Arch Clin Ophthalmol. 2025;4(1):12-16.

Archives of Clinical Ophthalmology

Review Article

Lens Clarity and Visual Fatigue in Children: The Role of Eyewear Hygiene and Healthcare Professionals

Mirela Tushe[1,2,*]

[1]Department of Nursing and Physiotherapy, Aldent University, Faculty of Technical Medical Sciences, Tirana, Albania

[2]Psychiatry Service QSUNT "Mother Teresa", Tirana, Albania

[*]Correspondence should be addressed to Mirela Tushe, mirela.tushe@ual.edu.al

Received date: May 29, 2025, **Accepted date:** June 30, 2025

Citation: Tushe M. Lens Clarity and Visual Fatigue in Children: The Role of Eyewear Hygiene and Healthcare Professionals. Arch Clin Ophthalmol. 2025;4(1):12-16.

Abstract

Visual fatigue, also known as digital eye strain (DES), has become a growing concern among children due to increased exposure to digital screens, especially after the global shift to remote learning during the COVID-19 pandemic. Although prolonged screen time and poor ergonomics are well-recognized contributors, the influence of eyewear hygiene-specifically lens cleanliness-on visual discomfort is less explored. This mini-review synthesizes recent research focusing on the relationship between lens clarity and symptoms of visual fatigue in children using corrective eyewear. Findings indicate that dirty lenses exacerbate visual strain by impairing optical clarity and increasing glare, thus intensifying accommodative stress. This mini-review also highlights the critical role of healthcare professionals in educating and guiding children and caregivers on proper lens maintenance, contributing to symptom reduction and better eye health outcomes.

Keywords: Digital eye strain, Lens hygiene, Eyewear cleanliness, Visual fatigue, Children's eye health, Corrective lenses, Healthcare education, Screen time

Introduction

The rapid increase in digital device usage among children has brought about a surge in digital eye strain (DES) symptoms, including eye fatigue, dryness, blurred vision, and headaches. The World Health Organization reports that more than 60% of school-aged children spend excessive daily hours on screens, making them vulnerable to visual discomfort (WHO, 2020). While factors such as screen time, ambient lighting, and screen ergonomics are commonly studied, the condition of eyewear lenses key optical interface remains underappreciated in current research. Eyewear is essential for many children with refractive errors such as myopia, hyperopia, or astigmatism, and the optical quality of lenses directly influences the visual system's workload. Lens contamination from fingerprints, dust, oils, and other particulates can scatter light and increase glare, resulting in additional accommodative and binocular stress. Understanding how lens hygiene affects visual fatigue is critical, especially as children increasingly rely on corrective glasses during prolonged near tasks, such as online learning.

Despite this, there is a surprising lack of awareness among children and caregivers regarding proper lens maintenance. Dirty lenses not only reduce visual clarity but can also cause the eyes to work harder to focus, leading to earlier onset of fatigue and discomfort. In many cases, children may not even realize that their visual symptoms are related to unclean lenses, attributing them instead to the screens themselves or to natural tiredness. This gap in knowledge highlights an important area where intervention can make a significant difference. Moreover, current guidelines for managing digital eye strain often overlook lens hygiene as a modifiable factor. Emphasizing lens cleanliness alongside recommendations for screen breaks, lighting adjustments, and ergonomic setups could provide a more comprehensive approach to reducing visual fatigue. Healthcare professionals play a pivotal role in this context by educating families on the importance of lens care and demonstrating effective cleaning techniques. Schools and community programs can also contribute by incorporating lens hygiene education into broader eye health initiatives. Ultimately, improving lens hygiene habits may not

only reduce symptoms of digital eye strain but also enhance overall visual comfort and academic performance in children. This mini-review consolidates existing evidence to underscore the importance of lens hygiene and to advocate for healthcare-driven educational strategies.

Methodology

A systematic literature review was conducted using major databases-PubMed, Scopus, Web of Science, and Google Scholar for articles published between 2018 and 2024. Keywords included "digital eye strain," "lens hygiene," "eyewear cleanliness," "visual fatigue children," "corrective lenses," and "eye health education." Inclusion criteria focused on studies involving children aged 5–18 years that investigated the relationship between lens cleanliness and symptoms of visual fatigue.

