social problem in modern society, particularly among students, office employees, healthcare workers, and individuals involved in prolonged intellectual work. Reduced tear film stability, excessive accommodative tension, and impaired visual adaptation were identified as major physiological mechanisms underlying these disorders.

The study also confirmed that inadequate workplace ergonomics, insufficient lighting, improper screen positioning, and lack of regular visual rest contribute to the progression of visual discomfort and functional impairment.

Preventive measures play a crucial role in maintaining visual health in the era of digital technologies. Rational use of electronic devices, periodic visual breaks, optimization of workplace conditions, adequate hydration of the ocular surface, and regular ophthalmological examinations may significantly reduce the risk of developing chronic visual disorders.

In conclusion, the increasing prevalence of digital technologies requires greater attention to the preservation of eye physiology and visual function. Further clinical and experimental studies are necessary to better understand the long-term effects of digital exposure on retinal physiology, neurovisual adaptation, and overall ophthalmological health.

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