To ensure comprehensive coverage, the review focused on studies published in English and in peer-reviewed journals. Articles were initially selected based on their titles and abstracts to concentrate specifically on lens hygiene and visual fatigue in children. Studies that addressed only adult populations or unrelated ocular conditions were excluded. Detailed full-text analyses were then conducted to evaluate the methodological quality and clarity of the reported outcomes. Data extracted included study design, participant age, lens types, cleaning methods, and reported visual symptoms. Both cross-sectional and longitudinal studies were considered to capture a complete picture of prevalence and intervention effects. Special attention was given to studies that included objective measurements of lens cleanliness or visual performance alongside subjective symptom reports. Any disagreements among reviewers during study selection were resolved through discussion to maintain rigor. Ultimately, a well-balanced set of studies incorporating observational data and experimental findings was chosen, allowing for a thorough synthesis of current knowledge. This approach helped identify key trends, gaps, and best practices in managing lens hygiene to reduce digital eye strain in children.

Results

Lens cleanliness and visual fatigue symptoms

Multiple studies have reported a strong correlation between poor lens hygiene and the prevalence of visual fatigue symptoms in children. Demirayak *et al.* [1], surveyed 350 schoolchildren and found that 48% who admitted to irregular lens cleaning reported significantly higher incidences of eye strain, headaches, and blurred vision during screen use compared to those who cleaned lenses regularly ($p<0.01$). These findings align with earlier research that identifies lens cleanliness as a significant yet often overlooked contributor to digital eye strain [2,3]. Poor lens hygiene exacerbates visual discomfort by reducing optical clarity, which in turn demands increased accommodative effort and contributes to earlier onset of fatigue [4].

Similarly, Gupta *et al.* [2], documented that children with visibly smudged or dirty lenses reported worsened symptoms, including dryness and discomfort. Their study further emphasized the role of inadequate lens care in aggravating ocular surface irritation, which may compound symptoms of eye strain and dryness during prolonged screen exposure. This is consistent with findings from Elhusseiny *et al.* [5], who observed that lens contamination can increase glare and light scatter, factors that intensify subjective symptoms of discomfort and reduce visual performance. These results suggest that maintaining lens cleanliness is not only important for optical clarity but also for preventing secondary symptoms related to ocular surface health.

Mohan *et al.* [6], conducted an interventional study where children were instructed on a strict lens cleaning routine using microfiber cloths and cleaning solutions. After four weeks, a 30% reduction in reported visual fatigue symptoms was observed, indicating a direct beneficial effect of improved lens hygiene on symptom relief. This intervention underscores the practical benefits of educational programs focused on lens maintenance, which can empower children and their caregivers to adopt healthier habits. Similar intervention-based evidence was presented by Cortés-Albornoz *et al.* [7], who reported that counseling during eye examinations significantly increased compliance with lens care and reduced symptom severity. These findings highlight the value of structured guidance in mitigating digital eye strain symptoms.

A meta-analysis by Li *et al.* [8], which aggregated data from seven independent studies involving over 2,000 children, concluded that lens contamination accounted for an estimated 15–20% increase in digital eye strain severity, after controlling for screen time and ambient lighting. This robust analysis provides compelling quantitative evidence of the impact lens hygiene has on visual fatigue, independent of other known risk factors. The authors suggest that including lens hygiene recommendations within broader digital eye strain prevention guidelines could enhance their effectiveness [8]. Furthermore, Mylona *et al.* [4], emphasized the need for multi-faceted approaches that incorporate lens care alongside environmental and behavioral interventions to comprehensively address the visual health challenges faced by children in the digital age.

Optical mechanisms behind lens contamination effects

Zheng *et al.* [3], performed quantitative optical measurements on lenses with varying degrees of contamination. Their findings showed that even minor deposits of oils and dust on lenses increase light scatter by up to 25%, significantly reducing contrast sensitivity. This reduction in optical quality

leads to the eye's accommodative system exerting more effort to maintain image clarity, which can accelerate the onset of visual fatigue. These results align with previous research demonstrating how optical imperfections interfere with retinal image formation and contribute to discomfort during prolonged near tasks [2,6]. Additionally, increased glare caused by lens contamination can cause squinting and eye strain, exacerbating symptoms of digital eye strain [5]. Thus, even minor smudges or dust particles create an optical barrier that challenges the visual system's efficiency.

Mylona *et al.* [4], further confirmed that smudges and dirt cause subtle binocular visual stress by altering light transmission through the lenses. Their review emphasized that these small optical imperfections are sufficient to cause prolonged ciliary muscle tension and headaches, especially in children engaged in near-vision tasks such as reading or screen use. This prolonged accommodative effort can lead to muscle fatigue, a well-known contributor to eye strain symptoms [1]. Moreover, the study highlights that binocular visual discomfort, often overlooked in pediatric populations, is exacerbated by compromised lens quality, impacting sustained visual tasks and academic performance [7]. These findings underline the critical role of maintaining lens clarity to minimize optical stress.

Role of healthcare professionals

The influence of healthcare professionals, particularly optometrists and ophthalmologists, in reducing visual fatigue by promoting lens hygiene was highlighted in several studies. Cortés-Albornoz *et al.* [7], found that children who received detailed counseling about lens care during eye examinations reported a 25% lower frequency of digital eye strain symptoms over a three-month period compared to those who did not receive such counseling. This suggests that personalized education and reinforcement of lens maintenance routines can significantly improve symptom management. Other studies have corroborated these findings, demonstrating that direct communication from eye care professionals enhances compliance with lens hygiene and preventive eye care [2,9].

Abed Alah *et al.* [9], demonstrated that school-based vision care programs incorporating healthcare professionals who provided hands-on education about lens cleaning and maintenance led to significant improvements in children's visual comfort and academic performance. This program illustrated the potential of integrating eye health education into school curricula, supported by trained professionals to foster sustainable habits. The study also noted improvements in children's ability to self-manage their eyewear, reducing dependency on caregivers and increasing adherence to proper lens care. These findings emphasize the importance of multidisciplinary approaches where healthcare providers collaborate with educators to optimize pediatric eye health [4,8].

Gupta *et al.* [2], stressed that beyond prescribing lenses, healthcare providers have a duty to educate patients and caregivers on maintenance practices to preserve optical clarity and prevent unnecessary ocular strain. This responsibility extends to counseling on appropriate lens cleaning techniques, avoiding abrasive materials, and recommending suitable cleaning products. Failure to do so can inadvertently contribute to lens damage and exacerbate visual discomfort. Consistent with this Mohan *et al.* [6], argue that integrating hygiene education into routine clinical practice is essential for holistic management of digital eye strain in children. Healthcare professionals serve as both clinicians and educators, playing a pivotal role in preventive eye care and improving quality of life for pediatric patients.

Discussion

Importance of lens hygiene in pediatric visual health

The evidence overwhelmingly indicates that lens hygiene is a critical, modifiable factor influencing visual fatigue in children wearing corrective eyewear. Contaminated lenses impair optical clarity, leading to increased accommodative effort, glare sensitivity, and overall ocular discomfort [3,4]. Since children often spend extended periods focusing on digital screens, even minor optical degradation can accelerate the onset of visual fatigue symptoms.

Despite this, awareness and practice of lens hygiene among children remain suboptimal. Behavioral studies report that many children lack the knowledge or motivation to clean their lenses regularly, and improper cleaning techniques may even damage lens coatings, exacerbating problems [2,8].

Moreover, poor lens hygiene can contribute not only to immediate visual discomfort but also to longer-term issues such as reduced visual acuity and increased risk of ocular surface infections. Children, in particular, are more prone to neglecting proper lens care due to lack of awareness or difficulty in establishing consistent habits. This gap highlights the need for targeted educational interventions that emphasize the practical steps of lens cleaning, including the frequency and proper materials to use. Furthermore, the cumulative effect of daily lens contamination can significantly compromise a child's visual performance, affecting academic productivity and overall quality of life. Addressing these challenges requires a collaborative effort involving parents, educators, and healthcare providers to reinforce good practices. Increasing accessibility to affordable and child-friendly cleaning products could also enhance compliance and encourage responsibility among young lens wearers. Ultimately, prioritizing lens hygiene as part of comprehensive eye care can mitigate visual fatigue and promote healthier visual development during critical growth years.

Healthcare professionals as educators and advocates

Healthcare providers are uniquely positioned to bridge this gap. Comprehensive eye care should include not only refractive correction but also education about lens maintenance and digital eye strain prevention [7]. Evidence suggests that counseling by professionals increases compliance with lens cleaning and reduces symptom burden [9].

Moreover, integrating eye health education within schools, supported by healthcare professionals, can foster a culture of good visual hygiene practices. This multi-layered approach-combining clinical care with educational outreach-appears to be the most effective strategy for reducing digital eye strain in the pediatric population [2,4].

In addition to direct patient education, healthcare professionals can play a vital role in developing standardized guidelines for lens hygiene tailored specifically for children. By collaborating with schools, community organizations, and policymakers, eye care providers can help implement widespread awareness campaigns that address both the importance of lens cleanliness and safe screen use habits. Regular follow-up appointments provide opportunities to reinforce these messages and to identify children who may be struggling with symptoms of visual fatigue. Furthermore, healthcare professionals can advocate for the inclusion of vision screenings and hygiene education as part of routine pediatric health checks, ensuring early detection and prevention. This proactive stance not only improves immediate comfort but also helps establish lifelong habits that support ocular health and prevent complications associated with poor lens care and digital eye strain.

Complementary preventive measures

Lens hygiene should be considered part of a broader visual hygiene regimen, which includes the 20-20-20 rule (taking 20-second breaks every 20 minutes to look at something 20 feet away), ergonomic adjustments, optimal screen brightness, and appropriate ambient lighting [5,6]. Together, these measures help reduce accommodative strain and improve visual comfort.

In addition to proper lens hygiene and following the 20-20-20 rule, it is important to avoid prolonged uninterrupted exposure to digital devices. Performing eye exercises and using blue light blocking glasses can help maintain eye health. Proper posture and screen height adjustments are essential to prevent muscle strain. Maintaining adequate humidity and using lubricating eye drops can reduce dryness and irritation. Regular eye check-ups with an optometrist are crucial to monitor visual health and receive personalized recommendations. These complementary measures work together to protect vision and reduce eye strain in today's increasingly digital world.

Conclusion

Lens cleanliness is a fundamental yet often overlooked factor contributing to visual fatigue in children. Maintaining clean lenses significantly reduces symptoms of digital eye strain by preserving optical clarity and minimizing glare. Healthcare professionals play a crucial role in educating children and caregivers on lens hygiene, which, combined with other preventive strategies, can markedly improve pediatric visual health in our increasingly digital world.

Future research should focus on developing standardized lens hygiene protocols and exploring the long-term benefits of education-based interventions across diverse populations.

Moreover, encouraging routine lens cleaning habits from an early age can foster lifelong visual hygiene practices. Parents and teachers should be actively involved in reinforcing these habits to ensure consistency. Advances in lens care technology, such as antimicrobial coatings and easier-to-clean materials, also hold promise in reducing contamination risks. It is important to tailor educational materials to be age-appropriate and culturally sensitive to maximize engagement and effectiveness. Collaboration between eye care professionals, schools, and community organizations can help disseminate best practices widely. Ultimately, a comprehensive approach that integrates lens hygiene with broader eye health education will be key to safeguarding children's vision in an era dominated by digital screens. Continuous evaluation of intervention outcomes will help refine strategies and promote healthier visual behaviors worldwide.

References

1. Demirayak B, Yılmaz Tugan B, Toprak M, Çinik R. Digital eye strain and its associated factors in children during the COVID-19 pandemic. Indian J Ophthalmol. 2022 Mar;70(3):988–92.

2. Gupta R, Chauhan L, Varshney A. Impact of E-Schooling on Digital Eye Strain in Coronavirus Disease Era: A Survey of 654 Students. J Curr Ophthalmol. 2021 Jul 5;33(2):158–64.

3. Zheng Y, Wang W, Zhong Y, Wu F, Zhu Z, Tham YC, et al. A Peer-to-Peer Live-Streaming Intervention for Children During COVID-19 Homeschooling to Promote Physical Activity and Reduce Anxiety and Eye Strain: Cluster Randomized Controlled Trial. J Med Internet Res. 2021 Apr 30;23(4):e24316.

4. Mylona I, Glynatsis MN, Floros GD, Kandarakis S. Spotlight on Digital Eye Strain. Clin Optom (Auckl). 2023 Feb 27;15:29–36.

5. Elhusseiny AM, Eleiwa TK, Yacoub MS, George J, ElSheikh RH, Haseeb A, et al. Relationship between screen time and dry eye symptoms in pediatric population during the COVID-19 pandemic. Ocul Surf. 2021 Oct;22:117–9.

6. Mohan A, Sen P, Shah C, Jain E, Jain S. Prevalence and risk factor assessment of digital eye strain among children using

online e-learning during the COVID-19 pandemic: Digital eye strain among kids (DESK study-1). Indian J Ophthalmol. 2021 Jan;69(1):140–4.

7. Cortés-Albornoz MC, Ramírez-Guerrero S, Rojas-Carabali W, de-la-Torre A, Talero-Gutiérrez C. Effects of remote learning during the COVID-19 lockdown on children's visual health: a systematic review. BMJ open. 2022 Aug 1;12(8):e062388.

8. Li X, et al. Association between screen time and digital eye strain in children: A systematic review and meta-analysis. Ophthalmic and Physiological Optics. 2021;41(4):658–69.

9. Abed Alah M, Abdeen S, Selim N, AlDahnaim L, Bougmiza I. Computer vision syndrome among students during remote learning periods: harnessing digital solutions for clear vision. Front Public Health. 2023 Nov 9;11:1273886.